# Macroderma

Volume 2 Number 2 September 1986


ISSN 0815-2152

*Macroderma* Volume 2, Number 2, September 1986

## Contents

*Macroderma*

*Macroderma* is published twice yearly in March and September by the Bat Research Group, Zoology Department, Australian National University, Head of Department - Professor C. Bryant.

Management of the journal is in the hands of an Editorial Group comprised by:



Printed in Canberra by Ciril's Printers
Typing by Elizabeth Jackson; Art work by Sue Craven
Cover design by Sue Craven from a drawing by Terry Clayton

# EDITORIAL

The first paper in this issue initiates a series of articles devoted to techniques. These will be published on an occasional basis as they come to hand. Readers are invited to submit others, particularly if they summarise specialist areas of information which would be of use to other researchers.

One of the most interesting recent developments in Australian bat research has been the discovery, yet unpublished, by Beth Crichton that *Mormopterus planiceps* stores sperm during hibernation, like temperate zone vespertilionids and rhinolophids. The most recent publication from Darrell Kitchener and his colleagues increases the number of endemic genera by the addition of *Falsistrellus*.

Detailed information on the Eighth International Bat Research Conference is still not to hand, but the venue will be Sydney, with field-trips/workshops elsewhere, probably in Queensland. The Conference organiser, Mike Augee, will be distributing information shortly.

P A P E R S

# BAT CAPTURE TECHNIQUES AND THEIR USE IN SURVEYS

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## Abstract

A lack of standardised methods for the capture of bats appears to have obstructed the collection of information about this group of mammals. The advantages and disadvantages of the various methods available for the capture of bats are discussed. No one method is uniformly successful for all types of bats, so that a combination of several should be used for effective surveys.

## Introduction

Compared to other Australian mammal groups, bats are poorly known and many basic questions of taxonomy, distribution and biology still remain unanswered. This is partly caused by the problems involved in capturing them. Consequently, many mammal surveys have either neglected or only partially surveyed this important group of mammals (Australian fauna 20%, Strahan, 1983). Problems of surveying include the effort involved in night work, the lack of well documented techniques, the often random nature of the results obtained and a lack of knowledge of bat behaviour.

The literature on bat survey methods is limited. Greenhall and Paradiso (1968), Tuttle (1976), and Nagorsen and Peterson (1980) discuss a range of techniques used in the Americas and comment on the use of equipment and collecting methods. Other papers tend to be more specific. Tuttle (1974) and Tidemann and Woodside (1978) discuss the construction and use of bat traps; Bleitz (n.d.) and Wilson *et al.* (1965) have described the use of mist nets for capturing bats and Borell (1937) and Parnaby (1976) describe the use of trip lines for catching bats over water.

Various authors have made comparisons between different techniques. Kunz and Brock (1975) compared mist nets and ultrasonic detectors for monitoring activity; Tidemann and Woodside (1978) compared catches made with bat traps and mist nets in the same areas; while Kunz and Anthony (1977) examined the efficiency of traps in various situations. Other authors give examples of techniques or the reactions of bats to different weather conditions: Handley (1967) used mist nets originally set up for a bird survey to sample stratification of bats in an Amazonian forest; O'Farrell and Bradley (1970) netted bats over a desert spring in Nevada and describe reaction to environmental variations.

Much of the previous survey work on bats in Australia has tended to rely on the use of a single survey technique. Until recently, in eastern

Australia the emphasis has been on the capture of cave dwelling species or the use of mist nets, while in northern Australia collection by shooting has been favoured. Recent use of different techniques in these areas has rapidly altered our knowledge of the bat fauna. Examples of this include the discovery of *Murina florium* a genus not previously recorded from Australia (Richards *et al.*, 1982); the rediscovery of *Phoniscus papuensis* by the use of bat traps in eastern Australia (Lunney and Barker, 1986)) and a change in the status of *Nyctophilus walkeri*, which previously had been considered rare, but is now known to be common throughout its range (Churchill *et al.*, 1984).

As part of extensive research in Australia capture techniques for bats have been reviewed and tested in the field. Much of this work and the techniques used were designed for capture and release studies with the aim of minimising disturbance to the bats. While concentrating on the use of mist nets, this paper reviews some of the other methods and equipment that can be used for capturing bats and discusses the application of these approaches to survey of the Australian bat fauna.

Researchers should be aware that the capture and holding of native fauna requires a permit from the relevant State or Territory authorities. Permission to work on private land and certain public lands must also be sought (Bureau of Flora and Fauna, 1983).

## A. Equipment and techniques for the capture and handling of bats

### 1. *Mist Nets*

Several types and lengths of mist nets are commonly used in Australia. These nets are similar to those used for the capture of birds and can be obtained from the Australian Bird Study Association[1] and various overseas suppliers, e.g. Bleitz Wildlife Foundation[2]. Mist nets are still made in imperial measurements. They are usually 2.15 m or 3 m high and come in a variety of lengths; 5.5 m (18 ft), 9.23 m (30 ft), 12.9 m (42 ft) and 18.5 m (60 ft).

The 5.5 m nets are best suited for small spaces in thick vegetation, for example, across tracks and over creeks. They are also useful for cave and mine entrances. The 9.23 m and 12.9 m nets are used for more general work and are often used as 'catching nets' in conjunction with longer nets that are used to funnel bats into a tight corner. 18.5 m nets are useful for reaching across large waterholes or rivers. It is also possible to join two nets together, by tying the bench loops, to form even longer nets. The use of a wide range of net lengths allows for greater versatility in net arrangements.

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[2] 5334 Hollywood Boulevard, Ca. 90027, USA.

For catching smaller bats 33 mm (1  in.) to 38 mm (1  in.) mesh sizes are recommended for monofilament nylon and terylene nets. The stronger braided nets used for large bats such as flying foxes have mesh sizes up to 100 mm.

Monofilament nets are favoured over nylon and terylene nets for the capture of small microchiropteran bats. These nets are very fine and difficult for bats to detect. Many low flying bats can bounce off, or even momentarily land on and then take off from heavier nets, but these problems are less likely to occur with monofilament nets. However, fine nets have disadvantages; bats become more tangled and take slightly longer to remove, and they are easily torn if they snag on any projection or vegetation. To maintain nets in good condition it is important to keep them off the ground, away from bushes, tree trunks, rocks and other snags.

Monofilament mist nets should be regarded as expendable items in survey work as they are very difficult to repair. However, the increased capture success of these nets far outweighs these disadvantages, and with practice it is possible to remove bats almost as quickly from monofilament as from other types of nets.

Heavier nylon and terylene nets have also been used on many occasions. Terylene nets are the same thickness as nylon but are softer. Nylon nets are probably least suitable for catching bats as they are stiff and do not form good pockets. However, they are cheap and useful for rough work, such as in caves or mines.

When taking bats from nets it is important to remove them from the side they entered. While this may sound obvious, it is often difficult to determine. One easy way is to look at the pocket holding the bat and see what side of the net the pocket has formed on. The bat will have entered from the other side. Apart from this clue the removal of bats from mist nets is a matter of patience and practice. If difficulties are encountered, a fine crochet hook may be useful to remove badly tangled loops. It has been suggested that a pair of fine scissors should be carried to cut out bats that are extensively tangled, although with experience, handlers should rarely have to resort to this.

One easy method to remove a bat is to hold it by the tail and pull it gently towards you. It is then easier to see where it is tangled. The net is removed from around the tail and feet. It is often a matter of holding and untangling one wing and shaking slightly, the other wing should follow. This approach does not stress the bat and saves the worker from being bitten. If the bat is badly tangled it will have to be removed one wing at a time, taking care to ease the net loops over the forearm without catching any of the other fine wing bones.

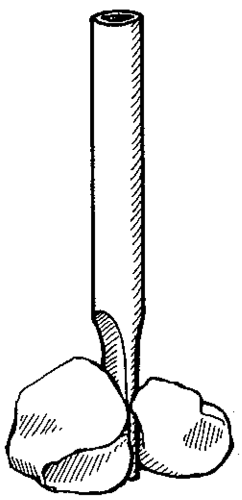
Net Poles

Poles to support nets can be made from a variety of materials and include 'bush poles' or saplings cut on site, wood dowels and aluminium tubing. 'Bush poles', tend to be cumbersome and usually have knots or bark that can snag bench loops, although the dried flower stalks of grass trees (*Xanthorrhoea* spp.) make excellent light poles when available. Aluminium tubing is by far the most satisfactory material as it is strong, light and smooth. Smoothness is important as it allows bench loops to slide freely along the poles, which is essential if nets are to be set and dismantled quickly.

Poles are easier to use if they are collapsible. Sections can be joined together by the use of internal ferrules. Sections should not slide inside each other as this arrangement tends to collect sand and invariably jams. Poles need to be made up for the height of the nets used. Longer sections can be used if nets are to be set high above ground level. It is recommended that a universal pole system be used where each pole section is identical and has its own ferrule which fits tightly into the next section.

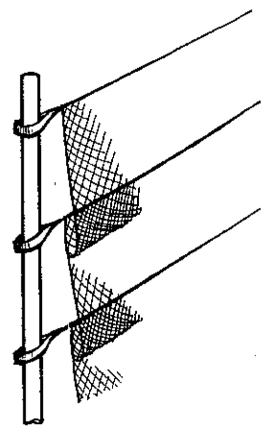
Pole Holders

One of the most difficult problems in pitching nets is supporting the poles. Poles commonly are pushed or driven into the ground or held with guy ropes. Wilson *et al* (1965) suggested the use of pole holders. The authors used holders that were made from a 45 cm length of steel water pipe. One end of this pipe was flattened to form a spade point (Fig. 1). These pipes were driven into the ground with a small sledge hammer and were angled slightly away from the line of the net. These holders proved effective on a wide variety of surfaces ranging from creek bed boulders to soft sand. Use of pole holders eliminates the need for a second person to hold the pole during the setting or removal of nets, allowing nets to be set by one person. With this system nets can be set quickly with limited manpower, making the placement of long net lines possible. If it is necessary to tension the net a single guy rope at each end is sufficient. After several months of continual use pole holders become burred at the top. The most convenient way of solving this problem is to saw the burred end off.



