

FLOCKING BEHAVIOUR OF A RESIDENT POPULATION OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS)

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The Great Indian Bustard *Ardeotis nigriceps* (Vigors) is one of the endangered birds of the Indian subcontinent. During the last few decades, its population has massively declined (Ali, 1970; Dharmakumarsinhji, 1978; Goriup and Vardhan, 1980; Rahmani, 1987, 1989). The Indian Government has taken various measures to reverse this trend (Rahmani, 1987, 1989). Ecological and behavioural studies on the Great Indian Bustard (henceforth called bustard) were done between 1981 and 1987 at three sites: Karera in Shivpuri district of Madhya Pradesh state (Rahmani, 1988, 1989), Nanaj in Solapur district of Maharashtra state (Ali and Rahmani, 1982-84; Rahmani and Manakadan, 1989), and Rollapadu in Andhra Pradesh state (Manakadan and Rahmani, 1989). Among the study sites, only at Karera Bustard Sanctuary, the bustards were resident and seen throughout the year, while in the remaining areas they were seen mainly during the monsoons. This paper on the flocking behaviour of the bustard is based on the studies done at Karera. However, wherever necessary, data from other areas are also used.

STUDY SITE

The 202.21 sq. km Karera Bustard Sanctuary (25°30' to 24°40' N and 78°5' to 78°12' E) (henceforth Karera) is located in the Shivpuri district of Madhya Pradesh state in India. The terrain of Karera is gently undulating, with scattered stones and boulders. The average annual rainfall recorded by us from 1983 to 1985 was 966 mm. Summers (March to June) are very hot (maximum recorded 48 °C) but in winter (November to February), the minimum temperature can go down to 4 °C. The original vegetation of the area was classified as Tropical Dry Deciduous Forests (Champion and Seth, 1968). There are a few hillocks, which some decades ago would have been covered with *Anogeissus pendula* trees, but indiscriminate cutting and lopping have eroded the hills leaving stunted specimens. The plains have degraded into open scrub. Wherever possible, the land has

been cultivated. Today the shrubs *Zizyphus rotundifolia* and *Acacia leucophloea* are the dominant natural plants, the latter scattered and the former in clumps in all the uncultivated parts of the plains.

The bustards are found in the open scrub land. There are 33 villages within the boundary of the sanctuary and the human density is 127 persons/sq. km. Similarly, the livestock population is also high i.e. 179.5/sq. km. During our study period, there were about 25 bustards in the Sanctuary. Most of the observations were done on unbanded individuals except two males and two females which were colour-banded.



Figure 1. — In winter, most male Great Indian Bustards of an area move together and flock cohesiveness is strong. A group of five male bustards forages in a Groundnut field (overgrown by *Celosia argentea*). This flock was seen together for three months in the winter of 1985-86. Photo by Asad R. Rahmani.

The breeding season of the bustard at Karera is from middle of March to the end of June. Although occasional nests were found in July and August also, courtship display of adult males was not seen after June.

Studies were done from May 1982 to May 1986 but in the present paper, data on flock composition are taken only from 1983 to 1985 for which I have complete set of data for all the months. Although the sanctuary covered 202 sq. km., the bustards were seen mainly in 50 to 60 sq. km. which were my study area.

METHODS

Flock composition : In order to study the social behaviour and flock composition of bustards, daily record of the following parameters was kept, namely (1) total number of bustards seen in the study area, (2) maximum number of bustards seen in a flock, (3) flock composition i.e. sex, adult, immature, (4) plots where seen, (5) time, (6) local weather conditions, and (7) local movement between plots. Results of all the parameters have not been used in this paper. Mother and chick were taken as one unit as they were always seen together. Only juvenile bird was noted separately. Male and female were identified according to sex dimorphic characters described by Baker (1921) and Ali and Ripley (1969). Birds moving together with some coordination of behaviour were considered as a group or a flock. Temporary association while foraging was not noted as a flock. Five types of flocks were identified : (i) all male group, (ii) all female group, (iii) mixed group, (iv) solitary male, and (v) solitary female. In three years, in the study area, a total of 1807 flocks were observed.

