# HUSBANDRY MANUAL FOR YELLOW-TUFTED HONEYEATERS *L.m. cassidix* & *L.m. gippslandicus*

**by**

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# INDEX

## INTRODUCTION

Honeyeaters are a large family of birds restricted to the Pacific region. Australia is well represented with honeyeaters. Most areas of Australia has at least one local species. Honeyeaters are popular with zoos and wildlife sanctuaries and some states of Australia which allow several species to be kept by the private aviculturist in captivity. A need for husbandry manuals or guidelines on all Honeyeater species is necessary for day to day husbandry, breeding the birds in captivity and as a reminder for even the experienced bird keeper. The aim of this husbandry manual is to provide zoos, other related institutions and private aviculturists with guidelines to keeping this genus (*Lichenostomus*) in captivity. This manual provides the trials and tribulations of the Yellow-tufted Honeyeater (*Lichenostomus melanops gippslandicus*) and the endangered Helmeted Honeyeater (*Lichenostomus melanops cassidix*) in captivity at Healesville Sanctuary. This manual contains data and detailed information on husbandry, feeding, breeding, cross fostering, sexing and veterinary involvement. Many successes and failures have occurred since 1989, we now conclude that all problems have been ironed out and that any further developments will only be minor ones.

The Lichenostomus melanops complex is made up of the following four subspecies:
Helmeted Honeyeater (*Lichenostomus melanops cassidix*)
Gippsland Yellow-tufted Honeyeater (*L.m.gippslandicus*)
Inland Yellow-tufted Honeyeater (*L.m.meltoni*)
Sydney Yellow-tufted Honeyeater (*L.m.melanops*)

These four subspecies are collectively known as Yellow-tufted Honeyeaters with the Helmeted Honeyeater being highly endangered. Since 1989 Healesville Sanctuary has been involved in an intensive captive breeding program with these two subspecies of closely related *Lichenostomus* honeyeaters as part of the Helmeted Honeyeater recovery effort following a Recovery Plan. There are as few as 100 Helmeted Honeyeaters left in the wild, therefore recruitment from captive bred birds is essential to the program. Healesville Sanctuary maintains a captive population that fluctuates from a minimum of 15 pairs. Presently Helmeted Honeyeaters are restricted to one site in the wild which is within Yellingbo State Conservation Reserve – Victoria. Another site at Tonimbuk – Victoria has been chosen to re-establish this subspecies. Helmeted Honeyeaters occurred at Tonimbuk as recently as the early eighties.
It is thought that the Ash Wednesday fires of 1983 wiped them out from this area and other areas where they used to reside. Rapid decline has resulted from processes such as habitat destruction by man, interspecific competition, high rates of predation and, as previously mentioned, natural environmental disasters.
This manual has been updated and improved since the 1995 edition due to several improvements and discoveries being made since that time. The information contained in this husbandry manual focuses on *L.m. gippslandicus* and *L.m. cassidix* because these are the two subspecies that we have kept in numbers and have had outstanding breeding results with. Much of the wild data presented here relates to *L.m. cassidix* because this subspecies has been studied and managed far more intensely than any other honeyeater species that we are aware. We have based this manuals structure on the Avian Husbandry Notes Guidelines as suggested by the Australian Bird Taxon Advisory Group for the Australasian Species Management Program. Currently these are the best known techniques and should give other institutions and individuals a good guide for the care and reproduction of this beautiful and fascinating species of bird.

## NATURAL HISTORY

### 1.1 TAXONOMIC POSITION

The Yellow-tufted complex currently consists of four subspecies. *L.m. meltoni* on the western side of the Great Dividing Range from southern Queensland through N.S.W, Victoria and into south eastern S.A., *L.m. melanops* on the coastal side of the Great Dividing Range from sth Queensland to Narooma N.S.W., *L.m. gippslandicus* from Narooma N.S.W to Warburton, Vic., *L.m. cassidix* (the Helmeted Honeyeater) is restricted to riparian forest around Yellingbo, Vic (Blakers et al. 1984) but formerly distributed from Healesville to SW Gippsland, Vic (Menkhorst and Middleton 1991).

The taxonomic position of the Yellow-tufted complex has been and is currently being investigated with the emphasis on identifying differences between *cassidix* and *gippslandicus* using DNA fingerprinting. Recent genetic studies have proven that the Helmeted Honeyeater (*L.m.cassidix*) is genetically different than the other 3 sub species. Three genetic distance measures showed high genetic distances between *cassidix* and the other three subspecies, therefore subspecific status of the Helmeted Honeyeater is definite (V. Hayes 1999).

### 1.2 HABITAT

The Yellow-tufted complex lives in varied habitats. *L.m.meltoni* lives in dry eucalypt woodland, mallee, casuarina and acacia stands. *L.m.melanops* is strongly associated with the hilly areas that are streams lined with Red Gum around Sydney (Longmore 1991). *L.m. gippslandicus* is usually found in tall riparian forests but will occasionally be found on drier slopes (Blakney and Menkhorst 1993). *L.m. cassidix* is associated with riparian vegetation, presently Mountain Swamp Gum *Eucalyptus camphora*, with an understorey of dense tea-tree *Leptosprermum lanigerum* (Woolly Tea-tree) and *L. continentale* (Prickly Tea-tree), but may also forage on drier slopes and in heathland (McMahon et al 1991, Menkhorst and Middleton 1991, McMahon and Franklin 1993).

### 1.3 LIFE HISTORY

All subspecies are communal, living in neighbourhoods of from six birds to as many as one hundred (Longmore 1991). The well studied Helmeted Honeyeater lives in neighbourhoods of one to 27 pairs, a number of other individuals will live with the colony but do not take up breeding positions (B. Quin pers comm). The birds in the neighbourhood will communally defend the territories against predators and competitors. This behaviour has been observed when Bell Miners (*Manorina melanophyrs*) have invaded Helmeted Honeyeater territories (B. Quin pers comm).

Once fledged young birds will disperse. Dispersion occurs predominantly with females who may take up temporary residence at nectar flows or at other Helmeted neighbourhoods. Females generally return to their previous breeding territory and mate just prior to the commencement of the breeding season. Young males will often remain in their natal territory and set up their own territory next door to that of their parents, sometimes encroaching into territory previously held by their parents (Franklin 1992, Runcimen 1992).

The birds are arboreal, foraging mainly in foliage, on limbs and on trunks of trees. They may occasionally come to the ground. Male Helmeted Honeyeaters spend more time foraging in the forest canopy than females who spend more time foraging on tree trunks and in the understorey (Moysey 1994).

The birds are mainly sedentary although the inland subspecies (*L. m. meltoni*) are more likely to become nomadic at times of nectar shortages, and may disperse widely. *L. m. meltoni* have been recorded as far south as Yellingbo (B. Quin pers obs). *L. m. gippslandicus* and *L. m. cassidix* are very sedentary and may remain in the same areas for many years (Blakers et al. 1984).

### 1.4 WILD DIET

The Yellow-tufted Honeyeater feed as individuals or as groups. They can congregate in small to large flocks at suitable nectar flows. At the end of a breeding season many juveniles may be seen together (I. Smales pers. comm). The main diet consists of plant exudates such as nectar or manna. They also consume lerps, spiders and insects. During the breeding season they primarily feed the chicks on insects but may occasionally include manna and lerps in the diet (Wykes 1982).

### 1.5 WILD BREEDING

The breeding season is primarily between July and March. *L.m.cassidix* usually start building their first nest in late July or early August whilst *L.m.gippslandicus* regularly begins nest building a few weeks earlier, at the start of July.

The following data is for Helmeted Honeyeaters but it may apply for the relatively unstudied other subspecies.

There may be as many as four nest attempts per season. One pair of *L.m.cassidix* had nine unsuccessful attempts in

the one season and another reared eight young from four nests in one season. The birds nest in neighbourhoods, sharing territory defence between a number of adjacent territories (Franklin et al. in press, Smales et al. 1990).
The female constructs the nest and incubates the eggs. Both sexes care for the young and there may occasionally be assistance from other non breeding and breeding birds from the same neighbourhood (Franklin et al. in press, Miller and Smales 1992).
The nest is cupshaped, placed in the outer branchlets suspended by the rim or wedged in a fork in the inner branches of a shrub. It is built at a height of between 10 cm and 20 metres. The nest is constructed of bark and grass bound with cobwebs and decorated with spider egg sacs. It is lined with fur, feathers, fine grasses, leaves or plant down (Franklin et al. in press). For *L.m.cassidix* there is some evidence that nests built early in the season are bulkier than those built later in the season (Franklin in prep).
Usually two eggs are laid, occasionally three (range 1-3, mean 2.01). The eggs take 14 days to hatch and the chicks remain in the nest for ten to fourteen days. The chicks are independent at about 40 days (Franklin et al. in press).
*L.m.cassidix* may become sexually mature in their first year. Females are able to breed in their first year with a female of nine months of age breeding successfully. Females appear to breed better in their second year (Franklin et al. in press). Males may also breed in their first year, for example one wild male fathered chicks at eight months of age (B. Quin pers comm). Very occasionally other birds may assist parent birds to feed their chicks (Franklin et al. 1995, Miller and Smales 1992).

## 1.6 ADULT WEIGHTS AND MEASUREMENTS

In the wild Helmeted Honeyeaters males are generally heavier than females (Franklin and Smales 1993).

