Feedback

The ASAB education newsletter

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Issue 48 **September 2010**

In this issue

Association for the Study of Animal Behaviour

Dear Colleague

As I mentioned in the May newsletter, this was going to be my last newsletter as Editor! However, due to some slippage on the time-table for finding a new Education Officer I will continue in post until December 31 2010. The very good news is that **ASAB Council has appointed Dr Rob Thomas (University of Cardiff) to serve as Education Secretary** and we are delighted that he is our new Secretary and look forward to working with him in the coming months. **The appointment of a new Education Officer will be the first major task of the new Secretary! All the relevant details are on page 22 of the newsletter**. Hopefully the post will attract a number of candidates who would like to take up the challenge. This means that I will produce the January 2011 newsletter and the new Education Officer will be responsible for subsequent issues.

You will notice that in this issue of the newsletter there are four animal cameos! This is because **attendees at the ASAB Easter Conference at Nottingham in 2010 were very enthusiastic about writing pieces about their research animal for FEEDBACK,** most authors being PhD students, and so I have included an extra one. It is likely that there will be four cameos in the January 2011 issue as we are beginning to be sent more pieces from the many keen potential writers of cameos that I met at the European Conference of Animal Behaviour groups, including ASAB, at the summer meeting in Ferrara, Italy in July 2010. So the January newsletter will have the first cameo from an Italian author.

As many of you will know, we have been working with Edexcel to produce resources that are focused especially on their GCSE Biology specification which has a module on Human and animal behaviour. With the new GCSE specifications coming on stream in September 2011 we are very pleased to be able to include in this issue of Feedback **a short piece from Edexcel** (page 18) **bringing us up to date with developments.** We are very grateful

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to Kathryn Booth (Business Manager - Science) for sending us this update.

ASAB Council recently gave the ASAB Education Committee the go-ahead to introduce **a competition to encourage school students in UK to carry out their own research, in their own time, into any aspect of animal behaviour**. The idea would be that individuals/small groups would carry out a research project, write it up for their teacher to make an initial assessment of its quality and the teacher would then send the best 2 or 3 to the ASAB judging panel. ASAB Council were happy to provide three prizes of £100 for the three best pieces of research and certificates would be presented to all individuals/groups taking part. The teachers are not to be forgotten either as the three teachers from the prizewinning schools will also receive cheques for £100 for their schools. The Education Committee doesn`t want to be prescriptive about topics so students could focus on any aspect of behaviour and on any animals. Needless to say, ASAB would ask the teacher responsible in participating schools to check the project to see that no moral or ethical questions are likely to be raised by any projects and that the welfare of any animals under investigation are respected. The likely date for submission of the student research would be 31 October 2010 to allow students to carry out their investigation during the summer vacation if they so wished. The winning pieces of research would be published in Feedback issues in 2011 as a series of illustrated articles.

Michael Dockery

Acknowledgements

Photographs were kindly supplied by Mick Hoult, Felicity Muth, Gareth Jones, Kathryn Hunt, Richard Yarnell, Michael Dockery, BoxWatch, Peter Costen, J Patrick Kelley, Roy Leverton, Andy Russell, Sean Doody, Zack Bittner, Mila Zinkova, Christine Muller and Ullasa Kodandaramaiah.

Linda Gray kindly supplied the drawings of the gazelles and the flamingos and Stephen Tomkins those of the brine shrimps.

We also thank Elsevier for permission to use material from articles in Animal Behaviour for the GCSE Biology, AS/A2 Biology, Advanced Higher Biology and the AS/A2 Psychology exercises.

Design by MIck Hoult

Forthcoming Events

2010

18 – 19 September	**Beachwatch Big Weekend**
2 – 10 October	**Red Squirrel Week**
24 – 25 October	**Feed the Birds Day**
11 November	**ASAB Education Committee Meeting, MMU**
5 - 6 December	**ASAB Winter Meeting, London Zoo – the theme is *Interspecific communication***

2011

6 – 8 January	**ASE Winter Meeting, University of Reading – this will include an ASAB sponsored lecture by Dr Rupert Marshall on `Bird song: sing it again Sam` - the lecture will be on Friday 7 January at 1400 hours in the `Biology in the real world` series.**
11 – 20 March	**National Science and Engineering Week**
27 – 29 April	**ASAB Easter Meeting, Anglia Ruskin University, Cambridge**

NEWS

The **ASAB Teacher Researcher Grant for 2010/2011 has been given to Richard Bottrill**, a member of the Biology Dept at Wilmslow High School, Cheshire. Richard is developing a resource focusing on the ISAs, i.e. Investigative Skills Assessments, that are central to current specifications. Within this area students should be able to "analyse, interpret, explain and evaluate experimental methodology, results and the impact of their own and others' experimental and investigatory activities in a variety of ways". He hopes to target certain areas of the specification for subject knowledge, which would allow teachers to check whether or not students have gained the understanding required to apply to novel situations. Richard hopes to use film of the behaviour of a colony of leaf-cutting ants at Manchester Metropolitan University as a case study to inspire students about animal behaviour. He has filmed students carrying out an investigation in the laboratory to determine whether leaf-cutting ants show a preference for colour when foraging for petals from roses. The resource will be designed to allow students to evaluate the methodology used and the results of the experiment and to apply the knowledge gained to questions relating to the organisms and the investigation itself. The resource will hopefully be available from the Education Officer in the spring term of 2011.

We have a **new resource now available for Key Stage 2, Years 5 and 6.** It is titled **`The behaviour of brine shrimps`** and essentially consists of two filmed investigations and a set of teacher notes. For more details of the resource see page 21 of the newsletter.

I came across a book with a very interesting title recently – ***152 Wild Things To Do*** by **Helen Babbs**. The book was written for The Wildlife Trusts, was published in 2010 by Elliott and Thompson (London) and is £12.99. I`m not sure of the significance (if any) of the number but the book offers lots of tips about how to get youngsters interested in wildlife. Might be worth investigating if it is in your local or school library.

One element of wildlife that might be of interest is the identification of wild plants, especially those in school grounds. **Plantlife is looking for volunteers to help with their latest Wildflowers Count survey.** So teams of pupils and teachers could contribute and record the wildflowers on their school field, playground edges, wildlife areas, etc.. To find out more information, and hopefully to participate too, go to their website, which is:
www.plantlife.org.uk/things_to_do

The Field Studies Council have recently added some **more identification guides** to their library. Among these are:
Guide to floodplain meadows, 2010, OP138, £2.75,
Grasses, 2010, OP136, £2.75,
Rocky shore lichens, 2009, OP132, £2.75, and
Guide to animals on Schedule 9 of the Wildlife and Countryside Act, 2008, OP124, £3.50.
These are as excellent as ever and can be bought from their usual address, which is:
Field Studies Council Publications, The Annexe, Preston Montford Lane, Shrewsbury, SY4 1DU. Tel: 0845 345 4072. Their e-mail is publications@field-studies-council.org
All their publications can be accessed through the FSC website which is located at
www.field-studies-council.org/publications

The Mammal Society produce some very useful Fact Sheets which contain an impressive amount of information that can be freely reproduced for your own use or for use in school projects. The following is a list of the key groups, but it might not be exhaustive.

Insectivores – hedgehog, mole, common shrew, pygmy shrew, water shrew
Rodents – grey squirrel, red squirrel, wood mouse, dormouse, harvest mouse, yellow-necked mouse, bank vole, field vole, water vole
Lagomorphs – brown hare, mountain hare, rabbit

© both Mick Hoult

Deer – Chinese water deer, sika, muntjac, red, roe, fallow
Carnivores – fox, wild cat
Mustelids – badger, otter, pine marten, polecat, stoat, weasel, mink
Seals – common, grey
Cetacea – bottle-nosed dolphin, minke whale

For details about these resources contact the Society at the following address:
The Mammal Society, 3 The Carronades, New Road, Southampton SO14 0AA Tel: 02380 237874. Their e-mail address is
enquiries@mammal.org.uk

NEWS

I had information recently from **Small-Life Supplies** letting me know that **caterpillars of the vapourer moth were now available** as this may interest schools. They have kits ready to be sent, which include two caterpillars, a QBOX to house them and liners to keep them in clean surroundings. Just feed the caterpillars with fresh bramble leaves (that are not wet) and you can see the caterpillars grow (they climb out of their skins to do this). The vapourer caterpillars are very pretty with four yellow tufts and red and black markings, making them ideal subjects to photograph and draw. After a few weeks the caterpillars will be fully grown. They then spin a cocoon around themselves, pupate under the lid of the QBOX and emerge in spring 2011. The males have brown wings and can be set free outside in the UK. Incredibly the females don't have wings at all! A detailed information sheet is included with each kit but be aware, they don't have that many, so order promptly as they will be ready for dispatch 6th September 2010 onwards. The kit costs £11.99, plus delivery, and could make an exciting project. They can also supply bags of fresh bramble leaves if you can't find them locally. Here is their weblink
http://www.small-life.co.uk/page8.html

We have recently had a couple of changes to the **ASAB Education Committee** and below are the **current members**.

They are: Dr Rob Thomas, Secretary, (University of Cardiff), Craig Roberts, (Independent Consultant), Dr Sue Howarth (University of Worcester), Dr Mike Topping (Loretto School, Musselburgh), Dr Lottie Hosie (University of Chester), Dr Sheila Pankhurst (Anglia Ruskin University), Dr Dee McCarthy (Hutchesons` Grammar School, Glasgow), Dr Andy Russell (University of Exeter), Polly Lee (St Monica`s RC Primary School, Flixton) and myself.

ANIMAL CAMEO

The southern masked weaverbird – *Ploceus velatus*

The southern masked weaverbird is a species of weaver which is found throughout southern Africa. As the name suggests, weaverbirds build nests through knotting and weaving grass, creating complex and striking structures.

To start building their nest, weaverbird males tear long grass strips and knot their fresh piece to a branch. They keep adding bits and eventually create a loop of grass woven firmly to the tree. The birds sit in the middle of the loop, adding grass from the top to the bottom of the loop to create the main chamber of the nest. This part of the nest is where the female will eventually lay her eggs and her chicks will stay until they are old enough to leave the nest. Once he has built the basic structure, the male weaves in more and more grass, just like a human weaver, until the nest is thick and sturdy enough to survive the colossal African storms.

Females go from male to male, checking out their nests and seeing how they compare. If a female likes a nest and the male builder, she will accept it and let him mate with her. She will then add a soft lining to the nest, like soft grass and feathers, to help keep her eggs safe and warm. However, if females reject the nest a male has built then after a few days it will start to look old and brown. The male will then tear down the nest he has so painstakingly built and start all over again, in the hope that this one will do better with the females.

Five fascinating facts

1. Weaverbirds are territorial, and to scare off other males they will fluff themselves up to make them look bigger than they really are.
2. Attracting a female is vital to producing young, and to do so the male will hang from a branch in his territory and do pull-ups.
3. The male has a particular display for when he is advertising a nest to a female. This involves hanging from his nest, flapping his wings vigorously, and making a lot of noise.
4. Whilst the males are bright yellow, females are dull brown and inconspicuous.
5. Weaverbird song is described as a 'twizzle' which sounds strangely robotic.

ANIMAL CAMEO

If a male does manage to persuade a female to accept his nest and mate with him, then he will start building another nest almost immediately to secure another female, and so on after this. These weavers are polygynous, which means that one male can mate with many females. This is unusual for birds, which are usually socially monogamous, meaning that they will pair with one other individual, but possibly mate with other individuals if they get the chance.

© Felicity Mith

Males do not get involved in caring for the young, and it is the female who does all the incubation and feeding of the chicks. Weaverbirds will eat seeds, grain and insects like caterpillars. However, the males will keep on the lookout for predators like snakes and birds of prey, and give an alarm call if they see any.

No one really knows quite how birds like the weaverbird build their nests, Do they learn from their parents? Or perhaps through playing with grass themselves when they are young? Or maybe just from watching other birds build nests? Scientists are right now trying to find the answers to some of these questions.

Felicity Muth,
University of St Andrews

© Felicity Mith

ANIMAL CAMEO

Greater horseshoe bat – *Rhinolophus ferrumequinum*

Rhinolophus ferrumequinum, commonly known as the greater horseshoe bat, can be easily distinguished by the presence of its extraordinary noseleaf: a fleshy horseshoe that surrounds its nostrils, which is in fact so large that it partially obscures the field of vision afforded by the bat's rather small eyes. Found across Europe, Asia and North Africa, the British population is currently classified as endangered by the IUCN Red Data List and estimated to contain only 6,000 individuals. These are distributed between 24 known colonies, confined to SW England and southern Wales.

A greater horseshoe bat

© Gareth Jones

Five fascinating facts

1. Greater horseshoe use ultrasonic calls to locate their favourite insect foods, noctuid moths and beetles.
2. Female greater horseshoe bats belong to one of the few groups of mammals that are able to store sperm over a prolonged period of time. Sperm storage is thought to promote competition between sperm from different males for fertilization of the female's egg.
3. Females give birth hanging upside down: infants are born into their overlapped wings.
4. It is common for a female greater horseshoe bat to mate with her 'step fathers' – that is the previous mates of her mother. This increases levels of relatedness between members of the population without a contingent increase in the level of inbreeding.
5. Birth timing is strongly affected by spring temperature, with young being born earlier after warmer springs. Cold springs and late births lead to population declines and male-biased sex ratios.

The perfect study organism, greater horseshoe bats are simple to locate in the wild. Easy to identify by sight, they have a distinct ultrasonic call and males leave yellow/brown scent-marks above their roosts. In the summer, maternity colonies form in the sun-warmed attics of large, old buildings, while in the winter both sexes roost in caves, mines and cellars. Most individuals hibernate near to their natal roost and females return annually to give birth and raise young. Greater horseshoe bats show unusual longevity for a small

The noseleaf of a greater horseshoe bat, which amplifies the ultrasonic calls it emits when searching for food.

© Gareth Jones

mammal, and can live to 32 years! This reflects the low fecundity of females who give birth to only one pup each year. Pups have a relitively long period of immaturity and most adults do not breed until their second or third year. Thus we can gather longitudinal data about individuals and measure their responses to changing environmental conditions.

