

Husbandry Manual
for
TASMANIAN DEVIL

Sarcophilus harrisii

MAMMALIA: DASYURIDAE



(www.tased.edu.au/tot/fauna/devil.html)

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1. Introduction

The Tasmanian devil was once widespread over Australia, but is now found in the wild only in Tasmania. They are the largest living marsupial carnivore, about as large as a small/medium-sized robustly built dog. They are black all over with white marks usually on the chest, but can sometimes be found on the rump as well. The males grow to an average of 10.59kg, and the females to an average of 7kg. The Head and Body length of a male is approximately 63cm, and 57cm for a female.

The name *Sarcophilus harrisii* means “Flesh-lover”, as their diet consists of opportunistically predated fresh meat and carrion. They were one of the first mammals observed by the earliest settlers in Van Dieman’s Land, and was described after Lt George, the first general surveyor for the colony, and its forbidding expression and black colour earned for it the rather severe popular name of Devil or Native Devil (Troughton, E. 1973). Despite its name, appearance and reputation, the Tasmanian devil is a rather shy creature, which is more skilled at finding animal carcasses than killing for itself (this would depend on availability of carcasses, the population density of devils and the type of prey species available).



(www.abc.net.au/science/scribblygum/April2001/default.htm)

2. Taxonomy

2.1 Nomenclature

Class: Mammalia
Order: Polyprotodonta
Family: Dasyuridae
Genus: *Sarcophilus*
Species: *harrisii*

2.2 Subspecies

No subspecies known.

2.3 Recent Synonyms

Nil synonyms.

2.4 Other Common Names

The Tasmanian devil is also known as the Native Devil, or Native Devil of Tasmania. It is a rather distinctive animal, easily defined even from its close relatives.



(www.australianstamp.com/coin-web/feature/nature/tasdevil.htm)

3. Natural History

The Tasmanian devil was once widespread over the whole of Australia, but it is generally accepted that the introduction of the Dingo, around 3,500 years ago, quickly resulted in its extinction through competition. It is now only found on the island state of Tasmania. Tasmania was isolated from the mainland at the end of the last ice age around 12,000 years ago which has meant that dingoes have never pressured its fauna (Strahan, R. 1995).

Great care needs to be taken with the captivity of the Tasmanian devil, and it can be quite challenging to consistently breed these animals away from their native habitat. Research that has been done, or is being done on the Tasmanian devil, is to try and find a cure for the outbreak of a deadly cancer that is having catastrophic effects on the wild population, killing up to 80-90% of adults in high density populations. (See Appendix for more information on Devil Facial Tumours; ABC News Online; Emma Young, Sydney).

3.1 Morphometrics

3.1.1 Mass And Basic Body Measurements

Female Head to Body Length: 57cm

Female Tail Length: 24cm

Male Head to Body Length: 63-65cm

Male Tail Length: 26cm

Height to Shoulders: Around 30cm, the size of a small/medium built dog.

3.1.2 Sexual Dimorphism

Males are larger weighing in at around 8-12kg, whilst females weigh in at around 6-8kg. Body size and mass seems to be the same no matter where the distribution is.

Males have larger, squarer chests and jaw lines where as females have easily distinguished narrow chests and triangular jaw lines. Scarification is also an easy way to distinguish between sexes. Males of breeding age get pronounced scarring on their backs from the female, through mate guarding.

3.1.3 Distinguishing Features

The Tasmanian devil is a unique and distinct animal easily distinguished between individuals and close relatives through the completely individual combination of white markings on its body.

3.2 Distribution and Habitat

Tasmania has the only wild population of Tasmanian devils. All other devils outside of Tasmania live in wildlife parks or zoos. Devils are adaptable animals and can live from coastal habitats right through to sub-alpine and alpine environments. Preferred habitat includes open woodland and dry sclerophyll forests.



3.3 Conservation Status

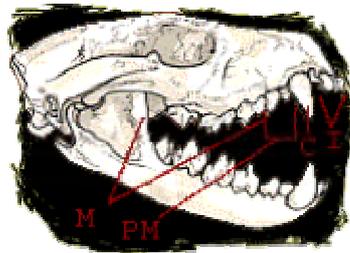
The Tasmanian devil is currently classified as a common and abundant species. Recent occurrences of DFTD, or Devil Facial Tumour Disease, seem to have had an impact on the wild population in areas of high population density. Moves have been made to officially change their conservation status to threatened or endangered.

IUCN status: No Classification

3.4 Diet in the Wild

Devils are opportunistic predators and foragers. They have no favoured prey and will eat anything of animal origin, including insects, amphibians, reptiles, birds and mammals. They have on numerous occasions also been observed consuming berries. Their sense of smell makes them highly skilled at finding carrion and decaying meat, but are also confident predators of prey around 6kg or smaller. Devils will also subdue larger prey that is incapacitated to some degree through injury, disease or age. Their powerful jaws and tooth structure allows them to consume bones, fur and exoskeleton. Much of the devils' food in the wild would also be stolen from other predators, including other devils.

The skull and jaws of the Tasmanian Devil



M- Molars PM- Pre-Molars C- Canines
I- Incisors

(www.evolutionnyc.com/IBS/SimpleCat/Product/asp/product-id/29134.html)

3.5 Longevity

3.5.1 Wild

Devils in the wild live on average to around 5-6 years. In the wild at the moment, Devils are suffering from a terrible debilitating disease, causing cancerous tumors that ravage their faces, necks and internal organs. DFTD tumors can attack the jaw structure making it impossible for the animal to eat, therefore starving to death. The disease seems to affect older male devils, then older female devils, and has not yet been seen affecting devils below the age of 2 years. Little is known about this disease and how long the animal carries the disease in a pre-cancerous state.

(www.dpiwe.tas.gov.au/inter.nsf/WebPages/LBUN-5QF86G?open)



3.5.2 Captivity

Devils live for around 7-8 years in captivity. No devil in captivity has been observed with DFTD.

3.5.3 Techniques Used to Determine Age in Adults

As devils age, they lose hair down the back of the body and along the tail. Hair loss is a natural ageing process, as it is in a lot of mammal species. Extensive scarring to the face can also estimate the age of male devils, as the older males tend to get into confrontation with each other, either around feeding time at a carcass, or around breeding time, when there is much fighting for the right to mate with a female. There is also scarification to the ears and rump, due to noted circumstances. Tooth wear, especially in the molars, is apparent in the older devil, as the teeth wear down faster than they grow (Guiler, E. 1992).

4. Housing Requirements

4.1 Exhibit/Enclosure Design

- Exhibit is designed to provide the basic requirements of the species (EAPA).
- Exhibit is best outdoors and can be fully enclosed (Taronga Zoo).
- Full covered front advisable so no member of the public has physical access to the animals. Glass fronts are available for this.
- Galvanized wire mesh around enclosure and buried to a depth of at least 1 metre and meeting a concrete floor so the animals are able to dig or burrow without escaping (EAPA).
- Nest boxes with sliding doors so keepers can manage the animals in a stress-free environment. This will free the animals from suffering capture stress for any interaction with keepers in zoos (Taronga Zoo). This is for animals that are not bred and hand-raised by keepers.
- A gate on perimeter of enclosure to allow keepers entry, plus double locked doors to promote double security and minimize animals escaping. Inward opening doors to be used only (EAPA)
- Environment as natural as the wild to be included in design such as ponds, natural substrate, climbing logs, rocky areas and soil to dig in (Brown, A. 1997).

4.2 Holding Area Design

- Area must be of suitable construction material, and enough room for the animal to be able to move around in.
- Devils under Veterinary care should be housed in solid walled and floored container with at least 4m² floor that can be covered (Wildlife Regulations, 1999).

4.3 Spatial Requirements

- Must be of sufficient size and allow the animal to avoid, or withdraw from, contact with people and other Devils (EAPA).
- The animal must be provided with sufficient space in all directions to enable it to exercise and encourage behavioural enrichment (EAPA).
- “Minimum enclosure sizes (cm) recommended for a pair of each genus of Australian Mammals. HB-Head and Body Length which is measured from the tip of the nose to the base of the tail; LxB- Length and Breadth required to give the minimum enclosure area; Ratio- ratio between the length or breadth of the enclosure and HB length; Height is the height of the enclosure.
- As recommended by IATA:
 - Genus: *Sarcophilus*
 - Common name: Tasmanian Devil
 - HB (cm): 65
 - Total Length (cm): 90
 - Enclosure Area (cm²): 202,500
 - LxB: 450
 - Height (cm): 150
- Additional floor area for each extra animal (m²): 3.0m x 3.0m (EAPA).

4.4 Position of Enclosures

Enclosures should have a north easterly aspect so that animals can bask in the sun during the day, emulating what the animals would do in the wild. They should be well drained and have high points where the devil is able to stand atop to get aspect (Chris Coupland).

4.5 Weather Protection

Each enclosed individual requires a den. Natural dens include hollow logs, fallen tree root systems, tunnel systems dug by the devil or wombat burrows, rock piles or very dense undergrowth. Within captivity, a combination of man made dens imitating these natural structures works well. This allows the devil to remove itself from inclement weather if it so desires.

4.6 Temperature Requirements

- The enclosure should be well shaded from the heat in summer. A wading pool should be included in the enclosure for the Devil to spend the hotter days wading.
- Spotlights/Infra red lamps may be installed for the colder months in zoos to encourage the Devil to bask under them. These can be placed at the front of the enclosures so that the public still has visual access to them (David Schaap).
- Average temperatures in NSW are much higher than Tasmania and so basking lamps can be an unnecessary addition to devil enclosures, especially if they are given a North Easterly aspect for basking, and have a well structured waterproof den. The colder the area, the more reasonable an addition it may be to the enclosure.

