



Parental behaviour in nuthatches (*Sitta europaea*)

Dr Michael Dockery

(ASAB Education Officer)

Dr Graham Read

(Manchester Grammar School)

Alex Graham

(Manchester Grammar School)

Guy Meachin

(Manchester Metropolitan University)



**ASAB
2006**

Parental behaviour in nuthatches (*Sitta europaea*)

Introduction

This ASAB (Association for the Study of Animal Behaviour) resource pack focuses on parental behaviour in nuthatches, in particular the parent-chick interactions during feeding. The pack consists of:

- ◆ a DVD with 25 (?) minutes of film - the footage is in two parts:
 - i) a summary of the key events in the rearing of a nuthatch brood;
 - ii) film of parent-chick interactions during feeding to provide an opportunity for students to collect data directly from the footage, add it to other data already obtained and use it in analysis;
- ◆ a set of background notes on the bird, with details of its breeding biology;
- ◆ three interactive exercises for data analysis and description (for AS/A2/Advanced Higher students);
- ◆ a set of additional, and differentiated, exercises related to aspects of nuthatch behaviour and based on secondary source material (for KS3 to AS/A2/Advanced Higher students).

The footage was captured by a colour camera mounted in the top of a nestbox (as supplied by BoxWatch - their website is www.boxwatch.co.uk) which was in a tree in the grounds of Manchester Grammar School in the spring of 2001. In the box, a pair of nuthatches established their nest. The eight eggs laid in April were successfully incubated and all the chicks were reared to fledging in late May. The DVD is a record of some of the events that took place in the nestbox over this period.

[This resource is essentially aimed at AS/A2 students of Biology and Psychology in England and Wales and Advanced Higher Biology students in Scotland. However, apart from the three interactive exercises with the statistical analysis of data, it could be used with GCSE and Key Stage 3 students. To this end, the additional data response exercises included in the pack are differentiated to meet the needs of these younger students.]

References

- Harrop, S. & Quinn, D. 1996. *Tits, Nuthatches and Treecreepers*. London, Christopher Helm.
- Matthysen, E. 1998. *The Nuthatches*. London, T. & A. D. Poyser.
- Maxwell, J. 2004. The nuthatch in Scotland - part 1. *Scottish Bird News*, 71, page 7.
[Part 1 deals with the period 1995 - 2000. Part 2, 2001 - 2004, will appear in a future issue.]
- Siegel, S. & Castellan, N. J. 1988. *Non-parametric statistics for the Behavioural Sciences*. (2nd edn) New York, McGraw-Hill.

For some relevant articles contact Michael Dockery. Those with access to journals could browse recent volumes (2000 onwards) of *Animal Behaviour*, *Behavioural Ecology* and *Behavioural Ecology and Sociobiology* which have contained several recent articles of interest.

An Internet browse reveals a number of websites of interest. For example:
RSPB site - www.rspb.org.uk/birds/guide/n/nuthatch/index.asp
Matthysen site - <http://bio-www.via.ac.be/u/matthys/nuttxt.html>

Acknowledgments

This pack was developed through an ASAB grant to Guy Meachin. We are particularly grateful to Dr Ken Norris (University of Reading) and Dr Victoria Braithwaite (Secretary of the ASAB Education Committee, University of Edinburgh) for their kind comments and suggestions regarding the text. We also wish to thank Judy Evans for her drawing of the nuthatch and Mike Taylor for supplying the photographs. Special thanks must also go to BoxWatch Ltd., who supplied the nest box and camera system from which the in-box footage was taken and to the High Master of Manchester Grammar School for allowing us to shoot some of the footage in the school grounds. Guy Meachin filmed all additional footage and Emily Staveley-Taylor recorded the commentary. Mick Hoult kindly designed the booklet which accompanies the DVD.



Background information on nuthatches

Appearance

Nuthatches are distinctive birds and quite easy to recognise (see front cover and Figure 1). They are about 140 mm in length with blue-grey upper parts and pale chestnut-brown underparts. They have whitish cheeks, a very striking black eye stripe and a dark cap. Overall, they look very compact as they have a short tail and rounded wings. Their legs are short but they possess quite large feet with very strong claws for gripping. Their bill is fairly short but stout, with a chisel-like appearance. They have a wingspan of 80 - 95 mm and a mass of 15 - 25 g.



Figure 1 A nuthatch

Undoubtedly one of the easiest ways to identify a nuthatch is by observing it in the field. If you see a small bird climbing head first down a tree it must be a nuthatch! If you see it climbing upwards then it could be a nuthatch or another small woodland bird, such as a treecreeper (*Certhia familiaris*).

Distribution

Nuthatches can be found from Western Europe to South East Asia. The birds in the British Isles belong to the European family but are similar to those found in Asia. In Britain they are fairly widespread in southern England, the Midlands and Wales but occur less frequently in northern England. They seem to be just occasional visitors to Scotland, the first proven case of them nesting was only in 1989. They have since expanded north and west from their origins in the Borders. [See also Maxwell 2004.]

Habitat

Nuthatches are generally found in deciduous woodland but can be found in coniferous woodland too, where they tend to be smaller. In mixed deciduous woodland (their preferred habitat) they spend most of their time on trees searching for food. Although their natural habitat is woodland, nuthatches can also be seen in gardens and are regular visitors to feeders and bird tables.

