Avocetta N° 24 (2): 113-119 (2000)

Finding out who is nesting where: a method for locating nest sites of hole-nesting species prior to egg laying

FABRIZIO GRIECO

Netherlands Institute of Ecology, Centre for Terrestrial Ecology
P.O. Box 40, NL 6666 ZG Heteren, The Netherlands
email: grieco@cto.nioo.knaw.nl

Abstract - A method to find out which species is more likely to start egg laying in a certain nestbox is described. Nestboxes were visited daily and the behaviour of the birds (Great, Blue and Coal Tits) that appeared around them was observed. The birds' response consisted mainly of giving alarm calls and showing inquisitive behaviour (i.e., approaching the observer and looking at close distance). Proximity of the individual (or the pair) to the nest and inquisitive behaviour of the female bird were found to be associated with nest ownership. Alarm calling and inquisitive behaviour of males were less selective and therefore not diagnostic. Nocturnal check of nestboxes provided useful information about the nest owners, but they were more reliable at late nest-building phases, when the female was closer to egg laying.
It is suggested that this observation method may be used in field studies of species breeding in nestboxes or even natural cavities. This work emphasises the importance of observing small details of behaviour as symptoms of the condition 'inside' the individual (motivation).

Introduction

Field studies on birds may sometimes require the gathering of information about the location of the nest sites of the species under study before the eggs are laid. For instance, when performing supplemental feeding experiments or manipulations of nestbox location or size prior to egg laying, it is useful to know what species is going to breed in a particular spot. Observation of nest-building activities can of course give the right answer, but that is not always easy. Nest-building may occur irregularly, and takes time to detect, especially in bad weather. In field studies involving many hundreds of nestboxes it is more convenient to gather information in a shorter time.
Looking at the form and structure of the nest may help identifying its owner. In tits, *Parus* spp., nests differ among the species (Cramp & Perrins 1993). However, species discrimination is not always easy. For instance, Blue Tit *P. caeruleus* nestcups may look as large as a normal Great Tit *P. major* one, or may lack the typical lining with feathers (Hinde 1952, Perrins 1979). In addition, the between-species differences in nest type become clearer at late nest-building phases, i.e. a few days before egg laying. Therefore, if one has to identify the nest owner well before laying, for instance for a pre-laying feeding experiment, one would need other means of identifying the species.
A different approach involves detailed observations of the behaviour of birds around potential nest sites. Personal observations in previous years suggested that male and female Great Tits differed in the behavioural response to the presence of humans near potential nest sites. Male Great Tits alarm-called in any part of the territory, while females appeared to respond more strongly if the observer approached a nestbox. During these encounters, the minimum distance of the bird to the nest varied markedly, perhaps reflecting the level of motivation of the individual. According to Hinde (1952), away from the nest the male Great Tit scolds at the intruder while the female remains in the background. Stokes (1960) noted that, in the early stages of nest-site selection, the male Blue Tit tended to fly ahead of the female to the nest, and went nearer the entrance hole. This situation was reversed after a nest site had been selected. This suggests that female, but not male behaviour could help the observer predict where a pair was going to breed.
The behaviour of tits around nestboxes was observed during daily surveys in spring 1998 to 2000, with the aim of finding out where Blue Tits were going to nest. This was because all the Blue Tit pairs in the study area had to be experimentally-supplemented with food

Accepted 26 June 2000

before they laid the eggs. An easy solution to the problem could have been providing all potential nest sites with additional food. However, Great Tits nesting in the same area were subject to other experiments, which required the absence of any food manipulation. For this reason, the researcher had to identify and provide food to all Blue Tit pairs, and at the same time not to feed Great Tit pairs. In this study, it is shown how the behaviour of birds around the nest could help in the correct identification of the species nesting in a certain site. Emphasis has been given to the asymmetry of behaviour in male and female in the presence of human intruders. Additional information on the nest owner was obtained through the nocturnal check of nestboxes in 1999.