◀ Fig. 1. Pole holder. This is propped up with rocks or driven into the ground, removing the need for guy ropes and allowing nets to be set by one person.

Fig. 2. Net pockets. ▶ These should be loose to help tangle the bats and reduce the chances of escape.



Net Setting

When setting nets it is important to ensure that the net is not set too tightly as bats are likely to bounce off tight nets. Ideally, the net should sag slightly along the bench strings (Fig. 2). Most importantly, the distance between the bench strings needs to be adjusted so that deep 'pockets' are formed in the net. These pockets of loose net help to tangle bats and lessen the chances of escape (Fig. 3). Watches, jewellery and shirt buttons can also become tangled and damage nets. Such items should be removed and buttoned shirts can be worn inside out to prevent snagging.

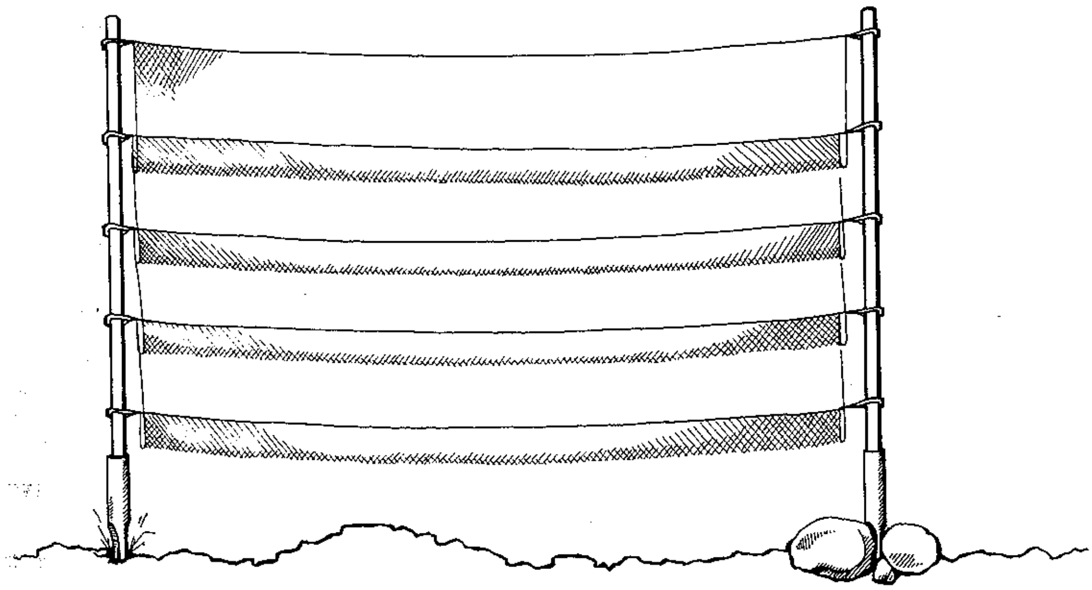


Fig. 3. Mist net set up using pole holders. Ideally the net should sag slightly and have large, loose pockets.

The timing of net setting is also important. Ideally, nets should be set in twilight just after the sun goes below the horizon but before it is completely dark. This reduces the chances of catching diurnal birds while the net is being erected. If the site is likely to be difficult to set up at dusk, nets can be set earlier in the day and rolled up (furled). This involves sliding the bench strings together and winding the net folds over the bench strings. Furled nets should always be tied with cord or tape to prevent them blowing apart. If it is very windy and the nets could become snagged on nearby objects, they should be taken down and the poles left in position.

After the nets have been set at night it is important to attend them continuously for the first hour or two after dark. If bat activity is low they may then be left unattended for short periods, but it is important to check them at regular intervals as bats can become distressed if badly tangled, or they may chew holes in the net and escape.

When arranging complex net patterns it may be necessary to set two or more nets from the same pole. This is easily achieved by adding the bench strings in order, i.e. the bottom loop from one net then the bottom loop from the other, until the top strings are reached. To remove the nets, slide the loops to the top of the pole as in Fig. 4. It is important to tie together the loops of each net separately, using their top loops while they are still on the pole, then lift all the loops off the pole and the nets will slide apart. The loops of the nets you are not ready to roll up are replaced on the pole and each net is rolled separately as shown in Fig. 4. Once the net has been folded, place it in a clearly labelled cloth bag. Cloth bags are preferable to plastic bags as they do not trap moisture if nets are put away damp. Nets are unrolled using the same method in reverse. It is necessary to untie the bench loops, before they are placed on the pole, to check that the strings are not crossed.

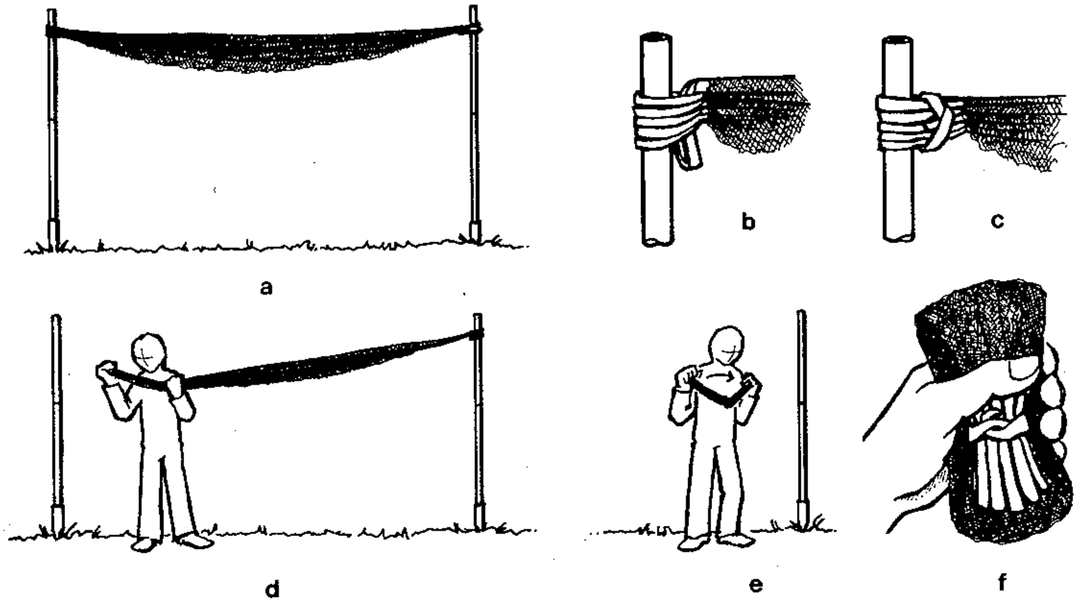



Fig. 4. Sequence of steps for folding a mist net.

Heavier nets do not need to be folded and can be stuffed into a bag. Starting at one end of the net take a small length of net and stuff it into the bag. Do this while working your way to the other end, keeping some tension on the net to avoid it sagging on the ground. To set these nets, pull out the bundle of loops at the top of the bag. Thread them onto a pole and keeping the tension on the net, walk slowly towards the other pole position, feeding the net out as you go.

2. *Bat Traps*

Design and Construction

Since the introduction of bat traps into Australia there have been almost as many trap designs as there are bat researchers, but with a few exceptions, these have not departed significantly from the design concept originally discussed by Tidemann and Woodside (1978). They do, however, vary greatly in catching effectiveness, ease of erection, portability, and construction complexity. In constructing bat traps it is desirable not to make them too large as they become unwieldy. It is also necessary to ensure that the trap is quick and easy to erect, stable and portable.

Setting Bat Traps

String tension is the most variable feature of bat trap use. Tension should relate to the flying speed of the bats to be caught. If bats hit the strings and bounce off them the tension should be loosened. If bats can fly through both banks of strings then the tension should be increased (Tuttle, 1974). At roost entrances this behaviour can be watched in a soft light. At other sites traps can be observed using a night scope. Fine fishing line should be used to string traps. Tidemann and Woodside (1978) recommend 0.25 mm diameter line, but if a slightly heavier line is used breakages are less frequent. It is recommended that traps set in exposed positions should be secured with guy ropes to prevent them from blowing over. Similarly, traps set in creeks, or on tidal flats need to be firmly anchored.

3. *Hand Nets*

Hand nets can be used for catching bats in roosts such as caves, mines and buildings, or the entrances to roosts, such as hollow tree spouts. Butterfly type nets with strong mesh bags, preferably of dark material, can be used. These should have a large rim, padded with cloth, as bats can be injured by striking the net rim. Hamilton-Smith (1964) has used an adjustable joint between the handle and the net to facilitate the capture of roosting bats from cave walls and ceilings. Extendable handles, which can be made from aluminium tubing, are needed in many roost sites.

4. *Trip Lines*

Trip lines have been used by several researchers. Borell (1937) used piano wire stretched taut above a water surface to trip bats into the water as they approached to drink. Parnaby (1976) used nylon fishing line for this purpose. To use this method, a number of taut lines are stretched across the pond above the water surface. Bats hit the lines and some are flipped into the water forcing them to swim to the bank. A few species can take off from the water surface. K. Stager (pers. comm.) has used a long stick with some leaves on the end to dunk bats when they hit the water. This prevented species such as *Rhinolophus* from taking off from the water surface.

5. *Holding Cages*

Hamilton-Smith (1964) and Greenhall and Paradiso (1968) have described temporary holding cages for bats. These can be made from various materials and some designs fold flat for storage. One which is easily constructed is a wooden framed box with flyscreen sides. The opening at the top is fitted with a long cloth sleeve that can be tied. The sleeve can be pushed down inside the box to create more area for the bats to hang.

