A dog's day with humans – time activity budget of free-ranging dogs in India

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Free-ranging dogs, *Canis lupus familiaris*, are an integral part of the human environment in India and many other countries. They can serve as the perfect model system for understanding the process of development of the human–dog relationship that led to the domestication of the wilder ancestors of the dogs and created 'man's best friend'. Yet, very little is known about the ecoethology of these animals and all our understanding of dog behaviour is based on studies of pets reared by humans. The free-ranging dogs lead a scavenging life, depending on human excesses for their survival, and rarely hunt. They are often considered as a menace by many people, as dirty animals that bark, bite and spread rabies. These notions are often founded on personal biases and little scientific data exist to either support or refute such claims. As part of an extended study on the behavioural ecology of free-ranging dogs in India, we carried out random sampling of dog behaviour through censuses in two cities and one township of India. We used our data from 1941 sightings to draw up a time activity budget of dogs during the part of the day when they share the streets with humans. Our analysis reveals that dogs are generally lazy and friendly animals, and their rare interactions with humans are typically submissive. Thus dogs do not usually pose a threat to human well-being, and proper management of our refuse and a tolerant, if not friendly attitude towards dogs can ensure their peaceful co-existence with us.

Keywords: Census, free-ranging dogs, time activity budget, scavengers.

THE dog, *Canis lupus familiaris*, is known as man's best friend, and yet, scientific knowledge on the ecoethology of dogs in their natural habitat is almost non-existent. A reason for this is probably that the presence of unattended dogs on the streets is forbidden by law in most westernized countries, and so, even if such dogs are present, their activities are interfered by humans, and stable social groups are not formed[1]. Due to their long history of domestication dogs have adapted excellently to living with humans in their homes, isolated from conspecifics. How-ever, dogs have descended from wolves (*Canis lupus lupus*), and like many other canids, they too are capable of forming stable social groups that are influenced by the same factors that affect social organization of wild canid systems[1–5]. Dogs that do not have owners and whose movements are not limited by human beings are typically called free-ranging dogs. These dogs can be interesting model systems for studying the effects of domestication on their behaviour, as well as for understanding the evolution of the dog–human relationship in nature.

Free-ranging dogs are a ubiquitous part of the urban ecology in many developing and under developed countries like Mexico[6,7], Ecuador[8], Zambia[9], Zimbabwe[10], Italy[11], India[12], Nepal and Japan[13]. Though dogs in India have lived outside of human homes for centuries[14], and have also been used for hunting, they have not undergone the usual domestication process to become exclusively pets as in most developed countries. Dog figurines and remains have been unearthed in the Indus Valley Civilization[15] and references to dogs can be found in ancient Indian texts like the *Rg Veda*, the *Puranas*, the *Mahabharata*, the *Ramayana* and the *Manu Samhita* and in many folk tales from across the country. The *Agni Purana* classifies the dog as a village animal, and though dogs have been considered as outcastes and have been associated with death and evil in the Hindu culture, the householder's daily duty included feeding the dogs and outcastes[16]. The European influence has introduced pedigreed dogs to the homes of the middle class and elite society, but the Indian Native dog (IN dog) or Indian pariah dog has continued to live on the streets, depending on garbage and begged food for sustenance[17].

The free-ranging dogs in India have a wide distribution ranging from cities to forest fringes[3,17,18]. Typically they have mongrel characteristics, with pointed ears, very short fur, wolf-like pointed faces and patch baldness in their coats. They live in small groups or singly on streets and depend on garbage and human generosity for their sustenance[17]. Competition for food is high and fights are common at garbage dumps, near roadside food stalls, or when humans occasionally offer food to the dogs. Such fights are sometimes a source of irritation for people, and this makes dogs unpopular among many humans. They breed twice a year, once in autumn and once in spring, but a given female usually produces one litter per year (qualitative observations). Mortality in early life is quite high, with less than 50% of the pups surviving beyond the juvenile stage (Paul *et al.*, in preparation). Though humans are generally tolerant of dogs, dog–human conflict is not uncommon, and a part of the human population in India is regularly affected by dog bites.

