FAUNA *of* AUSTRALIA

63. COLLECTION AND PRESERVATION OF MAMMALS

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INTRODUCTION

Fauna conservation and administration in Australia is, in general, the province of the separate State and Territory Governments and is not a federal matter. The Federal Government is responsible for fauna administration in the various oceanic island territories, for example, Norfolk Island, Christmas Island (Indian Ocean), Cocos (Keeling) Islands, subantarctic Heard Island and in national parks in the Northern Territory under federal control – Uluru (Ayers Rock – Mt Olga) and Kakadu, western Arnhem Land. The oceanic Lord Howe Island is part of New South Wales and the subantarctic Macquarie Island is under the control of Tasmania. Collecting permits must be applied for in writing to the separate State and Territory authorities. Permits also are required to export and import specimens from one state or territory to another. A federal permit is required to export material to a foreign country from any state or territory. Regulations limit the numbers to be taken of all but pest species.

Some of the collecting methods described below no longer are allowed because of humane and conservation reasons. They are significant, nonetheless, in terms of the historical development of collecting methods and the invaluable scientific materials they have yielded.

Success in collecting mammals relies on a blend of science, art and serendipity. Skilled collectors are good naturalists and know the general activity patterns of the various species. Collectors take into account freshness of mammal signs such as tracks, scratchings on trees, burrows, runways, nests, dens, remains of feeding activity, hair strands and faeces (Triggs 1984). Depending upon the purpose and type of collecting methods used, time of day or night, intensity of moonlight, weather, tide for marine species, season, migratory patterns of certain species, bait and habitat, including vegetation and soil type for burrowing species, are essential factors to be considered. Dense ground cover, runways, burrow entrances, crevices, ecotones between different vegetation communities, water sources, tree limbs and hollows, are potentially good collecting sites. General collecting employs a wide variety of sites and different types of collecting devices, whereas collecting for target species is highly selective.

HISTORICAL

Aborigines were the first to collect marsupials and other mammals in Australia. Men generally used a throwing spear and spear-thrower to bring down larger prey from a distance (Finlayson 1935b). They also used throwing-sticks, pitfalls, fire and climbed trees to secure both large and mid-sized species. Women used a wooden stake chiselled at one end (‘yam-stick’) and a shallow wooden dish (‘wirra’) as digging implements for small game (Finlayson 1935b). The scattered literature of hunting and other methods of collecting food animals by Aborigines has been reviewed by Anell (1960) and Lawrence (1968). Among eutherians, fruit bats, viewed as choice game, were hit with sticks while roosting in their camps (Dahl 1897). Dugongs were hunted with harpoon-spears. Hunting pressures by prehistoric Tasmanians caused the disappearance of a breeding colony of southern elephant seals on the Tasmanian coast. The only other breeding colony in Australian waters, on King Island, was extirpated by sealers by 1810.

Because Aborigines were outstanding trackers and experts on the habits and habitats of all mammals within their hunting area, their expertise was commonly used on scientific collecting expeditions. Unfortunately, in most areas these skills were lost by the middle of this century as the Aborigines shifted to a western culture.

Concerted effort to develop and maintain scientific collections of mammals within Australia for use in systematics has occurred primarily in the 20th Century, well after the establishment of State museums during the previous century. Collections made by H. H. Finlayson and other Australian naturalists in the early part of this century are invaluable, scientifically and historically, for they include species now extinct and provide some measure of man-induced habitat alteration that has caused the demise of many endemic species. The surge of collecting efforts in the latter part of the 20th Century has led to a far better understanding of the distributions of various species, descriptions of new species and even to a rediscovery of several thought to be extinct.

Until the mid-20th Century, systematic collection of Australian eutheria, except for prehistoric remains of Aboriginal man, received far less attention than that of marsupials and monotremes. Along with many marsupials, representatives of rodents and bats had been dispatched by 19th Century visiting naturalists to museums overseas for description and permanent housing. Most holotypes of Australian mammals are in foreign museums, notably the British Museum (Natural History). Except for marine mammals, most other eutherians were introduced to Australia as domestic animals, as game species that subsequently spread uncontrollably and developed into pests or as commensals of man. They are of more interest economically than taxonomically.

