Platypus

Ornithorhynchus anatinus

Captive Husbandry Guidelines

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M&MSG – Low Risk.

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1. Introduction

The platypus and the two species of echidnas, which make up the monotremes are arguably the most unique mammals and are of enormous community and scientific interest. In particular, the unique features and secretive lifestyle of the platypus have made it a longstanding focus of attention.

Platypus have been found in Australia as fossils as far back as 130 million years old (Strahan 1995). In 1992 fossil platypus teeth were discovered in Patagonia, in South America, which date back to approximately 60 million years of age, reflecting a Gondwanan distribution of monotremes (Strahan 1995). Although fossil platypus had well-developed teeth, the modern platypus only has milk teeth which are shed when weaned and replaced in the adult by hard horny plates which are used to crush their prey.

Platypus exhibits and platypus management across Australian institutions are very similar, however alternative approaches are continually being developed and used as further information on platypus husbandry and biology becomes available.

Captive management of platypus has an essential role to play in biological research as well as conservation-based educational displays. At the same time, the perceived poor survival of captive platypus has generated concern amongst managers, researchers, conservationists and the general community. Accordingly, there is a need to ensure that impeccable standards for captive management of platypus are developed. Whilst many standards may be universally applicable it would be false to say that we have the definitive “recipe” for exhibiting, maintaining and breeding platypus in captivity.

In order to ensure the best possible standard of captive management, ARAZPA, via its Monotreme and Marsupial Taxon Advisory Group, has developed a series of guidelines relating to captive platypus. These guidelines are based on successful practices in operation within our zoos. The foundation of this work is the Healesville Sanctuary, Guidelines for Platypus Management (Middleton and Serena 1991).

The protocols outlined in this document are written for the following purposes:

1) To provide a series of written procedures and standards in the areas of platypus husbandry and veterinary management, as examples in use and as benchmarks against which performance can be measured.

2) To establish standardised systems of data collection and analysis in order to facilitate routine monitoring of animals and their captive environments and contribute to further refinement of management protocols.

3) To encourage a co-ordinated approach among captive managers with respect to developing and adopting industry-wide policies and standards for captive platypus management.

All protocols are written with the expectation that:
1) They should be improved and modified as knowledge and experience accumulates.
2) Many people will ultimately contribute to the development of a comprehensive management manual for captive platypus.

As well as the ARAZPA Monotreme and Marsupial TAG Guidelines, several other reviews of the maintenance of platypus in captivity have been conducted (Carrick *et al*. 1982; Krueger *et al*. 1992). This document is meant to further expand this process by combining information on the successful management of platypus in captivity so that more universal techniques can be adopted.

2. Taxonomy

2.1 Nomenclature

Class : Mammalia
Order : Monotremata
Family : Ornithorhynchidae
Genus Species : *Ornithorhynchus anatinus*

Etymology
Ornithorhynchus - means bird snout.
anatinus – means of ducks.
Platypus – means flat foot.
The platypus was originally described as *Platypus anatinus* by Shaw in 1799. However as that name was already used for a genus of beetles, the term *Ornithorhynchus* was used which is the name used by Blumenbach (1800) to describe the platypus when he called it *Ornithorhynchus paradoxus*.

2.2 Subspecies

None.

2.3 Other Common Names

None.

3. Natural History

3.1 Morphometrics

Size varies with location with a general north to south cline variation in body size, with the smallest animals being found in Queensland and the largest ones found in New South Wales West of the Divide and Tasmania (Strahan 1995; Connolly & Obendorf 1998). Length is measured from tip of bill to tip of tail (Carrick 1995) (Table 1). There is a distinct sexual dimorphism with males being larger and heavier than females. The platypus is easily distinguished from all other mammals due to its soft flexible bill, webbed feet and aquatic lifestyle.

Table 1. Body Length and Weight for Different Locations in Australia. Figures from Carrick (1995).

Location	Length (cm)		Weight (g)	
	Males	Females	Males	Females
North Queensland	44.1 ± 3.1	41.0 ± 1.8	1018 ± 208	704 ± 49
South-east Queensland	49.3 ± 2.7	43.8 ± 1.6	1556 ± 194	1222 ± 94
New South Wales – East of Divide	50.5 ± 2.4	41.5 ± 2.0	1434 ± 218	857 ± 107
New South Wales – On Divide	47.4 ± 3.5	40.3 ± 2.0	1379 ±132	888 ± 92
New South Wales – West of Divide	54.9 ± 29	47.0	2215 ± 364	2000
Tasmania	53.2	53.5	1900	1500

3.2 General Description

The platypus is one of Australia's most easily recognisable animals. They are approximately 40-50cm long, have a dense waterproof fur over all of its body except the bill and feet, and a bill that is soft and pliable. It has webbed feet and the males possess a venomous spur on the inside of their hind legs.

3.3 Distribution

The platypus occurs in freshwater streams along the east coast of Australia from north Queensland to South Australia and Tasmania (Fig. 1). It also occurs in streams running westward from the Great Dividing Range.

Figure 1. Distribution of the platypus

3.4 Habitat

The platypus occurs in freshwater and occasionally brackish streams, creeks, lakes and ponds. These vary from shallow creeks with pools and riffles to large deep rivers. When out of the water, platypus live in burrows which are dug into the bank of the water body. Burrows are usually short and simple in construction with the entrance either above or below the water level, and often under a tangle of tree roots (Carrick 1995).

3.5 Wild Diet and Feeding Behaviour

In the wild platypus feed on a wide variety of freshwater adult and larval invertebrates

including dragonflies and caddisflies (Table 2). Small vertebrates are also eaten including fishes and frogs. The platypus has a complex bill apparatus that it uses to sift smaller prey items. They appear to be able to find their food by detecting the weak electrical impulses of invertebrates when they move their exoskeleton. Once food is picked up and sifted, it is stored in large cheek pouches, which is then thoroughly masticated while floating on the surface of the water.

Table 2. Food of the platypus in the wild from a study at the upper Shoalhaven River, NSW. Derived from Grant (1989).

Food	% Winter	% in Summer
Horsehair worms	17	
Freshwater shrimps	12	
Caddisfly larvae	41	64
Two winged larvae	12	18
Mayfly larvae	18	
Stonefly larvae		9
Dragonfly larvae		9

3.6 Longevity

3.6.1 Wild

Capture information from Tom Grant in the Shoalhaven River suggests a reasonable estimate of maximum longevity in the wild is 13 years for female and 6 years for males.

3.6.2 Captivity

In captivity platypus have been known to live for very long periods. Lone Pine Koala Sanctuary has held an animal to 21 years of age (O'Callaghan pers. comm.). Australian Reptile Park for example has had an animal live to 18 years of age, with Healesville Sanctuary having an animal live for 17 years of age, David Fleays Fauna Park and Taronga Zoo have both had animals live over 15 years.

4. Housing Requirements

4.1 Exhibit Design

Platypus husbandry has been a developing art since 1832 when Lauderdale Maule maintained a female and two young in captivity for two weeks. In 1848 Jules Verreaux, the eminent French biologist, reported that the species was 'no trouble' to maintain. However, since the early 1900's a string of very dedicated and determined platypus enthusiasts have identified problems in keeping platypus in captivity for long periods of time.

At present there are seven zoological institutions that hold platypus (Table 2). These facilities are fundamentally quite similar, although there are large differences in the buildings within which these facilities have been housed.

Table 2. Facilities Displaying Platypus.

Facility	Years Held on Display
Brisbane Forest Park	1992 - present
Bronx Zoo, New York, USA.	1947-1958
Budapest Zoo, Hungary.	1913-1917?
Fleays Fauna Park, Burleigh Heads, Qld, Aust.	1952 - present
Australian Reptile Park, NSW, Aust.	1968 - present
Healesville Sanctuary, Vic, Aust.	1933 - present
Lone Pine, Qld, Aust.	1972 -1988
Melbourne Zoo, Vic, Aust.	1937 - present
Sydney Aquarium, NSW, Aust.	1997 – present
Taronga Zoo, NSW, Aust.	1934 - present

The husbandry protocols contained herein are an attempt to establish new standards in platypus management where emphasis is placed upon scientifically based methodology, management initiative and a strong commitment to welfare. The procedures are designed to provide quality data, which contribute to effective daily management as well as scientific research.

The aim of any captive facility is to provide an optimum captive environment for platypus, incorporating the following features:

1) Animals are provided with opportunities to express a full range of natural behaviours.
2) The captive environment is comfortable and secure and allows for behavioural enrichment.
3) Animals can be caught and handled with a minimum of associated stress in order to monitor their physical condition and health.
4) Active animals can be routinely observed for the purposes of educational display, research, or behavioural monitoring including breeding behaviour.

Protocols

1. Captive facilities should include the following basic structural elements:
   a) Aquatic display tank(s).
   b) Aquatic off-display tank(s) or pond(s).
   c) Nest boxes.
   d) Tunnels linking the nest boxes to display and off-display tanks.

2. The captive environment should make provision for the following:
   a) Animals can engage in natural foraging behaviour on live food items.
   b) A selection of protected feeding and grooming sites are provided in secure locations.
   c) The aquatic environment is a dynamic one in terms of water movement patterns and flow rate.
   d) Water and nest box temperatures are maintained within the range normally experienced by platypus in the wild.
   e) Tunnel systems are modelled on wild tunnels, eg. with respect to length and internal dimensions.
   f) Opportunities are provided for behavioural interaction with other platypus. Although the Australian Reptile Park has found individuals to be more stable and

adjusted when housed by themselves.
g) Nest boxes are comfortable and contain dry, clean nesting material.
h) The environment includes a variety of natural objects, e.g. logs, rocks, soil and plants.

3. Platypus should have access to at least one aquatic area with a minimum area of $6m^2$ and a water depth attaining at least 0.4 m.

4. The aquatic environment should be maintained to a high standard of clarity and cleanliness. Tank water should be changed frequently if recirculating filters are not incorporated into the system. Filter inlets should be shielded to prevent platypus becoming trapped.

5. Facilities should be insulated from electrical currents, excessive noise and vibration, e.g. that associated with pumps and filtering equipment.

6. Water and nest box temperatures should normally be maintained below 25^oC. This is based on the thermoneutral zone for resting platypus on land being $20\text{-}25^oC$ (Grant & Dawson 1978b), with active animals likely to be most comfortable at or below the lower end of this range due to the production of metabolic heat associated with muscular activity. Environmental temperatures should under no circumstances exceed 32^oC, based on the fact that the resting body temperature of platypus is $32\text{-}33^oC$ (Grant & Dawson 1978a), and the observation that platypus may 'faint' when exposed to air temperatures of 35^oC for as little as 17 minutes (Martin 1902). Krueger *et al*. (1992) found that platypus spent more time resting than active in water at low temperatures ($<16^oC$), while the maximum ratio of active to resting behaviours in the water was when the water temperature was $16\text{-}18^oC$. They also found that platypus showed a steady increase in the proportion of time spent resting on land as temperatures increase from $10\text{-}12^oC$ to $22\text{-}26^oC$.