Table 1
*L.m.cassidix* weight in grams

| | | Mean | S.D. | Range | N |
|---|---|---|---|---|---|
| Male | Summer | 32.9 | 2.7 | 27.6 - 38.1 | 14 |
| | Autumn | 35.1 | 1.9 | 31.5 - 37.7 | 10 |
| | Winter | 33.9 | 2.8 | 30.6 - 37.0 | 4 |
| | Spring | 31.8 | 2.2 | 30.0 - 36.0 | 11 |
| Female | Summer | 30.5 | 2.9 | 26.0 - 36.7 | 17 |
| | Autumn | 31.7 | 0 | 31.7 | 2 |
| | Winter | 32.4 | 1.8 | 30.1 - 34.9 | 7 |
| | Spring | 28.6 | 1.6 | 25.9 - 31.1 | 10 |

Table 2
*L.m.meltoni* (Rogers et. al. 1990)

| | Adult Male | Adult female |
|---|---|---|
| Wing mm | 87.3 (3.45;165) | 84.1 (3.45;158) |
| THL mm | 39.6 (0.83;165) | 37.8 (0.83;158) |
| Tail mm | 87.8 (4.34;165) | 85.2 (4.34;158) |
| Weight gm | 23.8 (0.86;165) | 22.1 (0.86;158) |

| | Immature male | Immature female |
|---|---|---|
| Wing mm | 83.7 (2.72;97) | 80.2 (2.72;127) |
| THL mm | 39.3 (0.76;97) | 37.3 (0.76;127) |
| Tail mm | 83.2 (3.44;97) | 79.3 (3.44;127) |
| Weight gm | 22.6 (0.88;97) | 20.3 (0.88;127) |

Table 3
*L.m.gippslandicus* 2 populations (Smales unpub. data)

| | | **Male** | **Female** |
|---|---|---|---|
| Wing | mm | 92.2 (n=17) | 88.0 - 95.0 |
| THL | mm | 40.8 (n=16) | 40.0 - 42.0 |
| Tail | mm | 88.5 (n=16) | 90.0 - 102.0 |
| Weight | gm | 28.2 (n=16) | 26.5 - 31.0 |
| | | | |
| Wing | mm | 88.3 (n=12) | 82.5 - 92.0 |
| THL | mm | 39.6 (n=12) | 38.0 - 41.5 |
| Tail | mm | 90.5 (n=12) | 82.5 - 101.0 |
| Weight | gm | 26.9 (n=12) | 24.1 - 29.7 |

Table 4
Morphometrics at fledging compared with adults. All values are mean.

| | Weight (gm) | Head-bill length (mm) | Tarsus Length (mm) |
|---|---|---|---|
| 11 day old young (n=4) | 26.5 | 31.5 | 28.2 |
| 13 day old young (n=4) | 26.3 | 32.8 | 28.4 |
| Adult (n=46) | 32.2 | 41.5 | 29.1 |

Table 5
Morphometric gender differences in adult Helmeted Honeyeaters. All measurement are in millimetres.

| **Character** | **Sex** | **n** | **Mean** | **S.D.** | **Range** |
|---|---|---|---|---|---|
| Head-bill | m | 30 | 42.2 | 1.01 | 40.0-43.6 |
| | f | 32 | 40.5 | 0.69 | 39.0-42.1 |
| Skull depth | m | 20 | 13.4 | 0.86 | 11.7-15.0 |
| | f | 18 | 13.0 | 0.99 | 11.2-15.5 |
| | m | 14 | 14.6 | 1.01 | 13.2-16.2 |
| | f | 13 | 14.6 | 1.00 | 12.5-15.7 |
| Bill depth | m | 14 | 5.6 | 0.23 | 5.3-6.0 |
| | f | 13 | 5.3 | 0.24 | 5.0-5.7 |
| Exposed culmen | m | 19 | 15.3 | 1.18 | 12.0-17.0 |
| | f | 14 | 14.3 | 1.09 | 12.0-15.5 |
| | m | 14 | 14.9 | 1.80 | 10.3-17.7 |
| | f | 13 | 13.9 | 1.32 | 11.8-16.1 |
| Tarsus length | m | 36 | 28.9 | 0.91 | 26.0-30.0 |
| | f | 34 | 28.1 | 0.66 | 26.2-29.3 |
| Tarsus depth | m | 9 | 2.5 | 0.07 | 2.4-2.6 |

| Character | Sex | n | Mean | S.D. | Range |
|---|---|---|---|---|---|
| | f | 8 | 2.4 | 0.10 | 2.2-2.5 |
| Tail | m | 14 | 103 | 3.8 | 98-111 |
| | f | 11 | 100 | 2.4 | 98-105 |
| Wing | m | 21 | 98 | 2.5 | 94-102 |
| | f | 15 | 93 | 1.4 | 91-96 |
| Total length | m | 21 | 204 | 4.5 | 193-210 |
| | f | 17 | 199 | 5.2 | 190-208 |
| Tuft length | m | 19 | 15.8 | 1.8 | 12-18 |
| | f | 16 | 15.8 | 1.7 | 13-18.5 |

1.7 AGEING

The following is a guide to aging Helmeted Honeyeaters**.** (Franklin and Smales 1993)

1. If the bill or gape is anything other than entirely black the bird is approximately one year of age.
2. Iris colour varies with age, with adults having brighter and often redder eyes than young birds. However not all adults have red irides. (Franklin and Smales 2000)
3. If the retrices are pointed or the two central retrices are noticeably longer than the others, then the age of the bird is two years for birds examined from August to March and one year for birds examined from April to July. Adult Yellow-tufted Honeyeaters have rounded retrices.

These general rules may be applicable to the other subspecies.

4. A bird is considered an adult if it has completed its first moult, which with some birds is not until the end of the second April after hatching (Franklin et al. 1999). The colouration of the feathers of a bird before its first moult are somewhat duller than older birds.

1.8 SEXING

*L.m. gippslandicus* and *L.m. cassidix* are not sexually dimorphic in plumage, however, there is usually a size difference between the sexes with the male the larger of the two. There is also a behaviour difference with the males tending to be more aggressive and more vocal when there are predators eg. butcherbirds around. These are generally true but there may be exceptions. To ensure that pairings are male/female the birds can be surgically sexed. The method used presently is DNA sexing of the blood which is carried out by Genetic Science Services. Blood is extracted from a main blood vessel underneath the wing using capillary tubes and then stored in liquid nitrogen With experience individuals can be sexed on their behaviour. There is size dimorphism in two measurements of Helmeted Honeyeaters in the field, wing length and head-bill length (see Figure 1) (Franklin and Smales 1993).

The following is a **Field guide to sexing adult Helmeted Honeyeaters** (after Franklin and Smales 1993)

1. If the cloaca points forward and is creased at the front - male.
2. If the cloaca does not have a crease at the front, **and** the bird has a well developed brood patch - female.
3. If the bird has rounded retrices and at least one of the sixth, seventh or eighth primaries is fully grown, compare head-bill length and wing length measurements with Fig 1 for an indication of gender.

In the wild it is recorded that males occupy the upper tree canopy and females occupy

Table 6

Sexing criteria for *L.m.meltoni* (Rogers et al. 1990)

| | **Total Head length mm** |
|---|---|
| Adult | F <= 37.5; M>= 39.9 |
| Immature | F <= 37.4; M>= 39.2 |

**CAPTIVE HUSBANDRY**

**2. HOUSING REQUIREMENTS**

ADELAIDE ZOO
Yellow-tufted Honeyeaters, of unknown race, at Adelaide Zoo have been housed in off limit aviaries of 4m x 2m x 3.5m high and in a large mixed exhibit aviary of 20m x 5m x 6m high. The large aviary has a creek flowing through it and is heavily planted with shrubs and ferns. It has a sprinkler system and the aviary substrate is soil covered in leaf litter which is periodically replenished. The birds are fed in a smaller cage at the back of the exhibit which can double as a catch area when required.

HEALESVILLE SANCTUARY
Healesville Sanctuary has housed breeding birds one pair to an aviary in a number of different sizes. The smallest was 5m x 3m x 4m high. The largest was 10m x 3m x 4m high. A colony of four pairs was also established in an aviary 26m x 10m x 4m high. This aviary was heavily vegetated and had many corners and places for less dominant birds to retreat to.

Vermin entering an aviary may cause havoc to nesting birds, large rats may even take healthy adults. Mesh size needs to be 25mm x 25mm maximum otherwise the birds may escape however this size will permit the entry of small rats into the aviary. Much effort should be made to exclude mice and *antechinus* sp. Using mesh size 15mm x 15mm will exclude most vermin however small mice and *antechinus* sp may still enter. Bait stations should be set up inside the aviaries and the honeyeaters food lifted off the ground onto a rodent proof table.

Heavily vegetated aviaries are the preferred type for a number of reasons. Live vegetation supplies plenty of cover for the birds, it attracts insects into the aviary on which the birds can feed, it supplies much nesting material for the birds and provides many activities for the birds to prevent boredom. The best types of plants will have twiggy growth to supply nesting sites, loose bark for nesting material, dense vegetation and flowers to supply nectar and attract insects. Plants can be supplied growing in the ground or in pots. Harvested leafy vegetation can supply perches and cover until living vegetation has grown or, in smaller aviaries, can be used in leu of living vegetation.

Short term holding of birds can be accomplished adequately in smaller aviaries of 3m x 1m x 2m high or in small cages 600mm x 600mm x 600mm. Plenty of perching and dense vegetation needs to be provided in such situations. A screen placed over the front of the cage can reduce disturbance from elements outside the cage.