The zealous collecting efforts by early naturalists visiting Australia often led to herculean efforts. In 1798, the surgeon-explorer, George Bass, spotted and chased a large wombat on Cape Barren Island that he thought was new to science. He grasped it round the belly, carried it over a mile in his arms and eventually got it aboard his boat, but not before the wombat had torn the elbow out of his coat (Spencer & Kershaw 1910).

LIVE-CAPTURE

The technique of hand-capture is used even today for species that are trap-shy or otherwise difficult to collect. Marsupials that nest in crevices under rocks, bark or in tree hollows can be captured by hand during the day (Marlow 1958) and by night can be followed with spotlights by vehicle and hand-caught (Morton 1978b). Many nocturnal species actually ‘freeze’ in the beam of a strong light. By day, the diurnal Numbat, *Myrmecobius fasciatus*, can be out-run and captured by hand (Christensen, Maisey & Perry 1984). Feathertail gliders, known to use the ‘polehead’ box of a telephone pole for a nest site (Fanning 1980), and pygmy-possums the nests of birds, may be found more easily at these more visible sites and captured by hand. Marsupial moles are known largely from specimens accidentally dug out of the sand or tracked overland, on the presumably infrequent occasions on which they come to the surface, and extracted from beneath a bush (Stirling 1891b; Calaby *et al*. 1974). Workers building the Transcontinental Railway found several while excavating the railbed (Bolam 1927).

A bag of net or hessian affixed to the end of a pole is frequently used to capture both arboreal and terrestrial species. A Koala can be induced down a tree during the day by waving a cloth over its head (Gall 1980) or by placing a rope round its neck and pulling forwards. Normally, two people are required in this procedure, which culminates in bagging the animal once it is near the ground. Possums and other arboreal mammals can be captured in trees with a wire noose at the end of a long pole (Dunnet 1956a).

When capturing terrestrial mammals with a pole net, the collector usually sits on the front of a moving vehicle to gain ground on the animal prior to leaping off and netting it. Slower mammals can be run down with a hand net or long net (Andrewartha & Barker 1969; Dunnet 1956b; Rose & McCartney 1982). Netting or lassoing usually is done at night with head torches. Kangaroos also can be taken in late afternoon when they begin to be more active and more readily seen as dusk approaches (Frith & Calaby 1969). Beaters may be used to drive them into nets where they are caught and bagged (Jarman & Taylor 1983).

Live traps vary in size from small rectangular boxes to fence traps several hundred metres in diameter. With minor exceptions, most Australian mammals enter live traps after dark. This necessitates checking the traps at dawn and rebaiting and resetting in late afternoon. Traps need regular tending and closure when not in use. If numbered and set sequentially, the risk of loss is reduced. Small, box live-traps (about 80 x 90 x 250 mm and larger) usually are constructed of sheet aluminium or galvanised steel (Fig. 63.1b). Some fold to envelope dimensions for compact transport and most operate by a treadle mechanism that releases a trap door. Commercial names of these traps used most frequently in Australia are Elliott, Sherman and Longworth. Small traps are suitable for marsupial-mice, the smaller gliders and rodents. McDougall (1944b) gives a diagram of a homemade trap that he devised for his pioneering study of native rodents in Queensland canefields before similar commercial traps were available.

Larger, rectangular box traps for mammals the size of rabbits, possums and feral cats usually are constructed of wire mesh and may have either one entrance, or one at each end (Fig. 63.1a). A bait hook that operates a spring trap door may be used in lieu of a treadle. Some are collapsible for easier transport and are of various sizes to about 1 m long. The Mascot, Gordon, Havahart, Tomahawk and National makes are the most commonly used commercial box traps in Australia. Wire-mesh traps require a cover to protect captives from overexposure to rainfall, cold or intense sun. Box traps made of wood are more cumbersome, but diminish the problems of exposure (Dunnet 1956a). In areas with very cold nights, provision of nesting material or an artificial substitute lessens the possibility of death of the trapped animal. Several homemade box traps have been devised for marsupials. One large variety, made for capturing sizeable wallabies, is constructed of nylon mesh, a frame of steel rod and a cover of jute sacking (Edwards & Ealey 1975).