Studies of greater horseshoe bats indicate that females exert an unusual degree of mate choice. In many mammals males are the larger sex and can constrain female mate choice. However, female greater horseshoe bats are bigger than males. What's more, female bats live separately from males for most of the year: only in autumn do they disperse and form temporary groups with single territorial males. Mating occurs and, in an example of excellent family planning, sperm are stored through hibernation until April, when they can be used for fertilization. This means females do not need to spend time locating and mating with males in the spring. Instead they can begin to nurture their offspring as early as possible. This is important as earlier born pups have greater chances of survival as they experience longer periods of food availability before unfavourable feeding conditions arise in autumn. Breeding females form colonies to raise their pups, which are weaned at around 49 days.

Baby greater horseshoe bat

Patterns of female choice within this species are intriguing; females show sequential mate fidelity between years and there is considerable intra-lineage polygyny, where females from the same matriline often share breeding partners. Mate fidelity and intra-lineage polygyny increase relatedness among kin in a matriline, which could facilitate evolution of beneficial co-operative behaviours among these individuals.

Helen Ward,
Queen Mary, University of London


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Leaf-cutter ants – *Atta* and *Acromyrmex* species

Leaf-cutter ants are insects that inhabit tropical and subtropical regions of Central and South America. At present there are approximately 40 known leaf-cutter ant species, which fall into two genera; *Atta* and *Acromyrmex*. Leaf-cutter ants are eusocial meaning that only one female in every colony reproduces, with all other individuals tending to her needs. This reproductive female is known as the queen and she is much bigger in size than all other individuals within the colony.

Leaf-cutter ants are central place foragers, meaning they travel out up to hundreds of metres from their nests to locate remote food sources and then return with prey items in the form of harvested leaf fragments. However, unlike solitary living central place foragers who forage for personal consumption, leaf-cutter ants do not actually consume the leaf fragments themselves. The fragments are processed within the colony's nest chamber, in which a complex set of tasks including hoisting (carrying the leaf fragments to the top of the chamber), cleaning and shredding are performed, in order to produce a fungus garden. This fungus then yields specialised structures called gongylidia, which act as the primary nutritional source for the whole colony.


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Leaf-cutter ant colonies show division of labour in which the work is divided, such that different individuals perform different tasks and often specialise in them. These work divisions are often accompanied by physical differences between individuals, meaning that those who perform these different tasks are morphologically different from one another. The different groups created by these work and size differences are called castes. The smallest ants, known as the minimae, tend to the brood and fungus garden, whilst those of a larger size, known as the mediae, go out and forage. Some species also have even larger individuals known as majors: they act as soldiers, patrolling and defending the colony from threats. Majors are distinctive due to their oversized heads and large serrated jaws. Even within these groups further individual specialisation can occur. For example, different foragers often appear to perform different tasks, with the army terms scout and recruit commonly used to characterise two types of forager. The term scout is used to define those individuals that explore independently, whereas the term recruit is used to define an individual that forages based upon the information provided to it by a scout. Furthermore, it is known that certain individuals within the minimae will consistently perform the task of removing dead individuals from the colony, giving rise to distinct 'undertaker' ants! This division of labour has enabled leaf-cutter ant colonies to become incredibly efficient foragers, which is thought to be the main reason for their overwhelming evolutionary success.

Five fascinating facts

1. Leaf-cutter ants have existed on Earth for approximately 50 million years.
2. A single colony can contain millions of individual ants.
3. The queen can lay up to 30,000 eggs per day.
4. Foragers can carry leaf fragments that weigh over 20 times their body weight.
5. The relationship between the colony and the fungus is obligate and mutualistic, meaning that each relies on the other for survival.

Kathryn Hunt,
Queen Mary, University of London

ANIMAL CAMEO

Brown hyaena - *Parahyaena brunnea*

Brown hyaenas are one of only four species belonging to the hyaena family. The other living members of this family are the spotted hyaena (*Crocuta crocuta*), the striped hyaena (*Hyaena hyaena*) and the aardwolf (*Proteles cristatus*) and all are found in Africa. Brown hyaenas have a typical hyaena build, with large shoulders and neck and a sloping back. They weigh almost 50 kg and are 0.8 m high at the shoulders, which is bigger than a German shepherd dog. Males are slightly larger than females. Like striped and spotted hyaenas, brown hyaenas have very powerful jaws, which they use to crush bones. The aardwolf by contrast has small teeth and jaws as they specialise on insects, such as termites, for food.

A brown hyaena at Pilanesberg National Park, South Africa

Brown hyaenas are only found in southern Africa in semi-arid regions in Namibia, Botswana and South Africa. They live in social groups called clans, with between 2 and 14 members in each group. They forage alone, but all members will bring food back to the den for cubs. They are principally scavengers of large antelope carcasses, but will take a wide range of food items if they can catch them, including, insects, small mammals, birds, and reptiles. In contrast to spotted hyaenas, the brown hyaena does not hunt large herbivores.

Grass stalk covered in brown hyaena paste marking

Clans mark their territory in two main ways. Firstly, they use secretions from an anal gland. Such scent-marking is often carried out on grass stems and contains two pastes, one white and one black. The white paste is very strong smelling and can be detected by humans up to a month after it was deposited. The black paste does not smell as strongly and only lasts for a few days. It is thought that the white paste conveys information about ownership of the territory, while the black paste may be a form of communication with other group members, indicating the time since a hyaena had passed that way. It would be important for an individual hyaena to have this information to ensure it did not forage in an area that was recently visited by another hyaena which may have depleted the available food. This communication would allow clan members to forage more efficiently. The other way brown hyaenas mark their territory is by using latrines, made up of a number of scats.

There are thought to be about 10,000 brown hyaenas left in the wild. Today brown hyaenas are still shot by livestock farmers who wrongly believe that they pose a threat to their sheep and cattle. If farmers can be further educated about the feeding behaviour of brown hyaenas and told about the limited threat they pose to livestock then the future of brown hyaenas in the wild will be more secure.

Dr Richard Yarnell,
Nottingham Trent University

Mother returning to her den with warthog head for cubs

Five fascinating facts

1. Despite their dog-like appearance, hyaenas are more closely related to cats than dogs. Within the order Carnivora, species are grouped into two main branches, the cat branch and the dog branch. Hyaenas are classified on the cat branch, along with other species such as mongooses, which are also closely related to hyaenas.
2. Brown hyaenas can live in arid areas such as the Skeleton Coast in Namibia, where fresh water is not always available. In such areas they get all their water from their food and often eat tsama melons, which are desert fruits with a high water content. However, they will drink water where it is available.
3. Brown hyaenas have an excellent sense of smell. One individual was recorded to have detected the drying leg of a gemsbok from 1.8 km away and then moved upwind to find and feed on the leg.
4. Brown hyaenas have such powerful jaws that they can crack open the thigh bone of a giraffe.
5. Brown hyaena can travel great distances, often covering up to 30 km in a single night. One male brown hyaena was even recorded travelling 650 km down the west coast of Africa - that's the distance between London and Aberdeen.

A practical investigation for AS/A2/Advanced Higher students into a personality trait of brine shrimps Artemia franciscana

Michael Dockery and Emily Hills

Introduction

Over the last two decades there has been an increase in research into individual variation in animals (Wilson 1998). One area of interest that has sparked considerable research, and controversy, has been the personality traits of animals. Whilst research into human personality has been carried out for several decades (Hayes 1994) it is only in the last 20 years or so that animal personality has been the focus of investigation.

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When referring to human personality, a suitable definition might be "the traits, modes of adjustment and ways of behaving that characterize the individual and their relation to others in their environment" (Morgan 1961). Implicit in this definition is that the traits, modes of adjustment and ways of behaving are relatively stable, so that in the same situation an individual would behave in a very similar, and therefore predictable, manner. Personality traits, in humans at least, need to be characteristic of an individual to be meaningful. Luttbeg and Sih (2010) recognize that many animals will show personality traits, with consistent individual differences in two, or more, situations. They also believe that personality traits are more likely to be seen in situations or environments of medium risks and rewards: where the risks and rewards are high or low then the tendency will be for individuals to behave in a consistent manner.

A personality trait that has been studied in a variety of animal species is the boldness-shyness continuum (Wilson *et al*. 1994). This trait can be viewed as a spectrum, going from complete recklessness to inactivity. So, in any population of animals some individuals will be quicker to respond to a stimulus, such as the appearance of a predator (Murphy and Pitcher 1997) or a novel object (Wilson *et al*. 1993), whilst others will respond more slowly and some hardly respond at all. Those individuals that respond quickly may trade-off the possibility of exposure to a threat/predator if a potential reward is great, such as a high quality foraging patch (Pitcher *et al*. 1998). Slow responders may avoid the predatory threat by keeping still, or hiding, but they may lose out on a foraging opportunity. The likelihood of behaving in a risky manner may also be influenced by the nutritional state of the individual (Sih 1997), so hungry animals may need to be bolder in order to renew their energy demands. Hunger levels in fish are also known to influence grouping, hungrier fish spending less time in a large group (Krause 1993). This variability in behaviour is likely to vary on a day-to-day basis, so boldness may increase with hunger. This is not to say that boldness is the same as risky behaviour, being timid is risky too because an animal that is timid may not feed.

Research with poeciliid fish, *Brachyrhapsis episcopi,* (Jennions and Telford 2002), also found that there were gender differences in the boldness-shyness continuum, which may reflect different life history strategies that the two sexes show. Males may need to spend more time chasing females in order to increase their genetic representation in future generations, so males may be bolder.

The concept of a boldness-shyness continuum is one that sixth form students can readily relate to and we suggest here an investigation that would allow A Level and Advanced Higher students to gain some insight into individual variation in members of a population.

Many studies of boldness-shyness have used fish. For example, Godin & Dugatkin (1996) used guppies, *Poecilia reticulata*, Murphy & Pitcher (1997) used minnows, *Phoxinus phoxinus*, Dowling and Godin (2002) used banded killifish, *Fundulus diaphanous*, and Krause *et al*. (1998) used three spined sticklebacks, *Gasterosteus aculeatus*. Few schools and colleges are likely to have significant numbers of fish so we suggest using brine shrimps (*Artemia franciscana*), see Figure 1.

Brine shrimps are invertebrates that live in tropical and semi-tropical salt lakes. There are a number of species and all are in the genus *Artemia*. Students may already be familiar with them since adult brine shrimps are sold as `sea monkeys` or `fairy shrimps` in pet shops, primarily as live bait for fish. For details regarding their ecology, rearing and maintenance see Dockery, Barber and Maskew (2008) or Dockery & Tomkins (2000).

Brine shrimps are particularly suitable for carrying out classroom investigations into aspects of animal behaviour and may, therefore, provide school students with some insight into how well suited they are to their natural environment.

The investigation suggested here focuses on the time taken for brine shrimps to emerge from a refuge or shelter into an aquarium tank of saltwater. The aim is to determine the individual variation in emergence times of female and male brine shrimps from a refuge/shelter under a null hypothesis of no difference in emergence times.

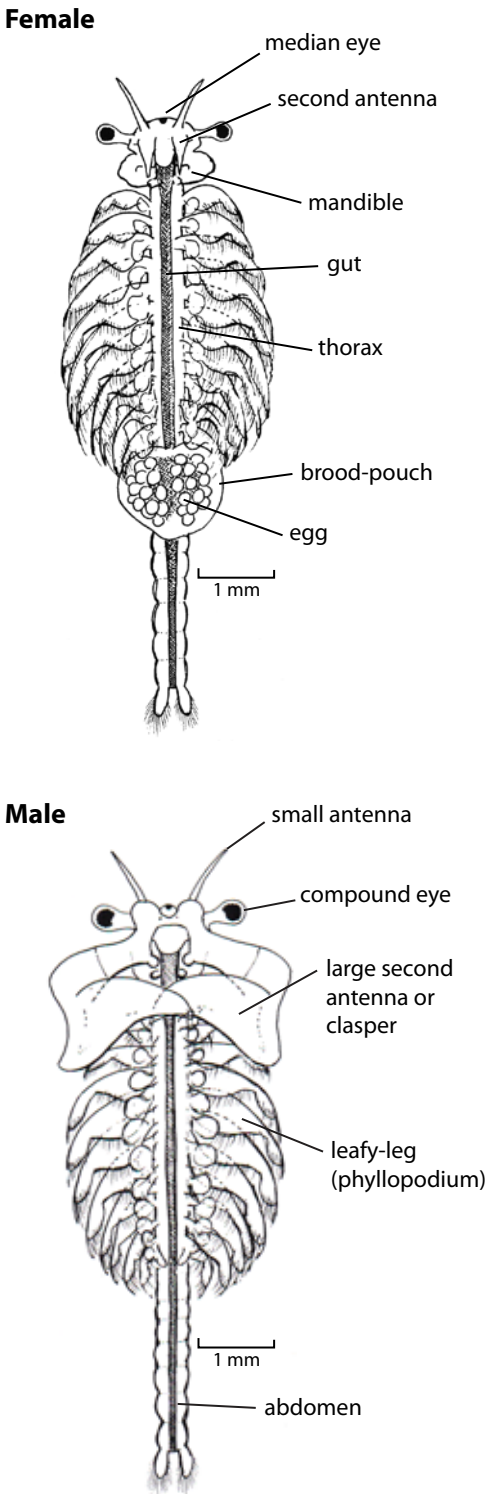
[This investigation is based on one aspect of an M.Sc. project carried out at Manchester Metropolitan University by EH.]

Materials and methods

The brine shrimps were housed in several aquarium tanks (29 x 21 x 20 cm). Each tank had its own well-established culture of algae and brine shrimps (newly-hatched nauplius larvae, juveniles and adult shrimps) and had been a self-sustaining population for several months.

For the investigation, a clean tank (30 x 20 x 20 cm) was placed on a laboratory bench under fluorescent lights to keep light intensity constant, see Figure 2. [If your labo-

Figure 1 Adult female and male brine shrimps



ratory bench surface is dark in colour, like wood, then it is best to put a piece of white card or paper under the tank as this makes it easier to see the brine shrimps.] Saltwater was poured into the tank until it was two thirds full and an acetate sheet placed over it to reduce evaporation. The tank was left overnight to allow the water to reach room temperature (24°C).

Figure 2 Aquarium tank in position in the laboratory.

