Husbandry Manual Guidelines for

Brush tailed Bettong

Bettongia penecillata

Mammalia:Potoroidae

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1 OH&S

Bettongia penicillata is classified as innocuous. However, care should be taken during handling of this marsupial. They have very long, sharp nails and sharp teeth which can inflict minor cuts or scratches. If bettongs are handled incorrectly their strong back legs can give a hard kick which also may cause minor injuries to keepers. Thick bags or sturdy nets should be used for capture, as bettongs are known to shred light fabrics with their strong back legs when first caught. Basic hygiene should be observed when maintaining these animals such as washing hands before and after handling and cleaning equipment after use.

2 Taxonomy

2.1 Nomenclature

Class: Mammalia

Order: Diprotodontia

Family: Potoroidae

Genus: Bettongia

Species: penecillata

2.2 Subspecies

The EPBC (Environment Protection and Biodiversity Conservation) Act of Threatened Fauna list the following Bettong species and subspecies under the categories Extinct, Endangered, & Vulnerable
Bettongia penicillata penicillata brush-tailed bettong (south east mainland) Extinct
B. lesueur araii boodie, burrowing bettong (inland) Extinct
B. gaimardi gaimardi, eastern bettong (mainland) Extinct
B. tropica, northern bettong Endangered
B. lesueur lesueur, boodie burrowing bettong (shark bay) Vulnerable
B. lisueur unnamed subsp, (Barrow & Boodie Is) Vulnerable

There are two subspecies of brush-tailed bettong (Wakefield, 1967):
Bettongia penicillata penicillata (south east Australia. Extinct)
Bettongia penicillata oglibyi (south western Australia, also re-introduced to SA and NSW) Low Risk

2.3 Recent Synonyms

Bettongia tropica (part)

2.4 Other Common Names

- Woylie (a local indigenous name of the Nyoongar referring to the animal's ability to carry sticks and leaves in its tail),
- Brush-tailed Rat-kangaroo

1 Natural History

1.1 Morphometrics

1.1.1 Mass And Basic Body Measurements

- Weight 1.1 to 1.6 kg with an average weight of 1.3 kg (Chrestensen 1983)
- Head & body length 300-380 mm
- Tail length 290-360 mm (average 310)
- Stands approximately 400 mm high

1.1.2 Sexual Dimorphism

Males and females are generally of similar appearance. Female have a pouch on the stomach area while testes on males may occasionally be visible. Sexes are difficult to tell apart without close physical examination. Christensen (1980) proved males varied in weight at different times of the year, being heaviest in December and lightest in August. Females did not have as noticeable weight change but were still heaviest during summer (Seebeck, Bennett & Scotts 1989)

1.1.3 Distinguishing Features

- Body is yellowish grey above and lighter underneath.
- Legs and feet are light brown
- Tail is light brown darkening toward the tip and with a black ridge of hair on dorsal surface on lower third of tail.
- Bounds with tail only slightly curved, back arched and head low.

1.2 Distribution and Habitat

The bettong is an Australian species of rat-kangaroo (closely related to potoroos and musky rat-kangaroos) that is found in a few restricted areas of Australia. At the time of white colonization the brush-tailed bettong was found in western New South Wales, north western Victoria, southern Northern Territory, north and south areas of Western Australia. However,

due to pressure by habitat destruction, hunting and feral predators (mainly the introduced Red Fox) by the 1960s the population distribution of wild *Bettongia penicillata* had become restricted to three areas of south west Western Australia: Tutanning, Dryandra and Tone-Perup River.

Picture of Aust current and historical distribution

Bettongia penecillata has a habitat altitude range of 0-300 meters above sea level. It prefers a habitat of mostly dry sclerophyll forest and open woodlands and these characteristically include clumped low understory. It commonly avoids areas of dense undergrowth. Forests of Jarrah (*Eucalyptus marginata*) and Wandoo (*E. wandoo*) that grow in well-drained, deep soils with low xeric scrub or tussock grass in the lower strata seem to be a favorite of this small marsupial.

1.3 Conservation Status

IUCN Classifies the Brush-tailed Bettong as Low Risk but Conservation Dependent
The brush-tailed bettong has one of the best success stories of species survival which has resulted from a recovery plan. Efforts of fox control and bettong reintroduction began seriously in the 1970s. In 1996 when wild populations had increased by 400 percent, it was the first Australian mammal to be downgraded from the listing as endangered species under the *Commonwealth Endangered Species Protection Act* as a direct result of a recovery program.

However, as of the 22 January 2008, the Environment Minister Mr David Templeman relisted the brush-tailed bettong as endangered under the State Wildlife conservation Act of Western Australia due to numbers in the wild decreasing dramatically since 2001. It was estimated that 70-80 percent of wild population had declined in the recent 5 years. Research by the Woylie Conservation Research Project (WCRP) is currently underway to determine the reason for such dramatic decline in numbers. The current hypothesis suggests that disease (especially toxoplasma) and predators such as cats (which carry toxoplasmosis) are the main impacts. This research is yet to be completed (WCRP Progress Report).

1.4 Longevity

1.4.1 In the Wild

- 4-6 years

1.4.2 In Captivity

- Life5-7 years (record was 9 years). Macropods commonly live for slightly longer in captivity than in wild situations.

1.4.3 Techniques Used to Determine Age in Adults

Molar progression
Molar Eruption-this is the more reliable method using molar indexing.

1 Housing Requirements

1.1 Exhibit/Enclosure Design

- Brush-tailed Bettongs are known to be good climbers and diggers, and they are generally quite small macropods. This requires enclosures to be designed very securely with appropriate materials to prevent escape. Footings which extend into the ground should be used to prevent animals digging out of an enclosure. Walls should be constructed of a non-climbable material such as brick or metal and of material which they cannot get through(large gauge wire mesh is unsuitable as bettongs may squeeze through.) An inward-leaning guard of metal is may be used to prevent animals climbing over walls.