Traps in trees should be firmly secured (Smith & Phillips 1984) and those on the ground should be bedded firmly so they will not tip. When setting a box trap at the entrance of a wombat burrow, all other entrances to the burrow system should be blocked, as should gaps between the trap and the entrance selected (McIlroy 1976). Box traps for rock wallabies can be set on top of outcrops and secured by wire with one or more pitons hammered into rock cracks (Copley & Robinson 1983).

For general trapping of small and medium-sized mammals, either plant or animal eaters, a dry mixture of rolled oats and peanut butter is effective. Ground sardine, bacon, raisins, treacle, honey or ground beef may be added or substituted, particularly to attract species with specialised diets. Fruits (apple, banana), vegetables (sweet potato, carrots) or pieces of fresh meat are effective in large box traps. All food baits are subject to infestations by ants and blowflies, which render them less attractive. For this reason, strips of leather soaked in linseed oil are a good alternative to a food bait. During periods of drought, standing water is a powerful attractant. For some species, particularly dingoes and foxes, the scent of anal gland secretions, urine or faeces is a strong lure (Newsome *et al*. 1983a).

Figure 63.1 Commonly used live-capture methods. **A**, wire trap used for middle sized mammals (old style wooden box trap in foreground); **B**, drift fence used to direct small mammals to pitfall traps (arrow) or small box traps; **C**, trap built around water source and used to capture large mammals. Water source is located on opposite side of the embankment. Large mammals are shunted through one-way gate (top centre) into the holding pen (foreground) for assessment; **D**, harp trap used to capture bats. The vertically strung nylon lines are not visible. See text for details.

(Photos by B.J. Richardson G.B. Baker & C. R. Tidemann, T.J. Dawson, J.E. Williams & T.W. Norton, respectively.)

The purpose of a drift fence (Fig. 63.1b) is to induce the animal to follow along the fence to a point of capture once the fence is encountered. The fencing need be only 100 – 200 mm high for small mammals, but should be flush with the ground or buried slightly. At various intervals along the fence, pitfall traps (plastic buckets or jars) are set into the ground at sufficient depth to retain the animal once it falls into the container (McKenzie & Archer 1982). In areas of heavy undercover, pitfall traps are effective without fencing. A few species are generally shy of box and other mechanical traps, but may be collected in pitfall traps. The great majority of specimens of *Ningaui* species (Ningaui), for example, resulted from pitfall trapping.

Large, high, semi-permanent fence traps, constructed from steel posts and strong wire netting, are primarily used for the capture of kangaroos and hoofed mammals (Fig. 63.1c). Either they are attracted to the trap by water or food, or are driven into it. A corral-like fence trap surrounding a watering or feeding point usually has swing gates. To confine the animals within the corral, the gates are operated, usually remotely by hand, with a cord release mechanism. The animals may then be herded into a smaller inner enclosure for individual capture (Ealey 1967; Frith & Calaby 1969; Johnson 1980b). A corral fence trap may have wing fences up to 1.5 km or so in length that extend from the entrance (Andrewartha & Barker 1969; Frith & Calaby 1969). The animals are herded by foot, horse, truck or aeroplane along the fence wings, if present, in the direction of the entrance where they are driven into the corral (Holst 1981; Henzell & McCloud 1984).

The addition of chloral hydrate to a source of water in arid environments has been successful as a narcotising agent for large kangaroos (Marlow 1956) and rabbits (Shepherd, Edmonds & Nolan 1981). The risk is in the selection of the proper concentration of the narcotic to immobilise the animals without poisoning them.

