

Husbandry Manual for Black-winged Stilt *Himantopus himantopus leucocephalus*

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Black-winged Stilt adult surrounded by three juvenile stilts (Adelaide Zoo, Dec. 97)

Taxonomy:

Class: Aves

Order: Charadriiformes

Suborder: Charadrii

Family: Recurvirostridae (Stilts and Avocets)

Genus: Himantopus

Sub-species: *Himantopus himantopus leucocephalus*

Black-winged Stilt Husbandry Manual

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1. Introduction and Taxonomy

Class: Aves

Order: Charadriiformes

Suborder: Charadrii

Family: Recurvirostridae (Stilts and Avocets)

Genus: Himantopus

Sub-species: Himantopus himantopus *leucocephalus*

ASMP : Australian Non-passerine TAG, Management Level 3

OH&S Classification: Non hazardous

Band size: P or R, to be banded above the knee

Weights: Adult females: 149-157g; adult males: 168-178g average (Adelaide Zoo records)

Measurements: 385-400mm; 61mm bill (Marchant & Higgins)

Sexing method: Laparoscopy or DNA analysis

2. Natural History

2.1 Morphometrics (see also developmental notes for youngsters and juveniles):

Three long front toes, only very slightly webbed at the base, the hind toe is absent. Sexes of adults are similar: back of head and nape black, separated from black back and wings by white collar. Rest of body white. Eye red, bill black, legs pink (Marchant & Higgins; Emmerich, A., pers. obs.). The female's mantle, scapulars and underwing can be a duller black than the male's, however, this is not a reliable method of sexing (Philip Zammit, Taronga Zoo).

The bill is long, straight, pointed and very fine with bulky adductor muscles (affecting the shape of the head) that facilitate rapid movement of the jaws and firm grip on food taken from surface of water or below it. (Del Hoyo *et al.*)

They rarely swim (only partially webbed toes).

The wings are extend beyond the tail. In flight the legs extend well beyond the tail and are an aid to manoeuvring (Emmerich, A., pers. obs.).

2.2 Distribution:



Throughout mainland Australia wherever suitable habitat exists. Apparently they move long distances across the sea and have been recorded at Lord Howe and Norfolk Islands. They can also be found in Indonesia and the Philippines and have recently moved to New Zealand. (Shaded areas on map indicate distribution) (Prizzy & Knight 1997; Reader's Digest 1976, del Hoyo *et al.* 1996).

2.3 Habitat:

They prefer extensive shallow wetlands, rivers, lake margins or brackish swamps with abundant small invertebrate prey. Highest densities of birds occur in areas of low rainfall, in treeless wetlands where there is adjacent open space for nesting. Forested areas are avoided. The majority of birds live inland, with a preference for fresh water, but also occupy estuaries and tidal flats and artificial environments such as irrigated fields and salt-works. Exhibit strong seasonal changes and are opportunistic in habitat selection (del Hoyo *et al.* 1996).

2.4 Habits/Behaviour:

Diurnal and nocturnal in all habitats, during both breeding and non-breeding season. Occasionally associate with Red-necked Avocets *Recurvirostra novaehollandiae*, Straw-necked Ibis *Threskiornis spinicollis* and Australian White Ibis *Threskiornis molucca* (Readers Digest 1976 and Marchant & Higgins 1993)

2.5 Nesting and Breeding in the Wild:

This species is a breeding resident here and it appears that most Australian birds do not move outside the country, however, they are seasonally nomadic or dispersive, according to rainfall. In southern Australia the bird is more common in summer than in winter (Murray-Darling region and Perth). Seasonal movements to coastal sites in late summer to autumn, and leaving from the coast in mid winter to early spring.

They breed in small colonies of up to 60 pairs, but may also nest singly. The largest colony on record contained an estimated 200 nests. Breeding season is from August to

December, but generally almost any month after rain. Sometimes the site may be shared with other species such as gulls, terns and waterfowl, Red-necked Avocets, plovers, sandpipers and grebes. Nests vary from a small mass of material to a fairly substantial, well-lined construction of made of twigs, stalks and other vegetation. It is normally built in the open, often amid grass and sedges and surrounded by shallow water.

Being opportunistic, they do not necessarily return to previous breeding sites and can move great distances to new sites. At the onset of the season, the male will chase the female quite aggressively.

Pair bonds are not necessarily maintained outside the breeding season.

