Husbandry Manual for Pygmy-possums

with particular reference to:

Eastern Pygmy-possum

Cercartetus nanus

Mammalia : Burramyidae

Compiler: Megan Forsdick
Certificate III in Captive Animals
(RUV 30204)
Western Sydney Institute of TAFE Richmond, June 2010
Lecturers: Graeme Phipps, Brad Walker, Jacki Salkeld

These husbandry guidelines were produced by the compiler/author at TAFE NSW – Western Sydney Institute, Richmond College, N.S.W. Australia as part assessment for completion of Certificate III in Captive Animals, Course number 1068, RUV30204. Since the husbandry guidelines are the result of student project work, care should be taken in the interpretation of information therein, - in effect, all care taken but no responsibility is assumed for any loss or damage that may result from the use of these guidelines. It is offered to the ASZK Husbandry Manuals Register for the benefit of animal welfare and care. Husbandry guidelines are utility documents and are 'works in progress', so enhancements to these guidelines are invited.

Maintenance Calendar

TASK	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Breeding season (*Cercartetus*)												
Birthing season (*Cercartetus*)												
Breeding season (*Barramys*)												
Birthing season (*Barramys*)												
Pouch checks	*C.nanus*	*C.nanus*	*C.nanus*							*C.nanus*	*B.parvus* *C.nanus*	*B.parvus* *C.nanus*
Torpor												
Increase in diet	*C.nanus*	*C.nanus*							*B.parvus*	*B.parvus*	*B.parvus* *C.nanus*	*C.nanus*
Reduction in diet												
Single sex enclosures (*B.parvus*)												
Multi-sex enclosures (*B.parvus*)												
Enclosure repairs												
Examine faeces for worms												
Full clean of enclosure												

Replace substrate												
Pest Control												
Clean nest box												
Weight												
Provide additional nesting material												
Record keeping and observations												
Clean enclosure												
Environmental Enrichment												

Occupational Health and Safety Warnings

Fig. 1. "Wellness at Work sign" (http://www.farsolutions.co.uk/images/Wellness.jpg)

OH&S hazards can include anything that may be seen as a potential risk to you as a keeper or a member of the public.

Hazard identification and risk assessment is important in any workplace to recognise all the possible situations where people may be exposed to injury, illness or disease. By identifying hazards, actions can be put into place to minimise these and to ensure a safe working environment.

Hazards do not only include direct animal risks such as bites, scratches or even worse, it can also include enclosure design and maintenance, tools and procedures used when building enclosures, as well as disease. In most animal care facilities, there are more risks with maintaining an enclosure and the use of tools than anything else.

Eastern Pygmy-possum

In the case of the Eastern Pygmy-possum, risks associated with direct animal contact are limited. Pygmy possums are classified as innocuous and therefore do not pose a threat towards human health.

However, there are other possible hazards that could potentially injure a person while working with this animal.

- **Material of enclosure:**

If an enclosure is constructed from metal, mesh or any other material that is likely to scratch someone, sharp corners need to be identified and dealt with.

Fig. 2. Metal corner (http://www.floridadisaster.org/mitigation/rcmp/hrg/content/features/features_index.asp)

Angle-grinders can be used to minimise this risk by filing or 'grinding' corners into smooth edges.
If this particular risk applies to your enclosure, it needs to be placed somewhere where keepers or members of the public are not going to walk past and get injured, so location is important.

Signage can also help if you are in the procedure of fixing the problem. It can warn people of possible injury and potentially minimise it.

- **Door heights and door lips:**

Heights of doors or the presence of door lips can be a big problem in the animal care industry. Pygmy-possums are small in size and enclosure doors cannot be too big otherwise there is a risk of the animal escaping. Therefore, keepers sometimes need to duck to get into the enclosure and result in hitting their head or tripping over the door lip.

Fig.3. Animal enclosure. (http://www.custombuiltaviaries.com.au/3.html)

Door heights can be raised to a level where the risk of bumping your head is minimised but also maintains the security of the enclosure at the same time.

Keep in mind: Pygmy-possums are nocturnal so it is easier to locate them and keep them inside the enclosure. However, there are times of the day where they start to become active and it is important that you always check doors when opening to make sure they are not hiding somewhere where they can easily escape, particularly if you have made a height change due to this OH&S risk.

- **Position of branches:**

Similar to door heights or door lips, bumping into braches or perches are a common occurrence. Eastern Pygmy-possums live off the ground in trees and so furnishings such as branches need to be placed in enclosures.

Fig. 4. Possum enclosure. (http://animal-world.com/encyclo/critters/ringtailpossum/Images/RingtailPossumWCMa3_U71.jpg)

Positioning these correctly will minimise the risk of injury. Make sure you don't have any branches that obstruct you in any way when entering the enclosure. Similarly, your route to feed bowls and nest boxes should be fairly clear of anything you could bump into. Branches should be positioned in a way that makes it easy to perform daily routines or duties, eg. cleaning or conditioning.

While saying this, as a keeper you need to also be aware of visual presentation of the enclosure. Routes clear of hazards need to be made to enable getting to different parts of the enclosure but at the same time, try to make it subtle by not having big gaps in the middle of the exhibit which is not aesthetically pleasing.

- **Manual handling:**

Manual handling injuries make up a large percentage of all workplace injuries. This involves the moving of objects using human energy. Examples include: lifting, carrying, pulling etc. It can also include injuries that are caused by a wrong movement of the body, injury from the load itself (burns, scratches, chemical spillage), or even squashed fingers.

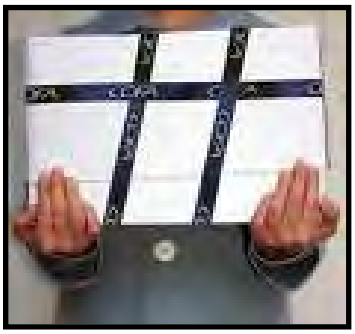


Fig. 5. **Correct handling technique** (http://www.cofa.unsw.edu.au/export/sites/cofa/schoolsunits/ohs/cofa_ohs_images/lifting_2.jpg_1691113714.jpg)

In the case of the Eastern Pygmy-possum, twisting and turning to get around branches or to move around in a small enclosure can easily cause an injury. Moving heavy bags of sand, mulch, or stones for the enclosure can be a manual handling hazard that could cause a back injury.
Carrying browse or branches can be a risk itself. Cuts or scratches can occur if moving or dragging a large quantity.

Minimising these hazards can be easy. By using the correct lifting and carrying technique or by the use of mechanical aids where accessible, you can reduce the risk of an injury.

Examples:

Fig. 6. Mechanical Aid- Trolley (http://www.industrysearch.com.au/products/images/p31786_1.jpg)

Fig. 7. **Mechanical Aid- Crane** (http://www.industrysearch.com.au/products/images/p31936_6.jpg)

Fig. 8. **Mechanical Aid - Trolley** (http://www.industrysearch.com.au/products/images/p31842_9.jpg)

Strategies to prevent back injury:

- Reduce the amount of manual handling required by better workplace design
- Use mechanical aids where possible (trolleys, cranes, hoists)
- Only lift within your capacity
- Get someone to help you
- Check the load before lifting
- Use the correct lifting technique.

Correct lifting and carrying technique:

1. **Prepare your route**: check there is nothing to trip over and that you have a clear path. Look for obstacles, stairways, open doors so you don't have to do so with your arms full.
2. **Check the load**: has it got sharp edges? Is it too heavy to lift? Is it too big to handle easily?
3. **Position yourself** by putting your front foot forward pointing in the direction you want to go and your other foot behind for balance.
4. **Use the correct hold** on the object using the whole hand and not just the fingertips. Get a firm comfortable grip at the start so you don't have to alter your hands once you have started carrying.
5. **Bend the knees** and use your legs to lift, NOT YOUR BACK.
6. **Keep your arms and back straight** while lifting and carrying and use your thigh to help lift the load.
7. Keep your chin in as you lift and carry.
8. **Do not twist** your back to lift; turn your whole body.

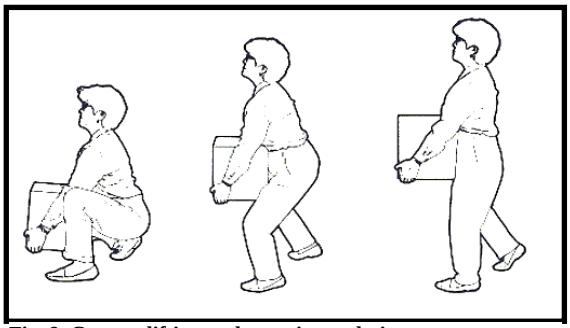


Fig. 9. **Correct lifting and carrying technique**. (http://bama.ua.edu/%7Eehs/New%20Web/woman.gif)

- **Use of tools.**

This includes the use of any sort of tool that could potentially cause an injury by not using it properly. Power tools are used in the building of an enclosure for an Eastern Pygmy-possum and could be involved in the maintenance of the enclosure.
When using tools, make sure you are focused and concentrating so that the tool will not slip and cause an injury.

Fig. 10. **PPE**
(http://www.westone.wa.gov.au/toolboxes/water/toolbox_11_04/uoc3/images/ppe.jpg)

By wearing the appropriate personal protective equipment (PPE) suited to that particular tool can minimise any risks or hazards. Examples of PPE: gloves, face/dust mask, goggles, boots, ear muffs, hat, and sunscreen.

Risk assessments:

All workplaces are different and therefore have different hazards. Once you have identified hazards in the workplace, you can complete a risk assessment that ensures all staff, public and animals are working and living in a safe environment.

Fig. 11. **Hazard sign**
(http://www.safety-signs.b-protected.com.au/uniforms-melbourne/safety-signs.htm)

<u>What is a risk assessment?</u>
A risk assessment can be described as the process used to determine the likelihood that people may be exposed to injury, illness or disease in the workplace arising from any situation identified during the hazard identification process.

By using a Hazpak graph, you can identify the hazards and then classify them into priority and order of risk.

<u>These are a few of the main risks and possible outcomes of hazards that were identified above:</u>

(1) A member of the public or an employee walks past the Eastern Pygmy-possum enclosure and scratches their arm on a sharp corner
(2) When entering the enclosure, you bump your head on the door on your way in.
(3) When entering the enclosure, you trip on the door lip
(4) When performing daily routines in the enclosure, you bump into one of the branches
(5) While lifting or moving a heavy object, you injure your back.

Fig. 12. **Hazard tape**
(http://www.qep.com/files/category_pictures/10945_0.jpg)

<u>For each hazard, think about</u>:

1. How severe could it hurt someone or how ill could it make someone?
2. How likely is it to be that bad?

Now you can use the table to help you numerically prioritise each hazard based on its risk.
The numbers show how important it is to take action.

1- Extremely important that needs something to be done as soon as possible.

6- This hazard may not need immediate attention just yet.

	+ + very likely could happen any time	**+ likely** could happen sometime	**- Unlikely** could happen but very rarely	**- - very unlikely** could happen, but probably never will
☹ Kill or cause permanent disability or ill health	1	1	2	3
!!! Long term illness or serious injury	1	2	3	4
!! Medical attention and several days off work	2	3 (3) (5)	4	5
! First aid needed	3 (2) (4)	4 (1)	5	6

Therefore: Order of priority→
(2) Bump head on the way in
(4) Bump into one of the branches
(3) Trip on the door lip
(5) Manual handling injury

→ All four of these hazards are classified as a '3' priority and need attention in the near future.

(1) Scratching your arm on the corner of the enclosure → This is classified as a lower risk, but still needs attention at some point

REMEMBER: Risk assessment outcomes can differ between workplaces. It is how you see the risk and how likely you think it is to happen at your particular animal care facility.

Other additional hazards in the workplace could include:

- Noise hazards
- Heat/ UV hazards → a large part of the day is normally spent outside so it is important to wear a hat and sunscreen as at times.
- Stress hazards (workload, dealing with public)
- Slips, trips and falls

Table of Contents

1. Introduction

This husbandry manual serves as a source of reference on the biology, maintenance, housing, health, behaviour, diet, breeding, restraint and transporting of Pygmy-possums held in captivity. It acts as a major source of information for the species. It presents information and experiences (both published and unpublished) together so that the knowledge of Pygmy-possums can be passed on, which in turn allows for techniques to develop rather than be reinvented. Resulting in the overall improvement in husbandry for the Pygmy-possum.

The Exhibited Animals Protection Act (EAPA) may be used as a minimum standard for keeping Eastern Pygmy-possums and it is a legal requirement for any animal held under an EAPA license. The EAPA is concerned with animal welfare with regard to ethical issues, physical wellbeing and behavioural enrichment.

This Husbandry Manual refers to the following species:

Genus: Cercartetus

- *C. nanus*, Eastern Pygmy-possum
- *C. caudatus*, Long-tailed Pygmy-possum
- *C. concinnus*, Western Pygmy-possum
- *C. lepidus*, Little Pygmy-possum (Tasmanian)

Genus: Barramys

- *B. parvus*, Mountain Pygmy-possum

The goal of this Husbandry Resource Manual is that it is used as a reference tool for the zoo industry.

History in Captivity

Current holding numbers within ARAZPA institutions (RC&P 2008):

Family: Burramyidae

Mountain Pygmy-possum (Burramys parvus)
Healesville Sanctuary 13 13 0 7 7 0 Follow recovery program recommendations
IUCN : EN

ASMP Monotreme & Marsupial TAG; Population Management Program; Management Level 1b
TAG Notes: This species had poor support from the region and was therefore lowered to no regional program level 3. HEALESVIL is commencing a captive breeding program in conjunction with the Victorian State Government to assist recovery program. Discussions are required with Healesville as to whether this will be an ASMP managed conservation program.

Little Pygmy-possum (Cercartetus lepidus)
Trowunna Wildlife Park 0 0 0 2 4 0 Acquire and develop breeding program after 2008

ASMP Monotreme & Marsupial TAG; No Regional Program; Management Level 3
TAG Notes: This species is being managed at a local level and therefore is not a regional concern at this time

Eastern Pygmy-possum (Cercartetus nanus)

Pearcedale Conservation Park	0	0	0	1	1	0	Acquire
Trowunna Wildlife Park	0	0	0	2	4	0	Acquire and develop breeding program after 2008
Totals	**0**	**0**	**0**	**3**	**5**	**0**	

ASMP Monotreme & Marsupial TAG; No Regional Program; Management Level 3
TAG Notes: This species is being managed at a local level and therefore is not a regional concern at this time.

- **The above section from the Regional Census and Plan 2008 can be found in Appendix 1**

In addition to these numbers, pygmy-possums (particularly the Eastern Pygmy-possum) are held at various non-ARAZPA accredited institutions such as Australia Walkabout Wildlife Park on the NSW Central Coast.

Conservation Status

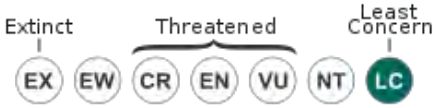
Fig.13. Eastern Pygmy-possum (http://www.warra.com/warra/images/research_projects/WRA1162.jpg

Eastern Pygmy-possum (*C.nanus*)

State (NSW):
In New South Wales *C.nanus* is considered **Vulnerable(VU)** under the Threatened Species Conservation Act 1995.

This act states that "a vulnerable species is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate."

Federal:
Under the IUCN (International Union for the Conservation of Nature and Natural Resources)
C.nanus is listed as **Least Concern (LC)** (2008, ver 3.1) and both subspecies are listed as lower risk by Australian Commonwealth Government legislation.



The IUCN Red List of Threatened Species states the following justification:
"Listed as Least Concern in the view of its relatively wide distribution, presence in protected areas, and because it is unlikely to be declining fast enough to qualify for listing in a more threatened category. This species, however probably requires close monitoring of population numbers and trends as it is thought to be uncommon in some regions."

History:
1996 – Lower Risk/ least concern

Mountain Pygmy-possum (*B. parvus*)

State (NSW):
In New South Wales, *B.parvus* is considered **Endangered***(EN)* under the Threatened Species Conservation Act 1995.

Federal:
Under the IUCN (International Union for the Conservation of Nature and Natural Resources)
B.parvus is listed as **Critically Endangered (CR)** (2008, ver 3.1)

The IUCN Red List of Threatened Species states the following justification:
Listed as Critically Endangered because its extent of occurrence is less than 100 km², its area of occupancy is less than 10 km², the population is severely fragmented, and there is continuing decline in the extent and quality of its habitat and in the number of mature individuals.

- **The Red List Categories and Criteria, Version 3.1 can be found in Appendix 2**

History:
1996 - Endangered (Baillie and Groombridge 1996)
1994 - Endangered (IUCN)

Fig.14. Mountain Pygmy-possum
(http://www.museumvictoria.museum/pages/12314/imagegallery/vic-mountainpygmypossum-large.jpg)

Threats to the Mountain Pygmy-possum:

- Development of the ski industry
- Habitat loss caused by increased temperatures and decreasing snow cover as a result of global warming.
- Predation by feral cats and foxes
- The Bogong moth (*B.parvus*' main prey) faces the threat of the use of pesticides in its breeding grounds

The mountain pygmy-possum occupies just a tiny area, estimated at less than seven square kilometres, and its populations are highly fragmented, putting it at particular risk

Conservation:
The entire range of the mountain pygmy-possum occurs within protected areas, although important parts of these are in ski-resort lease areas. Management plans for the species have been put in place in Victoria and New South Wales, and a national recovery plan is currently being prepared. A range of conservation measures have been recommended for this small possum, including protection and restoration of the remaining habitat, population and habitat monitoring, predator control, measures to protect the possums in ski resorts, further research, and captive breeding programmes. (Broome, L 2010)

Zoos Victoria has been involved in a captive breeding program, currently being undertaken at Healesville Sanctuary since 2007. The aim is to reintroduce the Mountain Pygmy-possum back into the wild.

- **For more information and details about the Zoo's Victoria conservation program see Appendix 3**

ASMP Category

TAG Group: Monotreme and Marsupial

C. nanus, Eastern Pygmy-possum
C. caudatus, Long-tailed Pygmy-possum
C. concinnus, Western Pygmy-possum
C. lepidus, Little Pygmy-possum (Tasmanian)

→ No Regional Program
→ Management Level 3

B. parvus, Mountain Pygmy-possum →Population Management Program
→Management Level 1b

- **ASMP Status and Management Levels can be found in Appendix 4**

Management documentation for the Mountain Pygmy-possum:

- Conservation Agreement between the Minister for the Environment and Heritage and Buller Ski Lifts Pty Ltd in relation to the rehabilitation and management of the area at the Mount Buller Ski Resort, VICTORIA can be found in **Appendix 5**

- Mt Buller and Mount Sterling Alpine Resorts: Environmental Management Plan (4.5.2 Rare or Threatened fauna, pg 31-32) can be found in **Appendix 6**

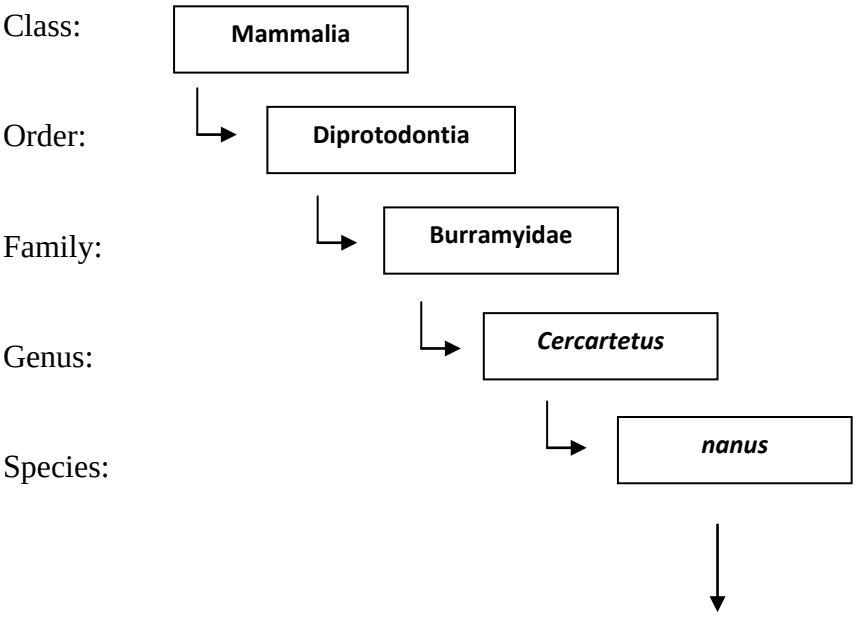
- Approved Recovery Plan for the Mountain Pygmy-possum (National Parks and Wildlife Services) can be found in **Appendix 7**

I have written these husbandry guidelines to gain a better understanding of the biology and ecology of this species and to discover potential threats that may be affecting these marsupials. This manual will hopefully allow keepers to successfully manage this species in a captive environment. By providing information and educating keepers and the general public, we can learn to care for this mysterious mammal in order to promote conservation and awareness.

2. Taxonomy

2.1 Nomenclature and systematic

Eastern Pygmy-possum:



Scientific name: *Cercartetus nanus* (Desmarest, 1818)

Members of the Genus *Cercartetus:*
The genus *Cercartetus* is a group of very small possums known as pygmy possums. Four existing species comprise this genus:

- Eastern Pygmy Possum, *Cercartetus nanus*
- Long-tailed Pygmy Possum, *Cercartetus caudatus*
- Western Pygmy Possum, *Cercartetus concinnus*
- Little Pygmy Possum (also known as the Tasmanian Pygmy Possum)*Cercartetus lepidus*

Mountain Pygmy Possum (*Burramys parvus)* does not belong to the genus *Cercartetus*, they are however part of the Burramyidae family.

There are two genera of pygmy-possums: *Burramys* and *Cercartetus*.
Burramys contains Mountain Pygmy Possum as well as gliders and *Cercartetus* contains the above mentioned existing species. Together these two genus' make up the marsupial family Burramyidae.

Fig.15. Eastern Pygmy-possum (http://www.austmus.gov.au/factSheets/images/eastern_pygmy_possum.jpg)

Fig.16. Long-tailed Pygmy-possum (http://www.das-tierlexikon.de/data/media/32/cercartetus_caudatus.jpg)

Fig.17. Western Pygmy-possum (http://www.zoo.latrobe.edu.au/Staff/mfc/Mallee/photogallery/western%20pygmy%20possum-juv_G_Nov%2006_LO_%20(89).JPG)

Fig.18. Little Pygmy-possum (http://www.livt.net/Clt/Ani/Cho/Mam/Mar/Brr/brr006.jpg)

Fig.19. **Mountain Pygmy-possum** (http://wwf.org.au/assets/mountain-pygmy-possum.jpg)

2.2 Subspecies

There are currently two (2) subspecies of *Cercartetus nanus*:

Cercartetus nanus nanus (Desmarest, 1818) (the Tasmanian subspecies)
Cercartetus nanus unicolor (Krefft, 1863) (the mainland Australian subspecies)

2.3Recent Synonyms

The Eastern pygmy Possum was first described as *Phalangista nana* with the scientific name meaning ‘dwarf’ in Latin.
Currently the authority for the scientific name is widely accepted as Desmarest 1818, however it has been reviewed that an earlier version of Desmarest’s account was published in 1817.

Names synonymous with *Cercartetus nanus* are:

Phalangista glirifomis (Bell, 1828) and
Dromicia britta (Wood Jones, 1925).

2.4 Other Common Names

Dormouse possum is the most common other nameused to refer to the Eastern Pygmy Possum because *Cercartetus nanus* resembles the European dormouse, *Myoxus glis*. (Walker 1975).

Other names used once to describe *Cercartetus nanus*:
Dwarf phalanger,
Minute phalanger
Dwarf cuscus
Pigmy phalanger
Bell's *Dromicia*
Opossum mouse
Dusky *Dromicia*
Pygmy opossum
Thick-tailed *Dromicia*
Mouse-like phalanger
Common dormouse-phalanger
Dormouse phalanger
Common dormouse-opossum
Pigmy opossum
Pigmy possum
Eastern pigmy possum.

3. Natural History

Pygmy-possums are mice-sized marsupials who are very secretive and not much is known about their natural history, especially in Tasmania. This is largely due to the fact of many unsuccessful live trapping for research purposes.
Nonetheless, they can be encountered by wood fire cutters and domestic cats that bring them home as prey. They are often brought into animal rescue shelters. Other observations come from encounters of bushwalkers and from wildlife surveys. Pygmy-possums are rarely seen as they are not easy to find.

Fig.20. Eastern Pygmy-possum (http://www.tasfieldnats.org.au/PygmyPossum/NestBoxes.htm)

The first specimen of Eastern Pygmy Possum known to Europeans was collected by François Péron, a naturalist aboard Nicolas Baudin's voyage to the south seas.

Whilst on a short stay on Maria Island, off eastern Tasmania between 19-27 February 1802, Péron traded with the Aboriginal inhabitants for a single small marsupial.

Péron wrote: (in translation)

> 'In the class of mammiferous animals, I only saw one kind of *Dasyurus*, which was scarcely as large as a mouse. I obtained one that was alive, in exchange for a few trifles, from a savage who was just going to kill and eat it'.

In an unpublished manuscript (now held in the Le Havre Museum in France) Péron also wrote that the animal 'was given to me by the natives; it was still alive; I believe it to be a new species and have described it as *Didelphis muroides* because of its resemblance to the *D. mus* of Linnaeus'.

The juvenile male collected by Péron was taken back to France, and is now held in the Muséum National d'Historie Naturelle in Paris.

