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RESEARCH NOTE

PRELIMINARY ASSESSMENT OF VIGILANCE AND PREDATOR AVOIDANCE BEHAVIOR OF ORANGUTANS IN GUNUNG PALUNG NATIONAL PARK, WEST KALIMANTAN, INDONESIA

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ABSTRACT

The response of different orangutan age-sex classes to perceived predator and conspecific threat was studied in a population of orangutans (*Pongo pygmaeus pygmaeus*) in Gunung Palung National Park, West Kalimantan, Indonesia. Data were collected on vigilance behavior, nest placement, travel distance, and travel height in the canopy. Adult males with fully developed cheek pads were significantly less vigilant, built nests that were lower in the canopy and closer to their last food source, and did not travel as far as did adult females, both those with and without offspring. Differences were also examined between habituated and unhabituated animals. Unhabituated animals traveled significantly greater distances, traveled higher in the canopy, built nests that were higher and farther away from their last food source, and engaged in more vigilant behavior than did unhabituated animals. These results are consistent with the interpretation that different classes of orangutans may vary their behavioral patterns in accordance with the degree of predator and conspecific threat experienced.

Keywords: Orangutan, *Pongo pygmaeus pygmaeus,* vigilance, predator, nest, conspecific threat

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INTRODUCTION

The predominantly solitary behavior of orangutans (*Pongo pygmaeus pygmaeus*) places them at one end of a continuum of social organization in primates (Rodman and Mitani, 1987). Most of their lives are spent without the protection from predators afforded to other primate species by group membership (van Schaik, 1983). This makes them an especially interesting species in which to study the behavioral patterns they engage in to avoid threat from predators, humans and other orangutans.

Observing predation and conspecific aggression in orangutans is difficult due to the rarity of these behavioral patterns. However, this rarity does not mean that these behavioral patterns do not occur or are not important. Perhaps the primary animal predator of orangutans is the clouded leopard (*Neofelis nebulosa*). Rijksen (1978) reports that in Ketambe, Northern Sumatera, six ex-captive orangutan juveniles, traveling alone, were killed by a clouded leopard at the feeding station. Clouded leopards normally select smaller prey, but such data indicate that young unprotected orangutans are also vulnerable to leopard attack. Additional predators may include the bearded pig, birds of prey, and, in Sumatera, the tiger. Galdikas (1995) relates an incident in which a four-year old orangutan, the wild-born son of an ex-captive, was apparently killed by a bearded pig, although this was not directly observed. The black eagle, *Ictinaetus malayens*, is known to prey on smaller monkey species and may be capable of preying on infant orangutans (MacKinnon, 1974). Although these possible cases of orangutan predation involved ex-captive animals, they suggest that the potential for predation in the wild does exist.

Orangutans may also be subject to several forms of conspecific threat. Infanticide has not been documented in wild orangutans, but Galdikas (1980) observed the death of two ex-captive infants and the attempted killing of a third at the hand of an adolescent ex-captive male. This may represent abnormal behavior on the part of ex-captive animals, or, alternatively, it may reflect a potential for committing infanticide not elicited under most circumstances. Conspecific threat may also be felt by females during forced copulations by males. Forced copulations are particularly common between females and sub-adult males, but also occur between females and adult males (Galdikas, 1985; Mitani, 1985). In addition, the serious threat males may pose to each other is attested to by the high occurrence of wounds, scars and broken digits seen on adult males (McKinnon, 1974; Knott, pers. obs.). In 1994, in Gunung Palung National Park, an adult male died from wounds inflicted during an apparent fight with another male (Knott, pers. obs.).

Finally, humans may pose the greatest threat to orangutans. Humans kill orangutans in order to obtain juveniles for the illegal pet trade, as food in some areas and in response to orangutan foraging in fruit gardens on the forest peripheries (Galdikas, 1995). The presence of large collections of orangutan teeth and bones, many charred, in caves in Sarawak (Northwest Borneo) demonstrates that hunting of these animals has occurred for at least 35,000 years (McKinnon, 1974). Furthermore, a preponderance of female canine teeth and milk teeth at these sites indicates a preference for killing females with young (McKinnon, 1974). The discovery of a bullet lodged in the rib of an orangutan skeleton recovered in Gunung Palung National Park (Knott, pers. obs.) attests to the real threat of humans to orangutans even in protected areas. The avoidance and threat behavioral patterns exhibited by orangutans when first contacted may be specific responses toward humans or they may reflect a more generalized threat response.