MELBOURNE ZOO
Melbourne Zoo has housed this species in a number of aviaries. One aviary is 25m x 10 m x 8m high. This aviary is heavily planted with shrubs, grasses and small trees of predominately Australian origin. There is a large pond at one end of the aviary. The aviary is of pole construction with 20 mm chicken wire used to enclose it. Another aviary is 10m x 15m x 2.5 m high. This is heavily planted with eucalypts and grasses.
Another aviary was 15m x 4m x 2.5m high. This aviary is densely planted with native shrubs and has a large pond at one end.

TARONGA ZOO
At Taronga Zoo the birds have been held in a number of aviaries. *L.m. gippslandicus* were collected from Victoria and initially housed at Taronga until the facility at Healesville was completed. These birds were housed in suspended cages, two birds to a cage, 1850mm long, 930 mm high and 650 mm wide. Wire used was 25 x 12.5 mm weldmesh. The cages were heavily furnished with leafy branches.

Birds were also housed in breeding aviaries 2.8 x 1.6 x 2.1 m high. The aviaries have a solid back, wire sides and roof, and completely protected from the weather. The wire used on these aviaries is 25 x 12.5 mm weldmesh. These aviaries were heavily furnished with leafy branches.
A pair of birds of unknown subspecies was housed in a display aviary. The aviary is one in a block and it is 12 m long, 4m wide and 3m high. The aviary was heavily planted with nectar producing shrubs, *Callistemon* sp and *Kunzea* sp and native grass tussocks. A pond runs the full length of the aviary .

## 3. HEALTH REQUIREMENTS

### 3.1 GENERAL EXAMINATION

(i) Visual examination - A healthy bird should have tight feathers, bright alert eyes, be active and perch with legs and body upright. Signs of disease include lethargy, sleepy eyes, fluffed plumage, crouched posture, tail bobbing with increased respiratory effort, or open mouthed breathing. Droppings should be evaluated. Normal honeyeater droppings tend to be liquid and yellow. Changes in colour and consistency should be noted.

(ii) Examination under manual restraint - The bird should be captured quickly to avoid exertion and hyperthermia. Examination should take place in a small room with closed doors, low ceilings and no exposed clear windows in case the bird escapes from the hand. A small soft mesh net should be available to assist rapid recapture in the event of escape. Electronic weighing scales should be available accurate to 0.1 g. The bird should be weighed in a clean cotton bag. Adult Helmeted Honeyeaters weigh approximately 30g (Range 28-40g) and Yellow Tufted Honeyeaters weigh approximately 28g (25-30g).

Begin by examining the eyes and adnexa. Examine pupillary size, symmetry and response to light. Note any swelling of the periorbital area and any nasal discharge. Examine the oral cavity with illumination, noting any plaques or inflammation. Examine the tongue for evidence of damage to the delicate brush tip or the frenulum.

An indication of appetite can be obtained by examining the crop and faecal output, as well as measuring nectar intake. Palpate the keel to indicate general condition in conjunction with body weight.

Palpate the abdomen and examine the vent for pasting of faeces, swelling or inflammation. Examine the uropygial gland.

All four quadrants of the coelomic cavity should be ausculatated with a good quality pediatric stethoscope. Moist rales, squeaking or wheezing sounds with respiration should be noted. Feather movement under the stethoscope can mislead the examiner to think that respiratory rales exist. Ausculate in a featherless tract wherever possible.

(iii) Examination under anaesthesia

If more invasive diagnostic techniques are required, general anaesthesia may be required to reduce the stress of prolonged handling and restraint, or painful procedures. Isoflurane and oxygen, administered by mask, T-piece and vaporiser, is the anaesthetic of choice. Fasting prior to anaesthesia should be routine (aspiration accidents have occurred), but should be restricted to 1 to 2 hours. Longer fasting periods in small birds can be life threatening.

(iv) Blood sampling

Blood samples can be collected from the ulnar vein, either conscious or under anaesthesia, by clearing feathers from the site, pricking the vein with a 25gauge needle, and collecting the drop of blood into haematocrit tubes. Pressure should be maintained on the site for a few minutes following collection to minimise haematoma formation. Larger blood samples can be obtained from the jugular vein on the right side of the neck. The total blood volume of a 30g bird will be approximately 3 mls. A clinically healthy bird can compensate for a loss of 10% of its blood volume. Do not collect more than 0.3 mls of blood, and ensure that haematoma formation is avoided.

### 3.2. POST MORTEM EXAMINATION

Because of the management implications associated with mortality of an endangered species, it is essential to prioritise post mortem examination and avoid autolysis. The examination should begin with a review of the history and any medical record. A standardised post mortem form assists with the development of a thorough technique. The identity of the bird should be verified and the body weight measured and recorded. Following external examination of the carcass, the feathers are dampened with soapy water or alcoholic hibitane to prevent aerosolisatiom of feather debris and potential pathogens. The thoraco-abdominal cavity is opened and the organs are examined in situ. Microbiological samples may be indicated at this stage. Organs are then removed and examined in more detail. A light source with 5x magnification is helpful. The sex of the bird should be confirmed and recorded. If no gross lesions are detected it is appropriate to take samples of all major organs for histological

examination. Microbiological swabs from liver, lung and heart blood may also be indicated. Care should be taken when handling organ sections to avoid compression artefact of the tissues. Slices of tissue should be cut with a sharp blade and gently transferred to the formalin pot. Air sac tissue should be placed on a small piece of paper before fixation to facilitate identification of the tissue for processing. Sections of intestines should be opened to ensure proper fixation of the mucosa. Proper labelling of the formalin pot is essential to assist the pathologist in identification of the tissues.

Appendix 1 summarises the post mortem findings for *L. m. cassidix* and *L. m. lichenostomas* between 1989 and 1994. Appendix 2 summarises mortality in Honeyeaters in general recorded by the Taronga Pathology Register between 1985 and 1994.

## 3.3. DISEASES IN CAPTIVITY

### PRINCIPLES OF DISEASE PREVENTION IN CAPTIVITY

Critical factors to avoid stress and the development of disease during adaptation to captivity include:

* Ensure food intake is adequate. Malnutrition is a significant predisposing factor. Palatability of the captive diet has not been a problem, but use of artificial nectar feeders, and location of food containers in an aviary have proved problematic. Birds are initially housed in a smaller cage within the aviary for 1-3 days to adapt to feeders and diet before the front of the cage is removed to allow access into the aviary. Feed containers should continue to be placed within the small cage, as well as at two or three other sites within a well planted aviary.

* Ensure the cage is in a peaceful and protected place with plenty of comfortable shrubby perches. Ideal smaller cages are opaque plastic boxes with stainless steel wire front. The plastic reduces feather damage and provides a visual barrier to outside disturbances. If a bird is constantly on the move within the small cage it should be let out into the aviary as soon as it is established that it is feeding adequately. Each case should be judged individually.

* Avoid direct interaction with other potentially aggressive birds. During introduction to potential partners, multiple feed stations and refuge sites are required, as well as frequent keeper observation to detect incompatibility. Most effective pairing occurs by opening up a series of aviaries to allow birds to select their own mates. The provision of multiple connected aviaries allows more escape routes during aggressive interactions.

### ASPERGILLOSIS

Aspergillosis accounted for the deaths of 5 of 27 Helmeted Honeyeater and 4 of 14 Yellow Tufted Honeyeater mortalities from 1989 to 1992. Most passeriformes are considered susceptible to this disease (Ritchie, Harrison and Harrison, 1994). Aspergillus is a ubiquitous fungus and infections should always be considered to occur secondarily to an immunosuppressive event.

Predisposing factors include transportation, overcrowding, malnutrition, poor ventilation, a moist contaminated environment, very young or old age, antibiotic therapy (particularly tetracyclines), corticosteroid administration, respiratory irritants (eg. disinfectant fumes, cigarette smoke, ammonia) or concomitant disease. Healthy birds can generally withstand exposure to a high concentration of spores.

Clinical signs include anorexia, weight loss, depression, respiratory distress, vomiting or diarrhoea. Open mouthed breathing and tail bobbing indicating increased respiratory effort and wheezing or squeaking respiratory sounds are suggestive of Aspergillosis.

In the Helmeted Honeyeater program, treatment was instigated based on a presumptive diagnosis from clinical signs of depression, anorexia and audible wheezing or moist respiratory sounds. Definitive diagnostic techniques (fungal culture, haematology, serology, cytology, radiology and endoscopy) were deemed counter-productive in terms of causing more stress and yielding potentially equivocal results. Differential diagnoses for these non-specific respiratory symptoms include bacterial or viral respiratory tract infections.

The recommended nebulising dose of Amphotericin B is 1 mg/ml of saline for 15 minutes twice daily. Treatment was continued for 5 to 7 days or longer depending on response.
Nebulising is best carried out in a wire fronted plastic box that the bird can be maintained in throughout the treatment period, thus avoiding transfer to and from a hospital box. The front of the cage is covered with a plastic sheet during the nebulisation period. The nebuliser is taped upright near the base of the cage so it cannot be knocked over, and vapour rises up to be inhaled by the bird. Concurrent treatment with oral broad spectrum antibiotics was also carried out, to destroy any primary or opportunistic bacterial pathogens. Amoxil drops at a dose of 100mg/kg was well accepted when added to the nectar or offered from the end of a 1 ml syringe. The therapeutic regime adopted was well tolerated.

It was critical to develop a treatment regime which did not cause further stress and thereby exacerbate the condition. Nebulisation with Amphotericin B was chosen for therapy because it involved minimal handling and carried the drug effectively to the primary site of infection. Amphotericin B is still one of the most efficacious antifungal drugs, especially for chronic infections and infections in immunocompromised hosts (Ritchie, Harrison and Harrison, 1994). It is not well absorbed following oral administration, and is too irritant for subcutaneous or intramuscular injection. It is highly nephrotoxic in mammals, but may be less so in birds (Ritchie, Harrison and Harrison, 1994). Inhaled anti-fungal drugs are more likely to be effective therapeutically than drugs relying on transportation via the circulation to the relatively avascular air sacs.