4.7 Substrate

- Enclosures are best built on natural substrate, utilizing natural undulations in Topography and changes in substrate.
- Soil, leaf litter and bark are desirable natural substrates. Unnatural substrates such as concrete will need a dense layer of natural substrate over it to protect the devils delicate feet.
- Natural substrate over unnatural substrate needs frequent replacement to prevent water logging and contamination with urinary and faecal waste.
- Mulched eucalyptus is a good substrate as it is also serves the purpose of a natural anti-bacterial.

4.8 Nest boxes and/or Bedding Material

- Hollow logs allow for nest covering for any part of the day.
- There is a nesting or holding box that can be used for the night if the animal so wishes to.
- The nesting box is also used as a holding box, so the keeper is able to move freely around the exhibit without the danger of attack from the animal.
- Box measurements: 710mm long x 530mm wide x 500mm deep (Taronga Zoo). This box should face NE and have an overhanging roof to prevent rain from entering.
- At Trowunna Wildlife Park in Tasmania, night boxes are not necessary, so dens are required that enable protection against all weather. Bedding is replaced weekly or on a needs basis if it becomes sodden. Fresh straw is used as well as freshly collected dry bracken fern and grass. Bracken is placed within the enclosure to stimulate nesting material collection and construction (Chris Coupland, 2005).

4.9 Enclosure Furnishings

- Devils like to hide in old stumps and logs, underneath rocks, in burrows and amongst dense scrub so some of these must be available at all times. A drainage pipe of an appropriate size can also be provided for privacy (Walraven, E. 1990).
- At Trowunna Wildlife Park, natural furnishings are used, as their enclosures are built upon natural structures.
- Devils also like to climb, especially the young, so climbing apparatus such as branches should be provided (Watts, D. 1987).
- A small pond should be available in the enclosure as Devils are fond of bathing and basking in the sun (Troughton, E. 1973).
- In the wild, Devils favor coastal scrublands and sclerophyll forests with rocky outcrops, so the enclosure must be fitted with an environment resembling as close to this as possible (Brown, A. 1997).
- Living trees with horizontal sloped and vertical stringy bark logs for climbing and privacy should be available at all times.
- Plants are to be non-toxic e.g. Dicksonia (tree ferns), Eucalyptus, Lilly-Pilly, Grevillia (Taronga Zoo). Devils are very hard on natural plantings, so wild collected or established sedges incorporated with enclosure high points allows devils to have aspect without destroying them.
- In wildlife parks, enclosures are much easier built around established plants and trees.
- The enclosure must have naturalistic furniture to aid and encourage normal behaviour (EAPA).
- Furniture may need to be replaced as one sees fit. Devils are very hardy animals and are able to destroy their enclosure furniture at a reasonable pace.
- A Devil must be able to see above the wall of the enclosure, so horizontal trees and mounds in the middle of the enclosure are good to include in the building and design of enclosures.



Captive Tasmanian Devils in an ideal surrounding of natural substrate, and trees and logs for foraging round, climbing on and nesting in.



5. General Husbandry

5.1 Hygiene and Cleaning

- Excrement and other animal wastes are removed on a daily basis to avoid unsightly accumulation for the public to see, and unhealthy accumulation that will attract vermin infestation and disease (EAPA).
- Ponds have drains installed in them to drain water away if the animal has defecated in it, and pumps to fill the pond without keepers having to enter the enclosure to do so (Taronga Zoo).
- Ponds usually cleaned a couple of times a week to give Devils fresh water, and a small bowl elsewhere in enclosure with fresh water daily.
- The use of insecticides and animal poisons in and around enclosures must meet with veterinary advice, and chemical registration and label requirements (EAPA).
- Galvanized wire is buried to a certain depth to prevent vermin such as mice and rats getting into the enclosures. The bottom of and surrounding the bottom of the enclosure is concrete and wire mesh to prevent the above (Taronga Zoo).

5.2 Record Keeping

- Taronga Zoo utilizes the Animal Record Keeping System (ARKS), a DOS computer database program supplied by the International Species Information System (ISIS) organization (Taronga Zoo).
- Each animal in the zoo collection is assigned an accession number that is recorded and stored, with such information as weight, sex, breeding behaviour to name a few, being stored.
- Visual checks are also used, and all data collected is written on an identification sheet, numbered and filed as hard copy. Information such as D.O.B., Sex, Name and Location are a few of the data collected.

5.3 Methods of Identification

- Devils have very different markings so it is reasonably easy to differentiate between different Devils in an enclosure. Identification sheets can be filled out and filed for easy access. Photographs or diagrammatic records can be used to tell the difference between Devils (See Appendix for ID sheet used by Trowunna Wildlife Park).
- Microchips can also be used to distinguish which Devil it is and would last longer than any other form of identification. Trovan microchips with individual number codes are injected subcutaneously between the shoulder blades.
- Males are generally larger than females and their genitalia more noticeable.

5.4 Routine Data Collection

Routine weight checks are collected and are a good way of monitoring the health of the animal. Mothers with young are routinely checked for health, and the young checked for growth and progression.

Devils that are to be transported between institutions are to have a full physical inspection and routine blood samples, which are to be documented and used for any research purpose.

Age and sex are routine data collections that are made on all new animals.

Any successful or unsuccessful methods of breeding the animals are noted every breeding season. Animal behaviour should also be noted so that staff are aware of any stereotypical patterns starting to emerge from the captive devil.

6. Feeding Requirements

6.1 Captive Diet

- Whole small animals such as mice and chickens with bones and skin are given to provide roughage (Walraven, E. 1990).
- Dog kibble is given also to provide roughage (care should be taken with kibble as it is very high in protein and is highly processed containing preservatives and additives. Very high protein can cause Alopecia).
- Clean drinking water must be available at all times.

(Examples of diets are found in Appendix; Taronga Zoo Diet From David Schaap and Trowunna Wildlife Park Diet From Chris Coupland).

Diets differ through the seasons, having 1 captive diet for the Spring/Summer seasons, and 1 for the Autumn/Winter seasons (these are found in Appendix 1).

There are also different diets when it is breeding season to help bring the female into oestrous.

The captive Tasmanian devil diet is similar in most zoos and wildlife parks as the Devil is a carnivore, so its diet is primarily meat and animal carcasses. In some wildlife parks, carcasses such as possum and wallaby obtained from contractors can also be fed as pieces or whole carcasses.

6.2 Supplements

Eggs for protein and raw bones are the only real supplements to the diet. If the Devils are eating whole carcasses, including the skin, fur and bones of an animal, then there is no real need for supplements as they should be getting all the necessary vitamins and minerals from the whole animal.

At Trowunna Wildlife Park, the main supplement they use is for mothers with young. They are fed a “pep” bowl weekly, consisting of grated apple, carrot, dried kelp extract, “body balance” natural vitamin and mineral supplements, a broken egg, mutton bird oil and a very small amount of cat kibble. All this promotes healthy skin and fur and maintains condition whilst gravid and weaning young. Eggs are given sparingly as the egg white can cause alopecia (Chris Coupland).

6.3 Presentation of Food

- Whole animals are given to copy a diet similar to what Devils would find in the wild.
- Carcass feeding and enrichment feeds can be provided in uncovered areas to mimic normal feeding behaviour. Food to be scattered to promote natural foraging behaviour.
- Activity feeds must not promote weight gain or dietary imbalances (EAPA).
- Feeding can occur at any part of the day or evening so as to break the animal from pacing with the anticipation of a next meal (Taronga Zoo).

7. Handling and Transport

7.1 Timing of Capture and Handling

- Capture and handling is best done first thing in the morning to prevent the animal suffering from Capture Myopathy (Taronga Zoo).
- Capture and Handling should be done as quickly as possible to prevent capture stress and prevent any injury to animal and keeper alike.

7.2 Catching Bags

- Canvas or hessian bags are used as catching bags. A hole can be made at the bottom corner of the bag for the devil to be able to put only the tip of its nose through. Once in the bag, the top should be twisted to prevent the devil from escaping.

7.3 Capture and Restraint Techniques

- Devils are best grasped by the tail and transported in a hessian sack for any movement (Walraven, E. 1990).
- Grasp the tail as close to the base as possible and hold the animal away from the body (Taronga Zoo). Gloves are advisable.
- Whilst holding the animal at the base of the tail, the second hand can be used to hold under the forelimbs in a pistol grip. The thumb and index fingers should be held under the forelimbs to help support the weight of the animal (Chris Coupland).
- Training the animal to come to the nest box for food may make capturing easier.
- Some animals that have been born and bred in captivity, and used as exhibit animals, may be able to be handled much easier than those that have been kept in as wild a state as possible. Those born and bred in captivity usually make much better exhibit animals than those that have not been.
- For anything involving touching or handling the animal for a period of time, the animal is best placed in a hessian sack and taken to the veterinarian for a general anesthetic (Taronga Zoo). Great care needs to be taken with anaesthetics as devils have an unusually high tolerance to them. Therefore, most handling should be done without the use of anaesthetics.

(Examples of capture and restraint techniques are found in Appendix).

7.4 Weighing and Examination

- Weighing is best done as soon as the Tasmanian devil is captured and placed in to a hessian bag (Walraven, E. 2004).
- Best done when the devil is not so active such as the daytime, but must be aware of the temperature, being inside a hessian bag for an extended period of time.
- Weigh scales are best when hanging so the hessian bag can be hooked on to the scales. The devil therefore cannot move around very much as they would on the floor or on a weigh table (Taronga Zoo).

7.5 Release

- This is done by facing the opening of the hessian bag away from keeper and towards a run of space, as the animal will usually dart straight out from the bag (Taronga Zoo).
- Keepers to have equipment such as a broom on hand in case the animal turns towards the keeper once they are out of the hessian bag. Also, a second keeper can be on hand should the first need any assistance.
- Preferably done out of the public eye.