Hybridization has occurred between the Black-winged Stilt and the Black Stilt *Himantopus novaezelandiae* in New Zealand (Marchant & Higgins 1993, del Hoyo *et al.* 1996)

2.6 Wild Diet and Feeding Behaviour in the Wild:

Insects, molluscs, crustaceans, (earth)worms, insects (beetles, dragonflies), fly larvae, tadpoles, small fish and water plants. CSIRO research on stomach content analysis revealed that a small content of their diet consists of ants and seeds which may be ingested accidentally whilst foraging for other foods (Philip Zammit, Taronga Zoo, pers. comment). Most food is obtained in shallow water or on damp land. Diurnal and nocturnal foraging is reflected in both visual and tactile detection and capture of prey. Tactile method includes “scything”. Visual methods include a direct peck at a visible prey or “plunging” whereby the birds peck and probe with their bill and head totally immersed in water.

Feeding activity often follows a tidal cycle (del Hoyo *et al.* 1996).

2.8 Longevity:

No data available for birds in the wild.

Longevity for birds in captivity can be calculated as described by Lindstedt & Calder (1976):

Longevity (t, years) of birds changes depending on body weight (M, kg) according to equation:

$$t = 28.3 \times M$$

3. Captive Husbandry – Housing Requirements

3.1 Shelter:

Part of the roof should be covered to offer shelter during adverse weather conditions.

A minimal part of the aviary should be sheltered. An open style aviary may help reduce the chance of aspergillosis.

3.2 Water:

Wading is very important as part of their feeding habits (they will find water insects etc. that will naturally live in a pond), drinking, general behaviour and to ensure healthy feet (see Health section). A food station is set up in the water, allowing the birds to wet food before swallowing.

The water should be on a continuous flow, preferably a natural system with macrophytes (aquatic plants), to avoid an unnecessary build up of unwanted micro-organisms.

Whether the pond is concrete or natural, a floor of rotted vegetation is good for softness on the feet and insect and plant growth. However, the water must be in a continuous flow for part of the day at least. Stagnation increases risk of botulism and other diseases. These areas, should they occur, must be allowed to regularly dry out (Schultz, D., Adelaide Zoo, pers. comment).

Additionally, irrigation/sprinkler systems are used during summer.

The pond should be saucer shaped and with a shallow gradient. This is especially important to allow easy access for chicks.

The chicks are precocial and leave the nest and swim straightaway (Emmerich, A., pers. obs.), therefore there is no need to drain ponds or other water sources during breeding.

Screening from open public viewing providing shelter should be incorporated into a stilt exhibit. Planting can be used to achieve this.

3.3 Substrate/Enclosure Furnishings:

The exhibit should reflect a natural, swamp-like habitat.

To avoid foot problems, attention should be paid to the water source and substrate. The best substrate is sandy with the opportunity to wade frequently. Fine beach sand is preferable due to its consistency and salt content. Hard floors must be avoided (Schultz, D. & Conaghty, S, Adelaide Zoo).

Tall, dense swamp plants are not recommended as the stilts may become entangled in the foliage. Sedge and grass tussocks are more suitable (Zammit, P., Taronga Zoo, pers. comment).

As Stilts feed and nest on the ground, it is very important to ensure that wire mesh and other building materials used are rodent proof.

3.4 Spatial Requirements (for a breeding pair):

The minimum requirement is 30 square metres for 4 birds. The minimum height is 3 metres. The pond size should be at least 30% of the floor area. For each additional bird, the floor and pond are should be increased by at least 4 square metres.

(Code of Practice, Government Gazette, Victoria, 1994)

3.5 Heat

The birds have been kept without artificial heat sources at Adelaide Zoo (in Winter temperatures can go down to zero degrees overnight) throughout the year (Emmerich, A., pers. comment).

3.6 Hygiene

Substrate:

The exhibit should be raked frequently to keep the substrate soft and aerated. The substrate should be changed regularly to avoid build-up of bacteria that can cause

infections in cracks of the foot. (Foot problems see 6.1 Health section). The pond should be cleaned regularly (Conaghty, S, Adelaide Zoo, pers. comment).

Standard procedures should be in place for the daily cleaning of food bowls, spot clean over the ground for any discarded food and faeces.

If there is a feed station in the pond, precautions should be taken that food does not fall into the water and rot, so a tray or larger dish should be placed under the food bowl to catch any spilled food.

4. Handling and Transportation

4.1 Capture and Handling Procedures:

Precautions in handling:

When disturbed or stressed, the birds fly upwards, often hitting the roof and injuring their beaks, heads or necks. Their long legs are fragile as well.