Study Area and methods

The study was carried out in the field seasons of 1998 and 1999 in a mixed forest within the National Park 'The Hoge Veluwe', central Netherlands (for details see van Balen (1973)). In this area, ringed populations of birds breeding in nestboxes have been studied since 1955. Four hundred nestboxes are currently present. The species breeding in the nestboxes are the Great Tit, the Blue Tit, the Coal Tit *P. ater*, the Marsh Tit *P. palustris*, the Pied flycatcher *Ficedula hypoleuca*, the Nuthatch *Sitta europaea*, and the Tree Sparrow *Passer montanus*.

Visits to nestboxes. Between 30 and 50 nestboxes were visited every day from 10 March to 15 April 1998, from 10 March to 24 April 1999 and from 23 March to 13 April 2000. Overall, 122 different boxes were visited in the three study years. Visits were made mainly to nestboxes where nest-building had already started. Nest-building phases were scored as: 0 (no nest material), 1 (a few pieces of moss in the nestbox), 2 (bottom of box covered by moss), 3 (half of box occupied by nest material), 4 (nestcup clearly visible and with some fine material, e.g. hair), 5 (complete nest with much lining material), 6 (nest with one or more eggs).

The observer stood about 2 m from each box and waited for birds to appear, and in no case for more than ten minutes. Birds usually approached the observer and left shortly afterwards, thus the actual observations lasted less than ten minutes. Two behavioural patterns were recorded: alarm calls (ACs; scolding or churring, Cramp & Perrins 1993) and inquisitive behaviour (Look At, i.e. bird looking at the observer, generally at a short distance from him). 'Looking at' means that the bird was pointing its eyes towards the intruder, moving its head from side to side apparently to watch the object from different angles. This behaviour was clearly different from jumping or perching on branches while looking around and/or alarming, whatever the distance from the observer. Also, it was noted whether or not the bird came within two meters of the nestbox during the interaction. Each behaviour was scored as 1 (behaviour shown) or 0 (behaviour not shown).

Effort was made to identify the sex of each approaching bird. Sexing Great Tits in the field is quite easy, but more difficult or impossible in the other species (Cramp & Perrins 1993). For species other than the Great Tit, two individuals of the same species were assumed to be pair members if they were observed at the same time. In no case were two or more pairs of the same species observed simultaneously around the focal nestbox.

The appearance of a Tit species, independent of whether it was an individual or a pair, was defined an 'encounter'. When two species approached the observer (e.g. a Great Tit joining a Blue Tit pair), each species was entered in a separate observation record with its response scores. Because pair mates usually stayed together while facing the observer, distance from nestbox was assumed to be the same for male and female. In addition, a small data set where male and female partners stayed at different distances from the nestbox is shown. Each encounter record was given a final nesting score (1 or 0) depending on whether or not the same species laid the eggs subsequently in that nestbox, respectively. Nests where the owner remained unknown were excluded from the analysis.

Roosting inspections (RIs). Only nestboxes where nest-building had begun were checked. Nestboxes were checked after sunset, between 30 March and 27 April 1999. If found, roosting birds were identified without touching them, since this could cause them to move to another roosting site in the subsequent days (pers. obs.). Nest-building was scored using the same criteria as in visits during the day (see above). In those inspections where a roosting bird was found, a nesting score (1 or 0) was assigned according to whether or not the species found was the same as the one that laid the eggs later in that nestbox, respectively. If no eggs were laid subsequently, the nestbox was given a score 0. Unlike for visits during the day, nestboxes with an unknown owner were included in the analysis to show the effect of desertion early in the nest-building phase on the predictive power of roosting inspections.

Data analysis.