Today, there is still little known about this group of marsupials and each species still faces its own threats. Owls, Tiger Quolls, Tasmanian Devils, Foxes, Dingos, and cats are just a few of the predators that Pygmy-possums fall prey to. Specifically, the Mountain Pygmy-possum is now classified as an endangered species as global warming gets worse and melts away the snow which it calls its home.

Case Study:

Throughout this manual, I will be using information from books, the internet, journals, and recent studies to formulate these husbandry guidelines. Not only will these resources be used but a large percentage of this manual will be information and skills gained from my own personal experience with the Eastern Pygmy-possum.
Before telling you a bit about these marsupials, I will introduce you to Australia Walkabout Wildlife Park's very own Pygmy-possum. (Located in Calga on the Central Coast, NSW)

Fig.21. 'Marni'
(http://www.walkaboutpark.com.au/index.php?id=157)

At only 12 months of age, **'Marni'**(formerly known as 'Miss Piggy') already has a huge history.

Marni found his way in to a suitcase in Leura in the Blue Mountains in April 2007. He was very young and had to be hand raised by a wildlife carer, He also had an injured leg and torn ear.

Marni was then transferred to Taronga Zoo, Sydney where they treated his injuries and continued to hand raise him. After many months of rehabilitation the decision was made not to release him, as the chances of Marni surviving in the wild would be minimal.

Marni was offered to the Walkabout Park.They accepted and he arrived on Friday 2nd November 2007.

Many of Australia's small marsupials such as the pygmy-possum are under threat from introduced predators such as cats and foxes. Fortunately, Australia Walkabout Wildlife Park is surrounded by a fox proof fence, ensuring the parks population of animals such as the Pygmy-possum are safe.

3.1 Diagnostic features.

These include any distinguishing features that separate these particular species from other similar species.

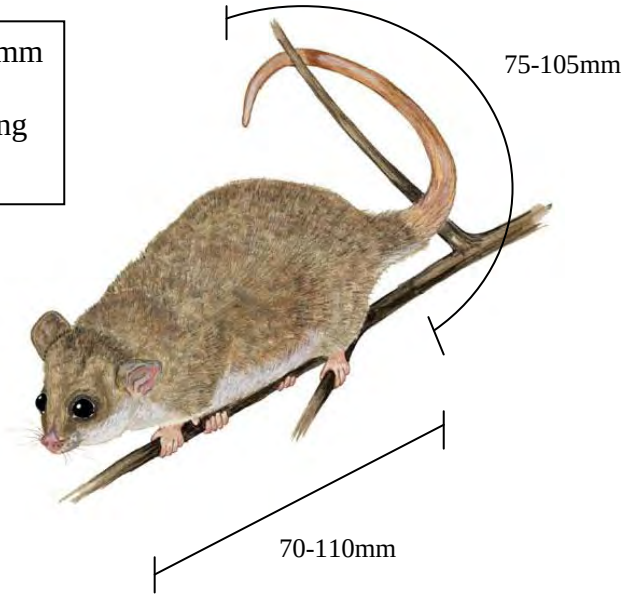
While Pygmy-possums may look very similar to each other, there are characteristics and features that contribute to the uniqueness of the species and separate it from other similar species. Factors such as location, habitat, and even diet are a few reasons why these particular animals can be so diverse.

- **Sexual dimorphism only occurs in the Mountain Pymgy-possum. Males and females appear the same in all other four species.**

➔ Eastern Pygmy-possum: *Cercartetus nanus*

The size of a large mouse, the Eastern Pygmy-possum is a very small marsupial which has soft, dense fur that is fawn-grey to olive on top and light grey-white beneath.
The rounded head has very large eyes, ears and long whiskers, which is common in most other pygmy-possums. The tail is around about the same length as its body and has a fat base that is sparse-haired and narrowed to a point.

Measurements: Head-body length: 70-110 mm
Tail: 75-105 mm
Weight: can vary between 15-43 g depending on what the time of the year is.



The Eastern Pygmy-possum is distinguished from the Western Pygmy-possum by having belly fur that is grey with a white tip, rather than completely white.

It is a lot larger than the Little Pygmy-possum, who only weighs in at an average of 8g. The Eastern Pygmy-possum also has a paler underbelly and there are only three molar teeth present, opposed to a fourth (reduced) molar tooth that is present in the Little Pygmy-possum.

Fig.22.Eastern Pygmy-possum (http://michaelsnedic.com/images/mammals/Pygmy-Possum-in-Tree-Waratah-web.jpg)

Not only does the Eastern Pygmy-possum present similar characteristics to other Pygmy-possums, but also to other species that may be from completely different families.
The Eastern Pygmy-possums second and third toes are fused together to form a single digit with two claws. This distinguishes it from rats, mice, and dasyurid marsupials.

➔ Long-tailed Pygmy-possum: *Cercartetus caudatus*

This arboreal marsupial is a brownish-grey colour with a pale-grey belly. It has distinct dark patches around the eyes and thin, membraneous ears.

The Long-tailed Pygmy-possum has a narrow pointed muzzle with a pink nose, and large eyes which is common to the possum families.

The prehensile tail is thin with a furry, slightly thickened base which is considerably longer than the total head-body length.

Fig.23. Long-tailed Pygmy-possum (http://news.bbc.co.uk/media/images/44307000/jpg/_44307364_pygmy203afp.jpg)

Measurements: Head-body length: 103-108 mm
Tail length: 128-151 mm
Weight: 25-40 g, again depending on seasons and time of year.

"The Long-tailed Pygmy-possum is distinguished from the prehensile-tailed rat (*Pogonomys mollipilosus)* by larger membraneous ears, furred base to tail, and possum hindfoot; the rat has small round ears, tail narrow and naked right to rump and five even toes on hindfoot." (Andrew Smith and John Winter 1997)

The Long-tailed Pygmy-possum's dark patches around its eyes separate it from other Pygmy-possums.

➔ Western Pygmy-possum: *Cercartetus concinnus*

Fig.24. Western Pygmy-possum (http://www.nrm.gov.au/projects/sa/alwi/images/2006-09d.jpg)

The Western Pygmy-possum is one of the smaller species of Pygmy-possums, weighing in at an average of 8-20g.
They are a fawn or reddish colour above and white below.
The tail is short and tapered with fine scales and some fur on the tip.
Females have 6 teets.

Like all other Pygmy-possums, Western Pygmy-possums have large membraneous ears and large eyes.

Fig 25. Western Pygmy-possum (http://www.fnpw.com.au/Images/Projects/PlantsandWildlife/Western_Pygmy_Possum_RayDayman.jpg)

Measurements: Head-body length: 71-106 mm
Tail length: 71- 96mm
Weight: 8-20g

The Western Pygmy-possum is distinguished from other pygmy-possums by belly fur that is completely white to the base, and also from the Little Pygmy-possum by nipple number and presence of only 3 molars.

Fig.26. Western Pygmy-possum (http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/images/cer-con_small.jpg)

It is distinguished from the Eastern Pygmy-possum by reduced lower third pre-molar tooth.
Like the Eastern Pygmy-possum, its second and third toes are fused together to form a single digit with two claws. This distinguishes is from mice, rats and dasyurid marsupials.

➔ Little Pygmy-possum: *Cercartueus lepidus*

Fig.27. Little Pygmy-possum (http://www.parks.tas.gov.au/file.aspx?id=4897&mode=thumbnail)

The Little Pygmy-possum is the smallest possum, only weighing an average of 7g.
Its soft, thick fur is pale fawn above and grey below.
Its tail is prehensile tapers to a point from a thick base.

Fig.28.Little Pygmy-possum (http://www.mammalogy.org/mil_images/images/mid/327.jpg)

- Has a fourth pair of upper and lower molars.
- Female has 4 teats.

The Little Pygmy-possum is distinguished from other pygmy-possums by its small size, and a greyer belly, specifically from the Western Pygmy-possum and Eastern Pygmy-possum by presence of a fourth (reduced) molar tooth.

The Little Pygmy-possum's second and third toes are fused together to form a single digit with two claws. This distinguishes is from mice, rats and dasyurid marsupials.

Measurements: Head-body length: 50-65 mm
Tail length: 60-75 mm

Weight: 6-9g

➔ Mountain Pygmy-possum: Barramys parvus

This rare subalpine marsupial is the only Australian mammal limited in its distribution.

Fig.29.Mountain Pygmy-possum (http://www.weedscrc.org.au/publications/images/mountain%20pygmy%20possum_l%20brome_dec.jpg)

Its grey-brown body is sometimes darker in the mid-dorsal area continuing to the top of the head.
Similar to the Western Pygmy-possum, Mountain Pygmy-possums also have dark rings around their eyes but not as distinct as the Westerns.

Its darker body contrasts its pale-grey to cream below, developing to bright fawn-orange in ventral area and flanks of adults (especially males) during the breeding season.

Fig.30. Mountain Pygmy-possum (http://www.dse.vic.gov.au/dse/nrenfoe.nsf/FID/-8964E6C3B4737F3CCA256D890011CD59?OpenDocument)

The Mountain Pygmy-possum's fur is fine but dense and its prehensile tail is long, thin and scaly with sparse, short hairs.

Sexual Dimorphism only occurs in the Mountain Pygmy-possum.

While measurements are very similar, females can get a lot heavier than males.

FEMALE ♀	MALE ♂
Measurements: Head-body length: 111mm Tail length: 136mm Weight: 30-82g	Measurements: Head-body length: 110mm Tail length: 138mm Weight: 30-54g

Fig.31.Mountain Pygmy-possum (http://www.climatechange.gov.au/impacts/images/biodiversity.jpg)

The Mountain Pygmy-possum is distinguished from the Eastern Pygmy-possum by a longer tail, larger size, and absence of a blade-like premolar tooth.
It is also distinguished from mice, rats and dasyuirid marsupials by the fused second and third toes.

3.2 Distribution and habitat

➔ **Eastern Pygmy-possum** ***Cercartetus nanus***

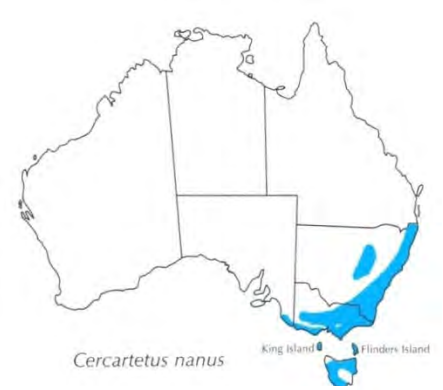


Fig.32. Distribution of Eastern Pygmy-possum. "The Mammals of Australia, third edition"

The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania.
In NSW it extends from the coast inland as far as Dubbo, Parkes and Wagga Wagga on the western slopes.

Habitat: BROAD →rainforests to sclerophyll forests, woodlands and heath

In most areas, heath and woodlands seem to be a preferred habitat, except in parts of northern NSW where they are found most frequently in rainforests.

Fig.33.Woodland habitat (http://uwarboretum.org/images/eps/woodland.jpg)

The Eastern Pygmy Possum appears to be mainly solitary and each individual will use several nest sites. Males have non-exclusive home ranges of about 0.68 hectares and females about 0.35 hectares.

➔ Long-tailed Pygmy-possum *Cercartetus caudatus*

Fig.34. **Long-tailed Pygmy-possum** (http://www.wettropics.gov.au/st/rainforest_explorer/Resources/Images/animals/mammals/LongTailedPygmyPossum.jpg)

Habitat: Rainforest, fringing forest of Eucalypt, Melaleuca and Casurina.

In Australia, the Long-tailed Pygmy-possum has been found only in Queensland rainforests between Townsville and Cooktown.
South of the Daintree River, it occurs in rainforests and fringing Casuarina forests at an altitude of 300 metres or more.

North of the Daintree, it is found on the coastal plain and in *Eucalyptus/Melaleuca* forests.

Fig.35. **Distribution of Long-tailed Pygmy-possum**. "The Mammals of Australia, third edition"

Fig.36.Map of Papua New Guinea (http://www.prema-eu.org/clip_image002.jpg)

The Long-tailed Pygmy-possum also occurs in the mountain rainforests of New Guinea's central Cordillera above 1,500 m,where specimens are often trapped on the ground in subalpine grasslands above the tree line.

There are however particular rainforests that are similar to those in Queensland that they do not inhabit. While this puzzles many biologists, it may indicate an inadequate search effort.

Cercartetus caudatus

➔ Western Pygmy-possum *Cercartetus concinnus*

Fig.37. **Distribution of Western Pygmy-possum**. "The Mammals of Australia, third edition"

Western Pygmy-possums are abundant and widespread in the temperate, semiarid and arid regions of Australia (across southern Australia)

Habitat: Heath, dry eucalypt forest, woodland with shrubby undergrowth, and dry sclerophyll forests.

- In Western Australia they occur between Jurien Bay on the west coast and Eyre on the Nullarbor.

- In South Australia they extend from the Eastern Nullarbor to the southern Great Victoria Desert, Eyre, Yorke, and Fleurieu Peninsulas and the south-west.

Fig. 38.Western Pygmy-possum (http://www.wilderness.org.au/images/Western-Pygmy-Possum250.jpg/image)

Western Pygmy-possums can also be seen in north-western Victoria and far south-western New South Wales.

Within these habitats, the Western Pygmy-possum enjoys mallee woodlands, heathlands, shrublands and dry sclerophyll forests.

➔ Little Pygmy-possum — *Cercartetus lepidus*

In Tasmania, this species is widespread and found in a diverse range of habitats.

Fig.39.Dry sclerophyll forest (http://www.forest-education.com/images/uploads/tas-grassy-understorey.jpg)

DOES NOT OCCUR IN RAINFORESTS.

In south-eastern South Australia and north-western Victoria, Little Pygmy-possums are found in areas with much lower rainfall and occupy Mallee and dry sclerophyll.

Habitat in Tasmania
East: dry sclerophyll forest and woodland.
South and West: wet eucalypt forest and sedgeland

Little Pygmy-possums are also found on Kangaroo Island off South Australia.

Spends most of its time in the lower dense canopies, generally nesting in the hollows of dead trees.

Fig.40.Distribution of Little Pygmy-possum. "The Mammals of Australia, third edition"

➔ Mountain Pygmy-possum — *Burramys parvus*

The Mountain Pygmy-possum is the only Australian mammal limited to its distribution to alpine and subalpine regions, where there is continuous snow cover for a period of up to 6 months of the year.

Fig.41. Mountain Pygmy-possum (http://www.animalpicturesarchive.com/ArchOLD-3/1112777155.jpg)

Habitat: Alpine heath, shrublands, and woodlands above 1,400 metres altitude.

Habitats consist of large boulders that play an important role on the life of a pygmy-possum. Not only are do the boulders improve temperature extremes and provide deep hibernation and sheltered nesting sites; they are also used as summer aestivation sites by the migratory Bogong Moth (*Agrotis infusa*). These moths, along

with other arthropods make up a major part of the possum's diet.

In August 1966, the first living Moutain Pygmy-possum was found living in a ski hut at Mount Hotham, Victoria. The fossil record and other previous fossils found in Jenolan Caves, New South Wales indicated that this particular species' home range has been decreasing with the receding snowline since the last ice age.

Today, Mountain Pygmy-possums only occur in three genetically isolated populations, separated by river valleys, on the highest peaks of south-eastern Australia.

- There are two populations in Victoria: 1. Mount Buller, and 2. Between Mount Bogong and Mount Higginbotham.
- The third population occurs in Kosciuszko National Park, New South Wales (1300-2228m)

Fig.42. **Distribution of Mountain Pygmy-possum.** "The Mammals of Australia, third edition"

Habitat patches, ranging from less than one to more than five hectares, are often more than one kilometere apart, but there appears to be substantial movement between them, especially by males and dispersing juveniles.

Fig.43. Subalpine habitat

Radio-tracked males at Kosciuszko frequently travelled 1-3 kilometres in a night and even females with large pouch-young commuted up to a kilometre from nest sites to the highest peaks where Bogong Moths are abundant.

"The size of home ranges, population density, sex ratios and longevity vary considerably and are related to the distribution and quality of habitat.

Fig.44. Location of Kosciusko National Park

In the highly productive basalt boulder-heaths at Mount Higginbotham, adult females are sedentary and have small (0.06 hectare) overlapping ranges. Densities can be as high as 94 individuals per hectare.
Home ranges are larger in the granodiorite boulder-heaths of Kosciusko and Mount Buller, varying from 0.2 to 7.7 hectares, with densities averaging 8-28 individuals per hectare." (Broome L.S, 2001a)

The total extent of the Mountain Pygmy-possum habitat is less than 6 square kilometers and is declining with the receding snowline due to global warming.

3.3 Longevity

3.3.1. Wild

Due to many unsuccessful trappings and lack of adequate research, there is little known about these mice-sized creatures. Scientists do know however that an Eastern Pygmy-possums maximum longevity in the wild is at least 5 years.

Genus:

Cercartetus	5 years
Burramys	13 years

Reference: (Jackson, S M 2003)

3.3.2 Captivity

Many species of animals thrive in captivity and therefore extend their longevity. A captive environment is free of predators, has access to veterinary treatment, protects individuals from temperature extremes, and has a constant supply of food and water.

Captivity lifespan can vary. Different factors come into play such as stress that could impact on an individual's well-being.

- There is record of an Eastern Pygmy-Possum living for 8 years. (Murphy, J.A; Phillips, B.T; Macreadie, B, 2003)

Genus:

Cercartetus	3-5 (10) years
Burramys	4(M) > 10 (F)(11) years

Reference: (Jackson, S M 2003)

3.3.3 Techniques to Determine the Age of Adults

There are no known techniques to determine the age of adult Eastern Pygmy-possums yet, however a technique used on a similar species, the Ringtail Possum *(Pseudocheirus peregrinus)*could potentially be applied in this particular situation.

The Australian Journal of Zoology talks about Ringtail Possums and how "adults were aged by comparing the degree of tooth wear with that of ringtails of known age." (LI Pahl, CSIRO)

Various parameters including body weight, patogium colour, scent gland development, pouch development and tooth wear are usually used in combination to determine the age of possums and gliders (Jackson, S M 2003)

The tooth wear index for Brush-tailed possums uses the upper left first molar to examine wear (generally while the animal is under anesthetic) and although there is variation in wear between individuals, it provides an approximate age (Jackson, S M 2003)

4. Housing Requirements

4.1 Exhibit design

Important considerations when designing a facility include: size, geometry, barriers, substrate, shelter, transfer areas, climate, reproduction and health. Problems in design and construction lead to unfavourable facilities which promote health problems.

Eastern Pygmy-possums are nocturnal and are therefore best housed in a nocturnal house. Pygmy-possumenclosures can vary in size dramatically.

- Breeding enclosures are generally largerthan exhibits.

Exhibits can vary between 2m squared to 10m squared, depending of the number of individuals. If exhibiting Pygmy-possums in a nocturnal house, consider the provision of public visibility. Avoid designing the enclosure too deep, otherwise visitors are not likely to see your mice-sized marsupials. 1m depth is perfect and the height of the enclosure can be anywhere above 1m

- The provision of an **airlock** is critical when caring for this particular species ESPECIALLY when housed in a nocturnal exhibit. They are extremely small, are fast movers and can easily escape.

- **Ventilation** openings are needed around an indoor enclosure and are to be covered up with 1mm welded mesh to avoid animals escaping

- Native flowering shrubs should be planted inside the exhibit, or if not possible, fake plants can be used (place flowers such as grevillea around the enclosure)

- This species is highly dependent on temperature. The provision of a **heat lamp**/s is critical.

- If housing in a non-nocturnal environment, consider placing **next boxes** against a section of one-way glass to enable visitors to see the animal sleeping

- By using a **substrate** such as mulch, soil or leaf litter, daily routines and maintenance is considerably easier

- **Water source**: a small bowl can be placed behind a rock. Pygmy-possums cannot swim so therefore they do not need large bodies of water. If a pond/ water feature is used for aesthetic reasons, make it shallow enough that if they fall in it, they are able to get out easily without drowning.

- **Visual barriers** are needed for this species. Large hollows, branches and browse can be used.

- Provision for **environmental enrichment**: if using cut browse as the main source of vegetation (enclosure is not able to grow shrubs), consider placing browse pots in certain areas of the enclosure so that replacing browse is easy.

Think about the following whenever designing an exhibit:

- Theme of exhibit
- Habitat provided
- Provision of light and shade
- Provision of keeper access → VERY IMPORTANT
- Provision of ventilation
- Provision for public visibility
- Ease of maintenance
- Provision for environmental enrichment
- Safety and security for keepers, animals and public
- Size

Risks to keepers, animals and the public are to be assessed thoroughly. Avoid sharp corners, trip hazards and low branches.

4.2 Holding Area Design

Holding areas or enclosures are the areas that the public do not see and are often located somewhere out the back in staff-only areas.
These can be used for many different reasons:

- Quarantine
- Whilst minor repairs are done to the exhibit. Eg: browse change
- Cleaning exhibits
- Placing food in exhibits
- Replacing furnishings
- Conditioning or Training of animals
- Vet check-ups
- Rehabilitation or recovery of an animal
- Breeding purposes

Fig.45. Example of a multi-species holding area
(http://0101.netclime.net/1_5/083/0c0/0ee/119802688857696.jpg)

Basically Holding Yards or enclosures are areas that animals can be transferred into for any reason. They may need to be separated from their social group or changes may need to be done to the exhibit and cannot be done with animals running around.

Holding areas for different species vary greatly. Both behavioural and physically needs of the animal needs to be met and for each species or even individual this may be different.
All holding areas need to be a specific size for the number of individuals being housed at one time.

Holding areas for pygmy-possums and similar species can be a fairly simple design depending on how long it will be held and for what reason.

Holding areas ensure the safety of keepers, members of the public, as well as the animals themselves.

Remember: Small possums such as the Eastern Pygmy-possum have been observed escaping from enclosures with 1cm^2 mesh so great caution needs to be taken when using these holding areas. (Jackson, S M 2003)

They can easily be held in wooden boxes with one or more panels or wire mesh

Holding areas for minor repairs such as browse change or enclosure cleaning:
From my experience, small basic animal plastic containers that can be bought from local pet shops do the trick. They are easily stored, can be used for many different species, and are easy to clean.

Fig.46. Plastic container. (own picture)

However, make sure that the nest box fits nicely inside with some room for the pygmy-possum to move around in.
Cleaning, feeding, and changes to enclosures take place during the day…when you are at work. Being nocturnal, these animals will probably be asleep in their nest box and it is therefore easy to put them into a holding container.

Simply block off the hole of the nest box, take it out and place into the container. Fresh water needs to be supplied along with some branches or twigs and leaves incase he decides to wake up and take a wander.

However, if the Eastern Pygmy-possum is housed in a nocturnal house where they are awake during the day and asleep at night and early morning, there could be slight differences in holding area design and requirements.

Generally they are the same, but greater care needs to be taken in nocturnal houses as they are very agile and can easily escape. Even if the possum is not asleep in its nest box, you will still need to capture him and place him, his nest box, some branches, some food and plenty of water into the container. You may want to use a larger container as they will be awake and therefore running around.

The larger the group of animals the larger the holding area needs to be.

Holding areas used for longer periods of time (such as quarantine or the recovery and rehabilitation of an animal.)

These types of holding areas should be relatively larger and higher than a simple plastic container. It needs to be suitable for a pygmy-possum to live in long term with appropriate furnishings.
Simple wire-framed structures can be put up but remember the mesh needs to be small enough that it will keep the animal inside!

Fig.47. Holding Area for longer periods of time. (own picture)

Appropriate nest boxes (more than one) are to be placed undercover along with food and water bowls. Browse and branches should be placed inside the enclosure to provide for the possum's specific physical and behavioural needs as well as providing a natural environment for the animals.
Ideally an airlock would be appropriate especially if housed outside or in a nocturnal house however if the enclosure is a temporary set-up, this may not be possible.

Fig 47 showsappropriate holding area. Keep in mind though, it is not is use and therefore does not show appropriate furnishings and features.

For breeding purposes:
"Eastern Pygmy-possums, Mountain Pygmy-possums, and honey possums have been bred successfully in enclosures that contained a soiled floor and were exposed to the weather so that grass and shrubs could grow. The Pygmy-possums have been held in enclosures up to 10m x5m x 3.3m high to allow ample opportunity for the animals to forage, organise their social behavior and experience natural light cycles and weather, which appear to be important when breeding these species." (Stephen M Jackson)

It is vital when providing an environment or holding area for breeding Pygmy-possums that it is as natural as it can be in order to be successful.

Fig. 48. An outside enclosure that can be used for breeding. ((http://www.kingbilli.com.au/photos/cen3.jpg)

All enclosures should have at least part of the exhibit enclosed. Nest boxes, food bowls and water needs to be placed undercover to protect the animals and their food from elements such as rain, wind, or extreme temperatures.

4.3 Spatial Requirements

The Exhibited Animals Protection Act, 1986 (NSW) is a set of minimum standards that applies to all species being exhibited in NSW. It ensures the safety of animals, staff, and visitors as well as providing a suitable environment for these animals in captivity.

THERFORE it is important that all animal care facilities abide to these laws along with ARAZPA standards if that particular facility is a member.

ARAZPA: Australasian Regional Association of Zoological Parks and Aquaria

For the Eastern Pygmy-possum, the EAPA states that:

1) Enclosures must contain visual barriers. This must include living or freshly cut foliage of native species of plants.

2) A variety of appropriately sized nest boxes and/or tree hollows must be provided to offer a refuge for the animals and allow them to nest away from other aggressive individuals. If held out doors nest boxes and tree hollows must be placed in a position of the enclosure where they are protected from inclement weather.