4.2 Transport Requirements:

During transport and prior to release into the new aviary, one of the wings should be taped for 24-48 hours to prevent flight-induced trauma (Schultz, D., Adelaide Zoo).

Holding cages for single birds:

The floor should be made of solid wood of at least 1.2cm in thickness and must be covered with a non-slip surface. The height of the cage should only be the height of the bird to avoid trauma. The length and width should allow the bird to turn around, bearing in mind that the beak is on average 60mm long. To aid air circulation, fly wire or shade cloth should be incorporated. Wire mesh alone is not recommended due to the fragility of the beak.

To avoid head trauma a padded roof is recommended. (See also “IATA Live Animals Regulations”, H11, p176). See appendix.

4.3 Box design (see Appendix)

5. Health

5.1 Routine tests:

Faecal floats to detect parasites.

Mawson *et al* (1986) recorded a variety of trematodes (incl. some of the genus *Trichobilharzia* and *Haematotrephus*), cestodes (incl. some of the genus *Davainea*, *Diorchis* and *Infula*), and nematodes (incl. some of the genus *Capillaria*, *Amidostomum*, *Contraecum* and *Tetrameres*).

5.2 Heat Requirements (see Captive Husbandry)

5.3 Cleaning Requirements (see Captive Husbandry)

5.4 Known Health Problems:

- Aspergillosis
- Nutritional bone deformities
- Foot problems: infected cracks and toe joints
- Trauma: self-inflicted/intraspecific aggression/predation

5.5 Routine Vaccinations:

None done routinely

5.6 Routine Pre and Post Import/Export Isolation:

They tend to accept close confinement for short periods.

6. Behaviour

6.1 Social Structure:

This species is territorial. At Adelaide Zoo breeding pairs have been housed separately in a mixed species exhibit, but not together with other stilts). Other zoos have successfully bred this species with two mated pairs in the same exhibit (Emmerich, A., pers. comment).

Introducing stilts into the territory of a mated pair of stilts should be done with caution. If it is necessary to introduce two adult stilts into an enclosure which already contains a pair of adult stilts, it is best done by introducing both pairs simultaneously into a new enclosure. Otherwise remove the already established pair from the enclosure, introduce the new pair and then re-introduce the other pair. A natural boundary of vegetation, rocks and logs can be used.

Groups of young stilts are easier to introduce, but the young should be of roughly the same age.

A period of observation during the introduction is strongly recommended.

If the parents want to re-nest, there may be aggression towards their young and they should be removed (Emmerich, A., pers. comment).

6.2 Habits:

When roosting or sleeping, they typically stand on one leg, head and neck retracted to fold of wing, and bill tucked under the wing. Wing-stretching, indirect head scratching and other comfort movements can also be observed.

When alarmed, feeding and roosting birds often head-bob and make distinctive yelping calls.

They bathe in the pond, especially on hot days. They sit in the water and dip underwater repeatedly. This may be interspersed with springing into the air and splashing back into the water.

Aggressive to other smaller waders during breeding (Emmerich, A. pers. obs., del Hoyo *et al.* 1996).

6.3 Courtship

Pairing results from persistent association of female with male, until all aggressive interactions cease. The time from the first encounter to the formation of a pair bond can be very short, sometimes only 3-4 days. When female encounters a potential mate she often gives a low call and assumes the posture resembling the receptive posture before copulation.

Preening and bill-dipping may also be part of the courtship.

The female initiates a pre-copulatory display in the water when feeding, by giving a few low calls while standing still and assuming a distinctive crouched posture with her neck extended. The male may respond with splashing in the water and excessive preening and walking several times behind female. Mating occurs by male flapping wings, flexing legs and mounting female. Mating is followed by crossing of beaks and the male covers the female's back with one of his wings.

Fighting can occur at breeding grounds. Typically, two birds fly at each-other, often 1-2m above ground, parachuting at the opponent (Marchant & Higgins 1993)

6.4 Behavioural Enrichment Activities:

Mealworms, fly pupae and other bugs scattered around the aviary and in water ad lib.

Add aquatic/seeding plants to pond.

At Adelaide Zoo *Cladophora species* (collected from one of the moats) are added to Stilt ponds. There are dragonfly larvae, worms, snails, water crickets, water boatmen and other bugs that enable the birds to forage for extended periods and enforce natural behaviour and activity (Emmerich, A., pers. obs).