7. Tunnels used by platypus should conform to the following criteria:
a) Should be at least 1 m long, and measure at least 6-7 cm high and 9-10 cm wide internally. These correspond to the minimum documented dimensions of tunnels in the wild (Burrell 1927; Grant 1983; Serena 1994). In practice, it is recommended that tunnels be at least 15 cm high and 15 cm wide internally to reduce the potential for fur loss due to rubbing.
b) Be constructed of materials, which minimise abrasion to feet, bill and fur while providing traction underfoot.
c) Slope at an angle 30^o or less.
d) The horizontal distance from the water's edge to burrow chambers should not exceed 4m and ideally be approximately 1.5m (Serena *et al*. 1998).
e) Enable water, which enters tunnels with platypus to escape through drainage and/or evaporation.
f) Have interiors, which are accessible via, secure lids/hatches for inspection or cleaning purposes.
g) Be rainproof (if located outdoors).
h) Be sufficiently well shaded and/or insulated that interiors do not exceed ambient air temperatures on sunny days (ideally, do not exceed 25^oC).
i) Be fitted with sliding internal doors (or comparable devices) so the tunnel can be

closed off at both the nest box and tank ends.

8. In the case of tunnels leading to breeding nest boxes, provision should be made for females to block burrows with soil 'pugs', particularly at the point where tunnels and nest boxes meet. Therefore females should be provided with a supply of soil (e.g. stored in one or more chambers opening off the side of the tunnel) sufficient to create at least one tightly packed plug up to 30 cm in length (Burrell 1927).

9. Non-breeding nest boxes need to conform to the following criteria:
   a) Nest boxes should be large enough to accommodate 2 adult platypus and a substantial volume of nesting material. Approximately 75% of the nest box volume should be filled with nesting material.
   b) Have a non-abrasive internal surface.
   c) Be provided with a hinged lid to facilitate human access for the purpose of inspecting animals, replacing nesting material, etc. Lids should latch securely when closed.

10. Each adult or weaned juvenile platypus should be supplied with several nest boxes.

11. Breeding nest boxes should be large enough to accommodate one adult platypus, and as many as 3 well-grown juveniles. If soil is provided to allow animals to dig their own nesting chamber then it should not be too dry, and should hold its structure.

12. Breeding females should be provided with a substantial volume of floating and submerged nesting material in tanks connected to breeding nest boxes. Based on Burrell (1927) and Fleay (1944), nesting material should include both grass and eucalypt leaves.

13. A dry ledge or section of bank (approximate minimum length and width = 0.6m x 0.25 m) should be provided directly below the tank end of nesting tunnel entrances for resting and grooming purposes. At least one additional dry resting site (ledge, emergent rock or log, or section of bank) should be provided per tank. Enough dry area should be provided in total that all platypus using the tank can rest out of the water simultaneously, without having to sit next to each other.

14. Each tank should be provided with at least one section of overhanging bank or comparable cover (approximate minimum length and width = 0.6 m x 0.25 m) under which platypus can float comfortably while consuming food items at the water's surface. At least one additional protected resting site per tank should be provided underwater.

4.2 Holding Area Design.

The layout of a holding facility should be designed to minimise disturbance from the surrounding area and to allow ease of access and traffic flow. An example of a holding facility can be found in Figure 2. This figure also shows the fundamental requirements of all platypus facilities.

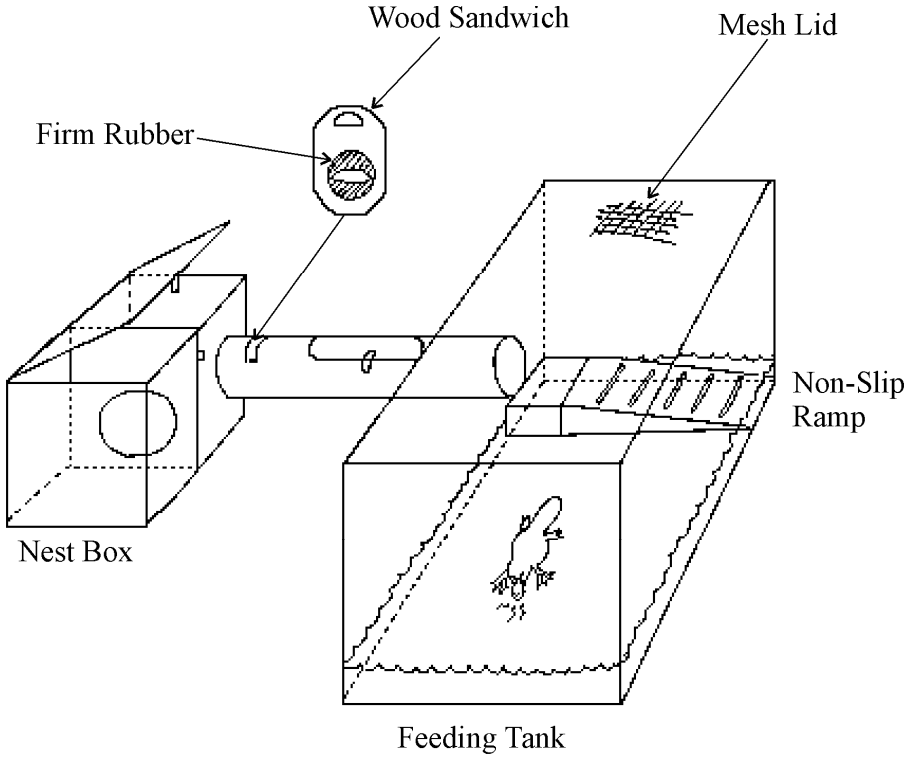
Included in the area should be:

- feed tank(s)

- associated tunnels and nest boxes
- storage, sinks, taps and hoses

Where use of space is limited it will be necessary to plan carefully where to put things. The feed tanks will need to be as large as is practicable and the tunnels should meet minimum requirements as far as internal dimensions and length are concerned.

Figure 2. Holding facility for captive platypus (Taken from Booth 1994).



A choice of nest box sizes and construction is desirable to give the platypus variety. These can be plywood or terracotta and filled with dirt or nesting material in any combination. Taps and hoses should be positioned for ease of use, as should drains and sumps. Minimise disturbance from surrounding areas but also from within your holding area eg. you should not need to step on or over the tunnel system, water pipes and drainage pipes should be insulated to minimise noise or vibration transfer.

4.3 Weather Protection

Where possible some tunnels and nest boxes should be either under a veranda or inside a building to protect them from rain entering the tunnel and nest box system. Any water from rain entering the tunnels or nest boxes should be able to be drained away quickly. It is also important to protect the animals from extremes of temperature that should not exceed 25^{o}C. Minimum temperatures should not normally be a problem as long as adequate nest boxes and nesting material are provided.

4.4 Substrate

Substrate should be non-porous and be easily cleanable. The type of substrate will be

partially determined by whether filters are used or not and what type of filter is being used. Sand, fish tank gravel, large river rocks or even a fibreglass or concrete base to the tank with no other substrate have been used with varying success. Sand and fish tank gravel are more difficult to clean or remove left over food, while hosing a concrete or fibreglass floor provide easy of cleaning, although looks unnatural.

4.5 Enclosure Furnishings

Anything put into the enclosures should be non-toxic, not sharp, be designed not to trap or entangle the animals and be as non-abrasive as possible. Enclosure furnishings can include plant material such as logs, fern fronds, tree branches, rocks or river pebbles. All of these items should be cleaned where appropriate and checked to ensure they have not come in contact with any toxins eg. weedkiller. Branches should be weathered or be soaked elsewhere to remove the tannins prior to being put into the tank so the tannins are leached out.

4.6 Spatial Requirements

Factors relating to spatial requirements include the number of animals sharing the enclosure, the number of bodies of water they share and obviously the size and shape of the water body.

1. Male platypus cannot be housed together as one will more than likely kill the other as has happened in the past in captivity. It appears that one male can be housed with one or two females depending on the holding capacity of the system.
2. Two platypus can easily share a single body of water if it is large enough, however a more ideal situation is for the animals to share a number of tanks of water so that each animal has somewhere to feed, swim and groom in the privacy of its own tank.
3. A minimum enclosure should provide the animal with a feeling of space and room to move, so size is arbitrary as things such as shape and furnishings can make even a small enclosure more interesting.

5. Handling and Transport

5.1 Handling Procedure

As a result of the venomous spur on the male platypus, they should be handled only by the tail (Fig. 3). Female platypus should also best handled by the tail, as they are generally able to free themselves if held any other way.

Envenomation by the spur of the male can cause extreme pain and debilitation of the limb, which has been spurred (Fenner *et al*. 1992). If spurred the area should be washed thoroughly using soap and water, and flush the punctures to remove free venom and contamination. The wounded area should be lightly bandaged and medical attention sought as soon as possible. Ice should not be used.

Figure 3. Restraint of platypus (drawing by Bronwyn Macreadie).

Animals need to be handled for routine husbandry and veterinary management, however this should be kept to a minimum. Care needs to be taken to ensure that all handling is done by the same 1-2 people and at the same time of the day, wherever possible, so that there is minimal disturbance or stress to the individuals.

There are presently two approaches to the handling of platypus:
a) Daily handling in which individuals are caught daily and weighed.
Advantages – It allows a continuous monitoring of body weight and general health.
- Platypus appear to like routine and seem to become accustomed to this.
Disadvantages – It could be a daily stress on the animals.
- It could potentially interfere with breeding behaviour.
b) A hands off approach where individuals are caught only rarely for weighing. Several methods of weighing platypus without the need for capturing them have been tried which have had limited success.
Advantages – Individuals are left undisturbed for long periods. Eg 4+ weeks.
Disadvantages- The condition of individuals is not accurately known.
- The disturbance when caught up is likely to be greater.

Protocol

1) Routine handling of platypus should be restricted to that required in addressing the management and veterinary needs of individual animals.

2) Only designated, trained staff should handle platypus.

3) All non-routine handling of platypus should require approval by the Veterinarian, Senior Platypus Keeper or Curator, and should be scheduled whenever possible to coincide with routine handling.

4) Daily weighing of platypus involves capturing animals by the tail and placing them in an opaque cloth bag prior to being weighed, unless scales are built into the tunnel system.

5) Veterinary protocols should make provision for sedation and/or anaesthesia when

this is deemed necessary to carry out procedures and examinations with a minimum of associated stress to animals (See Appendix 1 and 2 for details of methods).

