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EUROPEAN BADGER
Meles meles

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Taxonomy: When Carl von Linné (more commonly known as Carl Linnaeus prior to his ennoblement in 1761) included the European badger in the 10th volume of his ***Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus differentiis, synonymis, locis*** (understandably shortened to ***System naturae*** by most), he placed it in the Ursidae family alongside the bears (as ***Ursus meles***). Over the years, subsequent authors have moved the badger into the ***Meles*** genus (as proposed by the French zoologist Mathurin Jacques Brisson in his 1762 ***Regnum animale in classes IX***). Today, all badgers are part of the Mustellidae (Weasel Family), which is the largest and most diverse family within the Carnivore order. Globally there are 66 extant mustelid species, divided into 25 genera and six subfamilies; representatives of the Musteliidae include the Otters, Skunks, Weasels, Stoats and Badgers. Worldwide, we currently recognize nine species of badger, divided into seven genera: ***Arctonyx***, ***Suillotaxus***, ***Mydaus***, ***Melogale***, ***Mellivora***, ***Taxidea*** and ***Meles***. The only badger found wild throughout the UK and Europe is ***Meles meles***. Owing to terrific geographical variation, many subspecies of ***Meles meles*** have been proposed. Early species revisions by N Bobrinskii ***et al.*** have suggested that at least 10 of the 40-or-so proposed subspecies can be grouped into four main ones: ***Meles meles meles*** (widely distributed across Europe), ***Meles meles canescens*** (Transcaucasia), ***Meles meles leptorhynchus*** (south-east Russia and Siberia) and ***Meles meles amurensis*** (Manchuria). Subsequent authors have, however, been less sure of these groupings and it seems that everyone has their own ideas on which are and which are not valid.

In their 1961 ***Checklist of Palaearctic and Indian Mammals***, John Ellerman and Terence Morrison-Scott list 23 subspecies, while in his ***Mammals of the Palaearctic Region***, Gordon Corbet lists 39. At least part of the problem is that many of these proposed subspecies are based on rather minor differentiation in dental, skeletal and 'mask' characteristics and in their 1996 book ***Badgers***, Ernest Neal and Chris Cheeseman argue that these are perhaps better looked upon as "races" rather than true subspecies. The variation seen amongst certain 'subspecies' is, however, sufficient to make some authors argue that there may be as many as three species within the ***Meles*** genus and more recent studies seem to bear this out. Mitochondrial DNA (i.e. that inherited through the maternal line) data obtained by Naoko Kurose and his colleagues at Hokkaido University in Japan suggest that, at the very least, Eurasian badgers should be divided into European and Asian forms. The DNA evidence, coupled with recent studies by Russian zoologists Gennady Baryshnikov and Alexi Abramov -- on baculum morphometrics, fur colouration, skull morphology and dentition differentiation -- highlight the need for an overhaul of the current thinking of ***Meles*** phylogeny. (Photo: Badgers are part of the Mustelid family, along with well-known species such as the stoat, European otter and the controversial American mink, ***Neovision vision***, pictured here).

In a 2003 paper to the ***Russian Journal of Theriology***, a group of scientists from the Russian Academy of Science analysed cheek teeth variability in the Eurasian badger and were able to make some putative conclusions on badger taxonomy. The cheek teeth are the molars and premolars of mammals that are used in the mastication (i.e. grinding) of food. The cheek teeth of mammals tend to be highly complex in structure and because they are typically so highly adapted to specific tasks, they are commonly used in phylogenetic studies. After studying the cheek teeth in 661 skulls sequestered from 11 museums from across the globe, Baryshnikov and his colleagues found two obvious geographic groups (east and west), which they argue are distinct species. If we take the results of Baryshnikov ***et al***. and fellow Russian scientists Alexi Abramov and Andrey Puzachenko (who have done much work on untangling badger phylogeny through variations in hard tissue morphology), it seems that we can assign the western (European) group as ***Meles meles***, the eastern (Japanese) group as ***Meles anakuma***, a Far Eastern (Asian) group as ***Meles leucrus*** and also acknowledge the existence of a new subspecies (***Meles meles milleri***) from the far south-west of Norway. Additional studies on the skull and dental characteristics of the western group suggest that it can be further divided into two distinct forms (probably subspecies): the European badger proper (presumably ***Meles meles meles***), which inhabits most of Europe and the Caucasus-Pamir badger (probably ***Meles meles canescens***) found from Transcaucasia (the transitional region between Europe and Asia) to the Pamir-Alai Mountains in central Asia.

Recent work on the mitochondrial DNA of the mustelids by a multinational team of scientists largely supports the Russian study, although their data suggest that the Eurasian badger can be divided into four distinct phylogenetic groups: Europe, Southwest Asia, North and East Asia and Japan. In this paper -- published in ***Molecular Ecology*** -- Josep Marmi at the Universitat Autonoma de Barcelon (Spain) and colleagues write that the first three of the aforementioned groups has evolved separately since the end of the Pliocene (some 2.4 million years ago), while the Japanese badgers separated from the continental Asian ones during the middle Pleistocene (781,000 to 126,000 years ago). In their study, Baryshnikov ***et al***. speculate that the ancestor of the Eurasian badger was ***Meles thorali***, which had a Palaearctic distribution during the late Pliocene (about 3.6 to 1.8 million years ago).

Similar studies by other authors suggest that the Melinae subfamily requires some re-arranging -- including the removal of the American badger (***Taxidea taxus***) into its own monotypic subfamily (Taxidiinae) and the assigning of the ***Arctonyx*** to the ***Meles*** genus -- and predict the existence of three subspecies of ***Meles meles***.

Suffice to say, there is still much in the way of nomenclatural dust that has yet to settle. While the recent work with mtDNA, cranial morphometrics and dentition has made considerable headway in clarifying the taxonomic interrelationships of badgers, there is still a need for more data on the subject, especially with a view to assessing the validity of ***Meles*** subspecific taxonomy. For the purposes of this article, I consider ***Meles meles meles*** as the type species of European badger found throughout Western Europe. Pending further evidence to the contrary, I follow other authors in placing the Eurasian badger within the Melinae -- not to be confused with the Mellinae, which is a well-established subfamily ascribed to the hymenopteran digger wasps (***Mellinus***) -- a subfamily of the Mustelidae. Consequently, the basic taxonomic hierarchy for the European badger is as follows:

Kingdom: Animalia (Animals)
Phylum: Chrodata (Possess a basic 'backbone')
Class: Mammalia (Mammals)
Order: Carnivora (Possess carnassial teeth)
Family: Mustelidae (Weasel Family)
Subfamily: Melinae (Badgers)
Genus: ***Meles*** (Latin meaning 'badger')
Species: ***meles***

For more information on how animals and plants are classified see the Taxonomy page. (Back to Menu)

Length: Adults are usually between 70 and 100 cm (2 – 31/2 ft) long. (Back to Menu)

Weight: Weight varies according to season, with adults usually between 6 and 7 kg (13 – 15 lbs) in summer and 12 to 14 kg (26 – 31 lbs) in winter. The average adult weight in the autumn is about 12kg, while that for spring is circa 9kg (20 lbs). (Back to Menu)

Colour: Typically, mature badgers have a silvery-grey to black body and tail, with a paler stomach (the white abdominal fur being very thin) and dark paws. Badgers are easily identified by their characteristic black-and-white striped face (mask) and white margins to their ears. Variations to this colour scheme, although rare, include white (including albino and semi-albino), melanistic (very dark) and erythristic (ginger-brown and ginger-red - left) badgers. The pelage has three phases correlated with the moult phase: a thick winter coat, thinner summer coat and a light autumn coat. There is a single moult each year, beginning in the spring with shedding of the underfur and guard hairs, which proceeds from the back of the neck and shoulders backwards to the flanks; summer heralds pelage re-growth, beginning with the guard hairs followed by the underfur, proceeding back-to-front. The new coat is complete by the autumn. (Back to Menu)

Distribution: Badgers live in most of Europe, excluding northern Scandinavia, Iceland, Corsica, Sardinia and Sicily. They can also be found in parts of Asia, as far east as China. In the UK, badgers are most common in the south and west, being noticeably scarcer in the urban Midlands, parts of Scotland and parts of East Anglia. Some badgers inhabit urban areas, especially along the South coast of the UK, Essex, London, Bath and Bristol. Ireland represents the western limit of their range and badger populations in mainland Britain and Ireland seem to constitute two geographically-distinct populations; populations across Europe and the British Isles as a whole are morphologically and generally distinct. Badgers are also found on the Isle of Wight (although we have hardly any data on population sizes here). The Shropshire Badger Group estimates that there are currently 43,000 badger clans in the UK. (Back to Menu)

Longevity: Ageing of badgers is something of an acquired skill and is often based upon craniometric (i.e. skull) measurements. A paper in 1993 by biologists at the University College in Dublin suggests, however, that such measurements have insufficient reliability to accurately age badgers more than three years old (at which point the skull growth is complete). Instead, the scientists recommend that, for adult badgers, annuli in cementum (i.e. the dental equivalent to counting the rings of a tree stump) should be considered instead. Unfortunately, even the use of cementum annuli is not the universal answer, because their deposition is far from geographically catholic. Although this technique has proved quite successful for ageing badgers in Sweden, it is far less reliable for ageing individuals from the southwest of England. The longevity record for Eurasian badgers in the wild is fifteen years, while captive specimens have survived for nearly twenty. The average age to which badgers live to is two years (because of a high cub mortality) and only around 1% will live to be teenagers. Assuming a badger lives past the age of two (of which around 50% do), it may live for seven or eight years. The main cause of death in adult badgers is starvation (old badgers often have black, decayed and warn-down teeth), while the high juvenile mortality is often a result of parasitic load. (Back to Menu)

Sexing: Sexing badgers is not an easy task because there is remarkably little sexual dimorphism in this species (i.e. the males and females look very similar). Outside of the breeding season -- during which sexing can often be made on the basis of testes descent, lactation (i.e. highly visible teats) or cub association -- it is sometimes possible to separate males and females because the male is often (but certainly not always) bigger than the female, with a broader head, fuller cheeks and a less tufted tail. On a more intimate level, studies on the variation in skull morphology by Russian Academy of Science biologists have revealed that some

craniological characteristics show dimorphism between the sexes. Of these features, it seems that although variation was found in the overall skull size, the lower jaw (mandible) and molars, the most stable characteristic is the length (and to a lesser extent, the width) of the upper canines, which are larger in males than females. Given the spread of their data, however, I remain unconvinced that canine size is a fool-proof method of sexing a badger, although sexing a badger skull using their data as a whole is perhaps more reliable. Moreover, work by the WildCRU team at Oxford University on the badgers in Wytham Woods has found that the average variation in skull size between the sexes is of the order of half-a-millimetre! According to the Devon Badger Group (see Links), the only way to be sure is to roll it over! Males are referred to as boars, while females are called sows. (Back to Menu)

Activity: Badgers are primarily nocturnal (with some crepuscular tendencies) because their prey (earthworms throughout most of their range) only comes to the surface at night to breed. Generally, here in the UK, badgers emerge from their setts before dusk between May and August and after dark for the rest of the year; they are also less active from November to February – they tend to remain at the sett for about an hour before moving away to forage. Although badgers do not hibernate (see Q/A), in some parts of their range they may enter states of torpor during very cold or snowy periods – during torpor, the badgers will remain in the sett (often for several weeks) and metabolise fat reserves accumulated during the summer and autumn. There is usually a marked decrease in a badger's body temperature during the winter and early spring, with the body temperature between 2 deg-C and 9 deg-C (3.6 – 16.2 deg-F) lower from November to April than during the late spring. This decrease in body temperature allows for greater economy of fat reserves at a time when food is typically scarce or buried under snow. Indeed, this probably explains why studies have found that breeding sows may have three times the drop in body temperature of non-breeding individuals. In the American badger (***Taxidea taxus***), the same 9oC slump in body temperature is accompanied by a pronounced decrease (sometimes of more than 50%) in heart rate. During periods of exceptionally cold weather, badgers will often use a latrine inside the sett, rather than venturing outside. While activity is sporadic and unpredictable through the winter months, badgers may be seen out foraging during the winter, even in the snow! Post-winter emergence is generally late-February or early March and by mid-summer, badgers often spend time away from the sett during the day, even sleeping out in deep bedding piles. In more remote locations, cubs may be seen playing outside during daylight.