Rabies is a serious problem in India, with an estimated 2 in 100,000 people being affected every year[19]. Since 1985, 25,000–30,000 deaths have been reported due to rabies in the country[20]. In a multi-centric study based in six anti-rabies clinics, Ichhpujani *et al.*[21] reported 1248

fresh dog bites over a period of 18 months. The aggressiveness of dogs and their propensity to attack and bite is often put forth as a justification for culling the dog population in cities. Though most reported animal bites are by dogs (91.5%), only about 60% of these is by free-ranging/stray dogs, while the remaining 40% is by pets[22]. Thus there is indeed some amount of dog–human conflict on the streets, but these studies only report the human perspective of such conflict. No studies exist on either the conflict or cooperation that dogs receive from humans. Efficient management of a population requires an understanding of the behaviour and ecology of the species, and in order to mitigate dog–human conflict in our environment, scientific understanding of the behaviour of free-ranging dogs is necessary. As dog–human interactions are maximal during the daylight hours, and so are the incidences of dog-bite[23,24], we conducted a survey of free-ranging dogs to draw up their time activity budget during the human activity hours on the streets of India.

We sampled dogs in three different locations – the IISER-Kolkata campus at Mohanpur (22°94′N, 88°53′E), West Bengal; the Indian Institute of Science campus at Bangalore (12°98′N, 77°58′E), Karnataka, and the township of Kalyani (22°58′N, 88°28′E), West Bengal. The three locations were regarded as 'urban' considering the definition of urban and rural India according to the Census of India 2001 (ref. 25) and the National Sample Survey Organization[26].

Sampling was carried out in the morning (0630–1030 h), afternoon (1400–1630 h) and evening (1630–1930 h), when both humans and dogs are typically seen on the streets. We avoided the time between 1030 and 1400 h, as the dogs usually rest in shelters at this time, avoiding the heat, and hence are difficult to find on the streets (qualitative observations). Though we sampled along streets which were mostly lit in the evening, the dogs were often sighted at spots off the streets, where the lighting conditions did not allow for accurate observations. Hence we avoided sampling beyond 1930 h.

The observer randomly picked a road in the predefined area and started walking along the same, covering all bylanes along the road. Whenever a dog was sighted, its sex (determined by looking at the genitalia), age class (adult or juvenile, determined by the structure of the genitalia), and behaviour at the time of sighting were noted. For each dog, only the behaviour seen at the instance of sighting was recorded. For example, if a dog was observed to be scratching itself and then sniffing grass, scratching was recorded as the observed behaviour. Thus we obtained data equivalent to instantaneous scan sampling of the population. For each pre-defined area, a sampling bout lasted for 2–3 h, and all roads in the area were covered on foot. The data were collected between August 2008 and August 2011, in five phases – one sampling event each in Kalyani and IISc, and three sampling events on the IISER-Kolkata Campus. Thus we obtained a random sample spread over different seasons and areas, such that it would be representative of the population.

The data were sorted according to behaviours, and then the behaviours were sorted into various categories like inactive, maintenance, vocalizations, interactions, individual behaviours and others. We kept vocalizations as a separate category and did not put these under interactions because for every vocalization recorded, we did not know the context in which it was produced. While vocalizations are typically used for interactions, we did not always know who these were directed at, or why. In addition, not every vocalization needs to be an interaction. Interactions could be with dogs, humans or other animals like cows and cats. Dogs were seen to be walking both solitarily as well as with other dogs. However, if we did not see any direct physical interactions, we considered walking to be an individual activity, as our sampling methodology did not allow us to discern if the dog happened to be present with other dogs by chance.

The various behaviours that were recorded and categorized under these headings are provided in Table 1. The data thus sorted were subjected to statistical analysis using STATISTICA 7.0 and StatistiXL 1.8.

A total of 1941 free-ranging dog sightings were recorded and used in this analysis. For 1308 dogs we could record the age class and sex, whereas for the rest data were not available, though the behaviour was recorded. We used the entire data to draw up the time activity budget of the free-ranging dogs, and the subset of 1308 dogs for more detailed analysis.

We compared the five sampling events over the three locations for all the five behavioural categories (inactive, active, vocalizations, maintenance and interactions) to check if there were significant variations between samplings and locations. There was no significant difference between the five samples (ANOVA: $F_{4,20} = 1.134$, $P = 0.369$), and hence we could conclude that the overall behavioural profiles of the dogs in all our samples were similar. Thus for all further analysis we pooled the data from all the five samples under these behavioural categories.