Capture guns that fire a syringeful of narcotic into the muscle tissue are effective for hoofed mammals (Green 1976; Williams & Ridpath 1982), but less so for kangaroos. To get within range of the small hip area of kangaroos, the method must be used at night. If the syringe should penetrate the abdominal wall instead, the animal usually dies (Frith & Calaby 1969).

A more effective method to ‘shoot’ kangaroos, rock-wallabies, and wombats for capture without causing physical damage, is by firing a .22 calibre rimfire rifle loaded with supersonic ammunition 30 mm above the head between the ears. It is done at night aided by a strong spotlight and the stunned animal is tackled or otherwise caught immediately after the shot (Robertson & Gepp 1982). Several people usually are required in this technique.

Bats are collected by hand in their daytime roosts in caves, hollows of trees, under large leaves, in dwellings and other secluded sites. Scoop nets, fine fish nets and sticks are commonly used to collect bats. Methods for construction of hand-held nets and holding cages have been described (Hamilton-Smith 1964). Fine mist nets of nylon or silk are placed in areas where bats feed, drink or have their flyways (Van Deusen 1961). The bat flies into the net, becomes entangled and is removed by hand. Nets must be checked frequently through the night for humane reasons and dismantled before dawn to avoid catching birds. Lengths of small-mesh terylene curtain material, placed across small cave entrances and passageways, also serve as effective collecting nets (Purchase & Hiscox 1960).

The harp trap (Fig. 63.1d), a rectangular frame stringed vertically with fine wire or nylon line, has been modified in Australia for greater portability (Tidemann & Woodside 1978). A low-flying bat flies into the strung harp trap, usually set along a closed flyway, and tumbles down into a collecting bag at the bottom of the trap.

Trip-lining, in which several wires or nylon lines are strung tightly and horizontally over water, is also effective in catching small bats (Conole & Baverstock 1983). They can be retrieved by net from the water after they hit the wires and tumble in.

Troughton (1937) discovered and described a new species of bat following extraction of a colony from an organ in All Saint's Church in Hunter's Hill, Sydney. The collecting efforts provoked 'an impromptu fantasia' as the bats were dislodged!

Dugongs can be trapped alive in a large heavy net hung from rope and equipped with cork floats and lead weights (Heinsohn, Marsh & Spain 1976a). Small cetaceans, as well as dugongs, have been caught accidentally and drowned in shark nets (Heinsohn, Goudberg & Marsh 1980).

Rabbits can be caught by digging out burrows or by flushing them out of burrows by a trained ferret (Mykytowcyz 1956; Green *et al*. 1978). Large livetraps have been designed for rabbits (Shepherd & Edmonds 1976). The technique of using a wire fence with smeuses (holes fitted with traps) round rabbit warrens is commonly employed (Cooke 1983). Feral pigs can be captured in large weldmesh traps baited with wheat grains (McIlroy 1983).

KILL-CAPTURE

Generally, three types of kill-traps have been used to capture mammals in Australia. One is the regular breakback trap for small species, in which a springloaded rectangular bar pins, and usually kills, the animal as it moves the bait treadle. Traps are mouse-size, rat-size or are Museum Specials designed to kill the animal without damaging its skull. Steel leghold traps, now used particularly for rabbits, foxes and dingoes (Newsome *et al*. 1983a), catch medium to large species of marsupials as well and come in various sizes. The animal rarely dies from the damage inflicted by the trap, but rather, succumbs to shock or exposure. Damage to feet or legs can be overcome by padding the jaws with felt or similar material.

One of the most common methods of capturing species regarded as vermin or as valuable furbearers is by snaring, a technique whereby the animal runs into a noose or trips a mechanism that binds a cord or wire round its body. Thylacines, as well as wallabies and possums, commonly were snared in Tasmania (Pearse 1976) and the snare is still used for rabbits.

