HABITAT REQUIREMENTS, SURVIVAL STRATEGIES AND ECOLOGY OF THE GHOST BAT Macroderma gigas (DOBSON, MICROCHIROPTERA, MEGADERMATIDAE) IN CENTRAL COASTAL QUEENSLAND

By John Toop

Studies of the Macroderma gigas colony centred around the caves of Mt Etna Caves National Park Central Queensland, have identified the major habitat requirements and seasonal movements of the colony.

Overall the colony aggregates for a summer breeding season and disperses over a wide range during the cooler months.

At the beginning of spring, the pregnant females congregate in the warmest caves in the Caves area, finally giving birth over a period of one month, commencing mid October with the last young born by the end of November. There is no sexual segregation during parturition. Some males and immature females roost with the breeding females at all times. Birth caves at this time are initially rare, as only a few caves have reached an acceptable temperature. As the caves become warmer as summer progresses, the young may be shifted into a larger number of suitable nursery caves in the area.

Carried by their mothers initially, the young are later, left to roost at night in colonies in the nursing cave. The young commence flying on average at seven weeks with all young capable of flight at the end of January. At this time, the young accompany their mother during foraging and many 'doubles' of female and young were caught in the mist nets during February.

From mid summer, the numbers of adult bats slowly increases as the remainder of the males and one year old females join the bats already present in the area. Weaning is completed during March and mating then occurs through April. During the wet season in summer, early autumn J1, Johannsen's Cave becomes critical to the bat colony because it alone seems to offer dry roost sites.

After the wet season, numerous caves unsuitable during the wet are used as roosting sites before the onset of winter. At this time at the end of the mating season in May, sexual segregation can occur with predominantly males roosting in one cave and predominantly females in another.

With the onset of winter, the entire population again reassembles briefly in the warmest caves, finally dispersing during July. Some bats remain in the caves area during the winter, especially the pregnant females, and the warm caves used at this time are probably very important in relieving environmental stress on these females.

Seventy-five per cent of the population, however, disperses in small groups from the caves area and roosts in caves, rock shelters, overhangs and mines over a wide area. Animals from this colony have been caught during winter at distances of up to 20, 25, 35 and 50 km from the caves area and most probably the reports of single ghost bats further afield at Gladstone (90 km), Banana Range (130 km) and the foothills of the Blackdown Tableland (150 km) represent limits of dispersal of this colony. During this study a similar sized ghost bat colony at Cape Hillsborough (300 km) to the north has been kept under observation with at least 50% of its population being tagged and no interchange of colony members with the caves area colony has been detected.

In contrast to the 30-50 animals remaining in The Caves area, which invariably roost together, the dispersed groups are small with single and paired animals most frequently observed, the largest number being 12 bats located in an abandoned mine. This dispersal from the Caves area over a wider winter range is most probably in response to shortages in food supply during the cooler months.

With the commencement of spring, reassembly of the population commences in The Caves area and the population pattern cycles once again.

Microhabitat preference of the colony was initially difficult to determine. The ghost bat in the caves area roosts preferably in avens where warm air created by the bats can be trapped. Maximum/minimum thermometer readings at points below these roosts were invariably meaningless. To offset this problem, a remote infrared biological thermometer was purchased and two seasons data were obtained with this thermometer.

Ghost bats in central Queensland can warm an aven to 3°C to 4°C above ambient rock temperature with a very narrow preferred range of from 23°C to 26°C. Above this range the colony will cease aven roosting while below this range the colony will disperse to another site. At the lower preferred temperature, shifts can be to a site of similar temperature but of higher relative humidity. Initial difficulties in housing conditions for the captive colony at Taronga Park Zoo indicated that at below 70% relative humidity the ghost bat experiences difficulties such as wing membrane cracking so the preference for higher humidities can be readily understood.

Demographic studies were very successful with this colony because the entire population can be found at one site during the mating season and at the onset of winter. As a consequence, the entire population has been tagged over five years and the breeding, nursing and mating season could be precisely determined.

The population size of this colony fluctuates around 150 individuals with a 1:1 sex ratio, with 40-45 young being born each year. Both females and males commence breeding in their second year. Major mortality periods for the colony are at parturition for adult females, early nursing and weaning for young with older animals dropping from the population in winter.