Some nestboxes were visited or inspected more than once in any breeding season. This could lead to statistical events which were not independent from each other. In the case of visits, for instance, the same bird could be encountered several times. To avoid pseudoreplication, one encounter was chosen at random and included in the analysis as the observation unit. However, for the 30 visits where two different species appeared, both encounters were included in the analysis. This did not influence data independence, since in almost all these visits one of the two species was represented by a single bird, while the main analysis was performed on pairs (see Table 1). For each level of the predictor variables considered, the probability of being the nest owner was calculated by averaging the final nesting scores, and was expressed as percentage. For both visits to nestboxes and roosting inspections, the nesting score (with levels 0 or 1) was the dependent variable in a binomial linear model with logit link function as available in the Statistica version 5.5 package (StatSoft 1999). A full model was fitted including all variables. Variables were then sequentially dropped from the model according to the stepwise backwards procedure (Sokal and Rohlf 1997). Whether the removal of a variable caused a significant increase in deviance was tested with a χ^2 test.

All predictor variables were dichotomised, except for nest-building phase (7 levels), average daily temperature, date (in form of April date: 1= 1 April, 31= 1 May, etc.), and the sum of the three response scores (AC, Look At, Proximity) for each individual bird. All those variables were considered as continuous.

Results

Visits to nestboxes.

During 154 visits to 131 nestboxes, I recorded 184 encounters. Of these, 105 involved Great Tits (GTs), 72 Blue Tits (BTs), and 7 Coal Tits (CTs). Encounters with pairs and individuals occurred 92 times each. Two-species encounters occurred in 19.5% of the visits.

For a few nestboxes, the final nest owner remained unknown, thus only the encounters which occurred around a nestbox with certain ownership were considered here (n=157, including two-species encounters). The presence of a pair around a nest was not a better predictor of nesting than the presence of a single bird. The probability that the species seen was the actual nest owner was 62.2% for pairs (n=82 encounters) and 60.0% for single birds (n=75). The difference was far from significant (χ^2_1 = 0.01, p=0.90). In the cases where two species were seen in one visit, the behaviour of one species could have been influenced by the behaviour of the other. However, excluding visits with two species did not change the results. Sightings of pairs predicted the nesting of a certain species in 66.1% of the cases (n= 59), against 75.5% for sightings of individuals (n=49). The difference was not significant (χ^2_1 = 0.73, p=0.39). Although the sighting of a pair did not provide useful information on the nest owner, the behavioural response of the birds involved could be informative. For all encounters, irrespective of whether individuals or pairs were involved, proximity of birds to the nestbox was the only factor predicting nest ownership (χ^2_1 = 5.23, p<0.05; 157 encounters). However, this model did not take sex of birds into account.

Table 1 shows the results of the analysis of the response of male and female tits in terms of alarm calls, inquisitive behaviour and minimum distance from the nest during the encounters. This analysis refers to encounters involving pairs and with known nest owner (n=74). Only inquisitive behaviour of the female and proximity of the birds to the nest appeared to be associated to subsequent nesting. The positive sign of the parameter estimates for both variables indicate that the scores 1 (inquisitive behaviour and short distance from the nest, respectively) were associated with subsequent nesting (Table 1). The interactions between nest-building phase and the two variables

Table 1. Probability of nesting of the species that performs a particular behaviour and significance of the association between that behaviour and subsequent nesting. In parenthesis: number of encounters.

Variable	Probability that the species is the nest owner: behaviour shown	behaviour not shown	χ^2	df	*P*
male ACs	0.627 (51)	0.652 (23)	0.42	1	0.51
female ACs	0.694 (49)	0.520 (25)	2.19	1	0.14
male Look At	0.793 (29)	0.533 (45)	0.70	1	0.40
female Look At	0.862 (29)	0.489 (45)	4.42	1	0.04
Proximity to nest	0.941 (17)	0.544 (57)	3.88	1	0.05
Final model	Parameters				
	Estimate	Standard Error			
Proximity to nest	+1.082	0.545	3.93	1	0.047
female Look At	+0.769	0.321	4.29	1	0.016

were not significant, suggesting that the inquisitive behaviour and closeness of the female had the same predictive power at all nest-building phases.