Note: Behavioural enrichment should be provided in the form of flowers, foliage and branches (eg stringybark) of native species to provide additional food and nesting material.

3) Adequate climbing and gliding opportunities must be provided.

4) Social structure must be provided for.

Note: Mountain Pygmy-possums should be given larger enclosures for successful breeding:
Area: (L x W x H)(m) = (3.0 x 3.0 x 2.0)

Spatial requirements as stated by the EAPA:
Genus: Cercartetus
Common name: Eastern Pygmy-possum
Head body length (cm) 11
Total length (cm) 25
Minimum enclosure area (m^2) 1.00
Minimum enclosure height (cm) 100
Additional extra floor area for each extra animal (m) 0.3 x 0.3

- **Exhibited Animals Protection Act 1986 (NSW), relevant possum sections can be found in Appendix 8**

4.4 Position of Enclosures

Enclosures should be positioned in a way that they are wellprotected from prevailing winds, as well as poor weather. Nest boxes, food bowls and water should be placed in an area that is not in direct sunlight or cannot get wet.

4.5 Weather protection

Fig.49. Rain (http://www.spamula.net/blog/i40/rain2.jpg)

Fig.50. Sun (http://frugaldad.com/wp-content/uploads/2008/03/hot-sun.jpg)

Pygmy-possums that are kept either in nocturnal houses or inside a building generally do not have any issues with weather protection.
This section applies more to animals that are housed outside or are exposed to the elements in any way.

As discussed in "position of enclosures" Nest boxes should be under shelter, away from the rain and wind. Also keep in mind that in Australia, it gets very hot during the summer months so it is essential that all nest boxes and water bowls are kept in the shade undercover. The remainder of the enclosure can be left uncovered for air to rotate through.

4.6 Heating requirements

Generally, heating a Pygmy-possum enclosure is not required unless there are long periods of time where the temperature drops below approximately 5° C.
Pygmy-possums are well adapted to cold temperatures and undergo torpor during the colder months.

Fig.51. Western pygmy-possum in torpor (http://www.possumcentre.com.au/ImagesPygmyWPPSpoon.jpg)

TORPOR→ sometimes called temporary hibernation, (usually short term) is a state of decreased physiological activity in an animal, usually characterised by a reduced body temperature and rate of metabolism. During the active part of their day, these animals maintain normal body temperature and activity levels, but their temperature drops during a portion of the day (usually night) to conserve energy. Torpor is often used to help animals survive during periods of colder temperatures, as it allows the animal to save the amount of energy that would normally be used to maintain a high body temperature.

Animals such as pygmy-possums that undergo torpor should not be overheated and generally do not require a lot of additional heat.
The possums should be maintained at a temperature that is normal for the habitat it would live in. For example: Mountain Pygmy- possums should live in an environment that is less than 25°C (preferably 10°C - 20°C) to mimic the colder regions of New South Wales.

Fig.52. Heat lamp used in Pygmy-possum enclosure (own picture)

Temperatures above this are known to cause mortality (Jackson S, 2003). Similarly, observations made by Fleming (1985) showed that Mountain

Pygmy-possums were stressed by ambient temperatures above 29°C (Lying on their flanks, ears fully expanded, tail engorged with blood, and saliva spread of their forepaws) and exposure to temperatures greater than 33°C for less than an hour have proved to be fatal.

Heating will increase the activity of the animals and they are less likely to go into torpor during the winter months. Some zoo's and wildlife parks use heat lamps to ensure that the public have a chance of seeing this marsupial throughout the year.
However, this is not recommended if you are trying to breed pygmy-possums. Torpor may in fact be a breeding trigger, especially the Mountain Pygmy-possum so to successfully breed, you need a totally natural environment that mimics that of the wild. If you choose to use a heat lamp, make sure you have a metal cover to place over the top. All Pygmy-possums can jump very high and lamps can get very hot, especially for a small mammal like a Pygmy-possum. This prevents any injuries such as burns.

Fig.53. Heat lamp with cover (http://www.trevsgeckos.com/images/heat%20light%202.jpg)

The amount of time the heat lamp should be left on for depends on the temperature and the month of the year. When winter starts, the heat lamp should be turnedon when it starts to get dark and turned off during the day. When July sets in, heat lamps can stay on for a longer period of time but remember if your possums are housed inside, it won't be as cold as outside so be careful not to overheat them.

4.7 Substrate

Fig.54. Leaf litter (http://www.countrysideinfo.co.uk/forest2/FOLDER01/leaf_litter.jpg)

Keep in mind that the public like seeing animals in their natural environment so choosing the right substrate to suit the enclosure and habitat is important.
Sand or leaf litter substrates are appropriate for any species of pygmy-possum as this makes up most of the natural Australian bush.
Holding areas for Pygmy-possums can be layered with paper for easy cleaning if preferred.

4.8 Nest boxes and bedding material

In the wild, different species use different locations as nesting sites. This all depends on size, locomotion and of course, the habitat they live in.

Pygmy-possums use the following as nest sites:

- Tree hollows
- Forks of tea trees
- Leaves of grass trees

Fig.55. Tree Hollow (http://upload.wikimedia.org/wikipedia/commons/thumb/4/43/Hollow_tree_detail.jpg/300px-Hollow_tree_detail.jpg)

- On the ground inside logs or hollows
- Stumps
- Bird nests near the ground, and
- Underground by digging under the soil

Generally though, it is most common for pygmy-possums to be found in some sort of tree hollow with fibrous material used as bedding.

Nesting boxes are extremely important for all possum species as they provide a place to hide and feel secure, to raise young in, and particularly if the exhibit is outside, protection from all elements of weather.
Nest boxes should be large enough to comfortably fit one or more individual animals and the opening should be as small as possibly be still allow to the Pygmy-possums to move freely in and outside without injury or discomfort. The lid of the nest box should be able to open up completely if the possum needs to be captured or checked. If the lid cannot be opened, large doors can be cut out of the side of the nest box and used in the same way. There should also be a piece of plastic that can cover the nest box opening that is attached just above the hole that can swing into place when you need to restrain an individual. The diagram to the left shows this.

Fig.56. Nest boxes (own picture)

Stephen M Jackson, author of "Australian Mammals" recommends that a thin piece of wood with marks cut into it, attached to the sides of the next box to allow the possums (especially juveniles) to climb out of the box.
An average size for a suitable nest box for an Eastern Pygmy-possum is 18cm x 12cm x 10cm.

In the wild, Pygmy-possums will have use up to 3 nests at a time so it is important to provide **more than one nest box** inside the enclosure for the possum to choose which one to use.
He will change between them.

Nesting material:

The most common material Pygmy-possums use to build their nests with is the bark from the Stringybark tree (*Eucalyptus tetrodonta*).

Fig.58. Inside Nest Box (own picture)

It is soft, provides warmth, and is flexible.

This allows for the possums to manipulate the bark into a shape that is most comfortable for them. Inside the nest box, Pygmy-possums curl up into a tight ball and tuck themselves in the bark on cold days. They usually have one or two spots in

Fig.57.Stringybark tree
(http://www.waterwheelcreek.com.au/images/gallery/tall_stringy_bark.jpg)

the corners already ‘pre-made’ to fit their body shape.

Fig.59. Feather
(http://www.diggerhistory.info/images/asstd3/white-feather2.jpg)

The Stringybark is a very tall straight tree that can grow up to 30m with bark that is rough, fibrous, and stringy. The outer layer may be too hard for nesting material, so by removing this layer, a softer layer of bark will lie underneath that can be easily pulled off, broken up into smaller pieces and placed inside the nest box.

Other nesting materials such as soft feathers (Eg: emu) can be added to the nest box to give them some extra warmth and comfort. Fresh green leaves are appropriate and many eucalypt leaves will provide them with environmental enrichment because this is a natural smell that they would come across if they lived in the wild.

These materials can also be spread around the enclosure as another form of environmental enrichment. It means that they need to collect it themselves and take it back to their box, therefore stimulating a natural reaction.

Fig.60. Pygmy-possum in the tree tops
(http://www.mammalogy.org/mil_images/images/mid/326.jpg)

4.9 Enclosure furnishings

The most important pieces of furnishings in any possum enclosure are the branches. Naturally Pygmy-possums live in trees and are very agile while climbing and jumping between branches. By supplying a network of climbing perches, you are providing the Pygmy-possum with both its physical and behavioural needs.

Branches or perches should be placed in a way that allows maximum use of the enclosure.
Be sure to address any OHS issues such as position of branches to prevent injuries.

Fig.61. Eucalypt leaves
(http://www.kriyayoga.com/photography/photo_gallery/d/17745-2/eucalyptus_leaves-dsc00101.jpg)

Fresh browse with leaves should be placed inside enclosures attached to perches and walls of the enclosure every couple of days to add to the naturalistic setting. These leaves will provide added shelter as well as a visual barrier to hide from the public or other individuals in the exhibit.

Rocks and shrubs can be added to the bottom of the enclosure to create a natural environment and stringy-bark can also be placed in different areas within the enclosure for the possum to use as nesting material. Make sure these pieces are not too large as the possum may have difficulty carrying it around.

5. General Husbandry

5.1 Hygiene and Cleaning

In any animal care facility, cleaning is a major part of daily routines and is perhaps the most important.

Basic daily cleaning routine

All animal exhibits should be cleaned daily to remove faeces and uneaten food. Depending on what kind of exhibit you hold your pygmy-possums in, you may need to rake, dust or scrub to get rid of any dirt or to make the exhibit look aesthetically pleasing for the public.

Fig.62. Cleaning equipment (http://www.allprostaffnet.com/cleaning-tools.jpg)

Feeding areas should be as clean as possible to prevent any health problems that can occur due to bacteria entering the food or poor hygiene.

All animals in captivity need to have access to clean drinking water at all times. Water bowls need to be refilled DAILY. I recommend you clean the bowl in fresh water first to make sure all dirt and bacteria is removed.

Fig.63. water bowl (https://www.thereptileroom.co.uk/catalog/images/Exo_Terra_Water_Bowl.jpg)

REMEMBER: if you wouldn't drink it, don't expect the animals to.

A full clean and scrub of the enclosure should be done every couple of months.

However, whilst caring for an Eastern Pygmy-possum I have found an easier way to effectively clean the exhibit:

- Browse needs to be changed frequently before it completely dies and so by placing the possum into a holding area or transport container, you can change the browse, as well as do a light clean of the entire exhibit.
- A wipe down with a disinfectant such as F10 should be sufficient. Let the exhibit air out for 15 minutes before replacing the animals.

It is always easier to do regular routine cleaning rather than a big super-clean every couple of months!!

When animals permanently leave the exhibit for any reason and will not return, all nest boxes, bowls, perches, platforms, walls and wire need to be scrubbed and cleaned with an appropriate disinfectant before new animals enter. This ensures that there is no transfer of potential disease or the growth of bacteria which could become a major health problem.

Chemicals that should and should not be used

The most common chemicals used to clean animal exhibits are F10 and Animal House. Chemicals that should not be used in an animal exhibit include bleach (or chlorine) as well as any disinfectants that are not specifically intended for animal use.

The chemical that I use and recommend is
F10 CS Veterinary Disinfectant.

F10 is a disinfectant that, unlike other strong disinfectants on the market, has no negative side effects on people, animals, or on equipment and surfaces. It is ecologically friendly, biodegradable, and carries a wide range of registrations and approvals from around the world.

Fig.64. F10 SC (http://vetnpetdirect.com.au/files/P/t_17043.jpg)

In Australia, F10 is registered by the APVMA (Australian Pesticides and Veterinary Medicines Authority) for use in animal production and housing facilities, approved by AQIS (Australian Quarantine Inspection Service) for use in food export processing as a non-rinse disinfectant.

Benefits of using F10:

- Kills all types of pathogen – F10 is bactericidal, virucidal, fungicidal and sporicidal.
- Minimal chance of microbial resistance due to F10's unique benzalkonium chloride and polyhexamethylene biguanide combination of actives and mode of action.
- Rapid kill times – less than 30 secs for gram positive bacteria, 60 secs for gram negative bacteria, Canine Parvovirus 20 mins.
- Non-corrosive, non-toxic, non-tainting, non-irritating, aldehyde-free.
- Highly cost effective.
- Biodegradable & ecologically friendly.
- Tried, tested, independently verified and documented, and approved around the world.

How to dilute F10: (mL of solution: mL of water)
General disinfection: dilute 1:500
High level disinfection: dilute 1:250
For the most resistant viruses (eg parvovirus): dilute 1: 125

By using the general disinfection dilution for daily routine cleans, this will get rid of potential bacteria around nest boxes or feeding areas. You may want to use a higher level disinfection when scrubbing out the exhibit once the animal has permanently moved out.
F10 is easily used by placing the mixed solution into a spray bottle and simply spraying and wiping platforms and perches. Alternatively a bucket and sponge can be used.
A 200ml bottle will cost around $25 and the time it last depends on how much you use daily and what level of disinfection is required.

- **All MSDS'can be found in Appendix 9**

Animal house is also a great disinfectant, although it does foam up quite a lot and is more suited to exhibits that have a concrete floor that can be rinsed down easily. An example of an environment such as this could be a quarantine area or holding area that needs to be scrubbed down daily.
In our case with the Pygmy-possums this product would not be suitable as the substrate and all other furnishings would get wet. However, if your exhibit or holding area is getting fully scrubbed out and is metal or made from a material that can get wet, Animal House would be suitable to use by pouring and scrubbing with a brush. Remember to rinse off thoroughly after use.

Any disinfectant that states that it is safe to use in animal environments and has no side effects on both people and animals is ok to use. Be sure to read all directions and precautions before using.

- Another point to remember is the use of MSDS's.

An **MSDS** (Material Safety Data Sheet) is a document providing information, OHS, ingredients, and first aid for all chemicals used in the workplace. It is important for all staff to read MSDS's before working with that chemical and documents should be placed within 3 metres of the product to ensure easy access.

Changing of nest material, substrate, and branches.

Fig.65. Nesting material (www.thebegavalley.org.au/../?C=M%3BO=A)

Replacing nest material, substrates and branches all depend on how many individuals you are housing in the one enclosure.
The more animals → the more mess they will make and therefore → more frequent cleaning.

Nesting material needs to be replaced whenever it looks flat and rigid. This normally only needs to take place every couple of months.

Fig.66. Leaf litter (http://1.bp.blogspot.com/_zKDjcLXZBTI/R0clPvaRciI/AAAAAAAABMA/1KyenTuH4qg/s400/Blog_039a.jpg)

Depending on the substrate you use, you may only need to change it annually or whenever you do a big clean. Light coloured sand shows more dirt and faeces so by sifting this every month or two should be adequate.

Sand should be completely replaced at least bi-annually to get rid or any potential bacteria.
Leaf litter substrates can easily be replaced by throwing out the old leaves and collecting new dead leaves from the ground around your workplace. Leaf litter can be left for a long time, usually about 6-12 months before it needs to be changed.

Enclosures should contain a permanent branch network that can be screwed to the walls to hold it in place. These are also referred to as perches. I have found it is best to obtain a tree fork that can stand on the bottom of the enclosure and fill up a large amount of space within the exhibit.

These permanent perches only need to be replaced when they start to deteriorate.

Browse should be replaced every couple of days to ensure it stays fresh. Dead leaves do not appeal to the public eye and it isn't so great for the possums either. Environments need to be as natural as possible…this includes fresh branches and leaves.

Browse can be fastened to the branch network in any possible way. Remember that Pygmy-possums only weigh an average of 20 grams so they will use browse to climb and jump on. Therefore make sure that browse is spread apart and placed in a way that they can use and move along it effectively and easily.

Browse should be cut from trees that naturally occur in the Australian bush.

For example: Eucalypts, Tea trees, Wattle, Banksia.

Fig.67. Wattle
(www.jimlow.net/blog/?cat=11)

Cleaning of nest boxes

I recommend at least wiping the nest box out whenever you change the materials inside.
A proper clean of the next box, using F10 should be done approximately every 5 or 6 months and whenever the animals permanently leave the enclosure.

By spraying the inside and outside of the box and giving it a good wipe, this will get rid of any bacteria and the potential spread of disease.
Remember that this is where the possums spend a lot of their time and it isn't that ventilated, so leave the nest box outside in the sun so it can dry properly before replacing back into the enclosure.

Summary

Daily	Clean exhibit- remove faeces and uneaten food Rake, scrub or dust to make it look aesthetically pleasing Refill water bowls Distant and close examinations Record keeping and observations (note any changes in behaviour) Every couple of days → change browse
Weekly	Scrub and disinfect water and food bowl Fortnightly → Weight
Monthly	Every 3 months → full scrub of enclosure → replace substrate Every 4 months → Clean nest box and replace nesting material. Treat for parasites (Carbaryl powder)
Bi-annually	Collect faeces for faecal floatation to detect parasites

5.2 Record Keeping.

Keeping records in an animal care facility is extremely important.

> Record keeping is a way to COMMUNICATE to other staff members or facilities and is a log of an individual specimen's history

There is so much information in an animal care facility that can be recorded in different ways. Records can be done daily, weekly, monthly, or even yearly depending on what it is you are measuring or documenting.

Keepers can record and make comments about:

- Health problems and treatments
- Veterinary examinations
- Behavioural problems
- Reproductive stages
- Conditioning
- Changes in diet
- Movements within and between institutions
- Deaths or births
- Enrichment
- Weights and measurements.

Records can be documented or written in so many different ways.
These can include: diaries, computers (record systems), folders, specific record sheets for that species, cage cards, and many more.

Anything that you write as a keeper or carer is a record. Observations or comments are definitely included!

Fig.68.Daily Diary (http://www.mvmc.org.uk/user-images/4409/moleskine_daily_diary-1.jpg)

Remember when writing out records to keep them organised, up to date, and stored in a safe place such as a cupboard in an office.
If records are next to enclosures, make sure they stay there and can be easily accessed by any keeper at all times.

The collection of information on each individual's physical and behavioural patterns can contribute greatly to the husbandry of the species. In most larger institutions, ARKS (for general information on births, transfers and deaths), SPARKS (breeding studbook for species), and MedARKS (veterinary information) are used. These systems have been developed by the International Species Information System (ISIS). As these are standardized, there is a high degree of efficiency in transferring information between institutions. (Jackson, S M 2003)

Included in Appendix 9 are a set of records for Marni (Eastern Pygmy-possum) from both Taronga Zoo and Australia Walkabout Wildlife Park. (Seven pages)

The first five (5) pages are records of when Marni was first taken into care by Taronga Zoo. These records include observations, weights, diet changes and daily dietary intake. → Any information regarding Marni while he was in their care was recorded and passed on to Australia Walkabout Wildlife Park in November 2007.

The last two (2) pages are records from Walkabout Park for Marni's first year. The information in these are similar to that of Taronga Zoo's but are not DAILY records. Any changes to the normal daily routine or personal observations have been recorded.

- **These records can be found in Appendix 10.1 and 10.2**

PLEASE NOTE: in the following records, Marni is referred to as a FEMALE ♀, this was however a mistake and only when he got to Australia Walkabout Park was he properly and accurately sexed.

HE IS DEFINITELY A TRUE BLUE AUSSIE MALE!!

Codes that should be used when communicating and recording information:
(these are recognised in a wide variety of animal care facilities)

ACQ = ACQUISITION
Any importation from outside collection, public donation, or capture from grounds or from the wild.

B/H = BIRTH/ HATCHING
BIRDS: generally recorded as hatch date. If date of leaving the nest is used, note it.
MARSUPIALS: date of which the animal is 'permanently out of the pouch', or the day the juvenile is thrown from the pouch.
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, releases, sales, escapes

BRD = BREEDING
Reproductive details/ observations. Any nesting, laying of eggs, oestrus, menstruations, matings, courtship, pouch checks, sexing, or any other reproductive matter.

INT = INTERNAL MOVEMENTS/ TRANSFER
Any movement of an animal from its residing enclosure, 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 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. Eg behaviour, change to routine etc. Also anything else of interest. Eg animal management procedures, diet changes, maintenance.

5.3 Methods of identification

There are many different ways an animal can be identified.
Individual identification techniques can be temporary or permanent and each technique has its own advantages and disadvantages.
Examples of temporary: Cage cards, collars, thumb bands, markers.
Examples of permanent: Microchip, scale clipping (reptiles), ear tags, ear notches, tattooing

Considering a pygmy-possum's size, applying some sort of identification can sometimes prove difficult.
The following methods may be suitable for this particular species:

- **Microchip implants**: Very small microchips are inserted into the interscapular area (between the shoulders).

When the pygmy-possum needs to be identified, he is simply scanned and a number is given: this is his individual identification number.

Fig.69. scanner and applicator. (http://www.chaseview vets.co.uk/images/id2.jpg)

Advantages:

- Permanent form of identification
- Lies underneath the skin therefore it cannot be seen by members of the public.

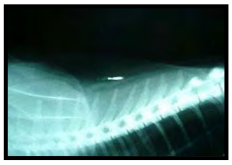


Fig.70. Microchip (http://www.traditionsanimalhospital.com/local/136/microchip1.jpg)

Disadvantages:

- Scanners are needed to be able to search for the microchip and to obtain an individual number. These can be quite expensive but it would definitely be beneficially if you are microchipping a number of animals.
- Need to use the scanner to identify ∴ not immediate when you look at the individual.
- Possum needs to be at least 10g
- Can be painful if done incorrectly

➔ **Ear notches:** This technique is more common in older individuals or even animals that are not on exhibit. However, ear notches can still be used on an animal on display.

A sharp punch or scissors are used to remove a small piece of tissue from the pinna (ear). These are different shapes and sizes to one another to be able to distinguish individuals.

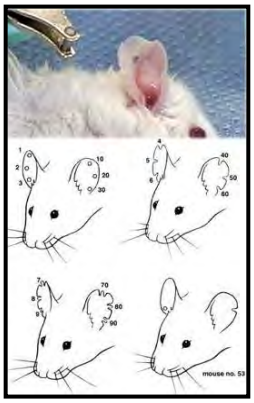


Fig.71.Ear notches on a mouse (http://www.bu.edu/research/compliance/lacu/lacf/images/ear-punching_clip_image002.jpg)

Advantages:

- Easily and readily identified by simply looking at the individuals.
- Cheap

Disadvantages:

- Not visually aesthetic (does not look good to the public) HOWEVER pygmy-possum ears are very small and notches would be tiny so could get away with this.
- Could possibly cause pain to the animal if not done properly.

Fig.72. Metal ear tags (http://www.nationalband.com/1005-1l1.gif)

➔ **Ear tags:**

Ear tags are plastic or metal tags that hang off the ears of an individual. Sometimes they can be different colours or consist of a number written on across it (eg: 5746)
Advantages and disadvantages are similar to those of ear notches.

Fig.73. Plastic ear tags (http://www.ece.ndsu.nodak.edu/%7Eglower/RFID/May17_Pictures/Collection_of_RFID_Tags.jpg)

Advantages:

- Easily and readily identified by simply looking at the individuals.
- Cheap

Disadvantages:

- Not visually aesthetic (does not look good to the public) → even small tags that would fit a pygmy-possum sometimes do not look good especially if there are multi-coloured possums flying all over the enclosure.
- Could possibly cause pain to the animal if not done properly.
- Pygmy-possum's ears are very thin and membraneous and a metal or plastic ear tag could be quite heavy and can even effect the functioning of the ear

→ **Tail Tattooing:** Tail tattooing is very common in animals such as rats and mice. Pygmy-possums are similar and any sort of tattooing is done under an anesthetic.

By tattooing small circles, different shapes or numbers, individuals can be identified visually.

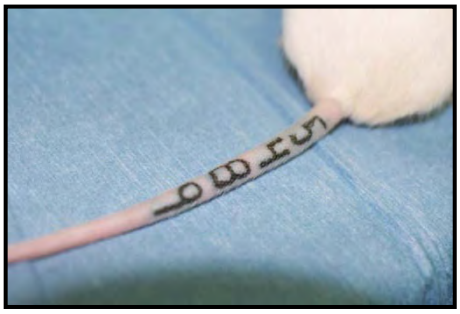


Fig.74.Tail Tattooing on a rat (http://www.braintreesci.com/images/mouse%202.JPG)

Advantages:

- Permanent form of identification
- Does not inhibit function of the animal
- Painless (done when the animal is under anesthetic.)

Disadvantages:

- May be able to be seen by the public but these markings would be very small.
- Keepers would more than likely have to catch the possums before they could get an accurate reading. This is easy if the timing is right (when they are sleeping or in torpor)

The above techniques are just examples of what CAN be done in order to identify individuals. **Personally** my preferred technique is…

a microchip implant.

Although it can be expensive, I feel that it is worth purchasing a good quality scanner which can be used over and over again. Implants do not inhibit the movement and functioning of the individual and through the eyes of the public, nothing can be seen → ∴ **NATURAL**

I have never come across or witnessed tail tattooing, but this could be a good option if money is the issue.

Marni has NO ID as he is the only pygmy-possum in the whole wildlife park. He is alone in his enclosure so there is no need for any necessary identification.
Names can be a form of identification → so can distinguishing features.
Marni's right ear pinna has been torn down and then healed ∴ deformed. It is very different to his left ear and if Marni ever needed to be identified for any reason, this distinguishing feature would play a large role.

5.4 Routine Data Collection

This includes any records which may be required as part of a long-term study such as growth and development and blood biochemistry.

February 2009
Marni is currently on a diet as he is getting quite large for his size and is very unfit.
We are therefore weighing Marni frequently (approx every 2 weeks) to see how he is progressing with his diet and exercises.

