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STATUS AND BREEDING BEHAVIOR OF THE BAHAMA PINTAIL AND THE NEW ZEALAND BLUE DUCK

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Most populations of waterfowl that have become adapted for life on islands have adopted a sedentary life-style, or at least their seasonal movements cover short distances. As Weller (1980) has pointed out, this characteristic has endangered many of the world's island waterfowl and has made them of special concern to conservationists. The role that captive propagation and releases might play in helping to preserve endangered waterfowl has long been recognized (Kear, 1975, 1978) and is especially well known in the case of the Hawaiian goose (*Branta sandvicensis*) and Koloa (*Anas platyrhynchos wyvilliana*) (Kear and Berger, 1980; Sedberg, 1967). There is room for argument about the economics and the usefulness of this approach, however, and the high cost of raising waterfowl for release may inhibit some agencies from embarking on propagation programs for other island forms. Private aviculturists may be able to play important roles in certain circumstances, as illustrated by the promising "Operation Pateke" in New Zealand, involving captive propagation and release of brown teal (*Anas aucklandica chlorotis*) (Mills and Williams, 1978; Williams, 1978, Hayes, 1981).

Ethologists can play their part in this sort of endeavor by carrying out behavior studies on vulnerable species and races, before they become endangered. Field studies are needed before it is too late to interpret the behavioral repertoire in relation to ecological conditions encountered by the ancestral colonists. Studies of behavior of captives in flight-pens can complement such field studies, by providing greater control and allowing experimental approaches (McKinney, 1981). We will try to show how such behavior studies can be helpful in making decisions on the feasibility of propagation programs and other conservation measures.

We will summarize our findings on two species that present very different problems. Detailed reports on these studies are in preparation and will be published elsewhere. The white-cheeked pintail (*Anas bahamensis*) is familiar to all waterfowl aviculturists; it is widely kept and bred in zoos and private collections. Three races are recognized (Johnsgard, 1978): the lesser or northern race (which we will call the "Bahama pintail") (*A. b. bahamensis*) in the West Indies and an adjacent part of South America, the greater or southern white-cheeked pintail (*A. b. rubrirostris*) breeding in northern Argentina, and the Galapagos race (*A. b. galapagensis*). Generally only the Galapagos race is judged to be endangered, because of its small population and several possible serious hazards, but we suggest that attention also be given to the West Indian race at this time. Human pressures are increasing on the avifauna of the West Indies, and there is still an opportunity to study the populations of bahamensis on many islands. There are only a few other situations in the world in which populations of dabbling ducks are apparently resident on the islands of an archipelago (e.g. the populations of green-winged teal, *Anas*

— 211 —

crecca nimia in the Aleutians and those of grey teal *A. gibberifrons* in the East Indies). These situations may prove to be especially important to study because of inter-island variations in breeding seasons.

New Zealand's blue duck (*Hymenolaimus malacorynchus*) is a relict form whose relationships still remain obscure. The blue duck is one of the world's river specialists among the ducks. It shares adaptations associated with a residential river-dwelling life style with the Andean torrent duck (*Merganetta armata*), New Guinea's Salvador's duck (*Anas waigiensis*) and the African black duck (*Anas sparsa*) (Kear and Burton, 1971; Kear and Steel, 1971; Kear, 1972; Kear, 1975; McKinney et al., 1978; Ball et al., 1978). These adaptations (e.g. invertebrate diet, territoriality, wing-spurs for fighting, small clutch size) are presumed to have evolved independently in these four species of diverse origins in different parts of the world.

The blue duck lives on clear, fast-flowing rivers in both North and South Islands of New Zealand. Its range has been reduced by human activities and destruction of native forests, and it is now restricted to the higher reaches of rivers (Fordyce and Tunnicliffe, 1973; Fordyce, 1976). Blue ducks have proved difficult to keep and breed in captivity, and it seems unlikely that they will be suitable for propagation programs (Kear and Williams, 1978).

WHITE-CHEEKED PINTAIL

We have studied white-cheeked pintails in captivity and in the field. Captive studies were carried out in large flight pens at the University of Minnesota's Cedar Creek Natural History Area (described in McKinney, 1967, 1981). Fourteen pairs of individually marked, full-winged birds were observed during 3 breeding seasons (1980-82). These birds were captive bred from stocks obtained from Sea World, San Diego. Although they appear to belong to the northern (or lesser) race (*behamensis*), it is possible that mixing with birds from the southern race (*rubrirostris*) had occurred at some time since the stock was imported. In May-June 1982, D.J.B. made a preliminary field study of the northern race in the Bahamas, including observations on the islands of Abaco, New Providence, San Salvador, Crooked, Acklins, and Great Inagua.