6.5 Mixed Species Compatibility:

Proven compatible species at Adelaide Zoo:

New Holland Honeyeater

Red-browed Finch
Chestnut-breasted Mannikin
Double-barred Finch
Java Sparrow
Freckled Duck
Bar-shouldered Dove
Peaceful Dove
White-breasted Ground Dove
Luzon Bleeding Heart Pigeon
Common Bronzewing Pigeon
Dollar Bird
Sacred Kingfisher
Eclectus Parrot
Regent Parrot
Mulga Parrot
Bourke Parrot
Palm Cockatoo
Red-tailed Black Cockatoo
Rock Parrot
Hooded Parrot
Red-collared Lorikeet
Musk Lorikeet
Shining Starling
Rufous Night Heron
Cattle Egret
Greater Egret
Crested Tern
Plumed Whistling Duck
Rajah Shelduck
Green Pygmy Goose
Straw-necked Ibis

Royal Spoonbill
Little Pied Cormorant
Green Peafowl
Siamese Fireback Pheasant (female)
Variegated Fairy Wrens

Mary River Turtles

An initial observation period is recommended with the following species from the above list:

Cattle Egret
Greater Egret
(Predation of chicks can be a risk with egret species)
Wandering Whistling Duck
Peafowl
Rufous Night Heron

In the initial introduction phase, these species were eating the Stilts' food and additional food stations with wire mesh cover were set up, thus enabling only the stilts with their slim beak to get to the food and preventing other birds from stealing it.

The size of the aviary will matter as they will be more easily attacked on in a smaller aviary as opposed to a large walk-through aviary where they have plenty of space to move away.

At Adelaide Zoo Black-winged Stilts have been housed in a variety of environments from smaller aviaries up to large mixed species walk-through aviaries.

Hooded Plovers are usually a compatible species outside the breeding season. At Adelaide, some aggression was shown towards them during breeding so the plovers were removed. Black-winged Stilts have also been housed with Nicobar Pigeons, although there was one recording of a Nicobar Pigeon being aggressive towards a juvenile Stilt. Harassment by terns and predation by Pheasant Coucals has also been recorded. A Whistling Duck has been suspected of killing a juvenile stilt.

7. Captive Diet

7.1 Feeding Requirements

Meat Mix*, *Wombaroo* Insectivore, whitebait, mealworms. Mealworms can be scattered throughout the enclosure. Meat and fish should be offered in a shallow dish (ideally placed in the pond on a rock).

*** Meat Mix Ingredients:**

1000g minced horse meat

20g calcium carbonate

500g parrot pellets (powdered)

600g *Wombaroo* Insectivore blended with 5 hard boiled eggs(with shell)

(see appendix).

Each bird gets approx. 35g meat mix with insectivore daily together with a few mealworms and 2-3 chopped up whitebait. Their food intake may vary and should be monitored/adjusted accordingly.

7.2 Supplements:

Mineral and vitamin supplementation is not required under normal circumstances if appropriate diet regimes are followed.

7.3 Presentation of Food

The food bowl should be placed in water to encourage 1) wading (good for their feet) and 2) natural behaviours as they prefer to drop food pieces in water and work them with their beaks before swallowing.

8. Breeding

8.1 Breeding System/Pair Formation:

Stilts are monogamous. A pair bond may be formed annually (Marchant & Higgins 1993).

8.2 Age of Maturity

Breeding starts at 2-3 years.

8.3 Regularity of Breeding

Ability to breed every year/more than once per year.

Double-clutching has been recorded at Adelaide Zoo. After the eggs from the first clutch went missing, the second clutch was laid 25 days later.

If the young from the first clutch are removed at 3 days-2 weeks of age, the dam will usually re-lay. Leaving the young with their parents may prevent a second clutch (Emmerich, A. pers. comment).

8.4 Season:

August-December, but may vary. At Adelaide Zoo clutches have been recorded as late as February. Other zoos have bred them as late as March (Emmerich, A., pers. comment).

8.5 Nesting

If the nests built in or near water, it consists of a mound of vegetation sufficiently high to raise the eggs above water level. If built on land, the nest is often just a slight depression on the ground, lined with a few plant stems.

Materials used for nesting include leaves and stalks of swamp plants and grasses as well as small twigs.

Nest-site selection and lining of the nest is shared between the sexes. They may build more than one nest at the same time. The female often is more active in the nest building process whilst the male assists.

They have been known to lay eggs on bare ground, rather than in the nest (Hoffman, N, Adelaide Zoo, pers. comment).

They may choose to nest near a rock for added protection. At Adelaide Zoo birds chose a site where aquatic plants were leading into the water, providing easier access for the chicks. They generally nest in an open area lacking shade.