6. *Handling Bats*

Most vespertilionids, with the notable exception of *Scoteanax* and *Scotorepens* spp., are generally placid, although all the large species can inflict a painful bite if distressed by rough handling. Molossid bats tend to crawl in the net folds and can become badly tangled if not removed quickly. *Taphozous hilli* and *T. georgianus*, two common cave species in central and northern Australia, have long narrow wings that can be broken if allowed to flap or hang from the net.

Once the bat has been removed from the net or trap, place it in a cloth holding bag. Do not put too many bats in the one bag as they are likely to bite each other. If possible, use different bags for different species, although species of similar size can be placed together. Some species of larger bats may attack and eat smaller ones. Molossid bats should always be kept separate from other species for this reason, and *Scoteanax ruepellii* will also eat smaller bats (Woodside and Long, 1984).

It is important to remember that pregnant and lactating females, juveniles or 'delicate' species such as *Hipposideros ater*, *H. cervinus*, *Rhinonicteris aurantius* and *Rhinolophus megaphyllus* cannot be held in bags for long periods as they are likely to suffer from stress. It is recommended that these animals be measured and released as soon as possible when there is a quiet period in bat activity, rather than waiting until the end of the night. Bats should, whenever possible, be released the same night as they are caught. If it is necessary to hold bats during the day, it is preferable to keep them in separate bags. They should be placed in the shade (a cave or mine is ideal) and given water at regular intervals by allowing the bat to lick water off a finger. They can be released at dusk the following night. If it is necessary to hold large numbers of bats, for example, during a roost census, a holding box can be used.

7. *Transporting Bats*

Transporting live bats is very time consuming and difficult, particularly over long distances and in warm temperatures. To send bats by air, a small polystyrene foam esky (6-pack size) can be used. The bat should first be fed, if possible given a drink, placed in a cloth bag (in hot conditions the bag should be slightly dampened), and then placed in the esky. The bat should not be sent unless it will arrive at its destination within a day. Export and Import Permits from the relevant State Wildlife Authorities are necessary before bats can be sent interstate.

B. <u>Survey Techniques</u>

The various approaches used for surveying bats fall into two categories: (i) observation or capture from diurnal roosting sites; and (ii) observation or capture at nocturnal feeding or drinking sites. At roost sites bats can often be captured by hand or with hand nets. They can also be captured using mist nets or bat traps when they are disturbed or as they leave the roost at dusk. When bats are flying at night they can be captured using mist nets, bat traps, trip lines or shooting. They can also be observed using spotlights and image intensifiers or by detecting their ultrasonic calls. The recording and identification of ultrasonic calls requires the use of specialised equipment, which is not discussed further in this paper.

Bats roost during the day in a wide variety of sites. All Megachiroptera in Australia roost in trees or foliage. The larger flying foxes mainly use fixed 'camps' which are usually a number of trees, often denuded of leaves. The location of these camps can be obtained from local people or by observation of dusk flight paths. The smaller pteropodids usually roost singly in foliage where they are almost impossible to detect, except by careful and long term observation of a population.

Of the almost 50 species of Microchiropterans in Australia, only about one-third roost in caves or similar situations. The majority of species roost in tree hollows, under bark or other sheltered spots. The incidence of bats roosting in man-made structures, particularly occupied structures, appears to be much lower than in Europe or North America. Consequently many useful techniques, such as entrance nets and funnels, can be used less often. It is very difficult to detect the roost sites of forest dwelling bats except by observation of emergence or tracking using light tags or radio transmitters. While detection of roost sites of cave dwelling species also presents problems, the effort involved is often worthwhile as considerable information can be obtained.

Searching roost sites is also useful for obtaining information about many species not commonly caught in mist nets, e.g. *M. gigas*, *Taphozous* spp. *Hipposideros ater*, *H. stenotis*, *H. semoni* and *Rhinolophus*, as well as providing extra information on roost site conditions.

1. *Roost Sites*

Locating Roosts

Caves are often difficult to locate but larger ones are usually known by speleological societies. Cave conservation conventions should be observed if caves are entered and researchers should observe the code of ethics published by the Australian Speleological Federation (1982). In many cases the bat fauna will already have been documented in speleological reports. Exploration of large caves is not recommended without contacting local speleological groups as finding roost sites can be difficult. These sites are often a long way underground or high up in areas that are not readily accessible.

Information on disused mines can be obtained from a variety of sources, which include geological maps showing the locations of different mines and the type of mining that took place, mining wardens, local prospectors and property managers. Old mines, especially gold mines that were mined prior to the 1940s, often involved the driving of adits (horizontal shafts) into hillsides. These are frequently used by cave dwelling bats. Sampling of mines can give a good indication of the presence of cave dwelling bats in an area. These mines are comparatively easy to find as they are marked on maps and usually have access tracks. However, they are often in an unstable condition, making exploration dangerous. If the mine is unstable then it is preferable to catch bats at the entrance as they emerge at dusk.

Cliff lines and escarpments often contain crevices or small caves that are used by bats as roosts. Information on the location of these areas can be obtained from topographical maps and aerial photographs. Local information is very important for locating these areas, local police can be helpful and knowledgeable and local residents may provide useful information on bat roosts.

Searching large cliff lines can present considerable problems. It is often difficult to know how much can be achieved with limited time and effort. The authors found that sampling small sections proved to be very effective. The cliff was examined from a distance using binoculars, preferably in both morning and afternoon light. Ideally, sample sections representing different crevice types or aspects were chosen, although in practice samples may have to be chosen purely on the grounds of accessibility. The base of the sample section of cliff was then traversed and each cave or crevice inspected. If the country is too rough or precipitous to be physically searched, a sample of cave dwelling bats from an area can often be obtained by netting nearby waterholes or creeks at night.

While boulder piles can usually be searched easily, it is often difficult to catch bats at these sites because of the numerous entrances to caves formed within them.

Some bats roost under bridges or culverts, e.g. *Myotis adversus* and *Rhinolophus megaphyllus*. Old Fairy-Martin nests are used as roosts by some species, e.g. *Eptesicus pumilus*. Disused buildings or roof spaces are often used by bats. It is advisable to look in dark corners such as disused cupboards, chimneys, etc. Old concrete gun bunkers are also used as roosts.

## Capture or Observation at Roosts

Bats in torpor can often be captured by hand. Various instruments can be used to remove bats from small holes, including forceps and flexible grips. A piece of stick can be used to gently disturb bats

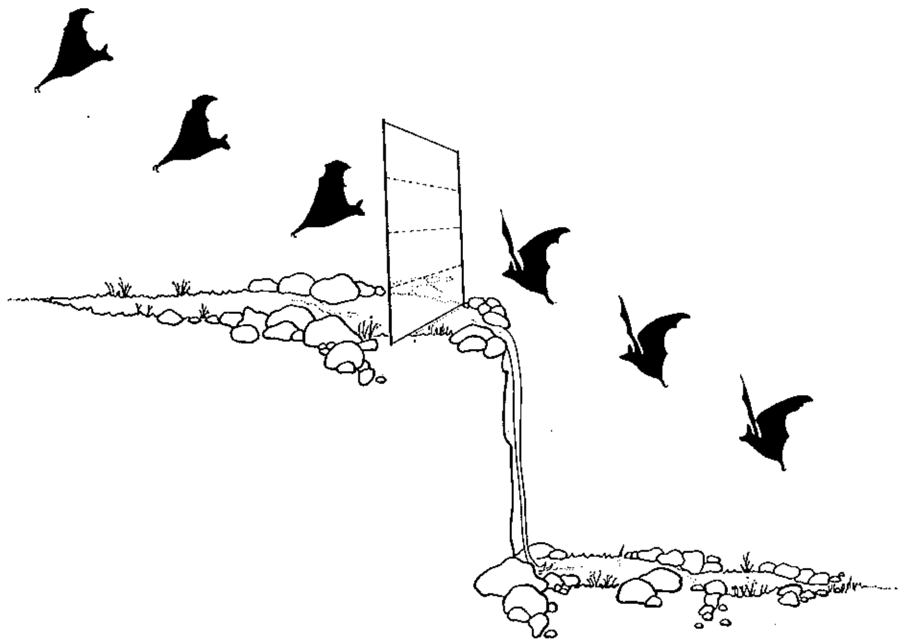


Fig. 5. Bats habitually fly close to the ground when passing over the lip of small waterfalls. Nets placed at these sites can be very effective.

Fruit and blossom eating bats can often be caught in nets placed around flowering plants. As insects are attracted to these plants, insectivorous bats can also be captured at these sites.

Net Placement

Nets should be placed to utilize the screening effect of background or overhead features. For example, bats tend to fly along the front of obstructions and vegetation edges and nets placed along an indented wall provided by a creek bank or road edge are effective. An extension of this idea is a net placed outward from a prominent protruding feature in a solid barrier, e.g. edge of clearing, high creek banks, thick vegetation or large trees can be used for one end of a net pattern. One of the most effective features, if available, is the use of overhanging vegetation as a 'roof' to a net line (Fig. 6).

Completely blocking an opening or placing nets across open spaces can cause a blocking effect and many bats will detect the net and turn back. It is preferable to guide bats into a corner and use a fine catching net to trap them. In very open areas nets can be placed near features such as trees, buildings or at right angles to fences. It is possible that bats use these features as navigation points and habitually pass by them.