The following day 20 female and 20 male adult brine shrimps were selected, without conscious bias, and pipetted up from two of the main stock tanks. The shrimps were carefully placed into a 1000 ml beaker of saltwater, with some substrate, and allowed to settle for 30 minutes. During this time, 40 small beakers (each 50 ml) were prepared to house the brine shrimps overnight. Each beaker had a teaspoonful of substrate placed in it to allow the shrimps to feed over the next 5 days, and each was then topped up with saltwater. Overnight, an acetate sheet was placed over the two sets of 20 beakers (each beaker holding either one male or one female brine shrimp) to reduce evaporation.

After the 30 minutes of acclimation, one male and one female shrimp were pipetted up from the 1000 ml beaker and each was placed individually into its own 50 ml beaker: the beakers were marked F1, M1, F2, M2, etc. to identify the pairs to be tested together. Apart from when they were being tested, each shrimp remained alone in its `home` beaker for the next five days. A plastic pot (120 ml) was used as the refuge/shelter, see Figure 3. This pot had a triangular cut made into it (making an equilateral triangle with sides of 3 cm) using a pair of scissors: the cut allowed adult brine shrimps to easily swim through it. A piece of acetate was cut to act as a cap and Sellotaped to the pot to prevent movement. A glass well was Sellotaped to the base of the pot to weigh it down so it did not float upwards when released in the water, see Figure 3. A second strip of acetate, rectangular in shape, was cut which covered the triangular opening in the pot and prevented the shrimps swimming out of the refuge/shelter as it was placed upside down onto the base of the tank. On releasing the refuge/shelter the strip of acetate dropped down and rested on the bottom of the tank, thus offering the shrimps the opportunity to swim out of the refuge/shelter.

Figure 3 The plastic pot used as a refuge/ shelter

When ready to be tested, each pair of shrimps were placed into the refuge/shelter and saltwater added to the point of the cut. The rectangular strip of acetate was then held in position to cover the cut. The refuge/shelter was carefully placed under the water and when the pot was full of saltwater it was turned upside down and placed in the centre of the tank. As the strip was released, a stop watch was started to record the time spent in the refuge/ shelter by each shrimp. If a shrimp remained in the refuge for the five minutes allocated for each test trial, it was given the maximum time of 300 s. After this test period was over, the two shrimps were returned to their own individual beakers, where they remained until they were tested again at the same time (0930 – 1130 hours) the following day.

The next pair of shrimps, F2 and M2, were then tested, followed in turn by the other eighteen pairs. Over the next four days the same procedure was followed, with each pair of brine shrimps tested in turn and their emergence times recorded.

Results and analysis

Here are sample data, showing the mean times of emergence for twenty pairs of shrimps, see Table 1 and Figure 2, using the set-up described above.

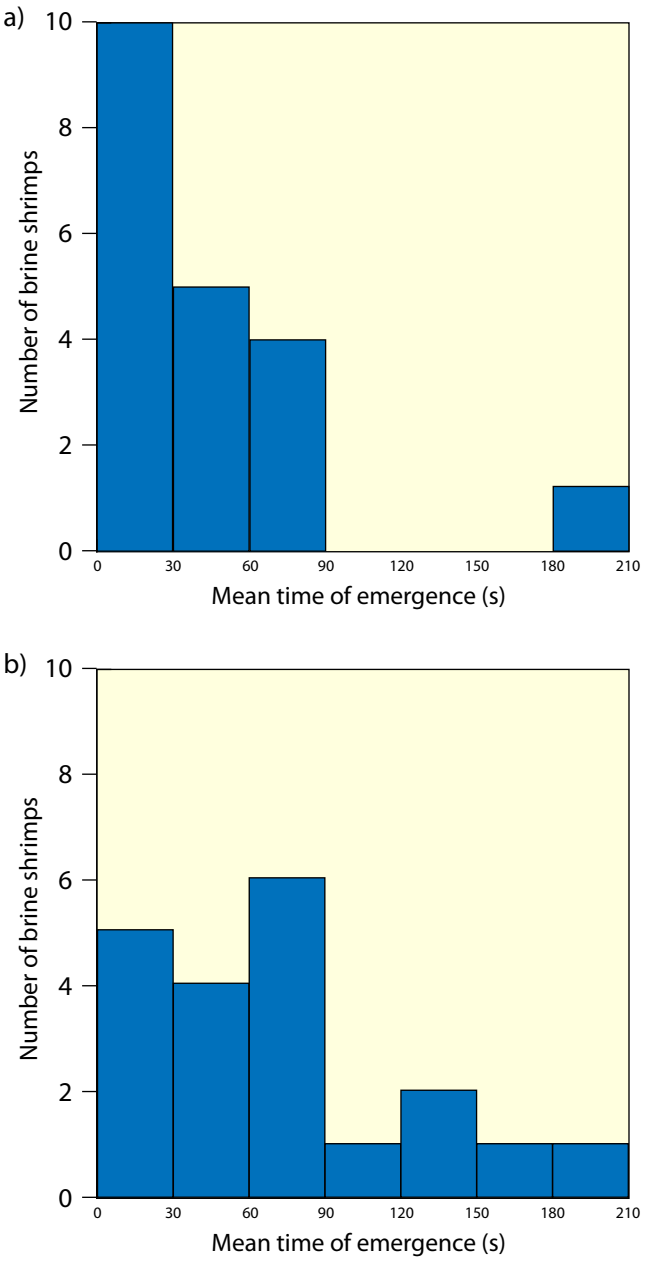
Table 1 Mean times of emergence (s) of the twenty pairs of brine shrimps.

No.	Female(s)	Male(s)
1	18.37	62.45
2	12.95	128.00
3	13.14	23.84
4	12.83	88.52
5	181.10	68.71
6	30.98	37.15
7	81.33	191.58
8	22.20	34.21
9	58.75	41.29
10	20.75	9.44
11	41.58	80.34
12	85.42	56.68
13	85.50	131.07
14	7.57	24.03
15	77.06	20.78
16	25.04	95.19
17	21.37	152.36
18	47.46	77.42
19	16.84	17.54
20	55.29	74.56
	Range = 173.53 s	Range = 182.14 s

The histogram, Figure 2a, shows a non-normal distribution of the mean emergence times for the female shrimps (also confirmed by an Anderson Darling test, with $P < 0.05$, showing that the distribution differed significantly from a normal distribution) whilst Figure 2b, for male brine shrimps, shows a closer accord with a normal distribution (the Anderson Darling test showed $P > 0.05$). A Mann Whitney test showed that the null hypothesis of no significant difference in mean emergence times between female and male brine shrimp was confirmed ($W = 340.0$, $P = 0.06$). This probability level is, however, close to the significance level of $P = 0.05$.

[These data could be analysed in other ways too. For example, if the sex of the `first out` of the refuge/shelter had been noted for each pair in each of their 5 trials, then a null hypothesis of no difference in the emergence times between male and female shrimps could be tested. The frequencies for `first out` for the females (N = 54) and males (N = 44) using a Chi-squared test ($X^2 = 1.020$, df = 1, $P > 0.05$) showed that female and male shrimps did not differ significantly in their order of emergence. A Sign test could also have been used on these data (N = 19, $P > 0.05$) which again showed no significant difference between female and male shrimps regarding their order of emergence.]

Figure 2 Histograms of mean emergence times (s) of a) female and b) male brine shrimps



Discussion

The sample data presented here showed that there was no difference in the mean emergence times of female and male brine shrimps from a refuge/shelter. This finding matches that for salmon *Salma trutta* (Johnsson *et al*. 2001) and poeciliid fish *Brachyraphis episcopi* (Brown *et al*. 2005). These data show that there was considerable variation in boldness-shyness so brine shrimps do not seem to show consistency in this behavioural characteristic. This may be typical of the species if the laboratory set-up here was judged to be medium risk and medium reward (Luttbeg and Sih 2010) or may be due to external factors not tested in this investigation. Further work, with larger sample sizes for example, is needed.

It has been suggested that boldness may increase with hunger (Krause *et al*. 1998: Sih 1997). This was not tested in this study, as the brine shrimps had access to food for the 5 days when they were isolated in their individual beaker. It would be possible to deprive the brine shrimps of substrate in a class laboratory for a few hours but leaving them in a beaker of pure saltwater for longer is likely to increase the mortality rate significantly.

The nutritional state of animals in the wild has been suggested to vary on a day-to-day basis (Brown and Braithwaite 2004) and so the propensity for boldness may be variable too, i.e. boldness in brine shrimps would be expected to show behavioural plasticity, and this seems to have been found here. Testing shrimps in schools, perhaps by depriving some of food for, say, 2 or 3 hours and comparing their emergence time with a group deprived of food for 4 or 6 hours, would be possible and within a normal school day.
One way in which the sexes may differ in hunger and boldness, both in the wild and in the classroom or laboratory, may be seen during courtship. In courtship behaviour, a male brine shrimp grabs a female about two thirds of the way along her body and then they swim around together for several hours (Dockery and Tomkins 2000), the female leading the male around the tank before they mate. When in the courtship position, the female can easily feed on algae on the substrate or the sides of the tank but the male could not since his mouth doesn`t reach the substrate or tank side. It would also be difficult for the male to consume any algal particles floating in the water as the two animals swim around since his mouth would be close to the female`s body. So it would, presumably, be crucial for a male to feed up before grabbing a female, so pre-courtship behaviour may be marked by greater boldness in order for a male to concentrate on feeding to build up his reserves in order to court and mate successfully.

Another factor influencing boldness is predation (for example, Krause *et al*. 1998, Brown and Braithwaite 2004 and Harcourt *et al*. 2009). This may suggest that individual differences in genetic heritability (Goddard & Bilharz 1985) could be influential but investigations with predators, such as fish, should not be carried out without the relevant Home Office licence and so are unlikely to be undertaken in schools.

In this investigation we used an emergence test to indicate boldness. However, it has recently been suggested (Burns 2008) that emergence tests may not be as reliable or as valid as other tests, notably open-field tests. [In such a test, the animal is placed in a new open environment (such as a large glass dish of saltwater in the case of brine shrimps) and boldness can be interpreted, for example, as the distance a shrimp moves from the edge of the dish. Staying in the outer or in the central part of the dish may also have the advantage of being more relevant to behaviours shown in the wild.] It would, therefore, be worthwhile comparing outcomes from the emergence test with those from an open-field test.

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GCSE Science - Edexcel

Kathryn Booth, Business Manager - Science

Edexcel, in consultation with Ofqual, are currently redeveloping their GCSE Science qualifications for first teaching in 2011. Edexcel offer a suite of five qualifications, including GCSE Science and GCSE Additional Science (which each have a Biology, Chemistry and Physics component), GCSE Biology, GCSE Chemistry and GCSE Physics. The qualifications are nested, so the Biology component from Science, the Biology component from Additional Science and an extension Biology unit make up the GCSE in Biology.

Ofqual define the requirements for Science, and the majority of requirements for Additional Science, but in the extension units, awarding organisations are free to choose the subject content. Edexcel's legacy GCSE in Biology contained a section on Animal Behaviour, which proved popular with centres, and as a result Edexcel are committed to

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continue with this as a major section of the full GCSE in Biology. Last year over twelve and a half thousand students took GCSE Biology with Edexcel.

Edexcel have taken the opportunity of the development of new GCSEs in science to review the content of the behaviour section. In a very broad brush introduction to the field, students now cover mating strategies and parental care, specific behaviours such as imprinting and habituation, types of conditioning, communication, and human behaviour through the course of human evolution. A new

© Andy Russel

emphasis has been placed on the work of professional scientists and how the scientific process has led to greater understanding of the field of behaviour. Students are now required to learn about the work of Tinbergen, Lorenz, Fossey and Goodall. This lends itself well to the *How Science Works* agenda, which is embedded in school science teaching. Practical work is being promoted through the use of suggested practicals within the specification and centres are encouraged to take a practical approach to this section where possible. Edexcel hope that this unit will give a good overview of behavioural studies to KS4 students and will encourage its study at higher levels.

© Christine Muller

Observations of blue tit behaviour in a nestbox

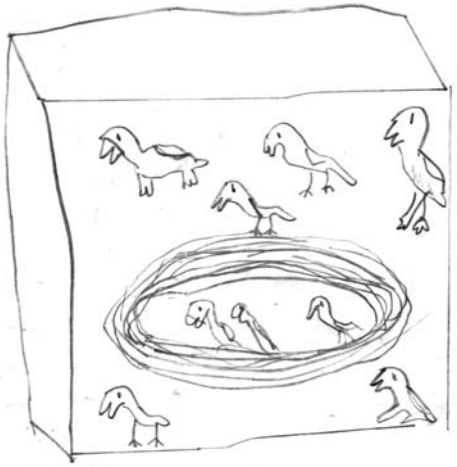
Children of Year 3 at St Joseph`s School, Chalfont St Peter

For the 2010 nesting season the school had loaned one of the ASAB nestboxes and the feed from the camera in the nestbox came into the classroom of Year 3 (7 – 8 year olds). Once the camera and nestbox was put up on the roof of the school the pupils in Year 3 began to make observations of behaviours they saw on the television monitor. Their teacher, Mrs Alexander, asked them to write to me about what they had seen and below are a few excerpts from the letters I received.

© Boxwatch

Thanks for the bird box – it`s like the best thing I have ever had in the school or in the class.
Luis

Thank you so much for supplying the equipment for the bird box. I really appreciated the experience of watching the blue tit family.
Ethan



At first, when we had the box it was bare but after a couple of weeks a blue tit kept popping in and out, as if she/he couldn`t make up her/his mind. About four weeks later the blue tits began to make a nest.
Freddy

Everybody in my class was very hyper when we saw a bird in the nestbox. When the bird went in the box everybody said "The bird!" It got a bit irritating.
Sofia

For about four weeks the blue tits came to the nestbox every day and finally, in a Maths lesson, one brought the first tiny bit of grass to the box. By the next weekend the floor of the box was covered in grass.
Finn

© Mick Hoult

The blue tits prepared the nest well. The female was moving the grass and things around the nest. It was funny watching her fussing so much. She put down feathers last of all to make the nest comfortable and insulated.
Ethan

After the nest was ready the female began to lay eggs, there were nine eggs. Sadly, two of them did not hatch.
Finn

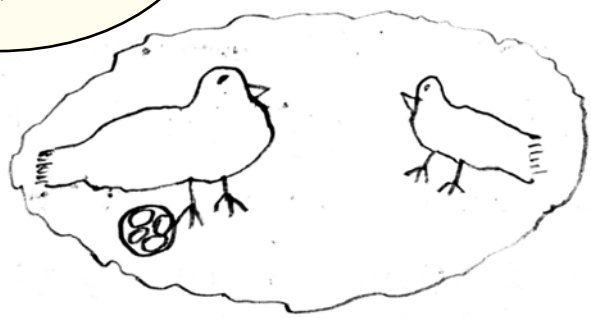
Some weeks later the eggs hatched and the chicks were wriggling about. Some people thought they looked very ugly while others thought they were cute.
Sofia and Freddy

For the next few weeks the mum and dad got food for the chicks. Mostly the male flew off to find food and the female stayed to look after the baby chicks. They grew bigger and they started to get their feathers.
Siobhan and Rui

© Mick Hoult

Over the holidays (half term break) they flew the nest. We wish them well. Thank you for giving us this wonderful opportunity to see the birds.
Stephanie and Katy

The blue tit family are all gone now (13 June 2010) but I will never forget them.
Ethan



NEW RESOURCE

New resource for Key Stage 2

`The behaviour of brine shrimps` is a new ASAB resource for Key Stage 2, being specifically aimed at Year 5 and Year 6 pupils.