Season has a profound impact on the ranging of badgers in the UK. A study by the University of Sussex found radio-collared badgers had largest ranges during the summer and autumn, with clan range declining during the winter months. A similar study published in the ***Journal of Animal Ecology*** during 2002 found that dominant female and subordinate badgers used only a small fraction of their territories, moved short distances at low speed and covered small areas each night during the winter and spring. Males were observed to use the same proportion of their territories throughout the year, although they moved faster, over longer distances and covered greater areas per period of activity during the winter than females. As food availability (i.e. young rabbits, in this study) increased in the autumn, so did body condition, although range was reduced (presumably a reflection of the fact that the badgers didn't need to move so far to find food).

A study published in the ***Journal of Biogeography*** found that the activity patterns of European badgers in Poland's Bialowieza Primeval Forest and other Palaearctic (from western Europe to Central Siberia) populations differed between spring and autumn and between adult and subadult individuals. On average, badgers were seen to emerge from setts at 19:00 and return to them at 03:42, with the highest activity seen between 20:00 and 03:00. The duration of activity was dependent on daily temperature and the badgers were inactive for an average of 96 days (about 3 months) each year. The study also found that in regions with warm climates, badgers were active throughout the year, with change in overall body mass; in areas with bitter winters badgers increased their body mass two-fold from spring to autumn, and underwent torpor for as long as six months. The conclusion of the paper was that the primary factor regulating these differences was a winter shortage of earthworms. A similar study published in the journal ***Mammalia*** during 2005 reports on the activity rhythms and movement patterns of badgers in cork-oak woodland of southwest Portugal. The research (carried out by Luis Rosalino and Margarida Santos-Reis at the Universidare de Lisboa in Portugal in collaboration with Oxford University's David Macdonald) found that badgers typically emerged from the sett just after sunset and returned before sunrise; overall, the badgers were active for an average of just over eight hours and travelled an average of just under 4km (3 miles) per night. The biologists also report that there was no significant reduction in activity during the winter months and that these badgers showed a much lower site fidelity than their northern conspecifics; an observation that may be explained by larger territory sizes in Mediterranean habitats.

The phase of the moon has been suggested to play an important role in regulating badger activity. The moon has long been thought to have a profound impact on the lives of plants and animals; as long ago as the first century AD, the Roman natural philosopher Pliny (Gaius Plinius Secundus) advised farmers to pick fruit for market before the full moon, when it was at its best. There are, of course, also the suggestions that lunar cycles can be linked with changes in human behaviour and even fertility; the word "lunacy" comes from the Latin "luna", meaning moon. Unfortunately, the data simply do not exist to scientifically validate such hypotheses at the moment. Data-wise, the situation for non-humans is a little different and several studies have demonstrated the pronounced impact that the moon can have on some animals (especially fish and marine invertebrates) and plants (perhaps most notably certain vegetables). In the case of the badger, opinions are mixed. In their aforementioned Polish study, Rosalino and his colleagues found no evidence that moonlight had any significant impact on badger activity. Nonetheless, in a fascinating (yet, it has to be said, heavily anecdotal) contribution to September 2005's ***BBC Wildlife Magazine***, Plymouth Marine Laboratory hydrothermal vent biologist David Dixon presented his observations on badger activity and lunar phases. Dr Dixon reports that dominant individuals in his study group of badgers in Plymouth (UK) scent-marked more often, mated more frequently (and for longer periods) and were more aggressive towards each other when the moon was new (and consequently with nights at their darkest, because the illuminated face of the moon was facing away from the earth) than when it was full (i.e. with nights at their lightest). The actual mating events that Dixon recorded were clustered within the moon's last quarter (i.e. the lunar 'dark phase', when only the left half of the moon is visible), implying that reproductive behaviour in badgers may be strongly influenced by the moon. Dr Dixon suggests that mating during the darkest nights may reduce the risk of being noticed by a potential predator, especially given that mating durations may exceed an hour. On reflection this seems rather unlikely given that the Eurasian badger has no natural predators (only competitors in the shape of foxes and bears). Similarly, despite studying the behaviour of Wytham's badgers for many years, Oxford's WildCRU team (principally Drs Christina Buesching and Chris Newman) have yet to find any evidence for lunar-mediated activity variation.

While badgers obviously have their own 'built in' activity rhythms, these patterns can be altered by human interference. A paper by a group of scientists fronted by Frank Tuyttens, now at the Agricultural Research Centre in Belgium, reported that anthropogenic (human-induced) control of badgers changed their natural circadian (daily) rhythm. Using infra-red video cameras, the researchers were able to demonstrate that badgers in a population subjected to lethal control by humans, emerged from their setts later in the evening than those from a nearby, undisturbed population. Indeed, it appears that human disturbance may have more wide-ranging consequences for badger populations than we previously realised. Several studies on the effectiveness of lethal control on badgers and whether it was effective at stamping out Bovine TB suggests that the more disturbed a sett becomes, the more unstable the population gets – thus highly disturbed setts are likely to encourage badgers to leave the main sett in search of undisturbed pastures. This may actually serve to increase the spread of TB! See Badgers and TB for more info on this subject. (Back to Menu)

Setts: A badger's homestead is referred to as a sett. Reflecting the dwelling of what is -- in parts of its range -- a highly social mammal, badger setts are large and spacious enough to accommodate as many as 35 animals (in the largest naturally supported clan ever recorded in Woodchester Park during 1989), although between six and eight individuals is more common. Setts are generally constructed on sloping ground in woodland or on the periphery of farmland, although they have been found in scrub, natural caves, tips, under buildings, in embankments, quarries, hedgerows and sea cliffs. In the UK, badgers seem to show a preference for deciduous woodland and copses (56% of setts), with fewer setts (13%) found in hedgerows and scrub and even fewer (9%) in open fields. Similarly, a study in the Republic of Ireland (RoI) published in 1993 reports that 43% of setts were in hedgerows or tree lines, 19% in woodland and 21% in scrub. The same paper found that the average sett density was similar in the RoI to that on the UK mainland, with roughly two setts per square-kilometre. (**Photo: Badger dens (called "Setts") are usually characterised by a large spoil heap of soil and discarded bedding outside each main entrance.**)

A large sett may consist of up to 100 m (330 ft) of tunnels, with as many as 40 entrances/exits, each about 30 cm (12 inches) in diameter. Here in the UK, a study found an established sett in the Cotswolds with twelve entrances and tunnels totaling more than 300 metres (1000 ft); the study estimated that the badgers had moved 25 tonnes (55,000 lbs) of soil to create the network. In his book ***Badgers***, Mammal Society chairman Michael Clark describes the internal architecture of a sett. Clark notes that the sleeping quarters are more like extensions off the tunnels than 'rooms' per se and these chambers contain bedding (in the form of dried grass

and leaves), which provides vital insulation of the chamber during the winter - in one particular experiment, Clark discovered that bedding may stay underground for as long as 14 months, before it is replaced. Clark also writes that dung is often found in discrete corners of the sett complex, although not to the extent seen in the dens of -- or parts of the sett used by -- foxes. The entrances may lead back into random blind tunnels and a maze of interlinking routes between bedding chambers is generally found. Around the edge of the sett's main entrance is a mound of highly compacted earth and, in many instances, discarded bedding material. The sett system often consists of a primary and several 'secondary' setts spread around the territory. During her Ph.D thesis at the University of Exeter, Penny Thornton classified these setts into four groups, based on their frequency of use and topography. Dr Thornton's scheme classifies setts as follows:

SETT TYPE	DISTINGUISHING CHARACTERISTICS
Main Sett	Many entrances (both used and disused), large spoil heap and well-worn paths. One main sett per clan.
Annex Sett	May also have well-used entrances with numerous paths to the main sett, which is typically 50 to 150m (164 - 492 ft) away.
Subsidiary Sett	Variable number of entrances. Only some entrances connect to the main sett by obvious paths.
Outlier Sett	One or two entrance holes and no well defined pathways to the main sett. Used sporadically.

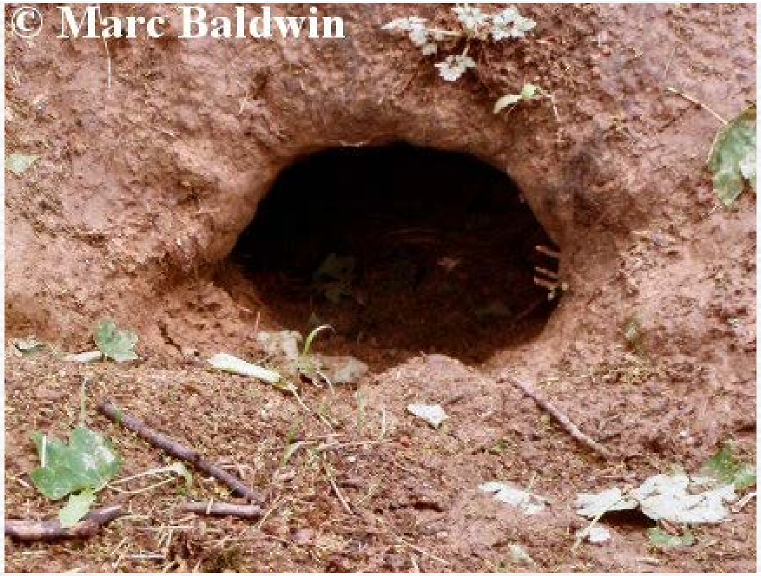
In the main sett, there are usually chambers on a number of levels. The main nesting chamber is often between five and ten metres (16.5 – 33 ft) from the tunnel entrance and about three metres (10 ft) below the surface. The chambers are lined with dry vegetation that is regularly changed - during the later winter and early spring it is common for badgers to drag the bedding outside to 'air' it out. Clans may dig a new chamber for each successive brood of cubs and setts may be inhabited by several generations of badger. In one particular case, a sett was inhabited by the same family of badgers for more than 200 years. This sett extension by successive clans may partially explain why badgers are often very reluctant to leave well-established setts. In very cold regions, the main sett is dug below the level at which the ground freezes and all members of the clan will sleep in the same chamber – it is probable that sleeping together helps 'share' body heat. Additionally, -- and because of a lack of air circulation within the sett -- ventilation holes are observed in some setts. Such holes are typically about 4cm (1.5 inches) in diameter and extend from the ground's surface to a tunnel directly below. Studies by Tim Roper at Sussex University suggest that in the deepest parts of the sett, it is only movement of the badgers themselves that engenders airflow.