- The enclosures should always be designed to prevent public being able to make physical contact with the animals. Bettongs may bite.

- If more than one animal is to be housed in the one enclosure, the animals should be provided with several hides as bettongs are naturally argumentive and do not enjoy sharing. If not enough possibilities of hides or nesting material are provided, animals may become stressed, and fight for nests leaving the less dominant animal with insufficient weather protection.

-Bare walkways should be provided for keepers to walk on as they go about their duties, as these animals are very difficult to see when hiding under a low grass mound. This will help minimize disturbing the animals when daily feeding, cleaning or maintenance is underway Should have roof (eg. Netting) to prevent predators such as crows, eagles, owls, foxes, dogs,etc)Crows

1.2 Holding Area Design

- Floor area should be minimum of 3.3 square meters per pair and should contain sufficient hides and nesting material for both animals. Access points for keepers should be designed to minimize possibility of accidental escape of the animal. Air locks effectively cover this.

1.3 Spatial Requirements

In the wild bettongs have territories of 20-40 ha with this divided into feeding and resting areas. It is therefore important to maintain appropriate spatial requirements for over-all animal health.

-Minimum floor area required for housing 2 Brush-tailed Bettongs is 10 square meters with additional area per extra animal is 2.25x2.25 meters. The minimum enclosure height is 200cm.

1.4 Position of Enclosures

-Positioning to allow morning and afternoon sun into different parts of the enclosure is good. This will help keep the enclosure drier.

- Enclosures should be positioned with drainage planned. If the enclosure is built on a hill, drainage should be built to take water away and leave entrances and walkways dry.

1.5 Weather Protection

-The enclosure should allow animals the option of protection from the elements such as wind, rain or sun.

-Small thatched huts or timber hides may be placed in the enclosure. A section of the enclosure may be covered in with a small roof constructed to provide shelter.

At Potoroo Palace a raised boardwalk for public with the windward side enclosed in the walk-thru bettong enclosure gives secure weather protection.

- When deciding on the position and construction of weather protection huts or hides, ensure that they would not be flooded in heavy rain and are strong enough to withstand strong winds which may affect the enclosure occasionally.

1.6 Temperature Requirements

As bettongs were found naturally in many different areas which had varying temperatures, from inland semi desert of Northern Territory to southern temperate forests in Western Australia and Victoria. Therefore, they adapt to may differing climatic temperatures, but do well in temperate areas of annual average of 15-30 degrees Celsius.

1.7 Substrate

Natural ground substrate is good as it encourages natural digging or foraging activities. A ground cover should be used such as leaf litter, dried grasses, or growing grass and shrubs. Not only does this look more natural for public presentation, but also it provides ready nesting areas and materials. Woodchips should be avoided as it is suggested (Claridge A.) that it may lead to foot sores and possibly subsequent injury or infections. Large quantities of hay may also pose health problems if it becomes moist and mouldy.

1.8 Nestboxes and/or Bedding Material

Bettongs make several nests on the ground, which are used for hiding and resting areas during the day. Females may leave their young in these nests once they have left the pouch. Bettong nests are called squats. Thick underbrush often is the ideal hiding area for a bettong nest. At Potoroo Palace Native Animal Sanctuary, bettongs preffered tussock grasses, straw and fiberous bark (as from *Eucalyptus* ……-yellow stringy)as their main nesting material. These could be made available by being part of the substrate, or leaving small piles for the animals to access.

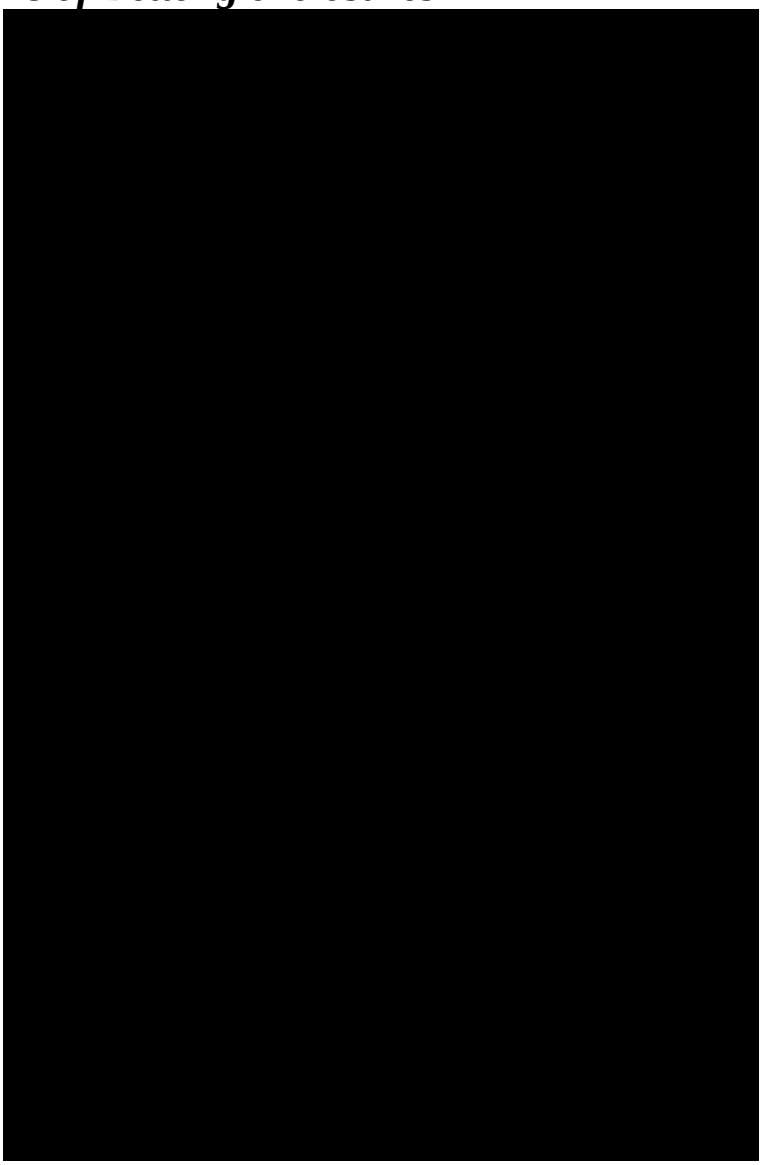
6 nest spots each They seem to use them randomly.