A more intuitive, although less precise, way to illustrate the different predictive power of male and female behaviour during the contacts with humans was to plot nesting probability against an index of increasing responsiveness of the pair mates. This index was defined by summing up the three response scores (ACs, Look At, proximity). The index values thus ranged from zero to three. The probability of being the nest owner increased significantly with this index in females, but not in males (females: χ^2_1=7.86, P=0.005; males: χ^2_1= 0.24, P=0.62; Figure 1). This figure does not say which behavioural pattern gave more information about the nest owner. However, it shows that using the combined female response scores resulted in greater discrimination between the two possible events (nesting vs. no nesting of the focal species). The absence of any response by the female was associated with a low probability of being the nest owner, at around 30%, against 50% in the case of a single behavioural pattern taken separately (see the column 'behaviour not shown' in Table 1). The high probability for males at the highest value of the response index (Figure 1) was due to eight males showing the strongest response together with their respective female partners. Therefore, this value was not independent from the effect of the female behaviour.

I then considered only the encounters where a clear difference in ACs, Look At or distance from the nestbox appeared between pair mates. The probability of being the nest owner was 55% (n=11) when the male, but not the female, alarm-called; 25% (n=4) when the male, not the female, showed inquisitive behaviour; and 67% (n=12) when the male was closer to the nest site than the female. In the opposite situations (i.e., when the female was more responsive than the male), the probability was 100% (n=9), 75% (n=4) and 94% (n=12), respectively. Thus, for all three variables, higher responsiveness of the female was associated with subsequent nesting. In the case of alarm calls, the difference in predictive power between sexes was significant (Fisher p=0.038).

Two-species encounters.

During 30 visits, two species were observed at the same time near a nestbox. Of these, 24 were GT- BT encounters, while 2 were GT-CT encounters. In these cases, the birds' response could be more informative

