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Hand-rearing and rehabilitation of comb ducks *Sarkidiornis melanotos*

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Abstract
Comb duck *Sarkidiornis melanotos* is a resident species in the city of Ahmedabad. These ducks breed regularly in natural cavities in large, old trees in the urban spaces, and sometimes in man-made cavities on rooftops. While eggs are successfully hatched in these nests, there are no viable water bodies for foraging. After hatching out, the precocial ducklings are found wandering on streets following their distressed mother and are then rescued by members of public. Such ducklings are hand-reared in wildlife rehabilitation centers with the objective of release back into their natural habitats. It is important to provide necessary requirements especially housing, nutrition, and behavioral conditioning for successful rehabilitation. Lack of resources, and available literature specific to Indian species and conditions makes it difficult for Indian rehabilitators. In this study we present methods of housing, physical care, diet plans, behavioral conditioning, and release techniques that were used to successfully rehabilitate 411 ducklings in Ahmedabad, Gujarat, India, between 2005 and 2018. These methods can be used as guidelines for other biologically and behaviorally similar species.

Keywords: duck**,** rehabilitation, diet, husbandry, soft release

Introduction
Comb duck *Sarkidiornis melanotos* is a large resident duck species commonly found in many parts of India. This species thrives in various types of open water bodies including rivers, swamps, and lakes. Adults have a white head with black markings, white neck, and underparts. Upperparts and wings are blue-black with blue-green iridescence (Grimmett *et al*. 2011). Males are much larger than females and have a large "knob" on the bill giving this species another common name "knob-billed duck". (Erritzoe, J., 1993). They typically breed in still water bodies like swamps, and lakes. (Madge, Steve & Burn, Hilary, 1987). Comb ducks are a resident species in and around Ahmedabad, often breeding within the city. They typically breed during the onset of monsoon season between late July and September. The breeding pair nests in cavities of large trees (Madge, Steve & Burn, Hilary, 1987) and sometimes on incidental man-made cavities on rooftops of buildings. Males can have more than one mate at a time. (Pitman, 1965) [9]. The comb ducks continue to nest in the same areas where old, large trees with cavities are present, but the lakes have now disappeared. They appear to show strong nesting site fidelity. Incubation period for this species is 31 days. (Mackenzie and Kear, 1976) [5]. Females lay between 7 to 15 eggs; larger females tend to lay larger clutches. Sometimes more than one female will lay eggs in a single "dump nest" (Clawson *et al*., 1979; Semel and Sherman, 1986) [2, 11]. After hatching, ducklings immediately jump out of cavity nests on to the ground and follow the parents, typically the mother. In nature, once the ducklings hatch out, they follow their parents to the nearby water body and feed on vegetation and invertebrates (Mukherjee, A. *et al*. 2002) [7]. Hatchlings are commonly rescued from such urban landscapes as lakes that were previously present are filled up for construction of buildings. Free roaming domestic dogs and cats pose extreme threats and are the main reason for such rescues. A total of 400 hatchlings have been successfully hand-reared and rehabilitated back in to the wild between 2005 and 2018 by the authors in two wildlife rehabilitation centers in Ahmedabad city. In this study we present methods of hand-rearing comb ducks including husbandry, nutrition, and pre-release conditioning for successful rehabilitation.

Materials and Methods
The experimental rehabilitation project was carried out at Animal Help Foundation (AHF) between 2005 and 2008, and at Jivdaya Charitable Trust (JCT) between 2013 and 2018 in Ahmedabad, Gujarat, India.