5.2 Catching Bags

Captured platypus can be held easily within a soft catching bag approximately 500mm wide by 800mm deep such as a pillowcase. For longer-term holding or more accurate weighing they can be held within a hessian sack, where the platypus is rolled up within this sack and immobilised. Though this method is usually only used in the field.

5.3 Weighing and Examination

Some institutions weigh their platypus routinely (eg daily or weekly) while other institutions adopt a hands off policy and don't weigh platypus at all. Those that do weigh regularly feel that this not only gives a better understanding of the animals' health and wellbeing but also allows veterinary inspections when and if necessary without undue stress to the animal. When weighing an animal it should be part of the routine to do a brief examination while you have the animal in hand – look for cuts or fur loss, feel for body condition (eg See Chapter 6).

Not weighing the platypus allows the animal to go about its daily routine largely uninterrupted. If an animal is not weighed or handled on a regular basis other methods of checking its health are usually installed

- Direct observation while on display.
- Use of video equipment (infrared is suitable).
- Scales or motion sensors within the tunnel system.

5.4 Release

When releasing a platypus into an enclosure for the first time it is often best to place it in the burrow system before the water so it will more easily be able to find the burrow entrance when leaving the water. Being in the burrow also gives the platypus the chance to explore this area before entering the water so it will feel more comfortable returning to the burrow. Placing the platypus into its new home should be done immediately prior to the animals' normal active period ie. just before dark.

5.5 Transport Requirements

Captured platypus should always be kept in the dark and at a temperature of less than 25^{o}C.

Short-term transport can be achieved by containing the platypus in a cloth bag tied at the top, inside a sturdy box eg. plywood. To restrict the platypus' movements they can be rolled up in a hessian sack or similar as this restricts movement and minimises heat production. In warm weather the bag should be moistened with water to reduce the temperature of the platypus. Platypus should be housed for a maximum of 6-8 hours. It is also important, particularly in summer, to check the animals temperature regularly (eg. hourly) by touching the surface of the bill lightly to ensure it is cool. Longer term the platypus would need access to water and food. Any long-term transport of a platypus would require significant discussion with a number of people such as veterinarians and people with experience working with platypus.

6. Health Requirements

6.1 Routine Health Checks

6.1.1 Tail Volume Index (TVI)

Platypus should be weighed regularly and should also be examined for condition using the method designed by Grant and Carrick (1978). These classes are:

1) Tail turgid. Ventral side convex.
2) Tail able to be folded slightly at lateral edges. Ventral side flat.
3) Lateral edges of tail easily rolled. Ventral side slightly concave.
4) Whole tail able to be folded along ventral midline.
5) Tail more or less strap-like. Vertebrae showing through ventral tissue.

6.1.2 Blood Samples

Blood samples should be taken to be analysed on admission and for routine health status monitoring. These should be assessed for full blood examination as a priority and given biochemical tests as required.

6.1.2.1 Full Blood Examination (first priority)

1) Haemoglobin.
2) Packed cell volume.
3) Red cell counts.
4) Mean corpuscular haemoglobin concentration.
5) Mean corpuscular volume.
6) Mean corpuscular haemoglobin.
7) Platelets.
8) Total white cell count.
9) Neutrophils.
10) Band forms.
11) Lymphocytes.
12) Monocytes.
13) Eosinophils.
14) Basophils.
15) Examination of fresh EDTA blood smear for red cell parasites.

6.1.2.2 Biochemical Tests (where volume of blood samples permits).

1) Sodium.
2) Potassium.
3) Chloride.
4) Bicarbonate.
5) Calcium.
6) Phosphate.
7) Urea.
8) Creatinine.
9) Total billrubin.
10) Total protein.
11) Albumin.
12) Globullin.
13) Glucose.
14) GGTP.

15) Alkaline phosphatase.
16) AST.
17) CPK.
18) LD.
19) Amylase.
20) Cholesterol.
21) Triglycerides.
22) Progesterone.
23) Testosterone.
24) Triiodothyronine.
25) Tetraiodothyronine.

6.2 Known Health Problems

6.2.1 Bacteria

Leptospira. Anti-leptospiral agglutinins were detected in the serum of 8 of 17 wild platypuses sampled in the Shoalhaven River, N.S.W. (McColl & Whittington 1985).

Salmonella. Salmonellosis was the only infectious disease associated with death in a sample of 48 documented platypus mortalities summarised by Whittington (1991). Two of the 48 animals were affected: one animal died within one day of entering captivity (after being found on a suburban lawn in Dubbo), while the second died after 15 days in captivity (Whittington 1988, 1991).

Aspiration Pneumonia. This was judged to be the probable cause of death in 3 of 20 Victorian platypus (held in captivity for varying periods of time) examined by McColl (1983).

6.2.2 Viruses

Cytomegalic Inclusion Disease. Cytomegaly and intranuclear inclusion bodies were observed in the renal collecting ducts of 3 of 4 wild platypus (obtained from the Abercrombie, Murrumbidgee and Queanbeyan Rivers, New South Wales) probably due to infection by an adenovirus. The condition appeared to have had little or no clinical effect on the animals (Whittington *et al*. 1990).

6.2.3 Protozoans

Coccidia. Coccidia were present in 10 of 18 Victorian platypus (held in captivity for varying periods of time) examined by McColl (1983). Apart from mild infiltration of eosinophils into the intestinal mucosa, no associated tissue abnormality was observed.

Toxoplasmosis. Several Toxoplasma-like cysts were observed in the heart muscle of a platypus that had been held in captivity for 4 years. The cysts were not directly associated with any inflammatory reaction (McColl 1983).

Theileria. Sparse infections were observed in 53 of 54 animals trapped in the Shoalhaven and Kangaroo Rivers, New South Wales. All animals appeared healthy, and had haematological parameters that fell within normal limits (Collins *et al*.1986).

Trypanosoma. Trypanosomes were observed in blood, lung, liver and/or heart tissue in 7 of 20 animals collected from the wild in Victoria. All animals were held in captivity for 1-

3 weeks before being examined histologically (McColl 1983). In addition, Mackerras (1959) has described *T. binneyi* from a platypus collected in Tasmania.

6.2.4 Metazoan Endoparasites

Trematodes. A small number of *Mehlisia ornithorhynchi* were found tightly attached to the duodenal mucosa in one of the 20 Victorian platypus examined by McColl (1983); the same species was observed to occur in one of four New South Wales animals examined by Whittington and Spratt (1989). No significant histological damage to the gut was reported in either case.

Platypus have also been reported to be infected with the trematodes *Maritrema ornithorhynchi* and *Moreauia mirabills* (references provided in Whittington & Spratt 1989).

7. Behaviour

7.1 Habits

Platypus are generally shy animals but can become accustomed to individual people and even more so they can fairly easily be manipulated into a routine. By doing the same thing at the same time each day the animals very quickly get used to what's going on. Weighing, examining and putting the animals on display, even hand feeding can be achieved by developing a "routine". Platypus can also get used to things such as human traffic noise and being observed all day, if these things happen on a regular basis.

In the wild home ranges overlap between adult and juvenile individuals, except sexually mature males that appear to be territorial, however they appear to seldomly interact with each other. Individuals generally have several burrows where they generally rest alone, although burrow sharing has been observed between a subadult and adult male, two adult females, a grown female and an independent first-year female, and two independent first year females (Serena 1994).

7.2 Captive Behavioural Problems

As with any animal, platypus can become bored and display stereotypic behaviour, for some known or unknown reason. It is always good practise to allow the animals to exhibit as much natural behaviour as possible. Stereotypical behaviour can be exhibited because of stress – which can be in varying forms, or just plain boredom. Things such as changes in their routine, changes in their environment, noise or vibration or even introducing two animals together can cause stresses – sometimes it can be difficult to find or resolve the problem. The problem could be as simple as that particular animal just not coping with being in a captive environment.

7.3 Behavioural Enrichment

As stated earlier boredom can cause problems but this can easily be overcome by providing things such as live food, creating water movement or housing more than one animal in an enclosure. Observations of platypus in captivity indicate that they seem to enjoy playing in a waterfall, also giving them a land area to move around on adds another dimension to their world. Lengths of burrows, intersections as well as different building materials and even dirt to make their own burrows can also provide extra stimulation to

prevent boredom.

7.4 Signs of Stress in Captive Platypus

Platypus show several signs of stress in captivity which have been reviewed by Grant (1998). It is critically important to understand these, particularly when bringing an animal in from the wild or when introducing platypus (See Appendix 5). If an individual does not adapt appropriately to captivity then it will need to be released (See Appendix 6).

Vocalising

A growl-like vocalisation may accompany handling some individuals. This can also occur in established animals, particularly when handled by someone who has not handled them very much previously.

Short Term

Distress is often difficult to detect. Although some individuals will struggle almost incessantly when contained in a bag or box. Most will settle quickly when placed in a container in a dark and quiet place. These animals are not necessarily unstressed and incidents of sudden death have been occasionally reported within a few hours of capture.

Longer Term

A number of distress behaviours have been reported, alone or in combination, which indicate that animals should be release back into the wild.

a) Quiet retirement to sleeping chamber and not feeding.
b) Excessive movement in and out of the water, accompanied by not feeding even while spending considerable periods in the water.
c) Failure to groom water from fur or to keep sleeping chamber dry.
d) Entering water whenever disturbed.
e) Stereotype swimming.
f) Prolonged periods of submergence under an object followed by return to the surface only to breathe.
g) Defecation inside the nesting chamber.

These behaviours may also occur in combination with weight loss and abrasions to the feet, bill and tail.

Non-corrected post capture lymphopenia in an individual animal may indicate unsuitability for captivity (Booth 1994; Whittington & Grant 1995).

7.5 Interspecific Compatibility

Platypus have been successfully housed with several other species including:

- Small fish eg. *Galaxias* spp.
- Water dragons eg. *Physignathus lesueuerii*.
- Tortoises eg. *Chelodina longicollis*.

7.6 Intraspecific Compatibility

In the wild home ranges of grown females overlap with those of neighbouring adult females, sub adult and adult males, and juveniles (<1 year old) of both sexes (Serena 1994). Home ranges of sub adult and adult, and subadult and juvenile males overlap, however home ranges of sexually mature males do not appear overlap (Serena 1994).

Individuals are best kept either solitarily, as two females, a pair or potentially a male with two females. As stated earlier males cannot be housed together but also it has been noted in captivity that certain individuals just don't seem to get on. Care needs to be taken when introducing animals for the first time, as there can be some aggression. Even if there is no aggression at times one animal will not cope with meeting another and can fret or go off its food. Observation and by knowing your animals normal behaviour will tell you if something is wrong.