Shooting is a highly selective method for collecting mid-sized and large species and has been used since Europeans first arrived. High velocity rifles, usually equipped with telescopic sights, are used at a distance and at a target on the body that causes minimum damage to the skin and skull. For nocturnal species, a powerful headlamp or hand spotlight is used to find and sight in on the animal. Frequently, the shooter sits on the front of a vehicle while the driver approaches the animal and assists with spotlighting.

Heinsohn *et al*. (1976a) described their method of harpooning dugongs once the collectors have drifted silently by boat towards them downwind as they feed. Rarely is the harpoon used for scientific collecting, although for commercial purposes both hand harpoons and explosive harpoons shot from guns were used by whalers in Australian waters (Dakin 1938).

Beams of strong light to illuminate flying bats at night greatly improve the efficiency of collecting them by shotgun (Youngson & McKenzie 1977). Foxes can be attracted to within firing range by the sound of a whistle, which has some resemblance to the squeal of a distressed rabbit (McIntosh 1963). Seals, sea lions, dugongs and small whales can be collected using a high-velocity rifle from a boat.

DEAD SPECIMENS

Fresh road kills of mammals are frequently in sufficiently good condition that they can be prepared as scientific specimens. Domestic cats may yield undamaged small mammals as prey items (Marlow 1957). Faeces of mammalian predators, such as foxes and dingoes, and the regurgitated pellets of avian predators may harbour intact skulls.

Archaeological sites frequently yield remains of prehistoric Aborigines and their food animals. One of the few existing specimens of a rare rodent (*Xeromys* – False Water Rat) was collected from the stomach of a crocodile (Magnusson, Webb & Taylor 1976). Fruit bats electrocuted on powerlines are good undamaged specimens if taken fresh. Almost all whale specimens have been collected following stranding (Bryden 1976). The manual effort to preserve them, before they rot or a high tide shifts them, can be formidable.

PRESERVATION

Methods of preserving dry skins of mammals as permanent scientific specimens were haphazard, and museum skins were ravaged by insects until about 1830, when European museums began to use arsenic trioxide as a routine insecticide (Farber 1977). Because many holotypes of Australian mammals residing in museums overseas are of this vintage or older, damage from poor preservation has rendered some incomplete or disintegrated beyond usefulness. Until museums could ensure large stable collections of well preserved and curated specimens, serious taxonomic work could not develop. Damage to holotypes and the geographical inaccessibility of many other specimens of Australian mammals in overseas museums delayed the progress of mammalogy in Australia. Development of curatorial expertise within Australian museums over the past 30 years, in conjunction with a major expansion in collecting efforts, has now ensured the nation of a readily available source of finely preserved specimens of its unique mammalian fauna.

Handling and Killing. Prior to preservation, a net bag for small mammals or a hessian bag for up to kangaroo-sized larger mammals permits handling of live captives without subjecting them to undue restraint. Procedures for ectoparasites, blood, faeces, examination of pouch young, assessment of reproductive status, marking and humane killing can be done while the animal is bagged. Quick and simple killing methods include neck dislocation, injection of barbiturates and inhalation of chloroform or ether.

Data. The first rule in the collection and subsequent preservation of scientific specimens is to prepare a permanent label to indicate sex, precise locality, collecting date, collector's name and field number, and the following body measurements (mm) in the order given: total length, tail length, hind foot length, ear length and body weight (g) (Fig. 63.2). Labels are written in permanent waterproof black ink and attached immediately.

Techniques. Liquid preservatives are useful as immersion fixatives for gross anatomy and histological work or for ultrastructural studies by perfusion via blood vessels (Padykula & Taylor 1976). Ethyl alcohol (70%), formalin (5%) and methylated spirits are the customary anatomical preservatives, although brandy may be used in dire emergency. Ecto- and endo-parasites may also be preserved in immersion fixatives. Whole mammals (‘spirit specimens’) require slitting midventrally to permit adequate fixation. Ultimately, liquid preservatives leach pigments and soften thin cranial bones. Histological fixatives are usually formaldehyde-based.