Housing and environment

The ducklings reached the wildlife rehabilitation center after they have been walking around for several hours following their mother in unsuccessful pursuit of a viable feeding ground. They are most often dehydrated and emaciated. Necropsy of hatchlings that have died soon after rescue show empty stomachs and gastrointestinal tracts. Hatchlings were kept warm under 100w, and 75w mercury vapor bulb that emits both UV and heat. UV rays allow birds to synthesize vitamin D3 that aids in metabolizing calcium and improves immune function in the body (de Matos R, 2008). These bulbs were hanged over the resting area of duckling at a distance such that the temperature is maintained at 34° C constant. The bulbs were kept on all day and all night for the first two weeks. There was some mortality observed when the bulbs were kept off during nights as temperature dropped below 26° C in enclosure. The authors only worked in outdoor enclosures and use of mercury vapor UV heat bulbs was most optimum. Dry Bermuda grass, timothy hay, dry fodder grass, rice husk was used as bedding under the bulbs (figure 1). The grass/husk was heaped up imitating a small "mound" nest. Up to ten similar sized ducklings were maintained per enclosure. Stressors like presence of humans, other animals, loud sounds, etc were avoided as much as possible. Enclosures were kept rodent proof.

Rodents like common rats *(Rattus rattus)* can predate on ducklings.

Fig 1: Ducklings kept warm under a mercury vapor UV heat bulb.

Initial rehydration

In case of extreme dehydration duckling should receive immediate attention from a trained veterinarian. The veterinarian may administer warmed fluids (Ringer's Lactate solution or normal saline) subcutaneously. If ducklings are sufficiently active, they are provided with a shallow bowl of drinking water mixed with electrolytes. Ducklings readily start dabbling their beaks in water and voluntarily start consuming water. This is the least stressful way of hydrating them.

Diet and nutrition

Food was offered immediately to the active ducklings after the initial rehydration. Typically, they use their beaks to detect, grab, and swallow food while filtering out excess water and inedible objects. In nature they are known to feed mainly on vegetable matter, including seeds of grasses, aquatic plants, agricultural grains as well as aquatic invertebrates. Initially, commercially available duck feed was used but was discontinued soon after as ducklings started getting "angel wing syndrome". This syndrome is usually caused due to high calorie diet that is especially high in protein (Arican *et al.* 2019) [1]. Commercial duck feed is typically high in protein for aiding faster growth and weight gain in domestic ducks and geese. After much trial and error, a combination diet was used as an optimum staple diet (table 1). This was given in a flat dish that is easy for them to access and dabble with beaks to eat. Ducklings often climb inside the food dish and eat, splashing food all over themselves. This is a normal method of eating for them but providing opportunity for bathing and cleaning followed each feeding. All ingredients were boiled together in a pressure cooker. The food was allowed to get to room temperature before offering to the ducklings. It is important to prepare the food a little watery, so it is easy for duckling to dabble their beaks in it. Food was either served at room temperature or lukewarm. Clean drinking water was always kept available. Food was given three times a day for the first 16 weeks. Quantity of food to be given was calculated at 15% of body weight (Nagy 1987) [8]. The cumulative portion for the entire flock was then divided in to three servings. The food quantity was increased by 5% every 3-4 days. This increase was further refined by monitoring the food wastage after every meal. If the wastage was more than 10% of total serving, quantity was reduced and similarly if there was less than 5% wastage, quantity was increased. We had kept 10% wastage as an indicator for a healthy portion size. Food was reduced to two times a day once the ducklings are shifted to a larger enclosure where they had access to several water plants like water lettuce *(Pistia sp.)*, water hyacinth *(Eichhornia crassipes)*, water chestnut *(Eleocharis dulcis)*, water lilies *(Nymphaeaceae)*, water stargrass *(Heteranthera dubia)*, vallis *(Vallisneria sp.)*, and algae.

Table 1: Ingredients for each meal.

Ingredients	Percentage amount in one serving
Rice	40%
Moong	12%
Chickpea	12%
Carrot	2%
Assorted beans	2%
Assorted gourds	2%
Spinach leaves/pigweed leaves	20%
Water	10%
Carnivorous fish food*	10-15% of meal
Multivitamin and mineral supplements** Grit	Dosage suggested by manufacturers. Sprinkled on food once a week

*Added to meal twice a week.
**Added every alternate day.