Behaviour

Most nuthatches live in pairs and generally stay in their territory throughout the year, occasionally joining mixed flocks of woodland birds in winter. They are quite aggressive when defending their territory against intruders, especially in spring. Their foraging is usually concentrated on the lower and middle trunk areas of mature trees, though they also search for prey, such as caterpillars, on the branches of trees too. A feature of their foraging behaviour is that they often peel back and remove pieces of bark to get at food, such as insect larvae. In the wild nuthatches store food, putting seeds and nuts into crevices and holes in the trunks of trees, returning to collect these later on.

Uniquely, they can walk down as well as up a tree trunk, as one

nickname, the 'upside-down bird', testifies. Their large feet and claws are adaptations for this method of moving on tree trunks. When they move upwards on a trunk, they show a characteristic zigzag movement which increases their stability.

Vocalization

Their vocalizations are loud but generally simple, consisting of just a few notes that are repeated. The male nuthatch is more vocal in spring when proclaiming ownership of a territory.

Diet

In their natural habitat of mixed deciduous woodland, nuthatches chiefly take animal food which they find on the trunk and branches of trees. They take both larval and adult forms of insects which they find using their sense of sight or by probing under bark with their bill using their sense of touch. Occasionally they have been recorded taking insect prey in the air.

In spring and summer animal food predominates for adult nuthatches. Their prey include flies, beetles, ants, moths, butterflies, bugs and spiders. The nestlings are exclusively fed on animals. One Russian study found that nuthatches fed the following percentages of food to their nestlings:

Prey type	%
Spiders	13
Beetles	13
Bugs	14
Flies	33
Ants, Bees, Wasps and Sawflies	23
Other prey	4

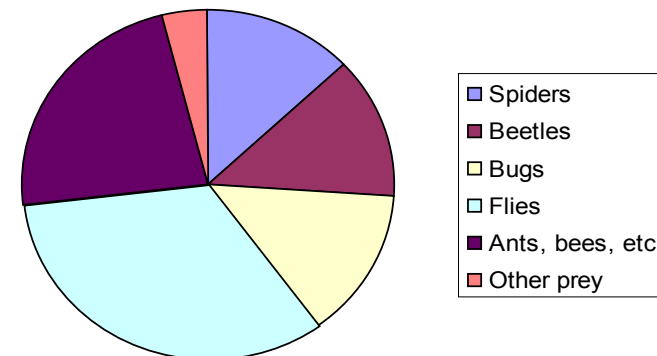
[From Kristin 1992, in Matthysen 1998.]

Oak trees are generally the preferred foraging sites where such trees occur, and often both the male and female forage on the same tree. As a consequence, competition between the two is rare and intra-pair conflict is seldom seen.

In winter, they find fewer animal prey and nuts and seeds are increasingly important in their diet. When foraging on large solid items such as nuts, they use their bill to break up the food item into smaller pieces before eating it. Their stout, strong bills enable them to open nuts, such as acorns, quite easily. When doing this, the food is usually trapped in a crevice in the tree trunk, unlike some other birds which use their feet to hold a nut. So you will not see nuthatches hauling up nuts on string as blue tits do. Among the nuts they eat are hazel, beech and acorns and in coniferous woods they eat the seeds from pine, fir and spruce cones.

Nuthatches are also frequent visitors to bird tables in gardens in winter where they take seeds that people put out and other types of food, such as fats, cheese and bread.

% of food fed to nestlings



Breeding biology of nuthatches

Since a pair of nuthatches usually stay together during the winter, pre-courtship behaviour is short. As a consequence, the pair begin searching for suitable nest sites in February/March. Their nests are typically found in holes in trees, though they do occasionally occupy nestboxes too. They may exploit a natural hole or one created by another bird, such as a woodpecker. Sometimes an entrance hole needs to be enlarged, using the bill. Occasionally they use mud to make an entrance hole smaller: pellets of mud are brought to the nest and hammered into the required shape.

In England, studies have found that oaks are the preferred tree for nuthatch nests. The sites are usually around 4 m above ground and generally face south. However, since they often take over woodpecker nests these apparent choices may reflect woodpecker choice rather than nuthatch preference.

Actual nest building generally begins in late March. Once the pair have selected their nest site, the female spends a lot of time collecting nest material. This is usually made of bark flakes, often from pine trees, with some dry leaves being added too. The cup is made by the female turning her body and pressing down to make a depression to contain the eggs. The female normally lays one egg per day with clutches varying from 6 - 10 eggs. The eggs are white in colour with some red speckles. On average in England, eggs weigh 2 g and are around 20 mm long and 15 mm wide. During the egg laying period the female is fed by the male, though she also leaves the eggs occasionally to forage for herself. Before she leaves, however, she usually covers the eggs with pieces of the nest material.

When the clutch is complete incubation begins. It is the female who incubates the eggs and during this time she is fed by her mate, usually at the nest entrance, though again she will forage occasionally for herself. When she returns, she sits on the eggs, turns herself until the nest

material is pushed away and continues the incubation. As she incubates, she moves occasionally and re-arranges the nest material with her bill.