7.6 Transport Requirements

7.6.1 Box Design

- Made from metal or wood, tin lined with an upward sliding door.
Measurements are as follows:
 - 1yr old + 690mm long
 520mm high
 395mm wide
 - Joeys 400mm long
 300mm high
 650mm wide
- Double boxes accepted for joeys (IATA).
- Other materials used include wire mesh, sheet metal, fiberglass, rigid plastic, strong welded wire mesh, and nylon mesh (IATA).
- Wire meshed ventilation openings, with a diameter of 2.5cm (1 inch), must be present on the sides (IATA).
- Containers must be marked with the following (IATA)
 - **LIVE ANIMALS**
 - **THESE SPECIES BITE**
- Space per animal: 1,400cm², 30cm high (IATA).
(See Appendix for full illustrations and guidelines).

7.6.2 Furnishings

- Oaten Hay is supplied for the base of the box (Taronga Zoo).
- Western Australia does not allow hay or straw to cross into their state, so shredded paper is used to transport the animal into Western Australia (IATA).

7.6.3 Water and Food

- If journey is less than 24hrs, the animal does not need additional feeding or watering (IATA).
- If feeding is required, the animal must be provided with pieces of raw meat, a little fish or dog food and milk or water (IATA).

7.6.4 Animals per Box

- One animal per box unless the box is a double and is built for joeys only (IATA).

7.6.5 Timing of Transportation

- The animal should be captured in the morning to prevent capture myopathy and therefore transport should be started straight after capture (Taronga Zoo).
- The time an animal is captured and transported to its destination should be minimised (EAPA).

7.6.6 Release from Box

- Should be done as quick as possible and preferably out of the public eye.
- Should be done in an open area of the enclosure similar to that when releasing an animal from a hessian sack (Taronga Zoo).
- Staff to have some sort of mechanical protection with them, such as a broom, to protect them from any devils that may change the direction of their escape.
- Can be left for the animal to remove itself from the box when it feels comfortable to do so.

8. Health Requirements

8.1 Daily Health Checks

- Distant exams are done every day, looking for fur loss, parasites, skin condition, the animals' body condition and their eyes for any cloudiness, redness or discharges (Taronga Zoo).
- Fur loss down the base of the tail is common among the older Devils, especially those over the age of 3years. This is because the tail diameter expands due to visceral fat deposition and can look furless, as the gap between the hair follicles expands. Devils over the age of 3years are also less likely to grow new fur on the tail if it is lost due to the ageing process (Chris Coupland).
- Look for signs of vomiting and diarrhea around the enclosure which could show ill health.

8.2 Detailed Physical Examination

Whilst the animal is restrained, you should start at the head and work your way down each leg to the foot.

- HEAD - Check the eyes and nose for any discharges.
 Check the teeth for any breakages or gum infections. Teeth can split or break due to diet or fighting with other devils.
 Check the ears for any parasites invading the inside of them, and for any splits or rips from other devils.
 Check for parasites.
- BODY - Check for parasites.
 Check for any injuries, open wounds and fur loss.
- LEGS &
FEET - Check for parasites and fur loss.
 Check for and injuries or open wounds.
 Check in-between toes for any wounds or split nails from digging.

8.2.1 Chemical Restraint

(See Appendix for information on Chemical restraint, P.Holz, Healesville Sanctuary).

8.2.2 Physical Examination

- Visual checks should be done daily whilst cleaning enclosures or at feeding time.
- Physical examinations include a whole body examination, starting with the head and working down to the tail.
- At the head you should be checking the nose, ears and eyes for any change in colour or discharges, and the mouth for any gum or teeth problems.
- The body and tail should be checked for any unusual lumps due to bites from other devils, scratches from knocking against enclosures, and any parasites that may be noticeable.
- Feet should be checked for any cuts or bruising on the pads and in-between toes, and claws checked for any tears, or rips around cuticles.

8.3 Routine Treatments

- Devils are prone to putting on weight so monthly weight checks are attended. Any abnormalities are reported to the Head Keepers (Taronga Zoo).
- A Devil stores fat in its tail and its diameter is a good indicator as to the health of the animal (Strahan, R. 1995).
- Monthly parasite control measures should be taken for endoparasites and ectoparasites.

8.4 Known Health Problems

- Devils in captivity suffer mainly from weight gain, and fur loss, or Alopecia, secondary to parasites.
- Staff monitor the animals' weight monthly and attend to daily health checks for parasites (Taronga Zoo).
- Preventative treatment: Monitoring oral intake to prevent weight gain. If an animal gains weight, they are placed on a weight reduction diet until they are within a healthy weight range for their sex.
- Devils are placed on the parasite preventative 'Program' to reduce or exclude the occurrence of ectoparasites such as fleas, ticks and mites and endoparasites such as worms (Taronga Zoo).
- External and Internal Parasite treatments attended to once a month.
- Devils also suffer bite marks from other devils in the same enclosure, and these must be checked as these lumps can become cancerous tumours from the trauma suffered to the body tissue.
- Devils also suffer from teeth problems, as their diet consists of crunching through hard bones. They can suffer from wear and tear to the teeth, and in some cases may need to have teeth removed, due to breaks or even bacterial infections.

8.5 Quarantine Requirements

- Animals are quarantined for a number of reasons:
 - Avoid introduction of infectious agents
 - Allow new animals time to become accustomed to their new surroundings and diets
 - Allow veterinary staff to perform procedures such as immunization, physical examinations and laboratory tests, to name a few.
- Length of quarantine depends on species, disease potential, and facilities available. Mammals are generally quarantined for a minimum of 30 days (TAFE NSW, 2001).
- Quarantine facilities should be situated away from the rest of the collection, in a separate building.
- If separate buildings are not available, then the quarantined animal should not be housed with any other animal and should not come in to contact with any other animal.
- Hygiene procedures should be used to prevent cross contamination to the other animals in quarantine, the other animals in the collection, feral animals and humans (TAFE NSW, 2001).

9. Behaviour

9.1 Activity

- Tasmanian devils are mostly nocturnal, active from dusk to dawn (Parish, S. 2003)
- They spend a lot of time foraging for carrion, so this type of activity should be encouraged within the enclosure.
- They enjoy wading in water so a shallow pond should be available, and enjoy basking in the sun at times, so a heat light should be installed for the colder and winter months, or parts of the enclosures should be open to the sunlight.
- Climbing branches should be within the enclosure, as devils like to climb small branches, especially the young (Strahan, R. 1995).
- Enrichment foods such as bird eggs can be placed on branches to promote their natural climbing behaviour.

9.2 Social Behaviour

- Tasmanian Devils are solitary animals but will show partial social tendencies, particularly when in high population densities in the wild.
- They are intra-specific klepto-parasites (regularly steal from their own species) and will often approach another devil within their interlapping home ranges to interact and dismember a carcass. This not only allows devils to eat small prey but also effectively dismember large mammalian prey (Chris Coupland).
- Devils also share latrine sites in the wild where they share chemical 'messages' by urinating, defaecating and dragging their cloaca around the site.
- Devils are also observed together during oestrous as they compete for mates.
- Devils that have been bred in captivity, and socialised early on in their lives are easily housed with other devils.

9.3 Reproductive Behaviour

The reproductive behaviour in females is usually defined by the development of a retained fluid roll on the nape of the neck. She will also show signs of lethargy and a disinterest in food, but a promotion in nesting behaviour. The males will become more energetic and feisty as they catch the scent of the female in oestrous.

9.4 Bathing

Devils like to bathe in shallow ponds and this should be available to them at all times. Devils are rather clean animals and will use their front paws to wash their face just as a cat does. They cup their hands, lick them thoroughly and then rub their heads, whilst sitting on the haunches and tail (Grzimek, Dr. B. 1972).

9.5 Behavioural Problems

- Males usually don't allow the female to feed during the mating period which has been recorded to last nearly as long as 2 weeks. This can cause deterioration in weight and health of the female and calls for the separation of the two by this stage (Taronga Zoo).
- Juvenile Devils are very destructive, and a constant supply of chewing material should be available.
- Stereotypical behaviour includes pacing throughout the enclosure in a circular pattern. As this psychological problem becomes ingrained the diameter of the circle reduces. In the early stages, a simple change to routine or enclosure furnishing can change the animals' subconscious behaviour.
- Placing an obstacle within the path of the stereotypical behaviour may be required to get the animal to revert to conscious thought and problem solving (Chris Coupland).

9.6 Signs of Stress

- A devil that is stressed will wander aimlessly around its enclosure, indicating that the enclosure is not large enough for the devil to participate in normal behaviour, or may not be to the size as outlined by EAPA. It will negotiate a circular pattern around the enclosure often wearing a pronounced path.
- A stressed devil may also go off their food and this problem should be investigated, as there could be some underlying health problem that may need veterinary attention.
- Loss of hair around the tail can also be an indicator of stress, but should be investigated, as it may be a parasitic problem, or dietary or age related.

9.7 Behavioural Enrichment

- Feeding times randomized so the devil is not pacing with the anticipation of its next meal. Devils kept on the light side of peak weight are usually much more inclined to demonstrate stereotypical behaviour as they anticipate feeding times or are frantically looking for food.
- Food items to be hidden to encourage the devil to forage as they do in the wild, and encourage normal food finding behaviour to enrich the animals day.
- Strips of hide and raw bones to encourage the animal to chew and strengthen its jaws, and to occupy the animals' time with normal activity as they would in the wild (Taronga Zoo).
- Bloodsicles (frozen blocks of blood) are a great way of keeping the devils' olfactory senses stimulated throughout the day and don't impact on the animals' diet (Taronga Zoo).
- Devils enjoy wading in water so a shallow pond must be made available, usually filled to the height of halfway up their legs. The animals wade and then retreat to a warm area to groom themselves.
- Devils also like to bask in the sun so a few basking lamps installed can encourage this behaviour even when there is no natural light. Also, if the enclosure or den has a NE aspect it will allow natural basking behaviour.
- Areas of dirt and leaf litter are good for the devil to dig in and hiding food items in amongst the leaf litter allows the devil to forage for food just as they would in the wild.