Squats are usually shaped as a small cylindrical tunnel or spherical nests. They are constructed of grass or shredded bark over a shallow depression in the ground or under a log or dead branch, in a hollow log or at the base of a tussock grass. Nests are approximately 150x200x200 mm with a dry weight of 500g

1.9 Enclosure Furnishings

(Branches, rocks, grass tussocks, streams or ponds. Behavioral enrichment furniture. Nesting requirements)

Some Designs of Bettong enclosures



1 General Husbandry

1.1 Hygiene and Cleaning

-Water dish cleaned and refilled
- Food dishes cleaned. These may be scrubbed with water daily and washed in hot soapy water and well rinsed twice a week. At Potoroo Palace, dishes are removed and cleaned with hot water daily.
- Food placed in enclosure
-Any spilt or leftover food from previous day removed

Occasional

- Feeding stations and water bowl stations should be moved to new ground *every week* to provide clean substrate which helps avoid diseased which may be contracted due to ingestion of faeces.
-Clean dry nesting material should be available within the enclosure daily and *checked weekly*. This may be achieved by placing small mounds or scatterings of straw and fibrous bark in areas of the enclosure.This is because bettongs make their own nests and regularly (pers obs) move nest areas and make new nests-especially if disturbed from a nesting area.

1.2 Record Keeping

Records which are essential to be maintained for any Brush-tailed Bettong in a captive animal institute are as follows:

The official scientific name, common name, and any personal name of the animal should be recorded. Information regarding permanent individual ID including gender, and any distinctive markings should be kept along with its place of origin and parents, including origin of parents if possible. Date of birth, any breeding activity and/or offspring and any medical history should be recorded. The date the institute acquired the animal, along with its history of transfers should also be kept and any future transport of the animal out of that institute, or date of death and reason should also be kept.
Also records of any noteable events should be kept. Follows is the appropriate codes for use with ISIS

ACQ: Acquisition

- Any important animal from the outside the collection, public donation, or capture form the grounds or from the wild.

B/H: Birth/Hatching

- Birds-generally recorded as hatch date. If date of leaving the nest is used it must be noted as such under information column.
- Marsupials-the date on which the animal is permanently out of the pouch, or the day a juvenile is thrown
- Placentals-the day on which they are born

D/30: Death within 30 days

- Death/euthanasia within 30 days of birth, hatching or acquisition

D/E: Death, established

- Death/euthanasia of any animal which has been resident in the collection for longer than 30 days

DIS: Disposition

- Includes exports from the collection, release, sales, escapes

BRD: Breeding

- Reproductive details/observations. Any nesting, laying of eggs, oestrus, menstruations, mating, coutiship, pouch checks, sexing of previously unsexed individuals or any other reproductive matter

INT: Internal Movement/ Transfer

- Any movement of an animal from its residing enclosre, be it within a section or to a different section. Transfers/exports out of the collection NOT included

TAG: Tagging

- Animal identification by banding, tagging, notching, tattooing naming or any other method of identification

W/L: Weight/Length

- Weight or length measurements

Rx/Tx: Treatment

- Any medical treatment administered to animals, either by Vets, or continuing treatments administered by animal care staff. Include observations of anything related to treatment. Flag if veterinary examination is required. Use VET code.

VET: Vet Examination Required

- Note if veterinary treatment/examination is required

OTH: Other

- Any notable observation made in reference to daily routine or animals, e.g. behavior change to routine etc. Also anything else of interest e.g. animal management procedures, diet change, maintenance etc

1.3 Methods of Identification

The number one method recommended for ID of individual bettongs is microchipping. Australian Veterinary Association (AVA) recommends microchipping as the preferred method of permanent ID due to its being accurate, easy to use, long lasting, and non-irritant to the animal.

Other recommended permanent ID includes ear tagging and ear marking, or tattoos.

1.4 Routine Data Collection

Each animal in an enclosure should be checked daily for general health and wellbeing. Signs of ill-health to watch for are un-normal behavior, uneven gait, un-interest in food, or unusual position. Amount of food eaten should be recorded daily, especially if animal is new or unwell.

Animals should be weighed monthly under normal conditions. During breeding, animals may be weighed fortnightly and pouch checking may be necessary. General health check-up may be preformed monthly along with fecal checks.

Any notable events should be recorded should be recorded on the day, and these include signs of breeding, medical treatment, movement of animal between enclosures, and any physical checks such as weighing.

1 Feeding Requirements

1.1 Diet in the Wild

Do not drink water or eat greens in wild. Fruiting bodies of underground fungi. With bulbs, tubers, seeds, insects and resin(from Hakea) as extra. Proportions of foods in diet are seasonal with the larger portion of the diet being fungal during summer and autumn. (deficient and imbalanced in amino acids as a main dietary component itself for mammals, bacteria in the for stomach digest the fungi and their byproducts provide necessary nutrients for the bettongs (bacteria and its byproducts) which are digested in the posterior stomach and small intestines.
Clarage, Seeback,& Rose give fungal fruiting bodies of Hypogeous as a major component of wild bettong diet with seeds,leaf/stem, roots/tubers, and exudates as minor and seasonal dietary components.
Christensen P showed they are mycophagous. Hypogeous fungi major component of diet in summer and autumn with 24 taxa eaten. Mesophellia most favored. Roots and tubers, leaves, invertebrates and gum exudates included in diet at various times.
Dietary components may vary with location. Western Australian sandalwood (Santalum spicatum) is important for some bettongs in some areas. This is symbiosis with the sandlewood, as Murphy, M, et al proved that sandlewood relies on bettongs taking and storing the seeds-an effective dispersal agent-.
Insects, fruits, seeds, leaves may all be part of the diet.
They eat the inner core of the fruiting bodies.