8. Captive Dietary Requirements

8.1 Captive Diet

It is important to provide captive platypus with a diet that caters for individual preferences in quantity and type of food so it should be varied, nutritious, encourage natural foraging behaviours and minimise obesity. The diet should include as high a proportion of live food as possible. The next best alternative, food items should be freshly frozen for storage purposes and thawed just before being offered to platypus. Yabbies should be frozen for a maximum of 4 months before being used as food. Mean daily food consumption by platypus in captivity has been found to vary between 14.9-21.2% of body weight throughout the year (Krueger *et al*. 1992).

The daily captive diet for adults and weaned juveniles should normally include an adequate selection from the following items (contingent upon availability and palatability and dependant on various state legislative requirements):

a) Yabbies (live and/or frozen).
b) Earthworms.
c) Mealworms.
d) Fly pupae.
e) Freshwater shrimp.
f) Prawns.
g) Goldfish.
h) Tubifex worms.
i) Trout fingerlings.
j) Aquatic insects.
k) Crickets.
l) Tadpoles.
m) Cockroaches
n) Egg custard mix.
o) Pelleted or other 'artificial' foods.
p) Blackworms.

Platypus should be fed at times that best suit individual activity patterns. In general, it is expected that this should involve providing the majority of food in late afternoon, for overnight consumption. In addition, display animals should be provided with a minimum of 10% of their expected daily food intake for each 2 hours that they are on display.

During the off-display period, animals should be provided with total expected total daily food intake.

Consideration should be given to systematically varying the proportion of different foods offered to platypus on different days, thereby providing a temporal dimension of variability to their diet.

8.2 Supplements
None required if a variety of food items are offered.

8.3 Presentation of Food
Food is always placed in the water into either the display tank or separate feeding tanks (if water clarity or filtration is a problem). As with any animal, food should be fresh and not contaminated, there should be variety of food types offered and leftovers need to be removed every few days. The length of time before removal depends on the filter system and the water temperature. Things like yabbies and mealworms will go "off" if left in water.

8.4 Estimating the Amount of Food Consumed (where possible)
8.4.1 Food Provided in Display Tanks
1. Goldfish:
a) Fed 1-3 times per week (10 fish per animal per day).
b) Fish are counted and placed into the display tank.
c) At the end of the display period the remaining fish are counted to determine the quantity consumed.

2. Fly Pupae:
a) Fed daily (20-40 g per animal).
b) Pupae are weighed on an electronic balance and placed into the display tank.
c) At the end of the display period the remaining fly pupae are estimated.
d) Occasionally remaining pupae are netted out and weighed to determine the accuracy of the estimate.

3. Yabbies:
a) Ad lib yabbies.
b) Yabbies are counted and placed into the display tank.
c) At the end of the display period the number of yabbies eaten is calculated by counting the number of exoskeletons in the tank.

8.4.2 Food Provided in Off-Display Tanks.
1. Yabbies:
a) Fed yabbies daily (10-70 per animal depending on size of yabbies).
b) Yabbies are counted and washed, Water is drained away through a colander for about 5 minutes. Yabbies are then weighed on an electronic balance and placed into the feeding tank.
c) Feeding tanks are drained and hosed out the following morning.
d) Remaining food items are collected in a fine mesh basket placed under the outlet drainpipe. The number of yabbies eaten is calculated by counting the number of thoraxes present.
e) All leftover yabby material is collected, washed, drained (for 5minutes) and weighed to determine the weight of food consumed.

2. Meal Worms:
   a) Fed daily (50 g per animal).
   b) Mealworms are weighed on an electronic balance and placed into feeding tank.
   c) Remaining mealworms are collected (as for yabbies) and quantity estimated. Occasionally remaining mealworms are weighed to determine accuracy of estimate.

3. Earthworms:
   a) Fed daily (50-120 g per animal),
   b) Earthworms are generally supplied in a plastic container including some soil. Worms are removed from the container with as little associated soil as possible and weighed on an electronic balance.
   c) Without further washing, worms are placed into the feeding tank.
   d) Earthworms are collected and weighed the following morning as for mealworms.

9. General Husbandry

9.1 Hygiene and Cleaning

It is critical that animal health is maximised through the application of high standards of hygiene and effective quarantine procedures.

1) The Senior Platypus Keeper should have a minimum of five years experience working with captive wildlife (or equivalent), unless specifically exempted by the Director.
2) Other keepers should: 1) have a minimum of two years experience working with captive wildlife (or equivalent) prior to assignment to platypus care, and 2) undergo a training period under the direct supervision of the Senior Platypus Keeper.
3) Platypus keeping staff should participate in all activities directly involving animals in their care, including implementation of and compliance with all husbandry protocols.

Protocol

1) All tanks frequented by platypus should be cleaned and filled with mains water, rainwater, pumped spring water or creek water.
2) Water in display tanks should be filtered at the rate of one complete water change for at least every six hours that animals are on display.
3) Display tanks should be drained and thoroughly cleaned (tank and furniture scrubbed and hosed down) at least once per week, depending on the filtering system and water quality.
4) Chemical agents should not be used to clean tanks or tunnels used by platypus.
5) Base substrate in display tanks should be replaced when it becomes soiled.
6) Off-display tanks should be drained, cleaned and refilled daily if not equipped with a system for filtering recirculated water. Other off display facilities such as natural ponds may not need to be cleaned.
7) The condition of nesting material in non-breeding nest boxes should be checked regularly. The presence of damp nesting material is not of major concern as long as it is not soaking wet and the platypus has access to dry nesting material.
8) Tunnels and nest boxes should not be scrubbed or hosed unless fouling occurs. Every effort should be made to allow excess water to drain or evaporate from the tunnel and nest environment. Drainage holes need to be checked for any blockages.

9) Platypus facilities should be operated as a quarantine area. Whether originating from the wild or another institution, newly arrived platypus should:
   a) Be thoroughly examined by an experienced veterinarian in accordance with the procedures outlined in Appendix 1 and 3.
   b) Be maintained in isolation for a minimum period of three weeks before coming into contact with established animals and their enclosures.

9.2 Daily Records

It is important to establish a system whereby the health, condition and reproductive status of captive platypus are routinely monitored. The collection of information on the physical and behavioural patterns of captive platypus can contribute to a database quantifying the changes of different individuals. This is particularly important in that any given institution can be expected to maintain only a relatively small number of platypus at any point in time. In consequence, adequate sampling of either behavioural or physical attributes will depend on gradually accumulating data based on standardised procedures. This process should be greatly facilitated by a common, cooperative approach to data collection among institutions.

9.2.1 Facilities That Handle Platypus Daily

The following information should be collected:

a) Dry body weight of animal to the nearest 10 g (or more accurately if feasible).
b) Relevant environmental temperatures.
c) Location of the animal in the nest box/tunnel system (early in the morning) and identity of tank(s) used for display/feeding if more than one is available.
d) Tail volume index (See Chapter 6).
e) Nature and extent of non-routine handling (including veterinary procedures).
f) Nature and extent of unusual noise or other disturbance in or near the platypus facility.
g) Animal's general demeanour.

9.2.2 Facilities That Do Not Handle Platypus Daily

The following data should be recorded on a monthly basis:

a) Dry body weight of animal to the nearest 10 g (or more accurately if feasible). In facilities where animals are handled regularly as a part of routine management.
b) Tail volume index (See Chapter 6).
c) Maximum tail thickness at the level of the cloaca.
d) Cloacal temperatures (to the nearest $1^{o}C$). Not mandatory.
e) A range of blood parameters, as listed in Chapter 6.
f) Water pH and conductivity in display and off-display tanks.
g) Animal's general demeanour.

In addition, activity levels and behaviour can be monitored as follows:

a) Key behaviours of active individuals should be observed and quantified. This work may involve the use of time-lapse video monitoring (e.g. for nocturnal observations), or rely on trained volunteers (e.g. during display periods). This is particularly important for paired individuals during the breeding season.
b) Activity budgets should be monitored as required (e.g. by means of automated, tunnel-mounted activity recording system) to provide information relevant to assessing the health or reproductive status of targeted individuals.

All information should be recorded in a standardised format on data sheets and ,where possible, incorporated into a computerised data-base to facilitate retrieval, analysis, and the preparation of internal reports and technical papers.

9.3 Marking Techniques

Platypus can be individually marked using several techniques. These include:

a) A passive integrated transponder (PIT) tag, implanted subcutaneously between the scapulae.
b) Tattoo on the inside of the upper or lower frontal shield.
c) Photographing the skin pigment pattern on the underside of the bill.
d) Freeze banding. Not recommended.
e) Leg band. Not recommended due to wearing on the skin and spur (in males) (Grant & Whittington 1991).

10. Breeding

10.1 Breeding System

Polygynous with both males and females having several partners.

10.2 Ease of Breeding

Although platypus have shown reproductive events on a number of occasions at various institutions (Table 3) they have only successfully reared young on two occasions (Fleay 1944; Fisk *et al*. in prep).

10.3 Timing of Breeding

Platypus have a distinct breeding season between July to March. Mating and egg laying occurs in July to November with young emerging from the burrow between December and March.

10.4 Age at First Breeding

10.4.1 Wild

Males – 2 years.
Females – 2 years.

10.4.2 Captivity

Platypus have only been bred and raised to an adult on two occasions in captivity, which was at Healesville Sanctuary in the summer of 1943-44 and in 1998-99. In 1972 a young platypus was found dead at the entrance to the burrow at approximately 50 days of age at Fleays Fauna Park in Burleigh Heads, Queensland. These are the only births of platypus in captivity although on a number of occasions eggs have been laid or matings observed with nest-building behaviour following.

The age at which platypus show reproductive behaviour in captivity appears to be much older than in the wild (Table 3). Each occasion where reproductive behaviour has been observed has had a number of things in common. These include:

1. The individuals were brought into captivity at a very early age, generally as soon as possible after weaning and leaving the burrow for the first time in February to March..

2. They were housed together with their mate all their lives.
3. They were kept in the same enclosure all of their lives.
4. Females appear to show reproductive behaviour after six years of age.
5. Continuity of the same people handling them. Platypus do recognise individual people and behave differently when someone else takes over while one of the keepers is absent. For this reason, most institutions have a policy of having the same keeper working with their platypus.

10.5 Ability to Breed Every Year

The occurrence of successful birth and weaning in 1943/44 and then eggs in the spring of 1944 by Jill at Healesville Sanctuary suggest that females can breed every year. Field research also shows that they also may not breed every year.

10.6 Ability to Breed More Than Once Per Year

Appear only able to raise one litter per year.