A group study at the University of Sussex, this time published in ***Behaviour*** looked at sett use in European badger populations. They found that subsidiary and outlier setts were used mainly during the summer and, although usage was not related to sex or body condition, outliers tended to be used by younger animals and had a larger number of fleas than the main sett. The biologists also recorded that the main sett was not divided into separate interior territories. A study by Jacek Goszczynski and a colleague at the Polish Department of Forest Protection and Ecology found that badgers had two peaks of sett use: one in April and another in August – September. The Polish biologists observed that the same setts were visited by foxes and badgers, which tallies with previous observations by Ernest Neal that various species -- including woodmice, bank voles, brown rats, rabbits, weasels and cats (feral and wild) -- may 'share' setts with badgers. Although foxes may share setts with (and even raise their cubs in setts occupied by) badgers, it is generally considered that the faeces, urine and food remains that have frequently been found in fox dens are odious to badgers, which will often move to another sett if they aren't breeding.

A study conducted by biologists Rafal Kowalczyk, Andrzej Zalewski and Bogumila Jedrejewska of the Polish Academy of Sciences' Mammal Research Unit in Poland's Bialowieza Primeval Forest found that, in addition to various setts throughout the territory, these badgers used a number of shelters. In this low-density population (about two individuals per 10 sq-km), the badgers used several setts and daily shelters (particularly tree hollows) to save energy while moving about their large territories (either foraging or exploring). An interesting finding of this study was that setts may play a role in marking the sites and, while the number of setts being used by the badgers at any given time increased with increasing territory size, sett density (that is to say, the number of setts per square kilometre) did not. Subsequently, the zoologists speculate that sett utilization in high- and low-density badger populations are regulated by different factors. In high-density populations, social factors (i.e. large group size, intraclan aggression, parasites etc.) force badgers to use multiple setts, while the increased food availability that permits clan formation in the first place allows more time and energy to be spent digging new and modifying existing setts. Conversely, in low-density populations, food is at considerably more of a premium and more time and energy must be spent looking for it (thus less can be spent modifying the sett); making use of natural shelters allows the badgers to cover a larger area more efficiently when foraging. (**Photo: Discarded bedding outside a badger sett.**)

Some interesting work has been done looking at whether the distribution of badger setts can be associated with specific biological features. One paper (published in the ***Journal of Natural History*** back in 1997) by zoologists at the University College Cork in Ireland reports on an interesting association between badger sett location and the common woodland fungus ***Phallus impudicus*** (Stinkhorn fungus). Dr Paddy Sleeman and colleagues found that Phallus fruit bodies were clumped in an area 24m to 39m (79 - 128ft) from the entrances of the four setts in their Irish study. A linked study published in the ***Entomologist's Gazette*** more recently recorded 12 families and 22 species of fly (Diptera) trapped at a badger sett in County Cork during June, July and November of 1999. Overall, the biologists suggest that badger setts attract flies -- that is to say the death of badgers and cubs underground attracts files -- which are (blow-flies specifically) primarily responsible for the spread of Stinkhorn fruiting bodies. The laxative effect of the fruit mucus would then explain the clumped distribution of Stinkhorn around the entrances to the setts. Off-hand, the data presented in these papers seem rather circumstantial, which probably explains why the association has been neither widely recorded or accepted.

Stinkhorn fungi aren't the only (possible) floral association and many studies have shown that sett creation and maintenance by badgers has a noticeable impact on the local floral community. In their study of seven badger setts from the Rogow District of Central Poland, Artur Obdzinski and Robert Glogowski from Warsaw Agricultural University recorded a decline in both number and coverage of acidophilous (acid-loving), oligotrophic (low nutrient-loving) and skiophilous (shade-loving) plants. This decline included species from all three main bud-height categories of flora: geophytes (buds underground), chamaephytes (buds close to the ground) and phanerophytes (buds more than 25cm/10in from the ground). Along with this decline, the botanists found an increase in basiphilous (alkaline-loving), eutrophic (nutrient-loving) and heliophilous (sun-loving) species. Included among the promoted flora were byrophytes (e.g. mosses and liverworts), therophytes (plants that over-winter as seeds) and hemicryptophytes (plants that have their over-wintering buds close to the soil). It seems that during the digging and maintenance of their setts, badgers alter the soil properties and vegetation structure, which in turn promotes the nutrient-, alklaline- and sun-loving species at the expense of those which are acid-, low nutrient- and shade-loving ones. Furthermore, there is a well-documented association between



badger setts -- or more specifically, their latrines -- and Elder bushes (***Sambucus nigra***) and nettles. The latrine areas around badger setts provide favourable habitat for Elder bushes and nettles (***Urtica dioica***) because as the badger dung decomposes it releases nitrogenous components into the soil; elder and nettles have a preference for nitrogen-rich soil. (**Photo: Sett entrances are usually easy to distinguish from fox earths -- although foxes are known to live in abandoned setts and even share setts with badgers -- because the entrance is dome-shaped, while fox earths tend to be more egg-shaped.**)

Sett maintenance seems to be something that all clan members play a role in, although how significant their contribution is appears to vary. A study by Paul Steward, Laura Bonesi and David Macdonald (all at Oxford's WildCRU) found that some 20% of clan members (adults and yearlings) were responsible for 60 to 90% of the digging and bedding collection that they observed during eight months of systematic monitoring at four setts in Wytham Woods (Oxford, UK) between October 1994 and May 1996. The zoologists also observed (in contrast to similar studies in Ireland) males to dig more than females (with boars of high social status more likely to dig than those of low status), both sexes to collect bedding at roughly equal rates and breeding sows to take a more active role in den maintenance than non-breeding sows. Dr Stewart and his colleagues suggest that by extending the sett, large frequently-copulating boars may increase their breeding success by creating a harem resource for several females. Similarly, they consider that highly resident breeding females may have more to gain from extending the sett than non-breeding sows, by reducing reproductive competition. Indeed, unpublished observations by the same authors suggest that some breeding females partially restricted entry to certain parts of the sett during breeding, while previous studies by carnivore ecologist Prof. Hans Kruuk in the late 1980s demonstrated that, when sett expansion is restricted, there is an increase in repeated aggression and litter infanticide between females.

In their book ***Badgers***, Ernest Neal and Chris Cheeseman note that for the setts studied in the UK, the relative humidity within the main sett was always 100%, while the temperature tends to vary from 6 deg-C to 19 deg-C (43 to 66 deg-F) even though the external temperature can vary from -4 deg-C to 33 deg-C (25 to 91 deg-F). Work by Tim Roper and Jude Moore suggests that the primary factor influencing these maximum and minimum temperatures is the cover surrounding the entrances; setts with woody cover surrounding the entrances showed less pronounced variations in temperature. (Back to Menu)

Territory: Territories of 20 to 50 hectares (ca. one-tenth of a square-mile) are common in rich habitats, covering areas as large as 150 ha (half sq-mile) or more in poorer regions. There are typically about 10 badgers per 100 ha in 'good' British badger territory (range: 2 to 300). According to Michael Clark's book ***Badgers***, the smaller territories observed in badger clans from Gloucester were about 40 ha (100 acres), with the smallest being 15 ha (38 acres). Roughly 70 ha (175 acres) was more typical of southwest England, while in the low-density areas of Scotland, territories were around 180 ha (400 acres). The largest territory Clark mentions was 309 ha (773 acres) in a clan from Scotland.

Territory boundaries are marked with scent (either urine or a hormonal secretion from glands located either side of the anus and at the base of the tail) and dung pits (latrines - left). Studies from Ireland indicate that males play a greater role in maintaining the clan's territory than the females and that these territories are fixed - i.e. when a neighbouring badger group was removed, the clan in question did not extend their territory to 'take up the slack' (as has been observed in foxes). This observation is interesting considering that debate has raged for years over what regulates the size and configuration of badger territories. One leading theory proposes that the availability of suitable sett sites directly determines sett density, thereby dictating social group density; social group density in turn determines the size of the territory. Indeed, studies from Gloucestershire suggest that when

badgers are recolonising an area, their first action is to occupy the setts before re-establishing the territory. This implies that, at least in some (probably lower-density) areas, setts are a crucial resource within the clan's territory. Data from Wytham woods, however, suggest that these badgers were constrained by food availability rather than suitable sett sites and a change in the distribution of food (with a subsequent increase in the carrying capacity) resulted in new setts being dug – this is known as the "**Resource Dispersion Hypothesis**" (or **RDH**) and seems to be the most probable explanation for badger sociality.

Badgers from the same clan will mark each other (a process known as "musking"); a musking badger will back onto another badger with its tail raised, secreting an odorous substance onto the conspecific's fur. The gland used specifically for scent marking is the subcaudal gland, which is located in the subcaudal pouch, just in front of the base of the tail (see: Behaviour and Social Structure).

Badgers deposit their faeces in latrines, most of which are located either at the main sett or at territory borders (these may cover several square metres). A study by Michael Hutchings ***et al***. back in 2001 found that badgers in south-west England selected woodland and avoided arable (i.e. farmed) land, for latrine sites (which are generally shallow, uncovered pits). They also found that faecal scent marks were strongly associated with the edge of pastoral fields (typical of territorial marking), rather than being in the middle.

Although territory may be defended against intruders (and studies at Wytham Woods by Chris Newman and Christina Bueesching suggest that borders aren't actively defended and that badgers from other groups are able to move freely over the area provided there is no conflict of interest with the territory holders), there is often an overlap between neighbouring clans. This overlap seems to be related to the availability of food. Work by Han Kruuk published in 1987 shows that the overlap between clan territories was greatest when food availability was lowest. This observation fits nicely with Territoriality Theory, which predicts that a territory will only persist while conditions make it worthwhile to maintain it; that is to say, territory systems should break down when conditions are poor because the costs of defending a territory aren't out-weighed by the benefits that a territory usually provides. (Back to Menu)

Predators: Contrary to popular misconception, adult badgers do not appear to have any natural predators across their range – although larger predators (such as bears) may kill them to reduce competition. Cubs are slightly more vulnerable and, in the UK, the only animals likely to kill one are Golden Eagles (***Aquila chrysaetos***) and Red foxes (***Vulpes vulpes***), although whether these are ever truly predatory is a matter of opinion. In Europe Wolves (***Canis lupus***), Lynx (***Lynx lynx***), Wolverines (***Gulo gulo***), Brown Bears (***Ursus arctos***) and Eagle Owls (***Bubo bubo*** - left) may take young badgers if the opportunity arises. (Back to Menu)

Food and Feeding: After the winter period, 'normal' feeding resumes and even where large clans persist, individuals typically forage solitarily. Tracking studies have demonstrated that clan members – 'though not necessarily all together – will often use the same feeding sites at different times throughout the night and that badgers tend to move from sett-to-sett within their range, only rarely straying into a neighbouring territory. Feeding during March is typically rather isolated, becoming gradually more social as the year progresses. Regular social feeding is common by about April or May and large groups of badgers feeding voraciously can be observed by September. The feeding regime of the badger may be influenced by prevailing weather conditions and in his book, ***Badgers***, Michael Clark notes that gales make feeding badgers nervous - presumably because it makes detection of threat by scent more difficult.

Badgers are variously described as opportunistic omnivores or local specialists, which -- throughout much of their range (and across the entire UK) -- feed primarily on oligochaetes (earthworms). One 1981 study on badgers from six areas in Scotland concluded that the dominant food everywhere was earthworms (***Lumbricus terrestris*** and ***L. rubellus***), with some 'less important' food items too. This is the general pattern across the British Isles, where earthworms constitute the primary component of the diet – badgers seem to prefer picking these invertebrates off of the surface, rather than digging for them. Across their range, badgers will also take insects (including caterpillars and moths), beetles, small mammals (including voles, rats, mice, moles, young rabbits and hedgehogs), fish, frogs, berries, roots, bulbs, nuts, fruit (in the autumn), fungi (esp. mushrooms) and various plant matter (including cereals like oats and wheat). They will eat carrion and those in urban areas are known to scavenge food from bins and gardens.