- Housing devils together is also a behavioural enrichment as it allows them to socialize during feeding times, and they are less likely to show stereotypical behaviour. The animals will mark food and water sources and establish a latrine area, and this also makes for a good public display. Animals that are housed alone are less active and are more inclined to become neurotic (Chris Coupland).

9.8 Introductions and Removals

- Introductions are usually done in the presence of the keeper as fights can break out among a pair of devils if the female is not ready and oestrous.
- Introductions best done in a holding area intended for breeding.
- Introduction done via a slide system, so keepers don't need to handle or restraint any animals. This means that both male and female devil can have access to both enclosures and each other, and can also be sectioned off from each other if necessary (Schaap, D.).
- Introductions obviously done around the breeding season of February through to May and when the female is coming in to oestrous, and removals done when the keeper deems it necessary.
- Removal may need to be done if the female is showing no signs of submission, or the male is causing a health hazard to the female he is mating with.

9.9 Intraspecific Compatibility

- Devils are usually only housed together during the breeding season, which runs from February through to May (Taronga Zoo).
- Devils are normally solitary animals that usually only come together for the breeding season or if they happen to come upon the same carcass in the wild, but there are instances where devils are quite accepting of sharing territory with other devils. Therefore, they are able to be housed with each other if the enclosures meet the EAPA standards for housing more than 1 devil in an enclosure at a time.
- Devils in zoos are usually housed on their own, due to the thought that they are totally solitary, but as previously mentioned can be housed with other devils.

9.10 Interspecific Compatibility

- Devils should not be housed with any other species as they are a predatory animal (Macdonald, D. 2002).

9.11 Suitability to Captivity

- Captive bred animals make excellent exhibit animals, whereas devils that are captured from the wild are very allusive and timid of their surrounds and keepers. Positive reinforcement reduces timidity and allusive behaviour, and allows natural behaviour to develop whilst on display.
- If the animal is able to participate in its natural behaviours, then the animal should show no signs of ill health or distress, and you should have a captive animal living to its full potential and age.

10. Breeding

10.1 Mating System

The mating system in *Dasyurids* is complex. Most females will mate and produce young in their second year, but some females do mate and give birth in their first year. Although a marsupial, they differ from other marsupials by being polyoestrous as well as being super foetal. During the females' oestrous peak she may mate with many males who in turn may father some or all of the offspring in the litter. She will solicit her mate and the success of copulation depends on the reproductive experience of her mate (Chris Coupland).

The female usually starts her oestrous cycle in the second to third week of February, and is 21 days in duration. Mating occurs 4 days either side of the peak which, in the wild, may result in the female mating with a number of males. The male will then guard the female for as long as he can over the 9 day period in order to increase the likelihood of him fathering larger percentage of offspring. During this time, males may fight with other males, and the female whilst trying to block her in the den. This can result in heavy scarification to the males' face and back (Chris Coupland).

Gestation is 21 days and is usually counted from the middle of the mating period in captivity. If the female doesn't conceive, she will go back into oestrous behaviour and continue to cycle and mate until she does. The birthing process usually lasts several hours, and is distinguished by the females' body behaviour with such signs as the balling of the body whilst standing and visual signs of contractions in the abdomen. She can produce up to 50 foetuses, with the average amount at around 18. She will produce on average 2 young in her first year, the around 3 to 4 in her subsequent years. She can only sustain 4 young at most, as she only has 4 nipples. The young develop in the pouch for around 16 weeks, the with their mother for around 20 weeks, staying together as siblings until around 45 weeks (Chris Coupland).

10.2 Ease of Breeding

Devils are short lived, therefore having a short generation time and a complex reproductive cycle. Consistent breeding in captivity requires a well regulated breeding action plan but is achievable. Several age cohorts of males are required to allow the female to successfully solicit what she chooses as the most experienced and genetically stronger male (Chris Coupland).

10.3 Reproductive Condition

10.3.1 Females

- Females need good body condition and nutrition leading up to the breeding season, with a good supply of visceral fat in the tail. Body condition and fat reserves are paramount as focus on food and water become secondary during the oestrous peak and mating period. Females can regularly go for 3-4 days without food or water at this time of the year.
- The female develops a fold of fluid on the nape of the neck. Success of breeding relies on the development of this fold and the submissive behaviour associated with the male grasping this fold. The scruff is used to drag the female back to the den for mating but also to grasp during copulation (Chris Coupland).

10.3.2 Males

- Males need to be in good condition to be able to mate with the female for up to 3 days, and in some cases even longer.
- He must be fit enough to be able to take complete control of the female, be able to drag her to the den and be able to mate with her continuously over the course of approximately 3 days.
- Males also require experience in breeding and may only gain intromission successfully at 3 or 4 years. A female will often mate with an experienced male initially, but young males are often chosen secondarily. A young male may require 1 or 2 years as a secondary mate to refine his solicitation technique and successfully sire offspring (Chris Coupland).

10.4 Techniques Used to Control Breeding

The ASMP studbook requires certain animals to breed in order to maintain diversity of the captive population. Breeding is controlled by removing all males from social groupings, prior to the onset of submissive behaviour, in early March. Throughout January males are cycled through social groupings in order to reestablish social bonds with prospective females (Chris Coupland).

10.5 Occurrence of Hybrids

- There is no occurrence of hybrids as devils are sufficiently separated from their closest relatives for hybridization to be impossible. Devils are also not housed in inter-specific groups.
- Once copulation has ceased, the pair are separated and held in individual enclosures. The female is not returned to a social environment in order to reduce population stress and promote the likelihood of conception.
- Devils are normally housed on their own or in social groupings that, in the breeding season, are manipulated by the keepers in accordance to ASMP recommendations.

10.6 Timing of Breeding

Oestrous behaviour usually begins in the 3rd-4th week of February with the peak and mating behaviour starting in the 2nd week of March. Females will continue to cycle on a 21 day duration until conception (Chris Coupland).

10.7 Age at First Breeding and Last Breeding

Devils don't usually breed till their 2nd year. They can breed in their 2nd, 3rd, 4th and even 5th year for some, but most will miss a year breeding.

10.8 Ability to Breed Every Year

Most females breed 2 out of 3 years. If 2 consecutive years are missed then generally a female will never successfully conceive (Chris Coupland).

10.9 Ability to Breed More than Once Per Year

Devils breed once a year, with females having young with her for up to 10 months. They usually don't start breeding till their second year and usually miss a year of giving birth.

10.10 Nesting, Hollow or Other Requirements

- Females are usually isolated once they have mated. They are placed in an enclosure of their own, and during this time they are quite inactive.
- Nesting material such as straw, hay, bark and mulch are scattered into the enclosure and the female Devil usually makes her own nesting area within the den.

10.11 Breeding Diet

During the 2 month lead up to the reproductive cycle, a female will tend to put on visceral fat in the tail. As females enter oestrous a gorge feed or full carcass feed will often promote the onset of the peak. Mothers with young are fed a 'pep' bowl weekly consisting of grated apple, carrot, dried kelp extract, 'body balance' natural vitamin and mineral supplement, a broken egg, mutton bird oil and a very small amount of cat kibble. This is to promote health of the skin and fur and maintain condition whilst gravid and weaning young (Chris Coupland).

10.12 Oestrous Cycle and Gestation Period

Oestrous cycle and gestation period are 21 days in duration.

10.13 Litter Size

Devils can give birth to 30-40 young, but with only 4 teats, 4 are the maximum amount of young the female devil can sustain.

Female devils usually sustain 2-3 young at a time.

10.14 Age at Weaning

This commences when the young exit the pouch. The mother initially brings the young hide to chew on and incorporate it into the aggressive play. She then starts to bring the young hide with some flesh attached. She will then take her young to a chunk of flesh and allow them to feed. Finally she will allow her young to go to the flesh independently of her. They are usually fully weaned by around 24 weeks of age.

10.15 Age of Removal from Parents

In most cases, the mother should be removed from the young, leaving the siblings together. This happens at approximately 10 months of age. In the wild, the young usually disperse from the mother around 38-40 weeks.

The female is removed from her litter when she has stopped lactating and this is usually when the litters are around 10 months old. Constant handling of the mother is required so that staff are able to observe the pouch and make sure that it is becoming more flaccid and that the teats are shrinking. All offspring except 1 are removed, the 1 young left with her to help her cease lactating. An offspring may have to be returned to her several times until it is known that the mother has stopped lactating. Finally all young are removed and the mother is able to recuperate in her own separate enclosure.

10.16 Growth and Development

Young devils grow very rapidly, leaving their mother at around 10 months of age. They are born in very early development, approximately 1cm. When born, these fetuses (as many as 50 born have been recorded) travel by touch (the young are totally blind at this stage) to the pouch and secure themselves to a nipple. The nipple then swells in the mouth so that the young cannot be removed without being damaged, and this ensures that they do not fall out of the pouch (Guiler, E. 1992).

At approximately 3 weeks old, the ears are appearing on the side of the head, and the whiskers and lips are forming and noticeable. They have lost the slipperiness they once had when first appearing at the teat (Guiler, E. 1992).

At 6 weeks, the young are approximately the size of a walnut.

At 8 weeks, the predominantly pink colour is lost as the skin thickens and pigmentation starts to develop. It starts at the tip of the nose and works down the body, and the individual nature of the markings are becoming apparent.

At 12 weeks, the eyes start to open and the offspring are becoming more aware of their surroundings. They make squeaking noises but are still firmly attached to the teat.

At 16 weeks they exit the pouch and start to play with their siblings.

At 20 weeks the young are weaning and start to play aggressively with their siblings.

At 24 weeks the young are fully weaned.