- **These records can be found in Appendix 10.3**

6. Feeding

6.1 Wild Diet

Fig.75. Eastern Pygmy-possum (http://www.wildlifetasmania.com/images/Eastern%20pygmy%20possum.jpg)

Eastern Pygmy-possums are nectarivores, which are animals that consume the sugar-rich nectar from flowering plants.

In the wild, the Eastern Pygmy Possum feeds mostly on nectar and pollen collected from heath banksias, eucalypt flowers, bottlebrushes, and grevilleas with its brush-tipped tongue.
Some keepers suggest that these flowers should be cut in the early hours of the morning when all the nectar is still there.

HOWEVER, through my experience of caring for an Eastern Pygmy-possum, generally, I don't like to put fresh flowers into enclosures in the mornings because this attracts ants and a pygmy-possum being nocturnal will only end up eating the flower that night. By picking flowers in the morning, placing them in a bowl in the fridge and then positioning them around the enclosure around lunchtime or later in the afternoon, this should be sufficient
If you really want to put in flowers into the exhibit in the morning, you can place them around the enclosure, but not anywhere near the nest boxes as a sleeping Eastern Pygmy-possum can become vulnerable to a large group of ants.

I do however recommend cutting flowers in the morning and placing in exhibits if your pygmy-possums are housed in a nocturnal house.

Flowers:

Fig.76. Banksia (http://www.seenobjects.org/images/mediumlarge/2004-09-05-banksia.jpg)

Heath Banksias (*banksia ericifolia*)are probably the most common know species in the genus. They are widespread throughout central and northern New South Wales, east of the Great Dividing Range and are famous for their orange-red colour.
New growth usually occurs during summer (lime green) and flowering is in autumn or winter where they turn an attractive orange colour.

Fig.77. Eucalypt Flower. (http://www.malleenativeplants.com.au/wp-content/uploads/2006/12/eucalyptus_foecunda_100_4382.jpg)

There are many different species of **Eucalypt flowers** and many are found on Australia's East coast. Every species of tree's flowers are different shapes, sizes, and colours. By researching your area, you can find out what species is most abundant.

Fig.78. Grevillea
(http://asgap.org.au/jpg2/imp4072.jpg)

Grevilleas are evergreen plants with needle-like to fern-like foliage and have distinctive flowers. They are valued for their beauty as well as for providing nectar to many different birds, insects and mammals. Ranging from small shrubs to large trees, these bright flowers are usually in blossom throughout the year and can be found in many areas around Australia.
The two most common flowers found on the East Coast are either white or pink in colour (fig.77)

Fig.79. Bottlebrush
(http://www.fbmg.com/CommunityEducation/PerennialSales/Perennial2007/perennialphotos/HannahRayBottlebrush.jpg)

Bottlebrushesare members of the genus *Callistemon*and mostly occur in the east and south-east of Australia.

Bottlebrushes can be found growing from Australia's tropical north to the temperate south. They often grow in damp or wet conditions such as along creek beds or in areas which are prone to floods.

Pygmy-possums frequently feed off a variety of fruits. This of course depends on availability, time of year and habitat.

While pollen and nectar provides the possum with most of its required protein, small insects are sometimes consumed throughout the year. This can be important to possums living in wet forests where fruit and flowers are less plentiful.

6.2 Captive Diet

Within a captive institution, it is the keeper's responsibility to try and replicate a natural environment. This not only includes nesting sites or furnishings. It also includes an appropriately balanced diet!

Fig.80. Grapes
(http://www.healthyweightlosshelp.info/wp-content/uploads/2009/01/grapes.jpg)

It is important that animals that are being cared for are given the correct type of food and the right amount.

Fig.81. Apples
(http://shuvecchadhaka.com/images/Apples_medium.jpg)

At Australia Walkabout Wildlife Park, their Eastern Pygmy-Possum enjoys a variety of fresh fruits and vegetables daily, as well at blossoms and the occasional mealworm.
Fruits include: Apples, Grapes, Watermelon, Rock-melon, Peaches, Pears, and Sultanas

Vegetables include: Sweet Potato and Carrot

Fig.82. Watermelon
(http://www.seedlesswatermelonseed.com/images/image_cover.jpg)

Note: A diet change will need to take place when changing from winter to summer and vice versa as there are different fruits in season at different times of the year.

Fig.83. Peach (http://aggie-horticulture.tamu.edu/syllabi/319/images/peachfruithalf.jpg)

Fig.84. Pear (http://www.bctree.com/images/photos/pear-bartlett.jpg)

Fig.85. Rockmelon (http://www.taste.com.au/images/articles/untitled12031014.jpg)

Fig.86. Sultanas (http://virtualhug.files.wordpress.com/2007/08/sul.jpg)

Fig.87. Sweet Potato (http://uhaweb.hartford.edu/KENNEY/sweet_potato.gif)

Fig.88. Carrots (http://www.businesspundit.com/wp-content/uploads/2009/03/carrots.jpg)

<u>General Daily Diet for a Pygmy-possum in Captivity:</u>

1 grape cut up into tiny pieces
1 sultana
Small amount of vege (carrot or sweet potato)
Small amount of fruit (any of the above mentioned)
½ tsp millet seed
1 Banksia flower
1 Grevillea flower

Remember "small" really does mean small! Possums eat with their hands so pieces must be small enough for them to hold.
The picture to the right (Fig 15) shows approximately how small the pieces should be.

Fig.89. Piece of Carrot (own picture)

The following recipe is a nectar mix that shouldn't be used as a substitute diet. Rather, use it as environmental enrichment by smearing on perches or use as a treat…only every now and then.

Fig.90. Bowl of food (own picture)

Nectar Mix

900mL Warm water
900mL Honey
6 shelled hard-boiled eggs
150g high-protein baby cereal
6 tsp Sustagen (vitamin supplement)

Method

1. Add the warm water into a 2 litre jug and then solely add the honey and stir until dissolved
2. Blend the eggs (no shells) until mushy
3. Add half the honey/ water mix and blend. Add remainder of mix and blend
4. Add sustagen and half the baby cereal and blend
5. Add remainder of baby cereal. Blend for 1.5 minutes to make lump free
6. Can be stored for up to 2 weeks.

Around 10-15mL should be given per day when needed.

Keeping mealworms

Fig.91. Mealworm
(http://www.recorpinc.com/images/mealworm.jpg)

Keeping mealworms is easy as they breed at a fast and constant rate.
By setting up an appropriate environment for them, you will only need to buy an initial pack from a pet shop.

Easy step-by-step guide:

- Purchase a deep plastic container. The size depends on how many mealworms you intend to have,
- Fill the container with bran, leaving about a 3cm gap from the top of the container.
- A small piece of folded hessian bag can be placed inside the container to enable them to escape from the bran if needed (this always makes it easy when collecting them daily)
- Place your mealworms inside!
- Food: around 3 small chunks of fruit and vegetables can be thrown in daily.

Whenever I have kept mealworms, I have always placed the container on a tray of water to prevent the entry of ants or other invertebrates.

Fig.92. Mealworms
(http://www.reptiles.swelluk.com/reptile-care/keeping-mealworms.html)

A mealworm:
Moisture: 62.62%
Fat: 10.01%
Protein: 10.63%
Fibre: 3.1%
Calcium: 420 ppm

Food Quality

Fig.93. Fresh Fruit (http://blog.americanfeast.com/images/Fresh%20Fruit.jpg)

The following rule applies to ALL ANIMALS that are under your care in captivity:

If you wouldn't eat or drink it…don't expect the animals to.

Clean water needs to be provided EVERY MORNING to prevent disease.
Food needs to be of a good quality in order for the animal to receive the right nutrients from it.
Food cannot be fed to animals if it is off or passed its 'used-by-date'
If you wouldn't eat it…throw it out.

Giving your animals the right food is the most important job as a keeper.

In your food preparation area or kitchen F.I.F.O should apply.

First- In – First - Out

This means that newer food needs to placed at the back of the fridge or freezer so that the older food gets utilized first. This prevents old food going off which risks contaminating other food surrounding it.

Food Storage

In order to keep food as long as possible and in good condition, the correct storage is needed for each group of food.

In order to keep fruit and vegetables fresh, they need to be stored in a cool room or refrigerator (5°C -10 °C). Food contamination can occur by leaving food out or storing in an environment with the incorrect temperature range.

Fig.94. Fridge (http://www.design-industry.com.au/en/wp-content/uploads/2007/07/fridge_01_400x400.jpg)

The following general rules apply to ALL ANIMAL FOOD PREPARATION AREAS.
Note: Some of these dot points may not particularly relate to the Eastern Pygmy-possum but it is important to abide by these in order to keep food fresh and clean.

- Food should not be left out of the refrigerator
- Food should not be thawed on the bench (thaw in fridge)
- Do not store cooked food underneath raw food (In Pygmy-possum's case → do not store fruit underneath meat)
- Do not share the same plate for cooked and raw food
- Do not store food containers without lids on top of each other.

Nutritional Problems:

Many different nectarivorous mammals in captivity including the Eastern Pygmy-possum are prone to two main nutritional problems.

These include:

1. **Low calcium level**

Like in humans and many other species, low levels of calcium can lead to bone and dental deficiencies or disease.

2. **Obesity**

Feeding a diet that is too high in fats and sugars can cause obesity and breeding problems. Insects such as mealworms are very high in fat and should only be fed out as a small part of their diet. Mealworms that are white can however be fed because at this stage which doesn't last very long are high in protein and low in fat.

Fig.95. Mealworm pupa (http://mealwormstore.com/images/pupa.jpg)

Pygmy-possums should be weighed at least once monthly, even fortnightly to ensure they are not gaining too much weight.

Fig.96. Mountain Pygmy-possum (http://www.abc.net.au/science/scribblygum/May2000/img/possum2.pg.jpg)

It is important to note that Pygmy-possums naturally pick up a little bit of weight in autumn, to prepare for the colder months.
If your Pygmy-possum is dramatically picking up weight, you can cut out the mealworms or sultanas for a period of time.

6.3 Supplements

Gut-loading is an excellent way of providing needed vitamins and minerals to your Pygmy-possum.
There are many different brands of Gut-load that you can buy online or at a large pet shop. It is basically a commercial mix that you feed mealworms or any other insect before they are fed to ensure that your Pygmy-possum are getting their required vitamins and minerals from the mealworms.
It is an easy way of providing any animal with needed nutrition.

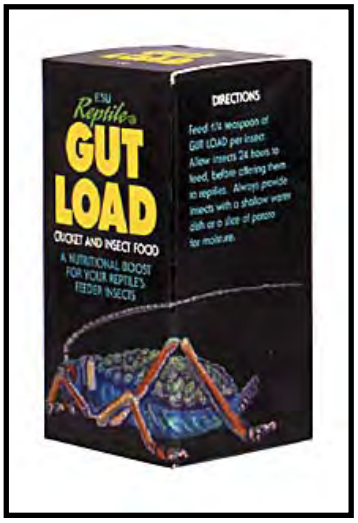


Fig.97. Gut Load (http://www.wormman.com/prod_images_large/gut_load1.jpg)

Commercially available live mealworms and crickets are often under-nourished
It is for this reason; I suggest gut loading your live insects for 48 hours prior to feeding the mealworms to your Pygmy-possum.
After all, you want your insects to be well fed before they are ... well ... fed.

Gut-load is usually cheap and can be purchased easily.

- **All manufacturer/ company details of products can be found in Appendix 17**

6.4 Presentation of food

Food should be cut up into tiny pieces that are small enough to fit in their hands… About 4mm^2 cubes.

Environmental enrichment is always encouraged in any captive environment where possible. Enrichment can be described as a means of "enhancing the environment of captive animals to provide more stimuli through alterations in the physical environment." (Project R&R, USA) We as keepers, therefore encourage natural behaviours that satisfy an animal's physical and psychological needs.

In the wild, animals will spend a large amount of time and energy finding and processing food, building their nests and defending their territories. The majority of their waking hours may be spent meeting these needs. Due to the fact that a captive environment is not the same as what the animals would be used to in the wild, behavioural needs may not be addressed and so, environmental enrichment is critical.

The aim of environmental enrichment is to increase animal well being by increasing exercise, satisfying behavioural needs and optimising the level of stimulation that our animals receive, as well as attempting to reduce abnormal behaviours, and keeping them active.

Eastern Pygmy-possums in captivity do not travel long distances to find food and so therefore do not use as much energy as they would in the wild. By scattering food around the enclosure, this is encouraging a natural behaviour and is therefore →ENRICHMENT. This can help to prevent obesity and boredom.

Fig.98. Exo Terra food bowl
(http://www.petdiscounters.com/mc_images/product/detail/hagen_exo_terra_pt2803_granite_rock_water_00.jpg)

If bowls are used, any sort of sturdy metal bowl is appropriate. Bowls can be either be attached to the cage wall or if you are going for the more natural look...hidden behind a rock or something similar so the public cannot see.

Personally, I prefer bowls that look natural and don't stand out in an enclosure. Exo Terra has a wide range of different sized bowls that can more than often blend into the surroundings in an enclosure.

7. Handling and Transport

7.1 Timing of Capture and Handling

Fig.99. Pygmy-possum at night. (http://wwwdelivery.superstock.com/Image/1701/Thumb/1701R-19111.jpg)

Eastern Pygmy-possums are nocturnal and therefore it is easiest to capture and handle these mammals during the day when they are asleep in their nest box. If held in a nocturnal house, early in the morning is generally a better time to restrain them before the lights are turned off.

During the warmer months (spring and summer), Eastern Pygmy-possums become more active and may possibly still be awake in the morning or during short periods throughout the day.
Especially during summer, even if a possum is still awake, capturing should be done in the morning before it gets too hot.

During winter months, Pygmy-possums are a lot easier to catch and handle as they go through a state of hibernation, called torpor.

Fig.100. Pygmy-possum sleeping. (http://www.abc.net.au/reslib/200909/r436286_2097421.jpg)

If you have no choice when to capture a Pygmy-possum and these agile creatures happen to be awake, they can be netted or easily trapped inside the enclosure.

Important note:
Consider your facilities opening and closing times, and the public:

- Do you want the public to watch the capture?
- Can the Pygmy-possum escape while members of the public are potentially opening and closing doors to inside areas?
- A crowd of people will probably scare the Pygmy-possum and continue to stress it out even more.

7.2 Catching bags

Fig.101.Catching bag (http://www.prime-weld.co.uk/store/images/uploads/smlnet.jpg)

Eastern Pygmy-possums can be easily caught if asleep, however if they are running around in a large enclosure, this may be more of a challenge. Nets are probably the easiest to use as they are so agile and quick. Using a bag would be a lot harder.
By catching it in a small net and transferring it into a cotton bag as soon as possible can make things easier.
Be aware that this method may prove difficult if there are lots of perches and branches, and only small open areas.

7.3 Capture and Restraint Techniques

If capturing a possum for the purpose of moving it into another enclosure or anything else that does not require direct contact, this can be easy. Quieter individuals can be encouraged to move from a nesting box into a bag.
Another way of moving possums into another enclosure or into a transport container is to move the entire nest box. By securely blocking the entrance, simply pick the box up with the possum inside. Once inside the enclosure, remove whatever is blocking the entrance. By moving nest boxes, possums settle in quicker and easier.

Directly capturing an Eastern Pygmy-possum is a lot easy than handling any other possum. They can be easily picked up and held in your hand.

If the possum happens to be awake it is highly recommended that you gently but firmly hold the base of its tail in between two of your fingers to prevent the possum from possibly escaping. These marsupials are very quick and can EASILY slip out of your hands!

Fig.102. illustrates the correct way of handling an Eastern Pygmy-possum while it is awake.

Fig.102. Correct handling technique. (http://www.mammalwatching.com/Australasian/Images/NSW/Pygmy%20Possum.jpg)

If the possum is asleep, which it should be during the day, you've got it easy. By simply opening the nest box, you will be able to see that the possum will be rolled up in a ball, fast asleep. You can then reach into the box and carefully bring him out. They will generally be asleep for most of the day and it takes a while to properly wake up and become active so gently holding him in your hands should be enough to secure him for a while.
BUT remember: once he starts to become active, he will try and escape so hold on tight!

By gently cupping the Eastern Pygmy-possum in your hands, you can significantly reduce the stress caused by handling. This way, it feels safe but is also restrained.

Fig.103. Pygmy-possum being gently cupped. (http://www.windgrove.com/ee/images/uploads/pygmy_hand.jpg)

Precautions:

- If enclosure is inside a building and the possum is awake, make sure all windows and doors are closed in case he escapes.
- Pygmy-possums are not known to bite however; they may do so during stress or capture, this is generally not painful.

7.4 Weighing and Examination

Weighing and examining can be either very difficult or very easy and it has all got to do with timing. If the possum is awake it may be very hard, but if he is asleep he can easily be placed onto a scale.

If the possum is asleep, a bag isn't normally needed however if it is awake, a small calico must be used to weigh successfully without it escaping.

In summer, I recommend weighing or examining an Eastern Pygmy-possum in the middle of the day when it will be asleep, but be considerate of temperature extremes.
In winter, possums will generally always be asleep so anytime of the day is ok.

Fig.104. Eastern Pygmy-possum being weighed on a digital scale. (Own photograph)

Digital scales are easiest to use. **Fig.104**. shows an Eastern Pygmy-possum being weighed.
Scales that measure grams is needed as your possum won't even reach the 50g mark.
Hanging scales can also be used by tying a bag with the possum inside to the end of the hook.

7.5 Release (from box or bag)

When a possum has been transported between enclosures it is important to let it feel comfortable in it's new environment.
Open the bag or box and uncover his head so he is able to see everything surrounding him. Stand back, out of the enclosure and let him venture out in his own time when he is ready. This reduces stress and the possum will probably settle in quicker into his new home. Once the possum has fully emerged, the box or bag can be removed from the enclosure.

Fig.105. Pygmy-possum inside a cotton bag. (http://www.marsupialsociety.org/images/bushfire_2a.jpg)

When first placing the box or bag inside the enclosure, make sure it is in the middle of the enclosure or in an open area. If there are lots of obstacles or walls and the possum gets scared and quickly runs, he could easily bump into perches, logs, or surrounding enclosure walls.
Minimise noise to reduce stress and don't let members of the public watch this procedure if during opening times.

Another alternative is to move the whole nest box if possible.
If a Pygmy-possum is moving into a new enclosure, it is often easiest to transfer the whole nest box with it inside. This way he will have something that is familiar to him once he moves into a new environment. The nest box can either be removed once the possum has settled in or left inside the enclosure permanently.
This is normally the easiest option but is not always possible.

Time of day

Outside opening hours is the best time to release animals into new environments. This way the park or zoo will be quiet with no members of the public to add to any stress that the animal may already be experiencing.

Pygmy-possums are nocturnal. Sometimes it is better to release them into a new enclosure late afternoon, as you can keep your eye of them for a couple of hours before you leave to go home and the possum is able to explore the new environment during the night.

If Pygmy-possums are released during the day or in the morning, they may have members of the public peering inside his new home while he is still trying to get used to it. However, this can be avoided by sectioning off the area to public for a day or two.

7.6 Transport requirements

Appropriate preparation needs to go into any transportation of an animal.
The following things need to be brought to attention and completed before transportation can take place:

- **Contact ARAZPA** if your facility is a member and fill out necessary forms.
- **Contact the Zoo or Park** the animal is going to. Make sure they have adequate housing and requirements for the Pygmy-possum BEFORE it arrives.
- **Vet check-ups** need to be done before any animal leaves your institution. This includes recording all information such as weights, observations and individual identification. Identification should be fitted before transporting. All this information needs to be copied and sent to the destination.
- **Conditioning** the animal a couple of months before transport **may** be appropriate to effectively reduce stress on the day.
- **Climatic conditions at destination should be researched:** Animals should not be exposed to temperature extremes or draughts whilst travelling and settling in to their new enclosures
- **Notify** the destination zoo of expected time of arrival and the route that you will be taking.

7.6.1 Box Design

Nest boxes should be placed securely into a transporting box to reduce stress and provide the possum with a warm comfortable area to rest.

Ideally, for both long-term and short term transportation, boxes need to be large enough to fit a nest box inside as well as room to move and for a water container and possibly a food container.

The International Air Transport Association has a set of guidelines for each species and their transport needs. The basic principles should be met at all times for the wellbeing of any animal.
All Pygmy-possum species are under "**Container requirement 31**" in the IATA book.
Under the same section are various different species of smaller primates and other possums. It is important to note that some of the information will not apply to Pygmy-possums as they are the smallest species on the list and some principles or notes may not be suitable.

IATA states that the transport box should have the following features:

Frame:
Solid wood, screwed or nailed and glued with a non-toxic glue, metal or non-toxic plastic.

Sides:
Wood, metal or plastic. The front must consist of a 2/3 solid panel with ventilation openings above a 1/3 wire mesh.

Handles:
Three sides of the containers, as illustrated in the diagram.

Floors:
The base of the container must be solid and leak-proof. It states there should be a droppings tray underneath, however Pygmy-possums droppings are so small and usually do not cause a lot of mess so this shouldn't be needed.

Roof:
Solid but with meshed ventilation openings optional.

Door:
Either the front of the container can be constructed as a vertical sliding door or a rear hinged or sliding door, extending the whole height of the container, must be provided. The door must be fastened with tamper proof fastenings.

Interior:
A couple of small branches should be firmly attached inside the container.

Ventilation:
Meshed ventilation openings, approximately 2.5cm must be provided along the base of the two long sides of the container and in the upper 1/3 of the sides and front of the container. Whenever openings are covered by mesh, care must be taken that there are no sharp edges present within the container; all edges must be covered with a smooth material that is tamper-proof.

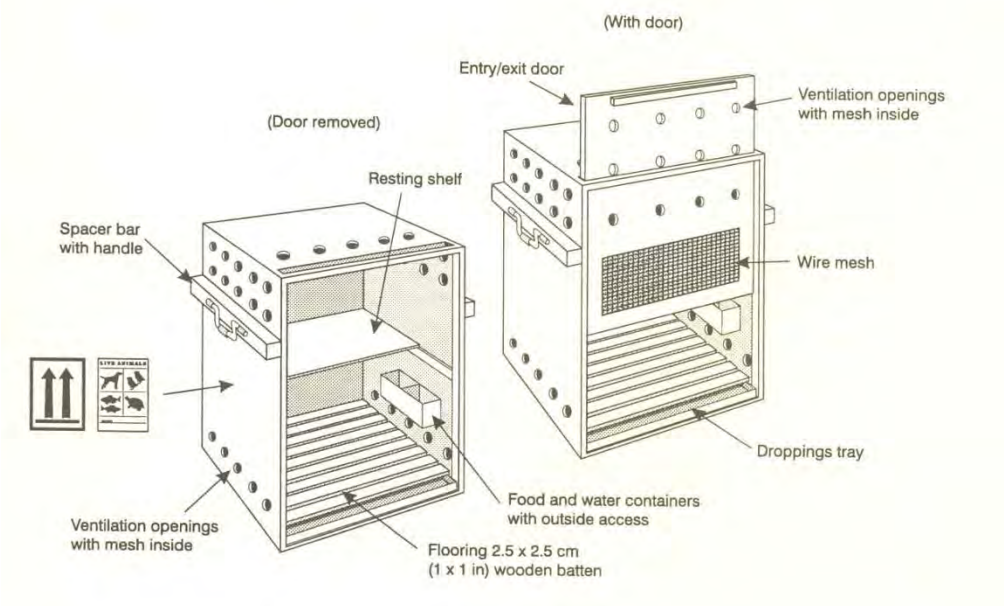


Fig.106. Appropriate box design for transporting species under "container requirement 31" of IATA pp. 211

A muslin or similar material, curtain must cover all ventilation openings including the front. Note that this illustration is for other primate species as well. For Pygmy-possums, a smaller version of this can be used with appropriate modifications to suite the possum.

IATA also states that **rigid pet containers** can also be used with the following modifications:

- A slatted floor must be firmly fixed to the bottom of the container, covered with an absorbent material
- A low resting shelf must be firmly fixed to the back of the container. (In the case of Pygmy-possums, their nest box can be firmly attached to the base of the container, with or without a shelf.)
- Container should be securely locked and tamper-proof.
- Fine wire mesh must be securely fastened over the door grill and all ventilation openings, these must also be covered in muslin or a similar material.

- **The International Air Transport Association (IATA) regulations for this species are located in Appendix 11**

For **short-term transportation**, cardboard boxes that may be effective for many other species of animals are definitely <u>not</u> appropriate for any species of Pygmy-possum. Pygmy-possums can be escape artists, so secure rigid plastic pet packs or containers are best for easy transportation.

They come in a variety of sizes so you are able to fit more than one nest box inside if needed or smaller pet packs can fit one small nest box nicely inside.
Make sure that all nest boxes, branches, food and water containers are securely fastened to the pet pack so nothing will move during transportation. Material can be placed around the sides of the pet pack to block any sunlight that may be stressful or harmful to the possum. Remember not to block any ventilation openings.

<u>Appropriate labels and documentation:</u>

! No Cardboard Boxes

Fig.107. “This way up” sign

Fig.108. “Live Animals” sign

<u>The following information should be sent with the animal:</u>

- Detailed list of contents: number of individuals, scientific names, and common names

- Temperature range required
- Feeding and watering instructions
- Date on which pygmy-possums were captured
- Consignor's and consignee's name, address and telephone number
- Official stamp of carrier showing date of his receipt of consignment.

REMEMBER: keep copies of relevant documentation.