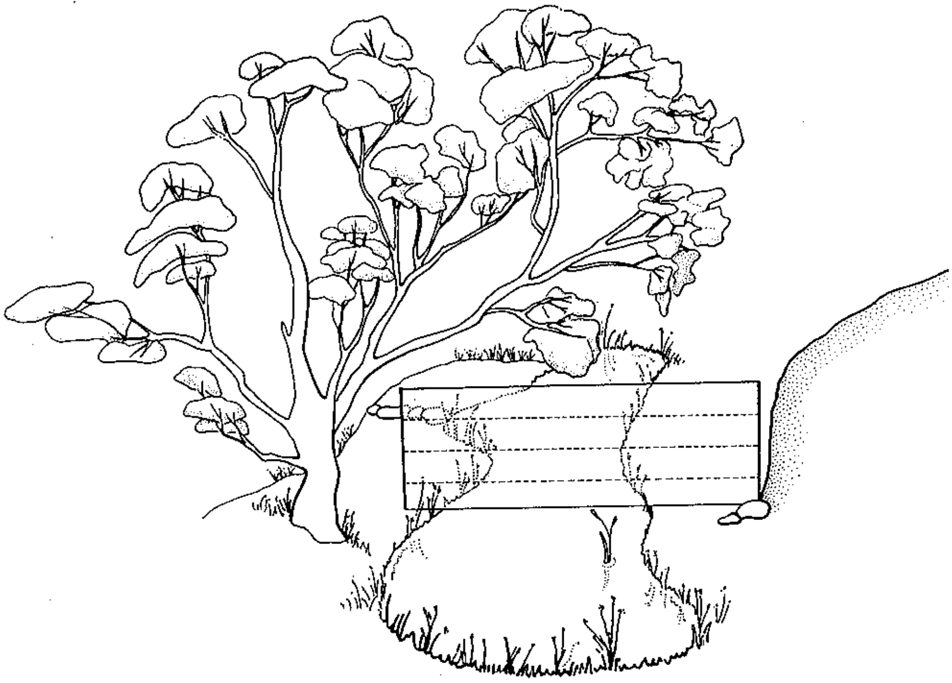


Fig. 6. An 'ideal' net site with an overhanging tree restricting the bats' flight path.

Net Patterns

When placing nets it is important to avoid the blocking effect. This can be achieved by the pattern of the nets and the use of different net types. For example, several different thicknesses of nets are used together in a pattern where the coarser, heavy nets are used to funnel or guide bats into a lighter fine catching net. The authors consider the most effective use of this approach to be a Y or Z pattern used over waterholes or in river beds (Figs 7 and 8). One disadvantage of these patterns is that bats tend to fly into the corners and 'pop' out.

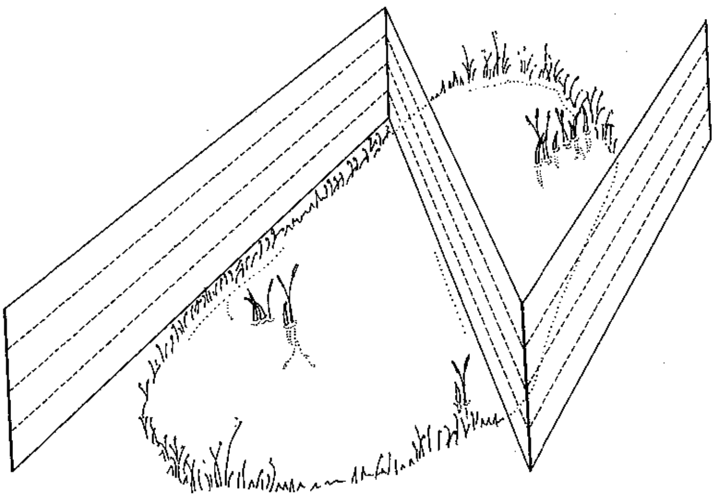


Fig. 7. Z-shaped net pattern is commonly used to 'funnel' bats into corners to catch them.

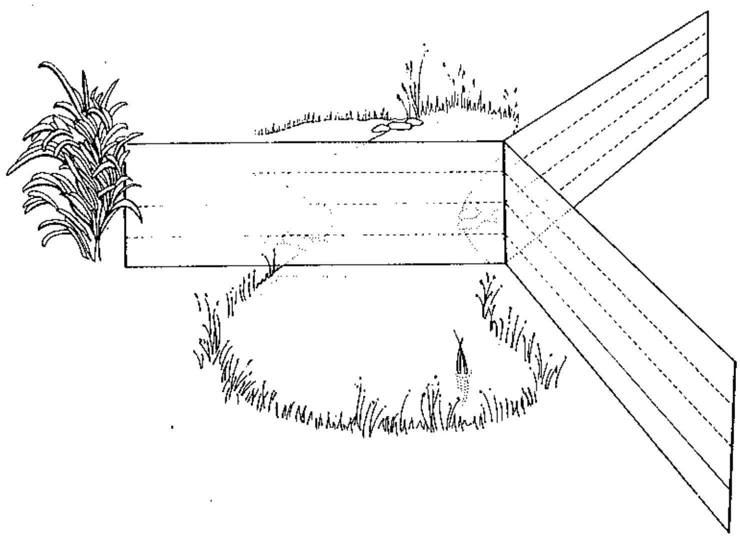


Fig. 8. The Y-shaped net pattern is also commonly used in association with vegetation to restrict the flight of the bats towards the main catching net over the water.

If nets are used over deep water bats can be removed from a boat or makeshift raft(an inflated car inner tube makes a good float), otherwise the net can be pivoted on one pole. The net is carefully swung to the bank to avoid shaking out the bats. They are removed and the net is replaced over the water (Fig. 9).

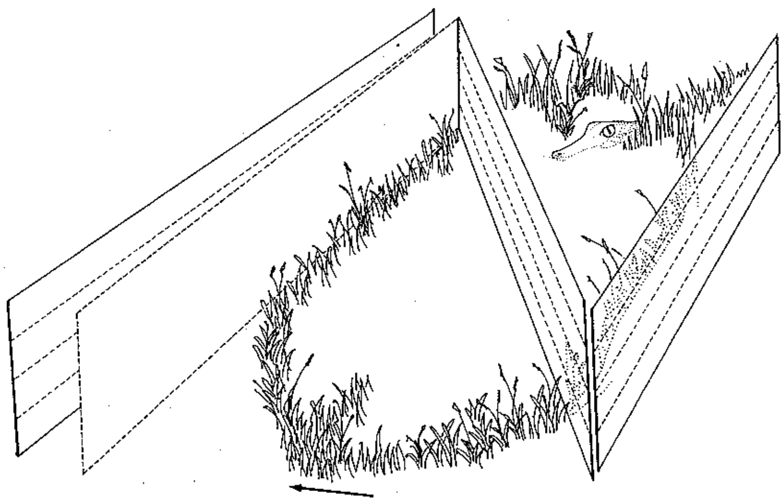


Fig. 9. The pivot net is used in areas where the catcher cannot enter the water. The net is set diagonally across the water to catch the bats and then gently swung over to one side to remove them. Pole holders are set at each of the net positions.

In open areas more bats will be caught if long lines of nets are set, even though, in general, one net, or an area of a net, will catch far more bats than other sections. As it is not possible to predict where these activity spots will be on any given night, a longer line of nets simply increases the chances of finding them (Fig. 10).

Fig. 10. In open areas long lines of nets increase capture rate. This set-up has extended the Y-shaped pattern to 'funnel' bats towards the main catching net.

## Siting of Bat Traps

The advantages of bat traps are discussed by Tidemann and Woodside (1978). While it is agreed that traps are more effective than nets in 'closed' sites, it is considered that this situation does not apply over most of Australia where there are few natural obstacles to channel bat flight. However, bat traps may prove to be effective in these open areas as their use increases and new approaches should be tried. Various researchers have used traps successfully in open areas (often near water) where no natural barriers were present to funnel the bats into the trap. It should also be possible to make traps more effective by using funneling screens constructed from hessian or other material.

When used in the same areas as mist nets it was found by the authors that traps often caught different species. Bat traps can also be used in high forest canopies by pulling the trap up with a rope thrown over a high branch. Nelson (1965) describes the hanging of mist-nets in a similar manner. Guys should be tied to the sides of the trap for orientation and to stop the trap swinging around. This is an easier method than using a mist net as it eliminates the need to lower the net to remove bats.

While bat traps placed anywhere in areas where bats are flying will catch some bats, best results are achieved by using them at sites that are restricted, such as on tracks, in creeks or gullies and in gaps in vegetation or cliffs. Bat traps can be used successfully at cave entrances or in passages where they are ideal for conducting a colony census. As some bats do escape from traps, they should be inspected after dark, the middle of the night and at dawn. Bat traps often catch many bats between midnight and dawn. As with mist nets, results are improved if the site is restricted vertically as well as horizontally, e.g. by a large over-hanging branch.

Trip lines are not as effective as mist nets but have the advantage that they can be used over water areas that are too large, difficult or deep to net. Trip lines should be as taut as possible with a random pattern of lines set 5 cm above the water surface (Fig. 11). Banks that are clear of vegetation are needed for best results. Nagorsen and Peterson (1980) suggest a height above the water of 15 cm and some experimentation with different heights could be justified. The disadvantage of this method is that trip lines have to be watched, otherwise bats will swim ashore quickly and either take off or crawl into vegetation.

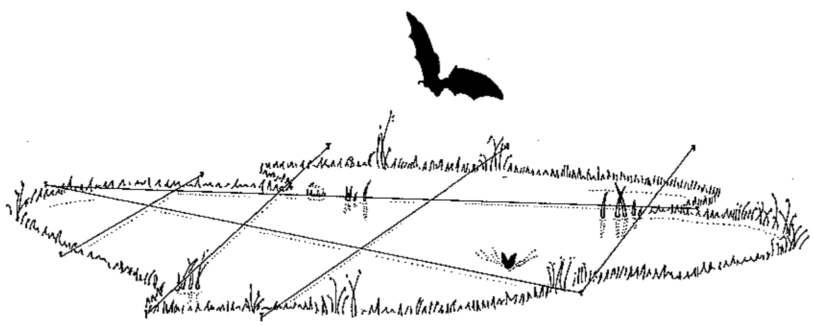


Fig. 11. Trip lines have the advantage that they can be used over water areas that are too large, difficult or deep to net.