1.2 Captive Diet

Brush-tailed Bettong Diet *(Jackson)*
Ad Lib
Water. Although Brush-tailed bettongs seem to get most or all of their water needs from their food in the wild, clean water should always be provided in captivity.
Daily Diet (per animal)
¼ cup Apple
1 piece Banana
1 piece Carrot
½ cup Kangaroo cubes
2 Pea pods
2 String beans
¼ slice Sweet corn
¼ cup Sweet potato
(Diet used by Taronga Zoo)

Brush-tailed Bettong Diet *(Potoroo Palace Native Animal Sanctuary)*
Ad Lib
Water
Daily Diet (per animal)
¾ cup Sweet Potato
¼ cup Sweet Corn

¼ cup Apple
¼ Carrot
¼ cup Roo pellets
1 tsp Oats
3 Sultanas
Mealworms (very occasionally)
Mushrooms (occasionally)

Diet of Potoroo Palace Native Animal Sanctuary is considered the institutes core diet. The bettong live in a large enclosure which supports much insect. Bettongs do not usually eat green leafy plant matter.

General Notes:
It is suggested (Guidelines to Use of Australian Native Mammals) that kangaroo pellet should be used in restricted quantities as it may contribute to development of lumpy jaw. However, if they contain a coccidiostat they are an essential part of diet?
Bettongs require a large proportion of fibre in their captive diet.

1.3 Supplements

Dog kibble (protein), mealworms, oats, (maby put pics of these)
Information yet to be collected

1.4 Presentation of Food

Food may be presented in low dishes, which are removed and cleaned on a daily basis. Occasional scattering of food around the enclosure or under tussocks stimulates natural foraging behavior.