Birds which became asymptomatic following treatment may never have had Aspergillosis, but clinically improved due to coincidence or because of the beneficial effects of humidification of inspired air. The observed increase in nestling survival following prophylactic nebulisation with Amphotericin B following early detection of suggestive symptoms does not necessarily mean that the nestlings had clinical Aspergillosis and recovered. Hand raising techniques improved concomitantly with the instigation of this treatment regime and probably contributed more to increased nestling survival. The significance of the program necessitated an intensive response to any detected early warning signs.

Prophylactic nebulisation of wild caught adult birds with Amphotericin B during introduction to captivity has been protocol in the early years of the programme. Prophylactic Itraconazole has also been used at a dose of 10mg/kg (approx one 0.38 mg bead per adult bird) orally BID for 7 days, particularly for wild caught birds under intensive treatment. Prevention of the factors which predispose to the disease are far more important than any prophylactic treatment regime.

## VITAMIN D TOXICITY

A significant mortality of *L. m. cassidix* and *L. m. gippslandicus* occurred in 1992 as the result of over supplementation with Vitamin D. A total of 32 birds died, nine *L. m. gippslandicus* (6.3) and twenty three *L. m. cassidix* (11.9.3). The birds died during the period from 13/10/92 to the 24/10/92 from an insufficiently diluted supplement administered on the 12th and 13th of October. The principle lesion was calcified material within the convoluted tubules of the renal cortex. Supplementation was undertaken principally to address a problem with thin shelled eggs being laid in captivity.

## THIAMIN DEFICIENCY

Twelve helmeted honeyeaters and eleven yellow-tufted honeyeaters died over a six day period in 1996. Histological lesions were compatible with thiamin deficiency. Three helmeted honeyeaters were tested and had brain thiamin levels below 1 mg/kg. Culture results were negative for pathogenic bacteria and viruses. Results were also negative for botulism and organophosphate intoxication. It seems most likely that the diet had been marginal for thiamin for some time and an extraneous factor lead to the clinical deficiency. Thiamin is not stored in the body and must be consumed on a regular basis to prevent deficiency. Antithiamin compounds exist in plants such as bracken and horsetail and some bacteria can also produce thiaminases. There was no evidence of exposure to these plants. The most likely scenario is one of bacterial contamination of the feed resulting in a precipitous drop in thiamin levels. To guard against this happening in the future the nectar mix has been reformulated and thiamin content increased.

TRAUMA

Most honeyeater species are noted for their aggressive temperament and intraspecific trauma is a significant cause of mortality in captivity. Incompatible pairings, or accidental pairings of same sex birds or aggression towards birds in adjoining enclosures all contributed to mortality. Severe trauma to the head and tongue were common, but occasionally mortality occurred due to Aspergillosis associated with the stress of constant harassment and probable malnutrition from being kept away from food sources. The superaviary concept, allowing free choice of partners in a large aviary with ample escape opportunities has proved the best way to overcome this problem. Multiple feeding stations are a necessity.

COLOUR LOSS

In captivity, the honeyeaters began to fade from bright yellow to greyish yellow on the captive diet. Feather colour is mainly affected by the presence of pigments such as canthaxanthines, carotene and carotenoids in the diet. Deficiency of these pigments does not necessarily lead to any metabolic problems, but it is possible that the brightness of the birds plumage may be a cue for breeding behaviour. Various agents were added to the diet to achieve an improvement in colour, including carrot juice and Siskred (a canary colorant), with varying success.
Fading occurred while the birds were on a diet of Wombaroo Lorikeet Mix. For the last two years the captive population have been fed on another artificial nectar mix known as Leadbeaters Mix (see Captive diets). Following the first moult after changing to the new diet, plumage colour improved to that of wild birds.

## 3.4 DISEASES IN THE WILD

CUTANEOUS MYIASIS

Wild nestlings (at least 4 chicks from two nests) have been found to have large fly larvae migrating under the skin, causing no apparent harm. The flies have been identified as *Passeromyia indicora* by Ken Walker from the Museum of Victoria. These flies have a life cycle involving free living adults which lay eggs on nestlings, the larvae then migrate and feed subcutaneously to emerge and pupate in the nest lining before the chick fledges. The flies are probably not host specific. Large numbers may be capable of causing mortality. All the Helmeted Honeyeater nestlings with detected larvae fledged successfully.

CAPILLARIA

A wild caught adult *L. m. cassidix* which died soon after transfer to captivity was found to have a heavy burden of *Capillaria spp.* in the crop causing a severe unglivitis. It is uncertain whether this burden would have been severe enough to cause death without the additional stress of recent captivity. The bird was in good condition when captured. Routine faecal examinations to date have not detected Capillaria eggs from wild or captive birds.

HEPATIC LIPIDOSIS

The wild caught *L. m. cassidix* with *Capillaria* died in excellent condition with an enlarged, yellow liver which on histology showed hepatocytes filled with large lipid droplets. When fat animals are suddenly starved or become anorexic, the liver is confronted by a huge incoming load of mobilized fat, and is simply unable to process it so that the fat accumulates in the cells. Liver function is probably impaired, but outright liver failure does not occur. In small birds with a high metabolic rate and reduced food intake, an inability to make available this stored energy may result in death from starvation.

AVASCULAR NECROSIS ASSOCIATED WITH LEG BANDS

Wild birds were initially banded with a metal CSIRO band and a colour site band on the left leg, and three colour bands on the right leg. This banding system was adopted to enable field workers to positively identify an individual if only the right leg was visible, as one of the colour bands on the right was a site band. Several cases of foot inflammation occurred, some being severe enough to cause loss of the foot due to avascular necrosis. Initial examination of affected legs suggested that during normal replacement of epithelium, the honeyeaters' long rectangular leg scales were trapped between the band and the skin, and were unable to migrate out between the limited spaces between bands. Most problems were observed on the leg with three colour bands, as the bands

extended from just below the hock to just above the tarsus, but problems were also encountered where there was just a metal band and a colour band. Modifications were made to the bands to make them narrower, but eventually it became necessary to reduce the number of bands to a maximum of two bands. The banding scheme recommendation for Helmeted Honeyeater legs was size 3, but now size 4 bands are used to increase the space between the leg and the band. Care must be taken with larger bands to ensure they cannot slip over the joints above or below the tarsometatarsus.

It cannot be certain that the bands are the primary cause of the problem, because in some cases there is evidence of hyperkeratosis and inflammation beyond what would be expected from the shedding of epidermis. Scrapings have been carried out to check for the presence of Cnemidocoptes mites, but to date none have been found in association with lesions. Another possible cause of the problem is trauma to the legs or feet causing swelling and inflammation which becomes exacerbated by the bands. Bell miners have been seen to attack the feet of other birds, and the birds habitat contains dense vegetation which could readily entangle feet.

COCCIDIOSIS

Coccidia are protozoans that inhabit the digestive tract of most vertebrates and are capable of causing disease in circumstances such as overcrowding, malnutrition and temperature stress. In birds, coccidia of genus *Eimeria* and *Isospora* have been identified. *Isospora* is the genus occurring mainly in passerines. As far as is known, most *Isospora spp*., unlike *Eimeria*, are not host specific (Hofstad, 1978). Birds become infected by ingesting sporulated oocysts which have been passed in the faeces of an infected bird.

During routine examination of faeces from wild caught *Lichenostomas melanops cassidix* and *L. m. gippslandicus*, two morphologically distinct oocysts were observed. It appeared that one type predominated in *L. m. cassidix* and the other in *L. m. gippslandicus*. Samples of faeces collected into potassium dichromate were sent to the Department of Agriculture in South Australia in December 1990 where Michael O'Callaghan was able to sporulate the oocysts and identify the parasites as belonging to the genus *Isospora*. Whilst it may provide interesting information regarding subspeciation, it would require a significant research effort to determine whether there is host specificity for the different morphological types observed, or to identify the parasites further. Being *Isospora*, host specificity is less likely, and apparent differences in host preference may reflect a geographic prevalence rather than anything more significant.

There is no evidence of pathogenicity associated with the coccidia of *Lichenostomas spp.* even though oocyst excretion rates are sometimes very high, particularly during the breeding season. No clinical disease has been observed and no histopathological evidence of intestinal inflammation associated with the organism has ever been detected

## 4. CAPTIVE BEHAVIOURAL NOTES

4.1 SOCIAL STRUCTURE

In the wild *L.m. cassidix* and *L.m. gippslandicus* live in neighbourhoods consisting of single pairs up to about one hundred individuals. In the aviary the birds are territorial and often cannot be kept in large numbers together. The exception is when the aviary has been designed to incorporate many areas in which to take refuge. When Healesville Sanctuary housed four pairs of *L.m.cassidix* together, the birds exhibited dominance behaviour, with the most dominant pair building and laying, the next subordinate pair building but not laying and the four most subordinate birds not exhibiting any nesting behaviour.

4.2 AGGRESSION

One of the most troublesome behaviours of this family is the amount of aggression birds will exhibit towards each other. Occasionally individuals may be killed by a conspecific.

Signs of aggression are : -repeated chasing.
-grasping with the bill , usually around the head or by the wing.
-grappling and tumbling to the ground.
-aggressive posture involves the aggressor approaching the aggresee with mouth gaping, wings may be partially extended.

Excessive aggression can be a unpredictable phenomenon. Some pairs will live and breed together and never show signs of aggression. Other individuals will not tolerate any cohabitation and will be unsuitable for breeding or display with smaller birds of any species.