Badgers may also take birds and their eggs, although precisely how significant they are as a predator of avians is still very much open to debate. Anecdotal evidence (largely from the 1940s and 1950s) suggests that badgers may occasionally be responsible for heavy losses of game birds and it appears that in years when their preferred food is scarce, badgers may take more birds. There is, however, little in the way of documentary evidence to support these notions. Indeed, from the numerous studies looking at the diet of badgers across their range, it seems that birds represent an uncommon addition to their diet (at least at the species level). A study by the Department for Environment, Food and Rural Affairs (DEFRA - formally MAFF) found that out of 289 calls regarding "nuisance badgers" in 2001 and 2002, only seven (2.4%) concerned predation on domestic fowl. Moreover, in an extensive review of records of birds in the diet of ***Meles meles*** by Tim Hounsome and Richard Delahay of the Central Science Laboratory in York (UK), the biologists report that bird remains were recorded in 2038 out of 36,699 stomach content and faecal analysis results documented in the literature (representing 5.5% overall, or roughly 8% when considering only UK records). They found that although the percentage frequency of occurrence of birds in the diet increased significantly with latitude, there was no obvious connection between the presence of birds in the diet and season. Ultimately, while it cannot be argued that badgers will consume birds, we cannot say with any reliability that badgers are important predators of avians; Hounsome and Delahay, in conjunction with several other authors, suggest that many of the bird remains found could easily have been scavenged carrion.

In some areas, badgers may dig out and eat the contents of wasp and bee nests, including the larvae, pupae, honey and honeycomb. Although invertebrates such as snail and various insects can form a substantial part of the diet, earthworms seem to comprise the primary component. A study on a population of badgers in southwest Britain found that 75% of individuals had worms in their stomach, with 65% having only worms. Various authors report that it is not uncommon for a single adult badger to eat 200 earthworms per night, especially on warm, still, damp nights, which make for excellent worming! Indeed, throughout much of their range, earthworms comprise about half of the badger's diet, while mammals and insects constitute about 10% and 15%, respectively. Oxford University's Dr Chris Newman estimates that these 200 worms, probably represent a maximum of 5,000 calories per night. Badgers may occasionally break into poultry houses or take other small domestic animals, but such instances are considered rare.

Badgers will actively predate rabbits (***Oryctolagus cuniculus*** - left) in parts of their range -- which are neatly skinned, leaving only the stomach and caecum -- and are one of two British hedgehog-eaters (the other being the Red fox - see

Q/A); foxes tend to eat the skin of the hedgehog (***Erinaceus europaeus***), while badgers leave it. Apparently, bearing witness to hedgehog predation is not something for the faint-hearted. In his ***Wildguide***, acclaimed wildlife photographer and TV presenter Simon King writes:

"***Of all the predators in Britain, badgers seem best equipped to deal with hedgehogs as a meal, digging a shallow pit next to the curled pin-cushion, rolling it in with muzzle or fore feet, and then using enormous power and long front claws to prize open the packed lunch. This whole procedure is usually punctuated by very loud and pitiful screams and grunts coming from the terrified hedgehog.***"

In the UK, badgers seem particularly partial to elder berries, the seeds of which they distribute in their dung. In a similar manner to most other mammals, the scat can often provide vital clues to the diet of the animal, because different foods lead to changes in consistency. Soft scat is associated with earthworms, while more 'jelly-like' excrement implies a predominance of berries and fruits in the diet.

As is to be expected from an opportunistic omnivore, the proportion of various food items varies according to location and season. A study by Eloy Revilla and Francisco Palomares published in the ***Canadian Journal of Zoology*** in 2002 found that the main food resource for badgers was young rabbits during the winter and spring, fruits in the autumn and reptiles in the summer months. The scientists also report that consumption of rabbits (both juvenile and adults) was related to rabbit abundance, with a type-3 response (i.e. as young rabbits increased in number, badgers slowly adjusted their diet to include more of them). Thus, it seems that in their study area of Spain at least, badgers are generalists and are not locally specialized. Another study by biologists at the Euskal Herriko Unibersitatea in Spain found that the diet of a badger clan from Biscay varied with season: fruit was a staple constituent in summer and earthworms were the main component in other seasons. A study of badgers in Denmark found that cereals were an important part of the diet during the spring and autumn, with small mammals more important during the summer months. The study also reported that, during the autumn, males ate twice as many earthworms as did females and that diet composition did not differ significantly with age. This dietic variation has lead to considerable debate over trying to describe the feeding group to which badgers belong. I think that Carnivore biologist Prof. Han Kruuk, formerly of Aberdeen University in Scotland, sums the situation up quite nicely in his book ***Hunter and Hunted***, in which he writes:

"***More complicated still, the Eurasian badger, for instance, may be highly focused in its food selection in any one area, concentrating on earthworms in northwest Europe, on rabbits in southern Spain and on olives in northern Italy. There is no doubt that in each of these areas badgers are highly specialized compared with the other predators around. Nevertheless, their specializations are different in different places. There is still earnest scientific debate about whether this animal is an omnivore or a specialist (I call it a local specialist).***"

If one were wishing a more cautious approach to classifying a badger's feeding habits, try the definition given by Universidad Rey Juan Carlos' Emilio Virgós and his colleagues in their 2004 contribution to the ***Canadian Journal of Zoology***, where they describe ***Meles meles*** as: "***facultative specialists that search preferentially for earthworms but probably take other food resources during their foraging bouts (beetles, fruits, and fungi).***"

Regardless of the trophic 'category' to which you choose to assign ***Meles meles***, in most populations, badgers feed copiously in the spring and summer months and have laid down appreciable subcutaneous (under the skin) fat reserves by the autumn. Indeed, from September to November badger switch to an anabolic metabolism (to lay down fat), switching back to a catabolic metabolism in December to allow fat store to be utilised. This layer of fat can be considerable and may increase the badger's weight by as much as 60%. Indeed, many consider the abundance of food resources to be ultimately responsible for the great variation in badger sociality (i.e. it is the underlying cause of badgers living either solitarily or as groups); recent work from Poland and Oxford certainly seems to support this idea.

Contrary to popular perception, Red foxes don't appear to compete directly with badgers for food; in fact, the two (esp. fox and badger cubs) can often be seen foraging together on good feeding grounds. An interesting paper -- published recently in the ***Journal of Zoology*** -- by David Macdonald, Christina Buesching and colleagues found that foxes may sometimes seek the company of badgers (presumably as a method of finding some of the best foraging grounds). Even when foxes are tolerated at feeding sites, badgers still have dominance, readily seeing off any foxes that overstep their mark. Unlike the Red fox (and many other carnivores), badgers are not known to cache surplus food.

Badgers rarely drink; instead they obtain most of their water from their food. Despite this, putting out water can be invaluable for cubs visiting your garden. One of the biggest causes of cub death is coccidiosis; coccidiosis is intestinal inflammation caused by single-celled protozoa (in badgers, ***Eimeria melis*** and ***Isospora melis***). These coccidia develop in the cells of the intestinal lining and, as they reproduce, they cause serious intestinal bleeding, which leads to very watery diarrhoea. Consequently, the cub loses substantial amounts of water as well as salts and various nutrients (dissolved in the water). Although adults develop an immunity to this parasite (if they get the chance!), cubs have not yet received sufficient exposure for an immune response to develop. Ergo, if you have cubs visiting your garden, put out a saucer of water for them - ultimately, water is far more important to a cub with coccidiosis than food. (Back to Menu)

Breeding Biology: Badgers become sexually mature at one year old and mating may occur during any month, although the majority are between February and May (mating is also quite common between July and September). Oestrous (the female's receptive period) in ***Meles*** is typically between one and two days, during which a sow may mate with several boars (prior to this, a boar's testicles descend following the over-winter retraction that acts to conserve heat). During courtship, the male will pursue the female and bite her nape (back of the neck) during intercourse. Reports exist describing the sow running around in circles -- first clockwise, then anti-clockwise, similar to that observed in courting hedgehogs -- prior to copulation, although it is unknown whether this is common behaviour. In a talk about the badger's natural history to a team of Earthwatch volunteers (of which I was fortunate enough to be one) in May 2006, Christina Buesching spoke of the behaviour of boars at Wytham during the breeding season. Dr. Buesching described how each night one boar would wander around the sett, sticking his head into each of the entrances and making a "churring" noise (which sounds similar to gargling with a very full mouth). If a receptive sow doesn't answer (or come out), he moves on to the next hole and repeats the churr. The following night a different (but again, only one) badger will patrol the sett.

In their 1996 edition of ***Badgers***, Ernest Neal and Chris Cheeseman describe some mating events. The biologists write:

"***The first sign of interest shown by the boar is often the raising of the tail into a vertical position and the emission of a loud and often continuous deep whinnying purr. He may then approach with a shuffling motion taking short steps with the legs kept rather rigid***."

Other descriptions note the presence of mutual grooming and 'ground pawing' by the boar immediately prior to mating. Many field reports describe vocal 'utterings' between badgers during copulations, serious attempts at which may last anywhere from ten minutes to one-and-a-half hours; intercourse of two to five minutes is known in sows that are not fully receptive. Mate-guarding (i.e. males chasing away competitors from their chosen mate) is known in badgers and, in some respects, badger clans are similar to the pride system observed in lions; sows are able to move into neighbouring territories where they are apparently free to mix with other badgers and leave when they please, frequently after mating. Once mating has taken place, females bear all the costs of reproduction and males play no role in raising the cubs.

In a study of 548 adult female badgers from Offaly in Ireland between 1989 and 1990, Thomas Hayden and Robert Whelan found that between 80% and 90% of females mate, only 65-70% achieve successful implantation and of these only 35-40% exhibit copious lactation. These figures are similar to results from studies on badger populations in southern England, where about 30% of females breed annually. The Irish paper goes on to report that reproductive performance of yearlings was inferior to older badgers and observed some evidence for density-dependant reproduction in this species (i.e. reproductive success was correlated with the number of badgers in the population).

After fertilization, sows undergo a phenomenon known as embryonic diapause (also referred to as 'Delayed Implantation'). Diapause is a dramatic reduction in, or a cessation of, mitosis (cell division) in the zygote (fertilized egg) at the blastocyst stage. In other words, the egg multiplies to form a hollow ball of cells (called a blastula), which is then suspended in the uterus for between three and 15 months, although the latter is rare. Currently, reproductive biologists divide those species displaying embryonic diapause into those which are facultative (i.e. delayed implantation is induced by environmental conditions, such as in the rodents and marsupials) and those that are obligate (i.e. that present at every gestation regardless of ambient conditions). Badgers are placed within the obligate class and, almost regardless of the time that mating actually takes place, a sow will delay implantation until late December or early January. So this, as well as the wide distribution of embryonic diapause among unrelated taxa (e.g. plants, insects, vertebrates) -- which suggests that it has arisen several times during the course of evolution -- raises the question "what is the point of delaying the implantation of the blastula?" It has been suggested that diapause might allow mating to move to the most optimal times (such as when females are best able to select high quality mates) or that it may relate to the storage of sperm.

In 1880, S. Fries proposed that delayed implantation may allow the young badger cubs to be born earlier in the growing season, thus providing them with the maximum length of time possible to develop before they had to face their first winter. Some 126 years on, Fries' hypothesis is still considered the most plausible explanation for this phenomenon. Indeed, in their recent paper to the journal ***Evolution***, Michael Thom, Dominic Johnson and David Macdonald of Oxford University argue that delayed implantation is a plesiomorphic (i.e. primitive) characteristic in mustelids, which evolved several times (probably because there are costs associated with it). The observation that delayed implantation increases in frequency as you move further from the equator, argue Thom ***et al.***, strongly supports the idea that it provides the beneficial trait of being able to uncouple mating and parturition. In other words, diapause permits sows the luxury of being able to select mates at premium times (e.g. when males have survived a particularly harsh season) while allowing births to coincide with the most favourable seasons.