The dogs were found in a state of rest or inactivity in 52.7% of the sightings, which was significantly higher than the cases in which they were found in various states of activity (Figure 1 a; χ^2 test: $\chi^2 = 5.46$, df = 1, $P < 0.019$). When the dogs were active, they were sighted most often as walking, either individually or with other dogs. The dogs spent 15.66% of their time walking, which contributed to 47.7% of the individual activities. Individual activities were divided into the three subcategories of walking, maintenance and other activities, and the dogs did not show these various behaviours in equal proportions (χ^2 test: $\chi^2 = 60.49$, df = 2, $P < 0.0001$). The amount of time spent walking was significantly higher than that spent in maintenance activities (24.8%) (Figure 1 b; χ^2 test: $\chi^2 = 23.66$, df = 1,

Table 1. Details of categorization of behaviours used for analyses with the various behaviours included in each category

| Behavioural category	Behavioural subcategory	Behaviours included
Inactive		Sleep, laze, sit
Maintenance		Groom, scratch, defecate, urinate, drink, eat, eat grass, chew object, food search, forage, sniff garbage, beg, follow, receive food
Vocalizations		Bark, growl, howl, angry bark
Dog–dog interactions	Aggressive	Attack, chase, fight, submit, bite
	Affiliative	Mock bite, play, allogroom, sniff dog
	Indirect	Mark, angry bark
Dog–human interactions	Affiliative	Submit, beg, follow, wag tail, receive food
Individual behaviours		Stand, alert, watch, run, walk, jump, inspect object, sniff
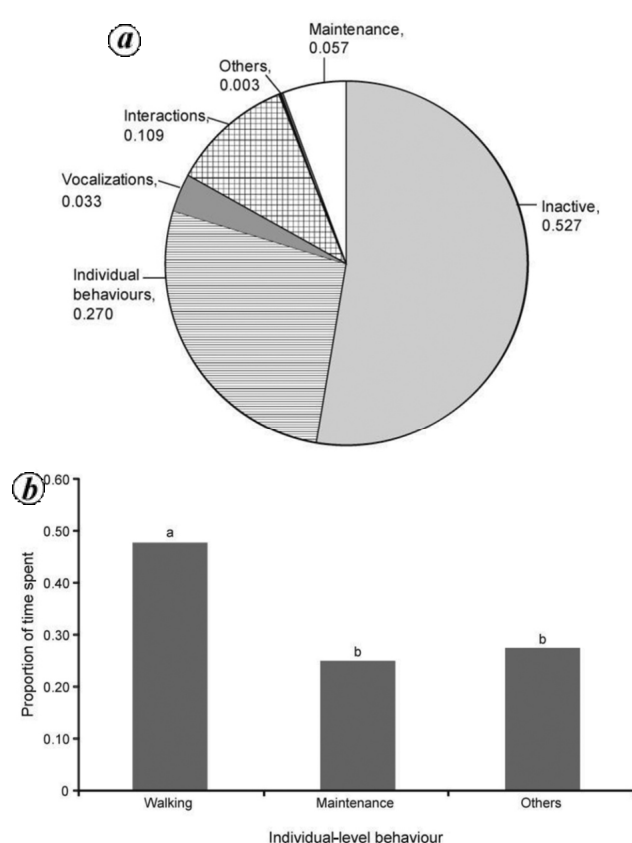
Figure 1. *a*, The time activity budget of dogs during the hours of human activity, between 0630 and 1930 h, calculated from 1941 dog sightings in three locations, over 5 different phases of observation spanning 3 years. *b*, The proportion of time of the total activity period spent in three different kinds of individual level activities. The free-ranging dogs spend most of their active time (47.7%) in walking. Different alphabets signify statistically significant differences between the values denoted by the bars.

$P < 0.0001$), as well as the time spent in other activities like standing, watching, sniffing, etc. considered together (Figure 1 *b*; χ^2 test: $\chi^2 = 18.01$, d$f = 1$, $P < 0.0001$). Thus it can be concluded that walking was the most common individual activity displayed by the dogs. There was no significant difference between the proportion of time spent in maintenance behaviours like grooming, scratching, foraging, etc. and the pooled behaviours in the 'others' category (Figure 1 *b*; χ^2 test: $\chi^2 = 0.39$, d$f = 1$, $P = 0.535$).