Primates commonly engage in a number of behavioral patterns to avoid predators as well as conspecifics. These include vigilant scanning, seeking safe nesting spots, avoidance through hiding or running away, and grouping. Many previous studies of orangutans have reported that unhabituated animals react to a perceived threat from human observers by displaying aggressively, vocalizing, throwing branches, hiding and traveling higher (e.g. Rijksen, 1978; Rodman, 1979; Galdikas, 1979). One aim of this study was to quantify how unhabituated animals react to threat from humans in order to interpret the occurrence of the same behavioral patterns in habituated animals who no longer perceive humans as a threat.

One of the few studies to address predator avoidance behavior in orangutans was conducted by Sugardjito (1983), who studied nest-building behavior of Sumateran orangutans in the Gunung Leuser National Park of Indonesia. He found that more vulnerable animals, defined as adolescents and mothers with offspring, nested at greater distances from the last food tree visited and also tended to nest at greater heights. In the current study, we compare his Sumateran orangutan nest-building results to those found in a population of Bornean orangutans.

Many investigators have noted a sex difference between adult males and females in their travel behavior. Males appear to use the ground and lowest strata of the canopy more often than do females (Rodman and Mitani, 1987). This difference has been suggested as due to greater travel difficulty of large adult males or, alternatively, that large males face less risk from predation than do females and smaller males (Rodman and Mitani, 1987). We thus investigated whether differences between age-sex classes in travel behavior may represent, at least in part, a response to threat.

Vigilance behavior is another common primate strategy used to detect potential threats. We were interested in studying the need for vigilance in the large, arboreal, semi-solitary orangutan. Do orangutans maintain a high degree of vigilance due to their solitary state or does their large size and arboreality afford them a relative degree of protection? The extent to which orangutans engage in vigilance has not yet been studied; we thus assessed vigilance in orangutans in general as well as compared rates of vigilance between the different age-sex classes.

METHODS

Study Site

The study was conducted at the Cabang Panti Research Site in the 90,000 hectare Gunung Palung National Park in West Kalimantan, at latitude 1° South on the island of Borneo. The 1500 ha Cabang Panti Research Site is deep within the reserve, occupying the major valley on the western slope of Mt. Palung. The park is an uninhabited primary rain forest. No ex-captive orangutans have been released into the park. Orangutan observations were conducted in peat swamp and freshwater swamp forests, in lowland mixed dipterocarp forest or alluvium, and on the lower slopes of Mt. Palung to an elevation of approximately 300 m. Data were collected between January and May of 1995.

Sample

The data consist of 33 half or full-day follows of animals representing four age-sex classes. These are comprised of 11 follows from 2 adult males, 6 follows from 2 adult females with offspring, 11 follows from 5 adult females without offspring and 5 follows from 5 sub-adult males. Adult males were defined as those having fully developed cheek pads. These animals were part of a larger, currently ongoing study of orangutan reproduction and behavior (Knott, unpublished). Focal animals were selected based on the objectives of sampling multiple individuals in each class and obtaining as many follows from each class as possible during the sample period.

Nest Building

The distance between the nest-site and the last visited food tree was estimated to the nearest meter by pacing. Nest height above the ground was also estimated to the nearest meter. Additionally, we measured the dbh (diameter at breast height) of the nest tree using a dbh meter tape.

Traveling and Aggressive Behavior

During each observation period an instantaneous sample (Altmann, 1974) was taken every five minutes of orangutan height in the canopy. All occurrences of aggressive or threatened behavioral patterns and vocalizations, either directed to human observers or other orangutans, were recorded. Aggressive and threatened behavioral patterns fell into the following categories: staring at the human observer, tree shaking, branch shaking, and branch throwing. Vocalizations included kiss-squeaking, grumphs and lork calls as defined by McKinnon (1974).

Vigilance

Vigilance was defined as either actively scanning or staring at a particular spot in the immediate or distant vicinity of the animal. All data on vigilance were collected by a single observer, eliminating the problem of inter-observer reliability. Passively "staring into space" was not counted as vigilance. Obvious bouts of scanning for food or travel path were also not counted as vigilance. The presence or absence of vigilance was recorded during continuous five minute intervals, timed with a countdown timer, throughout each orangutan follow. Intervals when the animal was not in clear view were excluded from the sample. When vigilance was observed, the length of each vigilant bout was recorded. A bout of vigilance was measured from the initiation of vigilance until the animal either switched its focus to another behavior or resumed passive "staring into space." This sampling method for vigilance proved feasible with orangutans due to the small percentage of time they spent engaging in vigilant behavior.