Parents will defend the nest aggressively using anti-predator strategies such as feigning injury (Emmerich, A., pers., obs. and Marchant and Higgins, 1993). At Adelaide Zoo one clutch was being guarded by 2 males with the female being chased off (2.1 birds housed together, Hoffman, N., Adelaide Zoo, pers. comment). They eventually settled down. It is advisable to remove last year's youngsters when parents are ready to breed again.

8.6 Dietary Changes Prior to Breeding and During Breeding

Bloodworms and fly pupae added to diet during courtship. If chicks are being parent reared, food should be offered 3 times a day to begin with. Chicks feed themselves.

8.7 Clutch Size:

3-4 eggs

Eggs are olive, blotched and spotted dark brown.

Eggs are usually laid over a 5-6 day period before incubation commences (at 24-48 hour intervals).

8.8 Incubation Period:

24-25 days. Both sexes incubate and change over very frequently (can be as often as every hour). Both sexes attend young. When incubating on hot days, they pant for many minutes at a time, the threshold temperature being 22-28 degrees C (Marchant & Higgins 1993).

Incubation normally starts after laying of the 4th egg, but occasionally after the 2nd (del Hoyo *et al*, 1996).

Hatching is supposed to be synchronous, but in 2 clutches recorded at Adelaide Zoo 2 chicks hatched together first, then a third the following day and a fourth the day after that (Emmerich, A., pers. comment)

8.9 Egg Weights and Measurements

See artificial incubation and appendix.

8.10 Brooding:

Both sexes brood during colder weather and at night until chicks are 3-4 weeks old. The female may spend more time brooding than the male (Marchant & Higgins 1993).

8.11 Inter-Clutch Period:

Mostly single-brooded, but may re-lay after failures. Replacement clutches may be laid 3 days to 2 weeks after loss of first clutch. Incubation may recommence as early as 18 days after first brood hatched.

8.12 Fledging Period:

28-34 days.

Young usually remain with parents after fledging.

8.13 Parental Behaviour/Anti-Predator Strategies

Both parents guard the nest aggressively. Walking away from nest, bouncing off the ground in a series of hops, distraction displays and aggressive behaviour. During laying they may react to intruders by flying in a wide circle, sometimes calling.

During incubation and fledging periods they usually perform distraction displays such as injury feigning (wings stretched out and lowered) accompanied by distress calls, sometimes swooping (Emmerich, A., pers. obs. and del Hoyo et al 1996).

8.14 Developmental Notes:

Chicks are precocial and leave the nest within 24 hours, often after just an hour. They are able to run, swim (once dried) and feed themselves.

Downy chicks are disruptively marked, light brown with darker markings dorsally and on the head. The long legs and long toes are characteristic on hatching.

Juvenile plumage is brown and grey where adults are black. The black on the back of the head and nape of adults is replaced by a dull grey, the wings and the back are brown and there is a grey patch around the eyes. Youngsters attain adult plumage at 15-18 months of age (Emmerich, A., pers. obs.).

8.15 Age of Removal from Parents:

Although chicks are precocial, parents attend to them until they are fully independent 2-4 weeks after hatching.

The family group is maintained for a few weeks up to 8-10 months after fledging (Marchant & Higgins 1993).

Parents may become aggressive towards their young when they are getting ready to nest again. Aggression was observed when juveniles were between 8-10 months old.

See 8.3 Regularity of Breeding.

8.16 Use of Foster Species

Unknown.

8.17 Hybridization in captivity:

Due to similarity between courtship and copulation behaviour, Black-winged Stilts and American Avocets have interbred in captivity and produced fertile offspring.

9. Artificial Incubation

9.1 Incubator Type

AB Newlife 75 Autoturn

9.2 Incubation Temperature and Humidity

The incubator should be housed in a room air conditioned to 25C and dehumidified by a separate domestic dehumidifier.

Incubation parameters should be set at 37.2-37.5C dry bulb and a 25C wet bulb reading. Humidity in the incubator is provided by the use of distilled water; humidity should be 50%.

Data on temperature parameters should be recorded at regular intervals prior to incubation.

Eggs can be disinfected with a commercial disinfectant such as Chickguard. Each egg can be identified with a pencil number (Hibbard, C., Taronga Zoo).

9.3 Incubation Length/Egg Measurements/ Desired % Weight Loss

Incubation length: 24-25 days.

Fresh egg weight: 32-35g.

Daily weight loss: 0.18g.

Egg measurements – see appendix.