While there has been much speculation as to the purpose of diapause, the biochemical cause of this phenomenon has yet to be established. It has been suggested that hormones in the badger's blood (e.g. progesterone and oestrogen) and possibly some proteinacious development factors are responsible for triggering resumption of blastocyst development. Indeed, studies in rodents have suggested that the female sex hormone estradiol and Epidermal Growth Factor Receptor (Egfr) may play a role in triggering blastocyst implantation; a single injection of the female sex hormone oestrogen has been shown to terminate diapause. Similarly, work on badgers by Rene Canivenc at the Universite de Bordeaux II in France has demonstrated a pronounced increase in luteal vascularization and progesterone production prior to implantation.

In April 1979 a paper published in ***Nature*** reported on the experiments of Rene Canivenc and colleague M. Bonnin on captive sows. The biologists exposed six sows to a 10:14 photoperiod (i.e. 10 hours of light, followed by 14 hours of darkness) at 5 deg-C (41 deg-F). Blood samples were taken from the badgers each week and analysed for progesterone. Progesterone is a steroid hormone that is secreted by a small, temporary endocrine structure in the ovary called the ***corpus luteum*** - in mammals it is known to prepare and maintain the uterus for pregnancy. The scientists found that when the photoperiod was decreased (i.e. more dark, less light), there was a sharp increase in progesterone levels to those seen just prior to implantation during January in wild specimens (18 and 20 nanograms per mL, respectively). Through manipulation of the photoperiod, Canivec and Bonnin were able to induce "whelping" (i.e. birth) during September, when in the wild the litter would not have been born until the following spring. Ultimately, Canivenc and Bonnin succeeded in demonstrating that delayed implantation in the Eurasian badger (under artificial conditions, at least) is apparently controlled by environmental factors (namely temperature and light, with earlier implantation induced by increased night length), rather than -- for example -- some genetic predisposition to implant after a given period of time. Subsequent experiments by the same authors, during which the temperature was controlled, suggested it to be light levels that triggered implantation.

While these experiments are certainly appealing and doubtless give us a good idea of some of the factors at play here, they do not seem to tell the whole story. As Neal and Cheeseman point out, there are several flies in this ointmental

logic! Among the problems is the fact that from about October-time onwards, badger emergence is entirely nocturnal and not obviously correlated with sunlight; also that implantation should be earlier at northern latitudes (because night length increases more dramatically and temperature drop is more pronounced) when the reality is quite the opposite. Furthermore, there are -- admittedly rather rare -- records of two sows living in the same sett giving birth several weeks apart.

Data from Stephen Ferguson and colleagues at the University of Saskatchewan in Canada suggest that reduced nutrition in the sow can lead to a lengthening of the diapause period. More recent work seems to support this idea and an interesting experiment by a team at the University of Oxford found that when females had a relatively high index of body condition (i.e. were healthy and well fed), they implanted early and the cub sex ratio was male biased (i.e. more males were born than females). The important point here is that their finding goes against the reasonably well-established Local Resource Competition Hypothesis (LRCH). The LRCH states that in years when female body condition is poor animals should lower competition for local resources by producing males (i.e. males are more likely to disperse, rather than hang around and use some of the scarce local resources).

Studies on the badgers of Wytham Woods in Oxford have suggested that body condition in sows is probably very important in determining implantation. The WildCRU biologists have found that females in poor body condition during the winter frequently reabsorb their blastocyst – females can even reabsorb embryos if they decide that they cannot carry it to term. In Wytham, about 95% of sows at reproductive age have blastocysts in their uterus and, by January, about two-thirds of these have embryos. About half of the aforementioned two-thirds give birth and about one-fifth of females lactate in any given year. Typically, only two sows per sett seem able to raise cubs to the point at which they appear above ground (representing about 5% of the population).

The connection between fat and hormones does seem to be an important one and Ernest Neal speculates that, given the lipophilic tendencies of steroids (i.e. they are fat soluble), hormones may be incorporated into the fat reserves built up during the summer and autumn. When the sow enters winter torpor, she begins to live off her fat reserves and as the fat is metabolised, the hormones are gradually released into the bloodstream (it may be this process that triggers implantation). There are various lines of indirect evidence that seem to suggest that this is a plausible theory and, if correct, this would make the quiet, rather inactive month of December a crucial time for the triggering of blastocyst implantation. Indeed, field observations seem to indicate that disturbed setts produce fewer litters than undisturbed ones.

When the aforementioned observations are combined with reports from the field, which suggest that litters are closely tied with food availability (i.e. in years of poor food supply cubs are often later than usual), it becomes clear that the trigger for implantation still begs research. Ultimately, it is probably a combination of light, temperature, current body condition and food supply that interact to trigger implantation.

Once implantation of the blastocyst has occurred, gestation is usually between six and eight weeks, with cubs born anywhere from mid-January to mid-March with the bulk occurring in early February. Births have, however, been recorded anytime from mid-December to April and, because badgers slow their metabolism in winter, gestation can last for between 37 and 20 days (average 63 days). A female may produce as many as six cubs, although two is most common and studies from Ireland have recorded in utero litter sizes of between one and four young. Typically, any given female will only produce one litter in a single year, although under plentiful conditions more than one female in the clan may reproduce. In common with all mammals, the young are altricial (i.e. born blind and helpless). Neonatal (newborn) badgers are thin with pale grey fur and measure about 12 cm (5.5 in.). The cub's eyes open after about five weeks.

The majority of cubs are born underground in a specially modified chamber close to the sett entrance, with good ventilation and a mass of bedding that is moved in prior to the birthing; on the basis of captive badger births, it has been suggested that the temperature inside the natal chamber is 18 to 20 def-C (64 - 68 deg-F). In rare instances however -- for example where the expectant mother is a subordinate sow looking for somewhere to give birth away from the attention of the alpha sow, but rising of the water table and soil type combine to prevent den excavation -- a sow may give birth above ground in large mounds or straw, hay, grass and/or reeds.

Young badgers (right) emerge from the nursery chamber at about eight weeks old (late April or early May) and the cubs have their first teeth at four weeks old. The permanent dentition is complete by 16 weeks (ca. 4 months). Weaning begins when the cubs are about 12 weeks old and during this process the sow will regurgitate food for the cubs; cubs are weaned and feeding themselves by five to six months old

(around end of June, early July). Cubs may be seen foraging with the sow by summer and by June all the juveniles will be familiar with the clan's territory. Badgers are unique among social mammals in that the cubs do not appear to be the central focus of the group, instead they are largely ignored by the adults and it is always the cubs who initiate play with adults, never vice versa (see Q/A).

By the time the cubs are fully weaned, if conditions are good the juvenile badger may weigh 6 kg (13 lbs). If the cub survives to the end of its first year, it will usually weigh between eight and ten kilograms (19 – 22 lbs) and measure 70 to 80cm (2.5 ft). One study from Ireland published in 1993 observed that more than 60% of cubs died during their first year, 35% to 40% of which died before they were weaned. Similarly, although when taken overall, the number of both sexes dying each year is approximately equal; substantially more males are known to die earlier in the year, with females dying later in the year. Presumably this trend reflects the tendency for males to be bolder and thus explore further from the relative safety of the sett than females.

On average both males and females mature at 12 to 15 months old, although males may mature as late as two years and females may begin ovulating earlier or later than the average. Dispersal is most common in badgers of two years old and seems intrinsically related to clan stability (i.e. the more stable the habitat and social dynamics of the clan, the less likely dispersal becomes). Males generally have a greater tendency to disperse than females. In a paper to the ***Joural of Mammalogy*** during 2008, David Macdonald and his team analysed 17 years of data from a marked population of badgers in Oxford and report that 36% of individuals never dispersed from their natal territory and, of those that did, dispersal distances rarely exceeded two or three home range diameters. These data support previous studies, which have found that while excursions into neighbouring territories for the purposes of (inter)breeding may be common, as a species, badgers have low dispersal rates and at a local (although not at the species) scale are genetically depauperate (i.e. local mixing of genes is severely diminished) – the global population appears to have gone through a genetic bottleneck at the last Ice Age.. Where dispersal does occur, sows may leave the clan in 'coalitions' of two or three animals.

Generally, about half the cubs will die within their first year through causes other than infanticide (i.e. the weather, disease, on the roads etc.) and there is often a 30% per annum mortality of adults. While disease and road accidents are invariably important features in the overall mortality of badgers, weather seems to be perhaps the most significant factor. In a paper to the ***Journal of Zoology*** in 2002, a team from Oxford University's WildCRU lab report on the population dynamics of the badgers living in Wytham Woods (Oxfordshire, UK) between 1987 and 1996. During this time, the population experienced a terrific increase in both badger numbers -- almost quadrupling from 65 adults to 228 -- and badger density (15 adults per sq-km in 1987 to 38 adults per sq-km in 1996). Despite the overall trend in population increase, however, cub survival was inextricably linked to rainfall. In 1990, a summer of unusually low rainfall resulted in 15 of the year's 23 cubs (65%) dying, although rainfall seemingly has little impact on the number of adults surviving. Presumably, during prolonged periods of dry weather, earthworms are scarce and difficult to dig for, leading to a decline in overall body condition and an increased chance of cub mortality. Fortunately for the badgers of Wytham, their population appears to have grown in response to an overall improvement in climatic conditions as well as the social rearrangement of territories observed during the study. (Back to Menu)

Behaviour and Social Structure: European badgers are atypical among the mustelids because in parts of their range they live in highly social family groups (clans) and yet show little sign of any cooperative behaviour. Clan formation is typically associated with areas abundant in resources and with high population densities; in areas where badger density is low (e.g. Scottish highlands and Scandinavia), clans tend to consist of a "basic unit" (one male and one female) and very occasionally a couple of related individuals.

Where subordinates persist, they do not appear to be “helpers” in the same way that can sometimes be seen in Red fox (and other canid) communities. Studies on the alloparental behaviour (i.e. individuals raising cubs that aren't their own) of badgers have provided mixed results. The vast majority of observations have failed

to find any evidence that subordinates help breeding individuals. Indeed, a recent scientific study, published in the Journal of Zoology, found that breeding sows with 'helpers' were actually in worse condition at the close of the breeding season than those without helpers! The study found that the majority of non-breeding females (helpers) were sexually mature adults that had lost their own cubs and concludes that the negative effect of helpers was probably a result of intense competition for resources. Despite these results, however, some reports of alloparental behaviour do exist. In a paper to the journal ***Animal Behaviour*** back in 1993, Oxford University zoologist Rosie Woodroffe writes of non-breeding sows babysitting and grooming cubs. Dr Woodroffe describes babysitters rounding up cubs that strayed too far from the sett, chasing a fox and a boar (who bit one cub) from the sett and mutual scenting (i.e. cubs marking babysitter and babysitter marking cubs). On three occasions, Woodroffe observed a mother and a subordinate carrying the cubs from the burrow where they slept with their mother to the burrow where the babysitter slept. In her paper, Dr Woodroffe suggests that such examples of alloparental care may have been missed during previous observation because the watchers mistook babysitters for mothers. She also suggests that babysitting may occur earlier in the year, before the cubs emerge from the sett.