The resource has two components:

The behaviour of brine shrimps

Manchester Metropolitan University

Tor Yip, Evie Astbury, Dave Jones, Dave Higson, Fraser Coombe, Harry Gallimore, Helen Duxbury and Michael Dockery

An ASAB & MMU teaching resource (DVD) for Key Stage 2 (Years 5 and 6) 2010

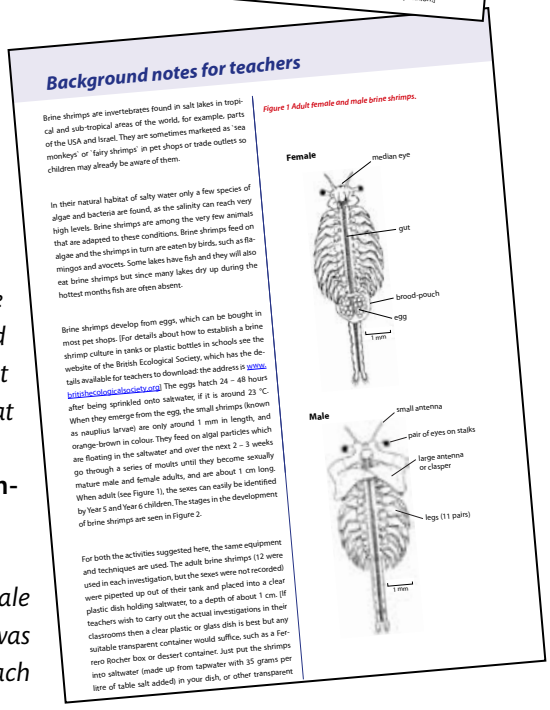
Introduction

Most teachers will know that primary school children have a great interest and enthusiasm for animals. Some pupils will have pets at home and many parents will have taken their children to wildlife centres for a closer interaction with more exotic animals. The majority of primary school teachers will also ensure that visits to farms and zoos are built into their curriculum experience at some time over the first seven years at school and may also be able to arrange for specialist animal services, such as falconry displays, to visit their school. Some schools may have the benefit of extensive grounds so that other experiences can be arranged for the pupils, such as setting up nature trails and/or wildlife areas and carrying out hunts for mini-animals (see Appendix).

In view of the perceived difficulties regarding health and safety and animal welfare considerations, fewer animals are now kept in schools so most pupils will not have the opportunity to observe and carry out investigations with live animals. This is perhaps to be regretted but it is also understandable.

One animal that we know does well in a primary school environment is the brine shrimp, *Artemia franciscana*. It is relatively easy to rear and maintain populations of these delightful creatures for several weeks in a large plastic bottle or even longer if they are kept in a small aquarium tank. Once established, a population of brine shrimps in a tank represents an ecosystem in balance and can be viable for many months. An alternative would be to buy in some adult brine shrimps, as many pet shops sell them as live food for fish! A typical price for 50 - 80 ish shrimps in a small plastic bag is in the range 60 - 80p.

Since many teachers might not feel confident about keeping a population of brine shrimps in their classroom, ASAB (The Association for the Study of Animal Behaviour) and MMU (Manchester Metropolitan University) have produced this DVD resource so that investigations of live shrimps can be carried out in a primary classroom without the hassle of rearing and maintaining the animals! [Though you would be foregoing the great pleasure of seeing the brine shrimps develop from eggs and grow into a thriving population!]



Background notes for teachers

Brine shrimps are invertebrates found in salt lakes in tropical and sub-tropical areas of the world, for example, parts of the USA and Israel. They are sometimes marketed as 'sea monkeys' or 'fairy shrimps' in pet shops or trade outlets so children may already be aware of them.

In their natural habitat of salty water only a few species of algae and bacteria are found, as the salinity can reach very high levels. Brine shrimps are among the very few animals that are adapted to these conditions. Brine shrimps feed on algae and the shrimps in turn are eaten by birds, such as flamingos and avocets. Some lakes have fish and they will also eat brine shrimps but since many lakes dry up during the hottest months fish are often absent.

Brine shrimps develop from eggs, which can be bought in most pet shops. [For details about how to establish a brine shrimp culture in tanks or plastic bottles in schools see the website of the British Ecological Society, which has the details available for teachers to download: the address is www.britishecologicalsociety.org] The eggs hatch 24 – 48 hours after being sprinkled onto saltwater, if it is around 23 °C. When they emerge from the egg, the small shrimps (known as nauplius larvae) are only around 1 mm in length, and orange-brown in colour. They feed on algal particles which are floating in the saltwater and over the next 2 – 3 weeks go through a series of moults until they become sexually mature male and female adults, and are about 1 cm long. When adult (see Figure 1), the sexes can easily be identified by Year 5 and Year 6 children. The stages in the development of brine shrimps are seen in Figure 2.

For both the activities suggested here, the same equipment and techniques are used. The adult brine shrimps (12 were used in each investigation, but the sexes were not recorded) were pipetted up out of their tank and placed into a clear plastic dish holding saltwater, to a depth of about 1 cm. (If teachers wish to carry out the actual investigations in their classrooms then a clear plastic or glass dish is best but any suitable transparent container would suffice, such as a Ferrero Rocher box or dessert container. Just put the shrimps into saltwater (made up from tapwater with 25 grams per litre of table salt added) in your dish, or other transparent

Figure 1 Adult female and male brine shrimps.

Female

median eye

gut

brood-pouch

egg

1 mm

Male

small antenna

pair of eyes on stalks

large antenna or clasper

legs (11 pairs)

1 mm

1. A DVD, with film footage of brine shrimps swimming in a tank, together with a commentary outlining the essential background information about the animals. A short piece of footage is also provided to give teachers the opportunity to explain the suggested procedure for collecting data and to provide a practice session for pupils. The main footage then allows children to carry out one, or two, investigations, one looking at whether brine shrimps shoal when in a container and the second whether shrimps show a preference for being in the `centre` or at the `edge` of a container. The DVD also has an animation showing the development of a brine shrimp from egg to mature adult and has a short piece of film showing the experimental set-up for the investigations. The DVD is available from Michael Dockery for £2 (incl. p & p). To receive a copy send a cheque payable to `ASAB` to the Manchester address on page 1 of the newsletter.

2. A set of teacher notes, giving background details about brine shrimps, outlines of the two investigations and a set of worksheets for each of the two investigations. These notes can be sent for FREE as a pdf, simply request them by sending an e-mail to Michael Dockery m.dockery@mmu.ac.uk .

The resource was recently trialled in three schools and here are two responses, one from a teacher and one from a pupil.

Teacher reaction – *"Upper junior children studying the behaviour of brine shrimps were captivated by the short DVD presentation which supported and enhanced their investigations. The information delivered was both relevant and appropriate for the age of the children involved, with explanations that were clear and concise."*
Joan Boswell, Year 5 teacher, St Monica`s Primary School, Flixton, Manchester

Pupil reaction - *"I learnt how to tell a boy shrimp from a girl shrimp: the male has enlarged grabbers. I enjoyed the whole lesson but my favourite part was arranging the data we collected into a chart and finding the average of each of the groups."*
Kate, Year 6 pupil, Our Lady of the Rosary Primary School, Davyhulme, Manchester

ASAB Education Officer

The Association for the Study of Behaviour (ASAB) is seeking an Education Officer (EO). We are looking for someone able to commit up to 50% of their time for an initial period of 2 years, reimbursed through an ASAB grant of up to £13k p.a.

Person Specification: Applicants should ideally possess a degree in Animal Behaviour or related subject (e.g. Biology, Zoology, Psychology), a formal teaching qualification and should have a recent background of teaching in the school, college or university sector. The successful applicant will have a genuine interest in curriculum development and the ability to communicate effectively with educators, pupils and students at all educational levels.

To find out more about the post and for a full job description, please contact the **ASAB Education Secretary, Dr Rob Thomas**, Cardiff School of Biosciences, Museum Avenue, Cardiff CF103AX. ThomasRJ@Cardiff.ac.uk Tel 029 20 876653.

To apply, please send (i) your CV and (ii) a short (1-2 page) explanation of your suitability for the post, to Dr Rob Thomas, at the address above (email applications welcome).

Deadline for applications: Friday 8th October 2010

Interviews: Mid-October 2010

To begin: Either 1st December 2010 or 1st January 2011.

Overall Objective: To develop and manage ASAB's educational remit and to ensure that its activities are aligned with the Association's overall strategy.

Main Duties

- To produce and edit the ASAB education newsletter Feedback, including soliciting articles, liaising with the contributors and designer.
- To oversee the development, production and distribution of ASAB educational resources, e.g. the national school nestbox scheme.
- To develop and maintain the ASAB education website.
- To contribute exhibitions, lectures or workshops at relevant educational conferences, to educational organisations (including schools, colleges and teacher training institutions) and public interest groups.
- To organise conferences for teachers on aspects of animal behaviour that are relevant to the school curriculum.
- To contribute articles for educational journals/magazines that assist the teaching of animal behaviour.
- To monitor changes in school curriculum development, to liaise with educational service providers (such as exam boards and publishers) and to represent ASAB's views on the teaching of animal behaviour at primary, secondary and tertiary levels.

KEY STAGE 1 - ANIMALS

Look at the photograph of a mini-animal, it is a worm. Worms live in the soil but are sometimes seen on the ground.

1. Does a worm eat plants or does a worm eat other animals?

A worm eats .....

2. Worms do not have eyes. Why does a worm not have eyes?

.....

Here is a rattlesnake.

3. Write down **ONE** way that a rattlesnake is like a worm.

.....

.....

4. Rattlesnakes eat other animals, such as mice and lizards. Write down how rattlesnakes kill their prey.

.....

.....

Challenge

Using books or the Internet, write down why the rattlesnake has its name.

.....

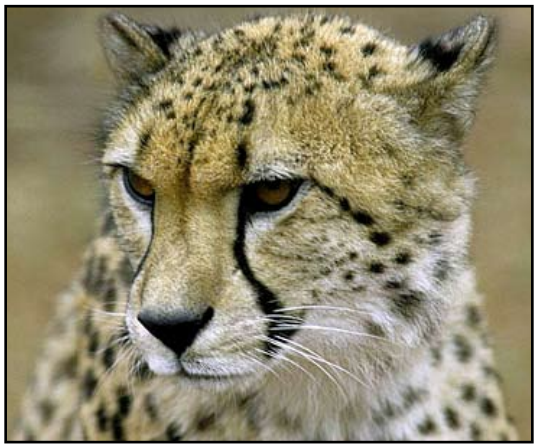
.....

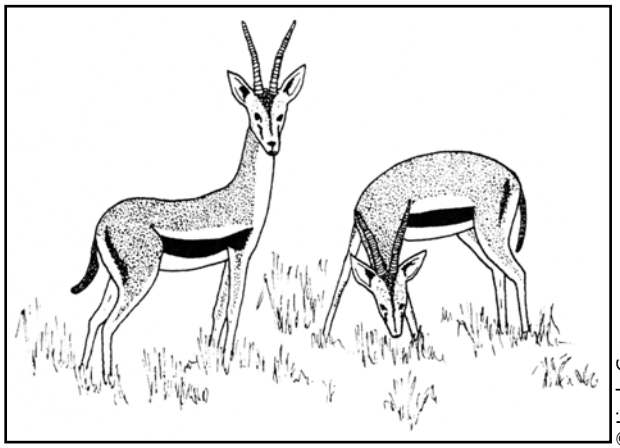
.....

['Suggested' answers - page 47]

KEY STAGE 2 - ANIMALS

Below is a photograph of a cheetah and drawings of two Thomson`s gazelles. These animals are found in East Africa.





1. Which is the prey and which is the predator?

The cheetah is the ..... and the Thomson`s gazelles are the ..... ②

2. Gazelles usually stay in herds. Give **ONE** advantage to an animal of staying in a herd.

.....

..... ①

3. One of the two gazelles has its head up and is looking around to spot any signs of danger. Underline the word below which means to keep aware or watch for danger.

a) sight b) inquisitive c) vigilant d) sensible e) valiant ①

4. If a gazelle does spot danger it gives a snort or call which other gazelles nearby can hear before it runs. Give **ONE** reason why it gives a snort.

.....

..... ①

KEY STAGE 2 - ANIMALS

© Jan Erkamp

Here is a photograph of a leopard. Leopards are also found in East Africa.

5. Give **TWO** similarities and **TWO** differences between the cheetah and the leopard.

a) One similarity is

.....

..... ①

b) Another similarity is

.....

..... ①

c) One difference is

.....

..... ①

d) Another difference is .....

..... ①

KEY STAGE 2 - ANIMALS

6. When a leopard has made a kill it often drags it to a tree and puts the prey in the branches of the tree well above the ground. Give **ONE** reason why a leopard would place its prey in a tree.

.....

..... ①

7. Both the cheetah and the leopard have spotted coats, Give **ONE** reason why having a spotted coat would be helpful to them.

.....

..... ①

8. Both cheetahs and leopards try to approach animals when the wind is blowing in the faces of the cheetah or leopard. Give **ONE** reason why they do this.

.....

..... ①

9. Lions also hunt in East Africa and if lions find cheetah or leopard cubs they kill them. Why do lions kill cheetah or leopard cubs?