After all the eggs hatch, usually within 24 hours, the female nuthatch breaks and eats the egg shells. She initially broods the chicks but soon begins to help her mate find food for them. The rate of finding food increases as the chicks grow and both parents are kept busy meeting their demands. Studies have shown that the parents often make 10 trips per hour initially but this rises to 20 trips per hour as the chicks grow (see Figure 2). Prey size is quite variable, with some apparently large items being presented to the nestlings. The chicks seem to produce quite a lot of saliva, which presumably is an adaptation for dealing with relatively large prey.

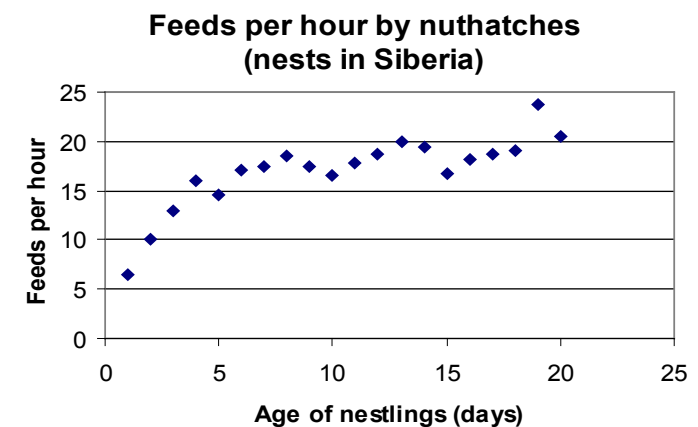


Figure 2 The number of visits per hour with food made by parent nuthatches. Data are from several places in Siberia.

[Matthysen 1998.]

As with many other small birds, nuthatches eat the faecal sacs of their very young nestlings but the response changes after a few days and then they remove the faecal pellets, and any soiled nesting material too.

As the chicks grow, their plumage develops. Typical dates of importance are:

Day after hatching	Plumage change
3	First feathers appear as dark dots on the skin
9	First feathers open
20	Wings completely feathered

[From Winkel 1970, in Matthysen 1998.]

The chicks open their eyes around day 10 (the tenth day after hatching) and from then onward they show an increasing tendency to beg for food close to the next entrance. Since there might be 6 - 9 chicks in the brood, there is an intense scramble for food and this continues for the remaining time they spend in their nest cavity or nestbox. Once they are fully feathered, it is only a few days before they fledge.

Nuthatches are generally quite successful parents, the mean number of chicks reared to fledging is 5 or 6. Failures result from some eggs not hatching, predation, human disturbance, food availability and animal disturbance (birds such as woodpeckers and starlings are often intolerant of nearby nuthatch broods). Having fledged, the young spend some time sitting in the tree canopy nearby, waiting to be fed. During this time they still produce begging calls which not only bring the normal response from parents but probably also contribute to the high predation rate that occurs when they are at this stage. After a week or so, they become increasingly independent of their parents.



Interactive exercises

These interactive exercises focus on the behaviour of the nuthatch nestlings and their parents when one of the parents returns to the nestbox with food. The time from hatching to fledging was around 3 weeks but these three interactive exercises use footage recorded early in the development of the chicks, just before they opened their eyes. This is because the nestlings stayed in the nest cup until they opened their eyes and recording the behaviour of fairly static animals is much easier. Once the young opened their eyes they moved close to the nestbox entrance when a parent arrived with food. As a result, the transfer of food was often out of shot, since the camera was in a fixed position in the top of the box. [In fact, during the nesting period, the staff at the school had to clean the camera and bulb as dirt had obscured the picture. This change in camera position is evident in the footage in Part 1 of the CD-Rom.]

In the early stages of chick development, when a parent returned with food it landed on the lip of the entrance hole to the box and then dropped to the nest surface. By this time, some of the chicks were begging and the parent put the food item (s) into the open beak/ mouth (gape) of a nestling. Usually only one chick was fed at a time but occasionally two chicks received food.

When a parent lands in the box with food it has to decide which chick to feed. We do not fully understand how it makes that decision but research with other species, such as blue tits (*Cyanistes caeruleus*), great tits (*Parus major*), zebra finches (*Taeniopygia guttata*), barn owls (*Tyto alba*), barn swallows (*Hirundo rustica*), tree swallows (*Tachycineta bicolor*), etc. have identified a number of factors that are influential. These include the position of the nestling in the nest cavity, the intensity of the colour of the gape, the size of the gape, the rate of the begging calls, brood size, etc.. The eight nestlings in this brood of nuthatches begged for food when a parent arrived but not all eight would beg each time, since some of the chicks would be resting or sleeping. Usually, two or more

engaged in begging displays, which, until their eyes opened, had three components:

- stretching their neck upwards;
- opening their beak;
- calling.

After the food was presented, the parent waited to see if a chick offers up a faecal pellet. If a chick did offer a pellet, the pellet was eaten or taken out of the box by the parent and calling ceased: if a pellet was not offered the parent left and the calling again ceased.

The exercises suggested here relate to:

- i) the number of chicks that beg for food when a parent lands on the nest surface;
- ii) whether a parent gives food to the chick that stretches upwards furthest;
- iii) the time spent in the nestbox by a parent when it brings in food.

[We have AS/A2/Advanced Higher students of Biology and/or Psychology in mind for the statistical analysis. However, the data could be examined using descriptive techniques (e.g. central tendency measures) or graphical representation with younger students.]