10.7 Breeding Behaviour

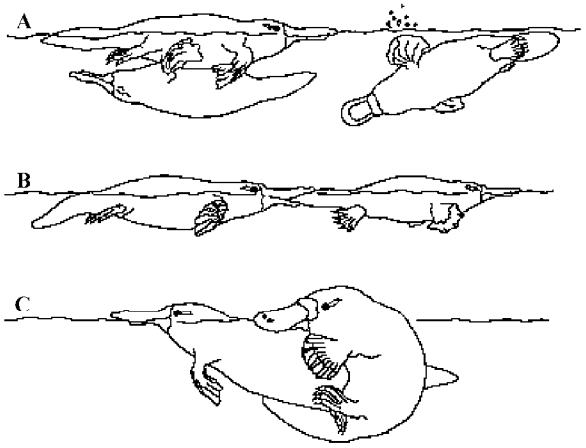
Breeding behaviour appears to occur only within the water, where the male repeatedly follows the female and bites her tail. Mating also occurs in the water where the male curls up behind the female to mount (Fig. 4). A detailed outline of the breeding behaviour can be found in Strahan and Thomas (1975) and Hawkins and Fanning (1992).

Table 3. Age of different reproductive events for captive female platypus. From Fisk *et al*. (in prep.)

Year	Event	Name	Age[1]	Relationship Time[2]	Institution
1943	1 Birth	Jill	6	4 years	Healesville Sanctuary
1944	Eggs	Jill	7	5 years	Healesville Sanctuary
1953	Nesting	Penelope	6	5 years	Bronx Zoo, New York
1971	Eggs		2	2 years?	Taronga Zoo
1972	Birth	Penny	8	2 years	Fleay's Fauna Park
1974	Eggs	Penny	10	4 years	Fleay's Fauna Park
1975	Eggs	Penny	11	5 years	Fleay's Fauna Park
1976	Eggs	Penny	12	6 years	Fleay's Fauna Park
1985	Mating	Darkbill	2	1.5 years	Taronga Zoo
1986	Nesting	Lightbill	2	2 years	Taronga Zoo
1987	Eggs	Lightbill	3	3 year	Taronga Zoo
1988	Mating?	Darkbill	5	5 years	Taronga Zoo
1990	Mating	Darkbill	7	7 years	Taronga Zoo
1991	Nesting	Darkbill	8	8 years	Taronga Zoo
1994	Mating behaviour	Koorina	4	3 months	Healesville Sanctuary
1995	Mating behaviour	Koorina	5	3 months	Healesville Sanctuary
1996	Mating behaviour	Koorina	6	1 year	Healesville Sanctuary
1998	2 Births	Koorina	8	3 years	Healesville Sanctuary

1 Age was estimated by the development of spurs and body weight of animals that suggested they were born during a particular breeding season.
2 Relationship time is the length of time the pair has been held together continuously.

Figure 4. Mating behaviour of the platypus. a) male and female passing and touching each other, b) Male grasping the females tail, and c) apparent copulation position (Figure from Grant 1989).



Since the first reproductive activity was observed in captivity in the spring of 1943 by Fleay (1944), reproductive events such as mating, nestings, egg production and the birth of young have had a number of characteristics in common (Table 3). For example the average age of females to be involved in any type of reproductive behaviour is 6.2 years (Fisk *et al*. in prep). These records contrast with observations of wild platypus that suggest that females can first breed when they are approximately two years of age, though some don't until their fourth year, and it has been reported that platypus can breed up to at least 13 years of age in the wild (Grant *et al*. 1983; Grant 1995; Grant & Griffiths 1992).

The two instances of successful rearing of captive born young in 1943/44 (Fleay 1944) and in 1998/99 (Fisk *et. al*. in prep) has provided the only information available to date on the females rearing behaviour and the timing of various reproductive events. A comparison of the breeding activity between the two breeding successes can be found in Table 4.

Table 4. Comparison of breeding activity between Koorina (this study) and Jill (1943/44).

Activity	Jill (Dates)	Day No.	Koorina (Dates)	Day No.
Torpor	28/5/43	-151		
	31/5/43 to 1/6/43	-148 to -147		
	4/6/43	-144		
	7/6/43	-141		
	12/6/43 to 19/6/43	-136 to -129		
	24/6/43 to 26/6/43	-124 to -122		
	28/6/43 to 3/7/43	-120 to -115		
	6/7/43 to 12/7/43	-112 to -106		
	17/7/43 to 21/7/43	-101 to -97		
	28/7/43 to 2/8/43	-90 to -85	25/8/98 to 30/8/98	-90 to -85
	8/8/43 to 13/8/43	-79 to -74	10/9/98 to 13/9/98	-74 to -71
	25/8/98	-62		
	29/8/98	-58		
	1/9/43 to 3/9/43	-55 to -53		
			21/10/98	-33
Mating	11/10/43	-15	6/11/98 to 8/11/98	-17 to -15
Nest building	23/10/43	-3	14/11/98 to 18/11/98	-9 to -5
Male separated	18/10/43	-8	20/11/98	-3
In nest all night	26/10/43 to 30/10/43	0 to 4	23/11/98 to 27/11/98	0 to 4
	2/11/43	7	29/11/98	6
	4/11/43 to 5/11/43	9 to 10	1/12/98 to 3/12/98	8 to 10
	8/11/43	13	6/12/98	13
			12/12/98	19
Young emerge	26/2/44	123	3/4/99	131
			8/4/99	136

10.8 Nesting Requirements

Female platypus should be provided with an earth mound in which to dig a nesting tunnel and chamber. The earth mound should have a significant clay component to allow provide stability to the soil, so that it does not collapse on the platypus once dug into. The earth mound should also be open to the weather as rain helps keep the soil stabilised, keep the female cool during the hot weather, maintain the humidity and minimise the drying of the eggs. Weeds should also be allowed to grow in the soil as they also help stabilise the soil.

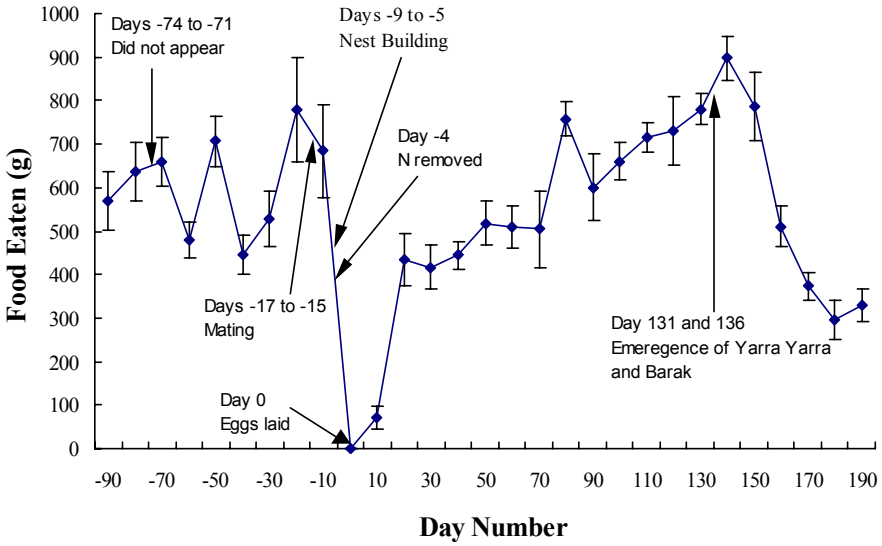
The female should also be provided with plenty of nesting material in the water of the feed tanks to allow her to build a nest within the nesting chamber. Nesting material includes small terminal branches of eucalypts with leaves approximately 20cm in length for ease of transport. The female transfers these to the nesting chamber with the use of her tail, which she curls around the branches. When Koorina was building her nest in 1998 she used approximately 80 litres of nesting material.

It appears the ideal system for breeding includes at least two separate systems. Therefore there are at least two feed tanks, two earth banks, and two sets of nest boxes and associated tunnels. After mating was observed (6-8 November 1998), and there was no further interest, between Koorina and 'N', he was locked off from Koorina so that she had no interference while building her nest (14-18 November), laying eggs (23-27 November), nesting and feeding.

10.9 Breeding Diet

The diet remains the same in captivity during the breeding season, however the females becomes voracious in her appetite, particularly during late lactation, when the energetic demands are at their highest. When Koorina bred at Healesville Sanctuary in the 1998-99 breeding season her food consumption increased by up to10 times her normal amount so that she was eating up to 1.5 times her body weight per day (up to 1500g of food)(Fisk *et al*. in press). The dramatic changes that occurred in her food intake with time can be seen in Figure 5.

Figure 5. Average food consumption of Koorina during the 1998/99 breeding season. Standard error bars are shown. Prior to day –4 the food consumption was for both N and Koorina.



10.10 Gestation and Incubation Periods

Gestation is suggested to last approximately 15-21 days based on the time between mating and Koorina's disappearance in 1998 (Fisk *et al*. in prep.). Once the eggs are laid, the female incubates the eggs by holding them against her belly with her tail, while she lays curled up in the nest chamber of the burrow. Hatching takes place about 1-2 weeks after the eggs are laid (Carrick 1995).

10.11 Litter Size

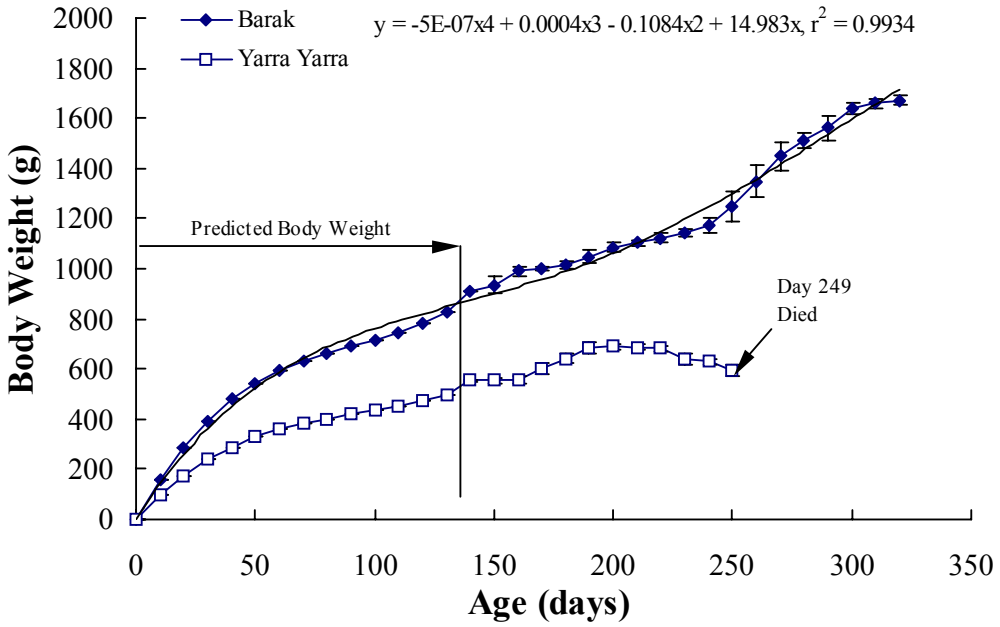
One to three young are normally raised. Although two eggs appear to be most commonly laid, only one generally raised successfully (Carrick 1995).