.....

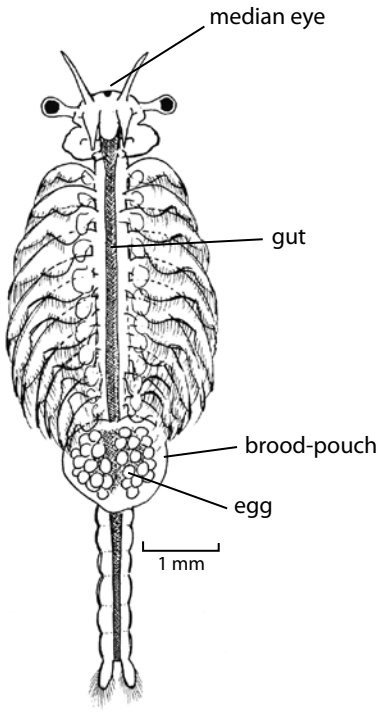
..... ①

['Suggested' answers - page 47]

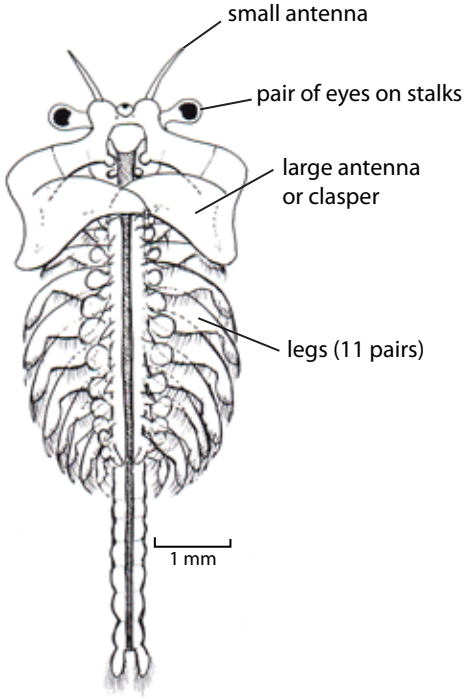
KEY STAGE 3 - BIOLOGY

The drawings below show a male and female brine shrimp. Brine shrimps are invertebrates that live in salt lakes in tropical and sub-tropical countries.

Female



Male



1. What is an invertebrate animal?

..... ①

2. Give **TWO** examples of any British invertebrate animals.

a) .....b) ..... ②

3. Brine shrimps feed on algae. Are brine shrimps herbivores or carnivores?

Brine shrimps are ..... ①

Scientists are interested to see if brine shrimps prefer to swim at the edge or near the centre of a glass dish. They calculate the area of the glass dish and then draw a circle on a sheet of acetate that is half the area of the dish: this will be the `centre` of the dish and the outer part is the `edge`. They put the acetate sheet under the dish, pour in saltwater and then put 12 brine shrimps in the dish, 10 females and 2 males, from a large tank of shrimps. They give the animals 2 minutes to adjust to their new environment and then the scientists count to see how many shrimps are in the `centre` and the `edge` every 15 seconds for 5 minutes.

KEY STAGE 3 - BIOLOGY

4. a) Why did the scientists make the `centre` and the `edge` equal in area? .

..... ①

b) The scientists selected 12 shrimps from a large number in the tank. What word describes the 12 shrimps they placed in the dish. Underline the correct term below.

i) population ii) favourite shrimps iii) sample iv) tankful v) pets ①

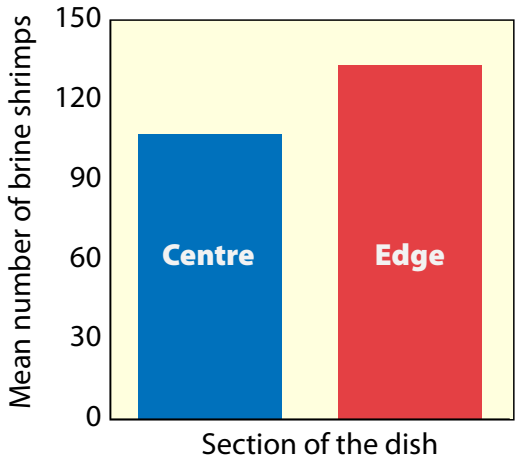
c) Describe **ONE** weakness of the investigation.

.....

..... ②

d) The data they collect is put in a graph, see Figure 2.

Figure 2 Mean number of shrimps in the `centre` and the `edge`.



i) Why did the scientists calculate the mean figure to put in the graph?

..... ①

ii) What does the graph indicate?

..... ①

iii) Suggest **ONE** reason why, in their natural habitat of a lake, brine shrimps are likely to be found at the edge of the lake.

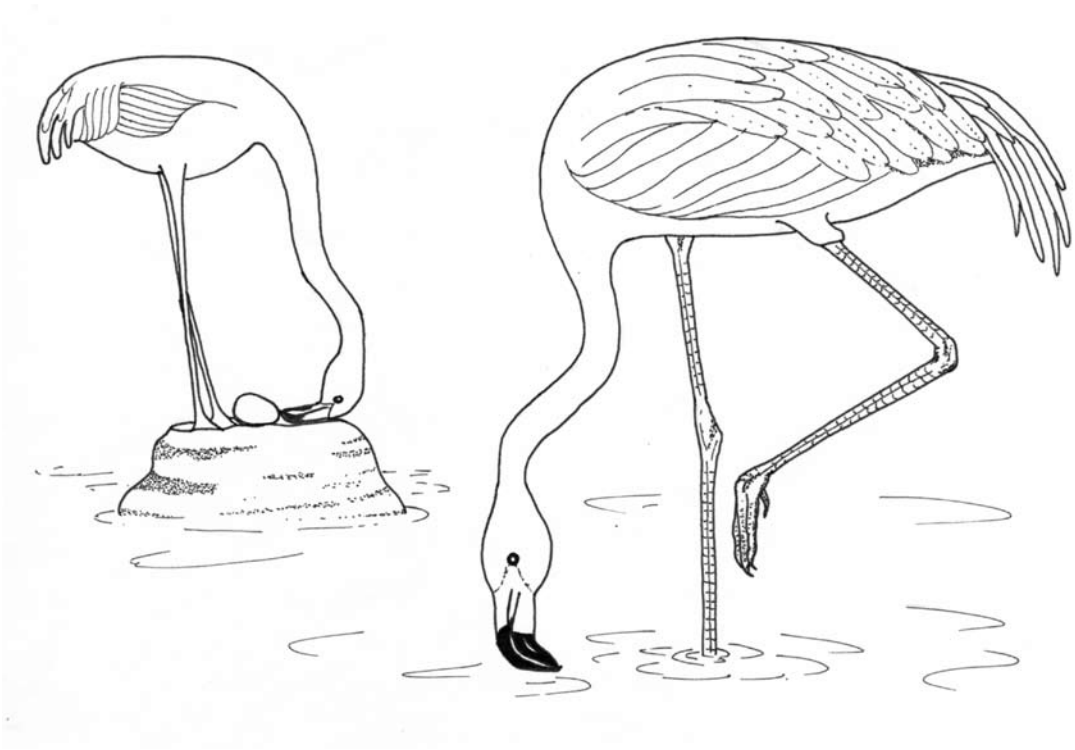
..... ①

KEY STAGE 3 - BIOLOGY

Below are drawings of adult greater flamingos: one is looking after the egg on the nest and the other is feeding in the water. Flamingos eat large numbers of brine shrimps and other invertebrates found in the lake.

Figure 3 Greater flamingos tending the egg a) and feeding b).

a) b)



Flamingos build a conical nest from mud and the single egg is laid in a slight depression on top. Both male and female greater flamingos incubate the egg and each may spend several days on the nest at a time.

A scientist recorded how long each parent spent incubating the egg at 19 nests at a site in southern France. He also recorded whether the nest was deserted or if the egg was successfully hatched. The data are in Table 1.

KEY STAGE 3 - BIOLOGY

Table 1 Percentage of time each parent incubated their egg at 19 greater flamingo nests and whether the nest was deserted or the chick hatched.

	Incubation time			
Pair	**% Male**	**% Female**	**Difference in %**	**Fate**
A	58	42	16	Nest deserted
B	64	36	28	Nest deserted
C	59	41	18	Nest deserted
D	48	52	4	Nest deserted
E	45	55	10	Nest deserted
F	49	51	2	Nest deserted
G	60	40	20	Nest deserted
H	56	44	12	Nest deserted
I	57	43	14	Nest deserted
J	50	50		Chick hatched
K	52	48		Chick hatched
L	42	58		Chick hatched
M	45	55		Chick hatched
N	43	57		Chick hatched
O	50	50		Chick hatched
P	54	46		Chick hatched
Q	47	53		Chick hatched
R	49	51		Chick hatched
S	44	56		Chick hatched

5. a) For how many pairs did the female do more of the incubation? ..... ①

b) Complete the table for pairs which hatched the egg to show the difference in the percentage of time males and females spent incubating the egg.

..... ②

c) Calculate the mean percentage difference for the ten pairs of greater flamingos that successfully hatched the egg.

The mean percentage difference in incubation time was ..... % ①

d) Greater flamingos nest in colonies, i.e. many pairs of greater flamingos all nest very close to each other in the same area. Give **ONE** reason why it would be advantageous for the birds to nest together in the same area.

.....

..... ①

['Suggested' answers - page 47]

GCSE BIOLOGY

Parental behaviour in western slaty antshrikes

When chicks hatch at a nest and beg their parents for food, the parents respond by searching for suitable food nearby and return to the nest to feed them. One problem parents face is that by returning frequently to the nest with food they are indicating to a predator where the nest is so the chicks may be taken. So parents may change their pattern of feeding to make predation less likely.

Figure 1 A western slaty antshrike

© J P Kelley

A recent study* investigated how begging calls may influence what parents do so that predators are less likely to see them returning with food. The scientists studied a number of nests of the western slaty antshrike *Thamnophilus atrinucha*, a bird found in C. America, see Figure 1. Adult western slaty antshrikes are about 17 cm long, weigh 25 - 30 g and females lay 2 – 3 eggs. Both parents share nest building, incubating the eggs and the care of the young, which are fed on insects usually brought to the nest one at a time.

© J P Kelley

The scientists recorded begging calls at the nests when the chicks were 3 – 5 days old so that they could play back the calls when they were 6 – 7 days old. They divided the nests into two groups. Chicks at half the nests heard their own recorded calls played back to them whilst the other half heard recordings of a series of random sounds played to them. The scientists recorded the number of trips each parent made carrying food, which chick was fed, the type of food brought back and if predation occurred at the nest.

* Tarwater, C. E., Kelley, J. P. & Brawn, J. D. 2009. Parental response to elevated begging in a high predation, tropical environment. ***Animal Behaviour***, **78**, 1239 – 1245.

GCSE BIOLOGY

Foundation tier

1. This study involved chicks begging for food at their nest. Why do chicks beg their parents for food? ①

2. Chicks of many species of birds are unable to see when they hatch from the egg, their eyes open several days later. But chicks do not have to learn how to beg, they beg for food very soon after hatching. Which term below describes behaviour which does not involve learning? Underline the answer below. ①

   a) risky behaviour b) trial and error learning c) innate behaviour

   d) habituation e) conditioning

3. The chicks beg their parents for food by calling. What type of signal does the chick give to the parent? Underline the answer below. ①

   a) touch signal b) sound signal c) visual signal d) chemical signal

4. Suggest **ONE** way that a chick could change the signal to a parent to indicate that it is hungry. ①

5. Western slaty antshrikes build an open cup nest in the fork of a tree, lay a modal clutch of 2 eggs and have a nestling period of 10 days.

   a) What does "lay a modal clutch of 2 eggs" mean? ①

   b) What does "a nestling period" of a bird species mean? ①

6. The scientists recorded the begging calls of chicks when 3 – 5 days old as they wanted to see what effect playing back the begging calls would have on the chicks. Half of the chicks in nests in the study area heard the recorded calls when they were 6 – 7 days old. The chicks in the other nests heard random sounds played back to them when they were 6 - 7 days old. Both recordings were played back at the same volume.

   a) Give **ONE** advantage of using recorded calls to play back to chicks in a nest. ①

   b) Why did the scientists only play back recorded begging calls at half of the nests in their study? ①

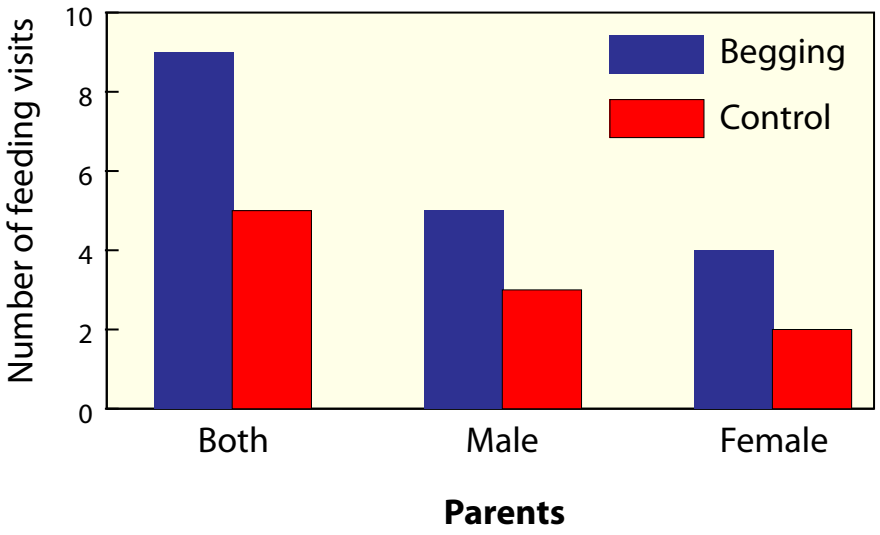
   c) Why did the scientists also play back a recording of random sounds at half of their study nests? ①

   d) Why did the scientists play back both the real begging calls and the random sounds at the same volume? ①

GCSE BIOLOGY

7. Figure 2 shows the mean number of parental feeding visits by the male and female western slaty antshrike parents to 11 nests when begging calls were played and when random (or control) sounds were played.