For each of the exercises, the basic approach is similar. Students need to be provided with a photocopy of a worksheet. Each (S1-S4) has the data for the footage when the chicks were 3 days old already on the sheet. So the students will collect data to complete the observations when the chicks were 10 days old. **Their analysis will allow a comparison to be made between the two data sets for day 3 and day 10.** [See the completed worksheet T1].

Once Part II of the DVD is running, the only additional apparatus the students need is either a stop watch or a stop clock.

Exercise A

How many nuthatch chicks beg when a parent arrives with food on day 3 and on day 10?

How do parents allocate the food items they bring in? It is likely to be dependent on the behaviour of both the chick and the parent. A parent, however, makes a decision on the basis of how many chicks are begging, since they only place food into an open beak. So although there are 8 chicks in the nest, in fact only a few of the eight beg each time, so parental choice is actually between, say, 3 or 4 chicks. But does this vary with the age of the chicks? As the chicks get older it might be expected that their demand for food would increase and so more would be begging when a parent visits. The analysis suggested here will answer this question.

The aim of this exercise is to determine how many chicks beg for the food brought in by the parent on a visit and ascertain if the numbers differ on day 3 and day 10. For the purpose of this exercise the number of chicks that beg is defined as follows: 'the number of chicks opening their gapes before the parent puts the food into one beak'. Sometimes a chick is seen to beg after the parent has put the food item into the gape of a chick but this late-begging chick would be discounted here since it did not influence the parent's decision making.

The teacher sheet (T1) shows the number of chicks that were begging when the parent arrived with food. A Mann-Whitney test can be used in the analysis of the numbers of chicks begging on day 3 and day 10 against a null hypothesis of no difference.

Using the Minitab statistical package, the test value $W = 136.5$ (with the median number of chicks begging on day 3 = 3.0, and for day 10 = 4.0) has an associated probability of $P = 0.075$ and the null hypothesis cannot be rejected. So the numbers of chicks begging when the parents arrive with food on day 3 and on day 10 is not significantly different. Presumably, with two parents supplying food (though the rate of feeding visits and quality of the food was not determined) then it might be expected that 3 or 4 should be begging on any visit. Certainly some chicks are resting or sleeping when a parent arrives and do not beg. It is likely that the parents have to increase the frequency of trips to take the increase in chick size into account, as research suggests (see the background notes). It might be interesting to monitor the number of times each chick was fed, if the chicks could be individually recognised.

Exercise B

Do parents consistently give a food item to the chick that stretches upwards furthest on day 3 and day 10?

As we noted earlier, the behaviours of both chick and parent determine which chick receives the food. Does the height that a begging chick stretches upwards influence a parent in allocating the food it is carrying? It might be expected that since the chick which stretches its neck upwards furthest would probably be nearer to the parent than any competing chicks then this would give the chick a competitive advantage over its siblings. Is this the case? The analysis suggested here will answer this question.

The students need to record those instances when a parent arrives in the box with food and at least two, or more, chicks beg. They can simply record whether the parent did, or did not, give the food item to the chick that stretched upwards furthest. The teacher sheet (T1) reveals whether the chick that stretched upwards furthest received the food item. The data can be placed into two sets of two mutually exclusive classes: whether a chick did, or did not, stretch highest and whether the begging was recorded on day 3 or day 10. This array can be put into a contingency table, Table 1.

Table 1 Frequencies of begging

Was the chick that stretched upwards furthest fed?			
Age of chicks	Yes	No	Total
Day 3	2	8	10
Day 10	8	4	12
Total	10	12	22

A two-way classification using a chi-squared test of association can usually be used to analyse such data since frequencies are available and they can be placed into mutually exclusive classes. However, the use of this test would be invalid since one of the cells would produce an expected frequency of < 5.0 . Hence a Fisher Exact Probability Test should be used (see a statistical text, such as Siegel and Castellan, 1988).

Using this test produces a probability of $P = 0.034$ which indicates a significant association between the two variables. So the parents switched their choice of receiving chick, favouring the chick that stretched upward most on day 10 but not on day 3. Whether this choice is consistent is not known, nor when this switch takes place, though the original tapes could be studied to determine if this switch occurred suddenly or changed slowly after day 3 as the chicks developed. This significant association may suggest that once a chick gains an advantage over rivals it could exploit this and so increase its chance of gaining food items. The outcome might mean that it would grow faster, and be taller, and so consolidate any advantage over its siblings.

Exercise C

Do parents spend the same amount of time in the nest when they visit with food on day 3 and day 10?

When a parent returns to the nest with food, it alights on the nesting material surface and then offers the food to one of the chicks. When the food has been accepted the parent always then waited to see if any of the chicks presented a faecal pellet. [Often this waiting included putting the head to one side, perhaps to get a better view of the chicks if one or more were still stretching their necks upwards and obscuring the view of other chicks.] If a faecal pellet was offered it was either eaten if small or carried out of the nestbox if large. The removal of the pellets maintains more hygienic conditions in the nestbox and reduces the possibility of disease.