Coupled with Woodroffe's observations, there are reports of apparent kin selection (i.e. relatives caring for offspring that aren't theirs) from badgers, although such instances seem very rare. Overall, subordinate badgers don't seem to have any input in raising the year's brood; even taking Woodroffe's work into account there are no reports of subordinates suckling the cubs, or providing food for the mother or cubs. Moreover, observations from Wytham Woods have found that adults to not even take cubs underground when danger threatens. Instead, subordinates seem to perform general sett maintenance duties, such as expansion of the sett and changing of the bedding. Presumably, this assistance is particularly helpful during late winter and early spring when bedding may be dragged out of the sett and left in the entrance to 'air', which one assumes kills off lice, ticks and fleas that can parasitize badgers. The airing of bedding may be a crucial factor in the maintenance of the sett and there is some suggestion that at least some instances where badgers have 'upped-sticks' and moved setts may be the result of parasites building up in the bedding.

Several studies have demonstrated that, across Britain, the average number of breeding females per clan decreases with increasing latitude (so Scottish clans typically contain only a single breeding sow, while several sows may reproduce in clans from southern England). Indeed, in high-density populations (such as those observed in south-west Britain), group sizes may be considerable (the record currently stands at 23 individuals, three of which were lactating sows). In these groups, where several reproducing females may co-exist, it appears that although sows compete directly for breeding status (the number breeding being directly related to the quality of the clan's territory), there is little competition between them thereafter. Furthermore, data from these groups suggest that, in high-density populations, reproductive suppression is mediated through female-female competition for resources, rather than through a need for co-operative care of the young (as has been demonstrated for other social carnivores). In other words, reproductive suppression is a mechanism for adjusting the group size to fit the availability of local resources instead of being a way of coercing clan members into babysitting. This idea is given further weight by studies from Sweden, Spain and Italy, which have found that when food is very scarce, badgers abandon the concept of sociality altogether and live alone or in pairs. Even where groups persist, there may be 'tiers' of affiliations. Work in Oxford has demonstrated that not only do sows sometimes show a preference for sharing sleeping chambers with other females, but sub-adult boars have been observed to form 'loose associations', spending more time with each other than other clan members.

Badgers within a given clan are usually closely related (although more than one family may sometimes make up a single sett) and establish a well-defined territory marked by scent and latrines (see Territory above), which they will vehemently defend against intruders if need be. Despite the territoriality associated with the sett and latrines, feeding grounds may overlap with neighbours and to date there are no confirmed records of a hierarchy among badgers (either between members of the same clan or between members of peripheral clans) feeding at the same location, although there is evidence that during times of limited food resources, adults may restrict access to key foraging areas by subordinate clan members. Indeed, based on computer models, some consider that badgers make use of a passive range exclusion mechanism. This concept suggests that feeding excursions deep into neighbouring territories aren't worth a badger's time and energy, because areas of lower food availability are encountered and the travel time (returning to their own sett) is lengthened. The idea is that badger territories are roughly hexagonally-shaped areas, each border touching that of a neighbour's range, such that they form a honeycomb mosaic. Each sett is roughly in the middle of the territory and badgers forage closest to the sett first, moving further away as they exhaust the food reserves. The upshot of this is that 'ridges' of higher food availability build up at the periphery of each range (because these sites are visited less often than those closer to the sett). If we remember that every badger clan in this mosaic is doing the same thing (i.e. eat outwards from the main sett), we can see that although it is worth the effort to walk up to the edge of your territory, the further into your neighbour's territory you go, the less food you're going to encounter. This means that, when you weigh-up the pros (i.e. food) with the cons (i.e. further to walk, more danger of attack from resident etc.), it is simply energetically unviable for a badger to wander outside its own clan's area when looking for food. Thus, these territories can be maintained passively, through exploitation competition and feeding optimization. The benefit of this is that the badgers don't need to put themselves at risk by seeing off intruders who are trying to raid their larder. This is not to say that aggression is either unnecessary or uncommon -- several studies suggest quite the opposite -- but it does suggest that aggression may be unnecessary for some aspects of badger territory perpetuation.

Interestingly, countless hours of direct observation have failed to demonstrate any dominancy hierarchy among badgers – many badger biologists consider that there is a hierarchy, and observations by amateur enthusiasts seem to support this idea, but that it is probably our finite methods of observation fail to detect it. The question is really, if this hierarchy does exist, what benefits do dominant animals reap? After all, they certainly don't seem to provide more food, or more mates. Despite a lack of evidence to suggest a stable social hierarchy in badger groups, fighting between clan members is well known and typically escalates from jaw-to-jaw contests to neck and frequently rump biting. Where direct aggression does occur, the resulting wounds can be serious. Work by Glen Cousquer, Veterinary Officer at the RSPCA Wildlife Hospital in Taunton (UK), shows that fight injuries can vary from incidental puncture wounds to large suppurative (i.e. pus-discharging) wounds. In an article to the ***World Wide Wounds website***, Cousquer writes:

"***Bite wounds often penetrate deep into the dermis, introducing bacteria into the subcutaneous tissues and setting up foci of infection. In some badgers these foci of infection burst out and coalesce, resulting in large open wounds that may subsequently become flyblown [maggot-infested]. Many badgers cope well with their wounds and it is not uncommon for badgers to be seen at the hospital with incidental wounds, requiring little or no treatment***."

Cousquer goes on to say that upon successful healing of a bite wound (see right), the badger is often left with an area of tough scar tissue, which may provide some protection from further aggressive interactions. A more recent paper to the journal ***Animal Behaviour*** by the mammal team at Oxford University's WildCRU reports that not only did males (and especially heavier males) receive more bite wounds than females, but that wounding rates (again particularly in boars) showed a density-dependent increase (i.e. as the population increased, so did the frequency with which males were observed to sport bite wounds). The rate of bite wounding in males was also seen to increase as the number of badgers living in adjoining territories increased. This, coupled with the observations that males were injured at about twice the frequency of females and that older individuals were more likely to sport bite wounds, suggests that the defence of territory may be a significant cause of these injuries. The biologists note that severe wounds were fairly infrequent in individuals less than three years old, which implies that -- assuming this rate wasn't masked by individuals moving away and dying -- agonistic encounters are typically restricted to badgers of breeding age and thus these fights are a result of social tensions. Interestingly, Prof. Macdonald and his colleagues failed to find any correlation between bite wound frequency and season, which is in contrast to both Dr Cousquer (who observed more bite-wounded casualties during February and March) and Dr David Dixon (who documented higher levels of intraspecific aggression on nights when the moon was in its new phase - see: Activity).

An example of a fight wound, usually obtained during territorial disputes. The image on the left shows the wound shortly after infliction with what appears to be serious tissue trauma to the rump. The image on the right shows the same badger approximately one month later - no veterinary treatment was provided.

There is still debate as to the underlying cause of group formation in badgers. Classically, an ecological principle called the **Resource Dispersal Hypothesis** (or **RDH**, for short) has been used to explain clan sociality. Recent work conducted in Spain suggests, however, that this may not be accurate. The RDH states that the size and configuration of areas defended by an animal (or group of animals) is decided on the basis of food availability. In the social primates, for example, work during the late 1970s demonstrated that those which feed primarily on foliage often have smaller territories than those which feed principally on fruit; this is believed to reflect the more sparse distribution of fruit compared to foliage (i.e. fruit is less abundant than foliage and so the primates have to move over a wider area in order find sufficient to satisfy their hunger). In the case of badgers, the spatial aspect of the RDH (referred to as RDHS) is frequently applied. In essence, where an important food resource is sporadically distributed, a pair of animals will decide upon the minimum area that can be shared with their conspecifics before competition for the food becomes likely. Within the context of this theory, badgers are referred to as "contractors", because they should maintain the smallest economically defensible territory with sufficient resources to permit reproduction (i.e. the smallest patch needed to support them throughout the year, without expanding). Recent data from the Donana region of south-western Spain, however, suggests that the RDH doesn't account for the group living in this population of badgers. The study found that for this population, female territoriality was driven by food availability, while male territoriality was driven by female availability. Additionally, the ranging behaviour of males suggested that they were 'expansionists', rather than 'contractors' and overall territory size was related to its richness, rather than the patchiness of its resources. While these data certainly don't disprove the RDH for badgers as a whole, the biologists suggest that there is a better hypothesis to explain the sociality of badgers in this sub-humid (i.e. long summers) area of the Mediterranean. Rather than a single factor -- i.e. food distribution -- governing the formation of groups, they suggest that a myriad of factors (the availability of key resources, the impact of the dispersing individuals' mortality on the population demography and other behavioural constraints that may favour philopatry over dispersal) may integrate to influence whether an animal stays on its parents' territory or moves away to find its own place.

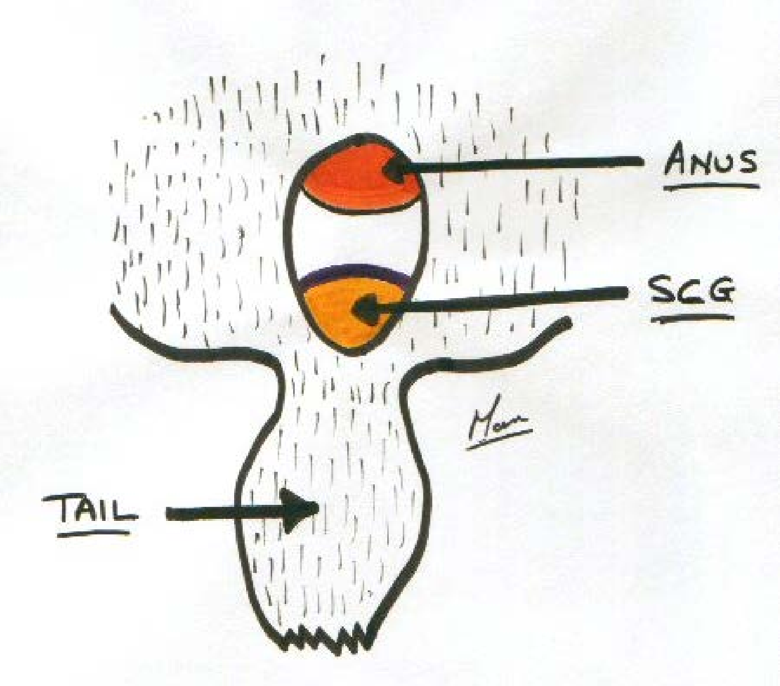
Whatever the underlying cause(s) of group formation in badgers, scent plays a pivotal role in group and territory maintenance, with clan members generally carrying the scent of the dominant boar. Valuable tools in the act of scent-marking are the subcaudal gland (which is close to the anus and imparts scent on to the faeces) and the paired scent glands located just inside the anus - anecdotal observations suggest that scent glands between the toes (i.e. interdigital glands) may also be used when marking objects such as trees near the sett. Arguably the most important scent-marking tool is the subcaudal gland (SCG), which is used to mark objects in the territory as well as other members of the clan (a process referred to as 'allomarking' - below). The SCG develops from sweat glands and consists of a pouch (the Subcaudal Pouch, or SCP) lined with several layers of sebaceous (cells that secrete an oily lubricant onto the skin and hair) and holocrine cells (those that release their secretion by disintegrating the cell itself), while the pouch itself is partially divided into two sections by a membrane (giving a heart-shaped appearance). The SCP opens to a horizontal slit (between 2cm and 8cm -- just under 1in. to just over 3in. -- wide) situated between the base of the tail and the anus.

Allomarking badgers - the cub on the left is applying subcaudal gland secretion to the back of the adult badger on the right. This mixing of scents helps to maintain a 'group odour' and aids recognition within the clan.