Behavior in flight pens.

Males were territorial during the pre-laying and laying periods of their mates. As in other dabbling ducks, pre-nesting behavior included spontaneous flights by females, flights by pairs, persistent quacking, and prospecting in cover for nest-sites. Males focussed their territorial activities around areas in which their mates were prospecting and, because early in pre-nesting periods females prospected in various parts of the pens, territories were not rigidly fixed. During this early pre-nesting period, there were dramatic changes in the aggressiveness of individual males and in dominance relationships between males.

During the 1980 breeding season, paired males initiated more of the aggressive interactions in which they were involved while their mates showed pre-nesting behavior (64% of 1687 interactions) than males whose females showed no breeding activity (44% of 1704 interactions). Of the interactions during pre-nesting, males initiated 86% of those that began within

the territory. Similarly, while females were in the laying phase their mates initiated 65% of 789 agnostic encounters in which they were involved, 81% of those that occurred within their territories. After a clutch had been completed or abandoned, the male's aggressiveness gradually returned to the level characteristic of the non-breeding phase and territorial behavior disappeared. When a female resumed pre-nesting behavior, after losing or abandoning a clutch, her mate became more aggressive again and territorial behavior was resumed.

Territorial behavior consisted of down-up displays (= down-up + head-up-tail-up according to Johnsgard, 1978), open-bill-threats, parallel swims along territorial boundaries, walk-offs, swim-offs, chases and fights. Although males vigorously defended their territories against most male intruders, they did not restrict their activities to the territory. Pairs often fed and swam outside their territories, and 2 females paired to different males even nested within one male's territory. This pattern of behavior, in conjunction with the finding that territories are defended only during the periods when the female is fertile, suggest that the primary function of territoriality in this species is mate-guarding (defense of genetic paternity by paired males) rather than defense of a feeding area or nest site.

This interpretation is supported by the high frequency of attempts by paired males to force copulation on females other than their mates. Paired males made frequent excursions into the territories of other males, and many of these excursions resulted in the intruder pursuing and attempting forced copulation (FC) on the female. Most FC attempts observed (74% of 283) were directed at females that had begun pre-nesting behavior or were laying eggs. This close relationship between FC activity and the fertile periods of the target females is expected if FC is a secondary male reproductive strategy (Burns et al., 1980, McKinney & Stolen, 1982; Cheng et al., 1982). However, 72% of observed FC attempts were made by males whose mates had begun pre-nesting behavior or were laying eggs. In view of the increase in male aggressiveness during this same period, it may be that FC activity coincides with a peak period of sperm production by the males. The cause-effect relationships between spermatogenesis, hormones, aggressiveness and FC activity are unknown in this species and this is a fruitful area for research (see Discussion).

Generally our captive white-cheeked pintails maintained the same pair-bonds throughout each breeding season. Of 21 observed pair-bonds, 18 were stable but 3 involved mate-switches. Two of the switches resulted in new monogamous pair-bonds but the third led to bigamy. The latter event was especially interesting.

In 1982, two pairs of pintail (Red, Blue) established territories on one flight pen pond. The aggressiveness of each male and the dominance relationships between them fluctuated over the study period (May 13 to August 11) and the sizes of their territories changed accordingly. Blue male was especially aggressive while his female was laying but he continued to hold his territory while she incubated. Red male became increasingly aggressive during this female's pre-laying and laying periods but Blue male was able to dominate him and there were many FC attempts on Red female. On July 4, while both females were incubating (a few days before blue female's eggs were due to hatch), Blue male supplanted Red male, drove him away from his mate and vigorously courted Red female. Red male tried to hold on to his mate, but for 10 days he was dominated by Blue male. Blue male sequestered Red female and she accepted him as her escort. At times when Blue female left her nest to feed, Blue male joined her and divided his

time between both females. When Blue's clutch hatched on July 19, however, Blue male became less active in escorting Red female and he spent most of the time with Blue female and their single duckling. Red male was able to hold his mate after this and Blue male's bigamous relationship ceased.

We do not regard this behavior as aberrant. Very similar sequences have been documented in two other Southern Hemisphere dabbling ducks in our pens: Cape teal (*Anas capensis*) (Stolen and McKinney, in prep.) and speckled teal (*Anas flavirostris*) (McKinney, in prep.). Each time the behavior of the bigamous male was similar in that he had attempted FC on the second female for some days, then suddenly switched to courtship and domination of her mate. We suspect that such behavior, not recorded so far in any Northern Hemisphere dabbling duck, is associated with the extended breeding seasons of many southern ducks. Under these conditions, females may be able to raise two broods per year, and breeding asynchrony in the population could lead to opportunities for bigamous relationships.