However, if no faecal pellet was offered the parent left to continue foraging. As the chicks developed, their demand for food would increase so it might be expected that the parents would need to maximise their foraging and so spend less time in the nestbox. Further, when the chicks are small they would probably find it less easy to swallow prey and often a parent was observed putting food into a chick's gape several times before it actually swallowed it. This would again lengthen the stop in the nestbox and so we might expect that the time a parent spent in the box on day 10 would be less than that on day 3. The aim of this exercise is to determine the length of a parental visit and to see if it differs on day 3 and day 10. This exercise will test a null hypothesis of no difference in the time spent in the box by a parent on a food trip.

As the students watch the footage, they need to use a stop watch to record how long the parent spent in contact with the surface of the nesting material whilst feeding one, or more, chicks. After adding their times to the first part of the data table the students can now analyse the data from day 3 and day 10 to determine if the times differ.

Using the Minitab computer package, the mean, standard deviation and variance associated with the time (s) spent in the nestbox on day 3 and day 10, are as follows:

	Mean	Stand. devn.	Variance	F value
Day 3	10.19	3.70	13.674	2.223
Day 10	7.13	2.48	6.151	

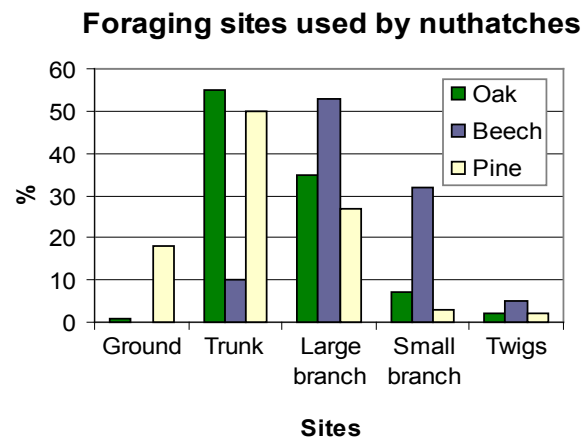
[A normality test, the Anderson-Darling test, showed that the data sets for both days had associated probability values of $P > 0.05$ and thus were not significantly different from a normal distribution.]

Since the requirements for a parametric test have been met, an independent (unrelated) t-test can be used to analyse the findings: this gave a value of $T = 2.45$, $P = 0.023$ with $df = 21$. So the parents were spending significantly less time in the box on a feeding visit on day 10 than they were on day 3. The chicks have bigger gapes and can take the food items from the parent much more quickly on day 10, no doubt aided by the increase in saliva production recorded in the background notes. This releases the parent faster so that it can continue the search for food to meet the increasing demands of the chicks.

These are just three suggestions but teachers or students may wish to carry out other studies based on observations from the footage. For example, they might wish to investigate if the parent gave the food to the begging chick that was the nearest to the parent. [These data are available from Michael Dockery, if needed.]

ADDITIONAL EXERCISE A

Using the graph below, answer these questions.



Percentage of foraging carried out by nuthatches in different areas of 3 woodland tree species.

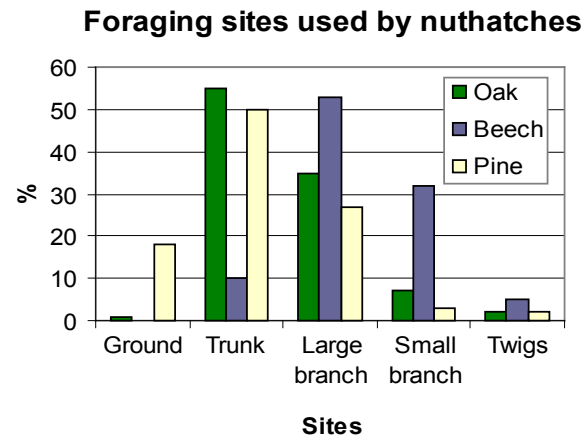
[Matthysen 1998.]

- i) Roughly how much more foraging is done on the trunks of oak trees compared with beech trees?
- ii) Why do nuthatches do so little foraging on beech tree trunks compared with other types of trees? [Tip: think about the type of bark on a beech tree.]
- iii) Suggest why twigs may not be profitable as trunks and branches for nuthatches searching for food.



ADDITIONAL EXERCISE B

Using the graph below, answer these questions.



Percentage of foraging carried out by nuthatches in different areas of 3 woodland tree species.

[Matthysen 1998.]

- i) On what part of an oak or pine tree do nuthatches find most of their food?
- ii) Record whether oak, beech and pine trees are deciduous or coniferous trees.
- iii) Estimate, as a percentage, how much more foraging is carried out on the trunks of oak trees rather than the large branches of oak trees.
- iv) Suggest **one** reason why nuthatches are more likely to find food on the ground beneath pine trees than beneath oak and beech trees.



ADDITIONAL EXERCISE C

Using the table below, answer these questions.

Breeding data from nuthatch studies across Europe.

Country	Clutch size	Fledglings/ clutch	No. of nests in the study
Belgium	7.2	5.0	22
France	6.0	3.8	29
Germany	6.5	3.9	400
Poland	7.7	5.1	66
Slovakia	7.5	5.7	42
UK	7.6	5.5	25

[Matthysen 1998.]

- i) Explain why, in the United Kingdom, clutch size is indicated as 7.6 eggs: the female could, after all, only lay either 7 eggs or 8 eggs.
- ii) Suggest **one** reason for the difference in clutch size, and **one** reason for the difference in fledglings/clutch, between the data for Belgium and for France.
- iii) Suggest **three** factors that might influence the number of fledglings that a pair of European nuthatches could rear.