When two prospective birds are introduced to each other great effort must be made to watch them carefully. The birds can often be getting along fine in the morning and be attacking each other in the afternoon.
The technique employed at Healesville to introduce two birds together is to house them, a single bird to a cage, in small cages that can be positioned to face each other. This establishes visual contact but prevents any physically contact. After a week the birds are then introduced to each other in one cage, usually the male is put in with the female because the males tend to develop stronger territorial ties to a cage after a period of time. After a week and provided there have been no aggressive interactions, the birds are then introduced into a large breeding aviary together and watched carefully. If there are signs of aggression the male is removed and housed inside a small cage inside the large aviary for a week. The two birds are allowed access to each other and tranquillity usually results. Occasionally aggression continues so some combinations of individuals may not be possible.

At the start of the breeding season the normal low-key aggression exhibited by some males to their mates may be confused with actual life-threatening aggression. Only experience, some risks and patience can teach a keeper the difference between the two types of aggression but generally life-threatening aggression is exhibited by the male relentlessly chasing the female and not allowing her to feed, whereas courtship aggression allows the female time to feed and rest and collect nesting material.

Other periods of aggression may occur prior to the breeding season when young stock from the previous season start to exhibit territorial behaviour and may turn on the birds they have been cohabitating with for the previous four or more months. When signs of this aggression are noticed the aggressive birds must be separated from the rest to prevent fatalities which will otherwise occur.

4.3 COURTSHIP

Courtship usually begins within a few days of the winter solstice. The first signs are an increase in activity and vocalisation by the birds and nesting material being carried. It is believed that males carry courtship material (bark, leaves, cotton) around much in the manner that male fairy-wrens carry flower petals. In one instance at Healesville the male was seen to pass a small item of fruit to a female just prior to copulation. The female dropped the offering soon after.
Corroborees are best described as a wing quivering display frequently exhibited by these birds. They can be performed in the company of one bird or with many birds. They are often, but not exclusively, associated with courtship. Corroborees may be a precursor to copulation. Copulation can last from one to five seconds. Successful copulation is usually indicated when the male dismounts from the female rather than the female disengaging from the male.

4.4 MIXED SPECIES COMPATIBILITY

Generally it is possible to house Yellow-tufted Honeyeaters with other bird species but there are a few aspects that need careful consideration.
1.It is preferable to house only females with other birds as females tend to be less territorially aggressive than males.
2. It is preferable to house them with species that can either compete successfully or are larger than Yellow-tufted Honeyeaters.
3. There must be plenty of cover for the Honeyeater and other species to get away from each other.
4. Mammals should be non predatory. Nocturnal mammals should be avoided as they are likely to disturb the birds at night.
5. Reptiles must be non predatory. Even Blue tongue lizards may prey on nestlings.
6. Breeding is less likely to be successful in mixed species exhibits because of disturbance and the limitations of necessary resources.

Species that have been housed with Yellow-tufted Honeyeaters are Superb Lyrebird *Menura novaehollandiae*, Bush Stone-curlew *Burhinus grallarius*, Crested Pigeon *Ocyphaps lophotes*, Flock Pigeon *Phaps histrionica*, White-headed Pigeon *Columba leucomela*, Brush Turkey *Alectura lathami*, Banded *Vanellus tricolor* and Masked Lapwing *Vanellus miles*, White-browed *Artamus supercilliosus* and Dusky Woodswallow *Artamus cyanopterus*, Blue-billed Duck *Oxyura australis*, Musk Lorikeet *Glossopsitta concinna*, Superb-fairy Wren *Malurus cyaneus*, Red-browed Finch *Neochmia temporalis*, Sacred Kingfisher *Todiramphus sanctus*, Eastern Whipbird *Psophodes olivaceus*, Golden Whistler *Pachycephala pectoralis*, White-plumed Honeyeater *Lichenostomus penicillatus*, Eastern Spinebill *Acanthorhynchus tenuirostris*, Olive Whistler *Pachecephela olivacea*.

4.5 BEHAVIOURAL ENRICHMENT

This element of captive husbandry is important for any species. In a large planted aviary the opportunities for foraging on live food and plant products are great, however they can be improved by releasing flying insects (moths or freshly hatched flies) into the aviary, and by placing flowers in the aviaries.
In smaller cages these opportunities are fewer and the inclusion of live food and flowers is particularly beneficial. Some suggested items; lerp, flies, moths, small crickets, maggots, mealworms, flowers (Eucalypts, Banksia, Melaleuca).
Other ways to enhance behaviour is to house conspecifics and other honeyeaters nearby but remembering this may be stressful to some individual birds.

## 5. HANDLING AND TRANSPORTATION

5.1 HANDLING

Capture Techniques

Yellow-tufted Honeyeaters are swift fliers and very manoeuvrable while flying. These two characteristics make them difficult to capture in small aviaries and problematic in large, well planted aviaries.
The best methods to capture these birds fall into three groups : hand net, mist net and automatic traps.

HAND NETS: This method is only practical in small aviaries that are free of plants and perches, as the net nearly always gets tangled in such aviary fittings. It is not desirable to house these birds in spartan aviaries, therefore, the inclusion of a wire lock or service corridor in the aviary design into which the birds can be chased or lured, makes capture a lot easier. Woven mesh rather than cloth, used on the hand nets works best. Woven mesh is easier and faster to move through the air, and it does not create the parachute effect usually associated with cloth material. Woven mesh is also not as visible to the birds as cloth, reducing the chances of the birds seeing the net and avoiding it.

MIST NETS: Mist nets are ideal for large aviaries with no facility for luring the birds into a service corridor. A clear area is needed to hang the net, free of anything that might tangle in it. These nets however are not specific in what they catch, so, in a mixed species aviary, many other birds may be caught along with the honeyeaters.

AUTOMATIC TRAPS: Automatic traps are the best method for catching birds in large aviaries. There are a number of suitable designs.

MANUAL TRAPPING: Trapping in feeding boxes is the most successful method if a catch cage is not present. This method also works for released birds in the field. Sting is used to drop sliding door.(fig 3)
Figure 3

Figure 4

Birds should be held in the hand using the technique shown above.

5.2. TRANSPORTATION

There are a number of techniques suitable for transporting these birds, depending on the length of the journey and the number of birds that need to be transported.

SHORT JOURNEYS: Short journeys can be defined as moving from aviary to aviary or other such simple movements. The best technique is to use 300 x 200mm, light cotton bags. To prevent the birds claws becoming tangled in the loose ends of the seam the bag should be turned inside out. This method is also ideal when the birds need to be weighed.

LONGER JOURNEYS: The requirements of food and water should always be considered when a bird is going to be transported any distance. For journeys up to an hour no food or water needs to be provided, the birds reserves should adequately see it through providing the bird has access to food and water prior to the journey.

The birds should ideally have access to moisture and some carbohydrates during trips of several hours. Depending on the mode of transport (smooth or rough) a small slice of orange should be sufficient. However, as long as the journey is likely to be fairly smooth a small amount of the birds standard nectar mix should be provided. If there is any chance of the liquid mix spilling, it should not be provided as the chances of the birds becoming drenched in the mix is high.

Any small box with wire small enough to prevent the bird damaging its beak would be adequate. Better still a completely enclosed box, with adequate ventilation, should be used. Provision should be made for suitable substrate on the bottom of the box, old non plush carpet is suitable and foam rubber on the roof to prevent head injuries.

**6. TAGGING**

Tarsal bands are the only recommended form of tagging. The band size recommended by ABBBS (Australian Bird and Bat Banding Scheme) is 03 for Yellow-tufted Honeyeaters, this may be suitable for races *meltoni* and *melanops*. Helmeted Honeyeaters were originally banded with 03 size however there were a number of cases of the bands being too small, therefore 04 is now used routinely. Occasionally 05 is used on exceptionally large individuals. Healesville uses 04 on *cassidix* and *gippslandicus*.

Metal bands and plastic colour bands are equally suitable depending on the individual institutions needs.

**7. CAPTIVE DIETS**

Very little is known about the nutrient requirements of this family specifically. A high carbohydrate diet is

necessary for this high metabolic bird. On average the bird feeds about every ten minutes (M.Miller unpubl. data.). A diet balanced with enough carbohydrates, protein and vitamins and minerals (as with all birds) is required. Healesville Sanctuaries diet is recommended. Diets as used at other institutions are presented.

ADELAIDE ZOO

Wombaroo Honeyeater and Lorikeet Mix is used at Adelaide Zoo. Fruit and a small piece of Madeira Cake are available. Live food fed includes mealworms, fly pupae and crickets as well as whatever live food is attracted into the aviary. Blossoms are available in the aviary from time to time. Three feeding stations have been established in the aviary. The birds are fed an insectivorous mix:

4 hard boiled eggs
2 dessertspoons bread crumbs
Mixed in a blender.
6 dessertspoons Wombaroo Insectivore Mix
Blend to 'fluffy' consistency

Water is ad lib.

HEALESVILLE SANCTUARY

A commercially available mix was used at Healesville Sanctuary for a number of years (Wombaroo Honeyeater and Lorikeet Mix) however various problems possibly associated with dietary deficiencies have become apparent (fading colour, thin shelled eggs, thin leg bones). Research was conducted through 1993-94 and the nectar mix part of the diet was subsequently changed to Leadbeater Mix. Since changing diets the birds colour has improved and there have been no instances of soft shelled eggs.

Food items are presented in small open bowls. The risk of faecal contamination of food is small and the payoff is the bowls are easier to clean than tube type feeders so hygiene standards can be maintained.