RESULTS AND DISCUSSION

Habituated vs. Unhabituated

We classified animals as habituated or unhabituated based on the number of aggressive/threatened behavioral patterns displayed in combination with alarm vocalizations. The median number of vocalizations for the 6 unhabituated animals was 116.5 times during each follow, whereas the 27 habituated animals had a median of 1.5 vocalizations per follow. These unhabituated animals had not been followed previously. Habituated animals had been followed periodically for a period of several months.

Mann-Whitney U tests were used to assess behavioral differences between habituated and unhabituated orangutans. Distance traveled and time spent being vigilant were divided by total observation time for each follow. Significant results ($p \leq 0.05$), presented in Table 1, indicate that in addition to aggressive displays and vocalizations, unhabituated orangutans reacted to a perceived threat from humans by traveling greater distances per unit time, traveling at greater heights in the canopy, building nests that are higher and farther away from the their last food source, and engaging in more vigilant behavior than did habituated animals. Unhabituated animals also tended to build their nests in larger trees and to have longer bouts of vigilance. However, these differences were not significant.

Table 1. Mean values of behavioral patterns exhibited by habituated and unhabituated orangutans (*Pongo pygmaeus pygmaeus*). Significance was tested using the Mann-Whitney U test and p values are presented. A p value ≤ 0.05 indicates a significant difference. Standard errors are presented in parentheses. Average travel height for each follow was calculated from the travel height values recorded every five minutes during the follow.

	Travel Distance/ Time (m/hr)	Travel Height (m)	Nest Height (m)	DBH of Nest Tree (cm)	Distance from Last Food Tree to Nest Tree (m)	Time Spent Vigilant/Obs. Time (sec/hr.)	Length of Vigilant Bouts (sec)
Habituated (n=27)	40.7 (5.95)	21.0 (0.64)	20.2 (1.2)	32.2 (3.78)	14.1 (3.02)	154.7 (20.92)	87.5 (4.97)
Unhabituated (n=6)	89.5 (18.43)	25.1 (1.50)	26.00 (1.98)	45.2 (9.99)	25.00 (2.57)	412.4 (128.89)	93.9 (26.58)
p value	.01	.01	.04	.18	.02	.04	.79

Table 2. Mean values of orangutan (*Pongo pygmaeus pygmaeus*)behavioral patterns exhibited by adult males, adult females with offspring and adult females without offspring. Significance values using the Kruskal Wallis test are presented as p values. A p value ≤ 0.05 indicates a significant difference. Standard errors are presented in parentheses. Average travel height for each follow was calculated from the travel height values recorded every five minutes during the follow.

	Travel Distance/ Time (m/hr)	Travel Height (m)	Nest Height (m)	DBH of Nest Tree (cm)	Distance from Last Food Tree to Nest Tree (m)	Time Spent Vigilant/Obs. Time (sec/hr.)	Length of Vigilant Bouts (sec)
Adult Males (n=11)	18.8 (4.26)	19.4 (1.28)	16.4 (1.57)	26.9 (4.41)	5.8 (2.71)	79.7 (16.67)	75.9 (8.29)
Adult Females without offspring (n=8)	56.3 (13.14)	22.0 (0.73)	23.5 (2.11)	42.1 (10.49)	19.8 (7.38)	236.4 (47.72)	106.9 (6.98)
Adult Females with offspring (n=6)	57.1 (10.74)	21.7 (2.38)	22.2 (6.18)	30.0 (3.73)	16.3 (4.24)	173.8 (13.72)	84.35 (6.10)
p value	.001	.36	.08	.26	.04	.005	.04

Table 3. Results of Mann-Whitney pair-wise test for significance between the age-sex classes of orangutans (*Pongo pygmaeus pygmaeus*). P values for each pair-wise comparison are presented. A p value ≤ 0.05 indicates a significant difference.

	Travel Distance/ Time (m/hr)	Distance from Last Food Tree to Nest Tree (m)	Time Spent Vigilant/Obs. Time (sec/hr.)	Length of Vigilant Bouts (sec)
Adult Males vs. Adult Females without Offspring	.002	.04	.006	.02
Adult Males vs. Adult Females with Offspring	.003	.04	.007	.92
Adult Females with offspring vs. Adult Females without	.80	.95	.70	.05

Age-Sex Classes

Differences between age-sex classes of orangutans were analyzed after removing unhabituated animals from the sample. This greatly reduced the observations of sub-adult males, so they were not included in the age-sex class analysis. The three remaining classes were compared using Kruskal-Wallis mean ranks tests. Results are presented in Table 2. Significant differences ($p \leq 0.05$) were found among the classes in distance traveled, distance between the nest and the last food tree, total time spent being vigilant, and average length of vigilant bouts. Mann-Whitney U tests were used to determine where significant differences lay between the different categories. As presented in Table 3, significant differences ($p \leq 0.05$) were found in all four categories tested between females without offspring and adult males and in three categories between adult females with offspring and adult males. Adult females without offspring traveled farther, made their nests in trees farther away from the their last food source, spent more time vigilant and had longer vigilant bouts than did adult males. Females with infants traveled farther, made their nests in trees farther away from their last food source, and spent more time being vigilant than did adult males. No significant differences were found between the two classes of females.