ADDITIONAL EXERCISE D

Using the table below, answer these questions.

Breeding data from nuthatch studies across Europe.

Country	Clutch size	Fledglings/ clutch	No. of nests in the study
Belgium	7.2	5.0	22
France	6.0	3.8	29
Germany	6.5	3.9	400
Poland	7.7	5.1	66
Slovakia	7.5	5.7	42
UK	7.6	5.5	25

[Matthysen 1998.]

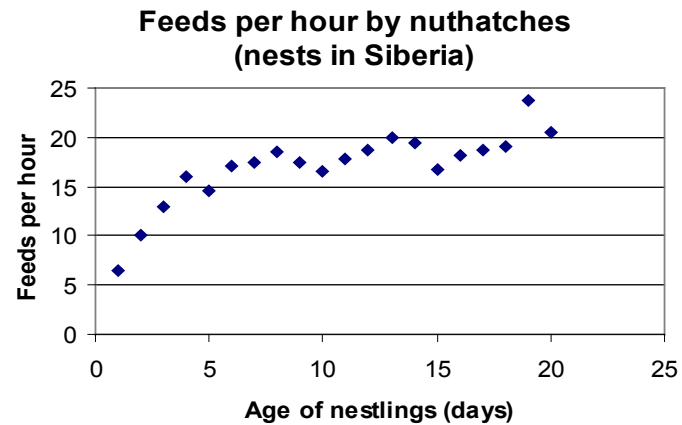
- i) On a sheet of graph paper and using the data in the table, plot a scattergram to show clutch size (x axis) against fledglings/clutch (y axis).
- ii) What does the pattern of points suggest is the link between the two variables?
- iii) In the table, clutch size shows variation, with the values for France and Germany being around 1 egg per clutch lower than the other four sites. Suggest **two** factors that might determine the number of eggs a female will lay in a clutch.



ADDITIONAL EXERCISE E

Using the graph below, answer these questions.

Number of feeds per hour taken to the chicks (nestlings) for the first 20 days after hatching. Data are from several places in Siberia.



[Matthysen 1998.]

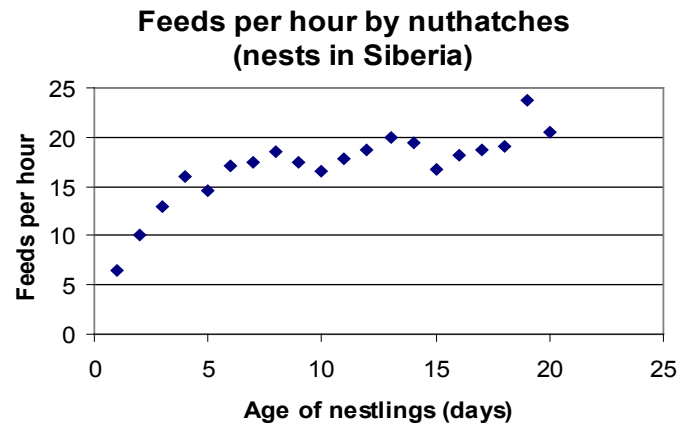
- i) What type of graph is illustrated here?
- ii) What does the pattern of points suggest about the relationship between the two variables?
- iii) Outline the pattern evident in the graph.
- iv) Why, from around day 5 on the graph, does the number of feeds per hour to the chicks not increase very much (staying between 15-20 feeds per hour)? The chicks will still be begging for food!



ADDITIONAL EXERCISE F

Using the graph below, answer these questions.

Mean number of feeds per hour taken to the chicks (nestlings) for the first 20 days after hatching. Data are from several places in Siberia.



[Matthysen 1998.]

- i) Look at the graph and in particular the point shown by the first diamond when the nestlings were 2 days old. How many feeds per hour do parents make when the chicks are two days old?
- ii) Most nuthatch parents seem to be able to provide up to 20 feeds per hour. At this rate, how long, on average, might the chicks wait before a parent returns with food?
- iii) Students try to explain what the graph shows. Which student do you think has given the best answer? Underline the answer you think is best.

Student A: as the nestlings get older they have more time to play;
 Student B: as the nestlings get older they need less food;
 Student C: as the nestlings get older they need more food;
 Student D: as the nestlings get older they hunt for more food;
 Student E: as the nestlings get older they want fast food!

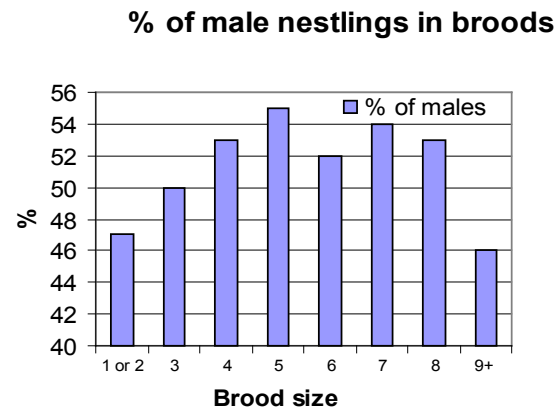
- iv) If parent nuthatches are making 20 trips per hour with food, what does that tell you about how far they go to find food?

- v) Suggest **two** types of food that nuthatch parents might feed to their young.