The daily ration for each bird is:

15 ml Leadbeater Mix (increased to 25ml in summer) (Appendix 3)
3 gm Insectivore Mix (Appendix 4)
3 gm chopped soft fruit
3-4 mealworms
5-6 maggots
water ad lib
in addition insects in the form of flies, moths, small crickets and any others that they eat should be offered when available eg caterpillars.

During the breeding season the birds must have greatly increased numbers of insects. The chicks are fed almost exclusively on insects, and the parents will not rear them if sufficient are not provided.

In addition to the artificial foods, the birds are given access to flowers of *Eucalyptus, Banksia, Grevillea* and *Callistemon.* These are presented as small branches with flowers intact. Small leafy branches infested with lerps are also periodically offered.

Water should always be available. Large bowls, at least 80mm deep are desirable. This gives the birds plenty of depth to bath, which they will do daily and to drink, which they do frequently by dipping their beaks in the water and licking up the water.

MELBOURNE ZOO

| | | | |
|---|---|---|---|
| | Leadbeater mix | ad lib | See Appendix 1 |
| | Cake mix | | ad lib |
| | Chopped fruit | | ad lib |
| | Dead flies | | 50 individuals |

The birds are given live flies, crickets and mealworms ad lib when rearing chicks.

| | | |
|---|---|---|
| Cake Mix | Plain Madeira cake | 3 kg |
| | Cheese | 250 gm |

| | |
|---|---|
| Fly pupae | 500 gm |
| Hard boiled eggs | 12 |
| Calcium carbonate | 3 tablespoons |
| Pet vite (multivitamin supplement) | 3 tablespoons |

TARONGA ZOO

| | |
|---|---|
| Wombaroo Lorikeet and Honeyeater Mix | ad lib changed twice daily |
| Egg Cake mix (see below) | 3 gm |
| Mealworms | 10 per bird |
| Orange | slice skewered on branch |
| Paradise mix (see below) | 5 gm |

and any insects that could be caught in Moth Traps set overnight.

Egg Cake Mix
Egg cake
Hard boiled eggs (shell included)
Mince meat and crushed dog biscuit combined
Fly pupae
Chick crumble
Calcium Carbonate powder
Pet Vite (multivitamin supplement)
Carophyll red

PARADISE MIX
Chopped fruit
Chopped greens
Soaked wheat
Soaked mung beans
Hard boiled egg (shell included)
Calcium carbonate
Pet Vite (multivitamin supplement)

**8. CAPTIVE BREEDING**

8.1 SEASON

At Healesville the breeding season in captivity mirrors that of the wild. It commences soon after the winter solstice and continues through to March.

8.2 NESTING REQUIREMENTS

The birds need living or dead foliage in which to build. The subspecies at Healesville (*cassidix* and *gippslandicus*) have shown a preference for nesting in the dead foliage in the aviary shelter (98.2% of nests, n=106). Whether the attraction is the dead foliage or the cover provided in the aviary is not clear.

Nesting material must be supplied and should include spider web, cotton batting, cotton wool, stringybark, dried grass, coconut fibre and feathers. The birds will often collect material from the plants growing in the aviary.

The female builds the nest alone. Although males may occasionally carry material they do not seem to assist in the nest construction. The nest can take only a few days to complete or may be worked on for a number of weeks. The speed of nest construction may depend on time of year (generally nests are built slower early in the season) and experience of the birds building (less experienced birds tend to take longer to build nests than experienced birds).

8.3 BREEDING TRIGGERS

Prior to breeding it is recommended to increase the number of flying insects in the aviary. Unfortunately this usually corresponds with the coldest part of winter, therefore few wild insects are available. Fresh fly pupae may be hatched in a warm room and liberated in the aviary every few days as an alternative source.

As mentioned previously it seems that light cycles are the main trigger with many birds commencing courtship and nesting soon after the days start to get longer following the winter solstice.

8.4 DIET CHANGES

During the breeding season the dietry components essentially remain the same. The days are longer so the birds consume more nectar mix. If the adults are feeding chicks the amount and frequency of insects needs to be increased. The birds will not rear young successfully unless they have access to live food. Live food in the form of moths, crickets and flies should to be provided a number of times a day, usually at three hour intervals.
The adults will feed their chicks about 7 times an hour (Miller 1994), this gives a good guide for minimum requirements. It is always better to have too many insects than not enough.

8.5 CLUTCH SIZE
The clutch size is 1 to 3 eggs, usually two. The following is a breakdown of the number of eggs per clutch per subspecies held at Healesville.

| | Eggs | Nests | Mean | |
|---|---|---|---|---|
| L.m.cassidix | 24 | 15 | 1.6 | |
| L.m.gippslandicus | | 78 | 39 | 2.0 |

8.6 EGG WEIGHTS AND MEASUREMENTS

*L.m.cassidix* (I.Smales unpub. data)
Wild egg length ranged 21.6 to 25.9 mm (n=20)
Wild egg width ranged 15.9 to 19.0 mm (n=20)

*L.m.gippslandicus*
Captive egg length ranged 21.25 to 27.0 mm (mean 24.3, n=6)
Captive egg width ranged 16.5 to 19.0 mm (mean 17.5, n=11)
Captive eggs weighed ranged 2.2 to 4.2 (mean 3.4, n= 12)

8.7 INCUBATION PERIOD
The normal incubation period is about 14 days. This may be extended slightly if the weather is particularly cold or if the female is a light sitter.
Incubation is carried out by the female alone.

8.8 CHICK DEVELOPMENT
Growth rates of a number of chicks are presented in Fig 2. Eyes generally open on day five after hatching. Follicular eruption commences with the femoral tract by the fourth day, all tracts had erupted by the sixth day with emergence from the sheath in all but the capital and alar tracts. In another brood the spinal, ventral and femoral tracts had erupted by day five and the primaries had already begun to emerge from their sheaths, but the follicles in the capital tract had still not erupted on day seven. At fledging, young were well feathered except for a bare belly and sparse feathering behind the eye and on the chin. The ear-tuft was bright yellow as in adults but the breast, throat and crown feathering is duller than in adults. The tarsi are pinkish and the gape fleshy. At 40 days old the young superficially resemble adults, the main difference being the dullness of the breast and crown feathers and the green-yellow breast feathers. Tarsi is fully coloured, dark slate grey as in adults. (Franklin et al. in press)

8.9 CARE OF NESTLINGS
Brooding and shading of the chicks is carried out solely by the female. Very young nestlings are brooded extensively regardless of the weather. Both sexes feed the chicks (Franklin et al. in press).
Both sexes defend the nest and young, the male more often than the female (Franklin et al. in press). The commitment to nest defence varies, some birds do not defend the nest or chicks at all, others are very aggressive towards intruders, including humans.
Individual birds may also conduct a distraction display varying in intensity from agitated short flights or jerky flights from perch to perch in a radius around the nest or fledglings, to dropping to the ground, to wing fluttering runs heading away from the nest along the ground (Franklin et al. in press).
Advanced nestlings and fledglings may be called away from an area by the parents (Franklin et al. in press)
Occasionally birds other than the parents may assist in feeding chicks (Franklin et al. in press, Miller and Smales 1992).

8.10 FLEDGING PERIOD
Under normal conditions the fledging age is about 12 days though chicks may fledge early if disturbed. Soon after fledging, the chicks are incapable of controlled flight. Therefore any deep water should be covered or removed, the maximum depth of any standing water must be 10mm. Birds should be checked regularly to ensure they have not

become entangled in foliage.

8.11 FEEDING RATES AND FOOD PREFERENCES

Helmeted Honeyeater chicks being fostered by *gippslandicus* parents were fed 5-6 times per hour in the first week, 8 - 10 per hour in the third week, declining to zero in week 6. Males and females evenly shared the feeding duties. The two most frequently fed items were mealworms (26.9 % of visits) and moths (17.1% of visits). The other items fed in decreasing preference are: free ranging insects (13.5%), nectar mix (9.9%), lerp (7.8%), flies (3.5%), maggots (2.5%), fruit and berries (0.7%), and insectivore cake (0.4%). Unknown items accounted for 17.3% (Miller 1994).

8.12 WHEN TO REMOVE FROM PARENTS?

Juveniles may be safely removed from their parents from day 40. This is often desirable if the parents are nesting again as previous chicks can utilise resources intended for the new chicks. At Healesville generally previous chicks are left in with adults until the new eggs are just due to hatch. Where possible it is desirable to leave chicks with parents for as long as possible as there may be some social and reproductive learning.

8.13 INTERCLUTCH INTERVALS

The renest period for *gippslandicus* and *cassidix* combined is 6.9 days (range 1 - 30) from a previous failed nest and 5.3 days (range 3 - 10) from a previous successful nest. A point of nesting failure is taken as any time during the incubation or care of nestlings. Success is achieved at fledging. The relay period from a previous failed nest is 13.2 days (range 6 - 37) and from a successful nest is 14.4 days (range 6 -30). The overall interclutch interval is 20.5 days (range 7 - 41) following a failed nest and 43 days (range 35 - 60) following a successful nest.

8.14 HATCHLING SEX RATIOS

The hatchling sex ratio is 1:0.8 in favour of males. For this analysis only clutches in which the sex of both individuals was known and only complete clutches were included. A few clutches were all males and this tended to bias the result towards this sex. Most clutches with two eggs were male\female.

**9. ARTIFICIAL INCUBATION**

9.1 INCUBATOR TYPE

Healesville uses Marsh Rolex fan forced incubators. The eggs are manually turned four times daily. Grids for auto turning would need to be small and it is better to turn manually to prevent damage to the thin shell of honeyeater eggs. In the incubator they are placed in a shallow tray lined with cotton wadding.