If trip lines are used over large pools, it is important to avoid shining bright lights onto the swimming bats as they can become disoriented and will generally swim away from the light. One way around this problem is for a person to stand on each side of the pool. The person on the far side shines a light onto the bat causing it to swim towards the other bank where it can be captured. Bats occasionally become disoriented when swimming and may go around in circles. A hand net with a long handle is useful, otherwise it may be necessary to wade or swim to retrieve the bat.

Shooting

This method has been widely used for bat survey as it is quick, relatively easy and involves fewer man-hours than other methods. Two approaches have been used: (i) that described by Youngson and McKenzie (1977) using a floodlight combined with spotlight; or (ii) using a spotlight for shooting and a trained dog to find the dead bats. It is a waste of time shooting without a dog over areas where ground vegetation will make recovery of bats difficult. Numerous bats of the same species, lactating, or females with young may be killed indiscriminately, raising doubts about the continued widespread use of this method. However, to date this is the only effective method of sampling high flying bats such as the forest dwelling *Taphozous* spp.

Effects of Environmental Factors on Trapping Success

The effectiveness of all capture techniques is influenced by a wide range of conditions such as temperature, relative humidity and previous weather patterns as these factors influence insects and, consequently, the flight pattern of insectivorous bats. Rain, wind and moon phase are all likely to have an effect on catching success. Due to the large number of variables involved, the exact nature of these influences is unclear.

Bat activity is reduced during periods of heavy rain. Nets become heavy with droplets and are probably easier to detect. However, periods between showers often result in bursts of bat activity and nets or traps can be placed in light rain if it is likely to be intermittent.

Capture rates also decrease on windy nights. With mist nets this is probably due to movement making them easier to detect. On certain occasions, in strong winds, bats can be blown into a net even though they try to evade it. Nets are difficult to handle in strong winds and, while trapping success appears to decrease, results vary markedly. Bat traps can be blown over on windy nights and need to be securely anchored.

Bat activity changes during the moon cycle. J. Toop (pers. comm.) has noted that at Mt Etna *M. gigas* remain in their roost for 4 days over the full moon. There is a noticeable wariness of small bats around the time of full moon and capture rates decline. One method of offsetting this effect is to place nets or traps in the shadows cast by trees, bridges, etc. In these positions trapping tends to be far more effective. The best nights for trapping are often the first two nights after a full moon.

## Discussion

One difficulty with bat trapping appears to be the unpredictable nature of the results. For example, the authors used identical mist net patterns over two nights for the two sites shown in Table 1. On each occasion weather patterns were ostensibly similar. It is not easy to overcome the erratic nature of these results, as continuous use of a trapping site over a number of nights will result in the bats learning the position of traps and avoiding them. This has been observed by the authors on only the second night for bats trapped at a cave entrance.

Table 1. Comparison of species caught on two consecutive nights, by mist netting at the same site.

| | Night 1 | | Night 2 | |
|---|---|---|---|---|
| | No. of bats | No. of species | No. of species | No. of different species caught on 2nd night |
| Site 1 | 28 | 7 | 6 | 4 |
| Site 2 | 10 | 4 | 2 | 2 |

Site 1, Iron Range; Site 2, Stark River. Both on Cape York, Qld.

Unless carried out over large areas or over long periods, bat catching techniques are locally random and success is dependent on local bat behaviour. This is likely to vary on any given night as it is influenced by a wide range of variables. While it is considered that mist netting is the most effective method of catching bats, several qualifications about their use needs to be made. In areas where the vegetation is closed, bat traps can often be more efficiently used. For general survey, neither technique should be used exclusively.

The use of mist nets does not adequately sample many groups of bats; small hipposiderids are difficult to net (especially *H. ater*) as their flight is slow and fluttery. *Phoniscus papuensis* has not yet been mist netted, probably for the same reason.

Mist netting is effective for most vespertilionid bats, blossom bats, reasonably effective for rhinolophid and some larger hipposiderid bats and, if used over water, for molosid bats. Unless heavy nets (such as those used for wading birds) are used, they are generally too light to hold larger bats such as *Pteropus* and *Macroderma*.

Mist nets are ineffective for sampling emballonurids as these bats feed above the canopy and, unless nets are set very high or sites can be located where these bats pass under branches, i.e. over water, they are rarely captured in nets. *Taphozous georgianus*, which utilises cave roosts, can be located during the day, but other, forest dwelling *Taphozous* are more difficult to survey.

While improved observation and catching techniques will solve many problems associated with surveying bats, others will remain. One serious problem, noted overseas, has been population decline in several species that have been studied in research projects from poor banding methods and excessive, or inopportune, disturbance of roosts. Many Australian species could also be vulnerable if they are repeatedly disturbed. In particular, these are the hipposiderids and rhinolophids. However, many other species are also susceptible to disturbance at certain times of the year.

The authors favour non-disturbing techniques for studying bats. This approach uses observation and entrance watches at roost sites, and use of spotlights and ultrasound at night. If bats need to be captured properly manned mist nets, bat traps and trip lines for capture and release on the same night ensuring minimal disturbance are favoured.

## Acknowledgements

We would like to thank all the people who have encouraged and helped us during our bat work. Our special thanks and appreciation go to Les Hall for all the help, discussions and support he has extended to us during our work. Two other people deserve special thanks for their help, these are Ken Stager and Tony Start who guided our approach to bat catching by discussion of their vast experience. We also extend our thanks to those without whose help our work would have been less effective. In particular, Dick Allison, Mike Archer, John Baker, Peter Baverstock, Pat Brown, John Calaby, Peter Dwyer, Cliff Ellis, Brock Fenton, Stan Flavel, Elery Hamilton-Smith, Darrell Kitchener, Dan Lunney, Norm McKenzie, John McKean, John Nelson, Harry Parnaby, Terry Reardon, Greg Richards, Martin Schulz, Chris Tidemann, Bruce Thomson, John Toop, Chris Watts, Dedee Woodside and Steve Van Dyck.

In particular we would like to thank the editors for their valuable polishing of a rather rough manuscript. Without their patience and persistence this paper would never have been published.

We would also like to thank both Robyn Redman (Figs 1-4) and Anne Hastings (Figs 5-11) for the illustrations.

We also wish to acknowledge the support of the Department of Anatomy, University of Queensland, and of the World Wildlife Fund (Australia) for funding the fieldwork from which this paper is largely drawn.

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# HOMING ABILITY OF THE LITTLE MASTIFF-BAT *MORMOPTERUS PLANICEPS*.

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## Abstract

A maternity colony of the little mastiff-bat *Mormopterus planiceps*, in St Aidens Orphanage (now Girton College), Bendigo was trapped repeatedly during February and March 1984. Seventy-one bats released 13 km south of St Aidens, and 31 bats released 13 km west of St Aidens, had a rate of return about the same as the 70 bats released at St Aidens. A high rate of successive recaptures indicated the bats did not learn to avoid the harp trap.

## Introduction

When Davis (1966) reviewed the homing ability of bats he provided some interesting data but left open the question of the homing mechanism. Wilson and Findley (1972) calculated that the rate of return of *Myotis nigricans* on Barro Colorado Island could be explained by the random research of a familiar area of 13 km radius. Williams and Williams (1970) fitted the large neotropical bat *Phyllostomus hastatus* with goggles and radiotransmitters and recorded that bats that could see flew directly home 10 km, but most of the vision-impaired bats did not return. Beyond 30 km, even normal bats were disoriented. They concluded that the bats could navigate by stars or post-sunset glow. Later Buchler and Childs (1982) and Childs and Buchler (1981) showed that *Eptesicus fuscus* oriented appropriately to artificial post-sunset glow in a planetarium and to artificial stars.

To resolve the question of whether small insectivorous bats find their home roost by some sort of celestial navigation or by random search will require the development of very small radio-transmitters that can be carried by bats weighing only 5 to 8 g. Meanwhile, the information that can be collected from tagged individuals will help develop an understanding of the natural history of bats. The behavioural ecology of the little mastiff-bat *Mormopterus planiceps* probably conforms to the general characteristics of the Molossidae but there have been no detailed studies of this Australian species. The narrow high aspect ratio wing of the Molossidae suggests they are adapted to flying fast in open areas above the tree tops or over water (Vaughan and Bateman, 1980).

For many years in the summer a colony of about 150 *M. planiceps* (large penis form, P. Baverstock, pers. comm.) have occupied the roof space above the lower porch on the Maryfields building of St Aidens Orphanage, Bendigo, Victoria. A few bats are present and active throughout the year. Four other species also use the same roof space, *Eptesicus regulus*, *Eptesicus sagittula*, *Scotorepens balstoni* and *Chalinolobus morio*. Two other species, *Chalinolobus gouldii* and *Nyctophilus geoffroyi*, are occasionally caught in traps set on the porch. The porch roof also serves *E. regulus*, *E. sagittula* and *S. balstoni* as a maternity site and early summer roost. Peak adult population estimates of these species are approximately 60, 40, and 45 respectively. Details of their population biology will be presented in a later paper.

In 1984 Girton College bought the St Aidens buildings for their residential school. They began repairs to the buildings and intended to close off the bats' access to the roosting cavity. The western face of the 2 storey building has an upper and lower porch about 2.3 m wide and 26 m long. The 4 m high ceiling of the lower porch and the floor of the upper porch are separated by 20 cm joists. Access to this space is obtained where the moulding has, in several places, come away 1-2 cm from the brick wall. The Mammal Survey Group of the Bendigo Field Naturalists Club, having studied the colony since February 1982, encouraged them to wait until the young bats were independent and a study of their homing ability could be made.

The purpose of this paper is to report the results of an experiment that tests the homing ability of *M. planiceps*.

## Methods

Bats were caught in two harp traps set on the porch of the Maryfields building at St Aidens during February and March 1985. They were removed from the traps early each morning, examined, sorted for release and held in cloth bags until evening.