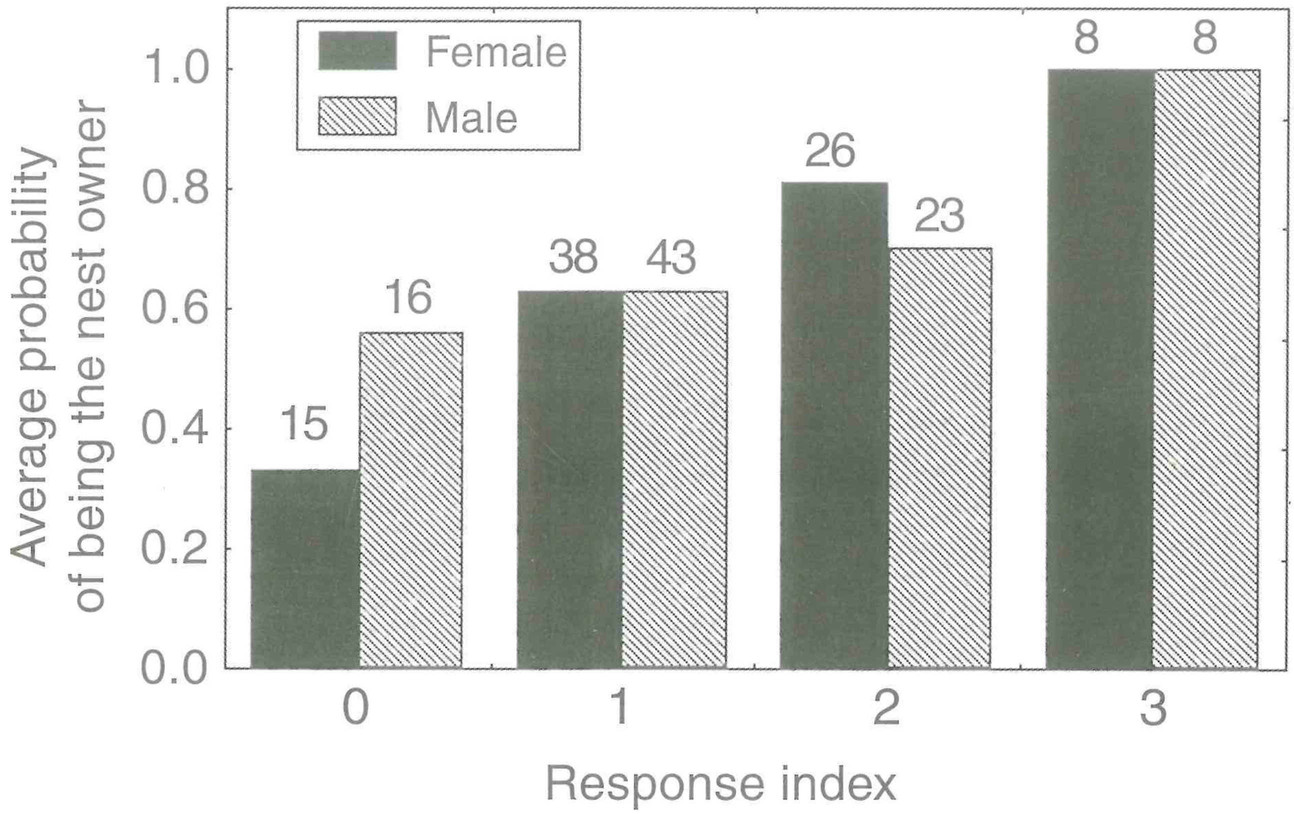

Figure 1. The probability of being the nest owner in relation to different degrees of response to human intruders, in male and female tits within pairs. The response index is the sum of the scores (0 or 1) for Alarm Calls, Look At and Proximity to the nestbox. Numbers on the bars indicate the number of nests where the individual bird showed a certain degree of response.

than in one-species encounters, since one of the two species was presumably more motivated to defend the nest. First, between-species differences were analysed. The nest-owning species alarm-called in 21 of 22 cases, slightly more frequently than the other species (14 of 22). However, the difference was not significant (McNemar's $\chi^2 = 2.50$, P=0.11). Inquisitive behaviour was shown at similar frequencies (nest-owning species: 8 of 20; other species: 5 of 20) (McNemar's $\chi^2 = 0.44$, P=0.50). In a few visits, a clear difference in distance from the nest between species was noted. In five of six cases, the nest-owning species was closer to the nestbox than the other.

In short, the difference in response between two species in approaching an intruder at the same time was of little use. This was probably due to the influence the behaviour of an individual may have on the response of others. Yet, between-sex differences in response were more informative when a pair was also involved. In ten visits, a difference in behaviour between pair mates was noted in one of the two species. These refers to eight GT pairs and two BT pairs. In seven visits, the female of the focal pair was more responsive than the male, i.e. she got closer to the nest or performed ACs while the male did not. The bird of the other species was either silent (three cases) or alarming (four cases, but three of these were males). In all seven instances, it was later revealed that the species represented by the pairs were the actual nest owners. On the other hand, when male GTs were more responsive than females (three visits), the other species reacted in all cases, showing ACs and inquisitive behaviour. In those cases, the focal pairs were less likely to be the actual nest owners (one of three cases).

Nocturnal inspection of nestboxes

In 1999, 122 boxes were checked one or more times, for a total of 160 inspections. Birds were found in 86 RIs (53.8%). The probability of finding a bird in a nestbox, expressed as the number of nestboxes found occupied divided by the number of nestboxes checked, increased with nest-building phase (χ^2_1= 4.46, P=0.035), and tended to decrease with average daily temperature (χ^2_1 =3.01, P=0.08). Therefore, the more advanced nest-building was, and the lower mean temperature, the higher the probability to find a bird roosting therein. The likelihood that the species found during RIs was the same breeding subsequently increased with nest-building phase (χ^2_1=6.30, P=0.01; Figure 2).