9.2 INCUBATOR TEMPERATURE AND HUMIDITY

Incubators are run at 37º C and relative humidity at 65%.

9.3 DESIRED % WEIGHT LOSS

The daily weight loss is 1.7%. The total weight loss is 22%.

9.4 HATCHING TEMPERATURE AND HUMIDITY

Hatching temperature is maintained at 37ºC. Relative humidity is increased to 80% two days prior to hatching to ensure the egg membrane doesn't dry and prevent hatching.

9.5 PIP TO HATCH INTERVAL

At Healesville the chicks that have been incubated artificially have hatched within twenty four hours of the first signs of pipping.

**10. ARTIFICIAL REARING**

Hand raising may be necessary if there are no foster species available, if a nestling is abandoned by its parents or if parents are required to renest without he loss of their current chicks.

10.1 BROODER TYPES

Helmeted Honeyeaters at Healesville were housed in a purpose built, thermostatically controlled portable room. The chicks were housed in white plastic tubs approx 600 x 600 x 600mm with fly wire fronts.

10.2 BROODER TEMPERATURE

The temperature in the hand rearing room was initially set at 28º C and gradually reduced so that once the chicks were forty days old ambient temperature prevailed.

10.3 DIETS AND FEEDING

Helmeted Honeyeaters were removed from the nest at between seven and ten days of age.

From the day of collection chicks were fed at half hour intervals for ten to twelve hours a day. By 20 days of age this had been reduced to 15 times per day and by 30 days of age to ten times per day. The young were self feeding by 40 days of age.

Equipment used were forceps with the points ground down. All equipment was washed and sterilised after each feed.

Food items used to handraise chicks were pawpaw, moth species captured in traps at night, (predominantly the Bogong moth *Agrotis infuso*), freshly killed houseflies and Wombaroo Honeyeater mix.

All insects had the head, legs and wings removed. Moths were rolled on cloth to remove the body hair.

*L.m.gippslandicus* honeyeaters were handraised on the same items as above but with the inclusion of field crickets, with the head, legs and wings removed.

Pawpaw was used in 3mm cubes and until thirty days of age the amount fed varied between 0.5 - 1 gm (mean 0.6 gm) per feed; from 30 days until weaning at 40 days the quantity decreased to 0 - 0.5 gm (mean 0.1gm) per feed. The average weight of individual moths after preparation was 0.3gm. They were fed at a rate of 0.6 - 2.1 gm (mean 1.6gm) per feed until thirty days and thereafter 0.1 - 2.9 gm (mean 1.8gm) per feed until weaning. Houseflies weigh *c*.2.5 mg. Quantities fed varied from five to 13 flies per feed (mean 9.8) up to 30 days of age, with zero to ten flies offered per feed for the next ten days. Nectar mix was usually introduced in small bowls when the chicks were 25 days old. Prior to this moths dipped in nectar mix were occasionally fed to chicks. All care must be taken to avoid moisture being introduced into the respiratory tract as this can cause rapid death. Items that have been dipped must have most of the moisture removed before feeding (Smales et al 1991). Maggots were occasionally fed to nestling *gippslandicus* but this was discontinued when the maggots were excreted undigested through the birds.

10.4 MARKING METHODS

Individual chicks can be marked using plastic leg bands. The leg of this species is large enough a few days after hatching to put on a band suitable for adults, however a close watch must be kept to ensure it doesn't slip down over the foot.

In the first few days of life, nail polish may used to temporarily mark the toenails of individuals but this tends to wear off after a few days and may need to be reapplied periodically.

See Section 6 for more details.

10.5 GROWTH AND DEVELOPMENT

See Section 8.9

10.6 HYGIENE AND OTHER PROBLEMS

All items must be sterilised between feeds. The cages and brooders must be regularly cleaned. Feeding implements should be used for single tasks only ie. a feeding tweezer and a separate set of tweezers used to collect faecal material.

Good hygiene will help prevent Aspergillosis, the most common disease encountered when handraising Helmeted Honeyeaters. See Section 3 for more details.

10.7 WEANING

Weaning age is reached at about 40 days. Prior to this the chicks become less interested in the food being offered and regularly use nectar and other items that should be introduced into the cage from about 25 days old. The birds should be completely self sufficient by no later than 45 days old.

10.8 SPECIAL CONSIDERATIONS

If raising chicks from the egg, substrate should consist of easily removed material that provides good grip, but will not cause undue wear on the birds bare belly and will not entangle its feet. Clean tissue paper or a light rubber mat is acceptable for this purpose.

Nestlings collected from the wild or from an aviary should preferably be left in their nest which is moved to the brooder. They can stay in here until fledging at which point a number of thin branches for perching should be placed in the brooder for perching.

Malimprinting has been evident in handraised Helmeted Honeyeaters. A glove with the colours and patterns of an

adult *L.m. cassidix* sewn on, was used and the keeper hid behind a screen. This alleviated the problem slightly, but housing the birds in juvenile groups and reduced human contact after placement in an aviary subsequently diminished any malimprinting.

## 11. CROSS FOSTERING

### 11.1 TECHNIQUES

*L.m. gippslandicus* have been used for a number of years to act as foster parents for *L.m cassidix.* The technique involves inducing the *L.m. gippslandicus* into nesting. Once the female *L.m. gippslandicus* is incubating for a minimum of three days (this helps to ensure her dedication to the nest is not short lived) the previously located *L.m. cassidix* eggs are collected. The *L.m. cassidix* eggs are transported by vehicle using a small insulated esky that has been previously warmed by putting a glass jar of boiling water inside. The *L.m. cassidix* nest is preferably collected complete, this reduces the need for direct human contact of the eggs. A clean spare nest is always carried in case the wild nest cannot not be collected without damage.

The *L.m. gippslandicus* eggs are substituted for the *L.m. cassidix* eggs. In many cases the eggs must be handled with human hands so it is essential to have clean hands before carrying out this procedure.

After transferral of the eggs the aviary is vacated for half an hour to give the *L.m. gippslandicus* time to settle down after the disturbance of the transfer. The nest is then checked to ensure the female is incubating her new eggs. If the female has not resumed incubation after a minimum of an hour the eggs are removed to an incubator until their fate has been decided.

### 11.2 TIMING

The timing of transferal is crucial. A number of criteria has been established to reduce the risks of failure. Through experimentation we have established that females will incubate eggs for at least five days past the normal incubation period. Therefore, it is crucial that the eggs that are to fostered are located within five days of the foster parents commencing incubation. The only exception to this is when the foster eggs are known to be more than five days old, in this case the eggs will hatch at or before the normal incubation period. To be safe it is better for the foster eggs to be older than the foster parents eggs, this ensure that the eggs will hatch early rather than late. For some females this seems to be more acceptable than eggs which do not hatch after she has incubated the normal incubation period.

### 11.3 TOLERANCES

*L.m. gippslandicus* appear to be tolerant of disturbance to a certain degree. Over the years much experimenting has been conducted to see how much disturbance they can take. In one instance two clutches of captive *L.m. gippslandicus* hatched five days apart. The older brood was of two chicks, the younger had one chick. To test acceptance of chicks of different ages one of the older chicks was moved to the nest with the single younger chick. It was accepted and fed by the adults. The younger chick was then moved to the nest with the single older chick. It was accepted and fed by the adults. This tested the birds willingness to accept foster chicks, accept foster chicks of different ages and accept increases in brood sizes using chicks of different ages.

Another experiment involved moving a nest with eggs and a nest with chicks to various locations around the aviary. This eventually showed that while birds do not accept the movement of eggs around they will accept some movement of nestlings (M.Miller in press).

Another involved collecting a wild pair of *L.m. gippslandicus* from the wild. The adults were collected at a nest that contained two six day old chicks. The adults were brought into the Sanctuary and housed in a small cage for a few days to ensure they were utilising the artificial diet. The chicks were collected and were being handraised by Animal Nursery staff. Once that adults were feeding and were liberated into a large aviary, the chicks were returned to the aviary and the nest they were in was wired in some living foliage in a prominent position. After some delay the parents eventually recommenced feeding the chicks. This was two days after being collected and during this time they had no contact with the chicks.

Occasionally captive *L.m. gippslandicus* lay only single egg clutches. When this has occurred we have added another egg to familiarise the adults to two eggs, knowing that most L.m. cassidix clutches that we foster are two eggs.

It must be stressed that the tolerance of individual females vary. Any new females must be watched carefully until her idiosyncrasies are known.

### 11.4 FOSTER SPECIES

Healesville uses captive *L.m.gippslandicus* as foster parents for wild-layed clutches of *L.m.cassidix*.

The process involves inducing *L.m. gippslandicus* laying in a captive nest, locating wild Helmeted eggs of a similar

age. Transporting the wild eggs to Healesville, removing the *L.m. gippslandicus* eggs and putting the wild eggs in their place. The captive *L.m. gippslandicus* then hatch the eggs and raise the chicks.
See Section 10 for more details on fostering techniques.

As an experiment newly artificially incubated and hatched *L.m. gippslandicus* was placed in the nest of Dusky Woodswallows *Artamus cyanopterus* that had a clutch of infertile eggs. The chick was raised to fledging but subsequently died from causes probably unrelated to the fostering attempt (Miller and Whitten in prep). In an emergency situation Crescent Honeyeaters *Phylidonyris pyrrhoptera* were used to raise a newly hatched *cassidix* for a few days prior to it being found dead below the nest.

It is unknown if other species can foster Yellow-tufteds but other *Lichenostomus* species should be able to.