7.6.2 Furnishings

Fig.109. appropriate nesting material (http://www.tasfieldnats.org.au/ExcnPhotos/092-BrunyIs/092-2249cr.JPG)

Clean, soft, and comfortable nesting material should be provided inside nest boxes to provide insulation and to stop the possum from potentially rolling around during transportation.
If transportation occurs at night, when a pygmy-possum is awake, a couple of thin branches or twigs can be easily secured inside containers for them to climb and grip on.

7.6.3 Water and Food

This depends on how long the trip will be.
More than often, transporting will be done during the day and therefore the Eastern Pygmy-possum will hopefully be asleep in his nest box, depending on the time of year and temperature. This makes things easy.

Fig.110. Food and water bowls that can be fastened to the sides of boxes (http://www.belvederestore.co.uk/images/uploads/B00220.jpg)

No food is needed for short distances, however water should be provided during transportation of most animals.

If trips are longer than a couple of hours or takes place during the night, a small bowl of food that is likely not to spoil needs to be securely fastened to the transporting box and water should be provided.(eg carrots, sultanas)

These are two different ways of providing water while transporting:

- By placing a piece of clean sponge or rag inside a container fastened to the side of the transport container and soaking it with fresh water. The Pygmy-possum can then easy lick off any needed moisture.
- Securely fasten a small dripper bottle to the side of the container. Note that this may not be suitable if the possum has never seen or used a dripper bottle before.

Food and water bowls or containers are to have smooth edges with no sharp corners.

7.6.4 Animals per box

Normally it is best to transport most animals separately even if they are social animals. However, Pygmy-possums are small enough to be transported within the same nest box only if they have been housed together.

Females and males should be transported separately as they would normally live in single sex groups outside of breeding season.
Up to five individuals can be transported together.
However, in the case of the Mountain Pygmy-possum, up to 10 related females usually live together and can be easily transported together.

Males are not normally territorial and if there is a bachelor group housed together, there should be no problems with transporting them together. Females with pouch young should not be transported unless the young have only recently been born and are still permanently attached to the teat. Social groups should be kept together where possible as this reduces stress. Pygmy-possums are not normally aggressive towards each other and are relatively easy to transport together.

Fig.111. Pygmy-possums together living together in a nest. (Van Dyck, S. "*The Mammals of Australia. Third Edition*", pp. 218)

7.6.5 Timing of Transportation

Transportation is easiest in the morning, around 9am when the possum will be asleep. This reduces stress and becomes a lot easier for keepers to handle and place into the transport box.

By transporting in the morning, this leaves the whole day ahead to reach the destination and depending on the distance, leaves enough time to deal with any complications or issues that may arise during transportation.

Important Note: During the warmer months of spring and summer, Pygmy-possums will become more active and may be awake for short periods of time during the day, or are likely to still be awake in the early morning.
During the autumn and winter months, whilst in torpor, a Pygmy-possums temperature and physiological activity decreases. This means they will normally always be asleep during this time.

- Consider the weather (particularly the heat during the summer.)→ transport when its cool to avoid heat stress.

Important notes when transporting any animal:

- Provide a safe a stable environment: radios off, careful handling, and safe driving.
- Reduced noise = Reduced Stress
- Keep out of direct sunlight/ Draughts
- Placement of transport box: make sure it is securely fastened down that it won't roll around during transport and take note of surrounding objects that may fall or move on top of the box during transport
- **Regularly** check on the animal to see if it is coping alright (especially if it is a social animal) and to give it some reassurance.
- Provide with fresh water/change sponges or food bowls whenever required.
- If driving: DRIVE SLOWLY AND CARFULLY
- Any animal in quarantine is to be kept completely separate from other individuals.

8. Health Requirements

8.1 Daily Health Checks

Fig .112. Eastern Pygmy-possum restraint (http://www.aqob.com.au/images/product/detail/Pygmypossumtraceyadams.jpg)

Each animal in every collection should be observed daily for any signs of injury or illness. It is important to be familiar with the NORMAL behaviour of an animal or group of animals in order to identify a problem. Observations are generally undertaken during cleaning and feeding each morning and normally becomes a natural habit for keepers to check over animals whenever they enter an enclosure.

Conditioning the animal to approach keepers first thing in the morning is an easy way to thoroughly check them over every morning. A small part of their diet can also be used to encourage individuals to approach keepers.

Each animal in the enclosure should generally be checked for the following and any abnormalities should be recorded appropriately:

- Coat Condition
- All limbs should be moving normally/ freely.
- Fur on the enclosure floor suggesting mating or fighting
- Faeces – number of pellets and consistency
- Appetite
- Reproductive observations
- Injuries- including abrasions, swelling and any lumps
- Eyes clear and fully open.
- General appearance - body condition and condition of coat.
- Discharges from the nose, ears, eyes, mouth or cloaca.
- Changes in behaviour. (This requires the keeper to know NORMAL behaviour. Examples of behaviour changes can be: approaching when it normally doesn't, changing the spot where it normally rests.)
- Changes in activity levels

! Anything out of the ordinary for that individual animal

8.2 Detailed Physical Examination.

8.2.1 Chemical Restraint

Fasting is not required before chemical restraint as possums are not generally prone to regurgitation. If hand –reared it is suggested that they be fasted one hour prior to chemical restraint to prevent regurgitation.
Generally, injectable substances are used for larger possums and inhalation of anaesthesia via a mask is preferred for smaller possums and gliders.
Isoflurane is preferred for inhalation anaesthesia, although halothane in oxygen can also be used. Mask induction is simple, rapid, and smooth with maintenance via the mask or intubation in larger species.(Vogelnest, L 2008)

- Induce at 5% and maintain at 2%

8.2.2 Physical Examination

Full physical examinations should be done at the same time as any surgical operations or medical procedures. It is easiest when the animal is under anesthetic. Parts of physical examinations such as weight, body condition, checking eyes and fur should be done regularly. Animals are generally weighted every month or so.

Fig.113.Encouraging approach
(http://blogs.abc.net.au/.a/6a00e0097e4e6888330120a6119b9d970b-300wi)

<u>The following should be assessed during a physical examination:</u>

Body Condition→ Assessing body condition is normally done by examining the base of the tail and allocating a condition score (1-5). Take note that in autumn, Pygmy-possums will naturally store fat in the base of the tail in preparation for the winter months.

Temperature→ usually 35-36° taken via the cloaca

Fig.114. Alopecia in a rat
(http://pics.hoobly.com/full/D6PC8CYIL99IRIRKSA.jpg)

Weight→ 15-43g depending on the season.
Weight records are important for all species of animals in a zoos collection.
Always look back at previous weights to get a good indication of general health. Sometimes when you work with an animal on a daily basis, it is hard to notice subtle weight losses or weight gains that could indicate a health problem.

- Remember to take into account: time of year, age, sex, reproductive status
- Animals should be weighed monthly to form an accurate trend pattern

Pulse rate→ Rule: Pulse rate decreases with increasing body size. Pulse rate of Sugar Glider: 200-300 beats/ min.

Respiratory rate→ rate decreases with increasing body size. Sugar Glider: 16-40 breathes/min at rest.

Fur→ Check for alopecia, ectoparasites or fungal infections.
Excessive scratching, fur loss, patchiness, irritation, discomfort, and biting at the tail or fur can indicate an irritation or skin condition.

Eyes →

- should be clear, bright and alert (no milky eyes unless old age and presence of cataracts)
- normal bilateral pupillary light response
- normal corneal reflex
- should not have any discharges

Fig.115. Pygmy-possum examination (http://www.peacockshock.com/archives/pygmy%20possum%20firefighter-thumb.jpg)

Presence of lumps over body→look and feel for any abnormal bumps that could indicate a disease or injury.

Cloaca→ should be examined daily to check that it is clean and free of faeces.

Pouch→ Check the following:

- Condition of the pouch
- Whether lactation is occurring by milking teats
- If pouch young are present, record sex, stage of development, weight if detached from the teat and measure to determine age from growth curves, if available

Males→

- Check testes- size (length, width, depth)
- Extrude penis and assess
- Check the size and activity of the sternal gland.

<u>Key things to look for that may indicate health problems for the Eastern Pygmy-possum:</u>

- Alopecia signs (fur loss)
- Weigh regularly to assess body condition (are prone to obesity)

8.3 Routine Treatments

There are no routine vaccinations needed for the Eastern Pygmy-possum.
Ivermectin injections, paste or oral drops can be used as a parasite preventative if necessary.
Ivermectin should never be used without consulting the advice of a vet first. The dose for ivermectin varies from species to species and also depends on the intent of treatment.

Fig.116. Ivermectin drops (http://www.pharmaq.co.uk/shop/images/ivermec_08.jpg)

In any animal collection, if no routine worming methods are used, faeces should be collected to be examined at least bi-annually in order to be examined for worms and eggs.

8.4 Known Health Problems

Fig.117. Mites
(http://www.homeventexperts.com/images/Dust%20Mites.jpg)

8.4.1 Ectoparasites

Ectoparasites include any parasite on the outside of the body.

➔ These include ticks, fleas and mites.

Ectoparasites such as ticks commonly affect species such as the Brush-tailed possum and Ring-tailed Possum, however don't seem to be a problem in captive Pygmy-possums, especially when housed in a nocturnal house. If a pygmy-possum was found with ticks, it could be potentially life threatening being such a small mammal.

Mites and fleas can easily be spread particularly when being housed near other larger possum species or reptiles. These ectoparasites tend to affect the bare patches of skin (ears and tail)

Signs:

- Excessive grooming
- Hair loss
- Inflamed skin

Fig.118. Tick
(http://www.salamatvet.com/images/tick-1.jpg)

Treatment:

- Acaricides
- Carbaryl powder (50g/kg used topically and in the nest box to control mites
- Injectable Ivermectin

Prevention:

- Maintaining good hygiene
- Routine examination of the fur and skin
- Quarantine of new arrivals to avoid the spread of ectoparasites
- Regularly changing the nest box bedding

Fig.119. Nematode
(http://www.cims.nyu.edu/~binliu/proj/ce/pics/worm-briggsae_WT_male.gif)

8.4.2 Endoparasitic worms

Worms have not been recorded in Pygmy-possums, however a number of cestodes, trematodes, and nematodes have been found in various species of possums and gliders.

Signs: no obvious signs unless diagnosed.

- May cause diarrhoea

Diagnosis: Faecal flotation and the presence of eggs

Treatment: Anthelminitcs (drugs that are used to destroy and treat parasitic worms), such as:

- Ivermectin
- Fenbendazole
- Oxfendazole

➔ Always confirm dosage with vet on purchase.

Prevention:

- Good Hygiene
- Quarantine new animals
- Daily removal of faeces

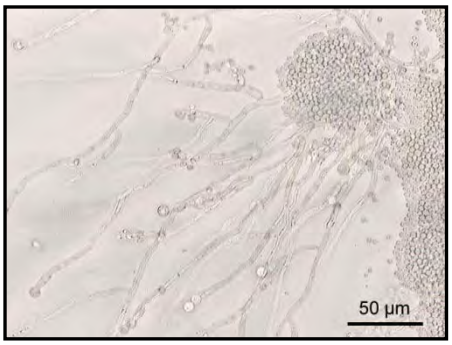


Fig.120. ***Candida albicans*** (http://forwearemany.files.wordpress.com/2009/12/candida_albicans.jpg)

8.4.3 Fungus

The fungus *Candida albicans* can result from antibiotic treatments causing candidiasis or thrush.

Signs:

- Diarrhoea (often a foul smelling with a yellowish green colour and sometimes frothy appearance)
- Oral Thrush → mouth appears sore, presence of ulcers, and crusty discharge

Diagnosis:
Through gram stains of the faeces or oral cavity using a high number of budding yeasts to confirm the diagnosis.
The organisms are about half the size of a red blood cell and stain a purple-blue.

Treatment:

- Nilstat® Oral Drops
- Mycostatin® Oral Drops

Prevention:

- Good hygiene maintenance (especially in hand reared animals)
- Minimise stress

8.4.4 Nutritional diseases

1. Nutritional osteodystrophy (Hind limb paralysis)
Occurs commonly in pet Sugar Gliders

Cause: lack of calcium in diets that only consist of fruit. Nocturnal animals are presumed to rely on gut absorption of vitamin D3, rather than skin absorption of UV light to convert vitamin D1 to D3. Diets should contain 1% calcium, 0.5% phosphorous and 1500 IU/kg of vitamin D3 on a dry weight base

Signs: sudden paralysis of hind limbs

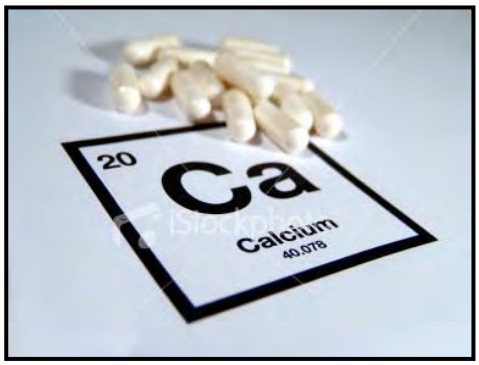


Fig.121. Calcium (http://1.bp.blogspot.com/_6nX1rVl6Ffo/SYKhDLtkmbI/AAAAAAAAADA/r9h0eN0siAs/s400/calcium-supplements.jpg)

Treatment:
May respond to high calcium, additional vitamin D3 diet and rest.
Diagnosis → Radiography of vertebral, pelvic, and long bones showing osteoporosis.

Prevention:
- Correct diet high in calcium
- Varied diet of insects, fruit, vegetables and flowers.
- Gut loading crickets or other insects 48 hours before feeding out.

2. Obesity
→ Can quickly develop and can cause reproductive problems.

Cause:
- Feeding a diet that is too high in fat and sugar.
- Insects such as meal worms are very high in fat and should only be fed out as a small part of their diet (When mealworms are at the stage when they are white, they contain hardly any fat and are high in protein)

Treatment:
DIET of high protein foods and less fatty foods.
Cut down food consumption
Scatter food so the Pygmy-possum is encouraged to forage → EXERCISING

Prevention: Weigh regularly and look at previous weights

Note: It is natural for Pygmy-possums to gain a little extra weight in autumn to prepare for the cold winter months where they enter torpor.

8.4.5 Alopecia

Remember: Stress reduces the animal's ability to fight infection

Cause:
- Attack by other animals in the enclosure
- Mites
- Stress
- Inadequate Nutrition
- Infectious causes
- Temperature too high or low (Environmental change)

Signs:
- Excessive scratching
- Fur loss
- Patchiness
- Bald areas
- Biting at fur or tail

Treatment:

- Mites can be treated with a parasite control product such as Ivermectin (Ivomec®, Heartgard®). Consult a wildlife veterinarian for dosage when purchasing product.
- Fur loss should be monitored carefully and watched for improvement or worsening.
- **Check the following**: diet and nutrition, temperature of enclosure, behaviour and interaction between individuals and modify if needed. Note that fur loss not only indicates the possibility of fighting, but also mating.
- May need to separate individuals if fighting is the cause.

Prevention:

- Correct nutrition
- Correct living conditions (appropriate temperature, clean nest boxes and feeding areas, individuals should be compatible)
- Avoid stressful situations (eg continual handling, moving to and from enclosures)

Regular episodes of fur loss from September to January each year have been observed in female Ground Cuscus. (Jackson, S M 2003) The skin where the hair loss occurred seemed to be unaffected and clinical examinations showed no abnormalities. It was suggested that this fur loss may be the result of either seasonal, hormonal, or temperature changes.

Key factors to keeping your Pygmy-possum healthy:

- Maintaining good hygiene
- Regular examinations
- Quarantining new animals
- Providing the correct environment and diet and
- Minimising stress

By following these simple guidelines, the risk of disease and illness can be greatly reduced.

8.5 Quarantine Requirements

Quarantine →strict isolation to prevent the spread of disease.

There are many different reasons for quarantining animals:

1. Prevention of transmission of diseases within institutions
2. Prevention of transmission of diseases between institutions
3. Prevention of disease transmission between countries- import/export of animals
4. Reduce the risk of zoonoses
5. Confiscations

Period of Quarantine can vary between species and groups of animals.

There is a 21 day minimum for animals within the country and a minimum of 30 days from overseas.
The Eastern Pygmy-possum will generally only be transported to and from institutions within Australia so a minimum 3 week period is long enough to be able to diagnose any potential problems.

The length of Quarantine can be affected due to:

- The level of RISK
- AQIS standards
- Incubation periods of diseases
- Control of parasites while in quarantine
- Costs
- Level of threat/vulnerability in the wild
- If from overseas
- Where has the animal come from?

Fig.122. Quarantine Sign
(http://media.moddb.com/cache/images/mods/1/13/12366/thumb_620x2000/quarantineSign.jpg)

Procedures that may be performed in quarantine:

- Physical Examination
- Weights and lengths
- Sexing
- Identification methods
- Numerous faecal floatation's/screening
- Any specific diagnostic tests.

If your daily routine includes both the existing collection and animals in quarantine, try whenever you can to do all the healthy animals first and the quarantine section last to avoid cross contamination. If this is not possible, BARRIER NURSE.

Fig 123.Appropriate PPE
(http://upload.wikimedia.org/wikipedia/commons/8/8d/Disp-med-ppe.jpg)

Barrier Nursing is extremely important when it comes to quarantine and infectious diseases. The whole point is to stop any disease transferring to the existing collection.

Barrier nursing includes:
Protective clothing such as gowns, overalls, masks, gloves
Separate tools and equipment (brooms, brushes) → make sure it STAYS right outside the enclosure

The equipment and clothing mentioned forms a sort of "barrier" against any potential diseases or risks.

DISPOSABLE GOWNS AND GLOVES ARE ALWAYS PREFERRED.

An example of a Quarantine Protocol for the Eastern Pygmy-possum:

a) **Reasons for the type of Quarantine**: import, export, new to the collection, signs of possible disease? CHOOSE ONE

b) **Period of quarantine required**: think about the above mentioned. Where is it coming from? Has it shown any signs to possible disease or parasites?

c) Procedures including entering and exiting areas:

- Barrier nursing? Or can you wait until the end to do the quarantine areas?
- Record all food intake, how much and what it ate
- Weigh and measure regularly...RECORD EVERYTHING

<u>Consider environmental enrichment:</u>

- Changing around position of perches and branches
- Change browse frequently
- Provide nesting material
- Scatter feeds
- Change time of feeding

Note that most quarantine areas will be concrete or basic wire enclosures so try and replicate the natural environment as much as possible. REMEMBER: stress reduces the animal's ability to fight infection →Reduction of stress will mean they can recover quicker.

d) Hygiene:

Disinfect floor daily
Wipe down perches and branches with disinfectant weekly
Clean out nest boxes weekly
Footbaths are important for all enclosures
Waste disposal within AQIS guidelines…don't let other species of the collection access the waste in any way.

e) PPE:

Gloves
Gown

f) **Record keeping** is one of the most important things to remember about quarantine procedures. All treatments, observations and results need to be records appropriately and regularly.

g) Housing:

- Best if multipurpose enclosures
- Something along the lines of an aviary type enclosure or concrete area
- Pest Control: holes are small enough that a rat would not be able to gain access, however you may need to think about trapping for mice around enclosure.
- Nest Boxes: easy to access and cleaned regularly to avoid harbouring diseases (at least 2 per individual)

- Plenty of logs, branches, and browse to climb in (throw away between use of area)
- No substrate. Concrete floor that is easy to clean and disinfect daily and easy to collect faeces.
- Quarantine areas need to be secure to prevent escapes or entry of unwanted animals
- Airlock

Keep in mind: The quarantine facility is more than likely not going to be a nocturnal house so the Pygmy –possum will not be very active during the day. This is an advantage as there will be minimum contact and therefore avoids the spread of disease.

9. Behaviour

9.1 Habits

Activity

Fig.124. Pygmy-possum at night.
(http://www.abc.net.au/reslib/200807/r275383_1162934.jpg)

All species of Pygmy-possums are nocturnal, meaning they spend most of the day asleep and are active at night.
All Pygmy-possums, (except the Mountain Pygmy-possum) are arboreal, meaning they live off the ground in trees. They are active climbers who use their claws as small nails to jump and climbamong the treetops. Their prehensile tails also helps them to grip and climb.

Pygmy-possums live in spherically-constructed nests made of leaves and bark inside tree hollows. These may be up to 6cm in diameter.
They will spend a large amount of their time gathering nesting material such as feathers and bark, particularly in summer and autumn, just before they enter torpor.

Pygmy-possums seldom vocalise, only occasionally hissing when disturbed or provoked.

Eastern Pygmy-possums will spend a large part of their active time foraging for nectar, seeds, and fruits.
In wet coastal regions, where fruit and blossoms are less abundant, a variety of insects are consumed, including flying moths, spiders, beetles, termites, grasshoppers, and mantises.
Eastern Pygmy-possums are able to catch flying insects with one paw; these insects are eaten by first biting off the wings and then consuming the bodies.
Feeding primarily occurs in short and quick bursts and is immediately followed by grooming.

Social Behaviour

Little, if any social hierarchy exists. Adults usually remain solitary outside of breeding seasons, but groups of up to 5 females can be found nesting together.
Unlike many animals, Pygmy-possums are generally neither aggressive nor territorial. They will happily live in the same area or even the same nest with other individuals.

Fig.125. Pygmy-possums
(http://www.tasfauna.org/RESOURCES/Photos/Pygmy%20Possums%20-%20King%20Island.jpg)

Pygmy-possums are described as being sedentary, meaning they generally stay in the same area, and don't tend to travel large distances. This, however changes during the breeding season where males will travel some distances to find a female to mate with.

Mountain Pygmy-possum:
Mountain pygmy possums have a social structure unlike any other members of the Burramyidae family. Groups of up to ten related females (mothers, daughters, grandmothers) share a home range high up the mountain. The males live together lower down the mountain and visit the females only to breed. Unlike many species, the males are not aggressive to each other and do not seem to mind this separation of the sexes.

Female areas have communal nesting sites and overlapping home ranges. Older females tend to share their ranges with up to 10 younger females. Only during nightly forages do the females leave the natal area. Since the natal area is in the higher elevations, where food is more abundant, these dispersals are relatively short distances.

Males have less structured home ranges. When not invading the female's range to mate, the males are nomads, foraging during the evening over broad expanses of nutrient poor resources. Their foraging distances can reach relatively long distances, decreasing their likelihood of survival due to predators and insufficient nutrients. They sometimes form bachelor groups.

Torpor

During the cold winter months, when food is scare, Pygmy-possums are one of only five marsupials that enter a state of hibernation called torpor.
Torpor can be described as“a state of lowered physiological activity typically characterised by reduced metabolism, heart rate, respiration, and body temperature that occurs in varying degrees especially in hibernating and estivating animals” (Merriam-Webster’s Online Dictionary, 2009)

Fig.126. Pygmy-possum in torpor
(http://www.abc.net.au/reslib/200909/r436286_2097421.jpg)

Torpor is only a state of hibernation, and is usually only short-term. This means that a Pygmy-possum will sleep for most of the day, maybe only waking up for only an hour or so. In this state the Pygmy-possums body temperature drops to almost the same temperature as the air around it, therefore CONSERVING ENERGY

The body does not shut down completely- metabolism, heart rate, and body temperatures are only reduced. The complete psychological state of the animal is only slowed down.
The Pygmy-possum curls up in a tight ball with its ears covering its eyes and its nose tucked into its chest. The pink, carrot shaped tail is used to store fat.

Torpor is often used to help animals survive during periods of colder temperatures, as it allows it to save the amount of energy that would normally be used to maintain a high body temperature.

Whilst Pygmy-possums are in this state of hibernation, no food or water is required. However in a captive environment, a bowl of fresh water should always be available to Pygmy-possums. These possums may wake up every day for a very short period of time, or may sleep for a couple

of days. Keepers should be constantly monitoring the time it spends sleeping and when it becomes active. An increase in diet is needed in autumn in preparation for torpor.

A **very** small bowl of food should be placed inside the enclosure, not necessarily everyday though, just for when he wakes up every now and then.
It is a natural instinct for a pygmy-possum to eat more before the winter months. It will put on a lot of weight and this is sufficient enough to keep him going throughout winter.

By observing the body condition and size of a Pygmy-possum, keepers should be able to decide how much food to place in enclosures, and when.

Note: In the winter, the Mountain Pygmy-possum can remain inactive for up to twenty days at a time.

9.2 Reproductive Behaviour

Fig.127. Pygmy-possum young (http://palaeo.gly.bris.ac.uk/Palaeofiles/Marsupials/baby.jpg)

There are two distinct breeding seasons. On mainland Australia breeding takes place from spring to autumn, while on Tasmania the season lasts from late winter to spring. The litter is size is predominantly four and occasionally five.
Like most marsupials, Eastern Pygmy-possums have young that are altricial at birth. The young nurse in the pouch for up to six weeks following birth and are then independent when they reach half of the mother's weight.

Both male and female Eastern Pygmy-possums become sexually mature at around 190 days (6 months). Breeding usually occurs in round nests located in tree hollows of the forest. The males often travel further than the females, although both sexes are rather sedentary.
However Eastern Pygmy-possums have been known to travel 500m to obtain a specific bark for its nest.

Fig.128. Mountain Pygmy-possum (http://fnpw.org.au/Images/Projects/PlantsandWildlife/poss8_large.gif)

As mentioned earlier in the chapter**, Mountain Pygmy-possums** have a breeding behaviour which is different to all other species of Pygmy-possum. Males and females live in small separate groups on different elevations of a mountain. Males will only travel higher up to visit females and to breed.

The mating behaviour of the Mountain Pygmy-possum is cued by several factors, including spring equinox, arrival of Bogong moths, male encroachment into natal areas, and disappearance of snow.