9.4 Hatching Temperature and Humidity

The egg should be transferred to a hatcher (AB Newlife) at the first stage of external pip. It should be contained in shallow perforated plastic lids and padded with cotton dentistry wicks to prevent excessive movement.

Hatching parameters should be set at 36.5C dry bulb and 32-33C wet bulb.

Prior to transfer to a brooder chicks can be maintained in the hatcher for 24 hours on a fine mesh floor, allowing circulation of fresh warm air around the chicks body surface and reducing access to the chicks own faecal material (Hibbard, C., Taronga Zoo).

9.5 External Pip to Hatch Interval

24-36 hours (on average 28 hours).

Candling eggs to detect internal pip due to the dark pigmentation of the egg is difficult. Physical movement can be detected by running a finger over the egg surface. Detection of the first stage of external pip can be determined by a slight irregularity of the egg surface (Hibbard, C., Taronga Zoo).

10. Artificial Rearing

10.1 Brooder Types and Design

Brooders should be constructed from fibreglass cast from a single mould thereby avoiding joints and corners that would allow debris to accumulate. Each brooder should have a floor space of 1500mm x 750mm and should house a maximum of 4 chicks. Artificial grass can be used as a substrate. Care should be taken to cut it to the exact size of the brooder box thus avoiding pockets that chicks may get trapped in. A high standard of substrate hygiene should be maintained (lesions to the feet may occur otherwise). Lighting should be provided for the chicks from 7.00am to 9.00pm and half-light overnight. (These birds feed on the basis of tidal movements rather than strictly during daylight hours. This method provides an artificial moonlight and prevents chilling of a disoriented chick away from the heat source overnight) (Hibbard, C., Taronga Zoo).

10.2 Brooder Temperature

Brooders should be set up in an air conditioned room maintained at 25C. Ideally, 2 heat lamps should be installed above the brooder, maintaining a temperature of 35-42C. One lamp should be higher than the other thereby allowing for this temperature range.

After 10 days the hottest heat lamp can be removed and the remaining one gradually heightened from the brooder floor over the following 10 days until the chicks have developed almost full coverage of contour feathers. The chicks can then be maintained at the air conditioned room temperature of 25C (Hibbard, C, Taronga Zoo).

10.3 Rearing Diets

Finely ground meat mix* (see appendix), white worms *Enchytraeus albidus* and water boatman (backswimmers).

24 hours after hatching chicks should be provided with shallow trays of cooled pre-boiled drinking water. Continued absorption of yolk sack contents produces a tacky green faecal. The yolk sac has been completely absorbed when the majority of the stool contains urate. Feeding may then begin (early feeding of solids may interfere with yolk sac absorption and can lead to death).

Approx. weight loss between hatch weight and weight at first feed is 15% which equals a first feed 48-72 hours after hatching. Chick hatch weight is 13-15g.

Commercially cultured white worms *Enchytraeus albidus* should be added to an artificial high protein diet (see meat mix – appendix). Chicks react to the stimulus of live food, but 100% live food will cause problems with poor weight gains. White worms can be phased out after 7 days.

Fresh food should be provided 3 x daily to avoid desiccation and spoiling of food. For behavioural stimulation, backswimmers can be offered regularly (Hibbard, C., Taronga Zoo).

10.4 Feeding Method:

Equipment used: shallow plastic water trays 150mm x 100mm x 10mm (lined with paper towel to provide traction). Shallow plastic food dishes 80mm in diameter and 10mm deep.

Feeding frequency: 3 x daily for the first 21 days, then twice daily.

Food presentation: Meat mix provided in shallow trays with white worms on top for the first 7 days. Water boatman are provided in the water tray (Hibbard, C., Taronga Zoo). See rearing diets 11.3.

10.5 Chick Growth Rate:

Legs lengthen rapidly. See appendix for growth chart.

10.6 Identification Methods:

Chicks can be banded with a temporary plastic colour band after hatching. The chicks tend to have different patterns and out of several chicks hatched, one is usually smaller than the others. See morphometrics and banding (introduction).

10.7 Weaning:

N/A

10.8 Rehabilitation

At 25 days old the chicks can be placed in a small sheltered outdoor aviary on a sand substrate. The chicks can remain outside during the day, but should be housed inside for the first 2 or 3 nights. They should then remain outdoors permanently.

Assimilation of chicks from 2 different clutches into one aviary should be monitored, but aggression is unlikely.

Hand-reared chicks may be less nervous than parent reared ones, these birds may be better specimen for housing in walk-through aviaries. Hand rearing is also a valuable tool in case of abandonment (Hibbard, C., Taronga Zoo).