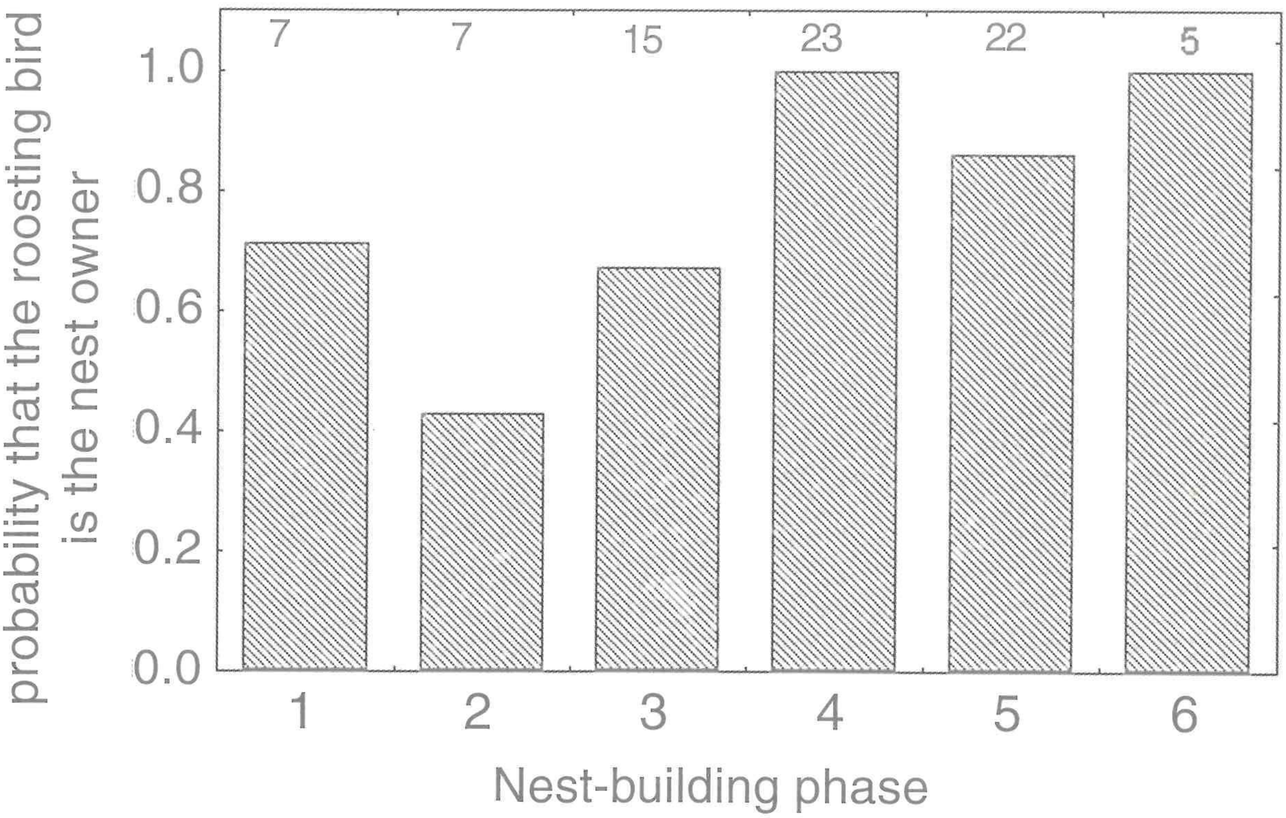

Figure 2. The probability that the species found in a nestbox during roosting inspections will be the nest owner, in relation to nest-building phase (see Methods). Numbers on the bars indicate sample size (number of nestboxes where a Tit was found). Nest-building phases: 1, a few pieces of moss in the nestbox; 2, bottom of box covered by moss; 3, half of box occupied by nest material; 4, nestcup clearly visible and with some fine material, e.g. hair; 5, complete nest with much lining material; 6, nest with one or more eggs.

The probability was lower at earlier phases, due to the high number of nests that were abandoned subsequently. Therefore, the predictive power of RIs was lower in early nesting phases because of the higher probability of desertion, rather than the presence of species other than the true nest owner. By excluding the nestboxes whose owner was unknown, the effect of nest-building phase was no longer significant (χ^2_1= 2.29, p=0.13).