ADDITIONAL EXERCISE G

Using the graph, answer these questions.



Mean percentage of nuthatch nestlings that were male.

[Matthysen 1998.]

- i) What type of graph is illustrated here?
- ii) What is the general trend evident in the graph?
- iii) Suggest **one** factor that might explain the greater male survival in clutches in broods within the range 4- 8 chicks.
- iv) Outline the consequences that the influence of this factor might have?



ADDITIONAL EXERCISE H

Using the data in Tables 1 and 2, answer these questions.

Table 1 The fate of 400 nuthatch clutches in nestboxes near Frankfurt, Germany. [Schmidt et al. 1992]

Percentage of the clutches that hatched	88 %
Percentage of the clutches that did not hatch	12 %

Table 2 The fate of the broods (%) that did not hatch. [Schmidt et al. 1992].

Taken by predators	25.0 %
Birds were disturbed by humans	37.5 %
Unknown reasons	37.5 %



- i) 12 % of the 400 broods did not hatch. How many broods is this?
- ii) For the percentage of broods that did not hatch a pie chart is drawn, see below. Put the correct labels in the three pieces to show what happened to the broods that did not hatch.



[Schmidt et al. 1992.]

- iii) Suggest **one** way in which humans could have disturbed the birds so much that they stopped nesting in that box.
- iv) Suggest **two** possible 'unknown reasons' that would stop a pair of nuthatches from hatching their chicks.
- v) Pairs of nuthatches that have raised chicks in the previous year often raise more chicks than pairs that are breeding for the first time. Suggest **one** reason that might explain this.

A. AS/A Level/Advanced Higher

- i) 55 % (± 3 %)
- ii) beech bark is quite smooth whereas that on pine and oak trees is rougher and this type of bark provides more sheltered places for insects, insect larvae, spiders, etc. to hide so the birds spend more time foraging on pine and oak trunks since the likelihood of finding food is greater
- iii) the twigs are slimmer and have fewer crevices in which prey might hide so nuthatches search on the trunk and branches where the reward is likely to be greater

B. KS3

- i) trunk
- ii) oak and beech are deciduous - pine is coniferous
- iii) 20 % (± 3 %)
- iv) oak and beech are trees with a dense leaf cover and hence there is little ground vegetation, and prey, associated with them - pine casts a lighter shade and more ground cover would mean more potential prey items under a pine tree

C. GCSE

- i) 7.6 eggs would be the mean clutch size and represents the statistical average number of eggs per clutch - in reality most female nuthatches will have laid a clutch in the range 5 - 10 eggs
- ii) clutch size would be dependent on factors like food availability and predation and the nuthatches in the Belgium samples may have had more food available or perhaps fewer predators active in the area: fledglings/clutch might depend on factors such as experience, and second year parents generally do better than first year parents and this may have tipped the value in favour of the Belgian birds - for both factors, however, sample sizes are not large so a few atypical nests may strongly influence these mean values
- iii) food availability - age and experience of parents - type of habitat, deciduous woodland being better than coniferous woodland - health/condition of female - the prevailing weather

D. KS3

- i) see graph (it should indicate a positive correlation)
- ii) as the clutch size increases, the number of fledglings/clutch raised increases
- iii) her condition, i.e. how well she has fed before nesting and how well her mate feeds her during the egg laying period - her previous breeding experience, second year breeders tend to lay more than first time breeders - quality of male sperm - the number of predators in the area

E. AS/A2 level/Advanced Higher

- i) scattergraph
- ii) there is, overall, a positive relationship between the two variables but it is not a linear relationship
- iii) the pattern of points shows that as the chicks age the parents increase the feeding rate - however, the relationship seems curvilinear so the feeds per hour reaches an asymptote (as, presumably does the mass of a chick) of around 20 feeds per hour from day 5 to day 20
- iv) the feeding rate stabilises around 15-20 feeds per hour when the chicks are around 5 days old since there is a limit to the number of flights a parent can make, even if the food is close to the nest and its quality and quantity does not diminish

F. KS3

- i) 10 feeds per hour (± 2 feeds per hour)
- ii) 3 minutes
- iii) Student C
- iv) they cannot be flying too far to find it since they would have to find, manipulate it and fly to and fro with it in the time, which would be around 3 minutes
- v) insect larvae, adult insects, spiders

G. GCSE

- i) bar chart
- ii) fairly constant pattern of around 50 % of the nestlings are male - some evidence that in small or large clutches more females occur
- iii) males might be preferentially fed by the parents - the males may beg more aggressively than females - males may behave more aggressively in the box and as a consequence females may receive less food
- iv) if more male nestlings survive then there would be greater competition for access to females - would probably be more male-male territorial aggression as having a good quality territory would be critical

H. KS3

- i) 48 broods
- ii) see pie chart
- iii) a nest might be close to an area frequented by humans - people may have regularly walked their dogs near a nest - children may play regularly close to a nest
- iv) death of one of the parent birds - insufficient food to sustain the parent birds or the chicks - the tree housing the nest could have been felled or have fallen
- v) they gain experience from raising a first brood - nuthatches usually nest in the same territory each year so a pair raising a clutch in their second year would know the likely location of good foraging sites