Peck rate : Peck or feeding rate was studied in order to find out (i) whether there is any difference in the peck rate between a solitary bird and a non-solitary bird, (ii) whether there is any difference of peck rates between sexes, and (iii) whether there is any difference of peck rates between different age classes. Five minutes were taken as an activity unit and all the pecks during this duration were counted. As we watched the bustard from 300 to 500 meters we were not always sure whether the bustard was successful in eating the food item or not. Nevertheless, every peck was counted. More details of this study such as peck rates in different habitat types or in different study plots are given separately (see Rahmani, 1989). In this paper I give only those results of peck rates which concern with the flocking behaviour of the bustard.

The studies of peck count or rate were conducted from May 1982 to August 1984 and 1271 readings were taken, spread over different seasons and months. Owing to various reasons, equal number of readings could not be taken every month or every season. Most of the readings were taken during the breeding season (summer) and winter when the birds were watched more regularly. Statistical analyses were performed using software packages.

Identification : To study the peck rate of different individuals, the bustards were identified as (i) Alpha male = adult territorial male which displayed ; (ii) Beta Male = Subadult non-territorial male ; (iii) Juvenile Male = less than one year old, generally seen with mother ; (iv) Mother = A hen with a juvenile ; (v) Breeding Female = A hen with an egg or a chick ; and, (vi) Non-breeding Female = A hen without an egg or a chick.

RESULTS

Flock composition

Male and female bustards live in their own flocks. Mixed flocks are rare and temporary (Fig. 2). Even in a mixed flock, different sexes form their own sub-groups. Most of the mixed flocks were seen in good feeding areas such as certain crop fields where the birds had congregated to forage. For example, I saw

a flock of 22 hens with juveniles in a Soeha *Eruca sativa* and Bengal gram *Cicer arietinum* field in another bustard area called Sonkhaliya in the Rajasthan state (Rahmani, 1986). At Rollapadu, with a population of 50 to 70 bustards, a flock of 24 male bustards was seen for a week in a newly-sown groundnut (*Arachis hypogea*) field.

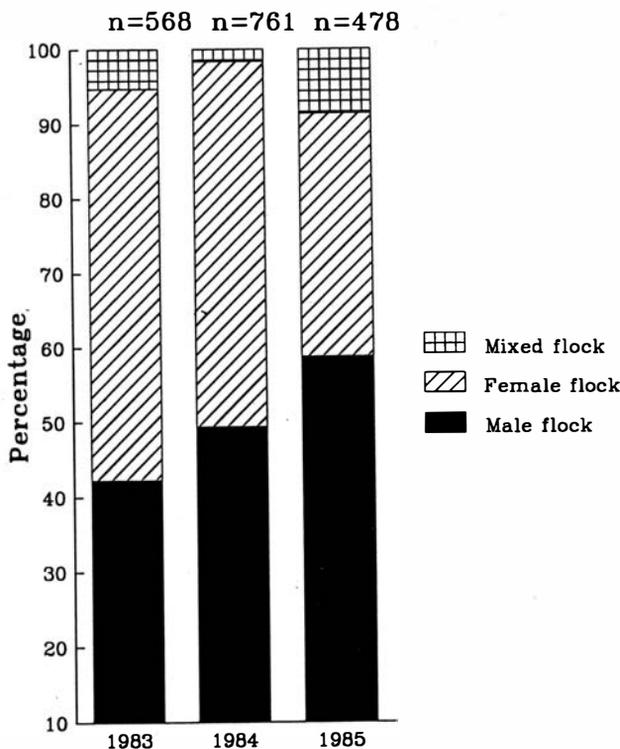


Figure 2. — Percentage of flocks in different years.

Mean flock size varied from season to season (Fig. 3). For both sexes, maximum was reached in February just before the start of the breeding season, and the minimum in June when most of the adult birds were breeding. The maximum absolute flock size of male was 6 and of female 10, recorded in December 1982 and 24 December 1985, respectively.

As the breeding season approaches in March, the adult males of an area start separating from the male flock and return to their respective territories. Similarly, the female flocks also break up into smaller groups of 2-3 birds and soon the adult females separate for nesting. Solitarily hens were more commonly seen during the breeding season than in the non-breeding season (Table I). Only the late nesters or the immature hens move together. In the males also, the immature birds live in flocks but the territorial cocks are solitary. Except for the females and immature males, other adult cocks are not tolerated in the territory.