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**APPENDIX 1:**

Summary of mortality records for *Lichenostomas melanops cassidix* and *Lichenostomas melanops gippslandicus* from 1989-1994 from Healesville Sanctuary. This summary includes captive birds and wild birds presented to the sanctuary for post mortem examination.

**HELMETED HONEYEATER *Lichenostomas melanops cassidix* MORTALITY 1989-1994**

| No | Date | I/D | Sex | Cause of Death |
|---|---|---|---|---|
| 1 | 2/10/89 | No band | 0.1 | Wild caught nestling died during hand raising at 15.4g of pulmonary and pericardial Aspergillosis. |
| 2 | 2/10/89 | Green band | 1.0 | Sibling of above, died at 13.9g of disseminated Aspergillosis with abscesses in lungs and hyphae in multiple tissues and within blood vessels. |
| 3 | 11/11/89 | - | 0.1? | Being handraised from 2 days old due to disappearance of siblings from nest. Interstitial pneumonia, unknown cause. |
| 4 | 12/10/90 | - | - | Two wild nestlings found dead in nest, 13.1 & 13.8g. Probable hypothermia. |
| 5 | 13/10/90 | - | - | Wild fledgling, died at 22.6g. Drowned. |
| 6 | 16/10/90 | 900558 | 1.0 | Euthanased at 44 days (19.9g) due to failure to thrive during hand raising, brought in from wild due to poor growth rate, no underlying cause identified. |
| 7 | 24/12/90 | 900950 | - | Wild nestling. Fell from nest after banding. Cerbral and pulmonary haemorrhage. |
| 8 | 15/1/91 | 890813 | 0.1 | Cage mate trauma between females, death from starvation. |
| 9 | 24/1/91 | 900658 | 0.1 | "Matilda" Euthanased due to chronic ill thrift and generalised dermatitis following leg band problems and loss of one foot. |
| 10 | 24/5/91 | 890806 | 0.1 | Severe chronic granulomatous Aspergillosis secondary to ongoing aggression from mate. Fungi present in multiple tissues including great vessels of heart and marrow of skull. |
| 11 | 24/10/91 | 910765 | 0.1 | Tracheal obstruction with Aspergillus granuloma. |
| 12 | 26/10/91 | 910764 | 1.0? | Sibling of above. Tracheal obstruction with Aspergillus granuloma. |
| 13 | 10/11/91 | - | 1.0 | Nestling drowned, thrown or fell from nest at white site, Yellingbo. |
| 14 | 21/11/91 | 900892 | 0.1 | Trauma from cage mate (male). |
| 15 | 2/12/91 | 911106 | 1.0 | Fledgling, localised bronchitis and possible hypothermia. |
| 16 | 17/12/91 | 900618 | 0.1 | Renal tubular necrosis and calcification. |
| 17 | 21/12/91 | - | - | Fostered nestling found dead beneath nest, stomach full, cause of death unknown. |
| 18 | 23/12/91 | - | - | Fostered nestling found dead in nest, parents attempting to feed and brood, cause of death unknown. |

| | | | | |
|---|---|---|---|---|
| 19 | 8/1/92 | 900422 | 1.0 | Renal calcification? |
| 20 | 8/1/92 | - | - | Two wild nestlings found traumatised in nest, stomachs full. |
| 21 | 16/6/92 | 900827 | 0.1 | Head and neck trauma, caught in trap. |
| 22 | 15/8/92 | 890814 | 0.1 | Haemorrhagic enteritis associated with 2 cm long acacia twig. |
| 23 | 25/8/92 | 911107 | 0.1 | Cage mate trauma and starvation, *Mucor sp*. isolated from sinuses. |
| 24 | 1/9/92 | - | - | Egg - early embryonic death, thin shell. |
| 25 | 1/9/92 | - | - | Egg - early embryonic death, thin shell. |
| 26 | 2/9/92 | - | 1.0 | Wild fledgling found dead in water near nest after heavy rain, hypothermia/drowning. |
| 27 | 2/9/92 | - | 0.1 | Sibling of above, as above. |
| 28-46 | 13-24/10/92 | - | 11.8 | Hypervitaminosis D causing calcific material within the lumen of convoluted tubules in the renal cortex. |
| 47 | 26/10/92 | WE-025 | - | Wild parents. Egg fostered under captive YTHs which both died. In incubator until 21/10 when transferred to wild Crescent Honeyeater nest for fostering. Found dead below nest at approx 5 days old. |
| 48 | 20/6/93 | 93/492 | 1.0 | Parasitic unglivitis due to Capillaria, hepatic lipidosis, and testicular atrophy. |
| 49 | 6/9/93 | 041-37877 | - | Wild nestling, autolysed, possible infectious bronchitis. |
| 50 | 22/4/94 | 930470 | 0.1 | Amputated foot following banding injury. Euthanased due to fracture of supporting femur and chronic feather problems. |
| 51 | 12/6/94 | 930792 | 0.1 | Sudden death in good condition, unknown cause. |
| 52 | 4/8/94 | 94/521 | 1.0 | Amputee from band problems. Died during surgical sexing. Anaesthetic death or blood loss from abdominal musculature. |

**YELLOW TUFTED HONEYEATER *Lichenostomas melanops gippslandicus* MORTALITY** 1990-1994

| No | Date | I/D | Sex | Cause of Death |
|---|---|---|---|---|
| 1 | 26/10/89 | 890782 | 1.0 | Wild caught adult, died within two days of being held in captivity, stress? |
| 2 | 27/4/90 | 900392 | 1.0 | Laryngitis with intense pulmonary congestion and haemoohage, focal pulmonary Aspergillosis. |
| 3 | 24/9/90 | 900394 | 0.1 | Focal granulomatous Aspergillosis of both lungs. Trauma to tongue and upper beak from cage mate. |
| 4 | 6/12/90 | 900395 | 0.1 | Acute egg peritonitis. |
| 5 | 8/1/91 | - | 0.1 | Aspiration pneumonia in hand raised nestling, cultured *Pseudomonas aeruginosa*. |
| 6 | 7/9/91 | 910425 | 1.0 | Generalised weakness following aggression with bird in adjoining cage, head trauma while under treatment, dystrophic renal calcification. |

| | | | | |
|---|---|---|---|---|
| 7 | 7/9/91 | 910494 | 1.0 | Ulcerated tongue and pharynx, *Aspergillus* granuloma in one lung. |
| 8 | 15/12/91 | 910497 | 1.0 | Chronic inflammation of tongue believed secondary to trauma, calcium deficiency. |
| 9 | 26/12/91 | 900692 | 0.1 | Unknown, desiccated carcass. |
| 10 | 31/12/91 | 900695 | 0.1 | Possible starvation after transfer to new enclosure. |
| 11 | 16/3/91 | 920220 | 0.1 | *Antechinus* predation. |
| 12 | 9/4/92 | 890789 | 1.0 | Hydropericardium of unknown cause, abdominal trauma (interstitial haemorrhage & necrosis of fat). |
| 13 | 3/9/92 | 900396 | 0.1 | Acute egg peritonitis from rupture of thin shelled egg in distal oviduct. |
| 14-22 | 13-24/10/92 | - | 6.3 | Hypervitaminosis D causing primarily renal calcification. |
| 23 | 20/12/92 | 921057 | 1.0 | Pulmonary Aspergillosis. |

**APPENDIX 2:**

Mortality records from Taronga Zoo Pathology Register from 1985-1994.
(courtesy of Bill Hartley, Consulting Scientist)

**HONEYEATER CASES FILED IN TARONGA PATHOLOGY COLLECTION**

| TPC No. | Location | Species | Disease |
|---|---|---|---|
| 112 | Taronga Zoo | New Holland | Intestinal coccidiosis |
| 140 | Tasmania | Strong billed | Sarcocysts* |
| 280 | Taronga Zoo | Black faced | Candida gizzard |
| 440 | Tasmania | Strong billed | Sarcocysts* |
| 443 | Tasmania | Yellow throated | Sarcocysts* |
| 609 | Taronga Zoo | Scarlet | Mycotic pneumonia |
| 1206 | NSW | Unknown spp. | Poss. Toxoplasma pneumonia |
| 1214 | WA | White cheeked | Hepatic siderosis* |
| 1283 | SA | Black faced | Oesophageal capillaria |
| 1332 | Taronga Zoo | New Holland | Microfilaria* |
| 1344 | Healesville | White plumed | Leucocytozoon* |
| 1566 | Healesville | Yellow tufted | Mycotic pneumonia |
| 1733 | Healesville | Helmeted | Mycotic osteomyelitis |
| 1851 | Taronga Zoo | New Holland | Visceral gout |
| 1870 | Healesville | New Holland | Necrotic bronchitis |
| 2031 | Taronga Zoo | New Holland | Papilloma on toe |

* Incidental findings - not cause of death

There are specimens from 16 Honeyeater species on file in the TPC out of a total of 2,370 avian cases and only six of these are from Taronga Zoo in the 9 year period.

There may well have been other deaths in Honeyeaters in Taronga Zoo over the last 9 years, but they were either not submitted for PM, were autolysed, no samples taken for histopathology or no lesions seen in tissue sections.

**APPENDIX 3**

LEADBEATER MIX

1 litre Honey
1 litre hot water
2 hard boiled eggs
0.5 teaspoon Sustagen powder
0.2ml Pentavite
125 gm High protein baby cereal

Dissolve honey in hot water. Place mixture in food processor. Add eggs and Sustagen. Blend together well. Add Pentavite. Add High protein cereal to desired thickness. Fruit can be added to mixture prior to blending.