1 Handling and Transport

1.1 Timing of Capture and Handling

Cool day or in cooler parts of day

1.2 Catching Bags

Hessian potato sacks
Heavy cotton bags
Bags should have

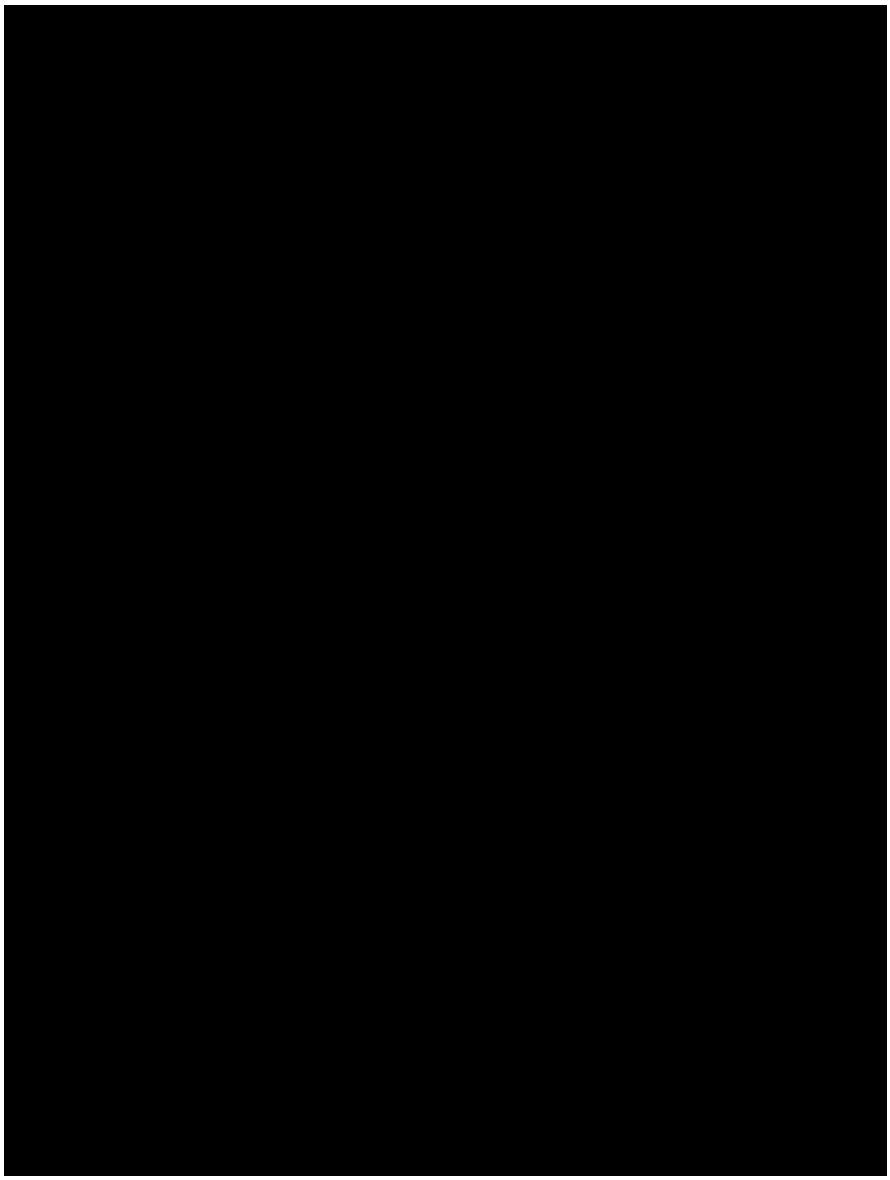


Figure 1 Net used for catching bettong. Note padded rim on net and long handle

1.3 Capture and Restraint Techniques

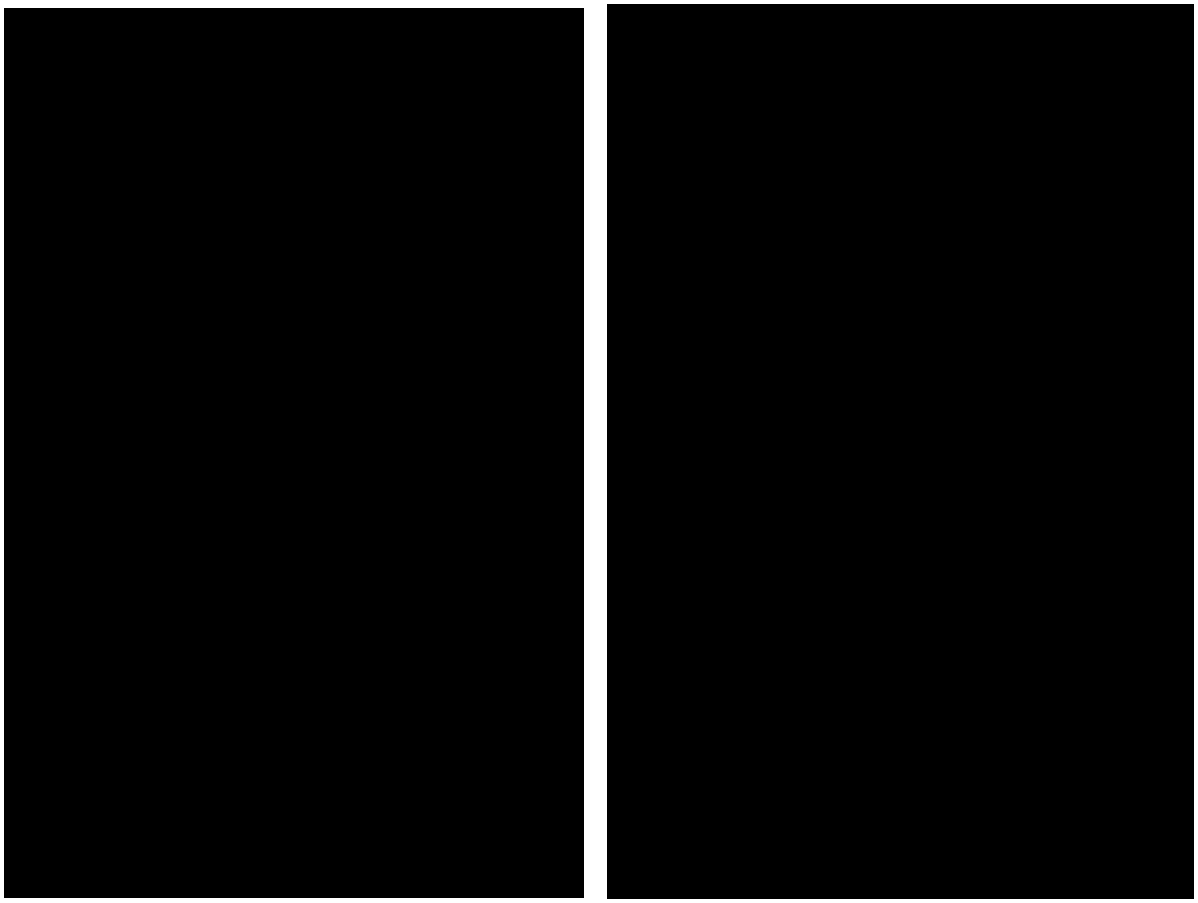
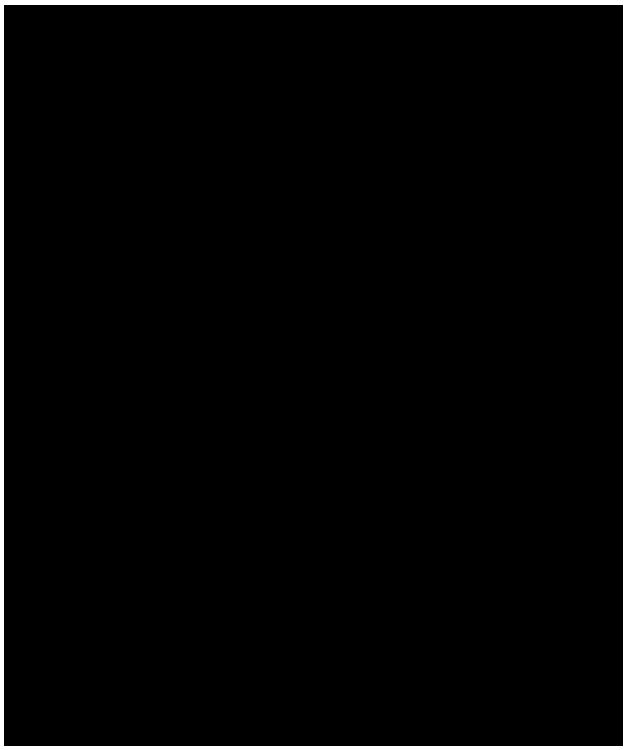


Figure 2 Tailing bettong. Note head is covered at this point and hand is gripping nearest the base of the tail



1.4 Weighing and Examination

1.5 Release

1.6 Transport Requirements

1.6.1 Box Design

Appropriate boxes for transporting include small dog or cat pet packs, specially made wooden boxes or cages. Tied hessian bags should be placed in the bo

1.6.2 Furnishings

1.6.3 Water and Food

1.6.4 Animals per Box

1 animal per bab

1.6.5 Timing of Transportation

22 hours no water 5 hr travel- over night in bags

1.6.6 Release from Box

Untie bag and let animal come out as when it wants. Bags were left for up to 7 days in the area to let bettongs smell themselves.