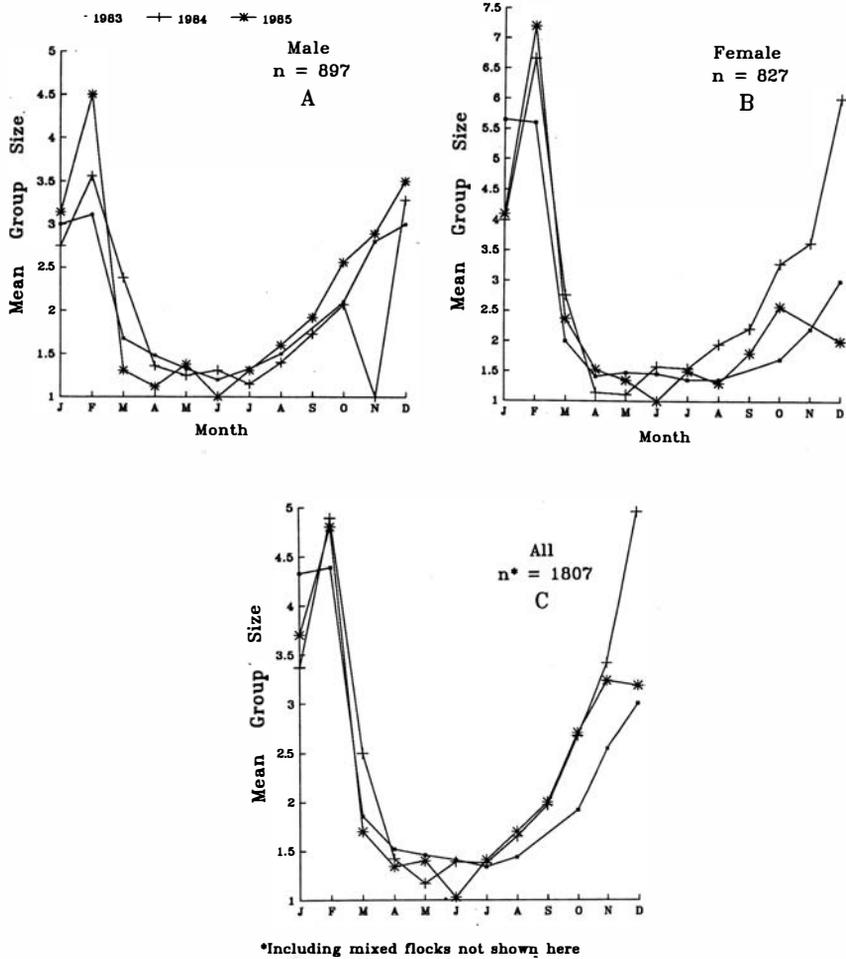


Figure 3. — Monthly variation in the mean group size of the Great Indian Bustard.

Like solitary males, solitary females were also common (Fig. 4). The next most common sighting was of two females (Fig. 4). This could be of a mother with her juvenile daughter. Similarly, a group of three female bustards generally consisted of mother, juvenile daughter and perhaps older daughter of previous year. Mother and a male juvenile were frequently seen in a female flock but never with a male flock. In the winter of 1982-83 for four to five months, a mother and a juvenile male (which was taller than the mother) were seen with another female. In the first three months of observations, the three birds used to forage, fly and roost together but later the third female started separating and by the time of the breeding season in March, mother and juvenile male were left alone.