Control groups were released about 9 to 10 p.m. at St Aidens and the test groups were released about midnight at Sedgewick and Marong. Sedgewick is 13 km due south of St Aidens and to return directly the bats could fly over forested areas and open meadows. Marong is 13 km due west of St Aidens. To return directly the bats would have to fly over the Town of Eaglehawk and City of Bendigo (population 60,000) for most of the distance.

On February 13, 14, 15 and 16 equal numbers, and similar proportions of adult males and females, were released at St Aidens and Sedgewick. All juvenile bats were released at St Aidens until February 16 and 10 were released at Sedgewick along with the adults. On February 21 and 22 all bats caught were released at Marong.

Trapping for recoveries was continued until 1 March and after a week's break, resumed for the period 8 March to 17 March with one trap on the Maryfields porch.

## Results

The total number of captures during the experimental period, 13 February to 15 March, was 219 (110 males : 109 females). The number of individual bats involved was 86 and the sexes were equally represented. The age structure of the 2 sexes was different. There was a predominance of captures of 1 year old males compared to 1 year old females, and more 2 year and older females were captured than adult males. Several bats were recaptured 5 times or more and a one year old male was captured 11 times in the 18 trapping nights.

Most of the 22 bats that were trapped for the first time during the experimental period were juvenile females (9) and males (6). The remainder were adult males (7). These bats had a low rate of recapture. Only 6 (27%) were caught again.

The control group consisted of 70 bats caught and released at St Aidens on February 13, 14, 15 and 16. The test groups were 71 bats released at Sedgewick on February 13, 14, 15 and 16, and 31 released at Marong on February 21 and 22. Since recaptures started with the second night of trapping, the bats released on the first night had the greatest opportunity to be recaptured. On the basis of the number of bats subsequently caught, the bats released at Marong had about one-quarter the chance of being recaptured as those released on 13 February. Tables 1, 2 and 3 contain a summary of the data relating sex and release location to the number of trapping days until recapture. Not included are the data relating to repeated recapture at St Aidens after the initial return.

Table 1: Recapture of bats initially captured at St Aidens, Bendigo, Victoria and released at St Aidens.

| Sex | Not Recaptured | Number of trapping days until Recapture | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3-4 | 5-9 | >9 | |
| Male | 8 (31%) | 6 | 1 | 4 | 3 | 4 | 26 |
| Female | 11 (25%) | 23 | 4 | 1 | 4 | 1 | 44 |
| Total | 19 (27%) | 29 | 5 | 5 | 7 | 5 | 70 |

Table 2: Recapture of bats initially captured at St Aidens, Bendigo, Victoria and released at Sedgewick, Victoria.

| Sex | Not Recaptured | Number of trapping days until Recapture | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3-4 | 5-9 | >9 | |
| Male | 9 (31%) | 3 | 3 | 2 | 7 | 5 | 29 |
| Female | 13 (31%) | 15 | 5 | 3 | 6 | 0 | 42 |
| Total | 22 (31%) | 18 | 8 | 5 | 13 | 5 | 71 |

Table 3: Recapture of bats initially captured at St Aidens, Bendigo, Victoria and released at Marong, Victoria.

| Sex | Not Recaptured | Number of trapping days until Recapture 1 | 2 | 3-4 | 5-9 | >9 | Total |
|---|---|---|---|---|---|---|---|
| Male | 5 (31%) | 3 | 5 | 0 | 0 | 3 | 16 |
| Female | 7 (47%) | 2 | 0 | 3 | 1 | 2 | 15 |
| Total | 12 (39%) | 5 | 5 | 3 | 1 | 5 | 31 |

## Discussion

Involved statistical analysis of the data is not warranted. Only the Sedgewick released bats had the same conditions as the St Aidens released bats and their rate of non-recapture is almost identical. Bats released on February 16 had unseasonably cold wet weather to contend with for several days. Several stayed at the release site for more than 2 days and that accounts for some of the longer return times for the Sedgewick released bats. The bats released at Marong returned almost as reliably and as quickly as those released at Sedgewick. Some of the bats made 2 to 4 return trips from Sedgewick to St Aidens and then returned from Marong once or twice. The recommendation to release all bats within 1 km of the capture site (Phillips, 1985) is not important to the welfare of a fast high-flier like *M. planiceps*.

In March when all young bats are independent fliers a high percentage of both the adults and young leave St Aidens. The influx of 7 new adult males into the banded population in February and March indicates a possible male dispersal phase occurring at that time. This coincides with the breeding season that occurs in March as evidenced by the perianal swelling (enlarged Cowper's glands and/or para-anal glands) of males, vaginal discharge (semen?) in females, and bats copulating in the holding bags.

Mostly the bats get caught when they return to the porch and make several attempts to land on the smooth brick wall before crawling vertically into the roosting space. The repeated capture of the bats apparently does them little harm. No weight loss was detected in the sample of bats weighed after several 13 km flights and after several successive captures. The high recapture rate indicates an insignificant ability to learn to avoid the trap. Kunz and Anthony (1977) studying *Myotis lucifugus* arrived at a similar conclusion. Trap addiction may occur but it would be difficult to separate from incompetence in landing on the brick wall.

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## S H O R T   C O M M U N I C A T I O N S

### VERTEBRATE PREY OF THE GHOST BAT, *MACRODERMA GIGAS*, AT PINE CREEK, NORTHERN TERRITORY

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The Ghost Bat, *Macroderma gigas*, has been recorded taking a variety of vertebrate prey (Douglas, 1967; Pettigrew *et al*, 1986). During the course of a faunal survey in the Pine Creek area of the Northern Territory (Lat. 13°49'S, Long. 131°49'E) in October 1983 the vertebrate prey remains at roost sites were collected and subsequently identified (Table 1).

Four species from the prey remains were not observed directly during the faunal survey. These were the Darling Downs Dunnart, *Sminthopsis macrourus*, Red-backed Button-quail, *Turnix maculosa*, Grey-headed Honeyeater, *Lichenostomus keartlandi*, and Masked Woodswallow, *Artamus personatus*. The majority of bird prey species were common in the region during October 1983. The exceptions to this were the Diamond Dove, *Geopelia cuneata*, Yellow-tinted Honeyeater, *Lichenostomus flavescens*, Striated Pardalote, *Pardalotus striatus*, and Gouldian Finch, *Erythrura gouldiae* (Schulz and Menkhorst, 1983). These species tend to show seasonal fluctuations in the semi-arid region of the Northern Territory, and their absence from the Pine Creek area in October is likely to be a reflection of this.

The largest prey species of *M. gigas* is the Spinifex Pigeon, *Petrophassa plumifera* (recorded as Red-plumed Pigeon, *Lophophaps ferruginea*, by Frith, 1973) which weighs between 90-100 g. Pettigrew *et al* (1986) detected Barn Owl (*Tyto alba*) feathers on the floor of a day roost site south of Pine Creek but discounted this species as a component of the bat's diet due to it's large size (ca. 300 g) and occasional cave-roosting habits. In this study, the Dollar Bird, *Eurystomus orientalis*, was recorded as a prey item. This species can weigh up to 125 g (Banding Scheme records, n = 3) which is somewhat larger than the Red-plumed Pigeon.

It is difficult to comment on the abundance of the mammalian prey species (with the exception of the bats) as little pitfall trapping was carried out to provide an indication of the actual abundance of these species. Of the two bats recorded as prey species the Dusky Horseshoe-bat, *Hipposideros ater*, was found in small numbers in several mine shafts and the Little Cave Eptesicus, *Eptesicus pumilus*, occurred in groups of varying sizes in at least ten mine shafts in the area (Schulz and Menkhorst, 1986). Pettigrew *et al* (1986) observed a Ghost Bat to pursue and capture a Dusky Horseshoe-bat.

The skink, *Sphenomorphus isolepis*, was the only reptile recorded as a prey item. This was a common species at the entrance of mineshafts in the area (Schulz and Menkhorst, 1983). Douglas (1977)

Table 1. Vertebrate prey of the Ghost Bat, *Macroderma gigas*, and the abundance of these species in the Pine Creek region.

| Prey species | Approx no. found at roost site*1 | Abundance of prey species in the region*2 |
|---|---|---|
| BIRDS | | |
| Red-backed Button-quail (*Turnix maculosa*) | 3 | NR |
| Peaceful Dove (*Geopelia striata*) | 8 | C |
| Diamond Dove (*G. cuneata*) | 2 | R |
| Varied Lorikeet (*Psitteuteles versicolor*) | 2 | C |
| Hooded Parrot (*Psephotus dissimilis*) | 1 | C |
| Owlet-Nightjar (*Aegotheles cristatus*) | 2 | U |
| Red-backed Kingfisher (*Halcyon pyrrhopygia*) | 2 | C |
| Rainbow Bee-eater (*Merops ornatus*) | 1 | C |
| Dollar Bird (*Eurystomus orientalis*) | 1 | U |
| White-winged Triller (*Lalage sueurii*) | 4 | C |
| Jacky Winter (*Microeca leucophaea*) | 2 | C |
| Rufous Whistler (*Pachycepala rufiventris*) | 2 | C |
| Northern Fantail (*Rhipidura rufiventris*) | 1 | C |
| Grey-crowned Babbler (*Pomatostomus temporalis*) | 1 | C |
| White-throated Gerygone (*Gerygone olivacea*) | 1 | U |
| Varied Sittella (*Daphoenositta chrysoptera*) | 1 | C |
| Little Friarbird (*Philemon citreogularis*) | 1 | C |
| Yellow-throated Miner (*Manorina flavigula*) | 2 | C |
| Grey-headed Honeyeater (*Lichenostomus keartlandi*) | 3 | NR |
| Yellow-tinted Honeyeater (*L. flavescens*) | 4 | R |
| Brown Honeyeater (*Lichmeria indistincta*) | 2 | C |

| Prey species | Approx no. found at roost site*1 | Abundance of prey species in the region*2 |
|---|---|---|
| BIRDS (cont.) | | |
| Striated Pardalote (*Pardalotus striatus*) | 2 | R |
| Masked Finch (*Poephila personata*) | 3 | C |
| Long-tailed Finch (*P. acuticauda*) | 2 | C |
| Gouldian Finch (*Erythrura gouldiae*) | 1 | R |
| Masked Woodswallow (*Artamus personatus*) | 2 | NR |
| Black-faced Woodswallow (*A. cinereus*) | 1 | C |
| Little Woodswallow (*A. minor*) | 1 | U |
| Pied Butcherbird (*Cracticus nigrogularis*) | 1(*) | C |
| MAMMALS | | |
| Pigmy Antechinus (*Planigale maculata*) | 1 | R |
| Darling Downs Dunnart (*Sminthopsis macrourus*) | 2 | NR |
| Dusky Horseshoe-bat (*Hipposideros ater*) | 2 | U |
| Little Cave Eptesicus (*Eptesicus pumilus*) | 4 | C |
| Western Chestnut Mouse (*Pseudomys nanus*) | 5 | U |
| Delicate Mouse (*Pseudomys delicatulus*) | 10 | U |
| REPTILES | | |
| Skink (*Sphenomorphus isolepis*) | 14 | C |