Table 2 lists the species found during roosting inspections (first column) and the species, with relative frequencies, which bred subsequently (actual nest owners). For instance, of the 68 nestboxes where a Great Tit was found, about 80% were actually Great Tit nest sites, one was then occupied by a Pied flycatcher, while for the remaining boxes the actual owner was not known. In a very few RIs the species found was not the actual nest owner (two Blue Tits and one Pied flycatcher; Table 2). However, if the box was found empty during RIs (row 'None' in Table 2), species other than the GT were also likely to be the nest owners, namely Blue and Coal Tits.

The probability that GTs were the actual nest owners was higher for boxes where a GT was roosting than for boxes found empty. Compared with nests where GTs were found, empty boxes were relatively more likely to be either of another species than the GT or to be abandoned (Table 3; χ^2_2=22.4, P<0.0001, counts of CT, BT and PFC aggregated). Blue and Coal Tit nests were significantly more likely to be found empty than GT nests (frequency of empty nests: CT and BT pooled: 11 of 17; GT: 20 of 76, χ^2_1=7.57, P=0.006; Table 2).

Discussion

This study showed that it is possible to predict which species is more likely to be the owner of a particular nest site in natural or artificial cavities. Two types of response of birds to human intruders were related to nest ownership: 1) inquisitive behaviour of females, not males and 2) proximity of birds to the nestbox during the interaction. Because only Great Tits could be sexed frequently enough, it would be wise not to generalise these conclusions for all the species under study. In practice, the distance of the birds from the nestbox would be the only clue available when the birds cannot be sexed effectively in the field, as in the case of Blue Tits.

A smaller data set of the behaviour of pair mates revealed the predictive power of male-female asymmetries in the response to human intruders. All the data pointed in one direction, i.e., the more evident alarm calling and/or inquisitive behaviour in the female than in the male was associated with subsequent nesting of that species. On the contrary, the more alarming and/or inquisitive behaviour of the male relative to its mate was unrelated to nest ownership. These differences between the sexes could be combined with the response of birds of another species interacting at the same time. At least in Great Tits, the responsiveness of the female (or the male) was associated with the absence (or presence) of a strong response by the other species, respectively. This confirmed that the response of the female, not of the male, carried information on nest ownership. Therefore, the main suggestion on a practical ground is to look at the difference in behaviour *between sexes* within pairs, rather than *between species*. Additional information could result from rare events. For instance, displacement (i.e. not autochthonous) song by a female Tit, or milder forms of ACs usually given in situations of anxiety (Cramp and Perrins 1993) may reveal conflict, and therefore be diagnostic.

Roosting inspections also provided some information about the actual nest owner. Finding a Great Tit roosting meant a very high probability that that nest was of a Great Tit. On the other hand, finding a nest empty increased the probability that the nest owner was of another species, namely either Coal or Blue Tit. This was because birds of these two species roosted in their

Table 2. Numbers of nestbox inspections where a certain species was found and distribution of species breeding in those boxes (percentages in parenthesis). GT: Great Tit. CT: Coal Tit. BT: Blue Tit. PFC: Pied flycatcher. Unknown: no egg laying after the last RI.

Species		Actual nest owner				
found	n. nestboxes	GT	CT	BT	PFC	Unknown
GT	68	55 (80.9)	0	0	1 (1.5)	12 (17.6)
CT	5	0	5 (100)	0	0	0
BT	3	1 (33.3)	0	2 (66.7)	0	0
None	46	20 (43.5)	4 (8.7)	7 (15.2)	1 (2.2)	14 (30.4)
Total	122	76 (62.3)	9 (7.4)	9 (7.4)	2 (1.6)	26 (21.3)

nests less frequently than GTs before laying. The fact that all five CT observations predicted breeding by CTs correctly may be due to nesting habitat segregation. Since CTs prefer coniferous wood plots as breeding habitat (Hinde 1952, Cramp & Perrins 1993), it was less likely that GTs or other species could roost or take over and breed subsequently in CT nests.

Predictive power of RIs was slightly higher at later nest-building phases. Therefore, RIs are not the best method to gather information on the nest owner if experimental treatments have to start well before egg laying. RIs may be used in bad weather conditions, when low activity levels of birds around their nests do not allow to make appropriate diurnal observations, or as last chance before egg-laying, when observations at the nestbox did not provide any clear clue about the nest owner's identity.