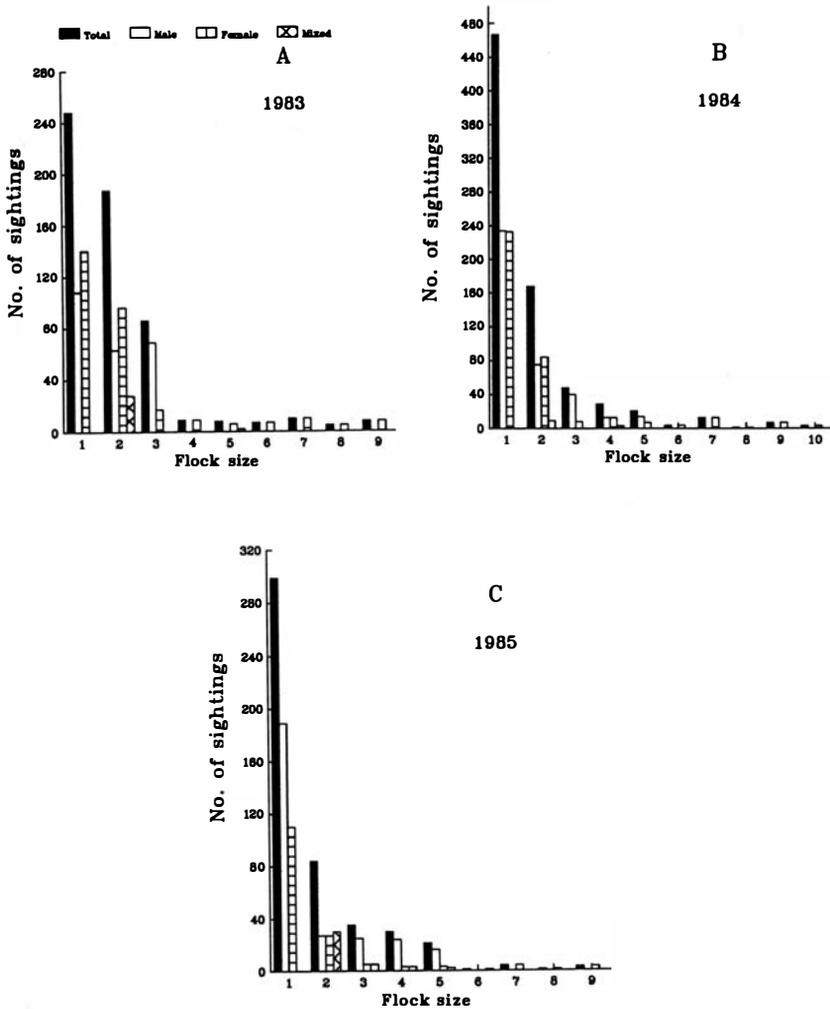


Figure 4. — Number of sightings of different flock sizes of the Great Indian Bustard in the Karera Bustard Sanctuary.

Results from colour-banded birds

An adult territorial male (Male-A) was colour-banded in the morning of 30 May 1984. The same evening, it was seen displaying for a short period, and regular display started within 10 days. After that it displayed at its traditional spot for three consecutive years. After its disappearance in the winter of 1986-87, exactly the same display spot was occupied by another male. A sub-adult male (Male-B) was also banded (in 1985) but its band came out in few days so we could

TABLE I

Number of solitary hens in the breeding versus non-breeding season. Sighting/month given in brackets.

Year	No. of solitary hens		
	Breeding season	Non breeding season	
1983	122 (24.4)	18 (2.57)	$\chi^2 = 69,$ df = 1, P < 0.01
1984	210 (42.0)	23 (3.28)	
1985	104 (20.8)	6 (0.85)	
Total	436 (87.2)	47 (6.70)	

not gather any data on its movement and social interactions. The two colour banded females (Female-A and Female-B) were not seen regularly, indicating a much larger home range of hen bustards. Between June 1984 and June 1986, Male-A was seen in the study area 70 % of the study trips (n = 281), while Female-A was seen only 12 % of the trips (n = 281) and Female-B (banded in 1985) was seen 10 % of the trips (n = 184). The interval of sightings of colour-banded male was 1-3 days (longest 8 days) while colour-banded females were not seen for 2-3 months at a stretch.

Results of the study on the peck rate

1. Sex-wise peck rate

The average peck rate (PR) of male and female bustards was significantly different (One-way ANOVA, $F_{1,109}=4.33$, $P < 0.05$) with cocks having a significantly higher PR than hens (11.5 vs. 10.6) (Table II).

2. Peck rates of different individuals

There was no significant difference in the PR of Alpha and Beta males or Alpha and Juvenile (Table III). Similarly, there was no significant difference between Mother and Juvenile which foraged together in the same areas. The only significant difference in the PR was between Breeding Hens and other individuals such as Non-Breeding Hens, Mother, Alpha and Beta.

3. Peck rates of solitary and non-solitary birds

There was no difference of the PR between the solitary and non-solitary hens ($t = -0.29$, St. Err. = 2.11, Df = 437, NS) and very little difference between the

TABLE II

Peck Rates of different sexes and different individuals.