Because genes provide the blueprints for synthesis of proteins in the body, comparison of proteins has become a valuable tool as an index of genetic relatedness between taxa. Proteins from the serum of blood are the most

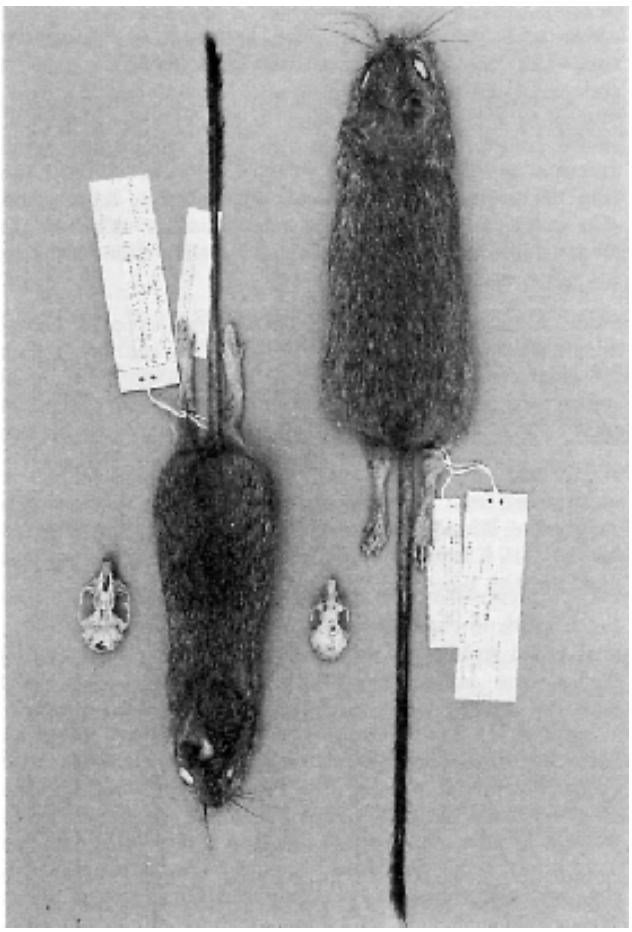

Figure 63.2 Rodent study skins and cleaned skulls prepared for a museum collection. (Photo by G. Chapman)

commonly used for this purpose. From living mammals, blood is usually taken from the orbital sinus of the eye region for very small species, from the tail vein or from the heart by cardiac puncture under anaesthesia. Blood samples taken in the field are frozen prior to transport to the laboratory for subsequent analysis. Other tissues, such as liver or muscle, can also be sampled from freshly killed specimens. These tissues are cut into small pieces, placed in a buffer solution and frozen for later analysis.

Recently, small skin and muscle samples were collected from dried museum study specimens of the presumably extinct Thylacinus cynocephalus (Thylacine) and the proteins successfully extracted and analysed (Sarich, Lowenstein & Richardson 1982). The proteins collected from individuals of various taxa are used to measure similarities in antigen-antibody reactions, an analysis called comparative serology. Analytical techniques include immunodiffusion, double diffusion, microcomplement fixation, haema-glutination inhibition (Kirsch 1977b) and more recently, radioimmunoassay (Sarich *et al*. 1982).

Another technique used as an index of similarity of taxa involves the collection of a complement of chromosomes, the karyotype, from individuals of the species in question. Chromosomes are at their thickest and are most readily seen in metaphase, so the objective in collecting procedures is to obtain complements in this phase. This can be accomplished by injecting an animal with dilute colchicine a few hours before killing it. Colchicine prevents the completion of cell division, so metaphase stages accrue in those few hours. After such treatment, postmortem samples of tissues, frequently taken from bone marrow

or spleen, are dissociated into individual cells in a culture medium prior to fixation and staining of the chromosomes (Kirsch 1977b). Chromosome preparations have also been made by crushing the tissue of the testis (Sharman 1961a) and by taking leucocytes, fibroblasts, or other cell types into culture, techniques that permit the investigator to keep the animal alive (Young *et al*. 1982). Following various staining procedures, photographs of the chromosomes from an individual are lined up by size and can be compared with other karyotypes in terms of relative lengths of arms, banding patterns, and relative amounts of DNA (Martin & Hayman 1965; Hayman 1976). These comparisons, which evaluate similarities and differences of chromosomes between species, are used to develop interpretations of relatedness among species (see Chapter 12B).