10.12 Growth and Age Determination

The potential for age assessment based on weight or linear measurements is complicated

by the considerable size differences that exist among populations of adult platypus (Grant & Temple- Smith 1983). To date the only growth curve known is by Fisk et al. (in prep.), which has actual growth of captive born young from their emergence on day 151 and 155 and predicted weights from day one until the emergence (Fig. 6).

Figure 6. Growth of Barak and Yarra Yarra. As the actual weights were unable to be determined prior to their emergence, a predicted weight was determined using the food intake of the female during this period. Standard deviation bars are shown on the post emergence body weights.



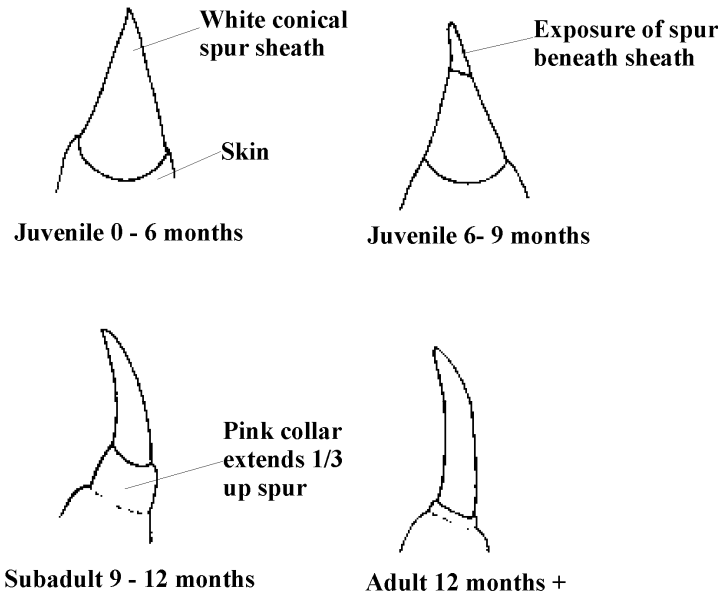
Although not rigorously verified, one promising criterion for their time inside a nursery burrow vs those that should be spending significant time in the water is the readiness with which the pelage dries after being wetted. However, application of this criterion is complicated by the fact that the pelage of platypus that are highly stressed or otherwise in poor condition may also tend to dry inefficiently (Grant & Carrick 1978). Presently the best method of determining age classes in males is with the use of spur development (Grant 1989).

Sex/Age Class Using Spur Development (Fig. 7)

1) Female less than 8-10 months. Spur 1-2 mm long, whitish or brownish.
2) Female more than 8-10 months. No spur.
3) Male about 6 months. Spur 14-18 mm long; conical, white and opaque; Basal 35-50% covered by pink or whitish collar of skin.
4) Male about 6-9 months. As previous, except superficial white layer chipping away from spur proper.
5) Male about 9-20 months. Spur curved and sharp, 14-18 mm long; basal 35-50% covered by pink or whitish collar of skin (retracts with age).
6) Male more than about 20 months. Skin collar at spur base ± entirely regressed. Spur progressively blunted with age.

Figure 7. Male spur morphology changes and aging in male platypus (Taken from

Grant 1989).



10.13 Age at Weaning

The young suckle milk that is secreted from the mother's abdominal surface. Lactation appears to last approximately 4-5 months (Carrick 1995).

11. Artificial Rearing

11.1 Housing

Facilities in which milk-dependent juveniles are initially maintained should consist of the following:

a) An indoor feed tank approximately 1-2m by 1-2m.
b) A nest box divided into two chambers of equal size by a partition bisecting the box's long axis and reaching up to the lid. Provision should be made for platypus to move freely from one chamber into the other through an aperture 0.2 m in diameter, located 0.05 m above the nest box floor.
c) A tunnel connecting the nest box and tank.

Other criteria governing the facility and its operation are as follows:

a) The nest box and feed tank environs should be quiet.
b) Lighting should normally be subdued.
c) Ambient temperatures should be maintained in the range 15-25^{o}C.
d) A soft, dry, clean substrate should be provided in the nest box.
e) Water depth of the feed tank should initially be maintained in the range 5-10 cm, and gradually increased as animals become stronger and more adept at swimming/feeding.
f) Water should be changed at least daily (more frequently if required).

- Two 11-week-old platypus raised by Robertson (1989) were housed in a solid timber box measuring 600 (L) × 500 (W) × 500 (H)cm and was half filled with dried

kangaroo grass (*Themeda australis*).This was heated to 22-25^{o}C with a 250 Watt dull emitter heat globe that was suspended over the box.

- An 8-10 week animal hand-raised by Taronga Zoo (Beaven 1997) was held in a wooden box (62 × 62 × 129cm) throughout the rearing process. This box was lined with sphagnum moss and divided into four compartments. The platypus had access to all four compartments and was kept in the box at all times other than feeding sessions. The temperature within the box was approximately 22^{o}C. Access to water was not given except when being monitored.

11.2 Temperature Requirements

Robertson (1989) and Beaven (1997) when hand-raising platypus held the ambient temperature at 22-25^{o}C. The water temperature for the individual raised by Beaven (1997) was kept above 32^{o}C initially, as it was found that the animal would not swim or feed in water with a temperature lower than this. Over a period of 45 days commencing at day 88 (and weighing 500g) this was reduced to 17^{o}C. At this weight it was felt that the animal had sufficient body condition to tolerate an expected weight loss as a result of the water temperature change. This individual adapted well to these changes and was eventually housed in water approximately 19-21^{o}C.

11.3 Diet

1) Young platypus should be offered the following foods:

a) Milk.

- A high energy milk formula, e.g. double strength Divetelac or Wombaroo echidna milk. The results of detailed analyses of platypus milk are reported in Griffiths *et al*. (1984) and Gibson *et al*. (1988).
- Robertson (1989) made a mixture of 15g divetelac and 100g water, which was made to a creamy consistency. This mixture was initially offered in the palm of the hand, however due the mess of this method, a camera cleaning brush was adapted to fit a 20ml disposable syringe, which proved very successful. Milk flow could be controlled better and the bristles appeared to stimulate the sensitive nerve endings in the bill. Feeding occurred twice per day, morning and night, with a maximum of 20ml per day given. From day 45 there was a noticeable reluctance to take the milk mixture, however it would take a blended egg and crayfish mixture that was wetted with a few millilitres of milk.
- Beaven (1997) made up a formula containing Divetelac (1 scoop in 50ml water), vegetable oil (0.8ml), and thickened cream (1.8ml) that was mixed together. This formula was offered at room temperature in 5ml quantities. This formula was offered in the hand and using a camera brush or sponge as recommended by Robertson (1989), and at different temperatures without any success. Beavan's (1997) individual was successfully tube fed using a 2.5ml E.T. tube, however this also proved difficult as the platypus gained strength. This was due to the difficulty in passing the tube beyond the pharyngeal area into the oesophagus. It was from this point that live food was given.

b) Live Food.

- Natural (live) food items, with emphasis initially placed on easily captured, soft-bodied species (e.g. earthworms, tubifex worms). Beaven (1997) offered a juvenile platypus brine shrimp, bloodworms, mosquito larvae, mealworms, fly pupae,

maggots, crickets, grasshoppers, earthworms, cockroaches and small yabbies. All the smaller food items were placed in the water tray. This tray was 40 × 25 × 15cm, with the water level being 10cm depth. Water temperature was kept above 30°C initially. A resting area was placed in the tray to allow the platypus to climb in and out of the water. Larger food items such as crickets and yabbies were initially offered by hand. Preferences for any particular food sources changed from day to day. Initially little interest was shown in the yabbies. To overcome this, their legs and exoskeletons were removed, which proved successful.

- Solid foods should be offered by hand and in the water. Beaven (1987) found that initially the 8-10 week old platypus they raised would not swim or feed in water lower than 31.5-32°C. Instead it would scratch and climb out of the tub. This was suggested to be due to a lack of waterproofing.

2) Few data are available with respect to the ideal feeding schedule for milk dependent platypus. Until this has been adequately characterised, juveniles should be offered food at 2 hour intervals throughout the day. The volume per feeding should not exceed 10ml, in keeping with this species' very small stomach. Beaven (1997) provided six feeding sessions each day, beginning at 0600h and ending shortly after 1800h. The room in which the animal was kept was under reverse cycle lighting. This location was chosen because of the isolation of the room and not because of the light regime. Each session lasted between 15 minutes and 2 hours.

3) When Beaven (1997) handed raised a juvenile platypus, it was taken from the box at the beginning of the feed session and allowed to wake up properly in the keepers' lap. It was then placed on a rock within a tray of water so that she could make her own way into the water. This usually occurred with 10-15 seconds. The animal was removed from the water once she started to scratch at the sides of the tray and pull herself out of the water. The animal was lifted from the tray and towel dried as she did not have total waterproofing. The animal was then placed in the next box until the next feeding session. All food was either counted or measured in and out of the water.

4) Parenternal fluid therapy should be commenced during periods of inanition, under the supervision of the Veterinarian.

11.4 Specific Requirements

The following information should be recorded on a daily basis:

a) Dry body weight to the nearest 10 g (or more accurately if possible).
b) Tail volume index (See Chapter 6 for method).
c) Maximum tail thickness at the level of the cloaca (mm).
d) General activity and demeanour.
e) Characteristics and frequency of defecation and urination. Amount (g) of different food types consumed.

The following should be measured and recorded on a weekly basis:

a) Total length including bill (mm).
b) Dorsal bill length (mm) exclusive of the dorsal shield. Maximum bill width (mm).
c) Tail length (mm) measured from cloaca to tip exclusive of terminal hair.
d) Maximum tail thickness at the level of the cloaca (mm).

Photographic records should be used to supplement morphometric data in providing information on growth and development. Areas of particular interest are the bill, feet, spurs and pelage. Both still and video technology may be employed as deemed appropriate by the veterinarian.

11.5 Identification Methods
As mentioned in Chapter 9.

11.6 Hygiene and Special Precautions
After feeding, the nasal area should be cleaned with a soft tissue and regularly washed with fresh water to prevent milk entering the nasal passage and lungs (Robertson, 1989).

A hand-raised animal (Beaven, 1997) was found to suffer from the fungus *Trichosporum beigelii*. The platypus scratched continuously at its stomach, undertail and underlimbs resulting in hair on these areas falling out. An iodine (betadine) solution was then applied to the affected skin daily with cotton wool. An anti-fungal drug, Itraconozol, was also used to treat the fungal problem. Sporanox (Itraconozol) beads were removed from a capsule and injected into a cricket. The medicated cricket was the first to be fed during the 0600h feeding session and it was monitored to ensure that it was totally digested.