*1 - It was difficult to assess the abundance of prey items represented. Figures provided are approximate only.

*2 - Regional abundance of prey species

NR = Not Recorded
R = 0-5 records
U = 6-30 records
C = over 30 records

Status from Schulz and Menkhorst (1983).

(*) - Young bird.

recorded *M. gigas* taking a variety of lizards of the families Agamidae, Gekkonidae and Pygopodidae. Species of Agamidae and Gekkonidae were common in the Pine Creek area but were not recorded as part of the diet of *M. gigas*. Douglas (1977) recorded *M. gigas* feeding on the Rocket Frog, *Litoria nasuta*. Since this study was conducted at the end of the dry season, frogs were largely inactive and therefore it is not surprising that these were not recorded as prey items.

Pettigrew *et al* (1986) recorded two additional species of birds as prey of *M. gigas* from day roost sites in the Pine Creek area. These were the Red-backed Wren, *Malurus melanocephalus*, and the White-breasted Woodswallow, *Artamus leucorhynchus*. Both these birds were common in the area. M. Archer (pers. comm.) found a partially-eaten carcass of the Carpentarian Dunnart, *Sminthopsis butleri*, in a mine-shaft south of Pine Creek.

This study, similar to that of Douglas (1977), found *M. gigas* to take a wide variety of vertebrate prey. In addition to the vertebrate prey a large variety of insects were also recorded as prey items.

## Acknowledgements

Special thanks to Karina Menkhorst for assisting in the collection of prey remains from day roost sites. Thanks to I.J. Mason for identifying feather remains, M. Archer for identifying the remains of the dasyurids, the late J.A. Mahoney for identifying the remains of the rodents, L.S. Hall for assisting in the identification of the bat remains, and L.F. Lumsden for comments on an earlier draft of this paper.

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# A NEW LOCALITY RECORD FOR THE BARE BACKED FRUIT BAT *DOBSONIA MOLUCCENSIS* (QUOY & GAIMARD 1830)

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The Bare-backed fruit bat *Dobsonia mollucensis* has previously been found only along the coastal regions of the Cape York Peninsula, east of the Great Dividing Range, and north of Cooktown (Lat. 15°30'S). Both rainforest and other well timbered vegetation are known to be utilized by this species (Hall and Richards, 1979; Hall, 1984).

On the night of June 1986, a single *D. mollucensis* was observed in a fruiting 6 m high fig tree in the Chillagoe Caravan Park, Chillagoe (Lat. 17°10'S). This bat was approached to within approximately 4 m and identification, based on the wings originating from the midline of the bat's back, was clearly made. Total observation time was approximately 5 minutes, after which the bat climbed up into the foliage at the top of the tree until it was no longer visible. It was not caught and its sex and reproductive status were not determined. Substantial 'fruit bat' activity was heard on this and the previous two nights, but whether this was a result of *Dobsonia* activity is not known.

This observation represents a considerable range extension south for this species (approx. 200 km), and the first record of its occurrence west of the Great Dividing Range. The environmental determinants of this species' distribution in Australia are not known, but must now be interpreted in terms of this range extension. The species may be capable of utilizing the drier open woodland west of the Great Dividing Range, though it should be noted that permanent water is available in the Chillagoe region. *Dobsonia* roosts in caves as well as dense vegetation (Hall and Richards, 1979) and this southern range extension may have been facilitated by the 225 km band of cavernicolous limestone outcrops that extend from the Palmer River (Lat. 15°35'S) south to Chillagoe. Fruit bats have been observed roosting in a cleft of Spring Cave, Chillagoe (D. Matts, pers. comm.) but whether these were *Dobsonia* is not known. It is notable however that Black and Spectacled flying foxes, *Pteropus alecto* and *P. conspicillatus*, have been observed roosting in a similar habitat at Walkunder Tower, Chillagoe (Stager and Hall, 1983), and it may have been these two species that were present in Spring Cave. A skeleton of *P. alecto* has been found in a cave in Ellis Rowan Tower, Chillagoe (K. Williamson, pers. comm.) and so it appears that karst use by fruit bats as roosting sites is common in this area.

Nothing is known of seasonal movements or the population densities of *Dobsonia* across its Australian range. That it has not been recorded at Chillagoe before, despite previous work on bats in this region, suggests that it may be uncommon there, and/or that movements through the region may be occurring.

The Chillagoe region of North Queensland has recently been an important area for bat research in Australia (c.f. Tower Karst No. 5, 1984) with six of the fifteen bat species found there representing range extensions over previous known distributions: *Pteropus conspicillatus*, *Rhinolophus philippinensis*, *Hipposideros diadema*, *Miniopterus australis*, *Mormopterus beccarii*, and *Dobsonia moluccensi* (Hall and Richards, 1984, this study). The north eastern Australian distribution of most of these species was previously considered only to be east of the Great Dividing Range.

The above information was collected during the 1986 Chillagoe Caves Expedition, which was sponsored by the Manhattan College of New York. Their financial assistance, and the support of fellow members in the field, particularly Dr Frank G. Howarth, is gratefully acknowledged.

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## NOTES ON THE NATURAL HISTORY OF THE QUEENSLAND TUBE-NOSED BAT, *NYCTIMENE ROBINSONI*

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Summary

The fascinating fruit bat, *Nyctimene robinsoni*, appears to be a well adapted member of our rainforest fauna. Cryptic roosting habits, a propensity for living in the understorey and sub-canopy strata, and an obviously important role as a seed dispersal agent, would make this species an excellent subject for future studies.

I would like to report observations on the ecology of *Nyctimene robinsoni*, the Queensland tube-nosed fruit bat, recorded over the last

Reviews of this species have been presented by Hall (1983) and Richards (1985). *N. robinsoni* is, in summary, a small (about 45 g) pteropodid fruit bat, distributed coastally north from approximately the Queensland border, and is a member of a diverse genus centred on New Guinea. Although it is believed to be a rainforest specialist, it can also be found in sclerophyll vegetation and urban areas. The following observations were made on rainforest inhabitants or caged captives.

1. Roosting Patterns

Several records were obtained of individuals roosting in foliage in the rainforest sub-canopy layer. Another individual was observed roosting in an exposed tree along a rainforest margin. No roosting groups were ever seen, nor have they been reported in the literature.

There is no doubt that the colour pattern of this animal is an adaptation for camouflage. The yellow or lime-green spots on the brown wings and ears resemble a sun-flecked dead leaf. The dark dorsal stripe continuous with the single stretched leg gripping a twig resembles the centre rib and stem of a dead leaf. During the thousands of hours that I have spent in north Queensland rainforests I have successfully captured hundreds of dead leaves camouflaged as *N. robinsoni* in the understorey!

2. Sociality

The individualism shown in roosting behaviour extends to other aspects of behaviour. It is virtually impossible to keep more than one of these animals, regardless of sex, in the same cage. The pandemonium resulting not only from threats and vocalizations but also from deliberate attacks necessitates their separation, however, it does not occur if animals are able to separate from each other by several metres in an aviary. Based on mist net captures, more than one *N. robinsoni* will forage at the same tree, but whether at the same time or not is unknown.

3. Foraging Behaviour

*N. robinsoni* has two patterns of foraging in rainforest. They appear to restrict their activity to the understory, though I have little information on their possible use of the upper canopy stratum. Although it is difficult to collect data in the canopy, I have never mist-netted *N. robinsoni* above the sub-canopy layer.

Cauliflorous (trunk-fruiting) trees are visited, and are listed in Table 1. Fruits are either consumed at the tree or are carried away for consumption elsewhere. At the Claudie River, Cape York, a *N. robinsoni* was mist-netted together with a *Ficus nodosa* fruit (weighing 12 g) over 200 m from the nearest fruiting tree.

Table 1: Fruits included in the natural diet of *Nyctimene robinsoni*

| FAMILY | SPECIES | FORM & FRUITING PATTERN |
|---|---|---|
| Moraceae | *Ficus copiosa* | Canopy tree, cauliflorous |
| | *Ficus nodosa* | Canopy tree, cauliflorous |
| | *Ficus ?variegata* | Canopy tree, cauliflorous |
| Myrtaceae | *Eugenia erythrocalyx* | Canopy tree, cauliflorous |
| | *Syzigium cormiflorum* | Canopy tree, cauliflorous |
| | *Psidium guajava* (guava) | Exotic tree, fruit borne on periphery of branches |
| Rubiaceae | *Randia sessilis* | Understorey tree, fruit borne periphery of branches |

I suspect that *N. robinsoni* may behave like other pteropodids and defend a feeding territory, resulting in fruits only being carried away by conspecifics that steal a fruit as they are evicted by the resident of the territory. This "raiders versus residents" behaviour is the main mode of seed dispersal by *Pteropus conspicillatus* (Richards, in prep.).