The gland secretion has be likened to a margarine-like paste, predominantly composed of long-chain (unsaturated) fatty acids with a little protein and water – the odour is generated by the bacteria in the pouch. Data from Wytham's badger population show that every individual has a different mixture of compounds in their SCG secretion because the species of bacteria in the pouch determine the type and rate of compound metabolism. This means that each badger gas its own individual scent.

A series of recent experiments carried out by a team of scientists, fronted by Christina Buesching at the University of Oxford, has provided some interesting information on the composition and variability of SCG scent. In one set of tests, Dr Buesching and her colleagues used gas chromatography to determine the composition of the SCG secretion. Gas Chromatography is a process during which a sample of a given substance is vaporized and injected into chromatographic columns; in these columns it separates into its individual components allowing the individual ingredients to be identified and measured by a piece of equipment called a mass spectrometer. Effectively, a gas chromatograph can be thought of as a “mechanical nose”. The biochemists were able to identify 110 different components, 21 of which were present in every sample (this has since increased to about 32 out of roughly 150). Of particular interest was the discovery that the SCG secretion shows distinct seasonal and clan-specific variation. Buesching's experiments found that clan member secretion-chemistry was more similar to members of their own group than to those from outside the clan; the composition varied according to season, sex, age, body condition and reproductive status. These results suggest that not only does the SCG's secretion convey information about clan membership, but it may also provide information about the health and fitness of the individual.

A second paper by Dr. Buesching and colleagues found that not only did sex have important implications for SCG properties (males had larger glands, containing more secretion than females), but so did reproductive condition and season. Although the paper reports that there was no observable effect of pregnancy and lactation on secretion colour or volume, there was a significant negative correlation between the levels of progesterone in the blood and the volume of SCG secretion during the spring and summer (i.e. the more progesterone, the less SCG secretion). For males, those in breeding



condition (i.e. with descended testes) had substantially more secretion in their SCG than non-breeding males, although this finding couldn't be linked to the levels of testosterone in the blood. Reproducing boars also had a significantly whiter secretion than their non-breeding counterparts, although overall sows had consistently darker SCG secretions than males, with the secretions for both sexes found to be darkest during spring.

Allomarking (above) is frequently observed in badgers and -- according to a paper by Han Kruuk, Martyn Gorman and Alan Leitch published in the journal ***Animal Behaviour*** in 1984 -- can be split into two categories: mutual or sequential. "Mutual" allomarking involves two badgers pressing their SCPs together simultaneously, while "Sequential" (or "One-Way") allomarking is characterised by one badger marking the body of another. In a 2003 paper to the journal ***Behaviour***, WildCRU scientists Christina Buesching and David Macdonald and biologist Pavel Stopka from the University of Charles in Prague report their observations of allomarking in the badgers of Wytham Woods between November 1994 and April 1996. The zoologists found that sequential allomarking was significantly more common than mutual marking, occurring in 2,866 of 3,021 instances (~ 95%); mutual allomarking was only observed 155 times (~ 5%). Both forms of allomarking were considerably more common during the mating and cub-rearing seasons (winter and spring, respectively) than at other times in the year and although females showed no preference for the marking of one sex, boars -- which also marked more prolifically than females -- preferred to mark sows, although neither sex marked a specific individual preferentially. Males also seem to mark sows post-mating, a feature that Dr Buesching likens to giving her a wedding ring (in other words, saying: "I've mated with her, she's mine!"). Further, yearlings and juveniles were seen to mark most frequently (musking adults of the same sex) and non-breeding sows musked breeding sows more commonly than ***vice versa***. (**Diagram: Approximate location of the anus and subcaudal gland (SCG) of the badger. Modified from Neal and Cheeseman, 1996.**).

The observation that males marked more than females corresponds nicely to previous work by the same zoologists (see above), which found that males hold substantially more secretion in their SCPs than females and that both sexes produce more secretion between January and May (corresponding to the peak allomarking period). Another interesting finding of this study was that, while mutual marking varied according to sex and season, sequential marking was dependant upon factors such as age and reproductive status (i.e. fitness-related parameters); this implies that the two forms of marking may have, at least partially, different functions. Given that the process involves the exchange of minute quantities of SCG and facilitating the mixing of SCG flora, Dr Buesching and her colleagues suggest that allomarking may serve to maintain a common 'clan scent' – this explains why allomarking only ever occurs between members of the same clan. Sequential marking, on the other hand, is probably more involved in advertising individual-specific information (using your clan members as billboards that advertise your status), with perhaps the added function of distributing the clan scent. Indeed, some fascinating data from the WildCRU team was that the secretions degrade in a specific way, with two components breaking down rapidly (over a period of hours) while others barely change. The scientists hypothesise that these two rapidly-degrading components represent the oestrous marks, meaning that a passing boar coming into contact with the scent several days later won't waste time and energy tracking down the sow (who will have since finished oestrous), but will still be able to read the other messages encoded in the scent (i.e. her age, sex, clan etc.) – the remainder of the scent will persist for about two weeks.

Overall, these specific group odours are thought important for intra- and interclan (i.e. within and between groups) communication. Indeed, badgers are well known to be able to distinguish between the subcaudal secretions of clan members, neighbours and unfamiliars, while studies on peccaries (wild pigs of the Tayassuidae family) and mice have shown that group odour can reduce aggression between conspecifics.

The frequency with which a badger deposits its scent on the territory varies according to a host of factors, including reproductive status, season, sex and location on the territory. A paper to the journal ***Acta Theriologica*** in 2004 by Christina Buesching and David Macdonald reports on how scent-marking by badgers in Wytham Woods changes according to these factors. The act of SCG scent-marking takes about a second and involves the badger squatting (with a bending of the knees and a raising of the tail) and pressing the semi-circular shaped opening of the SCG against the substrate (frequently a prominent object such as a tuft of grass or rock). Between April 1996 and June 1997, 442 incidences of object-marking were observed, the frequency of which varied with the season as well as the sex, age and reproductive status of the badger; reproducing badgers

scent-marked more frequently than non-reproducing ones, adults scent-marked more frequently than juveniles and, during the cub-rearing season, females scent-marked more frequently than males. Females were seen to over-mark (i.e. re-apply the scent to the exact same area) more frequently and more consistently than males, who only over-marked during the mating season; overall, roughly one-third of scent-marks were over-marked within 24 hours. Buesching and Macdonald conclude that, based on these data, not only do scent-marks play a role in signposting territory boundaries, they also serve as advertisement signals directed at other group members.

Complementary to the scent laid down by the SCG are scents from urination and faeces. In their 2004 paper, Buesching and Macdonald observed badgers urinating on top of their sett, either in specially dug pits, on the grooming area or (most frequently) on the spoil heap. Urination typically involves squatting, although boars have been observed to perform raised-leg urination. Various studies have demonstrated that urine scent-marks may be used to over-mark the scent left by foxes, while scenting in general is carried out along the main foraging path before the badgers begin to forage more widely. The badgers then find their way back to this path, which shows them the route back to their sett. It has been suggested that countless generations marking the same feeding route may explain why, even when a field is ploughed, the badgers can re-establish the exact same path and also how badgers collecting bedding unerringly find their way back to their sett without looking where they are going (bedding is brought back to and carried down into the sett backwards). It may also help explain the results of a fascinating study conducted by a team of biologists in the Croix-aux-Bois forest of northeastern France in 2003. This particular study found that if you take a badger away from its home sett and release it somewhere else on its territory it homes (i.e. finds its way back to the main sett) quickly, while if you release it in the home range of one of its neighbours', it will also find its way back after wandering randomly for a while (presumably getting its bearings). If you release this badger outside the home range of its neighbours (regardless of the distance), however, it fails to find its way back home. These results are interesting because they suggest that badgers may recognise neighbouring (that is to say contiguous) territories as being close to their own.

Faeces are often considered to be a more robust marker than urine. Although the faeces itself may not smell particularly pungent to us, the anal sacs empty into the rectum and coat them with a jelly-like substance that probably smells stronger to other badgers. Badgers generally deposit faeces into specially dug -- not to mention strategically placed – latrines, which are located close to the sett, along well-used foraging paths and at the territory boarders. Young badgers often use latrines throughout the territory (so-called 'hinterland' latrines), using communal ones as they get older. Indeed, observations on captive badgers suggest that scenting behaviour starts when they're about nine-weeks old (with females showing a greater tendency to scent-mark than males), although more recent biochemical observations suggest that cubs don't begin producing SCG secretion until they are about four months old. As Ernest Neal and Chris Cheeseman point out in their book ***Badgers***, the captive observations correspond to roughly the age at which wild cubs begin to leave the sett. They also comment on how living in an area permeated by its own smell seems to bring "assurance and relaxation" to the individual concerned.

In conjunction with scent, recent data suggest that vocalization may play a key role in social interaction. In a fascinating paper to the ***Journal of Mammalogy***, Prof. David Macdonald, Paul Stewart and Josephine Wong (WildCRU) describe a range of calls recorded during their observation of the badger setts in Wytham Woods. The researchers observed 16 calls: bark, chirp, chitter, churr, cluck, coo, growl, grunt, hiss, kecker, purr, snarl, snort, squeak, wail and yelp. A full description of the calls, along with audio files (.wav) and details of when the calls are performed can be found on the WildCRU website. In the paper, Prof. Macdonald and his colleagues write that churrs, purrs and keckers are restricted to adults; chirps, clucks, coos, squeaks and wails to cubs; while the remaining eight calls (i.e. bark, chitter, hiss, growl, grunt, snarl, snort and yelp) were exhibited by both. In his 1975 opus Grzimek's ***Animal Life Encyclopedia*** (Volume 12, Mammals III), the late German zoologist Bernhard Grzimek described a "piercing scream" that is apparently emitted by wounded badger. Grzimek writes:

"***This call*** [referring to a call reported during badger copulation] ***resembles the death scream of a mortally wounded badger, a sound which is so terrifying that many a hunter has ceased getting badgers after hitting one and hearing the cry.***"

Despite the WildCRU biologists linking the acoustic structure of the calls they witnessed to their function (which they inferred from the context in which the call was made), they found no evidence for either alarm calls to conspecifics or the long-range 'scream' to which Grzimek refers. Given the absence of loud (and thus long-distance) calls, it is reasonable to assume that vocalization is probably an inherently interpersonal form of communication that is used on a strictly close-range basis (i.e. between individuals in close quarters).

The promiscuity of badgers has long been suspected. There are numerous reports of Eurasian boars being hounded by other males during copulation, and a three year study of the Honey Badger (***Mellivora capensis***) in the Kgalagadi Transfrontier National Park in South Africa revealed a strict hierarchical system in males with respect to female access. The dominant boar had unrestricted access to the breeding sow; other subordinate males were only seen to reach the female if the dominant badger had left the sett to chase away another omega boar. Similarly, a recent paper to the journal ***Molecular Ecology*** by a team of biologists from the University of Sheffield, University of Leicester and the Central Science Laboratory in York reports on the breeding biology of the badgers in Woodchester Park, Gloucestershire. The scientists found that males from outside of the sow's social group -- typically boars from neighbouring social groups – sired about half of the cubs to which they could confidently assign paternity. Moreover, there were very few (ca. 22%) successful matings between members of the same clan. These cases of observed and inferred promiscuity undoubtedly serve to reduce the threat of inbreeding. Indeed, a paper published in the ***Quarterly Review of Biology*** recently suggests that the delayed implantation coupled with superfetation may combine to help increase the reproductive fitness of female badgers. Superfetation is the situation where two foetuses are present in the uterus at the same time, but that have been fertilized at different times. Despite claims that many animals exhibit superfetation, verifiable cases are rare and the condition has only been well documented in the group of freshwater fish called Mollies (Poeciliidae). The authors of this study argue that this combination of features (the superfetation and embryonic diapause) may make it difficult for dominant boars to detect cubs that are sired by other males, promoting what the biologists refer to as "cryptic polyandry". Not only does this cryptic polyandry reduce the likelihood of inbreeding, but it may also reduce the probability of infanticide -- dominant badgers are known to kill the offspring of subordinates -- and increase the breeding sow's window of reproductive opportunity by increasing her scope for conception. Indeed, it is suspected that breeding sows may move between neighbouring setts killing cubs in order to reduce the competition for food and give her own a better chance of survival. More generally, infanticide could be a means of saving costs associated with lactation and provisioning for cubs, which would suggest that females in poor condition after breeding might be more prone to infanticide than those in better condition.