At 40 weeks they start to become independent of their mother, exploring outside the den without her.

At 45 weeks they are separated from their mother.

At 12 months they are separated from their siblings.

At 24 months they are considered adults and are at the breeding age, where reproductive behaviour begins. In captivity they can be housed in mixed age enclosures.

At 5-6 years, they are at a retiring age from the display enclosures. The ageing process has begun and arthritis starts to set in. They can be housed in an enclosure with other older devils.

At 6-8 years, arthritis is apparent as the body slows down. The pelvis wears, teeth become worn and are susceptible to abscesses and infections. The eyes become cloudy and some sight may be lost. Bite marks become hard and celluloid and are susceptible to developing into tumours. Death usually results at these ages, depending on the animal.



Three young at about 20 days old. The head is still proportionally large but the ears are appearing on the sides of the head, although for sometime they will still be applied to the sides of the head. The rows of whiskers on the face can be distinguished and the lips are forming. The eyelashes have not yet appeared but can be seen as a dark pigmented line on the lids. Devils of this size are becoming easier to handle because they have lost the slipperiness of the very young.

(Guiler, E. 1992)



These two pouch young are grimly holding on to the teat and using their forepaws to grasp their mother's fur.

(Guiler, E. 1992)



The furring is virtually complete by the end of the winter. The completion of furring varies by about a week within one litter.

(Guiler, E. 1992)



August is the beginning of trials for the pouch young. They have grown so much that there is little room for them in the pouch and they have to hold on tightly to the nipple or their mother's fur. Late winter or early spring sees the young left in a den while the mother forages and brings back pieces of food for them. During this time they are alone and virtually defenceless and liable to be eaten by any wandering devil, tiger cat or other predator. The most severe weather of winter is in July-August, particularly in the highlands which have heavy rain and often snow on the peaks. This is a time of hardship for most native animals as food is scarce. Devils may fare better than most other species since, being carrion eaters, they devour other animals which have perished and in doing this they clean up the bush. Dead animals, including devils, are seldom seen except on roads where they have been run over by vehicles.

(Guiler, E. 1992)



In October the young are quite unafraid and are easy to handle, apart from a strong tendency to wriggle.

(Guiler, E. 1992)



(www.animalpicturesarchive.com/list.php?qry=Tasmanian%20devil)



Tasmanian Devils make very good mothers.

11. Artificial Rearing of Tasmanian Devils

11.1 Housing

To be kept in a bag resembling the mothers pouch. Wool linings are acceptable as they are a natural fibre and a breathable material. These linings can be kept inside a hessian shoulder slung bag that the keeper must keep on them at all times.

11.2 Temperature Requirements

Nil artificial temperature requirements needed. To be kept at body temperature.

11.3 Diet and Feeding Routine

Divetelact is used whilst the young are being bottle-fed. When the young are close to weaning, it is advisable to start putting blood in the Divetelact mixture. Once the young start coming out of the pouch they will start to lap up the mixture. You should then start introducing chunks of mince to them, as this is softer for them than pieces of meat. The content of the food should then change by decreasing the amount of milk mixture and increasing the amount of meat. Before being fully weaned they should be lapping up water. Pieces of hide can also be incorporated into the diet. The diet should be controlled to resemble the wild weaning period.

11.4 Specific Requirements

If possible, young should be raised together with siblings, or at least with other young devils from separate litters.

11.5 Data Recording

The weight of the young should be recorded weekly to make sure that the animal/s are putting on weight. The individual ID and the progression of each animal needs to be recorded. Any health issues and their treatments need to be recorded as well.

11.6 Identification Methods

Devils are identified using their colours and markings, and differing between sexes. They are also microchipped as a permanent ID. See Appendix for ID methods.

11.7 Hygiene

Main hygiene cares are the changing of pouch liners, which need to be washed with natural based cleaners. Natural fibres are best for liners. There are no real hygiene problems with devils. The only problem is if the animal has diarrhea from the change of diet or incorrect diet for the age of the animal, then warm water only should be used on the animal.

11.8 Behavioural Considerations

Young devils grow up with siblings usually and this should apply when hand-raising orphaned devils. They should be raised in sibling awareness, and these usually make the best exhibit animals. They are usually nocturnal so most feeding should be attended to throughout the night. Young devils are also aggressive chewers so there should be some chewing apparatus available for them.

11.9 Use of Foster Species

No foster species can be used.

11.10 Weaning

Devils are fully weaned by the age of ~ 10 months (38-40 weeks). See 11.3 Diet and Feeding Regime for weaning process.

11.11 Rehabilitation and Release Procedures

Devils should be released back to the same area that they were rescued from. If unavailable then a local release should be done so that their progress can be followed. You should isolate the devil for around 3-4 weeks, whilst also decreasing contact with them. The devil should have a gorge feed before release so if the animal does not find food for a few days then it will have less of a chance of starving. They should be released at dusk as this is their most active period, and they will have time to find food and shelter throughout the night. Unfortunately rescued devils are no longer able to be released at this point in time secondary to the outbreak of DFTD.

12. Acknowledgements

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16. Glossary

- **Alopecia-** Hair loss
- **Apparatus-** Tools or equipment for doing work or for a special purpose
- **Bloodsicles-** Frozen blocks of blood that is used as enrichment for carnivores
- **Capture Myopathy-** A condition involving muscular wasting and partial paralysis which affects some wild animals when captured; also called overstraining disease.
- **Carcass-** The body of a dead animal
- **Carrion-** Putrid flesh
- **Catastrophic-** Disastrous, a culmination of a tragedy
- **Debilitating-** Feebleness, weakness
- **Diagrammatic-** Drawing, figure of lines, an illustrative figure in outline
- **Galvanized-** Covered with a protective zinc coating
- **Hybrid-** Crossbreed, offspring of two animals of different species
- **Juvenile-** Young, youthful, immature
- **Oestrous-** Coming into the reproductive cycle in reproductive organs, involving the female hormone oestrogen
- **Olfactory-** Of smelling, involving the sense of smell
- **Quarantine-** Isolation to prevent the spread of infectious agents, or disease
- **Ravage-** Devastation; destruction of
- **Robustly-** Sturdy, strong
- **Rump-** Tail end, buttock
- **Sclerophyll-** Of woody, evergreen vegetation; having leaves that are hard and tough, and usually small and thick, so reducing the rate of loss of water.
- **Substrate-** Layer of earth lying under another
- **Vermin-** Injurious animals, pests; noxious animals or insects

17. Appendix

Timeline for Maintenance Activities

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BREEDING SEASON		■										
ENCLOSURE REPAIRS	■											■
ENCLOSURE RENOVATIONS							■					■
FULL CLEANING OF ENCLOSURE	■											
ROUTINE HEALTH CHECKS Monthly	■											
ANNUAL VET CHECKS	■											

- Breeding season between February to May
- Enclosure Repairs done over December/January when the young are taken from the mother to travel to different enclosures or institutions.
- Enclosure Renovations are done July and December, before the young are ready to disperse from the mothers pouch and when the young are being removed from the enclosure.
- Full Cleaning of Enclosure done in January after the young have left the mother and before the breeding season starts again.
- Routine Health Checks done monthly (see Chapter 8).
- Annual Vet Checks attended to in January after the young have left the mother and before the breeding season starts again.

Devil disease appears to be spreading. 11/11/2004. ABC News Online



[ABC Online](#)

Devil disease appears to be spreading. 11/11/2004. ABC News Online

Last Update: Thursday, November 11, 2004. 8:21am (AEDT)



Devil disease appears to be spreading

There are concerns that a facial tumour disease afflicting the tasmanian devil has spread.

It is feared a tasmanian devil run-over near Cradle Mountain has facial tumours characteristic of the disease.

Under threat: It appears the cancer is spreading across Tasmania.

So far the cancer has been found in devil populations in the north and north-east of the state, as far south as Judbury and as far west as Bronte Park and Derwent Bridge.

Until yesterday, there was no evidence of the disease in the far north-west and west coast.

Manager of the Devil Facial Tumour Disease Project, Alistair Scott, says if the devil is confirmed to have had the disease, it would be Tasmania's western-most case.

He says samples are being examined at the Animal Health Laboratory.

Keeping western Tasmania free of the disease is considered pivotal to managing the fatal condition.

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NewScientist.com

Facial tumours kill off Tasmanian devils

16:45 25 October 03

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A mysterious disease has wiped out 90 per cent of some populations of Tasmanian devils in the past three years. The facial tumours may have killed one third of the Australian island's total population, a workshop in Tasmania heard last week.

Scientists fear that the problem is having knock-on effects on other species. Although Tasmanian devils are mainly scavengers, they also eat sick or small mammals and a range of invertebrates.

"These animals are very important in the whole ecology of Tasmania," says the meeting's organiser, Rick White from the University of Tasmania in Hobart. Reports suggest there are more than the usual number of carcasses of wild animals such as wallabies in areas where devil numbers have fallen.

And the number of cats seems to be increasing. Farmers have reported an increase in lambs aborted due to toxoplasmosis infection, which is carried by feral cats.

Retrovirus suspect

The first confirmed cases of facial tumours in Tasmanian devils were reported in the late 1990s. New studies suggest that 50,000 of the 150,000 devils alive a few years ago have died from the disease.

Tumours normally first appear around the jaw and neckline, and the consensus is that a retrovirus is the most likely cause. Scientists are trying to identify the agent involved.

Bryan Green, Tasmania's environment minister, has organised a task force to tackle the problem. One suggestion is to boost numbers of devils held in captivity on mainland Australia to create a sustainable population. But as there is no test for the disease, transferring animals from Tasmania to Australia might contaminate mainland populations.

One positive piece of news is that in areas where devil numbers have plummeted, such as eastern Tasmania, the disease has a much lower transmission rate. Historical records also suggest there have been three previous massive declines in devil numbers in the past 140 years.