Figure 2 Mean number of parental visits to the nest by male and female western slaty antshrikes to 11 nests when begging calls were played (blue bar) and when random (or control) sounds were played (red bar).



a) What type of graph is shown in Figure 2? ①

b) Make **TWO** observations from the data in the graph in Figure 2. ②

GCSE BIOLOGY

Higher tier

1. Chicks of many species of birds are unable to see when they hatch from the egg, their eyes open several days later. But chicks do not have to learn how to beg, they beg for food very soon after hatching. Which term below describes behaviour which does not involve learning? Underline the answer below. ①

   a) risky behaviour b) trial and error learning c) innate behaviour

   d) habituation e) conditioning

2. The chicks beg their parents for food by calling. What type of signal does the chick give to the parent? Underline the answer below. ①

   a) touch signal b) sound signal c) visual signal d) chemical signal

3. Suggest **ONE** way that a chick could change the signal to a parent to indicate that it is hungry. ①

4. The scientists recorded the begging calls of chicks when 3 – 5 days old as they wanted to see what effect playing back the begging calls would have on the chicks. Half of the chicks in nests in the study area heard the recorded calls when they were 6 – 7 days old. The chicks in the other nests heard random sounds played back to them when they were 6 - 7 days old. Both recordings were played back at the same volume.

   a) Give **ONE** advantage of using recorded calls to play back to chicks in a nest. ①

   b) Why did the scientists only play back recorded begging calls at half of the nests in their study? ①

   c) Why did the scientists also play back a recording of random sounds at half of their study nests? ②

   d) Why did the scientists play back both the real begging calls and the random sounds at the same volume? ①

GCSE BIOLOGY

5. Figure 2 shows the mean number of parental feeding visits by the male and female western slaty antshrike parents to 11 nests when begging calls and random (or control) sounds were played.

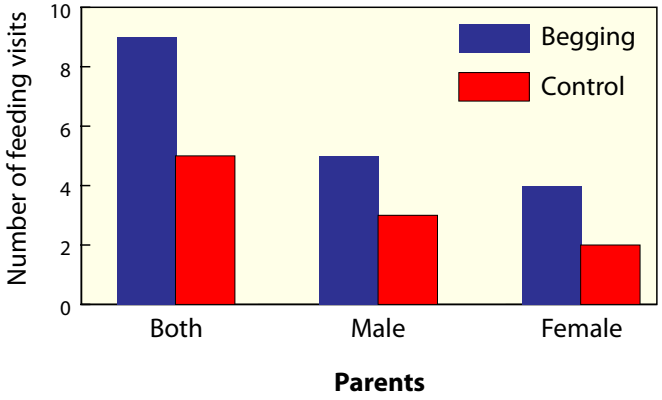


Figure 2 Mean number of parental visits to the nest by male and female western slaty antshrikes to 11 nests when the begging calls were played (blue bar) and when the random (or control) sounds were played (red bar).

a) What type of graph is shown in Figure 2? ①

b) Make **TWO** observations from the data in the graph in Figure 2. ②

6. To reduce the loss of chicks in the nest to predators it may be better for a parent to either increase the load of food they carry to the nest on each trip or reduce the number of trips they make. Suggest why it may be better for parents to **increase the load of food** they carry back to the nest. ②

7. Figure 3 shows the percentage of feeding visits made to the nestlings and whether the chick that was fed was the closest, the one that reached up highest or the one that was the largest (heaviest).

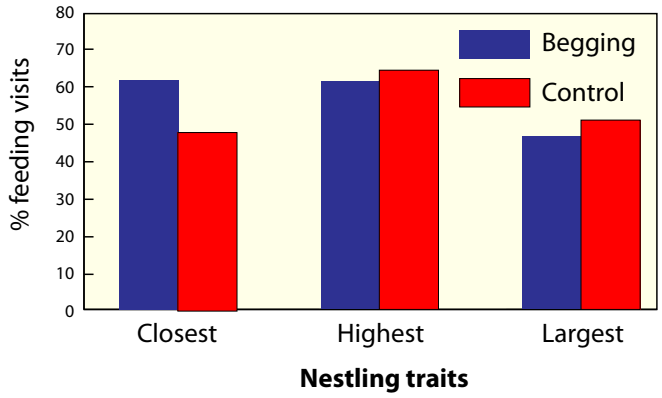


Figure 3 Mean percentage of feeding visits made to the nestling that was closest, stretched highest or was the largest when calls were played (blue bar) or when random (or control) sounds were played back (red bar).

Make **TWO** observations on the data they collected and represented in the graph. ②

[We thank Elsevier for permission to use Figures 1 and 2 from the article by Tarwater, C. E. *et al*. in Animal Behaviour, 2009, 78, 1239 – 1245.]

['Suggested' answers - page 47]

AS/A2 BIOLOGY

Vigilance behaviour in agile wallabies

Agile wallabies, ***Macropus agilis*** are herbivorous animals found in Australia and Papua New Guinea. In Australia they are found in grassland, often with scattered trees and also in agricultural areas. In these tropical areas they drink during the day and night, though the peak times are 0900 and 1700 hours.

© S Doody

Figure 1 Agile wallabies drinking simultaneously from a `safer` excavated hole and from the `riskier` river.

The wallabies either drink directly from a river or at a hole they excavate close to the river, see Figure 1. However, the rivers are potentially risky sites as saltwater crocodiles, ***Crocodylus porosus***, are in the rivers and prey on the wallabies. Saltwater crocodiles, see Figure 2, are ambush predators, i.e. they wait for potential prey to come near and strike, or else they swim slowly towards prey and strike. So, is it better for an agile wallaby to drink at a hole or at a river? A recent study* tried to answer this question.

© Mila Zinkova

Figure 2 A saltwater crocodile

The scientists set up cameras in natural vegetation near a river to record activities along a flat area of river bank, see Figure 2. The cameras could use both infrared and natural light so that coverage was possible for 24 hours. Focal sampling was used to select the animals to observe and the behaviours to record, including whether wallabies drank at a river or a hole, the time spent drinking, the time spent being vigilant (i.e. the time spent with their `heads up` watching for predators and not with their `heads down` drinking) and if the animal drinking was solitary or in a group.

* Steer, D. & Doody, J. S. 2009. Dichotomies in perceived predation risk of drinking wallabies in response to predatory crocodiles. ***Animal Behaviour***, **78**, 1071 – 1078.

AS/A2 BIOLOGY

1. For many prey animals the risk of predation is high. Nevertheless, they do need to engage in other activities, apart from being vigilant for predators. Suggest any **TWO** behaviours, apart from drinking and being vigilant, that the agile wallabies could show. ②

2. The place where wallabies drink (the drinking site) was the area of risk investigated by the scientists.

   a) Suggest **ONE** reason why a drinking site might be a good place for an ambush predator, like a crocodile, to wait for their prey to arrive? ①

   b) Suggest **TWO** reasons why prey animals like agile wallabies would need to be especially vigilant at a drinking hole or at a river. ②

3. Crocodiles are just one type of ambush predator. Name **ONE** other ambush predator. ①

4. Agile wallabies have two options when they wish to drink: at water holes a short distance from the river or they may drink directly from the river, (see Figure 2). Suggest **ONE** advantage and **ONE** disadvantage to a wallaby of drinking from **both** a river and from a hole close to the river. ④

5. This study was carried out during the dry season. Identify **ONE** advantage to carrying out the study in the dry season. ①

6. The scientists used infrared lights and cameras to record behaviour and used focal sampling to record the behaviour of particular agile wallabies. What is a focal sample? ①

7. The scientists found that there was a significant difference in the total amount of time that agile wallabies were vigilant when drinking at water holes or at a river: the mean and standard deviation activity (drinking) times, in minutes, were 5.6 ± 5.17 min and 1.3 ± 1.25 min respectively.

   a) What is meant by standard deviation? ①

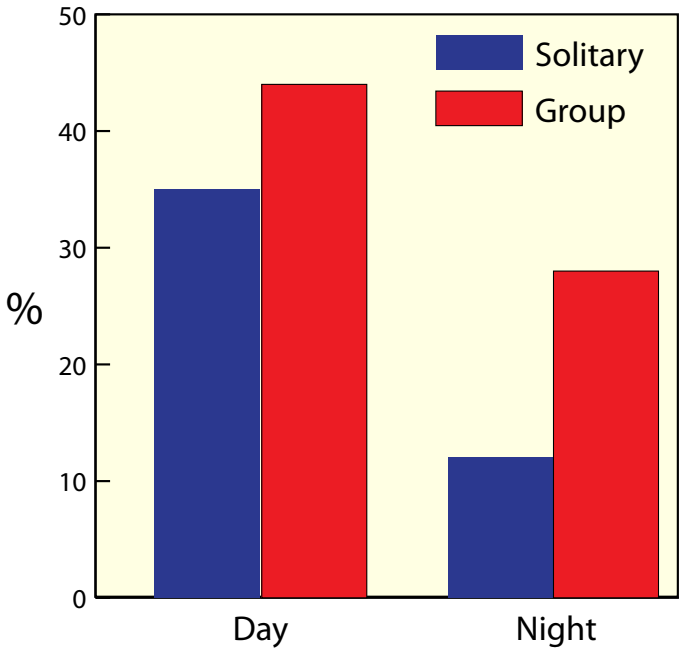
   b) Why is knowledge of the mean and standard deviation of a set of data important? ①

   c) Suggest **ONE** reason why the times spent in vigilance, between the drinking holes and the river, were significantly different. ①

AS/A2 BIOLOGY

8. Sometimes agile wallabies drink alone, sometimes they drink in groups. Figure 3 shows data the scientists collected for these behaviours and the percentage of wallabies **drinking from the river at night or during the day**. Make **THREE** observations on these data which are represented in the graph. ③

Figure 3 Percentage of agile wallabies drinking during the day and at night and whether in a group or solitary.



9. Why does being in a group seem to be beneficial to agile wallabies when drinking water at holes and at rivers? ②

[We thank Elsevier for permission to use Figure 3 (d) from the article by Steer, D. and Doody, J. S. in Animal Behaviour, 78, 1071 – 1078.]

['Suggested' answers - page 48]

ADVANCED HIGHER BIOLOGY

Eyespot displays in butterflies

Eyespots are found on the wings of some species of butterflies and moths. The function of the eyespot is not fully understood but it may serve to limit attacks by predators. This was recently tested* in a field study in Stockholm using the peacock pansy butterfly ***Junonia almana***, see Figure 1. The butterfly is found in tropical areas of Asia and has prominent eyespots on both the forewings and hindwings in the wet season.

Figure 1 Eyespots on the forewing and hindwing of a peacock pansy butterfly

Pupae of the butterfly were obtained from Malaysia and kept in Stockholm until the adults emerged. The predators used in this study were great tits, ***Parus major***, which were caught in the wild in Sweden for the purpose of the study and later released back into the wild after the experiments were concluded, see Figure 2.

Figure 2 An adult great tit

The experimental trials took place in a cage which contained a large willow log. Wings from dead specimens of the butterflies were fixed to short pieces of stiff card, see Figure 3, with a dead mealworm placed at the centre of each set of wings. On half of the butterflies the eyespots were painted out using paint of a similar colour to the bark of the log on which the two cards were placed: on the other half the eyespots were preserved (though an equal area of paint was applied to other areas of the wing – see Figure 3). Each experimental trial used one butterfly of each type. The researchers put one adult great tit in the cage after the cards were placed on the log and recorded when each great tit made pecks at the mealworms and which mealworm was attacked first.

Figure 3 One of the model pairs used in an experimental trial, the butterfly with eyespots to the left and the butterfly with the eyespots painted out to the right.

* Kodandaramaiah, U., Vallin, A. & Wiklund, C. 2009. Fixed eyespot display in a butterfly thwarts attacking birds. ***Animal Behaviour***, **77**, 1415 – 1419.

ADVANCED HIGHER BIOLOGY

1. This study was conducted in a laboratory. Suggest **TWO** advantages to carrying out behavioural studies in a laboratory. ②

2. The butterflies used in this research were purchased as pupae from a supplier in Malaysia. The pupal stage is one of four developmental stages in all butterflies and moths. What are the other three stages called? ①

3. The birds used in this study were caught at a research station in Sweden, taken to the laboratory, kept in individual cages and fed daily on seeds, suet, mealworms and water. The scientists noted in their research report that "the conditions and general treatment of the birds during the experiment were approved by the regional ethical committee in Sweden". Why is it important for scientists to add information about ethical considerations in their research report? ①

4. After emerging from their pupal case and drying out, the fully developed butterflies had clearly visible `eyespots`, see Figure 1. Give a definition of an `eyespot`. ①

5. The wings of several dead butterflies were separated from the body and then placed on a piece of stiff card with a mealworm as a food reward, see Figure 3. Half the butterflies had their eyespots untouched whilst the other half had their eyespots painted out, see Figure 3. Each trial consisted of one `typical` butterfly and one with the eyespots painted out.

   a) Why did half the butterflies have their eyespots preserved and the other half had their eyespots painted out? ①

   b) Why was the paint used to mask the eyespots the same colour as the background bark? ①

6. Why did the butterflies chosen for the investigation all have wingspans that were very similar? ①

7. The scientists recorded the number of pecks at the two mealworms for each trial and the time taken to peck at the mealworm. What scale (or level) of measurement is used when time is recorded? ①

8. In 35 trials, the prey without spots were attacked first in 25 of the trials whilst the prey with spots were attacked first in 10 of the trials. A statistical test (the binomial test) showed that this was significant at a probability level of $P = 0.017$. What does $P = 0.017$ mean? ①

9. Suggest **ONE** reason why butterflies with eyespots are less frequently attacked by birds than those without eyespots. ①

ADVANCED HIGHER BIOLOGY

Sperm investment by male moths

Mating with a close relative has disadvantages. So it might be expected that animals would benefit if they avoid mating with relatives. One possible way for this to occur would be if males could allocate sperm according to whether the female is related or unrelated to them. This was recently tested* using the Indian meal moth, ***Plodia interpunctella***, see Figure 4.

© Peter Costen

Figure 4 An adult Indian meal moth

The animals used in this research were reared from stock kept at a UK university but developed from wild populations in Western Australia. Larvae were reared in the laboratory and male and female kept separate after pupation to ensure the adults would be virgins. After emerging as an adult, each male and female were randomly paired after which the females were transferred to separate containers and allowed to develop their eggs. After emerging, the larvae were kept in family groups until approaching pupation. On emergence as adults, virgin males were assigned to either a `sib` group and mated with a randomly selected female full sib, or a `non-sib` group in which males were paired with a randomly unrelated female. After mating the females were immediately frozen to allow the number of sperm transferred to be counted.