The behaviour of the Mountain Pygmy-possum has a characteristic pattern, with the male first pursuing a female and sniffing her anal region. If the female chooses to mate, she allows him to mount and clasp her flanks. Copulation lasts several

minutes, after which the male leaves. The female may show extreme post-copulatory aggression towards the male if he chooses to stay in the vicinity after copulation.
After birth and growth of young males, females are aggressive towards them and force them to leave the natal area. Older males leave first, followed by juvenile males and sometimes juvenile females. Over time, the sex ratio of a natal area becomes female biased.

Mating occurs between late September and mid October. Female oestrous lasts ~20 days. After fertilisation, there is a gestation period of 13-16 days, followed by birth in the last week of October to four altricial young.

9.3 Bathing

In the wild, Pygmy-possums do not bath or swim, it is therefore not necessary for any particular bodies of water to be provided in a captive environment.
Drinking water should be provided in a small bowl.

Fig.129. Western Pygmy-possum (http://www.fnpw.com.au/Images/Projects/PlantsandWildlife/Western_Pygmy_Possum_RayDayman.jpg)

9.4 Behavioural Problems

Generally, pygmy-possums in captivity don't show any undesirable or stereotypic behaviour. Stereotypical behaviour can be described as a behaviour that is repeated and possibly negative such as excessive self-grooming, pacing, howling, barking, squawking, unusual movements such as swaying or head bobbing.
It is important to be sure it is not a natural behaviour characteristic to that particular species.

If keepers know what is normal for each animal, behavioural problems can be picked up quickly by observing behaviour that is abnormal for that particular individual.

While there are no common behavioural problems or negative behaviours associated with Pygmy-possums, individuals can develop problems due to boredom, changes in the environment or to their social group. Providing behaviour enrichment activities can minimise behavioural problems.

Fig.130. Pygmy-possum (http://www.australianfauna.com/images/mountainpygmypossum.gif)

Aggression towards keepers:
Eastern Pygmy-possums are relatively easy to take care of in captivity.
They can occasionally hiss loudly when un-expectantly disturbed or provoked but show no aggression towards other individuals or keepers.

! An animal's temperament can change dramatically during breeding season

Pygmy-possums are able to bite when they are uncomfortable or in pain when being handled but this is not normally painful and doesn't regularly occur.

Most animals are usually more protective and aggressive during the breeding season and while rearing young. Pygmy-possums may hiss more frequently during these time periods and may be harder to handle. Always approach any breeding animal or mother with caution.

9.5 Behavioural Enrichment

Before exhibiting any animal, no matter what the species is, both the physical and behavioural needs of an animal need to be addressed.

Life in captivity may not be as good as it could be in the wild. Keepers have the responsibility of trying to replicate the natural environment and proving environmental enrichment to bring out natural behaviours.

Environmental Enrichment can be described as a means of enhancing the environment of captive animals to provide more stimuli through alterations in the physical environment. This means that by proving stimuli such as toys, and other various activities we can encourage natural behaviours that satisfy an animal's physical and psychological needs.

Fig.131. Pygmy-possum with banskia (http://www.australiassouthwest.com/SiteCollectionImages/InlineImages/Pygmy_possum.jpg)

The aim of environmental enrichment is to increase animal well being by increasing exercise, satisfying behavioural needs and optimising the level of stimulation that our animals receive, as well as attempting to reduce abnormal or stereotypical behaviours, and keeping them active.

When providing environmental enrichment items or activities the following safety questions need to be considered:

- Can the animal be caught, entangled, or trapped inside the item?
- Can the item be used as a weapon to hurt conjoining animals?
- Will the item aid in the animals escape?
- Can the item fall on the animal?
- If the item is eaten or chewed, will it harm the animal?
- Can the animal be cut, pinched or otherwise injured by the item?

The following techniques can be used to help minimise behavioural problems in Eastern Pygmy-possums:

To encourage foraging and ingestive behaviour:

- Scatter feeds
- Provide banskia's and other pollinating plants.
- PVC piping with small holes with puree inside
- Smear fruit or vegetable puree on branches
- Alter feeding times (remember Pygmy-possums are nocturnal so food shouldn't be given during the day, unless in a nocturnal house)
- Change or rotation of foods (eg: change around fruits given)
- Hiding fruit around enclosures
- Providing whole fruits: this only really applies to food such as sultanas as anything bigger would be too hard to grip and hold.

To encourage sensory behaviour:

- Scatter small amounts of kangaroo faeces on the floor
- Rub koala faeces on branches or perches
- Install sprinkler/drip system
- Spray/mist enclosure

To encourage social behaviour:

- House with other individuals of similar species. Remember not to mix Mountain Pygmy-possums with other species of Pygmy-possum, as they have a completely different social structure.

To encourage courting and parental behaviour:

- Scatter nesting material (eg: Stringybark or feathers) at appropriate times of the year for them to collect
- Change around nesting boxes
- Provide more nesting boxes than individuals

To encourage natural movement behaviour:

- Provide branches with different sized diameters to exercise feet.
- Provide thin ropes to climb
- Rocks (Mountain Pygmy-possum)

To encourage exploratory behaviour:

- Change/ replace browse frequently
- Change around logs/ branches to provide a changing environment
- Provide hollow logs
- Change substrates

Drawing up a monthly enrichment calendar is a good idea as it ensures everyone in the workplace knows what to do, and when to do it.

- **Appendix 12** shows an example of how this can be done. (Every workplace's calendar will be different according to the enclosure and how many individuals are housed, even an individual's temperament.) Calendars can be changed monthly and more than one enrichment technique can be used daily.

When animals are in quarantine or holding areas, it is still important to provide as much environmental enrichment as possible. By changing around perches, nest boxes, and substrates creates a changing, natural environment.

By providing animals with a range of behavioural enrichment activities we can:

- Improve the overall health and longevity of animals
- Improve the overall wellbeing and happiness of animals.
- Improve our enjoyment and understanding of animals.
- Recognise abnormal behaviours and signs of stress.

- Improve the chances of breeding animals.
- Improve the visibility and activity of our animals, which is especially important for species that are shy or sometimes inactive in captivity.

9.6 Introductions and removals

The most important thing to remember when introducing any animal is to take it slowly. For some species, introductions may take a long time and may be potentially dangerous for either the new comer or the existing individuals. Sometimes both.

Whenever a new animal is received at a captive facility, remember to always place it in quarantine for a short period of time before letting it have contact with other individuals. This prevents the possible spread of disease.

The Eastern Pygmy-possum is generally a calm animal who is tolerant of other individuals sharing its space, food, and nest box. Introductions are not extremely difficult but care should always be taken when introducing a new animal to a new environment and to other animals. It is possible that individuals may fight at the start, but normally they settle in quickly and easily without aggression involved.

If an animal is removed from an environment, and aimed to be re-introduced again there shouldn't be any problems with aggression when finally placed back into the enclosure. As noted before, Pygmy-possums are very calm animals who are solitary by nature but don't mind sharing its space with other individuals.

If there are problems between individuals there are two solutions that may fix this:

- Remove problem animal for a period of time and then reintroduce again. The social dynamics will most likely change. Eg a male may not be dominant when reintroduced.
- Remove ALL animals, change the whole exhibit and re-introduce again.

This principle applies to most, if not, all species of animals.

9.7 Interspecific Compatibility

Pygmy-possums can either be solitary or social animals who rarely engage in competition for food or space. Therefore the following species from the same Genus *Cercartetus* can be housed together during non-breeding seasons:

- Eastern Pygmy-possum, *Cercartutus nanus*
- Long-tailed Pygmy-possum, *Cercartetus caudatus*
- Western Pygmy-possum, *Cercartetus concinnus*
- Little Pygmy-possum, *Cercartetus lepidus*

During breeding seasons, individuals can change their temperament dramatically and it is advised to keep species separate if breeding, however females of different species with young in the pouch can be housed together.

Mountain Pygmy-possums should be kept separate from the above mentioned species at all times due to their completely different social and breeding behaviours.

9.8 Intraspecific Compatibility

In the wild, Eastern Pygmy-possums are usually solitary, especially during the breeding seasons however in captivity; they are a lot more tolerant of sharing nest boxes. Males show a low level of aggression even with females around. Therefore it is safe to house both sexes together.

In the case of the Mountain Pygmy-possum, ideally, females and males should be housed separately, only having contact during the breeding season. Up to 10 females can be housed together (normally form the same descendants) and bachelor groups can be formed.

10. Reproduction

10.1 Mating System

The mating system varies between possum species and is dependent on factors such as body size and food availability.

- Mountain Pygmy-possums have a polygamous mating system.
- All other Pygmy-possums have a promiscuous mating system.

All species of Pygmy-possum are very secretive and there have not been many studies in the wild regarding reproduction and mating. Healesville Sanctuary breeds *B.parvus* and *C.nanus* and are currently identifying mating behaviour and trends.

The **Mountain Pygmy-possum** has a VERY different mating system to the *Cercartetus* group. Females live together in related groups up on the mountain and are fairly sedentary. Males and females will only interact during mating season at the start of spring. Male encroachment and the arrival of Bogong moths trigger reproduction. After the breeding season is over, females will act aggressively to mature males and will force them down the mountain again.

Eastern Pygmy-possums are a lot more relaxed. They don't mind companionship but mainly live in single-sex groups or alone. Unlike the Mountain Pygmy-possum, males and females will share the same environment but only share the same nest box during breeding season (summer). Males will get kicked out of the area once the female has given birth.

10.1.1 Breeding in Captivity:

Eastern Pygmy-possum

Although *C.nanus* is not threatened, Healesville Sanctuary allocated resources to the captive-breeding of this species for three main reasons:

1. As of the number of animals in the wild decreases, it is increasingly important that policies are developed to ensure that wild populations are not further depleted and that zoos are stocked from self-sustaining captive populations. This goal has not yet been achieved for *C.nanus* and, to the bet of our knowledge; there are no published records of captive-breeding for this species. To date, Healesville Sanctuary has opportunistically acquired injured or orphaned individuals from the wild, or healthy animals transferred from other zoos
2. Field data suggest that numbers of *C.nanus* may be declining in some parts of Victoria, a knowledge of how to breed the species in captivity would prove invaluable for its future survival.
3. If reliable captive-breeding techniques are developed, detailed studies of the life cycle of *C.nanus* can begin. For example, at time of writing, it is now known whether the delayed implantation of an early embryo, or embryonic diapause, can occur in C.nanus. Embryonic diapauses is known to occur in at least three species of small diprotodont

marsupial: Honey Possum, Feathertail Glider and Western Pygmy-possum. (Murphy, J.A; Phillips, B.T; Macreadie, B, 2003)

- **An excellent paper that was published in the International Year Book (2003) 38: 173-178, "Husbandry and breeding of the Eastern Pygmy-possum at Healesville Sanctuary" can be found in Appendix 13**

This paper describes the conditions for successful breeding of *C.nanus* at Healesville Sanctuary in 1998 and 1999, and suggests goals for future husbandry and research.

10.2 Ease of Breeding

Out of all the Pygmy-possums, the Eastern Pygmy-possum has been held the most often in captivity. There has however been little success in regards to breeding until recently.

Healesville Sanctuary in Victoria has been successful in breeding them consistently by placing them in large double meshed enclosures (10 x 5 x 3.3m high) that were heavily planted with native grasses and flowering shrubs. Under these conditions, over 30 pygmy-possums have been born over a five-year period. (Murphy,J.A; Phillips, B.T; Macreadie, B, 2003)

A method that Healesville has achieved, particularly with the Eastern Pygmy-possum: *C.nanus* was housed communally in a large outdoor enclosure. Given the mainly solitary of the species in the field, where single animals occupied 71% of nest boxes, successful breeding in a communal enclosure was unexpected. However, this procedure has also been successful for breeding the Mountain Pygmy-possum. (Murphy,J.A; Phillips, B.T; Macreadie, B, 2003)

For detailed information on enclosure design, species of native plants and nest box design, see the relevant paper in **Appendix 13**

The new husbandry techniques developed at Healesville Sanctuary resulted in the successful breeding of *C.nanus* in 1998 and 1999, strongly suggest that the approach is reliable. Despite the mainly solitary nature of the species, maintaining a group of *C.nanus* in a large communal outdoor facility has resulted in successful captive-breeding. While not intuitively the best approach, the success of the 'communal' method could be the result of numerous factors, including:

1. An increased potential for individuals to find compatible mates
2. An increased stimulation to breed because there are more potential competitors
3. A combination of these factors, together with the provision of sufficient space

- S.J Ward explains the patterns and breeding of the Western Pygmy-possum which were investigated through field observations, published accounts and the histology of specimens in Australian Museums. This paper which was published in the Australian Journal of Zoology 1990 can be found in **Appendix 14**

10.3 Reproductive Condition

10.3.1 Females

Possums and gliders are generally placed in several categories based on their reproductive status. The examination of reproductive status in medium to large species can be facilitated by putting them inside a transparent plastic tube and examining them with an octoscope. (Jackson, S.M 2003) Smaller species can be examined whilst holding on their back.

For females the categories are:

- Non-parous (females that have never bred) - pouch small with no skin folds, clean and dry, teats very small
- Parous (females that have bred previously but not presently) – pouch is small but distinct, dry and dirty, the teats are slightly elongated.
- Pregnant - pouch is pink in colour and glandular in appearance, skin fold may be observed on the lateral margins
- Pouch young present - attached to the teat
- Lactating (young absent from the pouch but still suckling) – pouch area large, skin folds flaccid, hair sparse and stained, skin smooth and dark pick, teats elongated
- Post lactation with teats expressing only clear liquid and/or regressing. (Jackson, S.M 2003)

If young are present in the pouch, there are a number of developmental stages and measurements that can be recorded and compared to growth graphs.

- **A list of developmental stages and measurements can be found in Appendix 15**
- **A growth graph and table for the Eastern Pygmy-possum can also be found in Appendix 15**

10.3.2 Males

In some species the males will have a scent gland in the middle of their forehead and on the sternum, which becomes increasingly developed with age. The activity of the gland can be measured by the following scale: (Jackson, S.M 2003)

1. Little or no activity – little or no staining of the surrounding hair; little or no hair loss over the gland area; no obvious gland product.
2. Medium Level activity – Some staining of the surrounding hair; some loss of hair over the gland area; waxy glandular products visible
3. High activity – much staining of the surrounding hair, total loss over gland area, waxy glandular product prominent (Jackson, S.M 2003)

- Testes may increase in size slightly
  → The testes should be measured by measuring the length, width and depth in millimeters.
  → Testis volume can be calculated: $V = \pi/6 \times (\text{length}) \times (\text{width})^2$ (Jackson, S.M 2003)

10.4 Techniques Used to Control Breeding

Separation of the sexes is the most accurate and easiest technique to control breeding.
Most Pygmy-possums form single sex groups during non breeding seasons and only come together to mate. By keeping sexes apart and only introducing them during mating season is the best way to control breeding.

Stephen Jackson explains that day/night length can be been used as a control in Brush tail possums. The altered day/night lengths that result from maintaining possums and gliders for public display is likely to affect their breeding. In a group of Brush tail possums moved from an outside enclosure to a room with a 10h light and 14h dark cycle, the possums indoors gave birth after 81 days compared with 134 days for the control group outdoors. This suggests that photoperiod plays an important role in the initiation of breeding in the Brush tail possum. (Jackson, S.M 2003)

10.5 Occurrence of Hybrids

There is no known hybrid species of pygmy-possum.
Different species of pygmy-possum are to be kept separate either permanently or just during breeding season.

- It is best if they are kept separate all year round.

10.6 Timing of Breeding

There is a large variation in the timing of breeding between Pygmy-possum species. Food availability is known to influence the timing and duration of the breeding season. Breeding can be seasonal or continuous. (Jackson, S.M 2003)

In South-East Australia, breeding usually occurs between November-March but may occur all year round in areas where the dominant *Banksia sp* flowers in winter. (Murphy,J.A; Phillips, B.T; Macreadie, B, 2003)

Breeding Season:
B.parvus: September - October
C.caudatus: August - February
C.connicinnus: ALL YEAR (Able to reproduce for most of the year)
C.lepidus: September- April
C.nanus: Oct/Nov – March/April

10.6.1 Environmental Cues/ Triggers:

Mountain Pygmy-possum
The mating behaviour of the Mountain Pygmy-possum is cued by several factors:

- Spring Equinox
- Arrival of Bogong moths (*Agrotis infusa)*

- Male encroachment into natal areas and
- Disappearance of snow

In captivity keepers can do the following things to trigger breeding:

- Provide Bogong moths
- Introduce males into female enclosures (representing female natal areas)
- Warmer weather → sep/oct

Eastern Pygmy-possum

In captivity keepers can do the following things to trigger breeding:

- Increase in diet
- Introduce males into female enclosures during breeding times (sep-april)

Bogong moths:

Each spring, Bogong Moths migrate to the Snowy Mountains to escape the harsh heat of Queensland. During the day they hide in dark crevices and during aestivation, they will not eat. Bogong moths disappear in the autumn and make their way back to their winter breeding grounds in Queensland.

- This is the main trigger for Mountain Pygmy-possum reproduction.

10.7 Age at First Breeding and Last Breeding

- Sexual maturity varies between species of pygmy-possums.

Mountain Pygmy-possums become sexually mature at approximately one year of age, whereas the Eastern Pygmy-possum will start breeding at 5 months of age.

Sexual Maturity can depend on food availability

All other three Pygmy-possum species become sexually mature at approximately 12-15 months. All species of Pygmy-possum can breed up until their death. (Jackson, S.M 2003)

In the wild sexual maturity can depend on food availability and season of birth (Murphy,J.A; Phillips, B.T; Macreadie, B, 2003)

In captivity, sexual maturity can be lower, particularly for the other three species of possums.

- Difference is NUTRITION and DIET

10.8 Ability to Breed Every Year

All species of Pygmy-possums are able to breed every year after they are sexually mature.

10.9 Ability to Breed More than Once Per Year

The Mountain Pygmy-possum only has a 1 month gap every year to breed so they will only give birth to one litter per year.

Other species of Pygmy-possum may breed up to three times in a year as they have a larger breeding season.

Litters/year:
B.parvus: 1
C.connicinnus: 2-3
C.nanus: 2-3

10.10 Nesting, Hollow or Other Requirements

All species of Pygmy-possum will use a nesting area.

Cercartetus species will require a nest above the ground, (normally man-made nest box)

In the wild, *B.parvus* will usually build its nest between crevices in rocks or near the ground. In captivity, rocks should been present in the enclosure anyway so you could place rocks around a nest box on the ground, only leaving the entry hole free. Place some nesting areas in trees aswell.

Provide a couple of nesting areas throughout the enclosure. Small nest boxes are better than natural hollows as it allows keepers to monitor breeding behaviour and the progress of the young. It also means that keepers are able to properly clean the nest box before and after use. If a pygmy-possum uses a hollow as a nest site, I could be hard to access her for medical checks and observations.

It is important to provide nesting material during breeding season and well after this time. Scatter various eucalypt leaves as well as branches of stringybark around the enclosure. Native grasses, flowers and shredded paper are also good options. This is a form of environmental enrichment as she will need to harvest them herself. If housed in a breeding enclosure with native plants growing, she can also gather materials from these sources naturally.

10.11 Breeding Diet

- Pygmy-possums do not require a breeding diet.

An increased diet however should be provided for lactating females, particularly arthropods.
In the Mountain Pygmy-possum → Bogong moths trigger reproduction.

10.12 Oestrous Cycle and Gestation Period

Eastern Pygmy-possum (*C.nanus*)
Oestrous cycle: Not known, possibly an average of 20-30 days
Gestation period: 30 days

Mountain Pygmy-possum (*B.parvus*)
Oestrous cycle: approximately 20 days
Gestation period: 13-16 days

Oestrous can be determined by examining the urine for the presence of non-keratinised and keratinised epithelial cells, polymorpho-nuclear leucocytes and sperm. At the time of oestrus there is a massive increase in the number of epithelial cells and leucocytes in the urine (Jackson, S.M 2003)

10.13 Litter Size

Mountain Pygmy-possum
Normally, a single litter is born in spring in Victoria but in NSW litters may arrive as late as summer, depending on when the snow melts. Births are highly synchronised and litter size varies from three to four. Two litters can occur if the first is lost or snow melt is very early. Successive litters have been produced in captivity and two litters in the one season have been observed at Mt Buller. (Australian Government Website)

Juvenille activities:
Young live in the pouch for four to five weeks and then spend another four to five weeks in the nest with the mother, who continues to suckle them. They are then weaned at nine to ten weeks. Juveniles trapped on Mt Blue Cow in late January weighed on average between 15–22 g. They gained weight rapidly during autumn and reached 40–60 g by May but did not reach adult weight until the end of their second summer. Most juveniles breed at one year of age, after their first spring. (Australian Government Website). Nests are usually made out of fibrous material and hidden away either in rocks or long grass. The mother brings back nesting material such as grass curled up in her tail.

Eastern Pygmy-possum
Juvenille activities:
Females give birth to up to four young, which stay within the pouch for about six weeks. After this time, the young are left within the nest, occasionally travelling with the mother by clinging onto her fur as she forages.

Average litter sizes:

B.parvus	1-4 (4)
C.caudatus	1-4
C.connicinnus	3-6
C.lepidus	2-4
C.nanus	2-6 (4)

10.14 Age at Weaning

Weaning (days):

B.parvus	70-75
C.caudatus	92
C.connicinnus	50
C.lepidus	90
C.nanus	50-65

- For more details on weaning and artificial rearing, see chapter 11.

10.15 Age of Removal from Parents

Mountain Pygmy-possum

In the wild, after the birth and growth of young males, females are aggressive towards them and force them to leave the natal area. Older males leave first, followed by juvenile males and sometimes juvenile females. Over time, the sex ratio of the natal area becomes female biased.

Young male Mountain Pygmy-possums should be removed from their parents once weaned and before they are sexually mature. (8-12 months)

Females can stay within the natal enclosure however they may be rejected if there are too many individuals.

Eastern Pygmy-possum

Eastern Pygmy-possums are a lot less aggressive. They are usually solitary but don't mind the company of either sex. Young can be removed once they are independent at 4-5 months.

- If removing young for hand rearing, the possum should have a layer of soft velvety fur in order to have a greater rate of survival.

10.16 Growth and Development

It is important to monitor both the mother and the young very closely. Measurements should be taken every couple of days and compared to a growth chart to which indicates how development is progressing.

Keepers should be aware not to over handle the young as it could affect their relationship with the mother and measurements and weights should only start at approximately day 40 once the young have exited the pouch.

Keeping records of weights, measurements and observations is important. It means that growth curves can be drawn up and will assist with future breeding and development of young.

- **A list of developmental stages and measurements can be found in Appendix 15**
- **A growth graph and table for the Eastern Pygmy-possum can also be found in Appendix 15**

11. Artificial Rearing

Artificial rearing is not only limited to hand rearing. There are various other techniques that can be used which may be a better option for both you and the animal:

- Let the parents do it. Full stop. Don't be tempted to interfere. Monitor the situation and provide anything extra they may need
- Help the parents (eg doing some of the feedings)
- Foster the young (to another member of the same species, eg aunt or sister. There hasn't been much success with possums however)
- Cross fostering (Different species)

Fig.132.Young Pygmy-possum (http://3.bp.blogspot.com/_u8lpcWcCkWs/R4KDUNv-KKI/AAAAAAAAAUI/B4rei4GB1Nk/s400/Baby.jpg)

<u>Animals may need to be artificially reared for various reasons:</u>

- Orphaned
- Rejection
- Inexperienced mother
- Educational reasons (normally hand reared to able them to interact with the public)
- Injury
- Deformity/ sickness
- Pets or possibly donated from public
- Parents may escape, leaving young behind
- Bullying

Fig.133.Baby possum (http://www.abc.net.au/science/scribblygum/May2000/img/f_baby_possum.jpg)

Whichever technique is used to artificially rear an animal, make sure it's the right decision that will benefit that animal in the future. Care programs should be set up appropriately and OH&S risks should be researched thoroughly.

<u>A care program may include:</u>

- nutritional requirements, such as food dictated by breeding and growth patterns,
- appropriate environment,
- teaching animals to catch their own food,
- providing socialisation opportunities with other animals and
- providing animals with materials to create their own living environment.

Prognosis of different age classes

Generally, furless young are a lot harder to rear than furred ones.

Factors to consider before commencing the task of hand-rearing a furless joey include:

- The increased chance of problems arising later in the process
- The time, expertise and expense involved.

- Unnecessary distress to the animal and
- The emotional attachment. (Vogelnest, L; Woods, R 2008)

It is recommended that possums considered for hand rearing should have a fine velvety covering of hair. Pygmy-possums have a lower survival rate if they are raised as a furless joey.

11.1 Housing

Fig.134.Brushtail being fed in a warm, secure pouch
(http://www.chidlowmarsupialhospital.org.au/images/userfiles/Brush_Tail_Possum_Joey_100_0521.jpg)

Most possums are best raised in groups. This replicates the wild where there will normally be around 3 other young in the pouch. It may also help with the 'lack of socialisation' risk that may appear later on if not correctly socialised.

Substitute pouches can be made from a variety of materials including:

- Calico or
- Wool with a woven cotton liner.

Note:**Fig.134**. is a common Brush-tailed possum however this is a an example of types of material and housing that should be used.

Furless young can be wrapped in a cotton handkerchief then at the end of a stocking. (Vogelnest, L; Woods, R 2008)

A heat source such as a heating pad is vital for Eastern Pygmy-possums. Be sure to address the appropriate temperature requirements as outlines below in 11.2.