Freezing is a means of temporary preservation suitable not only for intact mammals and their tissues, but for ectoparasites, endoparasites and tissues used for viral, bacterial and rickettsial studies. Many of the diseases found in marsupials are discussed in review articles (Arundel, Barker & Beveridge 1977; Potkay 1977). Introduction of the viral disease, myxomatosis, in the rabbit has been followed diligently by collection and preparation of tissues of both host and insect vector (Fenner & Ratcliffe 1965).

Traditional preservatives for skins to be air-dried are borax and arsenic trioxide, the latter as an insecticide. Coarse salt is a temporary preservative for large flat skins prior to tanning. The effectiveness of any dry preservative is diminished if subcutaneous fat remains attached to the skin.

Taxidermy. For mammals smaller than a fox or small wallaby, a conventional study skin is prepared by removing the body from the skin through a longitudinal slit along the abdomen and replacing the body with a cotton wool body of similar size and shape. The tail and legs are supported by straight lengths of wire wrapped to shape with long-fibred cotton wool. The forelegs are directed forward beneath the body and the hind legs and tail straight backwards. The abdominal slit and mouth are sewn closed, and the skin is pinned to a board and allowed to air dry. The dried study skin is compact for storage in a museum cabinet and permits examination of all essential external features of the animal (Fig. 63.2). Use of flat cardboard, rather than a tubular body, as a compact method for the preparation of skins of small mammals in Australia, was suggested by Harrison (1960), but has not been widely accepted.

Skins of larger mammals are opened up, prepared flat and are frequently tanned before permanent storage. Life mounts, in which the skin covers an artificial body in a life-like stance, are prepared for museum dioramas and general displays.

A practical note to be added here is that clumps of hair will come away from the bodies of certain soft-furred marsupials during the skinning process if they are not allowed to cool for 12 – 24 hours before proceeding. This is a particular problem with possums.

Fresh skulls are soaked in water overnight to prevent permanent blood staining of the bone and the brain is removed by flushing the cranial cavity with water. The flesh on skulls (and on the remaining skeleton, if it is to be prepared) is allowed to air-dry thoroughly. Large specimens, or smaller ones that have become flyblown, can be cleaned by gentle heat in a waterbath or by immersion in potassium hydroxide (2–4%), until the flesh separates from the bone. Neither method is advised for small skulls because liquid can macerate bones and loosen teeth. Larvae of dermestid beetles are the most effective agent for cleaning skeletal material and are used routinely in most museums (Russell, 1947). Preparation of mammals skins and skeletons and their subsequent care are described in detail in a number of publications (for example, Anderson 1965; Brown & Stoddart 1977; Edwards, Bell & King 1981).

LABORATORY CULTURE

Rodents are the only native eutherians sustained as long-term laboratory colonies for breeding studies and other research purposes. The Institute of Medical and Veterinary Science, Adelaide, has successfully maintained a variety of species of both rodents and marsupials over many years, and Watts & Aslin (1981) describe their methods of keeping native rodents in captivity.

Except for large fruit bats, Australian bats rarely are held in captivity for long periods. Little or nothing is known about the husbandry or breeding biology of most species. Marine mammals are held primarily at zoos for display purposes. Large terrestrial eutherians, like the rabbit, dingo and hoofed mammals, are held captive mainly for studies related to their economic importance.

Interest in the husbandry of marsupials as laboratory animals stems primarily from the unique reproductive features they offer, including opportunity to study pouch young. Most Australian marsupials have been kept in captivity, either for scientific purposes or in zoos, and descriptions of their special requirements are available in various scientific publications (Collins 1973). As yet, no marsupial has been developed for use as standard laboratory stock comparable to the status of laboratory rats and mice.

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