We pooled all kinds of vocalizations like bark, growl, howl and angry bark under the category of vocalizations, which comprised only 3.3% of the activities of the dogs. Interestingly, all interactions recorded, including those with dogs and humans claimed only 10.9% of the total 23% of the active time of the dogs. Considering these two categories together, the dogs spent only about 14% of their total time in any kind of active interactions with each other or with humans, whether through actual physical interactions or through vocalizations. This was significantly lower than the total time spent in other behaviours when the dogs were not sitting idle or resting (χ^2 test: $\chi^2 = 144.9764$, d$f = 1$, $P < 0.0001$). Of the interactions recorded, 84.7% were with other dogs, which was significantly higher than the proportion of interactions seen with humans (χ^2 test: $\chi^2 = 101.505$, d$f = 1$, $P < 0.0001$), and only two cases of chasing a calf were recorded (Figure 2 *a*). Of the 32 interactions seen with humans (0.13% of all interactions), none was aggressive, and 16 were in fact submissive interactions like tail wagging, submitting and begging for food.

We categorized all instances of interactions between dogs into aggressive, affiliative or indirect interactions. Attack, chase, fight, submit and bite were listed under aggressive interactions; mock bite, play, allogroom and sniff dog were categorized as affiliative interactions; mark and angry bark (very loud bark with an alert body posture) were included in the category of indirect interactions. We also noted that dogs produce three other kinds of vocalizations – bark, growl and howl, which we did not use in the category of interactions as dogs can produce these sounds without having other dogs in the vicinity (for example, when they are in pain), and we had no records of the context in which the vocalizations had been recorded. The three kinds of interactions did not occur in equal frequencies (Figure 2 *b*; χ^2 test: $\chi^2 = 110.029$, d$f = 2$, $P < 0.0001$), with affiliative interactions comprising 65.21% of all interactions, which was significantly higher than the two other categories of interactions taken together (χ^2 test: $\chi^2 = 10.12$, d$f = 1$, $P = 0.001$).

For a subset of the data (1308 dogs), we had complete records of the sex and age classes. For the rest, either the
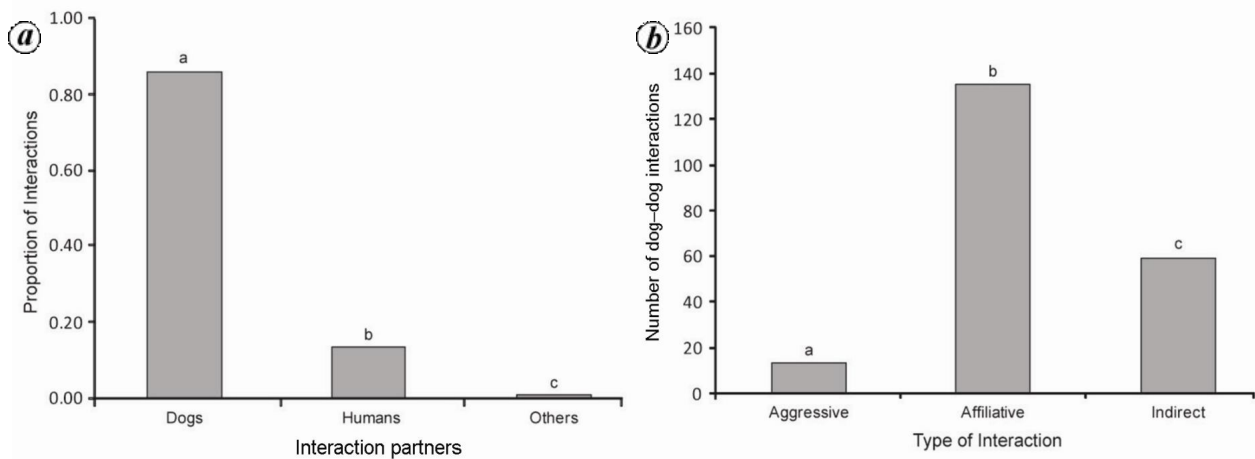
Figure 2. *a*, The distribution of interactions with dogs, humans and other animals, calculated out of the total number of interactions of any kind shown by the dogs in the 1941 sightings. Most interactions recorded were between dogs. *b*, The distribution of interactions between dogs into the categories of affiliative, aggressive and indirect. Most interactions recorded were affiliative in nature. Different alphabets denote statistically significant differences between the values denoted by the bars.