Field Study

Throughout much of the Caribbean and the northern fringe of South America, the lesser white-cheeked or Bahama pintail has declined drastically in numbers and has disappeared completely from some regions. In the Bahamas, where these ducks are fully protected, they are locally common only on certain islands (Abaco, Andros, Great Inagua). These are large islands, with extensive areas of relatively inaccessible duck habitat. Formerly, Bahama pintails were reported to be abundant throughout the archipelago (Allen, 1905; Phillips, 1923) but now they are rare or uncommon on most of the islands.

Although they tolerate super-saline water and may be seen feeding with flamingos, Bahama pintails seem to prefer brackish or fresh water. They frequently make use of mangroves for nesting or shelter but they will use any vegetation that is growing in or near water if it is tall and dense enough for a duck to hide under.

Breeding pairs were spaced out with no more than one pair to a 15-20 ha mangrove island or 30-60 ha pond (Table 1). Territorial encounters, similar to those observed in the flight pens, involved parallel swimming, down-up displays, open-bill threats and short chases, and extra-territorial excursions by paired males to visit nearby pairs were frequent.

Each of the 5 broods observed was attended by a male as well as a female and males appeared to remain with their mates through the brood rearing period. Males showed little obvious interest in the ducklings, however, but they courted the female and defended her against other males. Mutual pre-copulatory displays were seen between males and females with ducklings, suggesting that these birds were preparing to initiate a second breeding cycle. If some pairs are double-brooded, it may be that males tend to remain with their mates through incubation primarily for the opportunity of siring a second brood as suggested by Siegfried (1974) for Cape teal, but studies of marked birds are needed to investigate this point.

Table 1. The distribution and status of White-cheeked Pintails on the islands surveyed.

Island	Number of birds seen	Status ¹	Population Estimate ²
Acklins	15	U	366
Crooked	2	R	80
Grand Bahama	0	-	-
Great Abaco	18	C	many
Great Inagua	120 ³	C	many
New Providence	20	R	68 ³
San Salvador	11	R	69

1 A = abundant, C = common, U = uncommon, R = rare.

2 Estimates are of number of birds on each island. I have estimated populations only for those islands on which I surveyed a significant portion of the island's surface area. Estimated population = $\frac{\text{number of ducks seen} \times \text{area of island}}{\text{area surveyed}}$

3 This is probably an overestimate as the ducks on Paradise Island were probably the only ducks on New Providence.

Breeding seasons of pintails within the Bahamas differ in length between the northern and southern islands in the archipelago. In the north, the breeding season is fairly restricted and synchronous but in the southern islands (notably Great Inagua) the season is extended and more dependent on irregular rainfall, and therefore breeding is less synchronous (Table 2). It is likely that breeding strategies are different in these two parts of the range, associated with these differences in breeding synchrony.

On Paradise Island, 5 adult pintails were found breeding on the ponds of a golf course. They were in 2 groups, one pair with a brood on one pond, one male and 2 females with their broods on another pond. On the pond with 2 females broods, the ducklings differed in age by 3-4 weeks, and the male courted and attended both females. An extensive search of the area yielded no other pintails. This appeared to be an instance of bigamy in wild birds.

It is not known whether Bahama pintails move away from their breeding areas during the wing-molt, but the observation of a flock of 60 full-winged birds on Great Inagua shows that birds are sociable at times, even at a time of year when other birds are breeding.

Table 2. Paired status and evidence of breeding by White-cheeked Pintails on the islands surveyed.

Island	Date	Evidence
Acklins	3-6 June	6 pairs; 1 trio
Crooked	3, 6, 7 June	1 pair
Great Abaco	20-22 May	9 pairs, mutual Head-pumping by 2 pairs; behavior of all pairs suggested females incubating
Great Inagua	28 May-3 June	1 brood of 4 fully-feathered young; 1 pair apparently nesting; 1 pair courting
New Providence	19 May	2 females apparently nesting; 1 brood of 4 fully-feathered young
	26 May	1 brood of 6 downy young; brood of 4 fully-feathered young still with both parents; other female still nesting
	15 June	fast nesting female with 5 downy young; brood of 6 downy young reduced to 4; 4 fully-feathered young moving about away from parents
San Salvador	11 June	1 brood of 5 downy young with 2 adults; 1 pair and 2 lone ducks

NEW ZEALAND BLUE DUCK

Blue ducks were studied by one of us (F.M.) on a 14 km stretch of the Manganui a te ao River near Tongariro National Park in the mountains of North Island, New Zealand between August 1980 and June 1981. This stretch of river was being considered for a hydro-electric installation at the time of the study, but it has since been decided not to go ahead with the scheme. The main study involved four breeding pairs on adjacent territories, all of which bred successfully during the year.