1 Health Requirements

1.1 Daily Health Checks

Every animal held in captivity should be observed at least once a day to monitor general health. For this reason a visual check of each animal should be conducted daily.
Ultimately, the animals in the exhibit should be checked early in the day. Establishing a first-thing-morning check is a good habit. The exhibit is given a brief visual checked and any unusual activities or un-routine observations are noted before any daily cleaning or feeding is started.
Below is a list of things to check and to watch for during the morning check and during other feeding/cleaning times

- Faeces softer than normal
- Dirty vent
- Coat condition- lost hair/fur, unusually wet
- Base tail condition (fat amounts)
- Blood, scratches, scabs, swellings, lameness
- Loss of coordination, or reluctance to move,
- Wet fore-arms?
- Food uneaten

1.2 Detailed Physical Examination

Health checks can include testing of samples from blood, feaces, tissue and ectoparasites
Faecal sample tested for endoparasites

Ticks in ears

1.2.1 Chemical Restraint

- **Sedation**
  Sedations is an effective method for minimizing stress during prolonged periods of restraint in confined areas such as during translocations, or in preparation for anaesthia during medical operations.

Intramuscular injection of Valium R (diazepam). Dose rate is 1-2 mg/kg (Jackson 2000). It is usually given in the thigh muscle.

Intravenous injection of Valium R (diazepam). Dose rate site is 0.5-1 mg/kg (Jackson 2000). Intravenously is the most recommended method for macropods, but may be difficult with bettongs as their bodies are comparatively small to other macropods.. are the coccygeal vein near base of tail, cephalic or medial saphenous viens. Should be used during prolonged periods of restraint in confined areas such as during translocation, or medical operation.

- **Anaesthia**

It is recommened the bettong be sedated first before anaisthia to reduce stress. Bettong should be placed in a *dark, quiet* place of restricted movement during recovery from chemical restraint to prevent injuries. A pet pack (cat size) with soft substrate and a towel placed over it may suffice. Ensure bettong is not left in a draught during recovery period.

Tiletamine/zolazepam (Zoletil) injection. Dose rate is 5-15 mg/kg intramuscular. The animal should be sedated with diazepam first to reduce stress.

Isoflurane and *oxygen* administered by a facial mask has also been successfully used the anaesthetize bettongs.

1.2.2 Physical Examination

Physical examination should be conducted with limiting the stress caused to the animal as a priority. This is done by keeping the time the animal is restrained for to a minimum and handling the animal in the correctly.

The animal should be restrained in a hessian or thick cotton sack, exposing those areas for examination by moving the handler's external grip appropriately and using the opening in the sack. Handlers should rarely need to remove the animal from the sack during examinations until release.

As much as is practical, the head should remain covered.

Particular attention should be paid to the following in any restraint procedure: capture myopathy, shock, hypo- and hyperthermia, respiratory failure, cardiac failure, trauma and secondary infection (shepherd, 1984; Tribe and Middleton, 1988)

Following are important checks to be done when physically examining an animal.

- Weigh monthly and ensure weight is recorded for monitoring (see General Husbandry Section 1.2)
- Coat condition and tail condition
- Eyes clear dark with no discharges around them
- Hair loss/injuries/dirtycloaca should be noted
- Check over body for ticks
- Pouch check on females for young and size and condition of young and condition of pouch if no young are present.
-

1.3 Routine Treatments

Faecal tests should be conducted monthly to monitor endoparasite levels and may be wormed accordingly.

Providing coccidiostat in pellets

1.4 Known Health Problems

- **Chronic Pneumonia**

Signs: Hoarse breathing, mucus discharge

*Treatmen*t: Provide warm/dry exhibit that is well drained, ensure substrates and nesting material are dry.

- **Toxoplasma**

Signs: Sudden death, respiratory problems, neurological problems-staggering. Lethargy, depression, in appetence, respiratory distress, convulsions, diarrhea, staggering
Treatment: recommended euthanasia

- **Ectoparasites**

Signs: Excessive scratching, small fleas or mites in fur on close inspection, grey to black ticks in fur (especially near ears?).
Treatment: Topical application of ivamectin (Ivomec) or Cydectin (moxidectin) 200 ug/kg weekly four to six times (Blyde 1999)

- **Endoparasites**

Signs: Loss of condition, progressive weight loss, sometimes diarrhea?
Treatment: ivermectin 200-500 ug/kg (orally, topically and by injection) benzimidazoles, systamex (oxfendazole) and Panacur (fenbendazole) and livamisole (Jackson 2000)

- **Salmonella**

Signs: Diarrhoea, dysentery, depression and dehydration
Treatment: Course of antibiotics: Excenel (ceftiofur) 2 mg/kg IM SID 7-10 days, or Bayrtil (enrofloxacin) 5 mg/kg IM SID 7-10 days (Jackson 2000).

- Note: hair loss and scabs may result from fighting or territory disputes between co-housed animals, especially newly introduced animals.

Septic Arthritis has been recorded in wild individuals

- Haematology

1.5 Quarantine Requirements

Quarantined animals should be housed in a separate enclosure away from established animls. These animals should be maintained last in the daily routine with all other mammals cleaned and fed first. This helps narrow the possibility of transferring disease from quarantined animals to the established collection. Each quarantine enclosure should have its own food and water dishes. The quarantine area should have its own equipment that is used exclusively for quarantine purposes and not in the rest of the collection (eg. Rakes, brooms, rubbish bins, and gloves). A quality disinfectant should be provided for cleaning equipment and keepers hands. It is advisable to use a disinfectant shoe bath when entering and exiting the quarantine area.