White says it is possible that the disease is latent in the animals, and appears only above a certain population density. If so, the population might stabilise and eventually recover.

Emma Young, Sydney

[Return to news story](#)

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Trowunna Wildlife Park

Tasmanian Devil Identification and History Proforma

Stud Number:

Sex:

D.O. B (if known):

Sire:

Dam:

Location:

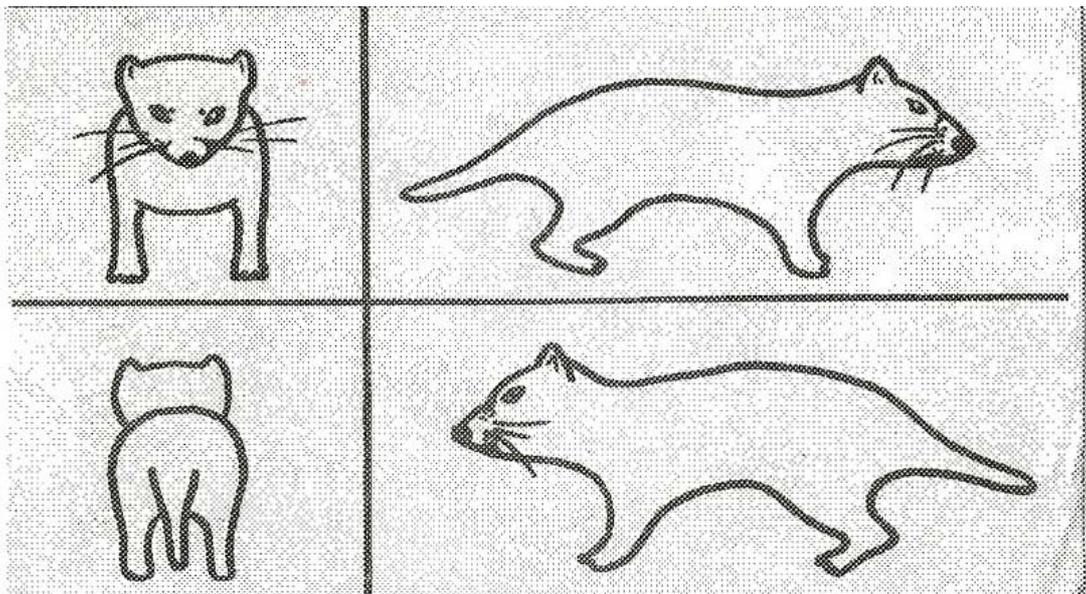
Date:

Local ID:

Event:

Devil Name:

Markings:



Comments:

Example of Tasmanian Devil Diet at Taronga Zoo

Summer Diet (October–June) Diet below is per animal

Monday	100gms cubed meat	
Tuesday	2 Chicks	1 Bone
Wednesday	1 Chick	1 Rat
Thursday	2 Chicks	1 Egg
Friday	1 Mouse	½ Rabbit
Saturday	Starve Day	
Sunday	1 Chick	1 Bone

Winter Diet (July – September) Diet below is per animal

Monday	200gms cubed meat	
Tuesday	2 Chicks	1 Egg, 1 Bone
Wednesday	2 Chicks	1 Rat
Thursday	2 Chicks	1 Bone
Friday	2 Mice	½ Rabbit
Saturday	Starve Day	
Sunday	2 Chicks	1 Bone

Feeding Regime At Trowunna Wildlife Park

Fed Daily With 1 Fast Day Routinely A Week

1 large chunk or 2 smaller chunks of wallaby or rabbit. The animal carcass is brought to the park partially gutted, and is cut into the torso piece and 2 leg pieces prior to delivery.

The carcass pieces are then cut into fist size chunks. These are hand fed to the animals as enrichment. The holding of the meat reduces timidity towards the keeper and encourages natural pulling behaviour and dismemberment of the carcass.

Male and female devils without young are fasted once a week on a rotational basis between enclosures. These devils are fed apples to incorporate vegetable matter into their diet.

Full carcass feeds promote social behaviour between the devils and occurs regularly at the park. Devils are fasted the day before and then allowed to interact in a natural social setting, dismembering the carcass overnight.

Devils can eat up to 40% of their own body weight in 1 sitting, so these devils are usually fasted again for 1 or 2 days after the gorge feeding to allow digestion and encourage activity.

Devils are also fed small thumb sized chunks spread around the enclosure to promote foraging behaviour. These chunks are spread over branches, in hollow logs and among other enclosure furniture to allow exploration and natural foraging behaviour.



Capture, Handling and Weighing Techniques

Source: David Schaap, Australian Mammal Keeper, Taronga Zoo



Capture, Handling and Weighing Techniques

Source: David Schaap, Australian Mammal Keeper, Taronga Zoo

Container Regulations according to IATA



Container Requirements

CONTAINER REQUIREMENT 79

The illustrations shown in this Container Requirement are examples only. Containers that conform to the principle of written guidelines for the species but look slightly different will still meet the IATA standards.

Applicable to:

<i>Carnivorous</i>	<i>Herbivorous</i>	
Desman	Agouti species	Moonrat
Ermine	Chinchilla species	Muskrat
Ferret species	Gopher	Nutria
Fox (farm)	Guinea pig	Paca
(also see	Gundi	Pacarana
Container Req. 82)	Hamster	Pika
Marten species	Hare	Rabbit species
Mink	Hutia	Squirrel species
Sable	Lemming	Tuco-tuco
Solenodon	Marmot	
Stoat		
Tasmanian devil		

See USG Exceptions in Chapter 2 and Exceptions BA-02, CX-01/02, GF-01, IB-01 and OS-02 in Chapter 3.

Note 1: Mink are to be housed in individual compartments of the container.

Note 2: Normally one animal per compartment unless the animals are used to co-habiting.

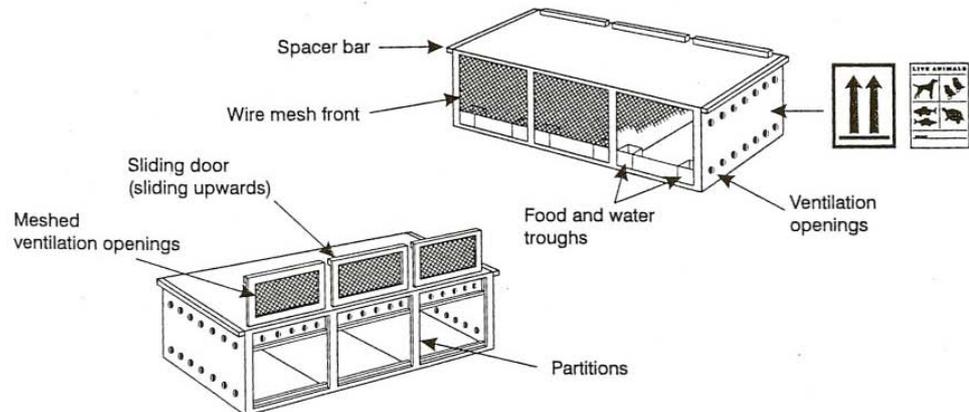
1. CONTAINER CONSTRUCTION

(see Exception QF-01 in Chapter 3)

Materials

Wood lined with wire mesh, sheet metal, fibreglass, rigid plastic, strong welded wire mesh, wire mesh, and nylon mesh.

EXAMPLE:



Principles of Design

The following principles of design must be met in addition to the General Container Requirements outlined at the beginning of this chapter.

Dimension

When constructing travel containers for these species the normal habits and movement must be considered, they must be able to move around freely. The size of the container will vary with the species, refer to the density guidelines in this Container Requirement. Multiple compartmentalised containers must have individual access doors.

Frame

The strong weld mesh lining can form an internal cage round which the outer casing of wood or other suitable material is constructed. When the frame is made from solid wood, it must be screwed together. The frame can also be formed by the wooden base, sides and top of the container being screwed together and then lined with weld mesh, if the weight of the animal permits this type of construction.

Sides

The sides and door must be made of metal sheet, weld mesh lined wood or plastic. One third of the front of the container must be made from weld mesh. Containers made without a wire mesh liner must have wire meshed screening over all ventilation openings.

Wire meshed ventilation openings, with a diameter of 2.5 cm (1 in), must be present on the sides. Curtaining may be required for some species, this can be provided by nylon mesh or other similar material which will reduce the amount of light within the container but allow good ventilation.

CONTAINER REQUIREMENT 79 (cont'd)**Floor**

The floor must be solid and leak-proof, it must be covered with a layer of absorbent material, such as wood shavings, for bedding.

Roof

Must be made of solid sheet metal, wood or plastic.

Doors

A sliding door must be provided at the rear of the container to give access into the container. Each compartment of a container must have its own sliding door. All doors must be provided with a secure fastening so that they cannot be opened accidentally.

Ventilation

- △ Ventilation is provided by wire mesh at the front of the container and wire meshed ventilation openings, with a minimum diameter of 2.5 cm (1 in), which must be present on the sides. When non-wire lined containers are used any internal sharp edges from the wire mesh must be covered with smooth material.

Spacer Bars/Handles

Must be made to a depth of 2.5 cm (1 in), must be present on the sides of the container as shown in the illustration.

Feed and Water Containers

Metal food and water containers must be provided, they must fitted into the wood/plywood at the front of the container and be fixed to the uprights of the framework so that they cannot be moved by the animal, there must be a means of outside access for replenishment. Soldered tin must not be used.

Rigid Plastic Pet Containers
(see Container Requirement 1)

Rigid plastic pet containers can be used for the air transport of small numbers or individual animals. The following modifications must be undertaken:

- the height and width of the container must allow the animal to stand in a natural position, turn around and lie down comfortably;
- the floor of the container must be made non-slip before being covered with absorbent bedding;
- the grill door and all ventilation openings must be covered with fine wire mesh, if this is fixed on the inside, all edges must be protected and made smooth. The door must be fixed shut at both the top and the bottom in such a manner that it cannot be opened easily;
- food and water containers must be fixed inside the container and have outside access for replenishment;
- the container must be correctly labelled.