Conclusions

Several lines of evidence lead us to believe that some responses of unhabituated animals to humans may represent the normal behavior of orangutans when responding to threat. First, aggressive behavioral patterns and vocalizations directed to humans, such as branch shaking and throwing, are the same as those directed at other animals and conspecifics during periods of apparent threat (McKinnon, 1974; Rijksen, 1978; Galdikas, 1995; Knott, pers. obs.). These behavioral patterns have been observed directed toward other orangutans, pigs, hornbills, siamangs and binturongs (McKinnon, 1974; Rijksen, 1978; Galdikas, 1995). Second, the high frequency of behavioral patterns such as traveling high in the canopy, building nests away from the last food tree, and being vigilant that were exhibited by both the unhabituated animals and the most vulnerable age-sex classes among habituated animals, suggests a common underlying cause. Both groups of animals appear to feel more threatened. If it is assumed that habituated animals are no longer threatened by humans, the differences observed between habituated females compared to adult males may reflect different baseline levels of predator/conspecific threat avoidance behaviors for each class.

The smaller size of adult females, the occurrence of forced copulations, and the possible risk of infanticide may make them more vulnerable to con-specific or predator threat than adult males. Many researchers have found that males travel at a lower height than do females (Galdikas, 1988; Rodman and Mitani, 1987). Although this difference was not significant in this study, we did find that females traveled farther on average each day than did males. If these differences do reflect conspecific/predator threat avoidance, why would traveling higher in the canopy and farther each day provide greater protection?

This may be a strategy to avoid large males who tend to travel lower in the canopy and who may be limited by their body size from traveling as high as females (Rodman and

Mitani, 1987). However, adult males may travel lower in the canopy simply because they are less threatened and not because they have to (Rodman and Mitani, 1987). Additionally, traveling higher in the canopy would not seem to be an effective way to avoid sub-adult males who are close to females in body size. Females may travel greater distances during the day, spending less time feeding or resting in individual trees, as a way to avoid encountering threatening animals. Alternatively, even among habituated animals, females may still perceive a greater risk from humans than do adult males which may account for these observed differences in travel patterns. The hypothesis that more vulnerable orangutans travel at a greater height and greater distances as a way to avoid threatening conspecifics and predators needs to be evaluated through observations of their behavior during actual threatening incidences, but such observations are rare. Furthermore, travel differences between adult males and females may simply reflect different energetic constraints on females compared to males.

Given that adult males engage in mortal combat it may be wondered why females may perceive more of a threat from conspecifics than do adult males. The answer may lie in the overall different behavioral strategies of adult males and females. Whereas females actively avoid contact with conspecifics that pose a threat of forced copulations or a possible risk to offspring, fully-developed males readily seek out and respond to threats from other adult males. A female has little to gain from interaction with threatening conspecifics, while the reproductive success of adult males may be positively affected by successfully winning aggressive encounters with other adult males. Defeated males can die or be injured, and may possibly leave the area. One would thus expect sub-adult or injured males, who would be less likely to win encounters with other adult males, to take evasive action to avoid their more powerful competitors.

Similar to Sugardjito (1983) we found that adult males were more likely to build their nests closer to the last food tree than were females. We did not find a significant difference between the different age-sex classes in regard to the height of the nest in the canopy as did Sugardjito, but there was a strong tendency for males to build their nests lower in the canopy. It is difficult to interpret these results as a reflection of body size since lower nests do not appear to offer any greater support to large adult males, in fact the opposite would appear more likely to be true. Unhabituated animals, those perceiving the most threat from humans, were significantly more likely to build nests that were both higher and farther away from the last food tree. Clearly, the characteristics of higher nests that may be attractive safety features, such as the amount of cover and access to escape pathways, need to be examined.