Sex/Individuals	Mean	SD	No. of samples
Sex			
Male	11.5	7.05	589
Female	10.6	6.41	433
Individuals			
Alpha Male	12.11	7.14	288
Beta Male	11.89	7.46	167
Juvenile Male	9.97	5.01	109
Mother (with juvenile)	12.44	7.36	98
Breeding Hen	6.89	2.71	59
Non-Breeding Hen	10.81	6.26	276

TABLE III

Scheffe's Test to find the significance between columns.

	NBF	MOF	BF	ALM	BEM	JUM
NBF	0.00	4.41	18.84*	5.51	2.77	1.25
MOF		0.00	27.83*	0.18	0.43	7.19
BF			0.00	32.95*	26.92*	9.42
ALM				0.00	0.13	8.31
BEM					0.00	5.53
JUM						0.00

* P < 0.01.

NBF = Non-breeding Female ; MOF = Mother ; BF = Breeding Female ;
 ALM = Alpha Male ; BEM = Beta Male ; JUM = Juvenile Male.

solitary and non-solitary males ($t = -1.76$, St. Err. 0.67, Df = 587, $P < 0.1$). This shows that even when the bustard is in a flock, it feeds more or less individually.

DISCUSSION

Ali and Ripley (1969) reported that the Great Indian Bustard is « normally met with in scattered pairs, or parties of 5 or 6, but droves of up to 25 or 30 not unknown ». We never found bustards in pairs. Their polygynous mating system also indicate that the Great Indian Bustard should not live in pairs. We frequently saw a flock of mothers with a juvenile male ; sometimes the juvenile was taller

TABLE IV

Peck rate of solitary and non-solitary bustard.

Sex	Mean	SD	No. of samples
Solitary Female (SF)	12.78	8.84	194
Non-solitary Female (NSF)	12.17	6.12	245
Solitary Male (SM)	12.30	8.76	272
Non-solitary Male (NSM)	11.12	7.15	317

than the mother, erroneously giving an impression of a « pair » of bustard. Actual pairing as seen in geese, cranes, eagles etc... was never found in the bustard.

Male and female live in their separate flocks, with strong flock cohesiveness, especially in males. In all the years of study, mixed flocks were rare. Mixed flocks were mainly seen in winter in certain crop fields. Martinez (1988) in the Great Bustard *Otis tarda* also found that mixed flocks were common in winter when individuals of smaller flocks join together on good feeding grounds. During the breeding season (March to June/July at Karera), adult males which in winter were living with sub-adult males, separate from the flocks and move to their respective territories, where other adult males are not allowed. In the Great Bustard also (Martinez, 1988), during the breeding season flocks are very small and an increase is observed in frequency of solitary birds, mainly adult males which are the first to leave the large winter flocks. In the Great Indian Bustard, territories are traditional and some have been occupied since the last ten years of our study and monitoring periods. A colour-banded adult cock occupied the same territory for three consecutive years. After its disappearance, exactly the same spot was selected for display by another male. Since 1981 (the starting of our study) at Nanaj, the same territory is being occupied (latest observation in August 1990) and an adult bustard is seen displaying on the same ridge.

Male bustards appear to be more parochial and traditional in the habitat use than the females because if the males are not disturbed, they can be repeatedly seen in an area for many months. However, the hens appears to move in a larger area and with greater unpredictability. The two hens which we had colour-banded were seen very infrequently while the colour-banded males were seen almost daily in the study area.

Although the fledging period of the Great Indian Bustard is not known, it appears that the young bustard lives with its mother for a year till she lays another egg. At Nanaj, for three days we saw a juvenile female closely moving with an adult hen (its mother) which had an egg. Once we saw her sitting side by side to her mother which was incubating the egg. During the incubation recess, the mother used to feed the juvenile, which was all the time around the nest or near her mother. Later the egg was abandoned for no apparent reason. We suspect that the egg was deserted because the previous year's juvenile was still accompanying the mother. After a month, probably the same hen with a female juvenile was seen with another egg, about 100 metres from the previous nest. In the beginning the juvenile female was seen around the nest (as earlier) but as incubation of this egg progressed, she was driven off by the mother. This egg hatched successfully.

Neginhal (1980) has described seeing a male Great Indian Bustard around a nest, which he thought to be looking « after his spouse during the... incubating period » (implying strong pair bond or monogamy in this species). I suspect Neginhal had seen a juvenile male bustard of previous year which was still attached to its mother, similar to what we observed at Nanaj in the case of juvenile female.