- If a container has wheels, they must be removed or rendered inoperable.

2. PREPARATIONS BEFORE DISPATCH

(see Chapter 5)

Squirrels must be given a piece of sacking from which to make their own bedding.

3. FEEDING AND WATERING GUIDE
(for emergency use only)

Animals do not normally require additional feeding or watering during 24 hours following the time of dispatch.

If feeding is required due to an unforeseen delay, the carnivorous species must be provided with pieces of raw meat, a little fish or dog food and milk. The herbivorous species must be provided with carrots, fruit, nuts or grains. The shipper's instructions must always be followed.

Note: Laboratory and SPF animal containers must not be opened, therefore, these animals must be fed under scientifically controlled conditions. A viewing panel must be incorporated into the container of SPF animals.

4. GENERAL CARE AND LOADING
(see Chapters 5 and 10)

Animals known to be for laboratory use must be separated completely from other animals to reduce any risk of cross-infection or contamination, e.g. specific pathogen free (SPF) consignments.

Mink, when disturbed, give off a strong feral odour which will contaminate other loads.

When animals are to be carried in quantity, maintain proper separation of cartons in the aircraft. Care must be taken that there is adequate air circulation throughout the stacks and the boxes are secured in a manner which will prevent them from toppling during flight.

Warning: These species bite.

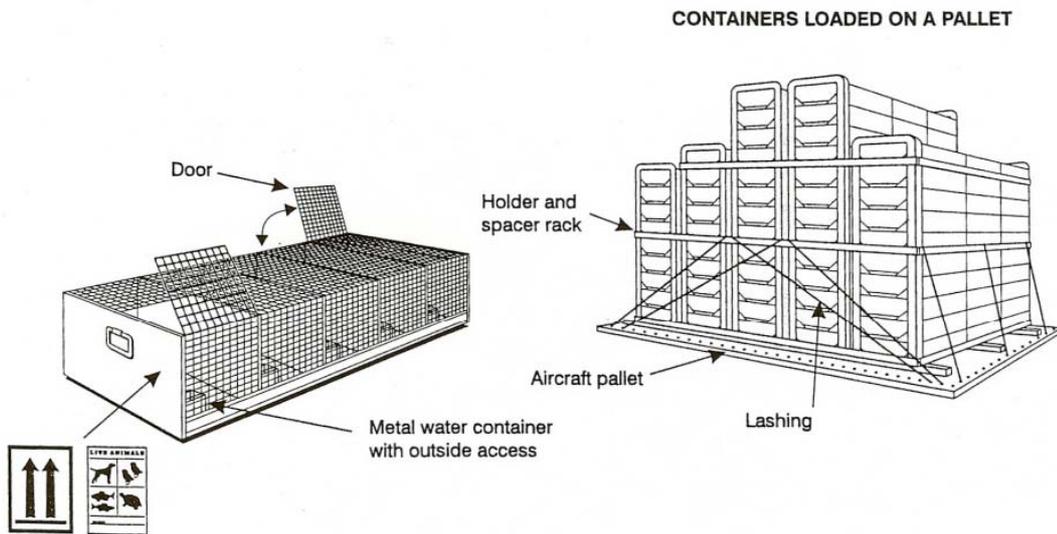
CONTAINER REQUIREMENT 79 (cont'd)

DENSITY GUIDELINES						
Species	Weight of Animal (grams)	Maximum Number per Compartment in Container *	Space per Animal		Height of Box	
			cm ²	in ²	cm	in
Chinchillas	450-550	2 **	260	40	23	9
Hamsters	Young	18	32	5	13	5
Smaller Animals	170-280	12	90	14	15	6
	281-420	12	160	25	15	6
	421 or more	12	230	36	15	6
Larger Animals	2,000 or less	4	770	120	20	8
	2,001-5,000	2	970-1,160	150-180	25	10
	5,001 or more	1	1,400	220	30	12

* If ground temperature exceeds 24°C (75°F), reduce maximum number per compartment in the container by 10%.

** If ground temperature exceeds 24°C (75°F), allow 520 cm² (80 in²) per animal. A temperature in the box of more than 27°C (80°F) is liable to be lethal to chinchillas.

EXAMPLE:



Restraint and Anesthesia of Dasyurids (*Dasyuromorphia*) (14-Aug-2002)

P. Holz

Healesville Sanctuary, Healesville, Victoria, Australia.

Introduction

Dasyurids represent the carnivorous marsupials that range in size from the narrow-nosed planigale (4 - 9 g) up to the Tasmanian devil (up to 9 kg). Table 1 lists all the dasyurids with their weights. They have four pairs of upper incisors, three pairs of lower incisors, well developed upper and lower canines, two or three pairs of upper and lower blade-like premolars and four pairs of upper and lower molars with sharp, shearing cusps. The forefeet have five clawed toes, the first toe on the hindfoot is either short or absent, and the second and third toes of the hindfeet are not fused. This fusion is seen in many of the other marsupial groups, such as the macropods and possums.

The number of teats ranges from four to twelve. Many species lack a pouch. In phascogales eight teats are situated on a circular patch of skin on the abdomen. In other species low lateral folds develop at the sides of the mammary area of a lactating female. These folds do not constitute a pouch in the strict sense and provide very little protection for the young which, as they develop, dangle from the mother's belly between her fore- and hindlegs. A permanent pouch is present in most ningauis, kultarr, spotted-tail quoll and Tasmanian devil.

Manual Restraint

Wild animals perceive handling as a major stressor usually associated with being killed. Consequently, manual restraint is only used for minor procedures or prior to the induction of general anaesthesia. Any attempt at physical restraint will result in considerable panic and struggling on the part of the animal which will activate the "fight or flight response". This will lead to a release of catecholamines that may result in untoward effects such as hyperthermia or ventricular fibrillation.

As well as attempting to escape the animal will try to defend itself. In the case of dasyurids they will endeavour to bite the individual attempting to restrain them. This will result in a minor degree of pain and inconvenience when caused by an antechinus or dunnart, but the larger members of the group, such as the Tasmanian devil, can inflict severe injuries. Considerable care is required when attempting to restrain this last group.

When restraining or transporting dasyurids it is advantageous to place them in a bag. This can range from a pillowcase in the smaller animals up to a large Hessian (Burlap) sack for Tasmanian devils. Animals in bags tend to relax as outside stimuli and visual threats are removed. The chance of injury is decreased, as they cannot kick out against solid objects. It also gives the operator the upper hand as they know where the animal is but the animal does not know where the operator is. Small dasyurids can be gripped by the scruff of the neck and placed in a bag. Alternatively, they can be held firmly around the body (Fig. 1). It is important not to clasp them too firmly as suffocation is possible. Larger dasyurids, such as quolls and devils, can be caught in a net or restrained by the tail and then lowered into a bag. Devils must be closely monitored while in the bag as they can chew their way out.



Figure 1. Manual restraint of an eastern quoll. - To view this image in full size go to the IVIS website at www.ivis.org . -

Chemical Restraint - Gaseous Anaesthesia

This is the anaesthetic technique of choice. If the animal can be manually restrained, the safest way to induce general anaesthesia is via a non-rebreathing circuit (e.g., Ayre's T-piece), and a mask (Fig. 2). Masks can be custom made using variably sized plastic bottles. The bottom is cut off and a piece of rubber glove is stretched over the opening. A hole is then made in the glove to accommodate the animal's face. For animals in bags anaesthesia can be induced either through the bag, or by extracting the head and placing it in the mask.

Induction involves exposure to 5% isoflurane delivered at an oxygen flow rate of 200 ml/kg/min with a minimum of 1L/min. Maintenance of anaesthesia generally requires 2% isoflurane, but this varies between species and individuals.

If isoflurane is unavailable halothane is an acceptable substitute, but is not as safe and requires close monitoring.



Figure 2. Tasmanian devil maintained on isoflurane with a facemask. - To view this image in full size go to the IVIS website at www.ivis.org . -

Chemical Restraint - Injectable Anaesthesia

If the animal cannot be restrained to induce gaseous anaesthesia it will require an injectable induction. Sedation suitable for transport will occur after 1 - 2 mg/kg diazepam is injected intramuscularly.

To induce general anaesthesia Zoletil (Telazol) can be injected at 10 mg/kg intramuscularly [1]. Zoletil is a combination of tiletamine and zolazepam. The advantage of Zoletil is its low volume and rapid effect. However, relaxation is variable, constant limb movement having been observed in Tasmanian devils. Recoveries can also be prolonged, in excess of six hours in one Tasmanian devil [2]. Alternatively, xylazine/ketamine combinations can be used. Dose rates are 4 mg/kg xylazine combined with 20 mg/kg ketamine injected intramuscularly.

Venepuncture Sites

Ventral coccygeal vein - Insert the needle perpendicular to the tail, in the ventral midline, and advance it until the vertebrae are reached. Withdraw the needle slightly and blood should enter the needle hub. This vein is useful for smaller dasyurids (Fig. 3).

Femoral vein/artery - Direct the needle at the pulse felt in the groin region. Arterial blood is often obtained and digital pressure is required to prevent hematoma formation.

Medial metatarsal vein - This is a small vein running along the medial aspect of the hindleg.

Cephalic vein - This vein is present on the dorsal surface of either foreleg. It can be used in Tasmanian devils and quolls.

Jugular vein - This vein is suitable for blood sampling in all dasyurids.