11. References

Code of Practice for the Display and Exhibition of Animals,
Government Gazette,
Victoria,15/12/1994

Del Hoyo, J., Elliott, A., Sargatal, J.
Handbook of the Birds of the World, Vol III
Birdlife International, Lynx Edicions

Lindstedt, S.L., Calder, W.A.
Body size and longevity in birds
Condor 78, 91-94, 1976).

Live Animals Regulations
IATA Resolution 620, Attachment "A"
26th Edition, effective 1 October 1999.

S. Marchant, S. & Higgins, P.J.
Handbook of Australian, New Zealand and Antarctic Birds
Vol. II
Oxford University Press 1993

Mawson, P.M., Angel, P.M. & Edmonds, S.J.
Records of the South Australian Museum
A checklist of Helminths from Australian Birds,
Vol. 19, No 15, Aug. 1986, p 251.

Pizzey, G. & Knight, F
Field Guide to the Birds of Australia
Angus & Robertson 1997

Reader's Digest Complete Book of Australian Birds
1976

Regional Census & Plan
10th Edition
ARAZPA

12. Bibliography

Blakers, M., Davies, S.J.J.F., Reilly, P.N.
The Atlas of Australian birds
Melbourne University Press 1984

Del Hoyo, J., Elliott, A., Sargatal, J.
Handbook of the Birds of the World, Vol III
Birdlife International, Lynx Edicions

S. Marchant, S. & Higgins, P.J.
Handbook of Australian, New Zealand and Antarctic Birds
Vol. II
Oxford University Press 1993

Pizzy, G. & Knight, F
Field Guide to the Birds of Australia
Angus & Robertson 1997

Reader's Digest Complete Book of Australian Birds
1976

Rutgers, A. & Norris, K.A.
Encyclopaedia of Aviculture, Vol. I
Blandford 1970

13. Appendices

APPENDIX I

*** Meat mix Ingredients:**

1000g minced horse meat

20g calcium carbonate

500g parrot pellets (powdered)

600g *Wombaroo Insectivore* blended with 5 hard boiled eggs(with shell)

(this meat mix has been used by Adelaide Zoo for **parent-reared** chicks)

Wombaroo Insectivore:

Wombaroo Food Products, Mount Barker Road, Glen Osmond, SA 5064

Taronga Zoo have used the following for **hand-rearing**:

50% Meat Mix: 50% minced lean beef heart
30% *Wombaroo Insectivore* supplement
10% *Iams* cat chow (soaked in water overnight)
10% trout chow – grower

50% Egg Mix 3 hard boiled eggs (blended with shell)
3 slices of wholemeal bread
75g *Wombaroo Insectivore* supplement
2 handfuls f boiled brown rice

APPENDIX II

Chick Hatching Data – Black-winged Stilt *Himantopus leucocephalus*

Egg ID	External Pip date	External Pip time	Hatch complete date	Hatch complete time	Chick Weight (g)
#1	06/10/96	07.45	08/10/96	07.00	15.25
#2	07/10/96	07.00	08/10/96	22.15	13.53
#3	06/10/96	07.45	08/10/96	07.00	12.90
#4	07/10/96	07.00	08/10/96	22.15	14.76
#5	04/10/96	07.00	05/10/96	08.30	14.04
#6	05/10/96	07.30	06/10/96	10.51	14.98
#7	04/10/96	07.00	05/10/96	13.00	14.68
#8	04/10/96	07.00	05/10/96	13.00	14.77

APPENDIX III

Egg Measurement Data – Black-winged Stilt *Himantopus leucocephalus*

Egg ID	Weight (g)	Days into inc. (on arrival)	Length (mm)	Width (mm)	Average daily weight loss to pip (g)	Shell weight	Shell thickness
#1	19.74	18	45.76	30.80	0.157	1.46	0.30
#2	18.04	18	43.89	29.94	0.172	1.61	0.23
#3	17.17	18	45.07	29.12	0.143	1.23	0.41
#4	19.26	18	46.32	30.28	0.166	1.75	0.25
#5	17.85	21	39.38	31.45	0.195	2.05	0.25
#6	18.79	20	42.75	31.28	0.195	1.87	0.22
#7	18.15	20	41.89	31.25	0.220	1.77	0.24
#8	18.49	21	41.80	31.12	0.206	2.11	0.25
Average			43.357	30.655	0.181	1.731	0.269
Mean			43.32	30.96	0.183	1.76	0.25