9. Behaviour

1.1 Activity

Bettongia penecillata are naturally nocturnal.

1.2 Social Behaviour

1.3 Reproductive Behaviour

1.4 Bathing

Not Applicable for this species

1.5 Behavioural Problems

Escaping. Digging deep holes, Excissive mating. Fur loss or coat condition deterioration. Dominance. Aggression. Excessive fighting resulting in injury.

Digging out
Chewing cords
Dominance with new individuals
Fight over food if over crowded areas

1.6 Signs of Stress

Urination. Fast bownding. Pacing.

Urination on the spot

1.7 Behavioural Enrichment

Scattering food. Putting nuts or occasionally dried fruit in food. Providing large pieces of food stuffs which require chewing or nawing. Providing varies of terrain such as mounds, corners. Buring food around the enclosure.

1.8 Introductions and Removals

May be very domineering to new arrivals-fighting mating, chasing away from food,

1.9 Intraspecific Compatibility

Have been kept successfully with Koalas, and echidnas

1.10 Interspecific Compatibility

1.11 Suitability to Captivity

1 Breeding

Define: gonochoric, gonochoristic dioecious

1.1 Mating System

Breeding is continuous

1.2 Ease of Breeding

Bettongs will breed almost continuously in captivity. This will result in females and also males losing body condition if they are not removed from breeding for a time regularly. Due to natural territorial behavior of bettongs, young should be removed form breeding pens to avoid possible mortality as dominant males may attack young adults if the enclosure dose not provide enough space.

1.3 Reproductive Condition

Reproductive condition should be monitored. Bettongs breed continuously and this may put a lot of stress on individual animals over time.

1.3.1 Females

There may be a dominat female within the breeding group. She will more likely eat first and this may cause some stress and malnutrition of other females. Females may lose much weight if breeding continuously. Breeding should be stopped if females drop weight to less than 900 g.

1.3.2 Males

Males may lose weight from continuous breeding. Ultimatley animals should be periodically rested to maintain condition. Delroy L. B. et al 1986 noted successful breeding when males were rested every 6 months.

1.4 Techniques Used to Control Breeding

Separate males and females
Have males desexed- castrated?
Females could be pouch pulled- that is young manually removed form the pouch. Though as bettongs breed continuously this would not be an effective long-term technique.

1.5 Occurrence of Hybrids

Information Currently Unavailable

1.6 Timing of Breeding

May breed and give birth approximately every 100 days after first breeding of females at 180 days of age. This results in continuous breeding throughout the animal's 4-6 years of life.

1.7 Age at First Breeding and Last Breeding

Female:

May produce first young 170-180 days or 6 months of age
May produce young up until death at 4- 6 years

Male:
9-12 (170-180 days)months of age

1.8 Ability to Breed Every Year

After reaching sexual maturity (6 Month for females and 9-12 months for males) bettongs will continuously breed every year usually multiple times per year for the rest of its life.

1.9 Ability to Breed More than Once Per Year

As with others of the Potoriodia family, Brush-tailed bettongs may breed at any time of the year. A female may have up to three young per year but she is always breeding with one young in the pouch and one at foot.

1.10 Nesting, Hollow or Other Requirements

Bettongs need many hide areas. Hollow logs, piles of branches and tussock grasses are a favorite type of nest. Dry grass or fibrous bark should be available as the mother will coil it in her tail and take it to her nest area. Plenty of nests will help reduce squabbles among neighbors and will lower possible young mortality from fights. It has been observed that bettongs may have communial nesting (Delroy L. B. et al 1986). This has been observed in captivity mainly among females or among males in non-breeding pens (eg. No females present).

1.11 Breeding Diet

Good variety of food is important for successful breeding. As the young joey grows food quantities will need to be gradually increased. Diet should consist of fruit apple, pear, banana, occasionally paw paw or organges; root vegetables like sweet potato, potato, parsnips and carrots; and protein such as dry dog food and kangaroo cubes. Extra foods such as sunflower seeds, oats, or sultanas may be offered a few times per week. Bettongs may also dig in their enclosure for fungi or soft wood/ roots at certain times of year. Always watch for obesity.

1.12 Oestrous Cycle and Gestation Period

Do have embryonic diapauses (ability of animal to withhold development of its embryo be keeping it unattached to the uterus wall, until conditions are favorable.)
Gestation average 18-21 days.

1.13 Litter Size

Usually 1 rarely 2 in which case one of the two will likely die in the first few weeks of pouch life

1.14 Age at Weaning

Remains in pouch for 90-98 days and will continue to suckle until approximately 130 days if allowed.

1.15 Age of Removal from Parents

Will stay with mother until the next joey leaves the pouch and takes its place as the follower. Young have been removed form parents and successfully raised from 550 g (approximately 120 days).

1.16 Growth and Development

1 Artificial Rearing of Mammals

1.1 Housing

Macropod young are raised in their mother's pouch until they are developed enough to cope with the outside environment. They will then gradually spend more and more time out of the mother's pouch investigating until they no longer need the pouch for protection or milk anymore. The aim of artificially rearing these animals is to provide an environment as similar to that of the mother as practical. Thus the basics of housing this species during the earlier times is to provide a warm, dark, secure area which simulates the pouch. The most effective pouches are of cotton-with cotton sheets being the ideal material of combined warmth, softness, and breathability. Pouch size will need to increase as the young grows. Corners should be rounded. This inner lining should sit inside a insulation layer- such as a bigger pouch made from baby blanket or sheepskin (depending on how much warmth is required). This may then sit in a pouch bag which suspends the pouches. Cotton back bags are commonly used.

Lining bags should be changed whenever they become soiled with milk or feaces/urine and usually after feeds.