Feeding studies have been carried out by identification of prey remains found in roost sites together with faecal analysis. In the forested coastal environment of central Queensland, the prey chosen is predominantly arboreal in keeping with the wing and sonar characteristics suggesting a gleaning bat. Identification of prey remains from roosts was usually to a species level while remains from faecal pellets could only be identified as of insect, mammal or bird origin because of the small size of the fragments.

During the warmer months the predominant prey are insects with large species such as grasshoppers *Valanga sp,* Rhinoceros beetles *Xylotrupes gideon,* Longicorn beetles *Agrionome spinicollis and* various species of cicadas and Tettigoniid grasshoppers forming the bulk of the remains found in roosts.

Although the majority of the beetle prey do not stridulate there is strong evidence that insect sounds attract ghost bat attacks. The Rhinoceros beetle *Xylotrupes gideon* feeds in large noisy groups in introduced poinciana trees at Olsen's Caves and invariably numbers of ghost bats will be present hawking back and forth from nearby roosts in the scrub feeding on these insects. Stridulating cicadas are heavily preyed on and the single call of a foraging ghost bat can silence calling cicadas over an area of a hectare in the scrub at the caves.

As the weather cools, the percentage of insect fragments in the dung decreases while the proportion of bird and mammal bones increases. Remains of feathers, rodent tails and bat wings from feeding roosts have identified 22 species of bird, 3 species of rodent and 3 species of bat preyed upon by Macroderma gigas with the owlet nightjar *Aegothelas cristatus,* little strike thrust *Colluricincla megarhyncha,* Lewin's honeyeater *Meliphaga lewini,* house mouse *Mus musculus* and sheath tailed *bat Taphozous georgianus* being the most common species taken.

Australian Owlet-Nightjar

The bulk of the bird remains are of scrub species; they and the bat remains are found in feeding roosts all through the caves area. Rodent remains, on the other hand, have only been collected in feeding roosts adjacent to cleared and preferably ploughed agricultural land where it is possible for the bat to hunt ground dwelling animals.

Bat remains under feeding roosts show a seasonal species diversity. The little bent-wing bat *Miniopterus australis* is mainly taken for only two weeks in mid January when the young bent-wing bats initially fly from the breeding cave Bat Cleft on Mt Etna. In contrast, the sheath tall bat *Taphozous georgianus* is largely taken during the colder months when easier prey is scarce. The horseshoe Bay *Rhinolophus megaphyllus* is very rarely taken with only three remains of kills having been found.

In contrast to desert colonies of ghost bats, ground dwelling prey is rarely taken. No reptile or ground dwelling frog kills have been recorded at all while ground dwelling arthropods are very scarce with a scorpion and a carabid beetle being recorded on only two occasions. Tree frogs are only rarely preyed upon with ten *Litoria caerulea* being collected under roosts surprisingly during the cooler months when prey is scarce. During the summer wet when these frogs are very common in the vine thickets, they are not preferred by the ghost bats.

During the course of this work, ghost bats were held for extended periods in captivity. A total of four pregnant females with four males have been held for six months through parturition and nursing to obtain growth records of the young during the phase of development when they are left high in the avens of the nursing cave and are consequently unobtainable.

The highlight of the captive animal studies was the close observation and recording of the birth of a ghost bat. The ease of handling of the animals allowing, even the close use of video equipment without detriment to either the adult or the young. Of the four young raised in captivity, one died from a broken wing but three survived and were successfully released with their mothers, back into the cave colony from where all have been recaptured over a period of years. One of these, a female, has since successfully bred in the wild.

In addition, two females and two males were held for a period of nine months through the mating season, however, both females failed to become pregnant and undoubtedly greater numbers of bats would have to be held to have a successful breeding colony.

Captive animals were held in a constant temperature room 8 m x 3 m with wire mesh on the ceiling for roosting. Adult females were found to require one baby rat per day to maintain weight and the bats rapidly adapted to eating segmented adult rats when rat breeding failed to keep pace with consumption.