* Lewis, Z. & Wedell, N. 2009. Male moths reduce sperm investment in relatives. ***Animal Behaviour***, **77**, 1547 – 1550.

1. Suggest **ONE** possible cost to related individuals mating. ①

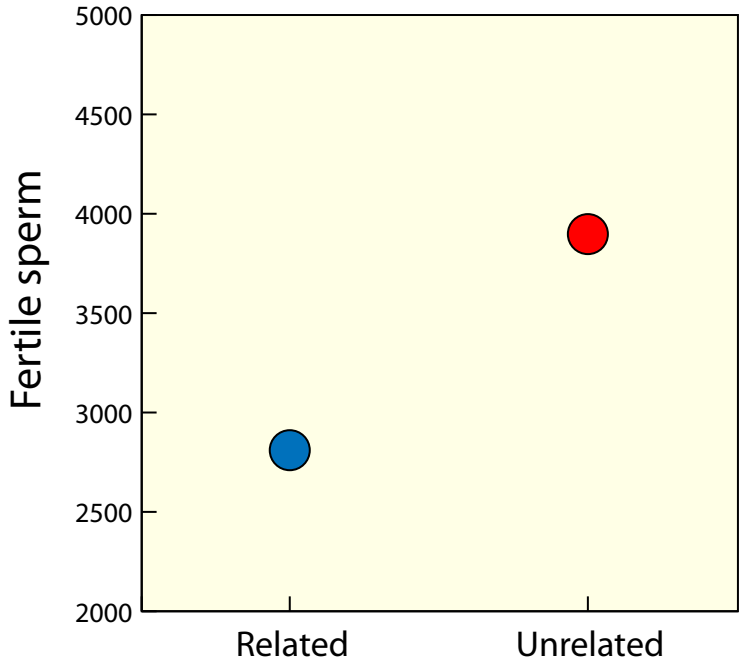
2. Suggest **ONE** way for an individual animal to avoid mating with its kin. ①

3. For the experimental trials, virgin male moths were randomly assigned to one of two groups, `sib` and `non-sib`: the males from the `sib` group were paired with a random full female sibling and the males in the `non-sib` group were paired with a random unrelated female. Why were the females moths allocated randomly to the males? ①

ADVANCED HIGHER BIOLOGY

4. After mating, the females were killed and the number of fertile sperm inside each female were counted. The data shown are recorded in Figure 5.

Figure 5 Mean numbers of fertile sperm provided to related and unrelated females.



a) Describe what the graph shows. ②

b) After using a statistical test the probability level was given as P = 0.044. Would this probability level be judged low enough to suggest that there was a significant difference in the number of fertile sperm the males transferred to related and unrelated females? Explain your answer. ②

5. Why is inbreeding a potential problem when zoo animals mate? ②

[We thank Elsevier for permission to use Figure 1 (b) from the article by Lewis, Z & Wedell, N. in Animal Behaviour, 2009, 77, 1547 -1550.]

['Suggested' answers - page 48]

GCSE PSYCHOLOGY

A psychologist carries out a survey among students at a school. She wants to determine how stressful they might feel in certain social situations. Twenty social situations are listed on the survey sheet and for each situation a student ticks a box, from 1 – 5, to show the amount of stress they might feel: 1 if very little stress, 2, 3 or 4 as the stress increases and 5 if they would find the situation very stressful. A systematic sample is used to identify which students participate in the investigation. Table 1 shows the findings for just 3 social situations.

Table 1 Number of students identifying expected levels of stress for 3 social situations.

	Stress level				
SOCIAL SITUATION	**1**	**2**	**3**	**4**	**5**
a) walking down a familiar street	37	23	0	0	0
b) taking part in a school play	7	12	24	11	6
c) going for a job interview	3	8	9	17	23

1. How many students took part in the survey? ①

2. What percentage of students indicated stress level 3 for the social situation `taking part in a school play`? ①

3. What is a systematic sample? ②

4. Suggest how the psychologist might have decided which pupils would take part in the survey. ③

5. Outline **ONE** advantage and **ONE** disadvantage of using a systematic sample to select participants for a survey. ④

6. In this survey the students had to respond by ticking one of 5 boxes to indicate how stressful they might feel in social situations. Outline **ONE** advantage of restricting answers to survey questions in this way. ②

7. Sometimes surveys use open-ended questions. Identify what an open-ended question is and outline **ONE** advantage of using open-ended questions in surveys. ③

8. When psychologists carry out surveys they give standardized instructions to those taking part. Identify what standardized instructions are. ②

9. Provide suitable standardized instructions that the psychologist might have used in this survey. ②

AS/A2 PSYCHOLOGY

Competition in male butterflies

The speckled wood butterfly ***Parage aegeria*** is a fairly common butterfly in England and Wales. Adults are dark brown with paler orange-yellow markings on their wings, with eyespots too, see Figure 1. They have two broods, with adults emerging from April – June and from July – September so they are quite frequently seen. They favour sunny clearings in deciduous woodland where males can either establish a territory in a `sunspot` which they patrol to ward off other males and attract females, or males can adopt a perching strategy, sitting on a leaf/twig and waiting for a female to fly by their perching position.

© Mick Hoult

Figure 1 A speckled wood butterfly

A recent study* looked at whether males differ in their selection of either the patrolling or perching strategy by recording the amount of time males spend flying in an experimental cage when alone or with one other male. The scientists also manipulated the conditions in the cage to create one large sunspot, several smaller sunspots or keeping the cage in shade.

* Bergman, M. & Wiklund, C. 2009. Differences in mate location between residents and non-residents in a territorial butterfly. ***Animal Behaviour***, **78**, 1161 – 1167.

AS/A2 PSYCHOLOGY

1. The experiments took place in a large outdoor cage. Suggest **ONE** advantage of carrying out a study of butterflies in an outdoor environment. ②

2. The butterflies used in this research had been reared in a laboratory at a university in Stockholm, Sweden. Suggest **ONE** advantage of using laboratory-reared stock in behavioural research with animals. ②

3. The mean age of the butterflies used in the research programme was 4.9 days (range from 1 – 11 days).

   a) How is the mean of a set of data calculated? ①

   b) Name **ONE** other measure of central tendency and explain how the measure would be determined for any set of data. ②

   c) What is the range of a set of data? ②

   d) The range is a measure of dispersion in a set of data. Name **TWO** other measures of dispersion. ②

   e) For any **ONE** measure of dispersion you identified in question 3 d), explain how you would determine that measure of dispersion. ②

4. The scientists were interested to see if the behaviour of a male butterfly changed when he was with another male in the cage compared with being alone. One measurement made by the scientists taken was the time spent flying in the cage.

   a) What scale (level) of measurement is time? ①

   b) Give **ONE** characteristic of this scale (level) of measurement. ①

5. To determine if there was a difference in the amount of time spent in flight when a male was alone or with another male, a parametric test could be used.

   a) Give **TWO** of the conditions necessary for the correct use of a parametric test to analyse a set of data. ②

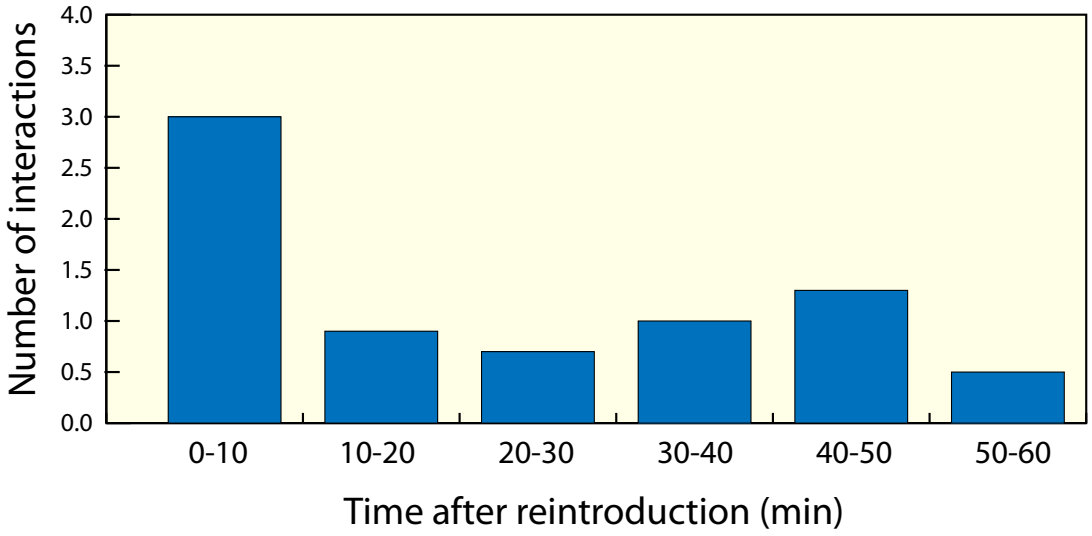
   b) Suggest **ONE** test the scientists could have used to analyse their data if the conditions for a parametric test had been met. ①

   c) Suggest **ONE** test the scientists could have used to analyse their data if the conditions for a parametric test had not been met. ①

AS/A2 PSYCHOLOGY

6. Figure 2 shows the number of interactions between two males.

Figure 2 The mean number of interactions in 10 minute intervals from when two males were introduced into the cage.



Give **TWO** conclusions that can be drawn from the graph. ②

[We are grateful to Elsevier for permission to use Figure 6 page 1165 from the article by Bergman, M. & Wiklund, C. in Animal Behaviour, 2009, 78, 1161 – 1167]

['Suggested' answers - page 48]

SUGGESTED ANSWERS

KEY STAGE 1 - ANIMALS

1. worms eat plants, such as fallen leaves

2. worms don`t have eyes since they spend the bulk of their time underground (though they do have light-sensitive cells scattered beneath their outer skin and can therefore respond to light: they generally move away from areas of high light intensity) – worms do come above ground occasionally, after rain and at night, and then use their sense of touch to move around

3. they are both long and thin - they both grow, reproduce, move around, etc.

4. they inject poison through their fangs into the body of their prey, which they then eat whole

Challenge

the rattlesnake has some sections of its body at the tail that are like beads – the snake can vibrate these quickly and the vibration creates the noise (which can be heard several metres away), which is used to scare away dangerous animals/predators such as hawks, eagles and the road runner, a fast-moving bird that spends most of its time on the ground – the sound warning also indicates to other animals that it is dangerous/venomous

KEY STAGE 2 - ANIMALS

1. the cheetah is the predator and the gazelles are the prey ②

2. other gazelles will respond to danger and so each gazelle can benefit – if a predator attacks, the chance of one gazelle being targeted is less if it is in a big group ①

3. c) vigilant ①

4. to warn other gazelles of danger – if it snorts to warn others then it is likely that other gazelles will also call if they see a predator and it can then benefit – if it is a female gazelle it indicates to its young that a predator is nearby and to hide in the grass ①

5. a) and b) - both have spotted coats – both have long tails – both are predators – most live alone, though male cheetahs do go around in small groups of 2 or 3 ②

c) and d) – cheetah has longer, thinner legs – leopard is more muscular and powerful – cheetah has a much smaller head than a leopard – leopards can climb trees very well – cheetahs rely on speed to catch prey but leopards lie in ambush ②

6. other predators can`t take it – it acts like a larder and stores food for later – the smell of the dead prey animal is less obvious to other predators if it is in a tree ①

7. both use the grasses and other vegetation to camouflage their presence before attacking the prey – the spots break up the outline of the hunter so prey animals can`t make it out very easily ①

8. so their smell doesn`t carry to the prey and warn them – if the cheetah/leopard stepped on a twig/branch when creeping close to the prey the prey would be less likely to hear a twig snapping ①

9. because other predators will be competitors – other predators will take prey which lions may need to ensure their own cubs do well and survive ①

KEY STAGE 3 - BIOLOGY

1. an animal without a backbone ①

2. a) and b) bees, moths, wasps, butterflies, spiders, flies, earthworms, etc. ②

3. herbivores – primary consumers ①

4. a) to allow a fair comparison to be made between the two areas of the dish – if the areas were not equal then further calculations would be needed (to determine the relative areas of the two sections of the dish) to make a decision as to whether there were more in the `centre` or the `edge` ①

b) iii) sample ①

c) the sample was biased as there were five times as many females as males – there was no substrate (food) in the dish and hunger levels may change the behaviour of the shrimps – a sample of 12 could be unrepresentative as it is not a large sample ②

d) i) it takes all the values into account in its calculation – using the median or the mode to summarise the data could be unrepresentative if the data are skewed – it is easier to compare two bars if the mean values are used rather than trying to compare a series of bars of individual values ①

ii) there are more shrimps found in the `edge` than in the `centre` of the dish ①

iii) the water at the edge of a lake would be shallower and warmer and this may favour algal growth – the shrimps could hide in the vegetation at the lake edge and avoid predation by flamingos ①

5. a) 9 pairs ①

b) see student response – the numbers should be: 0, 4, 16, 10, 14, 0, 8, 6, 2, 12 ②

c) 7.2 % ①

d) a large number of flamingos would be better able to defend the nests/chicksfrom attack by predators – if predators did attack then the chances of an individual chick or adult being taken are reduced if the individual is in a large group ①

GCSE BIOLOGY

Foundation tier

1. chicks can`t access food themselves ①

2. c) innate behaviour ①

3. b) sound signal ①

4. increase its rate of calling – increase the loudness of its begging calls ①

5. a) western slaty antshrike females most frequently lay 2 eggs ①

b) the period that the chicks spend in the nest, from hatching to fledging ①

6. a) quite easy to playback the calls in the field using battery powered machines – it is easy to control the volume, call frequency, etc. on playback machines so playback calls would be comparable – playback machines are relatively light and easy to transport into the field – random sounds are easily produced so can be used for comparative purposes ①

b) to enable them to compare the behaviour of these chicks with those at nests that heard random sounds played to them ①

c) to act as a control for the recorded begging calls – the playback of a series of random sounds would lack any meaning for the chicks and so would be a true comparison with the playback of previously recorded begging calls ②

d) to keep the volume of the calls and sounds as a controlled variable ①

7. bar chart ①

b) male parents made more feeding visits to the nests than did females and under both conditions – males made one more visit to the nest than did females, under both conditions - for both the male and female parents, the number of feeding visits to nests at which true begging calls were played back was greater than to the nests with chicks that heard the random sounds played back – the difference in the number of feeding visits to the true begging calls and the random sounds was two feeding visits under both conditions, the visits being greater to the nests that received true calls ②