Beaven (1997) found the platypus reared was commonly flatulent and often defecated and urinated at each feed. The urine was bright yellow and the faeces were a toothpaste consistency. Hiccupping was also observed.

11.7 Behavioural Considerations
The rearing of the platypus by Beaven (1997) has resulted in a platypus that is not imprinted. Previous attempts at artificially rearing juvenile platypus have resulted in significant imprinting.

11.8 Weaning
The estimated 11-week-old platypus hand-reared by Robertson (1989) weaned itself 80 days after first arriving at Fleays Fauna Park. Complete weaning from milk took place over a two-week period beginning on day 45. It was suggested by Robertson (1989) that it was critical to provide large quantities of food at this time due to their ravenous appetite and as they are very wasteful feeders. This animal remained quite "affectionate" and shows no disturbance of any human activity. Beaven (1997) began weaning the 8-10 week platypus after 96 days. At this time, all hand feeding stopped, forcing the platypus to catch the food herself. This decision was made due to the good weight gain.

11.9 Rehabilitation Procedures
The decision to transfer young juveniles to larger outdoor facilities should be based on a combination of the following criteria:

a) Loss of interest in milk.
b) Success in foraging on solid food items in water.
c) Ability to swim and dive.
d) Ability to flush cheek pouches of residual food.
e) Pelage dries efficiently after emergence from water.
f) Restless behaviour in juvenile facility.

g) Consistent positive weight gain.

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APPENDIX 1 - VETERINARY PROCEDURES

1. Introduction

The development of sound veterinary protocols for platypus is an integral and essential component of an enlightened approach to maintaining animals in captivity. Building up a more substantial clinical database and gaining confidence in the assessment and treatment of platypus should improve the health and survival of captive animals. Preventative medicine must be based on a understanding of 'sick platypus' and therapeutic plans must be based on clinical experiences. The keeping of detailed and accurate records is therefore fundamental to improving diagnostic methods and treatment techniques.

Until recently, the way in which platypus cases have been handled varied significantly from the conventional approach to mammals. The standard techniques of establishing a clinical database and formulating a sound and adaptable therapeutic plan have not been followed. Instead, a system of minimum intervention has evolved which has encouraged the widely accepted belief that platypus are super- sensitive to physical manipulation of any sort. The corollary of this is that the collection of clinical data from platypus has been severely restricted or even taboo. Instances of mortality following veterinary examinations have been used to support this view. In fact, the association between clinical manipulation and mortality is far more likely to be due to the timing of the onset of direct veterinary management, which in the current climate is normally introduced far too late when all else has failed. Veterinarians must actively seek a better understanding of the pathological processes that lead to morbidity and death in captive platypus. Simultaneously, veterinarians must familiarise themselves with, and involve themselves in, research aimed at elucidating the metabolic basis for captive mortality and arriving at therapeutic solutions. The most obvious deficiencies in the current clinical database are:

l. Published normal values for platypus blood parameters and the scope of possible seasonal variation for populations occurring outside New South Wales.

2. Published normal values for such clinically important measurements as heart rate, respiration rate, blood pressure and ECG.

3. Clinical data on both sick and healthy captive platypus.

2. Sedation and Anaesthesia

2.1 Sedation

Diazapam (Valium-Roche) is administered via intramuscular injection at an average dose rate of 1mg per kg dry bodyweight. (The response of individual platypus varies and adequate sedation may be achieved anywhere within the range 0.5-3.0 mg per kg.)

Sedation may render the platypus incapable of swimming and access to water will need to be denied in such cases. A recovery time of six hours is expected with this sedation protocol.

2.2 Anaesthesia

The standard procedure for platypus anaesthesia involves mask induction using isoflurane at 4% with oxygen in an Isotec vaporiser and a modified Bain circuit (flow rate of 1 litre per minute).

Anaesthesia is normally maintained by 2% isoflurane at a flow rate of 1 litre per minute. Vapour concentrations less than 2% may be employed if sufficient anaesthetic depth can be maintained.

Anaesthetised animals are monitored constantly with respect to respiratory function (rate, depth and character) and cardiovascular function (rate, pulse and mucous membrane colour).

3. Post Mortem Examination
Protocol

1) The value of dead animals declines quickly with time and a maximum of 24 hours is the limit, beyond which some tests (eg. microbiological) are worthless.

2) All dead specimens should initially be held at household refrigerator temperature.

3) If examination cannot be carried out within 36 hours, specimens should either be frozen fresh or preserved in 10% buffered formalin or, if formalin is unavailable, in alcohol (methylated spirits).

4) All carcasses should be accompanied by a detailed history including the results of any tests carried out on the specimen alive or dead.

5) Adrenal glands should be removed, weighed fresh and preserved (10% buffered formalin) for detailed histological assessment.

6) A range of other tissues may be stored in either frozen or preserved (10% buffered formalin) state, according to the needs of specific research projects.

7) The Non-domestic Animal Pathology Registry based at Taronga Zoo should be contacted for advice on any additional samples required and/or techniques to be applied to the individual case.

8) A large blood sample should be collected from all moribund and pre-mortem platypus prior to euthanasia if this is to occur.

9) Each case should be recorded photographically, with an emphasis on any notable gross pathological lesions. Photomicrographs should be included if appropriate.

10) Duplicates of all reports, sections, photographs and other data relevant to the pathology of the case should be submitted to the Non-domestic Animal Pathology Registry.

11) A complete clinical report for each case should be filed in the institution's veterinary case database.

APPENDIX 2 - RESCUE ENQUIRIES

Objective

To establish platypus rescue services which provide effective advice and assistance in response to queries by members of the public or outside organisations regarding platypus welfare, captive management and/or release.

Protocol

1. The following information should be collected in response to enquires regarding rescued platypus:

    a. Time and exact location of the initial rescue.

    b. Details of circumstances surrounding the rescue

    c. Response of the animal to rescue, its apparent condition and (if possible) tail volume index. (Criteria for TVI to be described by the staff member answering the call. See Chapter 6 for details).

    d. Animal's weight (if possible) and sex. (Sexing criteria to be described by the staff member answering the call – Chapter 10).

2. A staff member should normally be sent out in response to a platypus rescue call within a maximum of 12 hours to examine the animal and provide advice with respect to optimum handling of the case.

3. Staff members responsible for providing assistance in response to platypus rescue calls should have significant direct experience in platypus assessment, handling and captive management, e.g. Veterinarian, Senior Platypus Keeper, Supervisor (Animal Care).

4. Rescuers should be encouraged to arrange an immediate release for the following classes of animals:

    a. Adults or dispersing/post-dispersal juveniles which appear to be healthy and in good condition (minimum TVI = 3).

    b. Pre-dispersal juveniles which appear to be healthy, and are fat enough (minimum TVI = 2+) to provide a reasonable basis for concluding that they are still in contact with and being cared for by their mother. In addition, very young juveniles (i.e. juveniles which would not normally have yet emerged from their nursery burrow) should only be released if the precise location of the burrow is known and it appears to be intact.

6. Choice of a release site and release methods should follow the guidelines provided in Appendix 5.

6. Animals judged to be unfit for release should be transferred without delay to the institution.

7. For cases requiring platypus to be held overnight by rescuers prior to transfer or release (although this is not recommended) the following housing protocol should be followed:

a. Animals to be kept in quiet, dark, secure location away from other animals (e.g. household pets).

b. Animal to be provided with a clean, dry, non-abrasive substrate which does not provide potential for the animal to get tangled (e.g. a folded, unfrayed towel).

c. Ambient temperatures not to exceed (20-25^{o}C recommended).

d. No solids, liquids or medications to be administered.

e. All forms of disturbance to be minimised, including that motivated by human curiosity or affection.

5) In the case of dead platypus, Appendix 1 (Post Mortem Examinations) should be followed to maximise information gained.

2. ADMISSION DATA BASE AND TRIAGE

Objectives

To establish a minimum database for all platypus on admission.

To ensure that all platypus receive appropriate veterinary attention in accordance with their developmental and health status.

Protocol

1. The following information should be collected at the time of admission:

    a. Complete history: including exact time and location of capture/rescue, nature and duration of restraint/housing, description of any attempted treatments.

    b. Clinical examination details:

        i. Heart rate.

        ii. Respiration rate and character.

        iii. Cardiac/thoracic/abdominal auscultation and palpation.

        iv. Body temperature (cloacal).

        v. Hydration status - based on appearance of eye and mucous membranes and skin elasticity.

        vi. Blood tests - Full Blood Examination and Biochemical Analyses, based on a 1-2 ml sample drawn from a marginal venous sinus in the dorsal bill (Whittington & Grant 1983). See Appendix 4 for a list of the specific blood variables to be assessed.

        vii. Standard neurological assessment.

    c. Sex and estimated age: based on spur morphology, morphometrics, time of year and history.

    d. Body weight, condition and morphometrics:

        i. Body weight of dry platypus to the nearest 10g (or more accurately if possible).

        ii. Tail volume index.

        iii. Total length including bill (mm).

iv. Bill length (exclusive of dorsal shield) and maximum bill width

v. Spur length measured with callipers from the tip to the base of the outer curve (am) and spur colour, if present.

vi. Tail length (mm) measured from cloaca to tip exclusive of terminal hair.

vii. Maximum tail thickness at the level of the cloaca (mm).

Animals should be thoroughly checked for the presence of ectoparasites, especially ticks (*Ixodes ornithorhynchi*). These are suspected to act as vectors for blood parasites, e.g. species of *Theileria* and *Trypanosoma* (McColl 1983; Collins *et al*. 1986; Whittington 1988). All ectoparasites are to be removed by hand or (if necessary) through treatment with appropriate drugs or other compounds.

2. The entire database as described above (supplemented with details of any immediate treatments, additional tests and results) should be entered onto a veterinary case record card.

3. Each case should be categorised on the basis of the above in order that the appropriate follow-up protocol can be adopted. Categories are:

a. Milk-dependent juveniles.

b. Ill or injured adults/independent juveniles.

c. Healthy adults/independent juveniles.

d. Dead platypus.

3. ILL AND/OR INJURED ADULTS/INDEPENDENT JUVENILES

Protocol

1. Initial rescue and admission procedures should follow the guidelines provided in Appendix 2.

2. In general, housing parameters and quarantine procedures should follow the guidelines respectively provided in Chapters 4 and 9, with additional consideration given to the energetic needs of the patient. For example, animals may be provided with a supplementary heat source, or water depth may be reduced to minimise the potential for animals becoming exhausted or drowning while feeding. Badly debilitated animals may initially be maintained in the facility normally serving to hold very young (milk-dependent) juveniles.