Because of the insistence in feeding whole animals with the roughage contained (fur, elytra, feathers and bones, etc.) no difficulty with scouring was ever experienced with these captive animals. Probably because of the blood content of the food, the captive bats were never observed to drink, although water was available at all times.

The young born blind and essentially naked do not develop quickly. The ears prick after seven days and the eyes open at two weeks. At four weeks, the mothers finally leave the young roosting by themselves, and their weight at this time is at around 50 g. Pelage develops quickly and the young are capable of flight at the end of seven weeks, at around 70 g. Because of the intimidating size of the offered food, young did not successfully kill baby rats until 14 weeks old when their weight is around 90-100 g, although they would accept and eat segmented rat at 12 weeks old. All young were released before weaning so that their close association with their mothers would enable them to develop hunting skills to survive in the wild.

Behaviour patterns, mother young interactions, male young interactions and nursing female interactions with other young were recorded at this time.

Food preference tests revealed that baby rats and mice were preferred over any offered insect. Ghost bats also proved incapable of capturing birds (house sparrow *Passer domesticus)* when the lights were on in the room the birds proving capable of dodging all attack passes by the bats. Capture was immediate when the lights were extinguished, however, paralleling the situation in the wild where birds are taken from sleeping roosts in the scrub at night.

Capture of baby rats and mice, was usually carried out by the bats hovering momentarily overhead and then dropping vertically onto the prey. The wings envelope the animal trapping it on a small area of floor usually against a wall or in a corner where it was seized by the neck or head. Once seized the bat would fly back to the roost where the struggles of the prey would cease very quickly. The prey would then be consumed from the head with usually the hind legs and tail being discarded.

During eating the bats invariably used their wrist claws to hold the prey and indeed bat number 491 Zeus was captured with one wrist claw missing and this bat always had difficulty holding a baby rat during feeding.

Management strategies have been implemented at Mt Etna Caves National Park to maximise the survival of the ghost bat colony in the area. The main emphasis has been directed towards protecting the breeding aggregations during spring, summer and autumn. To this end, the major cave (J1 Johannsen's Cave) utilised by the ghost bat colony for parturition, nursing, wet season roosting and mating was closed to the public initially for the period of parturition and flightlessness of the young every breeding season.

The colony reacted in a favourable manner to this strategy, young mortality over this period has been reduced by over 50% and the colony has exhibited much reduced disturbance behaviour. In addition the colony for the first time dramatically increased its period of occupancy of the cave to include the colder months of winter.

Limited options would appear to exist to protect the bulk of the population during the winter months because the greater proportion of colony is dispersed over a wide area. Protection of the warm caves in the caves area utilised by the majority of the pregnant females during the winter would seem to offer the only useful strategy. Certainly, mortality has been recorded after disturbance at this time.

One such cave is located at Olsen's Caves and is adequately protected from interference at this time although in the future this cave could be developed for tourism.

In 1988 a large portion of the northern cavernous face of Mt Etna was obtained as part of Mt Etna Caves National Park. Unfortunately, E7 Speaking Tube on the western flank of Mt Etna was outside this section. This cave was an over wintering site and was deliberately destroyed by the mining company so it could not be used as a lever to extend the park.

The remaining warm sites are located on the Limestone Ridge section of Mt Etna Caves National Park. J1 Johannsens and J8 Ballroom. J8 Ballroom cave is freely accessible to the public at this time but the roost site is located in the bottom sections of the cave and is relatively free of disturbance.

J I Johannsens has only been utilised as a over wintering site since the cave was closed to the public for the spring and summer breeding. Its long term viability as an over wintering site was unknown, both with regard to environmental conditions and potential disturbance. To minimise the latter, the period of closure of J1 Johannsen's was extended to include the winter months for the protection of the pregnant females. This cave is now closed to the public from 1 June to 31 January.

Response from the bat colony has been very positive with females in residence through the winter.

This combination of management strategies has been successful in increasing the colony size in Central Queensland. Since the 1980s when the colony numbered around the 150 individuals the colony has increased to around 170 individuals.

For the future, as long as off park mortality factors (insecticide poisoning, entanglement in barbed wire fences etc) do not become limiting, the future of the Central Queensland colony would seem assured.