Higher tier

1. c) innate behaviour ①

2. b) sound signal ①

3. increase its rate of calling – increase the loudness of its begging calls ①

4. a) quite easy to playback the calls in the field using battery powered machines – it is easy to control the volume, call frequency, etc. on playback machines so playback calls would be comparable – playback machines are relatively light and easy to transport into the field – random sounds are easily produced so can be used for comparative purposes ①

b) to enable them to compare the behaviour of these chicks with those at nests that heard random sounds played to them ①

c) to act as a control for the recorded begging calls – the playback of a series of random sounds would lack any meaning for the chicks and so would be a true comparison with the playback of previously recorded begging calls ②

d) to keep the volume of the calls and sounds as a controlled variable ①

5. a) bar chart ①

b) male parents made more feeding visits to the nests than did females and under both conditions – males made one more visit to the nest than did females, under both conditions - for both the male and female parents, the number of feeding visits to nests at which true begging calls were played back was greater than to the nests with chicks that heard the random sounds played back – the difference in the number of feeding visits to the true begging calls and the random sounds was two feeding visits under both conditions, the visits being greater to the nests that received true calls ②

6. a larger (heavier) load would mean a parent would need to make fewer trips which would mean it would be less likely to be spotted by a predator as it flew to, and away, from the nest – increasing the load of each trip would be a more efficient way, in terms of parental energy, of transporting the food to the nest – increasing the load would mean the chicks would grow faster and leave the nest earlier (fledging sooner), thus reducing the chances of predation at the nest ②

7. *closest*: the chick closest to the parent was fed more frequently under the real begging call condition than under the random sounds condition – the difference in the % of feeding visits favoured the true begging calls by about 12 %

highest: the chick that stretched up highest received more food under the random sounds condition than under the true begging calls condition – the difference in the % of feeding visits under the two conditions was about 2 – 3 %

largest: the largest chick received more food under the random sounds condition than under the true begging calls condition - the difference in the % of feeding visits under the two conditions was about 3 – 5 % ②

AS/A2 BIOLOGY

1. feeding, resting, courtship, grooming, etc. ②

2. a) animals must drink so eventually will come down to the river or a hole – the number of animals feeding over 24 hours will be large – crocodiles can hide in the water ①

b) they have their head down when drinking – crocodiles can get very close to the wallabies as they can remain submerged until they are ready to strike – crocodiles can come on land so could grab a non-vigilant wallaby ②

3. lion, tiger, leopard, many snakes, spiders, etc. ①

4. **river**: *adv*: it has a more certain supply of water than a hole – many wallabies can drink at a river so it is less risky through a dilution effect – possible to take water more quickly from a river than a hole – much greater volume of water in a river

disadv: crocodiles can`t be easily seen in a river – difficult to spot crocodiles in a river at night – crocodiles have the element of surprise in an attack as they are largely submerged under the water

drinking hole: *adv*: it is further away than the river edge so is a greater distance for a crocodile to cover in any attack giving a wallaby the chance to escape – dominant individuals can drink exclusively from a hole - holes can be dug by wallabies so there could be several holes to drink from

disadv: a wallaby may well have its head in a hole if it is deep and so would be unaware of an attack from a crocodile – would take longer to drink the same volume from a hole as it would from a river – replenishment of water to the hole would be slower than that of the river – there would be a greater expenditure of energy digging a hole than drinking from a river ④

5. there would be a reduced chance of finding water away from a river in the dry season and therefore it would be more likely for wallabies to visit a river to drink – the chances of a successful attack by crocodiles would be greater in the dry season as a wallaby`s need for water would be greater so it would need to spend more time drinking – wallabies couldn`t derive as much moisture from the vegetation they eat in the dry season so would need to come to water to make up the loss ①

6. the researcher focuses on one individual which is showing the desired behaviour for a pre-determined time, e.g. 30 minutes ①

7. a) a measure of the dispersion of individual values around the

SUGGESTED ANSWERS

mean – the square root of the variance, another measure of dispersion ①

b) the two measures describe the distribution of the sets of scores/values – the two measures describe the distribution of scores and this influences whether a parametric or a non-parametric test can be used to analyse the data ①

c) the intake of water at the river is greater at the river so the wallabies spend less time drinking the same volume of water that they would at a hole – the risk from crocodile attack is greater at the river so it pays to spend more time being vigilant and spend less time drinking ①

8. the % of wallabies drinking from the river is always greater when they are in groups, whether it is day or night – the percentage drinking during the day is always greater than at night, whether the wallabies are in groups or solitary – the difference in the % of wallabies drinking from the river by day between the groups and solitary individuals is about 10 % - the difference in the percentage of wallabies drinking from the river at night when in groups or as solitary individuals is about 15 % - [or any other valid point] ③

9. there are many eyes in a group to be alert to danger from a crocodile attack – the dilution effect operates so if a crocodile does attack the chance of an individual being taken reduces as group size increases – it also helps to have several ears to listen for attack at night as when the crocodile breaks the water surface the noise could be heard ②

ADVANCED HIGHER BIOLOGY

Eyespot display in butterflies

1. close control of variables – easier to use equipment – can more easily record data and behaviour 24 hours a day ②

2. egg – caterpillar (larva) – adult ①

3. to provide evidence that careful ethical consideration had been given to all the procedures in the study – to enable their scientific peers to check to see if ethical procedures had been duly considered before the research began ①

4. a circular pattern/marking on the wings of butterflies and moths – a pattern of concentric rings of contrasting colour that surround an apparent `pupil` on the wing of a butterfly or moth – a circular pattern of colourful rings that are found towards the edges of the wings of some species of butterflies and moths ①

5. a) to determine if birds responded differently to the presence of eyespots on the wings of butterflies ①

b) so that the eyespot was removed effectively but the paint colour would not be a confounding variable – so that the paint colour used to mask the eyespots was cryptic against the bark ①

6. so that the size of a butterfly, and thus the size of its eyespots, would be a controlled variable ①

7. ratio scale (level) of measurement ①

8. it refers to the level of probability associated with a difference between the number of pecks in the trials – the P value means that there was a significant difference between the number of pecks at the moths with eyespots and those without eyespots since P < 0.05 ①

9. the eyespots may suggest they are the real eyes of a large animal and so would be avoided by a bird – the eyespots may be such a conspicuous signal that a bird does not associate them with a real prey animal, such as a butterfly or moth, but with a much larger animal which they would avoid – some butterflies with eyespots (such as the peacock) are known to flick their wings open and closed occasionally which may make the eyespots more convincing as `real eyes` – some butterflies have a back-up sound signal (a hissing noise) which reinforces the eyespot as the eye of a real predator ①

Sperm investment by male moths

1. a decline in genetic variability over time – a decrease in the growth, survival or fecundity of the offspring – an increase in the number of abnormal sperm being produced by males – reduced mating success ①

2. to be able to recognise kin – to engage in multiple mating and so lower the impact of deleterious effects of, say, producing abnormal sperm – to disperse from the area where they were born ①

3. to reduce the likelihood of potential bias – so that any individual female in the population has an equal chance of being selected for one of the groups ①

4. a) the number of sperm provided to related females is less than the number of sperm provided to unrelated females – males provided nearly 50 % more fertile sperm to unrelated females than they did to related females ①

b) there was a significant difference in the number of sperm transferred because the probability value of P = 0.044 was less than the frequently used probability level of P = < 0.05 which is often used as a standard level of probability ①

5. offspring may lack the vigour and genetic variability of those from unrelated individuals mating – it would increase the chance of homozygous recessive genes being expressed in offspring with consequent deleterious results – offspring may be more likely to be stillborn or suffer from some congenital defect compared with offspring from unrelated animals ②

GCSE PSYCHOLOGY

1. 60 students ①

2. 40 % ①

3. participants are selected at fixed intervals, say every 10 th student who is walking down a corridor, or in the lunch hall ②

4. she would have determined the number of students in the school and then decided to take a specific sample size, perhaps 10 %, and approached that number of students by asking every 10 th student she met in the corridor to participate ③

5. *adv*: easy to carry out – don`t need to identify specific students beforehand

disdav: can be time consuming, taking any refusals into account – can be biased, sex ratio for example, unless the sample size is quite large ④

6. quick and straightforward to complete – easy to score and then carry out any subsequent analysis ②

7. an open-ended question is one in which the respondent is free to record their answer as they wish, without any restriction

adv: the questions can be more realistic – the respondent can answer in a manner they wish and as fully as they wish ③

8. a set of instructions given to participants that explain what they need to do – a set of instructions given to all participants in the same way, in a neutral voice and using exactly the same words ②

9. for example - On the sheet below are a number of social situations. I would like you to rate yourself on how stressful you might find each situation using a five point scale. So you score 1 (or tick box 1) if you would not find that situation stressful, 2, 3 or 4 as it gets more stressful or tick box 5 if you would find the situation very stressful. Thanks very much for your help. Do you have any questions? I will provide you with the outcome of your survey at the end of the week when all the participants have completed the survey. [Or any similar and suitable instructions.] ②

A2 PSYCHOLOGY

1. it would be more like the natural habitat and so the behaviour of the butterflies may be more `typical` - the scientists would have more control over variables and so could manipulate conditions more easily and have an IV and DV ②

2. they would have a known genetic background which may correlate with or influence behaviour – the scientists could manipulate the genetic diversity if they wished in order to investigate the effects on behaviour ②

3. a) all the individual data points are summed and the total is divided by the number of data points ①

b) *median* – the individual data points are put in rank order and then the middle value (or 50 th percentile) is determined ②

mode – the most commonly occurring value in the data set

c) the spread of scores in a data set, from the lowest to the highest score ①

d) standard deviation, variance, interquartile range ②

e) *variance/standard deviation*: the deviation of each score from the mean is determined, then these values are squared and their sum found, which is then divided by N (the number of scores) – this value is the variance and if the square root of this value is found then this defines the standard deviation

interquartile range: the scores are first placed in rank order and then the first quartile or 25 th percentile and the third quartile or 75 th percentile are found and the difference between the two values defines the inter-quartile range ②

4. a) ratio scale (level) of measurement ①

b) the scale has a true zero – there are equal intervals between points on the scale ①

5. a) the two, or more, sets of data are normally distributed – the data from the two sets, or more, of scores have a similar/same variance – the scales (levels) of measurement used are both ratio/interval scales ②

b) t- test for independent (unrelated) samples ①

c) Mann-Whitney U test ①

6. the mean number of interactions between two males is greatest within the first ten minutes of re-introduction into the experimental cage – the number of interactions declines rapidly, by about two thirds, after the first ten minutes of re-introduction has passed – the number of interactions is fairly steady between 0.5 and 1.0 after the first ten minutes after re-introduction ②

List of ASAB educational resources

Below is a list of the current ASAB educational resources. Prices include postage and packing. For all ASAB resources make cheques payable to `ASAB` and send with the order form to:

Michael Dockery, School of Biology, Chemistry & Health Science, John Dalton Tower (Room T 1.33), Manchester Metropolitan University, Chester Street, Manchester M1 5GD. For free resources (*) just e-mail him.

Videos/DVDs/CDs

Stimulus Response DVD - £5 - GCSE/A Level (The teaching notes for **Stimulus Response** - £1)
Vigilance Behaviour in Barnacle Geese - £5 -A Level/undergraduates [£3 for video]
Let`s Ask the Animals - £5 - for Key Stage 2. [£3 for video]
The North Atlantic Gannet: video for resource pack - £5
Parental behaviour of burying beetles: DVD - £2
Parental behaviour of blue tits: CD-Rom including video footage - £2
Parental behaviour in nuthatches: DVD - £2
Foraging behaviour in bumblebees: CD - £2
Changes in plumage in Canada goose goslings: DVD - £2

Books

..... copies of **Animal Behaviour: GCSE** ..... copies of **Animal Behaviour: A Level**
both books written by *Michael Dockery and Michael Reiss* - £1

Posters

A2 poster **When is a moth not a moth?** - *Michael Dockery* - £1 - (includes four worksheets for Key Stage 2 pupils)
A2 poster **Birds` Nests** – *Anne Woodfield*. Copies of the poster are £1 each.
Laminated version of the A2 poster **Birds` Nests** – *Anne Woodfield*. Copies are £3 each.

Resource Packs

***Finding Food** (KS2) - *Michael Dockery*
***Observational studies of ringtailed lemurs in zoos** (A Level) - *Mary White [DVD available on loan from Michael Dockery]*
The North Atlantic Gannet: observing and recording selected behaviours (A Level)- *Carole MacLaren* (video above £5)
***The Birds and the Bees** – (A Level) *Jan Morton and Amanda Eggert*
Parental behaviour of burying beetles – (A Level) – *Melanie Gibbs* (DVD above £2)
Parental behaviour of blue tits – (KS2) – *Michael Dockery and Tor Yip* – (CD above £2)
Parental behaviour in nuthatches - (GCSE and A Level) - *Michael Dockery, Graham Read, Alex Graham and Guy Meachin (DVD £2)*
Foraging behaviour in bumblebees – (A Level) – *Patricia Stewart* - (CD above £2)
Environmental Enrichment – *Frances Steel* – the CD (with film footage) - £2
***Birds' Nests** – (KS1) – *Anne Woodfield* - (poster above)
***Patterns of Life: Moths, Adaptation and Predators** – (GCSE) – *Laurence Cook and Michael Dockery*
***Animals on the move** (KS2) – *Michael Dockery*
***Showing off - the art of communication** - (GCSE) - *Nicola Marples, Mick Hoult and Michael Dockery*
Changes in plumage in Canada goose goslings: - (GCSE/A Level) - *Les May* (DVD £2)
***How to avoid being eaten** (GCSE/A level) - *Michael Dockery, Laurence Cook, Nicola Edmonds and Julie Meneely*
Feed the birds (KS3) – *Ann Skinner* (DVD £2)
***Mini-animals** (KS1/KS2) – *Anne Woodfield, Michael Dockery and Mick Hoult*
Behaviour of brine shrimps (KS2) – *Tor Yip et.al.* (DVD £2)