Figure 3. Ventral coccygeal vein in an antechinus. - To view this image in full size go to the IVIS website at www.ivis.org . -

Common Name	Scientific Name	Weight - Male	Weight - Female
Mulgara	<i>Dasyercus cristicauda</i>	75 - 170 g	60 - 95 g
Little Red Kaluta	<i>Dasykaluta rosamondae</i>	25 - 40 g	20 - 30 g
Kowari	<i>Dayuroides byrnei</i>	85 - 140 g	70 - 105 g
Western Quoll	<i>Dasyurus geoffroii</i>	710 - 1310 g	615 - 1130 g
Northern Quoll	<i>Dasyurus hallucatus</i>	400 - 900 g	300 - 500 g
Spotted-Tailed Quoll	<i>Dasyurus maculatus</i>	370 - 550 g	340 - 420 g
Eastern Quoll	<i>Dasyurus viverrinus</i>	900 - 2000 g	700 - 1100 g

Common Name	Scientific Name	Weight - Male	Weight - Female
Southern Dibbler	<i>Parantechinus apicalis</i>	60 - 100 g	40 - 75 g
Northern Dibbler	<i>Parantechinus bilarni</i>	20 - 40 g	15 - 35 g
Fat-Tailed Pseudantechinus	<i>Pseudantechinus macdonnellensis</i>	25 - 45 g	20 - 40 g
Carpentarian Pseudantechinus	<i>Pseudantechinus mimulus</i>	14 - 18 g	14 - 25 g
Ningbing Pseudantechinus	<i>Pseudantechinus ningbing</i>	20 - 25 g	15 - 20 g
Woolley's Pseudantechinus	<i>Pseudantechinus woolleyae</i>	35 - 50 g	30 - 45 g
Tasmanian Devil	<i>Sarcophilus harrisii</i>	9 kg	7 kg
Fawn Antechinus	<i>Antechinus bellus</i>	42 - 66 g	26 - 41 g
Yellow-footed Antechinus	<i>Antechinus flavipes</i>	26 - 79 g	21 - 52 g
Atherton Antechinus	<i>Antechinus godmani</i>	85 - 125 g	53 - 73 g
Cinnamon Antechinus	<i>Antechinus leo</i>	67 - 124 g	32 - 74 g
Swamp Antechinus	<i>Antechinus minimus</i>	30 - 103 g	24 - 65 g
Brown Antechinus	<i>Antechinus stuartii</i>	29 - 71 g	17 - 40 g
Dusky Antechinus	<i>Antechinus swainsonii</i>	43 - 178 g	37 - 100 g
Dusky Antechinus	<i>Antechinus swainsonii</i>	43 - 178 g	37 - 100 g
Agile Antechinus	<i>Antechinus sp.</i>	20 - 40 g	16 - 25 g
Red-Tailed Phascogale	<i>Phascogale calura</i>	39 - 68 g	38 - 48 g
Brush-Tailed Phascogale	<i>Phascogale tapoatafa 1</i>	75 - 311 g	106 - 212 g
Giles' Planigale	<i>Planigale gilesi</i>	9.5 - 16.0 g	5.0 - 9.0 g
Long-Tailed Planigale	<i>Planigale ingrami</i>	3.9 - 4.5 g	4.2 - 4.5 g
Common Planigale	<i>Planigale maculata</i>	6 - 22 g	7 - 15 g
Narrow-nosed Planigale	<i>Planigale tenuirostris</i>	4.5 - 9.0 g	4.0 - 7.0 g
Wongai Ningau	<i>Ningau ridei</i>	6.5 - 10.5 g	6.5 - 10.5 g
Pilbara Ningau	<i>Ningau timealeyi</i>	2.0 - 9.4 g	2.0 - 9.4 g
Southern Ningau	<i>Ningau yvonneae</i>	4 - 10 g	4 - 10 g
Kultarr	<i>Antechinomys laniger</i>	30 g	20 g
Kangaroo Island Dunnart	<i>Sminthopsis aitkeni</i>	20 - 25 g	20 - 25 g
Chestnut Dunnart	<i>Sminthopsis archeri</i>	16 g	16 g
Kakadu Dunnart	<i>Sminthopsis bindi</i>	12 - 14 g	12 - 14 g
Fat-Tailed Dunnart	<i>Sminthopsis crassicaudata</i>	10 - 20 g	10 - 20 g
Little Long-Tailed Dunnart	<i>Sminthopsis dolichura</i>	11 - 20 g	10 - 21 g
Julia Creek Dunnart	<i>Sminthopsis douglasi</i>	50 - 70 g	40 - 60 g
Gilbert's Dunnart	<i>Sminthopsis gilberti</i>	14 - 25 g	14 - 25 g
White-Tailed Dunnart	<i>Sminthopsis granulipes</i>	18 - 37 g	18 - 37 g
Grey-bellied Dunnart	<i>Sminthopsis griseoventer</i>	15 - 24 g	14 - 20 g
Hairy-footed Dunnart	<i>Sminthopsis hirtipes</i>	13.0 - 19.5 g	13.0 - 19.5 g
White-footed Dunnart	<i>Sminthopsis leucopus</i>	26 - 32 g	19 - 25 g
Long-Tailed Dunnart	<i>Sminthopsis longicaudata</i>	15 - 21 g	15 - 21 g
Stripe-faced Dunnart	<i>Sminthopsis macroura</i>	15 - 25 g	15 - 25 g
Common Dunnart	<i>Sminthopsis murina</i>	16 - 28 g	10 - 22 g
Ooldea Dunnart	<i>Sminthopsis ooldea</i>	9 - 17 g	8 - 15 g
Sandhill Dunnart	<i>Sminthopsis psammophila</i>	30 - 44 g	25 - 35 g
Red-cheeked Dunnart	<i>Sminthopsis virginiae</i>	31 - 58 g	18 - 34 g
Lesser Hairy-footed Dunnart	<i>Sminthopsis youngsoni</i>	8.5 - 12.0 g	8.5 - 12.0 g

Tables 2 - 4 list published physiological parameters, and hematology and biochemistry values for some dasyurid species.

Table 2. Physiological Parameters [4].	
Tasmanian Devil	
Body Temperature (°C)	31 - 38
Heart Rate (beats/min)	102 +/- 16
Respiratory Rate	20
Arterial pH	7.44 +/- 0.04
PO ₂ (mm Hg)	98.5 +/- 15
PCO ₂ (mm Hg)	30.8 +/- 3.95
HCO ₃ (mmol/l)	19.3 +/- 2.24
Systolic Pressure (mm Hg)	131 +/- 26
Diastolic Pressure (mm Hg)	98 +/- 23

Table 3. Hematology [4-8].							
	Tasmanian Devil	Eastern Quoll	Western Quoll	Brown Antechinus	Red-Tailed Phascogale	Brush-Tailed Phascogale	Fat-Tailed Dunnart
Hb (g/L)	110 - 200	131 - 199	128.2 - 184.9	139 - 169	158 - 169	145 - 178	87 - 141
PCV (%)	39.1 - 41.7	38 - 46	37 - 54	39 - 43	45 - 48	0.38 - 0.54	0.26-0.43
RBC (10 ¹² /L)	5.84 - 6.59	7.1 - 13.1	7.07 - 9.87	9.01 - 11.14	9.2 - 12.7		
RCC (10 ¹² /L)						7.43 - 10.81	4.9 - 8.6
MCH (pg)	22.3 - 24.1	12.1 - 18.3	16 - 21	14.2 - 16.2	8.5 - 18.2	15.7 - 18.5	
MCHC (g/L)	34.6 - 35.5		315 - 353	344 - 375	317 - 331	313 - 349	302 - 351
WBC (10 ⁹ /L)	8.6 - 14.6	1.0 - 9.8	0.86 - 10.74	4.9 - 8.9	3.0 - 4.5	1.7 - 4.6	0.5 - 6.1 (26)
Neutrophils (10 ⁹ /L)	44 - 52	1.1 - 4.4	0.16 - 7.26		1.0 - 2.5	0.6 - 2.1	
Bands (10 ⁹ /L)			0 - 0.05			0	
Lymphocyte (10 ⁹ /L)	45 - 51	1.3 - 3.9	0.21 - 3.47		1.7 - 2.7	0.8 - 1.9	
Monocytes (10 ⁹ /L)	2 - 6	0.25 - 0.35	0.03 - 0.46		0 - 0.3	0.1 - 0.8	
Eosinophils (10 ⁹ /L)	0 - 4	0.23 - 0.34	0.01 - 0.67			0 - 0.04	
Basophils (10 ⁹ /L)	0		0 - 0.1			0	
Reticulocytes (10 ⁹ /L)							400 - 800 (5)
Platelets (10 ⁹ /L)						440 - 560 (3)	
Total Plasma Solids (g/L)			51.4 - 80.9	60 - 62			
Fibrinogen (g/L)			0 - 5				

Table 4. Biochemistry				
	Tasmanian Devil	Eastern Quoll	Western Quoll	Brush-Tailed Phascogale
Urea (mmol/L)			14.0 - 23.9	17.7 - 25.3
Creatinine (umol/L)			33 - 75	10 - 30
Phosphorus (mmol/L)			1.18 - 3.42	0.90 - 2.38
Calcium (mmol/L)			2.14 - 2.71	1.98 - 2.25
Glucose (mmol/L)			2.6 - 9.7	
Protein (g/L)			44.8 - 74.2	
Albumin (g/L)			27.2 - 35.8	
CK (U/L)			175 - 5747	
ALP (U/L)			102 - 1020	
ALT (U/L)	77 - 80	25 - 51	12 - 100	
AST (U/L)	190 - 200	53 - 60	16 - 274	
Sodium (mmol/L)		134.5		143 - 150
Potassium (mmol/L)		5.3		2.7 - 4.6
Chloride (mmol/L)				110 - 120
Bicarbonate (mmol/L)				15 - 28
Cholesterol (mmol/L)			2.2 - 6.6	
Bilirubin (umol/L)			0.2 - 6.9	

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