After emerging from the pouch, young can be moved into a more natural environment, with the pouch suspended over a small heating pad.

11.2 Temperature Requirements

Pouch young are unable to thermoregulate adequately and require supplementary heating at earlier stages of rearing.
Furless young should be kept at 34 – 36°C and then gradually lowered to 30°C.

Temperature is important for Pygmy-possums, as they enter torpor during the cooler months.
Heaters should be thermostatically controlled to avoid hyperthermia and hypothermia. (Vogelnest, L, 2008)

Fig.135.Thermometer Gun
(http://myhealthnfitness.com/images/Personal%20Health/CVHM-H13-2.jpg)

Temperature and humidity should be regulated with the use of a humidicrib or alternately, commercially available bird hot boxes with a thermostatically controlled heat source and humidity provided via an open container of water in the box. (Vogelnest, L; Woods, R 2008)

- Thermometers should be used to continuously monitor and record temperature.

11.3 Diet and Feeding Routine

11.3.1 Milk Formula

Low lactose formulas available for possums and gliders in Australia include:

- Di-Vetelact (Sharpe Laboratories)
- Wombaroo (Wombaroo Food Products) and
- Biolac (Biolac Milk products)

Fig.136.Di-Vetelact
(http://www.thevetshed.com.au/images/products/OYNKPNdIUi-1.jpg)

Biolac offers several formulas within the one brand, increasing the total solids (fat and protein) content as dietary requirements change as they develop and come out of the pouch. Biolac M100 is recommended. M150 and M200 should not be used on possums (http://www.biolac.com.au/possum.htm)
Two stages of Wombaroo possum milk are available, <0.8 and >0.8. <0.8 is for young that have not yet emerged from the pouch . >0.8 is for young that have exited the pouch and it is higher in fat and lower in protein. (Vogelnest, L; Woods, R 2008)

The formula required depends on the stage of development.

According to the manufacturer, the possum milk replacers are suitable for all species of possums and gliders. (Vogelnest, L; Woods, R 2008)

Milk powder/ formulas should be kept in seal proof containers in the fridge to avoid bugs gaining access and potentially ruining the entire bag.

READ ALL LABELS AND DIRECTIONS BEFORE USING PRODUCT

11.3.2 Feeding Equipment

For very small joeys:

- A syringe fitted with a bicycle tyre valve rubber
- Intravenous catheter
- 1 inch length of infant gastric feeding tube or
- Trimmed infusion set tubing may be used instead of a teat to achieve small and uniform drop flow. (Vogelnest, L; Woods, R 2008)

If using teats, they should be punctured with a hot needle. Pygmy-possums are able to lap from 10ml syringe fitted with a teat.

Fig.137.Pygmy-possum joey being fed
(http://blogs.abc.net.au/.a/6a00e0097e4e6888330120a5d64cbf970c-300wi)

Other feeding equipment that may be needed:

- Dishes
- Spoons
- Measuring cups
- Kettle
- Tissues
- Syringes
- Teats
- Variety of formulas
- Cotton buds
- Cotton wool
- Thermometers (possibly thermometer gun)
- Scales
- Storage containers
- Chopping board

Always remember to properly sterilize all feeding equipment in an anti-bacterial solution such as Milton immediately after feeding.

11.3.3 Feeding Routine

Unfurred young should be fed every two to three hours, rather than every one to two hours, as it is very exhausting for the joey. Recently furred young should be fed every four hours and then approximately once or twice daily prior to weaning. (Jackson, S M 2003)

The amount of milk offered per day is 10-20% of the body weight, which is then divided up for each feed (Jackson, S M 2003) however for very small species of possums like the Pygmy-possum, 50% may be needed daily. (Vogelnest, L; Woods, R 2008)

- Older furred young can be encouraged to lap from a spoon or dish.

Fig.138.Pygmy-possum joey being fedwith syringe
(http://chrisleavins.typepad.com/.a/6a00d8341c681b53ef011168671aa1970c-500wi)

Pygmy-possums should be provided with native flowers such as eucalypts, banksias, and grevilleas.

When feeding, it is important not to feed the milk formula too quickly. The rate at which the milk is squeezed into the mouth should not be faster than the rate it is swallowed. Ensuring the hole in the teat is not too big will help (it should be only the size of a pinprick) (Jackson, S M 2003)
Milk should be fed at approximately 36°C

Too much milk results in an accumulation in the pharynx, which is suddenly sneezed or coughed out the nostrils. To avoid this, be very careful of the rate at which milk is released to the joey and use a smaller hole on the teat if required. (Jackson, S M 2003)

IMPORTANT:
The number of daily feeds changes as the joey develops (Jackson, S M 2003)

If rearing in isolation from adults, inoculation of the gut with micro-organisms is recommended as digestion relies on hindgut fermentation. This is most easily accomplished by allowing access to faeces of adult conspecifics, but donor samples should be tested first to ensure yeasts are not present.

11.4 Specific Requirements

The skin of unfurred and slightly furred young should be kept moist by using Sorbelene cream (not with added glycerine) → ensuring the skin does not become dry and cracked. Baby oil does not appear to be absorbed. It tends to stay on the skin surface where it rubs off and is absorbed by the liner bag fabric (Jackson, S M 2003)

When first brought in, the possum may be dehydrated. If so, there are various ways to fix this:

- It can be given plain boiled water, with 5g (one teaspoon) of glucose to 100ml of water or 1g of electrolyte replacer of available (Jackson, S M 2003)
- Vytrate can also be used at a ratio of 20ml Vytrate to 250ml water (Jackson, S M 2003)
- Alternatively, fluids such as Lectade or Pedialyte, an electrolyte/ glucose replacer (if the animal has diarrhoea), or Glocodin can be given for a period of up to 24-28hours (Jackson, S M 2003)

It is important to warm the joey before feeding otherwise there is a greater risk of inhalation pneumonia. If the joey is really cold, place it in a warm water bath and dry off rather than putting in a hot box. (Jackson, S M 2003)

Stress → major problem with all hand-rearing, especially native mammals. IT CAN BE FATAL Therefore:

- Keep noise to a minimum
- Don't over handle the animal and
- Maintain high standards of hygiene. (Jackson, S M 2003)

11.5 Data Recording

When any animal is brought into a collection or for hand-rearing, its sex and approximate age according to growth charts needs to be recorded.

Any information you can think of or have access to…RECORD IT

During the hand-rearing process, it is important to regularly record information and observations that could become vital down the line. This information serves several purposes including providing important background information such as food consumption which will assist veterinarians reach a diagnosis if the animal becomes sick or fails to grow or gain weight. It also allows a comparison with growth curves to assess progress and to establish other growth curves that do not exist for other measurements. (Jackson. S M, 2003)

The following information should be recorded on a daily basis:

- Date
- Time when the information is recorded
- Body weight to the nearest 1g
- General activity and demeanour
- Characteristics and frequency of defecation and urination

- Amount (g) of different food types offered
- Food consumption at each feed
- Veterinary examinations and results

The developmental stages and measurements should also be recorded on a weekly basis is possible. (Jackson, S M 2003)

- **List of development stages and measurements can be found in Appendix15**
- **A graph showing measurements of young pygmy-possums and a growth chart can be found in Appendix 15**

11.6 Identification Methods

Pygmy-possums should not be micro chipped until they are fully grown.
General Rule: don't chip individuals under 10g (Jackson, S M 2003)

Other identification techniques can be used:

- Diagnostic features/ names
- Possibly ear notches

11.7 Hygiene

Maintaining a high level of hygiene is critical to the survival of a young possum.

The following was taken from Stephen Jackson's, *Australian Mammals: Biology and Captive Management*, 2008:

Fig.139.Milton (http://www.bluemarketing.com.au/product images/MIL0016.jpg)

Emphasis needs to be placed on the following:

- Maintain a clean pouch lining at all lines. Older joeys can be trained to urinate on newspaper by keeping a piece with the smell of urine on it.
- Maintain personal hygiene by washing and disinfecting hands before and after handling the joey. Use antibacterial solution for washing hands with furless joeys, as their immune system is not well developed.
- Wash hands between feeding different joeys
- Use boiled water when making up formulas for very young joeys
- Clean spilt milk formula, faeces and urine from the joey's skin and fur as soon as possible, and then dry the animal. → If the fur becomes solid, wash it under warm tap water and dry thoroughly.
- Wash all feeding equipment in warm soapy water and sterilize it in a suitable anti-bacterial solution such as Halasept or Milton, or boil it for 10 minutes. Once sterilized, the equipment should be rinsed in cold water.
- Many carers store teats and bottles in the fridge after they have been disinfected
- Only heat up milk once and then discard the leftovers
- Contact with other animals should be avoided unless you are sure they pose no health risk

- Stimulate to toilet before or after feeding. As with other marsupials, toileting can be done by the application of warm water to the cloaca using cotton wool to stimulate urination and defecation, which allows the animal to keep drier and warmer in its pouch.
- If furless, cover the joey's pouch after each feed.

Good hygiene is important otherwise condition such as candida or thrush (See section 8.4.3), can occur. Toileting between meals may also be required until good habits are learned (Jackson, S M 2003)

- Be careful with this stimulation…if done excessively, it can lead to cloacal prolapsed and possibly urethral swelling, in which case you would consult a veterinarian (Jackson, S M 2003)

If this occurs, it can be treated with creams such as Panalog (Squibb), Proctoseyl (Roussel) and Topigol (squibb) (Jackson, S M 2003)

11.8 Behavioural Considerations

Behavioural considerations are important to think about when hand rearing most species. Some particular groups of animals, for example primates are more likely to develop various behavioual problems.

Risks involved in hand rearing include:

- Imprinting
- Lack of socialisation
- Infection and low immune system and
- Acquisition of aberrant behaviours

Take care that the joey being hand reared does not become too attached to the raiser, as this will make the weaning process much more difficult. Raising several individuals together and not overhandling them will help them to socialise properly and reduce these problems. (Jackson, S M, 2003)

Pygmy-possum are not known to become too attached or develop behavioural problems.

11.9 Use of Foster Species

Foster species have not been readily used to date with any species of possums; however brushtailed possums have been transferred to other mothers of the same species of similar age (Jackson, S M 2003)

11.10 Weaning

General rule for weaning: decrease formula by 5% each week (providing the joey is gaining weight at a minimum of 5-10% per day) (Jackson, S M 2003)

When ready for weaning, the Pygmy-possum should be provided with an increase in solid foods. If slow to wean, it can be encouraged by slightly reducing the amount of milk while providing the solid food. (WATCH THAT IT DOESN'T LOOSE EXCESSIVE WEIGHT)

Pygmy-possums should be weaned at approximately 2 months and should be given flowers plants, finely chopped up soft fruits such as watermelon, grapes, rockmelon etc as well as several milliliters of leadbeaters mix.

- Water is to be supplied at all times during weaning.

Leadbeaters mix:
2/3 cup warm water
1 boiled egg (no shell)
2/3 cup honey
½ cup high protein baby cereal.

Method:
Mix honey and water together
Mix egg in with blender
Add baby cereal and blend until smooth.

11.11 Rehabilitation and Release Procedures

The most important thing to note about rehabilitation and release for any species that it does not only include young animals and hand rearing. Artificial rearing may be a part of it, however in many situations; keepers are faced with wild injured adults that require various care programs in order to potentially be released back into the wild if that is the desired outcome.

Once an animal has been received it is important to follow the rehabilitation and release procedure in this order:

Rescue → Release outcome, information and site → Rehabilitation → actual release

Release outcomes should be assessed before the rehabilitation procedure starts because the kind of rehabilitation that needs to happen will depend on the final outcome decision.

Rescue:
Normally as a keeper, we don't usually get much experience actually rescuing an animal. More than often, members of the public will hand in animals that they have found.

It is important to record the following information at the time of the rescue or when it is handed in:

- Date
- Time
- Details of person (name, phone number, address)

- Species (Rehabilitating and releasing some specific species should be avoided due to various reasons)
- Approximate age
- Exactly where they found it (UBD co-ordinate number) --> this is crucial for releasing it back into the wild.
- What happened? Was it knocked down by a car? Fell out of a tree?

RECORD ANY INFORMATION that you have access to. It may be useful in the future.

Release outcome:

The main decision to make is: is it able to be released back into the wild and do we want to? If the animal is too young to be released or suffering injuries that would disadvantage it in the wild, you may choose to keep it in the collection or even send it to a more permanent facility. Hand rearing would be an option in this circumstance for young animals.

Fig.140. Pygmy-possum jumping (http://www.google.com.au/imgres?imgurl=http://users.tpg.com.au/readmana/Pygmy%25201%2520Morcombe.jpg&imgrefurl=http://australian-)

However, if the main aim is to release the animal back into the area where it was found, keepers may need to maintain a hands-off approach to the rehabilitation procedure to avoid negative imprinting or other risks that come with caring for wildlife.

- The animal should be researched before starting with rehabilitation.

Sometimes, release sites can be chosen and researched a long time before the animal is intended on actually being released. Animals may need to become acclimatised to the area by feeding them with food found in that area and using browse and nesting material that they will come across once released.

Depending on the species and its progress, release sites can also be chosen once rehabilitation is underway.

When choosing a release site, always consider the following:

- **RESEARCH THE ANIMAL EXTENSIVELY**: Find out what and how much it eats, the type of habitat it lives in, is it social or solitary? What is it's home range area?
- Food: is there enough of the specific food type it eats and is it easily accessible to them?
- Other animals in the area: either the same or a different species. If the same species… is the area large enough so they can all live peacefully together (this is where home ranges are important). If different species…can they interact and live together?
- Other animals can also include numbers and species of predators in the area.
- Housing: are there enough trees or specific places for the animal to live? Do they meet behavioural and physical needs of the species? Do they suit the habitat or 'canopy cover' preferred by the animal.
- Hazards: Make a list of potential hazards in the area and assess if that is the right release site for that species. Even one hazard can make a site unsuitable. It just needs to be assessed and weighed up.

Hazards can include:

- Close to suburban areas: powerlines, roads, pets
- Large number of predators (Eg: foxes)
- Various activities that may happen on or near the site. (Eg mountain bike trails, dog parks)
- Interaction with other species.
- Human interaction (dumping rubbish, grazing cattle)

When assessing a release site I recommend drawing up an **information sheet** about the species. In very brief dot points, state the important bits of information:

- Distribution
- Diet
- Longevity
- Habitat

Then make a list of some things you need to look out for/ assess once on the site. These can include:

- **Hazards**

- **Habitat assessment**→ think about the following:
    - Trees: as food as well as protection.
    - Suitable habitat/canopy → can they jump from tree to tree?
    - Suitable nesting options
    - Water supply
    - Scat analysis (look out for evidence or other animals or predators)
    - Wildlife survey

- **Habitat recommendations** (what can be done to improve the site?)
    - Man made nest boxes
    - Ropes between trees
    - Planting native species
    - Fencing (to stop animals as well as people entering the release site)

Summary: Before an animal is released, there are many factors to consider such as food source and access to food, nesting availability, other species present and hazards. Canopy cover needs to be suitable to provide an inhabitable environment.

- ❖ **An example of an information sheet for release for the Eastern Pygmy-possum can be found in Appendix 16**

Features of a perfect release site for an Eastern Pygmy-possum:

- Variety of food trees (Banksia, Grevillea, Eucalypt) and enough of them to support the present number of animals PLUS the animal/s being released. + able to access them readily.

- Eucalypt or Stringybark trees for shelter, nest building and protection from birds of prey or owls.
- Canopy cover → Eastern pygmy-possum's have adapted to living in a range of different environments. They thrive in rainforests and sclerophyll forests with a medium-dense coverage.
- → Pygmy-possums are able to leap from tree to tree but make sure they are able to successfully move across the canopy without having to come down to the ground, where they are likely to be taken by predators.

Note: Adjustments or changes can be made as mentioned above can be made to provide a more suitable release site.

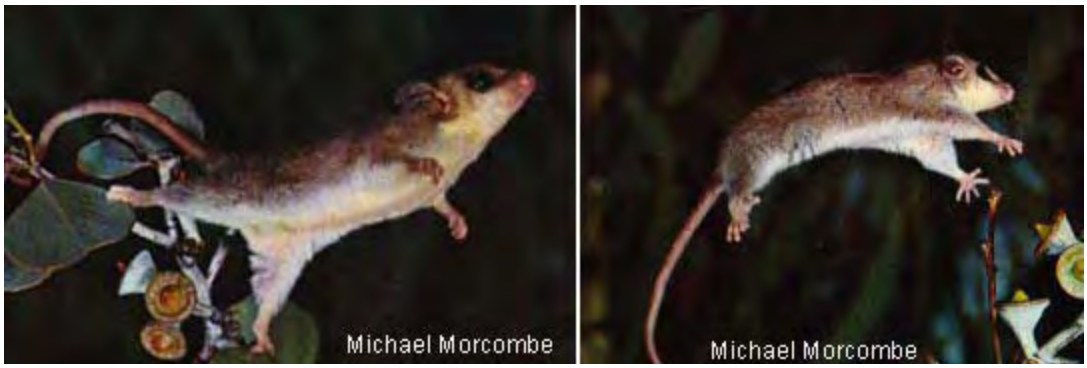


Fig.141. Pygmy-possum jumping
(http://www.google.com.au/imgres?imgurl=http://users.tpg.com.au/readmana/Pygmy%25201%2520Morcombe.jpg&imgrefurl=http://australian-)

Rehabilitation:

Rehabilitation of an animal does not only include artificial rearing. Yes, in some cases it will apply, but rehabilitation can be described as preparing that animal for its final release.

If an animal that has been hand-reared is to remain in captivity, there is not as much need to rehabilitate it except in some species where it may affect its effectiveness to breed. If breeding is not an issue, having a highly manageable and calm animal is generally a benefit to a captive situation. (Jackson, S.M 2003)

In Stephen Jackson's *Australian Mammals: Biology and Captive Management* book he writes:

If a possum or glider is to be released back into the wild it is important to take every measure to maximize its chances of survival. Measures include:

- Minimise the amount of handling by proving milk in a bowl as soon as the animal can lap and leaving solid food for it to consume while you are not there. It is very important that the possum does not associate you with food; rather, encourage it to explore its enclosure to find the food that you have left there.
- Make as little fuss as possible over the possum or glider to reduce the bonding it males with you. Placing the food in the enclosure at dusk before the animal emerges for the evening can facilitate this as they will not associate food with humans.

- Provide as much native food as possible, after dark, so that it becomes used to eating natural food items
- Provide lots of climbing opportunities to allow the animals to increase their climbing skills and fitness.
- Do not place the food on the enclosure floor as this encourages them to come to the ground where they are more likely to be taken by predators.
- Do not rear them near to domestic animals as this habituates them to predators, which they need to be wary of in the wild.
- Pair them up, if possible, when they are young with another possum of the same species and approximately the same age.

Fig.142. Pygmy-possum (http://www.co2australia.com.au/web_images/carbon-trading-WesternPygmyPossumSM.jpg)

Prior to release, the possum should be introduced to other Pygmy-possums so that they can learn socialisation skills. More nest boxes than individuals should be supplied as well as natural nesting material to allow them to practise nest building (Jackson, S.M 2003)

The above information is referring to hand reared Pygmy-possums. Adults will also come in who may be in shock or may have various injuries.

Keepers will probably have to administer medications or attend to dressing etc.
RECORD KEEPING IS IMPORTANT

As mentioned before, the rehabilitation procedure depends on the final desired outcome and the decision of its future should be settled on as soon as possible.
If a pygmy-possum is going to be released back into the wild, consider feeding it with food from the release site or acclimatizing it to the environment that it will live in. → Try to replicate what the release environment will be like. This makes it a lot easier for the possum to settle in and results in a higher survival rate.

Release:

Generally, soft releases are used in which a nest box or drey is supplied along with food so that the possum can slowly habituate back into the wild. The survival of possums and gliders released back into the wild is low, as they invariably fall prey to introduced predators such as cats and foxes. During a study of Ringtail possums, cats and foxes were found to be responsible for more than 80% of hand-reared Ringtails killed, a statistic which was later found to be similar to that observed for wild non-handreared possums. (Jackson, S.M 2003)

As Stephen Jackson wrote in his book, soft release is always the way to go. There is not set amount of time that an enclosure should be left out in the wild, it all depends on the individual and if it feels comfortable living outside independently.

I would recommend the following steps:

- Gain access to a large aviary. (2m x 2m x 2m approx)
- Move all nest boxes, furnishings and the possum into the enclosure to let him establish it as his home
- After a week or so move the enclosure to the release site.
- Leave the enclosure door closed for a couple of days for him to get his bearings
- Open the door and slowly decrease the amount of food given everyday.
- Monitor behaviour and only remove the cage once you are certain the possum is comfortable outside and isn't using the cage at all.

Fig.143. Western Pygmy-possum
(http://www.bushheritage.org.au/images/media_coverage_images/western_pygmy_possum_PE.jpg)

12. Acknowledgements

I would like the thank the following staff members at Australia Walkabout Wildlife Park for giving me the opportunity to work with the Eastern Pygmy-possum and regularly providing me with extra knowledge and information regarding captive husbandry of this species:

- Tassin Barnard
- Nick Carson
- Monica Corbett
- Ray Harrison
- Sally Smith

A big thankyou to Wendy Reilly who provided me with a significant amount of information on artificial rearing.

13. References

Atherton, R.G. & Haffenden, A.T. (1982) Observations on the reproduction and growth of the long-tailed pygmy-possum Cercartetus caudatus (Marsupialia: Burramyidae), in captivity. *Australian Mammalogy* 5: 253–259

Australian Government, Biodiversity, 2010, *Burramys parvus* (http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=267)

Baillie, J. and Groombridge B. 1996. *1996 IUCN Red List of Threatened Animals*. IUCN, Gland, Switzerland and Cambridge, UK

Broome, L.S. (2001a). Density, home range, seasonal movements and habitat use of the mountain pygmy-possum Burramys parvus (Marsupalia: Burramyidae) at Mount Blue Cow, Kosciuszko National Park. *Austral Ecology*. 26:275-292.

Broome, L.S, 2010. Senior Threatened Species Officer, *Department of Environment, Climate Change and Water, NSW*

CSIRO publishing. Survival, age determination, and population age of the Ringtail Possum. *Australian Journal of Zoology* <http://www.publish.csiro.au/paper/ZO9870625.htm >

Desmarest, A.G. (1818). Phalanger. Pp. 470–473 in, Nouveau Dictionnaire d'Histoire Naturelle, Appliquée aux Arts, à l'Agriculture, à l'Economie rurale et domestique, à la Médicine, etc. Par une Société de naturalistes et d'agricultuers. Tome 25. Deterville : Paris Nouvelle Édition

Department of the Environment, Water, Heritage and the Arts. (2009) Burramys parvus - Mountain Pygmy-possum. In: *Species Profile and Threats Database*. Department of the Environment, Water, Heritage and the Arts, Canberra. Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=267

Exhibited Animals Protection Act 1986, "*Standards for Exhibiting Australian Mammals in New South Wales*", p 11-12, 19

Heinze, D., Broome, L. And Mansergh, I. (2004) A review of the ecology and conservation of the mountain pygmy-possum Burramys parvus. In: Goldingay, R.L. and Jackson, S.M. (Eds.) *The Biology of Australian Possums and Gliders*. Surrey Beatty & Sons, Chipping Norton.

IUCN Red List (April 2010) http://www.iucnredlist.org

Jackson, S.M (2003) *Australian Mammals: Biology and Captive Management*, CSIRO Publishing, Collingwood.

Live Animals Regulations, 27th edition. Effective 1st October (International Air Transport Association) "*Container Requirement 31*"pp 211-213

Material Safety Data Sheet: *F10 Super Concentrate Disinfectant*. Available online at: http://www.lomb.com.au/images/products/F10SC_MSDS_Dec_2003.pdf

Mansergh, I. and Scotts, D. (1989) Habitat continuity and social organization of the Mountain Pygmy-possum restored by tunnel. *Journal of Wildlife Management*: 701-707

Mansergh, I. & Scotts, D. (1990) Aspects of the life history and breeding biology of the mountain pygmy-possum, Burramys parvus, (Marsupialia: Burramyidae) in alpine Victoria. *Australian Mammalogy*. 13:179-191.