3. Blood glucose and fluid deficits should be rectified with 2.5% dextrose in saline accompanied by a one-off administration of short-acting dexamethasone (1.0 mg/kg) if no contraindication exists. All animals should be supplied with a wide range of live food items, as described in Chapter 8.

4. Infectious disease should be considered as a potential primary or secondary cause of illness and microbiological techniques should be employed to investigate this possibility. Swabs in transport medium should be obtained from suspect lesions, evidence of inflammation and infection sought from the admission database and faecal analysis performed for parasitology including protozoan, helminth and fungi.

Appropriate treatment with anti-microbial agent should be initiated where indicated in accordance with standard mammalian criteria.

5. Supplementary diagnostic procedures should be used to expand the clinical data base as indicated, including radiology and endoscopy. Contrast radiographic studies have proved valuable as a diagnostic tool in some cases.

6. The following data should be collected on a daily basis:

a. Dry body weight to the nearest 10 g (or more accurately if possible).

b Tail volume index. (See Appendix 3 for details of method.)
Maximum tail thickness at the level of the cloaca (ram).

d. Amount (g) of various food types consumed.

e. Activity level, general demeanour and scope of behaviour, based on time-lapse video monitoring and/or direct observation by appropriately trained staff and/or volunteers.

6) Every opportunity to monitor, characterise and treat metabolic lesions should be taken.

In cases where serial blood sampling is considered necessary, priority should be given to analysing the following variables: glucose, protein, electrolytes, free fatty acids and haematological values.

8. The ultimate goal of caring for sick and/or injured platypus should normally be rehabilitating animals to the wild. Release procedures should follow the guidelines summarised in Appendix 5. Under some circumstances it may be considered preferable to introduce an animal into longer term captivity.

N.B. Adult platypus are usually not rescued unless they are ill or have been traumatised in some way. The veterinary management of these individuals should be directed at establishing the problem and correcting it. It may sometimes be necessary to immediately repair injuries, however, a 'stabilising' period of 12 hours following the provision of emergency care is good preparation for surgery. Platypus that fail to survive 12 hours would have been unlikely to survive general anaesthesia and surgery in any case. As the poorly understood 'stress response' appears to be highly significant in platypus, every opportunity to characterise and treat metabolic lesions must be taken. More generally, the well-established principles of 'stress free' husbandry should be adhered to, with special care taken to provide a secure and comfortable hospital environment.

4. HEALTHY ADULTS/INDEPENDENT JUVENILES

Protocol

Initial rescue and admission procedures should follow the guidelines provided in Appendix 2.

2. Housing parameters and quarantine procedures should follow the guidelines provided in Chapters 4 and 9, respectively.

3. All animals should be supplied with a wide range of live food items, as described in Chapter 8.

7) Animals in this category should normally be held for the minimum length of time required to arrange their release back into the wild, according to the guidelines provided in Appendix 5. If it is considered preferable to introduce animals into longer term captivity, procedures for acclimatisation should follow the guidelines provided in Appendices 2-4.

APPENDIX 3 - BRINGING PLATYPUS IN FROM THE WILD

Objective

To ensure that removal of animals from the wild for approved research/educational display purposes is carried out in a manner which has a negligible effect upon wild populations and which causes minimum distress to the individual animals concerned.

Protocol

1) Selection Criteria

a) To minimise possible demographic effects of removal, only pre-dispersal (January-May) juveniles should be taken from wild populations. Juveniles should be distinguished from adults on the basis of spur morphology (Appendix 6).

b) Juveniles should not be brought into captivity unless they have very substantial fat reserves, i.e. Tail volume index ~ 1 or 2 (Appendix 3).

c) There is some evidence that juvenile animals or ones that have been hand fed, after being abandoned, adapt more readily to captivity.

2) Capture/Transportation Methods

a) In shallow water (<0.9 m deep), platypus should be trapped using fyke nets, with the bag end tied to a stake so the entire top of the net is held out of the water (Jackson 1979). Fyke nets should be inspected at intervals of one hour or less.

b) In deeper water, platypus should be caught using unweighted gill nets (i.e. modified so platypus can come freely to the surface to breathe). Gill nets should be inspected every 10-15 minutes with the aid of a spotlight, and also lifted briefly from the water every hour to release fish and snagged inanimate objects (Grant & Carrick 1974).

c) Captured platypus should be restrained within clean, dry cloth bags while their sex/age class is ascertained. Qualifying Juveniles should be transported within three hours and transferred to a standard nest box and feeding-tank system.

d) Platypus should be transported individually in a clean, dry cloth bag held inside a standard wooden transport box (50*50*50cm).

e) Newly captured platypus should not be exposed to ambient temperatures exceeding 25^{o}C.

3) Housing

a) Animals initially should ideally be maintained entirely off-display. However as some facilities do not have off display facilities, placing them in the display facility is adequate. Although this has the disadvantage of individuals having to cope with noise from the public during the settling in phase, it has the advantage that the animal does not need to be moved once settled in.

b) Quarantine procedures should follow the guidelines provided in Chapter 9.

4) Food/Feeding

a) Animals should be provided with a wide range of natural (live) food items (Chapter 8).

b) Consumption (by weight) of various food types should be monitored daily for at least the first 12 weeks to provide data on food preferences and feeding rates and enable diet to be adjusted as required.

5) Management/Monitoring

a) Information on newly captured platypus should be obtained in accordance with admission procedures.

b) Handling should initially be limited to the minimum length of time required for an experienced wildlife veterinarian to carry out the procedures specified in Chapter 6. Blood samples (1-2 ml) should be obtained on a fortnightly basis for the first 6 weeks post-capture as part of routine health monitoring.

c) Activity levels and general behaviour should be monitored after capture (based on direct observation time lapse or video technology and a tunnel-mounted activity recording system) in order to document animals' adjustment to captivity.

d) Any veterinary procedures that are required should follow standard protocols for diagnosis and treatment.

e) All information bearing a health status and disease should be reported directly to the Veterinarian on a daily basis.

6) Release

Animals should be immediately released in any of the following events:

a) The attending veterinarian and senior staff judges that release is in the best welfare interest of the animal. Eg It appears to be continually stressed and does not appear to be acclimatising to captivity. See Appendix 4 for signs of stress.
b) An individual's tail fat index appears likely to fall below 3.
c) An individual shows a steady loss of 20% of its initial body weight with a continuing decline evident (Carrick *et al*. 1982).
d) All releases should be carried out according to the guidelines provided in Appendix 5.

APPENDIX 4 - INTRODUCING PLATYPUS TO UNFAMILIAR FACILITIES AND/OR OTHER PLATYPUS

Objective

Although some platypus acclimatise well to captivity they can be susceptible to further stress with changed captive conditions (Grant 1998). Although some animals will tolerate experimental manipulation, this should be terminated if any of the behaviours in Appendix 4 are exhibited. To minimise stress to captive animals resulting from contact with unfamiliar platypus or exposure to novel surroundings.

Protocol

1 Platypus should have continuous access to familiar quarters throughout the period that they are being introduced to unfamiliar enclosures or individuals.

2 Animals should not be placed on display until they have had an opportunity to become thoroughly familiar with the display facility during off-display hours (over a minimum period of one week).

3 Platypus normally should be introduced to each other through a perforated or mesh barrier (placed midway along a feeding tank for a minimum of 24 hours).

4 A human observer should be present for the entire period that platypus first share a common area.

5 Animals should be provided with separate feeding areas.

6 Final responsibility for determining when animals are ready to be placed on display or shifted to new quarters (and the specific strategy and timing of events associated with such changes) should rest with the Curator in consultation with the Veterinarian and Senior Platypus Keeper.

APPENDIX 5 - RELEASE BACK INTO THE WILD

Objectives

To ensure that platypus releases back into the wild are handled with due consideration for the welfare of the released animal and entail minimum impact upon wild populations.

Protocol

1. Platypus qualifying for release should include mis-rescued individuals, animals fallen accidentally into human hands or animals not adapting to captivity.

2. Only animals judged by an experienced wildlife veterinarian to be healthy at the time of release should be considered for release, or if deemed in the animals best interests.

3. Animals should normally be released shortly before dusk at the exact point where they were captured or rescued.

4. If circumstances prevent the release occurring at the exact point of capture/rescue then the nearest suitable site should be chosen. This should be determined institution staff in consultation with the rescuer and local wildlife officers.

APPENDIX 6 - SUMMARY AND RECOMMENDATIONS

An enormous amount remains to be learned about the behavioural and ecological requirements of platypus, both in the wild and captivity. It is inevitable that studies of wild animals should often be limited by the elusive, aquatic and principally nocturnal habits of the species. In many areas of research (e.g. behavioural biology, growth and development, dietary studies and reproductive biology) these limitations are likely to be most effectively addressed by combining information collected in the wild with data derived from platypus maintained in relatively controlled environments. Zoos clearly have a responsibility to play a central role in this regard.

In addition it must be recognised that the display of wildlife is a very powerful and valuable educational tool. The difficulties entailed in observing platypus in the wild means that captive display is likely to be the most effective way of engendering community support for the long-term survival requirements of this species.

The following issues are central to improving captive management:

1) Implementation of effective supportive, diagnostic and treatment methods for orphaned, injured and ill platypus.

2) Develop a sound understanding of the patho-physiological processes that lead to illness and death in captive platypus. This should entail detailed research into the acclimatisation phase immediately following the arrival of new platypus.

3) Utilisation of information gained in (2) above to identify key criteria for acclimatisation and survival, in order to:
    1) Identify suitable individuals for captivity,
    2) Monitor the progress of acclimatising platypus,
    3) Determine when such animals are to be released in their welfare interest.

4) Utilisation of information gained in (2) and (3) above to develop management protocols which optimise the transition of wild platypus into captivity and maximise survival.

5) Establishment of a communication networks which links professional people working with platypus and encourages the sharing of information. A universally accepted system of record keeping is central to this task.

6) Standardisation of veterinary and other records across the institutions maintaining captive platypus to facilitate exchange, pooling and interpretation of data.

7) Routine submission of all available cases and specimens, with appropriate documentation, to the Non-domestic Animal Pathology Registry based at Taronga Zoo.

8) Development of a 'Platypus Clinical Case Register' which supplements and complements the Pathology Registry (e.g. to be located at Healesville Sanctuary).

9) Facilitation and support of studies of platypus physiology, behaviour and ecology in the wild, particularly when these are complemented by appropriate captive studies. Areas in particularly urgent need of research attention in a captive context are nutrition, daily and seasonal variation in activity and behavioural patterns, and reproductive biology. There is also a plethora of captive environmental parameters that need to be examined with respect to platypus preferences.

10) In the longer term it is essential that protocols be developed which lead to reliable captive breeding of platypus based upon an improved understanding of the reproductive biology of the species. When combined with sound captive management procedures, this should enable research and educational display goals to be achieved with a minimum impact on both individuals and populations.