Sugardjito (1983), suggested the placement of the nest in relation to the last food tree reflects the degree of predator threat felt by the orangutan. He argued that clouded leopards are nocturnal and may be more likely to search out prey in a concentrated food source such as a fruit tree than in a random tree in the forest (Sugardjito, 1983). However, very little is known about clouded leopard hunting behavior and it may be unlikely that they monitor fruiting trees as a hunting strategy. Alternatively, as suggested by Rijksen (1978), orangutans may build nests farther away from food trees in order to avoid threat from other orangutans who may also seek out the same food source. Sugardjito rejected conspecific threat as a contributing factor to nest tree placement, due to a tendency for orangutans to only use their nests between dawn and dusk. However, we have found that orangutans can make night nests as early as 14:00 and arise anywhere from dawn to as late as 11:00, with the time varying greatly depending on food availability, age-sex class, and individual habits (Knott, unpublished). Thus, early retiring or late rising orangutans who place their nests close to an appealing food source could encounter conspecifics visiting the same tree.

Interestingly, in this study adult females without offspring were significantly different from adult males in nest placement behavior but did not differ from adult females with offspring. Sugardjito, however, reports that adult males and females without offspring were both significantly different from adolescents and females with offspring in the placement of nests in relation to their last food source. This difference between the two studies may be due to the choice of samples. Sugardjito lumped adolescent males and females together, whereas we looked at sub-adult males separately and included potentially adolescent females with older females without offspring. (We were not able to determine the age of females without offspring, but they all appeared to be sexually mature.) The two studies do concur in the placement of the nest tree in relation to the last food tree, with adult males more often making nests close to their last food source. A limitation of both studies, as is commonly the case in research on orangutans, is the small number of individuals sampled. Thus, individual idiosyncrasies may also affect the data in this regard.

If nest placement in relation to the last food source reflects predator avoidance behavior, it is noteworthy that in Ketambe 20% of nests were placed within the last food tree (Sugardjito, 1983), whereas in the present study only 6% of nests were placed within the last food tree. Sugardjito (1983) found that orangutans were less likely to build their nests in the last visited food tree if it was a fruit tree than if it provided another type of food. Non-fruit bearing food sources such as trees providing bark, leaves, or insects may be less likely to be sought out by predators or other orangutans than would be fruit trees. In our study only 6.6% of the last visited food trees provided non-fruit sources such as bark or leaves. Although Sugardjito did not report the percentage of last visited food trees which were fruit bearing, the observed differences between Gunung Palung and Ketambe could be due to a higher incidence of non-fruit trees as the last visited food source in Ketambe. Alternative explanations such as differences between Ketambe and Gunung Palung in the species of trees used for nest building and the availability of appropriate nest trees, need to be examined.

The assessment of vigilance revealed a clear difference between habituated and unhabituated animals and between adult males and all classes of adult females. It is difficult to escape the conclusion that this represents a lower perception of threat on the part of habituated compared to unhabituated animals and adult males compared to adult females. What is perhaps most intriguing is the small amount of time orangutans spent being vigilant. As demonstrated in Table 2, overall habituated animals only spent an average of 1.6 minutes vigilant per observation hour. This suggests that despite their lack of group membership, their position as the largest arboreal mammal in the forest, in combination with specific behavioral patterns to avoid predation, gives orangutans a relatively high degree of safety, obviating the need for constant vigilance.

Our results regarding vigilance may help inform other hypotheses regarding orangutan and great ape behavioral ecology. Tutin (1995) suggests that differences in vigilance may be a contributing factor to differences in birth interval between gorillas and chimpanzees, with longer birth intervals in chimpanzees being associated with a lower level of group protection and a presumed higher degree of vigilance. By this reasoning, orangutan mothers, exhibiting the lowest degree of group association (Rodman and Mitani, 1987) and the longest birth intervals (Galdikas and Wood, 1990) of any great ape, might be presumed to engage in a high degree of vigilance. However, the low degree of vigilance reported from this study suggests that, for orangutans, vigilance is not a major cost of single motherhood and is not a likely behavioral constraint on orangutan birth interval.

The results reported here represent a preliminary attempt to assess differences in travel patterns, nest placement and vigilance that may be related to predator and conspecific threat avoidance in orangutans. Some of these behavioral patterns may simply reflect the response of orangutans to perceived threat from humans, but others may reflect general behavioral patterns to avoid potential threats from other conspecifics and predators in addition to humans. Whatever the ultimate sources of these behaviors, the probable existence of different baseline levels of predator/conspecific threat avoidance must be taken into account when explaining differences between orangutan age-sex classes. Longer term studies should provide real life examples of what orangutans do when faced by threatening conspecifics or predators as well as larger sample sizes to bear out the results of this research.

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