T1

DAY 3	Number of chicks begging	Was tallest fed?	Time in box (s)	DAY 10	Number of chicks begging	Was tallest fed?	Time in box (s)
Feed 1	2	N	9.8	Feed 1	4	Y	9.3
Feed 2	3	N	12	Feed 2	4	Y	4.5
Feed 3	3	N	7	Feed 3	3	N	2.7
Feed 4	2	Y	13.8	Feed 4	4	N	7.3
Feed 5	5	N	5.4	Feed 5	3	Y	10.3
Feed 6	1	Not relevant	7.2	Feed 6	2	N	7.6
Feed 7	3	N	9.5	Feed 7	4	N	6.3
Feed 8	2	N	8.7	Feed 8	4	Y	3.6
Feed 9	1	Not relevant	5.3	Feed 9	2	Y	7.1
Feed 10	5	N	13.6	Feed 10	5	Y	8.6
Feed 11	1	Not relevant	18.3	Feed 11	2	Y	8
Feed 12	3	Y	10.5	Feed 12	7	Y	10.3
Feed 13	3	N	11.4	Feed 13			

S1 (Exercise A only)

DAY 3	Number of chicks begging	Was tallest fed?	Time in box (s)	DAY 10	Number of chicks begging	Was tallest fed?	Time in box (s)
Feed 1	2	N	9.8	Feed 1	4	Y	9.3
Feed 2	3	N	12	Feed 2		Y	4.5
Feed 3	3	N	7	Feed 3		N	2.7
Feed 4	2	Y	13.8	Feed 4		N	7.3
Feed 5	5	N	5.4	Feed 5		Y	10.3
Feed 6	1	Not relevant	7.2	Feed 6		N	7.6
Feed 7	3	N	9.5	Feed 7		N	6.3
Feed 8	2	N	8.7	Feed 8	4	Y	3.6
Feed 9	1	Not relevant	5.3	Feed 9	2	Y	7.1
Feed 10	5	N	13.6	Feed 10	5	Y	8.6
Feed 11	1	Not relevant	18.3	Feed 11	2	Y	8
Feed 12	3	Y	10.5	Feed 12	7	Y	10.3
Feed 13	3	N	11.4	Feed 13			

S2 (Exercise B only)

DAY 3	Number of chicks begging	Was tallest fed?	Time in box (s)	DAY 10	Number of chicks begging	Was tallest fed?	Time in box (s)
Feed 1	2	N	9.8	Feed 1	4	Y	9.3
Feed 2	3	N	12	Feed 2	4		4.5
Feed 3	3	N	7	Feed 3	3		2.7
Feed 4	2	Y	13.8	Feed 4	4		7.3
Feed 5	5	N	5.4	Feed 5	3		10.3
Feed 6	1	Not relevant	7.2	Feed 6	2		7.6
Feed 7	3	N	9.5	Feed 7	4		6.3
Feed 8	2	N	8.7	Feed 8	4	Y	3.6
Feed 9	1	Not relevant	5.3	Feed 9	2	Y	7.1
Feed 10	5	N	13.6	Feed 10	5	Y	8.6
Feed 11	1	Not relevant	18.3	Feed 11	2	Y	8
Feed 12	3	Y	10.5	Feed 12	7	Y	10.3
Feed 13	3	N	11.4	Feed 13			

S3 (Exercise C only)

DAY 3	Number of chicks begging	Was tallest fed?	Time in box (s)	DAY 10	Number of chicks begging	Was tallest fed?	Time in box (s)
Feed 1	2	N	9.8	Feed 1	4	Y	9.3
Feed 2	3	N	12	Feed 2	4	Y	
Feed 3	3	N	7	Feed 3	3	N	
Feed 4	2	Y	13.8	Feed 4	4	N	
Feed 5	5	N	5.4	Feed 5	3	Y	
Feed 6	1	Not relevant	7.2	Feed 6	2	N	
Feed 7	3	N	9.5	Feed 7	4	N	
Feed 8	2	N	8.7	Feed 8	4	Y	3.6
Feed 9	1	Not relevant	5.3	Feed 9	2	Y	7.1
Feed 10	5	N	13.6	Feed 10	5	Y	8.6
Feed 11	1	Not relevant	18.3	Feed 11	2	Y	8
Feed 12	3	Y	10.5	Feed 12	7	Y	10.3
Feed 13	3	N	11.4	Feed 13			

S4 (Exercises A, B and C)

DAY 3	Number of chicks begging	Was tallest fed?	Time in box (s)	DAY 10	Number of chicks begging	Was tallest fed?	Time in box (s)
Feed 1	2	N	9.8	Feed 1	4	Y	9.3
Feed 2	3	N	12	Feed 2			
Feed 3	3	N	7	Feed 3			
Feed 4	2	Y	13.8	Feed 4			
Feed 5	5	N	5.4	Feed 5			
Feed 6	1	Not relevant	7.2	Feed 6			
Feed 7	3	N	9.5	Feed 7			
Feed 8	2	N	8.7	Feed 8	4	Y	3.6
Feed 9	1	Not relevant	5.3	Feed 9	2	Y	7.1
Feed 10	5	N	13.6	Feed 10	5	Y	8.6
Feed 11	1	Not relevant	18.3	Feed 11	2	Y	8
Feed 12	3	Y	10.5	Feed 12	7	Y	10.3
Feed 13	3	N	11.4	Feed 13			