With some experience, the method presented may classify correctly a high proportion of nest sites according to the species breeding therein. Of the 101 nestboxes that were 'suspected' to be occupied by Blue Tits, 96 (95%) turned out to be actually BT nest sites. Additional ten BT nests could not be discovered before the date of laying of the first egg, since they were built very quickly (which usually happens late in the season).

This study aimed to provide a tool to collect the most useful information, with relatively little effort, on what species is going to breed in a certain spot. However, it also proved to be an example of how details of behaviour that are often considered as the product of subjective interpretation can be treated as symptomatic of the condition of the individual (it took Niko Tinbergen two years to convince some of his colleagues that the 'angry' expression of a Herring Gull was due to its eyes pointing forward when aiming at an opponent). Although difficult to be quantified in a table, there is quite a big difference between a bird that keeps jumping and feeding around a nestbox – even while alarming! – in the face of a human intruder and a bird whose attention is clearly attracted by the intruder. The expression 'looking at the human intruder' is an objective way to describe something 'inside' the animal (i.e., motivation) which is relevant to the observer.

Acknowledgements - I thank the board of the National Park 'De Hoge Veluwe' for permission to carry out fieldwork. The feeding experiment was part of a PhD project carried out at the Netherlands Institute of Ecology, Centre for Terrestrial Ecology, funded by the European Commission with a Marie Curie Fellowship (contract nr. ERBFMBICT971939). Temperature data were provided by the Dutch Meteorological Institute (KNMI). Arie J. van Noordwijk and Hans Källander gave useful comments on the draft, while Tracey Parrish and Iris Charalambides improved the English. Finally, I express my gratitude towards Adriaan Kortlandt for introducing me to the secrets of the 'clinical approach' to animal behaviour.

Riassunto - Viene descritto un metodo per localizzare la specie nidificante in una determinata cassetta nido nella fase antecedente la deposizione. Il principio di base di questo metodo è l'osservazione attenta di alcuni comportamenti degli uccelli che appaiono nei pressi delle cassette nido quando vengono visitate dall'osservatore. La risposta degli uccelli (principalmente Cinciallegra e Cinciarella in questo lavoro) consiste principalmente in richiami d'allarme e comportamento inquisitivo (il soggetto guarda l'osservatore). Prossimità dell'individuo (o della coppia) al sito di nidificazione e comportamento inquisitivo della femmina (non del maschio) aumentano la probabilità che la specie osservata sia quella che deporrà le uova in seguito. In genere, il comportamento del maschio è meno selettivo e quindi non diagnostico. Controlli notturni delle cassette nido forniscono utili informazioni, ma sono piu' affidabili nelle ultime fasi della costruzione del nido, quando la femmina si prepara a deporre le uova.

L'autore suggerisce che questa metodologia di osservazione possa essere utilizzata nelle ricerche di campo per determinare le specie nidificante in cassette artificiali o persino cavità naturali, nella fase precedente la deposizione.

References

Balen J. H. van. 1973. A comparative study of the breeding ecology of the great tit *Parus major* in different habitats. Ardea 61: 1-93.

Cramp S. and Perrins C. M. 1993. Handbook of the birds of Europe, the Middle East and North Africa. The birds of the Western Palearctic. Vol. 7. Oxford University Press, Oxford.

Hinde R.A. 1952. The behaviour of the Great Tit (*Parus major*) and some other related species. Behaviour 4 Suppl. II.

Perrins C.M. 1979. British Tits. Collins, London.

Sokal R. R. and F. J. Rohlf. 1997. Biometry. Third Edition. Freeman and C., New York.

StatSoft Inc. 1999. STATISTICA for Windows [Computer program manual]. StatSoft Inc., Tulsa, OK.

Stokes A.W. 1960. Nest site selection and courtship behaviour of the Blue Tit *Parus caeruleus*. Ibis 102: 507-519.