sex could not be recorded as the genitalia were not visible during the sampling, or the age class could not be accurately determined. There were a total of 711 females, of which 168 were juveniles and 597 males, of which 86 were juveniles. The behavioural profiles considering the proportion of all behaviours of the four kinds of dogs in the population, namely adult females, adult males, juvenile females and juvenile males did not vary from each other (Kruskal–Wallis test: $\chi^2 = 0.199$, d$f = 3$, $p = 0.978$). When the dogs were categorized according to either age or sex, we did not see any significant differences between the sexes (Mann–Whitney U test, $U = 850$, d$f = 41,41$, $P = 0.934$) or between the age classes (Mann–Whitney U test, $U = 892$, d$f = 41,41$, $P = 0.638$). We carried out similar analysis for each category of behaviours separately, and found significant differences of interaction patterns between the sexes and between the age classes. Males were more aggressive than females (Fisher's exact test, $P = 0.005$), and adults were more aggressive than juveniles (Fisher's exact test, $P = 0.001$).

The free-ranging dogs in India coexist with humans in every possible habitat, and yet, they are often considered as a menace by many people because of their scavenging habit, the territorial fights that often ensue between dog groups and because of occasional dog–human conflict that leads to people being attacked and bitten by dogs. Though there is no dearth of dog lovers in the country, dogs are faced by the challenge of interacting with perhaps a larger number of people who are intolerant of them, and consider them to be aggressive, unfriendly animals that should be removed from the streets[19]. This aversion towards dogs is a socio-cultural phenomenon that has very deep roots, going back to at least three thousand years[16]. Our sampling study in two urban habitats and one semi-urban habitat in India covered an area of approximately 768.5 acres and spanned over different

seasons. In five phases, we recorded 1941 dog sightings during the time of the day when humans are usually active, which included both adults and juveniles of both sexes, and was thus representative of the population at large.

Our analysis revealed that the dogs are inactive for over half of the day, either sleeping, lazing or just sitting. Considering the fact that we sampled only during the time when dogs could actually be seen on the streets, and were not hiding in shelters, this is actually an underestimate. If our sampling had spanned the entire day and included the time that dogs spend resting in their hideouts, the proportion of time spent inactive would have been higher. These results match the observations on free-ranging dogs in Berkeley, California, USA, in which repeated samplings were carried out in a 48 ha residential area for 7 months[27]. In this study, 1243 sightings were made on about 50 unique free-ranging dogs, which were found to be resting in 44.4% of the sightings. This study also reported that free-ranging dogs were most abundant in the early mornings and late afternoons, with the percentage of dogs found to be resting increasing with temperature, for an observed temperature range of 9°–29°C. Though we did not record the temperature during our sampling, the average temperature range during our observations was 8°–36°C, considering all the time periods and the three locations covered, with the mean temperature ranging from 18°C to 30°C (www.wunderground.com/history). Given that we did not sample very early in the morning and in the middle of the day, the actual temperature would have been higher than the minimum and lower than the maximum, and hence closer to the mean range.

When the dogs were not resting, they were most often seen to be walking. Since our sampling was based on random sightings, we did not have any method for recording the purpose of this walking. Dogs typically walk in search of food, and also for marking their territories.

Often they seem to be walking randomly, the purpose of which can be revealed only through detailed behavioural observations on focal individuals and groups. Interaction rates were found to be quite low, and all recorded instances of interaction with humans were submissive. Thus, this analysis does not support the general notion of free-ranging dogs being aggressive, unfriendly animals that are a constant source of nuisance to people on the streets of India.

Dogs bark and howl, often producing a chorus reminiscent of their wolvine ancestry, and this makes them score low with many humans. Many encounters between dogs are often interrupted by people who chase them away, often by throwing stones or dousing them with water. However, dogs were sighted producing some sound in only 65 cases, which was 3.34% of the total observations. Thus, the perception of dogs as noisy and aggressive creatures that present a threat to human well-being is quite ill-founded and biased. However, it is true that many dogs in the Indian streets are rabid, and dog bites do occur, though these are not regular incidents as perceived by some[28]. Dogs are efficient scavengers, and are responsible for removal of a large part of our garbage from the streets (Anandarup Bhadra, unpublished data). Though we need detailed observational data for a better understanding of the behavioural ecology of the free-ranging dogs, this preliminary study suggests that the general perception of these dogs as a nuisance is quite flawed. We would like to argue that the solution to dog–human conflict is not culling, but efficient management of garbage and rabies in the country, and a positive attitude towards the animals that are otherwise known to be man's best friend.

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