At 20 weeks of age, their staple diet is transitioned to a mixture of grains like jowar *(Sorghum sp.)*, bajra *(Pennisetum glaucum)*, and various other grass seeds as staple diet.

Bathing and hygiene

Ducklings are messy eaters, so food was given a little further away from their "grass nest". A shallow pool of water was kept near them once they finished eating. It was low enough for them to get in, alternatively one can organize a gradual sloping ramp and they will quickly learn to use it. The water level in the pool was such that they can swim inside but not drown. This helps them remove all food items from their beaks and body while allowing them to display natural behaviors. This bathing routine was allowed after each meal. Best option for a bathing pool is wide plastic tub, roughly 36 inches in diameter for 7 to 10 ducklings. Multiple tubs are for more ducklings. Alternatively, one can also use plastic "kiddy pools" with hard floor and sides. Water from tub was drained fully after each use and tub was cleaned using a safe detergent for utensils. Tub was disinfected daily after last use. Fourth week onward ducklings were given 15 minutes of swimming time in a larger pool during the hottest time of the day, so they dry easily afterwards (figure 2).

Fig 2: Ducklings provided an opportunity to swim after fourth week.

Absorbent paper (old newspaper) was spread out under the feeding dishes (figure 3). While the ink in newspapers may be a concern, it appears to be safe when it is taken off as soon as they finish eating. The ducklings defecate across the floor space, so old newspaper sheets were used as floor sheets and soiled sheets were changed with clean sheets

regularly. Cleaning of floor was done once a day with either a safe disinfectant for birds or diluted bleach solution. Use of phenyl was avoided as it can cause skin irritation. “Dry” cleaning was done as much as necessary.

Fig 3: Newspaper sheets under food dishes for easy cleaning. The larger duckling is two weeks older than the rest.

Monitoring and evaluating growth

The ducklings were always raised in a group. Singling them out for various reasons causes stress and was avoided as much as possible. In a group setting it was difficult to keep individual records without using expensive marking methods. A temporary method was to use a non-toxic marker pen on the yellow feathers of ducklings. While it was a cheap method, there was a huge disadvantage. We had to closely monitor each duckling while bathing as the marks would come off and we had to remark them each time. This was not practical and was discontinued after the initial growth data collection (table 2). Steady growth was observed throughout the week till fledgling period. The soft down feather gradually started to get replaced by wing feathers, tail feathers, contour feathers, semiplumes, flioplumes, and bristles from fourth or fifth week onward. It took between 20 to 24 weeks for the ducklings to fully fledge and develop complete plumage.

Table 2: Growth rate of Sarkidiornis melanotos ducklings taken every alternate day from day of hatching for 15 days. Data collected in 2006.

Duck #	Weight in grams							
	Day 1	Day 3	Day 5	Day 7	Day 9	Day 11	Day 13	Day 15
1	39	49 (+10)	64 (+15)	75 (+11)	88 (+13)	103 (+15)	120 (+17)	134 (+14)
2	48	59 (+11)	72 (+13)	89 (+17)	101 (+12)	117 (+16)	131 (+14)	150 (+19)
3	51	65 (+14)	79 (+14)	95 (+16)	108 (+13)	127 (+19)	146 (+19)	160 (+14)
4	44	56 (+12)	69 (+13)	84 (+15)	102 (+18)	116 (+14)	133 (+17)	154 (+21)
5	52	65 (+13)	80 (+15)	95 (+15)	109 (+14)	129 (+20)	151 (+22)	168 (+17)

Pre-release conditioning and soft release

Keeper interaction with ducklings was limited to giving food, and minimal handling during maintenance. Handling and interaction were avoided as much as possible to not imprint them on humans. Once fledgling ducks developed healthy feathers, they were given access to a large flight aviary and large water pools with natural vegetation growing in water (figure 4). The pre-release conditioning period is crucial for successful rehabilitation back into the wild. The main objectives of this conditioning were a) inculcate their natural foraging behavior, and b) provide them with ample opportunities to exercise their wings and practice flight. A special, large area was developed for this conditioning activity. Soft release was a method of choice for rehabilitation of hand-reared ducks. Soft release is a method of attempting to increase success by allowing animals to adapt to the wild more easily and gradually.