Despite the common observation that many badgers remain within their natal sett, some do disperse. A study on the well-established sett at Woodchester Park in Gloucestershire found that badgers of all ages permanently dispersed, with a tendency to move to smaller clans. Indeed, the social groups were in a neigh-constant state of flux, with immigrants from other setts that have died out, and emigration via aggression and death through various means. Similar data from Wytham Woods by Chris Newman and Christina Buesching show that about 50% of badgers never disperse, while 30 to 40% undertake extended spurts of dispersal (returning to the main sett after several weeks or months absent) and 10 to 20% disperse permanently. The age of dispersing individuals may be as young as seven or eight months and, although dispersal this young is rare, a study on the Honey badger in South Africa observed one female dispersing more than 50 km (31 mi) within three weeks of independence! The peak period for dispersal in European badgers is late June through to August. European badgers in the UK tend to experience two distinct socially-unsettled periods: March to April and August to September. The first of these periods is often because cubs are killed while exploring their home range.

A study by Eloy Revilla and Francisco Palomares published in the Journal of Animal Ecology found that prey type may influence dispersal, as well as clan behaviour and structure. The researchers found that on their study area in southwest Spain, badgers primarily ate rabbits and territories were occupied by small clans consisting of a single reproducing female and a reproducing adult male as well as some cubs (the current and previous year's). Dispersal in these clans occurred during the mating season of their third or fourth year of life. The biologists also observed that territory use by these badgers varied seasonally and between sexes. During the winter and spring, when food was abundant in this area, the sows tended to stay close to the sett and move very little, while during the summer -- when food was scarcer and the sows had high energy demands owing to the raising of cubs -- they covered the entire expanse of their territory looking for food. Boars displayed a different pattern of movement. Male badgers covered a roughly equal proportion of their territory during all seasons, but moved faster, over greater distances and covered larger areas per period of activity in the winter, when they were seeking mating opportunities and defending their mates from interlopers (mate guarding). Indeed, dominant boars were observed to form closer relations with dominant sows than subordinate ones during periods of rest. (Back to Menu)

Interaction with Humans: In many areas, people share a similar well-disposed attitude to badgers (more so than they do other urban wildlife, such as foxes); some however, dislike the presence of badgers on their property. Badgers are known to raid dustbins, and compost heaps; they also dig up and eat bulbs and other crops – habits which bring them into inevitable conflict with humans. Badgers are, however, protected under UK law, making it illegal to harm a badger or disturb their setts. The primary legislation is the Protection of Badgers Act (1992), which effectively consolidates all previous legislation, making it an offence to: wilfully kill, injure or take, or attempt to kill, injure or take a badger; possess a dead badger; cruelly ill-treat a badger; dig for a badger; mark tag or ring a badger; or interfere with a badger sett. The act brings a penalty of up to six months imprisonment and a fine at Level 5 (up to £5,000, which is roughly US$ 9,130 or € 7,230). Schedule 6 of the Wildlife and Countryside Act (1981) prohibits the use of certain methods of taking or killing a wild animal and the Powers of Criminal Courts Act (1973) allows any property used to kill, injure or take a badger (including dogs) to be seized. There are of course exceptions to these rules and the Protection of Badgers Act (1992) allows licences to be granted for research purposes and to permit the intervention of local councils in the event of serious damage to property. The same act also permits fox hunts to obstruct the entrances of badger setts to prevent a fox going to ground, provided a strict set of regulations are adhered to.

So, how effective is the legislation? The answer, it seems, depends on the country in question and where the badgers choose to build their setts. In a paper to ***Biological Conservation***, two biologists from the University of Belfast report on this subject. Linda Sadlier and Ian Montgomery looked at the effect that protective legislation has had on the badger population of Northern Ireland. Via a series of direct observation and survey questionnaires, Sadier and Montgomery found that not only was sett disturbance linked to clan size and number, but also that Northern Ireland's badger population is being constrained by high levels of sett disturbance. The authors consider that because most badger setts are constructed on agricultural land (off the "beaten track"), only landowners come across the badgers. Conversely, here in Britain, public rights of access across most arable and forested lands mean that destruction and/or disturbance to a badger sett is more likely to be spotted and consequently reported to the police. For more information on the legal aspects of badger protection, the National Federation of Badger Groups (see Links) has provided a concise summary, while the subject of badger baiting is covered briefly on the Hunting Wildlife page.

It is generally assumed that one of the main reasons some landowners dislike badgers on their property is related to the loss of earnings caused through consumption of crops. There are, however, little data available to suggest how if this is much of a problem. A paper in ***Mammal Review*** in 2004 looked at badger populations in Luxembourg. In the paper, the biologists report that during the period of 1995 to 1999, Luxembourg farmers made an average of only 31 claims per year for crop damage by badgers. This was found to be equivalent to an annual economic cost of some €344 (£240 or US$435), which is negligible compared to the damage caused by other large mammals (such as Wild boar, ***Sus scrofa***).

Badgers can also be carriers of parasites that may be problematic for humans and livestock. Lungworms (Metastrongylidae), hookworms (Ancylostomatidae) and rabies (Rhabdoviridae) have been recorded from badgers on the continent, while badgers in the UK are susceptible to a range of lice (esp. ***Trichodectes melis***), fleas (***Paraceras***

melis), ticks (***Ixodes canisuga***, ***I. ricinus***, and ***I. hexagonus***) and, in rare cases, mange. In a paper to the journal ***Applied and Environmental Microbiology***, Sian Williams and colleagues at the University of Liverpool report the presence of ***Salmonella enterica*** in the faeces of badgers from 18 social groups in Chester, while ***Salmonella agama*** has been cultured from the liver and faeces of a badger found dead on a farm in west England. These bacteria, along with ***Salmonella binza***, which has been isolated from a badger latrine, are important pathogens for humans and livestock. Badgers are also very susceptible to bacterial parasites and, unfortunately for both themselves and most of Britain's cattle industry, they appear to be highly effective vectors for ***Mycobacterium bovis***, which is responsible for causing tuberculosis in cattle (see: below and Q/A).

Undoubtedly, one rather obvious human-badger interaction is road death. Statistics for badger-road mortality (Road Traffic Accidents, or RTAs) vary according to source, although most sources quote figures in the region of 50,000, which probably stems from the figure of 15% RTA mortality given by Ernest Neal and Chris Cheeseman in their book, ***Badgers***. Given the variation in number, size and use of roads across the UK it is perhaps not surprising that there is considerable variation in RTA mortality in Britain. According to the Isle of Wight Badger Group, the number of badger road casualties has decreased slowly in recent years, with 88 road deaths in 1997, 77 in 1998 and 76 in 1999. Unfortunately, there are no reliable estimates of badger numbers on the Isle of Wight, which makes getting an idea of the impact of roads on this population difficult. Elsewhere, almost 70% of annual badger mortality Woodchester Park was attributed to RTAs by one 1997 paper, while nearly 50% of the annual losses observed at Wytham were the result of collision with vehicles. On a more local scale, badger groups often report that specific roads (and even specific stretches of roads within their jurisdiction) can be hotspots for badger casualties. For example, turning to page 13 of my local paper of 26th March 2004, the headline read: "***Badger 'graveyard' on district's roads***". According to this brief news piece in the ***West Sussex County Times***, stretches of the Fittleworth Road and the A29, as it cuts through Billingshurst, have seen unusually high numbers of badgers involved in road traffic accidents. I find that badger groups like to have road casualties reported to them. This way they can keep an eye out for such hotspots and divert their attention and funds to trying to reduce the impact on the badger population, often by installing "Badger Reflectors" on established crossings. These are small posts that reflect car headlights at the badger about to cross – hopefully dissuading it!

While certain stretches of road can be significant areas of mortality for badgers, the type of road can also make a difference. A recent paper in ***Biological Conservation*** reports on the effects of roads on badger mortality in southwest England. A team of biologists lead by Dr Philip Clarke of York University analysed information on when and where road-killed badgers were collected by MAFF (no DEFRA) during the mid-1980s. Perhaps unsurprisingly, they found that there was a strong seasonal skew in road deaths (more in spring) and that the number of badgers killed was inversely related to how busy the roads were. For example, the combined impact of motorways and dual carriageways accounted for only 5.5% of all recorded badger road deaths, while Class A and B roads accounted for almost 55%. Perhaps this reflects the tendency for single carriageways to cut through countryside where badgers are more likely to have established setts. The authors do point out that laws preventing stopping on motorways might have affected the data, leading to fewer carcasses being recovered. It should also be remembered that traffic can also impose a significant barrier reducing and even preventing dispersal – further work by the lead author suggests that high traffic loads may discourage badgers from attempting to cross motorways, dual carriage ways, Class A and Class B roads.

It seems that the predominant reasons for these road deaths are two-fold. Firstly, grass verges on roadsides are kept short and are good places to search for earthworms (probably explaining why road deaths are highest during July when drought conditions often prevail) – unfortunately the situation is compounded because badgers don't tend to run away from cars. Secondly, the high incidence of males dying on the UK's roads earlier in the year can probably be explained by these individuals ranging more widely while searching for the last (and generally younger) receptive sows. (Back to Menu)

Feeding Badgers (by Steph Powley)

Often the best way to tempt wildlife to linger in your garden long enough for you to get a decent look is with the lure of food. Badgers will be attracted to foods such as bread, nuts, peanut butter and dog food and in common with many species of British wildlife they are very fond of custard cream biscuits!

If you have spotted badgers feeding in, or passing through your garden in the past, then it

is best to place the food close to the path they normally take, so that they are most likely to find it. If you are unsure about whether badgers visit your garden, look for large holes in your perimeter fences, paths worn through the lawn and small circular holes in the grass appearing overnight, then place the food close to one of these signs. To watch the badgers feeding from indoors, put the light on in the room you wish to watch from when you put the food out at around dusk, this way the badgers won't be disturbed by movement and the light will illuminate the area where they are feeding. Alternatively, if your garden is well lit by streetlights, keep the lights in rooms overlooking your garden off.

To watch them from outdoors, you will need to stay upwind of the feeding site and remain very still and quiet throughout their visit because badgers will be alert for the slightest movement while they are eating. If you observe from outside, you will discover that badgers are very noisy eaters! If you manage to attract badgers to feed in your garden, you will find that they will come most nights and often stay for up to 30 minutes. When more than one badger comes to feed in your garden, you may witness squabbles between the animals, these seem to be more about the social hierarchy of the clan than the need for food, as such events occur even when food is plentiful.

Whatever wildlife you're feeding, it is best to avoid feeding them too much processed food, trying instead to include foodstuffs from their natural diet. Chocolate should be avoided. (Back to Menu)

Related Q/A:

[Q: Why shouldn't I feed animals chocolate?]
[Q: What is Hibernation?]
[Q: What's all this about badgers and tuberculosis?]
[Q: Why do badgers have stripy faces?]
[Q: Do foxes and badgers bury their dead?]
[Q: How significant are foxes and badgers as predators of hedgehogs?]

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