The two main advantages of foraging in a flock are a higher probability of detection of a predator by vigilance of companion, and improved location and chance of catching prey (Bertram, 1978). Therefore, foraging rate of an individual in a flock should be more than a solitary bird. I did not find any difference in the peck rates between a solitary and a non-solitary female, and very little difference between a solitary and non-solitary male, indicating that even when the bustard is in a flock, it feeds independently and flushing of live prey by other members of a flock (« beaters ») do not play a significant role in locating food. Similarly, predator detection by companions, thus leaving more time to search food, also does not contribute significantly while foraging.

The peck rate of a hen with an egg or a small chick was significantly lower than that of the hens which were not breeding (Table III). The main reason could be that a hen with an egg or a small chick is constantly looking for danger, hence she has less time for foraging. I found that adult bustards are not vulnerable to most ground predators (especially during day time) such as wolf (*Canis lupus*), jackal (*Canis aureus*) and fox (*Vulpes bengalensis*). However, an egg or a chick is always in danger of these and many other smaller predators also ; therefore a breeding hen has to be constantly alert to protect her egg or chick.

The difference of the peck rate of a male and female bustard could be due to two reasons : (1) Difference in the behaviour of the two sexes : The females were more timid and easily alerted than the males, therefore they spend more time looking for danger than the males. (2) Sexual size dimorphism : As the male bustard is larger and almost twice the weight of female, it needs more food, hence more peck rates.

SUMMARY

During the non-breeding season, males of an area join and move, forage and roost together. Females also move in flocks or with their juveniles. Mixed flocks are rare and temporary. Female with a juvenile generally join a female flock but never a male flock. Mean flock size varies from season to season. The largest flocks are seen just before the breeding season and the smallest flocks during the breeding season.

Number of pecks per five minutes were studied (1 271 observations). Although the bustards move in flocks, they do not help each other in locating food and perhaps also in locating danger, because there was no significant difference in the peck rates between a solitary and a non-solitary bird. There was some difference in the peck rate between the sexes. This could be because a hen, due to her smaller size, is vulnerable to more predators than the much larger male, so she has to look for danger more often, hence spends less time/5 minutes in foraging. Secondly, as the male is nearly twice the weight of a female, it needs more food, so more pecks/5 minutes. There was significant difference in the peck rate between

a breeding hen and a non-breeding hen. This could be mainly because a hen with an egg or a small chick has to constantly look for danger, thus she has less time for foraging.

RÉSUMÉ

En dehors de la saison de reproduction, les mâles de la Grande Outarde Indienne *Ardeotis nigriceps* (Vigors) se regroupent, se déplacent, et se nourrissent ensemble. Les femelles forment également des groupes, seules ou avec leurs jeunes. Les groupes mixtes sont rares et temporaires. Une femelle accompagnée de son jeune rejoint toujours un groupe de femelles, et jamais un groupe de mâles. La taille moyenne de ces groupes sociaux varie d'une saison à l'autre. Les plus nombreux s'observent juste avant la période de reproduction, et les plus petits pendant cette dernière.

Pour quantifier l'intensité de la recherche de nourriture chez les outardes, on a évalué le « taux de picorage » des oiseaux (nombre de coups de bec par 5 minutes ; 1 271 observations). On peut ainsi montrer que la vie en groupe ne facilite nullement la localisation de la nourriture chez les outardes, ni peut-être même la détection des sources de danger. On ne constate en effet aucune différence significative entre le nombre de coups de bec donnés par les oiseaux solitaires et ceux en groupe. Il existe, par contre, une certaine différence entre les deux sexes. La cause en est à rechercher peut-être dans la moindre taille de la femelle, plus vulnérable vis-à-vis des prédateurs que le mâle qui est beaucoup plus gros. La femelle doit donc être en alerte plus souvent, et passe ainsi moins de temps à rechercher sa nourriture. Par ailleurs, le fait d'être deux fois plus lourd que sa femelle force le mâle à manger plus, d'où le plus grand nombre de coups de bec donnés par 5 minutes. Il y a aussi une différence significative entre le « taux de picorage » d'une femelle couveuse et celui d'une non-couveuse. Cela pourrait être dû au besoin de la première d'être constamment attentive pour détecter un danger potentiel, ce qui réduit d'autant le temps disponible pour la recherche de la nourriture.

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