Merriam-Webster Online Dictionary, 2009, *Torpor* <http://www.merriam-webster.com/dictionary/torpor>

Mt Buller and Mt Stirling Resorts Management Board (ARMB) (2007). *Mt Buller and Mt Stirling Resorts: Environmental Management Plan*

Murphy,J.A; Phillips, B.T; Macreadie, B, 2003, Husbandry and breeding of the Eastern Pygmy-possum at Healesville Sanctuary, *International Zoo Yearbook* (2003) 38: 173- 178

NSW Department of Primary Industries, (2005) *Standards for Exhibiting Australian Mammals in New South Wales, Exhibited Animals Protection Act, 1986*

NSW National Parks and Wildlife Service (2002). *Recovery Plan for the Mountain Pygmy-Possum (Burramys Parvus)*

PetPlace.com, 2010, *Ivermectin*, viewed 28 March 2010 <http://www.petplace.com/drug-library/ivermectin-ivomec-heartgard/page1.aspx>

Project R&R, 2009, *Glossary* <http://www.releasechimps.org/resources/glossary/>

Pygmy Possums: Burramyidae - Eastern Pygmy Possum (Cercartetus nanus): Species Account, 2010 (http://animals.jrank.org/pages/2699/Pygmy-Possums-Burramyidae-EASTERN-PYGMY-POSSUM-Cercartetus-nanus-SPECIES-ACCOUNT.html)

Regional Census and Plan 2008, *Census of Mammalia in ARAZPA institutions as at 31 December 2007*, pp 26-27

Smith, A and Winter, J 1999, "*A key guide to the Possums, Gliders and Koala"* Page 15-18

Threatened Species Conservation Act 1995, as at 31 March 2010. Available online: <http://www.austlii.edu.au/au/legis/nsw/consol_act/tsca1995323/>

Threatened Species of NSW, 2005, *Eastern Pygmy-possum profile*, <http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10155

Van Dyck, S; Strathan, R, "*The Mammals of Australia, Third Edition*" pp 210-221

Vogelnest, L; Woods, R, *Medicine of Australian Mammals*, CSIRO Publishing, Collingwood, 2008, pp 412

Walker, E. P. 1975. Mammals of the World, Third Edition. *Johns Hopkins University Press, Baltimore*

Ward, S. J (1990a) Life History of the eastern pygmy-possum, Cercartetus nanus (Burramyidae: Marsupialia), in south-eastern Australia. *Australian Journal of Zoology* 38: 287-304

Zoos Victoria, 2009, *Burramys parvus*, http://www.zoo.org.au/Conservation/Programs/Australian/Mountain_Pygmy-possum

14. Bibliography

Internet:

America Zoo, 2009, 'Pygmy-possum' <http://www.americazoo.com/goto/index/mammals/16.htm>

Anderson's Creek Primary School, "Pygmy Possum" <http://teachit.acreekps.vic.edu.au/animals/pygmypossum.htm>

Animal Diversity Web, 2009, '*Burramys parvus'*<http://animaldiversity.ummz.umich.edu/site/accounts/information/Burramys_parvus.html>

Animal DiversityWeb, "*Cercartetus nanus*" <http://animaldiversity.ummz.umich.edu/site/accounts/information/Cercartetus_nanus.html>

Animal Info, 2005, "Mountain Pygmy-possum" <http://www.animalinfo.org/species/burrparv.htm>

Answers.com, 2009, *"Animal Classification: Pygmy-possums"*<http://www.answers.com/topic/pygmy-possum>

Australian Animals, *"Eastern Pygmy-possum"*<http://australian-animals.net/possum.htm>

Australian Government, 2007 "*Banksias*" <http://www.anbg.gov.au/banksia/>

Australian Government, 2007 "*Bottlebrushes*" <http://www.anbg.gov.au/callistemon/index.html>

Australian Museum, 2003, *"Eastern Pygmy-possum"* <http://www.austmus.gov.au/factSheets/eastern_pygmy_possum.htm>

CSIRO publishing, *"Survival, age determination, and population age of the Ringtail Possum"* Australian Journal of Zoology <http://www.publish.csiro.au/paper/ZO9870625.htm>

Department of Primary Industries, Tasmania, 2007, *"Little Pygmy-possum"* <http://www.dpiw.tas.gov.au/inter.nsf/WebPages/BHAN-53JVBQ?open>

Gardening Australia, 2009,"*Grevillea*" <http://www.abc.net.au/gardening/stories/s1866622.htm>

"*Gut Load Cricket Food*", 2009 <http://www.sugar-gliders.com/gut-load.htm>

Know your STO, 2007, *Top Health Concerns*, viewed 29 March 2010 <http://www.knowyoursto.com/articles/biology-health.html>

Office of Responsible Research Practices, 2008, *"Methods of Animal Identification"*<http://orrp.osu.edu/iacuc/osupolicies/guidelines/MethodsofAnimalIdentification.cfm>

Possum Care Centre, 2009, *Western Ring Tail Possum Fact*, viewed 29 March 2010 <Sheethttp://www.possumcentre.com.au/FactSheets/Fact5.pdf>

"Pygmy Possums: Burramyidae - Behavior And Reproduction", 2009 <http://animals.jrank.org/pages/2697/Pygmy-Possums-Burramyidae-BEHAVIOR-REPRODUCTION.html>

Sydenham, S. & Thomas, R. 2000, *"Pygmy-possums"*<http://www.kidcyber.com.au/topics/pygmyposs.htm>

The Australian Arid Lands Botanic Garden, 2008, *"Western Pygmy-possum"* <http://www.australian-aridlands-botanic-garden.org/general/mammals/m_spec/m_wpp.htm>

Unique Australian Animals, '*Eastern Pygmy-possum*'<http://australian-animals.net/possum.htm>

Zipcodezoo.com, 2009, *"Burramyidae"*<http://zipcodezoo.com/Key/Animalia/Burramyidae_Family.asp>

Zipcodezoo.com, 2009, *"Cercartetus nanus"*<http://zipcodezoo.com/Animals/C/Cercartetus_nanus/>

Zoos Victoria, 2008, *"Mountain Pygmy-possum"*<http://www.zoo.org.au/Conservation/Programs/Australian/Mountain_Pygmy-possum>

Books:

Cronin L, 1991, *"Key guide to Australian Mammals"* Page 68-72

Jackson, S, "*Australian Mammals*" Website: <http://books.google.com.au/books?id=Ys_NC1P9AX4C&dq=steve+jackson+%22Australian+Mammals%22&printsec=frontcover&source=bn&hl=en&ei=pJn1SYvHHpOIkQXo2fDSCg&sa=X&oi=book_result&ct=result&resnum=4#PRA3-PA215-IA1,M1>

Jones C, Parish S, *"Field Guide to Australian Mammals"* Page 82-85

15. Glossary

Acaricide: a chemical agent used to kill mites (medical dictionary)

Aestivation: cessation or slowing of activity during the summer; especially slowing of metabolism in some animals during a hot or dry period

Alopecia: hair loss

Altricial: helpless at birth

Arboreal: living in trees

Candidiasis: Infection with a fungus of the genus *Candida*, especially *C. albicans*, that usually occurs in the skin and mucous membranes of the mouth, respiratory tract, or vagina but may invade the

bloodstream, especially in immunocompromised individuals. Also called *candidosis*, *moniliasis*.

Cestodes:A subclass of parasitic worms of the class Cestoidea. In some classifications, it is not differentiated from the parent class

Cloaca:a common passage for fecal, urinary, and reproductive discharge in most lower vertebrates

Conspecifics: An organism belonging to the same species as another

Copulation:to mate

Hindgut fermentation: Hindgut fermenters use microbes (bacteria only) and fermentaion in their hindgut, the caecum and proximal colon. Microbes that are washed out cannot be digested and therefore high-quality protein is lost

Lactation:1. Secretion or formation of milk by the mammary glands.
2. The period during which the mammary glands secrete milk.

Natal Area: area/place of birth

Nematodes:A phylum of worms, having a long, round, and generally smooth body; the roundworms. They are mostly parasites, in plants and animals, but some are free-living in soil or water. Also called Nematoidea.

Osteoporosis:A disease in which the bones become extremely porous, are subject to fracture, and heal slowly, occurring especially in women following menopause and often leading to curvature of the spine from vertebral collapse

Pharynx: The section of the alimentary canal that extends from the mouth and nasal cavities to the larynx, where it becomes continuous with the esophagus.

Pupillary relex: Contraction of the pupil in response to stimulation of the retina by light (Sci-Tech Dictionary.

Prehensile: Adapted for seizing, grasping, or holding, especially by wrapping around an object

Sedentary: Remaining or living in one area

Torpor:A state of mental or physical inactivity or insensibility or The dormant, inactive state of a hibernating or estivating animal

Trematodes:parasitic flatworms having external suckers for attaching to a host

16. Figures and Diagrams

Fig.1. "Wellness at Work" sign
(http://www.farsolutions.co.uk/images/Wellness.jpg)

Fig.2. Example of a sharp corner of an enclosure
(http://www.floridadisaster.org/mitigation/rcmp/hrg/content/features/features_index.asp)

Fig.3. Example of a basic animal enclosure. Could be used for possums or birds.
(http://www.custombuiltaviaries.com.au/3.html)

Fig.4. Branches in a possum enclosure
(http://animal-world.com/encyclo/critters/ringtailpossum/Images/RingtailPossumWCMa3_U71.jpg)

Fig.5. Correct technique when handling boxes or other heavy objects
(http://www.cofa.unsw.edu.au/export/sites/cofa/schoolsunits/ohs/cofa_ohs_images/lifting_2.jpg_1691113714.jpg)

Fig.6. Mechanical Aid- Trolley
(http://www.industrysearch.com.au/products/images/p31786_1.jpg)

Fig.7. Mechanical Aid- Crane
(http://www.industrysearch.com.au/products/images/p31936_6.jpg)

Fig.8. **Mechanical Aid- Trolley**
(http://www.industrysearch.com.au/products/images/p31842_9.jpg)

Fig.9. Correct lifting and carrying technique
(http://bama.ua.edu/%7Eehs/New%20Web/woman.gif)

Fig.10. **Examples of personal protective equipment that may be needed for different tasks**
(http://www.westone.wa.gov.au/toolboxes/water/toolbox_11_04/uoc3/images/ppe.jpg)

Fig.11. **Hazard Warning Sign** (http://www.safety-signs.b-protected.com.au/uniforms-melbourne/safety-signs.htm)

Fig.12. Hazard tape
(http://www.qep.com/files/category_pictures/10945_0.jpg)

Fig.13. Eastern Pygmy-possum
(http://www.warra.com/warra/images/research_projects/WRA116.2.jpg)

Fig.14. Mountain Pygmy-possum
(http://museumvictoria.com.au/pages/12314/imagegallery/vic-mountainpygmypossum-large.jpg)

Fig.15. Eastern Pygmy-possum
(http://www.austmus.gov.au/factSheets/images/eastern_pygmy_possum.jpg)

Fig.16. Long-tailed Pygmy-possum
(http://www.das-tierlexikon.de/data/media/32/cercartetus_caudatus.jpg)

Fig.17. Western Pygmy-possum
(http://www.zoo.latrobe.edu.au/Staff/mfc/Mallee/photogallery/western%20pygmy%20possum-juv_G_Nov%2006_LO_%20(89).JPG)

Fig.18. Little Pygmy-possum
(http://www.livt.net/Clt/Ani/Cho/Mam/Mar/Brr/brr006.jpg)

Fig.19. Mountain Pygmy-possum
(http://wwf.org.au/assets/mountain-pygmy-possum.jpg)

Fig.20. Eastern Pygmy-possum
(http://www.tasfieldnats.org.au/PygmyPossum/NestBoxes.htm)

Fig.21. 'Marni'
(http://www.walkaboutpark.com.au/index.php?id=157)

Fig. 22. Eastern Pygmy-possum
(http://michaelsnedic.com/images/mammals/Pygmy-Possum-in-Tree-Waratah-web.jpg)

Fig.23. Long-tailed Pygmy-possum
(http://news.bbc.co.uk/media/images/44307000/jpg/_44307364_pygmy203afp.jpg)

Fig.24. **Western Pygmy-possum**
(http://www.nrm.gov.au/projects/sa/alwi/images/2006-09d.jpg)

Fig.25. **Western Pygmy-possum**
(http://www.fnpw.com.au/Images/Projects/PlantsandWildlife/Western_Pygmy_Possum_RayDayman.jpg)

Fig.26. **Western Pygmy-possum**
(http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/images/cer-con_small.jpg)

Fig.27. **Little Pygmy-possum**
(http://www.parks.tas.gov.au/file.aspx?id=4897&mode=thumbnail)

Fig.28. Little Pygmy-possum
(http://www.mammalogy.org/mil_images/images/mid/327.jpg)

Fig.29. Mountain Pygmy-possum
(http://www.weedscrc.org.au/publications/images/mountain%20pygmy%20possum_l%20broome_dec.jpg)

Fig.30. **Mountain Pygmy-possum**
(http://www.dse.vic.gov.au/dse/nrenfoe.nsf/FID/-8964E6C3B4737F3CCA256D890011CD59?OpenDocument)

Fig.31. Mountain Pygmy-possum
(http://www.climatechange.gov.au/impacts/images/biodiversity.jpg)

Fig.32. Distribution of Eastern Pygmy-possum.
"The Mammals of Australia, third edition"

Fig.33.**Woodland habitat**
(http://uwarboretum.org/images/eps/woodland.jpg)

Fig.34. **Long-tailed Pygmy-possum**
(http://www.wettropics.gov.au/st/rainforest_explorer/Resources/Images/animals/mammals/LongTailedPygmyPossum.jpg)

Fig.35. **Distribution of Long-tailed Pygmy-possum**. "The Mammals of Australia, third edition"

Fig.36. Map of Papua New Guinea
(http://www.prema-eu.org/clip_image002.jpg)

Fig.37. **Distribution of Western Pygmy-possum**.
"The Mammals of Australia, third edition"

Fig.38. Western Pygmy-possum
(http://www.wilderness.org.au/images/Western-Pygmy-Possum250.jpg/image)

Fig.39. Dry sclerophyll forest (http://www.forest-education.com/images/uploads/tas-grassy-understorey.jpg)

Fig.40. **Distribution of Little Pygmy-possum**. "The Mammals of Australia, third edition"

Fig.41. **Mountain Pygmy-possum** (http://www.animalpicturesarchive.com/ArchOLD-3/1112777155.jpg)

Fig.42. Distribution of Mountain Pygmy-possum. "The Mammals of Australia, third edition"

Fig.43. Subalpine habitat

Fig.44. **Location of Kosciusko National Park**

Fig.45. Example of a multi-species holding area (http://0101.netclime.net/1_5/083/0c0/0ee/119802688857696.jpg)

Fig.46. Plastic container. (own picture)

Fig.47. Larger Holding Area for longer periods of time. (http://www.kingbilli.com.au/photos/cen3.jpg)

Fig.48. An outside enclosure that can be used for breeding. (own picture)

Fig.49. Rain (http://www.spamula.net/blog/i40/rain2.jpg)

Fig.50. Sun (http://frugaldad.com/wp-content/uploads/2008/03/hot-sun.jpg)

Fig.51. Western Pygmy-possum in Torpor (http://www.possumcentre.com/ImagesPygmyWPSpoon.jpg)

Fig.52. Heat lamp used in Pygmy-possum enclosure (own picture)

Fig.53. Heat lamp with cover (http://www.trevsgeckos.com/images/heat%20light%202.jpg)

Fig.54. Leaf litter (http://www.countrysideinfo.co.uk/forest2/FOLDER01/leaf_litter.jpg)

Fig.55. Tree Hollow (http://upload.wikimedia.org/wikipedia/commons/thumb/4/43/Hollow_tree_detail.jpg/300px-Hollow_tree_detail.jpg)

Fig.56. Nest boxes (own picture)

Fig.57. Stringybark tree (http://www.waterwheelcreek.com.au/images/gallery/tall_stringy_bark.jpg)

Fig.58. Inside Nest Box (own picture)

Fig.59. Feather (http://www.diggerhistory.info/images/asstd3/white-feather2.jpg)

Fig.60. Pygmy-possum in the tree tops (http://www.mammalogy.org/mil_images/images/mid/326.jpg)

Fig.61. Eucalypt leaves (http://www.kriyayoga.com/photography/photo_gallery/d/17745-2/eucalyptus_leaves-dsc00101.jpg)

Fig.62. Cleaning equipment (http://www.allprostaffnet.com/cleaning-tools.jpg)

Fig.63. water bowl (https://www.thereptileroom.co.uk/catalog/images/Exo_Terra_Water_Bowl.jpg)

Fig.64. F10 SC (http://vetnpetdirect.com.au/files/P/t_17043.jpg)

Fig.65. Nesting material (www.thebegavalley.org.au/.../?C=M%3BO=A)

Fig.66. Leaf litter (http://1.bp.blogspot.com/_zKDjcLXZBTI/R0clPvaRciI/AAAAAAAABMA/1KyenTuH4qg/s400/Blog_039a.jpg)

Fig.67. Wattle (www.jimlow.net/blog/?cat=11)

Fig. 68. Daily Diary (http://www.mvmc.org.uk/user-images/4409/moleskine_daily_diary-1.jpg)

Fig.69. **scanner and applicator.** (http://www.chaseviewvets.co.uk/images/id2.jpg)

Fig.70. Microchip (http://www.traditionsanimalhospital.com/local/136/microchip1.jpg**)**

Fig.71. Ear notches on a mouse (http://www.bu.edu/research/compliance/lacu/lacf/images/ear-punching_clip_image002.jpg)

Fig.72. Metal ear tags
(http://www.nationalband.com/1005-1l1.gif)

Fig.73. **Plastic ear tags**
(http://www.ece.ndsu.nodak.edu/%7Eglower/RFID/May17_Pictures/Collection_of_RFID_Tags.jpg)

Fig.74. Tail Tattooing on a rat
(http://www.braintreesci.com/images/mouse%202.JPG)

Fig.75. Eastern Pygmy-possum
(http://www.wildlifetasmania.com/images/Eastern%20pygmy%20possum.jpg)

Fig.76. Banksia
(http://www.seenobjects.org/images/mediumlarge/2004-09-05-banksia.jpg)

Fig.77. Eucalypt Flower.
(http://www.malleenativeplants.com.au/wp-content/uploads/2006/12/eucalyptus_foecunda_100_4382.jpg)

Fig.78. Grevillea
(http://asgap.org.au/jpg2/imp4072.jpg)

Fig.79. Bottlebrush
(http://www.fbmg.com/CommunityEducation/PerennialSales/Perennial2007/perennialphotos/HannahRayBottlebrush.jpg)

Fig.80. Grapes
(http://www.healthyweightlosshelp.info/wp-content/uploads/2009/01/grapes.jpg)

Fig.81. Apples
(http://shuvecchadhaka.com/images/Apples_medium.jpg)

Fig.82. Watermelon
(http://www.seedlesswatermelonseed.com/images/image_cover.jpg)

Fig.83. Peach (http://aggie-horticulture.tamu.edu/syllabi/319/images/peachfruithalf.jpg)

Fig.84. Pear
(http://www.bctree.com/images/photos/pear-bartlett.jpg)

Fig.85. Rockmelon
(http://www.taste.com.au/images/articles/untitled12031014.jpg)

Fig.86. Sultanas
(http://virtualhug.files.wordpress.com/2007/08/sul.jpg)

Fig.87. Sweet Potato
(http://uhaweb.hartford.edu/KENNEY/sweet_potato.gif)

Fig.88. Carrots
(http://www.businesspundit.com/wp-content/uploads/2009/03/carrots.jpg)

Fig.89. Piece of Carrot (own picture)

Fig.90. Bowl of food (own picture)

Fig.91. Mealworm
(http://www.recorpinc.com/images/mealworm.jpg)

Fig.92. Mealworms
(http://www.reptiles.swelluk.com/reptile-care/keeping-mealworms.html)

Fig.93. Fresh Fruit
(http://blog.americanfeast.com/images/Fresh%20Fruit.jpg)

Fig.94. Fridge (http://www.design-industry.com.au/en/wp-content/uploads/2007/07/fridge_01_400x400.jpg)

Fig.95. Mealworm pupa
(http://mealwormstore.com/images/pupa.jpg)

Fig.96. Mountain Pygmy-possum
(http://www.abc.net.au/science/scribblygum/May2000/img/possum2.pg.jpg)

Fig.97. Gut Load
(http://www.wormman.com/prod_images_large/gut_load1.jpg)

Fig.98. Exo Terra food bowl
(http://www.petdiscounters.com/mc_images/product/detail/hagen_exo_terra_pt2803_granite_rock_water_00.jpg)

Fig.99.Pygmy-possum at night
(http://wwwdelivery.superstock.com/Image/1701/Thumb/1701R-19111.jpg)

Fig.100. Pygmy-possum sleeping
(http://www.abc.net.au/reslib/200909/r436286_2097421.jpg)

Fig.101.Catching bag (http://www.prime-weld.co.uk/store/images/uploads/smlnet.jpg)

Fig.102. Correct handling technique. (http://www.mammalwatching.com/Australasian/Images/NSW/Pygmy%20Possum.jpg)

Fig.103. Pygmy-possum being gently cupped. (http://www.windgrove.com/ee/images/uploads/pygmy_hand.jpg)

Fig.104. Eastern Pygmy-possum being weighed on a digital scale. (Own photograph)

Fig.105. Pygmy-possum inside a cotton bag. (http://www.marsupialsociety.org/images/bushfire_2a.jpg)

Fig.106. Appropriate box design for transporting species under "container requirement 31" of IATA pp. 211

Fig.107. "This way up" sign

Fig.108. "Live Animals" sign

Fig.109. appropriate nesting material (http://www.tasfieldnats.org.au/ExcnPhotos/092-BrunyIs/092-2249cr.JPG)

Fig.110. Food and water bowls that can be fastened to the sides of boxes (http://www.belvederestore.co.uk/images/uploads/B00220.jpg)

Fig.111. Pygmy-possums together living together in a nest. (Van Dyck, S. "*The Mammals of Australia. Third Edition*", pp. 218)

Fig.112. Eastern Pygmy-possum restraint (http://www.aqob.com.au/images/product/detail/Pygmypossumtraceyadams.jpg)

Fig.113. Encouraging Approach (http://blogs.abc.net.au/.a/6a00e0097e4e6888330120a6119b9d970b-300wi)

Fig.114. Alopecia in rat (http://pics.hoobly.com/full/D6PC8CYIL99IRIRKSA.jpg)

Fig.115. Pygmy-possum examination (http://www.peacockshock.com/archives/pygmy%20possum%20firefighter-thumb.jpg)

Fig.116. Ivermectin drops (http://www.pharmaq.co.uk/shop/images/ivermec_08.jpg)

Fig.117. Mites (http://www.homeventexperts.com/images/Dust%20Mites.jpg)

Fig.118. Tick (http://www.salamatvet.com/images/tick-1.jpg)

Fig.119. Nematode (http://www.cims.nyu.edu/~binliu/proj/ce/pics/worm-briggsae_WT_male.gif)

Fig.120. *Candida albicans* (http://forwearemany.files.wordpress.com/2009/12/candida_albicans.jpg)

Fig.121. Calcium (http://1.bp.blogspot.com/_6nX1rVl6Ffo/SYKhDLtkmbI/AAAAAAAAADA/r9h0eN0siAs/s400/calcium-supplements.jpg)

Fig.122. Quarantine Sign (http://media.moddb.com/cache/images/mods/1/13/12366/thumb_620x2000/quarantineSign.jpg)

Fig.123. Appropriate PPE (http://upload.wikimedia.org/wikipedia/commons/8/8d/Disp-med-ppe.jpg)

Fig.124. Pygmy-possum at night. (http://www.abc.net.au/reslib/200807/r275383_1162934.jpg)

Fig.125. Pygmy-possums (http://www.tasfauna.org/RESOURCES/Photos/Pygmy%20Possums%20-%20King%20Island.jpg)

Fig.126. Pygmy-possum in torpor (http://www.abc.net.au/reslib/200909/r436286_2097421.jpg)

Fig.127. Pygmy-possum young (http://palaeo.gly.bris.ac.uk/Palaeofiles/Marsupials/baby.jpg)

Fig.128. Mountain Pygmy-possum (http://fnpw.org.au/Images/Projects/PlantsandWildlife/poss8_large.gif)

Fig.129. Western Pygmy-possum (http://www.fnpw.com.au/Images/Projects/PlantsandWildlife/Western_Pygmy_Possum_RayDayman.jpg)

Fig.130. Pygmy-possum
(http://www.australianfauna.com/images/mountainpygmypossum.gif)

Fig.131. Pygmy-possum with banskia
(http://www.australiassouthwest.com/SiteCollectionImages/InlineImages/Pygmy_possum.jpg)

Fig.132. Young Pygmy-possum
(http://3.bp.blogspot.com/_u8lpcWcCkWs/R4KDUNv-KKI/AAAAAAAAAUI/B4rei4GB1Nk/s400/Baby.jpg)

Fig.133. Baby possum
(http://www.abc.net.au/science/scribblygum/May2000/img/f_baby_possum.jpg)

Fig.134. Brushtail being fed in a warm, secure pouch

Fig. 139. Milton
(http://www.bluemarketing.com.au/product_images/MIL0016.jpg)

Fig.140. Pygmy-possum jumping
(http://www.google.com.au/imgres?imgurl=http://users.tpg.com.au/readmana/Pygmy%25201%2520Morcombe.jpg&imgrefurl=http://australian-)

Fig.141. Pygmy-possum jumping
(http://www.google.com.au/imgres?imgurl=http://use

(http://www.chidlowmarsupialhospital.org.au/images/userfiles/Brush_Tail_Possum_Joey_100_0521.jpg)

Fig.135. Thermometer Gun
(http://myhealthnfitness.com/images/Personal%20Health/CVHM-H13-2.jpg)

Fig.136. Di-Vetelact
(http://www.thevetshed.com.au/images/products/OYNKPNdIUi-1.jpg)

Fig.137. Pygmy-possum joey being fed
(http://blogs.abc.net.au/.a/6a00e0097e4e6888330120a5d64cbf970c-300wi)

Fig.138. Pygmy-possum joey being fed with syringe
(http://chrisleavins.typepad.com/.a/6a00d8341c681b53ef011168671aa1970c-500wi)

rs.tpg.com.au/readmana/Pygmy%25201%2520Morcombe.jpg&imgrefurl=http://australian-)

Fig.142. Pygmy-possum
(http://www.co2australia.com.au/web_images/carbon-trading-WesternPygmyPossumSM.jpg)

Fig.143. Western Pygmy-possum
(http://www.bushheritage.org.au/images/media_coverage_images/western_pygmy_possum_PE.jpg)