Fruits presented on trees in the normal manner are also eaten by *N. robinsoni* (Table 1). *Randia sessilis*, a hard-skinned fruit that is similar in size and internal texture to a passionfruit, was consumed at the McIlwraith Range by *N. robinsoni*. About half of the flesh from these fruits was extracted through an opening in the skin about 2 cm in diameter.

4. Feeding Behaviour and the Tubular Nostrils

The tubular nostrils of *Nyctimene* have always presented a quandary to students of this genus, with explanations including their use as "snorkels" whilst eating mushy fruit or as an aid to directional olfaction. I cannot provide conclusive evidence to support or refute either explanation, but from observations of many captives I can describe the following function of the tubes.

I had little success in maintaining captives if I just cut their fruit into bite-sized pieces, and now present them with large pieces or intact fruits, suspended from the roof of a cage. If a banana is hung up, *N. robinsoni* will hang on it, head upwards. As the jaw is opened, the fruit skin is pierced by the lower canines (remember that this species has no lower incisors), and the upper teeth are raked downwards by movement of the head. This action, using the lower teeth as a pivot, must involve the neck muscles as well as those of the jaw to tear open the skin. This behaviour would give a small animal a tremendous advantage in utilizing tough-skinned fruits such as *Randia sessilis*. In dealing with a banana, *N. robinsoni* tears away a long piece of skin before consuming the inner flesh. Of most interest, though, is the action of the upper lip during this procedure. It is pulled away enough to expose the dentition, but I am unable to say whether this is deliberate on the part of the bat through muscular action, if it happens automatically as the gape is opened wide, or whether the lip is just pushed away as the teeth are raked downwards. The point I wish to make, though, is that if the nostrils were both normal in size and in their position on the muzzle, they would be occluded by the upper lip (i.e. the skin between the nostrils and the lip) ..... is this why the nostrils are extended as tubes?

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## PREDATION ON HARP TRAP CAPTURES - WHODUNIT


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Three dead bats were found in a harp trap set north-east of Combienbar, east Gippsland (Lat. 37°19' 45''S, Long. 149°04' 02''E) in April 1986. In the same trap there were four live bats: *Eptesicus regulus*, *Chalinolobus morio* and *Nyctophilus geoffroyi*. The dead bats exhibited the following conditions:

1. *Eptesicus sagittula* Adult Male - Gaping wound on left side of abdominal cavity on the ventral surface; liver and most of digestive tract missing; large hole in patagium adjacent to the abdominal wound; skin peeled back in the vicinity of the wound edge; 2. *E. regulus* Adult Female - Head almost severed from body and attached only by a flap of skin; rear of skull broken open, left hemisphere of the brain partially eaten, right hemisphere near intact; rib cage and sternum broken and all thoracic organs (heart and lungs) missing; skin peeled back over from the thoracic cavity to posterior of diaphragm on the ventral surface, no skin peeled back on the dorsum; 3. *E. regulus* Adult Female - Blood present on side of the head; fracture on left side of skull. Otherwise no apparent injuries.

Trap deaths in harp traps are rare, for example, in 370 harp trap nights in Victoria between October 1985 and April 1986 five bats (excluding those reported here) died (Fisheries and Wildlife Service data). These deaths were all due to drowning.

Predation on bats captured in harp traps had not previously been observed in Victoria by the authors. Due to the nature of the wounds and the precision of the organ extraction it would appear the predator was a habitual carnivore. A likely suspect is the Brown Antechinus (*Antechinus stuartii)*, a common carnivore in the area. Less likely potential predators are several species of large forest-dwelling bats, viz. *Falsistrellus tasmaniensis* and *Scoteanax rueppellii* (not yet recorded from Victoria) and the Sugar Glider (*Petaurus breviceps*). It was felt that the former could be ruled out as it is unlikely that these bats would be able to escape once caught in the holding bag of the harp trap. No predator faeces or traces were found in the catching bag. If anyone has come across similar circumstances and traced the culprit we would be very interested to hear from them.

## AUSTRALASIAN BAT WORKERS - RESEARCH INTERESTS.
## UPDATE AND CHANGES OF ADDRESS

Michael Augee, School of Zoology, University of NSW, PO Box 1, Kensington NSW 2033.

Beth Crichton, Department of Anatomy College of Medicine, University of Arizona Tucson, Arizona USA 85724.

Surapon Duangkhae, Faculty of Science, Mahidol University, Pharama VI Road, Phayathai, Bangkok, Thailand 10400.

Margie Falanruw, Yap Institute of Natural Science, Box 215, Yap WCI USA 96943.
Fruit bats (*Pteropus* spp.) of Micronesia, especially the West Caroline Islands.

M. Brock Fenton, Department of Biology, York University, Downsview, Ontario M3J 1P3 Canada.

Helen George, 14 Kilmory Place, Mt Kuring-Gai NSW 2080. (02) 4579827.
General research into flying foxes.

Peter Helman, 24 Winnecke Street, Ainslie ACT 2602.

David Makin, Department of Zoology, Tel Aviv University, Ramat Aviv 69978 Tel Aviv, Israel.
Ecology and conservation of Israeli bats, particularly *Rousettus*.

Gerry Maynes, Australian National Parks and Wildlife Service, GPO Box 636, Canberra ACT 2601.

Chris Pavey, 64 Arafura Street, Upper Mt Gravatt, Qld 4122.
Distribution and field identification techniques.

Joanne Richter, Genetics Department, University of Adelaide, GPO Box 498, Adelaide SA 5001.
Chromosomes of Australian bats.

Simon Robson, Department of Biology, Boston University, Boston Mass. 02215 USA.

Phil Towers, Riverina College of Advanced Education, Wagga Wagga NSW 2650.

Merlin Tuttle, Bat Conservation International, Breckenridge Field Laboratory, University of Texas, Austin TX 78712 USA.

Peter Wilson, 233 Hawkesbury Road, Winmalee NSW 2777.

Stephen Winderlich, Uluru National Park, PO Box 119, Yulara NT 5751.

## NOTICES

*Human death from rabies of bat origin in Europe*

It is with regret that we report the death from bat transmitted rabies of Rudolf Lehmann of the Department of Zoology, University of Helsinki. His case is reported in **The Lancet**, February 15, 1986, page 378. It appears to be the first reported case of human rabies of bat origin in Europe.

Although rabies has not been reported in Australia it occurs in some of the Indonesian islands. Bat researchers who travel to these and other affected areas should seriously consider pre-exposure immunization against this uniquely horrible disease. The new vaccine has little in the way of side effects except the price, which is now about $500 for the course of three injections. The consequent peace of mind, however, is difficult to value. Immunity is good for two years and can be extended with booster shots.

*Proceedings of Seventh International Bat Research Conference*

Proceedings of the Seventh International Bat Research Conference and the Third European Bat Research Symposium (joint meeting) held at the University of Aberdeen, August 1985 have appeared in *Myotis*, 1985-86, Volumes 23-24, 256 pp. Editors H. Roer and P. Racey. Available from Zoologisches Forschunginstitut und Museum Alexander Koenig, Bonn, Federal Republic of Germany.

*First National Flying Fox Symposium*

The first National Flying Fox Symposium was held at the University of Queensland, August 1986. The Symposium was well attended both by biologists and fruit-growers and papers on a wide variety of topics were presented. The series of open forum discussions served to highlight our ignorance of these common mammals, which sometimes cause losses of economic significance to the fruit industry. Les Hall is to be commended for his initiative, particularly in promoting dialogue between growers and biologists. Hopefully this will provide the stimulus for a series of such symposia. The proceedings will be published in **Australian Mammalogy**, Volume 10, Numbers 1 and 2, in May 1987.

*Bat Organisations and Journals*

Bat Conservation International has moved to Breckenridge Field Laboratory, University of Texas, Austin TX 78712, USA.

Ku-ring-gai Bat Colony Committee has produced two issues of a newsletter - Newsletter of the Friends of Bats: Issue 1 in June 1986; Issue 2 in September 1986. New subscribers are invited to join by sending $6 to The Treasurer, KBCC, 11 Warandoo Street, Gordon NSW 2072. The aims of this organisation revolve around preservation of the Gordon *Pteropus* camp and were reported in detail in *Macroderma* 1: 72-74, 1985.

## CURRENT LITERATURE

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## INSTRUCTIONS TO AUTHORS

Manuscripts plus two copies, complete with illustrations and tables, should be submitted to the Editor, Christopher Tidemann, Zoology Department, Australian National University, GPO Box 4, Canberra, ACT 2601.

MS should be in clear concise English and typed with double spacing on A4 paper.

Papers should consist of: title; names and addresses of authors; abstract of not more than 200 words; introduction; materials and methods; results; discussion or the latter two combined. References should conform to the World List of Scientific Periodicals, 4th Edition and references in the text should conform to the format used in this issue.

All pages, figures and tables should be consecutively numbered and the correct orientation shown on figures. Metric units should be used throughout. Camera ready copy is desirable for diagrams, but they should, at least, be submitted in black on a white background. Black and white photogrpahs may be used. Tables should be in a format suitable for reproduction on a single page of the journal.

Common names, where used, should conform with the recommendations of the Australian Mammal Society (Bull. Aust. Mammal Soc. 6: 13-23).

Short communications should meet the requirements for papers, except that subheadings other than title, names and addresses of authors and references should not be used. Short communications should not exceed 5 double spaced typed A4 pages.

Manuscripts are not being routinely refereed at this stage, although editorial amendments may be suggested. Specialist opinion may be sought in some cases.

Notices may be in any format, but clear and concise English should be used.