Fig 4: Duck with full plumage foraging in pre-release conditioning pond.

At AHF, a large, fenced area of approximately 100ft x 50ft with two artificial ponds of 20ft diameter was used. The ponds were located roughly in the centre of the scape. This area was open to sky to encourage flights to river shoreline that was around 500mtrs away. Being reared in captivity, they initially lacked the motivation to practice flight when not exposed to a larger space. At the age of 20+ weeks they had a full set of flight feathers and started exhibiting wing-flapping. Wing-flapping strengthens the wing muscles getting them ready for flights (Ruaux *et al*., 2020). Some ducks started practice flights readily while others needed some encouragement. They started taking short flight within the first week. These were typically from one end of the longest side to another, flying over the ponds.

By second week, they would fly out of the fenced area, circle around, and fly back and land near the ponds. They seemed to be using the ponds as landmarks to home back during their practice flights. With each passing day, their flights got longer both in time and in distance. By third week they started landing at the river shoreline where natural flocks of adults and juvenile comb ducks forage regularly. By fourth week, ducks flew out in the morning and started foraging with the wild ducks. They would however return by late evening, just before dawn. Interactions with wild ducks were observed on many occasions. All hand-reared ducks had leg rings and so were easily identified using a 10x42 binocular. By fifth week the ducks started staying out for the night and would come back once in two or three days and eventually by sixth week they stopped coming altogether. During this entire period food was kept out near the ponds in the evenings. On days they came back, they would eat a little before going inside their enclosures for the night. This was done to ensure they get to eat something in case they could not forage enough out in the wild.

At JCT, pre-release conditioning was done in a large flight cage that was 30ft x 60ft x 15ft (LxBxH). Same routine was followed until the ducks started taking short flights. They were then shifted to a fenced, open to sky space with a pond in the centre. This was at another location where wild flocks of comb ducks used to forage in a nearby water body. To keep them safe at night, a 10ft x 10ft cage was used near the pond. Same routine was followed as mentioned above for the last four to six weeks before they are rehabilitated successfully back in to the wild.

Results and discussion

The main aim of this study was to improve welfare standards, develop science-based practices that are practically viable in a country like India. A total of 411 orphaned comb duck ducklings have been successfully rehabilitated back in to the wild between 2005 and 2018. These were exclusively rescued from within city limits of Ahmedabad, Gujarat, suggestive of the rapid and extensive urbanization. It is interesting that the ducks continue breeding in the same locations as they historically used, using the same tree cavities. Nesting is observed in the same tree cavity over a span of 13 years. It is likely that different breeding pairs have used the same tree for nest and successfully hatching babies over the years. Some years rescued hatchling numbers were as little as 15, while some years the numbers were over a 100. These numbers are substantial considering the importance of conserving urban wildlife in a place where habitat degradation and fragmentation is occurring at a very rapid rate. Wildlife rehabilitation plays a major conservation role in these situations. Rehabilitation of the rescued ducks contributes to the natural recruitment of progeny back into the population. There is no previous published work on hand-rearing wild ducks in India and lack of knowledge on the subject perhaps results in certain deaths or unsuccessful rehabilitation of hundreds of ducks every year. It took several years of trial and error, and a lot of experimentation to work out practices that are most efficient in hand-rearing ducks. This study can be used as guidelines for duck species that are biologically, and behaviorally similar to comb ducks. These same methods have been used in hand-raising and successfully rehabilitating orphaned ducklings of lesser whistling duck *(Dendrocygna javanica)*, another species that nest in human dominated landscapes in Gujarat.

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