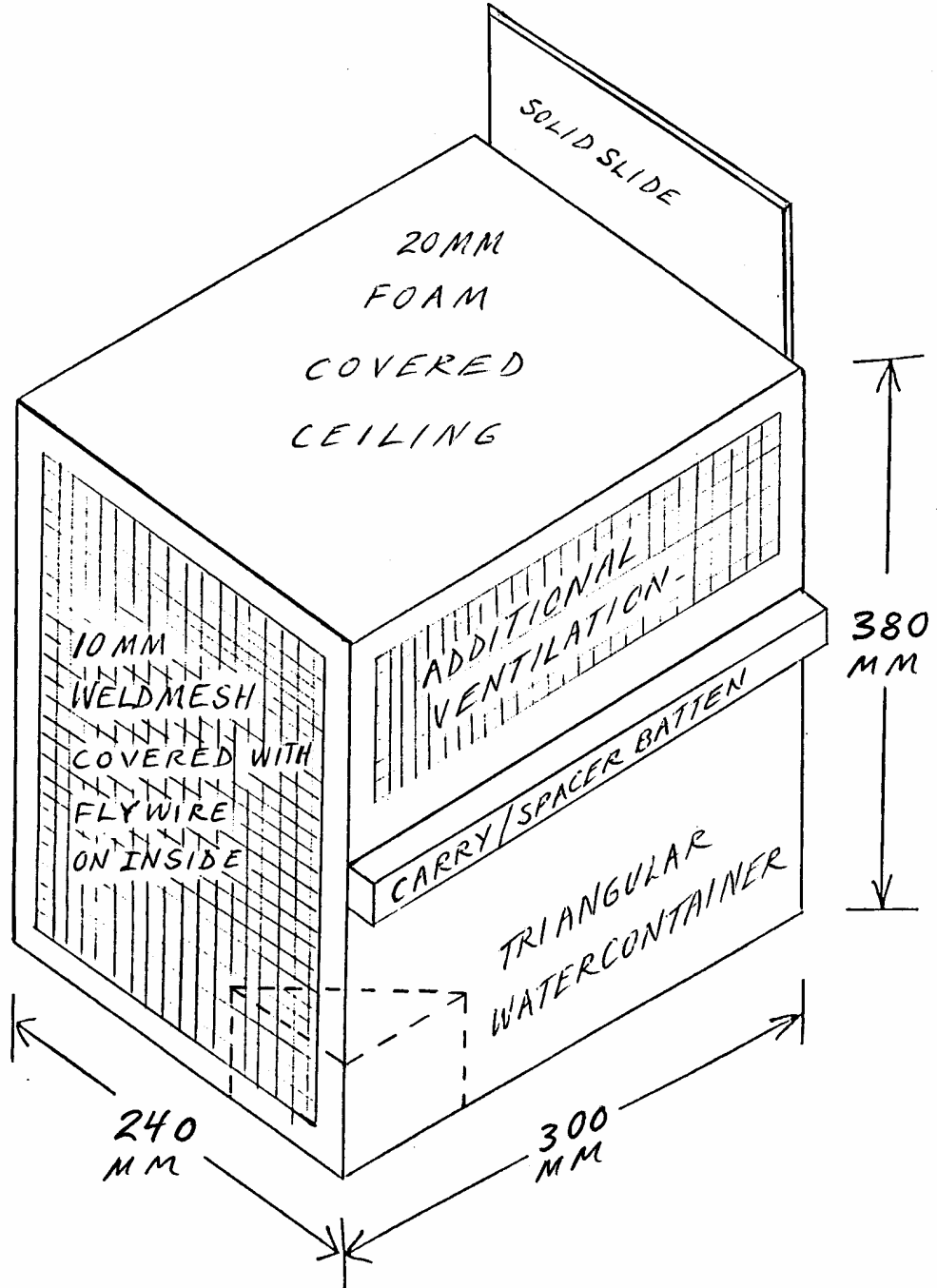
APPENDIX IV

Chick Weight Gain (average);

Day	Grams	Day	Grams	Day	Grams
1	13 - 15	8	25 - 40	15	58 - 68
2	12 - 13	9	30 - 45	20	72 - 90
3	10 - 15	10	36 - 53	25	95 - 115
4	12 - 18	11	45 - 58		
5	15 - 24	12	52 - 63		
6	22 - 27	13	53 - 65		
7	23 - 30	14	57 - 66		

APPENDIX V

Suggested Transport Cage:



(IATA Live Animals Regulations 1999; design by zur Eich, W.).

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