1.2 Temperature Requirements

Joeys are maintained at approximately 28 degrees Celsius. This temperature should be regularly monitored with a thermometer by checking the temperature in the inner pouch.

The method used for maintaining this temperature will vary with the age of the joeys. Very young unfurred joeys may have their pouch kept in a humid crib (thermostatically controlled heated box) They are vulnerable to the cold at this time. It is essential to ensure they are well hydrated all the time as the natural mother's pouch is a very warm humid environment at all times.

When joeys are furred or velvet (just getting fur) they are much more able to regulate their own body temperatures and maintain some heat. Usually a warm hot water bottle properly monitored (never let them get cold as they could act as a heat sponge) and a warm place with proper pouch lining (eg. Sheep skin) should be sufficient to maintain temperature.

1. Diet and Feeding Routine

Joeys should be fed on a milk formula during early development and gradually given the opportunity to access solid foods. Never feed cows milk to joeys as they cannot digest the lactose. There are a few recommended types of milks which are very good for raising joeys. Biolac, Wombaroo, Digestelac and Di-vetalact. Recommended dosage and make up is essential to follow. Dihareea or other digestive complaints will result.

If using Digestelact, Di-Vetaelact the joey should receive 10-20 percent of its body weight each day. If using Biolac the ratio is 10-15 percent of body weight daily.

Feeding

Unfurred joeys should be fed milk approximately every 2 hours to 3 hours if they weigh less than 300g

Furred joeys may be fed every 4 hours. As the joey gets older and starts experimenting with solid food night feeds may be extended to every 5-6 hours. They may start eating solid foods at approximately 370g.

Joeys of 500g may be weaned from milk onto water and solid food. They would be out of their mothers pouch by now.

Animals of 550g should be eating solid food constantly and showing signs of good health such as weight gain

1.3 Specific Requirements

Joeys need to be kept in a warm quiet place as stress is a big influence on them. Hydrations is important at all times. Sometimes it may be necessary to provide some form of lubricant directly onto the skin if it is dry. This is important especially if the joey is still unfurred. Vasaline or baby oil can be used.

1.4 Data Recording

Detailed records should be kept during the entire time of rearing.
It is recommended to keep a journal along with official records for more general events which may help during rearing.
Date of Birth sex, condition on start of rearing and periodic weighings should be recorded in official records.
The journal should contain records of how much the joey ate at individual feeds. Date when it started eating solid foods and record of condition of feaces should also be recorded. This will help when monitoring over all condition and also for future rearing as a reference.

1.5 Identification Method

Colored or numbered tags.

1.6 Hygiene

As with all young animals hygiene is important for the animal and the keeper. All feeding equipment such as bottles and teats must be cleaned in hot soapy water-preferably before any milk dries. Hygiene of the pouch is of utmost importance to preventing digestive and other problems. Pouch liners should be changed whenever they become dirty- at least a couple times per day. Toileting should be done with soft, clean cloth. Use a new cloth each time. Ensure that any spilt milk formula is cleaned promptly. This may include replacing pouch liner and cleaning the joey's mouth thoroughly after feeds.

1.7 Behavioural Considerations

Bettongs are naturally very shy and naturally nocturnal. The best way for a bettong to learn how to use its natural instincts (as with other animals) is to be around other bettongs.

1.8 Use of Foster Species

Information Currently Unavailable

1.9 Weaning

Young may be weaned at 550 g which would be approximately 120 +/- 14 days. They will have left the pouch for the last time by this weight. (Delroy, L. B. et al 1986)The weaning

process is the gradual change of all-milk diet to an all-solid diet. It is important to make solid food available for the joey to experiment and play with form early- while it is still permanently in the pouch. During weaning, the number of feeds per day is decreased while proportion of solid foods in the diet is increased. Depending on the future of the animal such as captive maintained or preparation for rehabilitation solid food should be present at all times. Animal destined for captive care should have a variety of food stuffs such as roots, hard vegetables. Those being prepared for rehabilitation should be give natural food stuff such as roots, and fungi.

1.10 Rehabilitation and Release Procedures

Once it is eating independently and is completely weaned, the young bettong may be released. Limiting contact to humans as soon as bottle feeding finishes is essential in the rehabilitation process. Humans should not be associated with food as later in the wild this could be detrimental to the animal. Food should be placed out during the day and animals should be encouraged to be entirely nocturnal as they are in the wild.

Release

There are generally two options of release. They are termed as Hard release and Soft release. Hard release has been used many times with bettongs during reintroduction programmes. Hard release is essentially taking the animal to the chosen area and letting it go. Soft release is more time-consuming. Animals are maintained in an enclosure and when released a opening in the enclosure is created to allow the bettong to come and go as it desires. Food is regularly supplied until the bettong leaves the area to find its own territory or the opening is gradually left closed for longer periods conditioning the bettong to be out for longer and find its own food. Both have their advantages and disadvantages. Hard release may be very stressful and Soft release may cause animal dependency if the bettong wont leave the supplied food area. Delroy et al 1986 found success with bettongs that were raised in captivity and once released a feeder providing roo pellets was maintained for a short while. Bettongs naturally dispersed from the release area over time.

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Appendix

Euthanasia

BRUSH TAILED BETTONG

OH&S:

Not easy to handle

Stress much when being handled and easily injured during capture

2 people required for euthanasia, as one person must restrain the animal.

Cloth bag is used for holding, handheld net for capture.

Recommended:

Overdose i/p barbiturate injection by intravenous if skilled preferably in tail vein

Injection areas include lateral caudal tail veins, cephalic vein in forearm, lateral sphenoids, and tarsal vein in hind limb.

Overdosing anaesthetic gases or carbon dioxide,

Induction of anaesthesia followed by an injection of barbiturate i/n or i/c

Chemical restraint with ketamine+xylazine or zolazepam+lilotamine i/m prior to barbiturate overdose.