Pairs were strictly territorial throughout the year, except during the wing-molt. Defense was especially vigorous during the pre-breeding and breeding season. Egg-laying occurred between August and October. During the post-breeding flightless period, territory-owners became inconspicuous and some birds spent much time hiding while juveniles moved short distances up-stream from their natal territories and began to compete for mates. Territory defense is primarily by the male and males are bold and aggressive toward all sorts of intruders (including humans, cormorants and stoats).

There were many indications that life in the fast-flowing rivers inhabited by this species is demanding, and this is surely one of the most hazardous habitats imaginable for ducklings. Unlike most ducks, which take a mixture of plant and animal foods, blue ducks are primarily insectivores (Kear and Burton, 1971). Feeding entails moving the bill below, around and between rocks and boulders to remove aquatic insects and their larvae from the surfaces. Most feeding is done in rapids or rough water stretches, either by swimming with the head and neck submerged or by diving.

Egg-production is energetically costly for all female waterfowl, but this may be especially so for blue ducks. Clutch-sizes are relatively small (4-9, mean 5.4 eggs, Johnsgard, 1978) and one captive female laid at 2 day intervals instead of the usual daily rate found in most ducks (Cheyl Pirani, personal communication). Females feed energetically during their periods off the nest and, by the end of the incubation period females are likely to be in poor condition. This may be one factor favoring active participation by the male in brood-care.

While the ducklings are feeding, the female feeds with them. Like all female ducks, she leads the ducklings to some extent but they tend to wander away and often appear to be leading the family. Females feed steadily and spend little time in alert postures. In contrast, as the female and ducklings move along with their heads submerged, the male stands on top of a rock in an erect posture and lags behind the family, apparently watching over them. If danger threatens, he gives loud whistles and the ducklings become watchful. After female and ducklings have moved several metres away from him, he enters the water, swims after them and jumps out on another boulder near them to resume his alert vigilance. At the end of the brood's feeding spell, the male escorts his family as they come out on a rock to preen and prepare for a spell of sleeping. After they have settled, he leaves them and feeds energetically alone. This division of parental roles is reminiscent of that seen in families of geese, swans and shelducks, where the male watches over and actively defends the brood while the female spends much time feeding.

The behavior of blue ducks and African black ducks is similar in many ways (McKinney et al., 1978, Ball et al., 1978). Both species have territories that provide all requisites for the pair and their young throughout the annual cycle: a source of food, a nest-site, and safe hiding places during the wing-molt. A stretch of river is readily patrolled and defended, and territory-owning males are constantly alert for intruders. Apart from temporary associations between 2 or 3 individuals (often juveniles) during the period after broods break up, neither species shows tendencies to be sociable with conspecifics. In both species the crucial matters of acquiring a mate and a territory are intertwined and competition for these requisites involves damaging fighting and mate-stealing tactics. One major difference between these two river ducks is that the blue males contribute directly to brood care in conspicuous ways, while African black ducks have not been observed to do this.

DISCUSSION

Bahama pintails are probably sedentary in the Bahamas, and the same is likely throughout the Caribbean. On all the islands surveyed in spring by D.J.B., hunters reported seeing comparable numbers of birds at other seasons. The absence of major inter-island movements is sug-

gested by the fact that on Grand Bahama there is an abundance of suitable habitat virtually within sight of the marles of Abaco, a pintail stronghold, but only an occasional pintail is seen on Grand Bahama each winter (Archie McBride, personal communication). If birds on other islands have similar sedentary habits, there is little chance that the species will re-establish itself on islands where it no longer survives without a release program.

Although the Bahama pintail is a protected bird, and fair numbers are known to survive on certain islands, we suggest that its future is by no means assured. The total population on small islands could easily be wiped out by poaching or by hurricanes, and on the large islands increasing human pressures may soon threaten the wildest areas. Apart from the special interest that it has for biologists because it occupies an archipelago, the "white-jaw" is a distinctive Bahamian bird worthy of protection as part of a unique fauna.

Does a re-introduction program seem likely to succeed in the case of the Bahama pintail? From the point of view of the bird's behavior, we think that it does. A captive-breeding program could be established, using wild caught ducks and, judging from the ease with which the species has been kept and bred by aviculturists, releases on many islands could be very successful. So far as our sketchy information goes, the 3 biological traits identified by Fyfe (1977) as characteristic of successful island colonists are likely to be present: (1) high reproductive rate, (2) adaptable in ecological requirements, and (3) gregariousness.

In the case of the blue duck, we reaffirm the opinion of Kear and Williams (1978) that propagation and release programs are unlikely to be successful. Not only has this species proved to be very difficult to breed in the few instances in which it has been kept in waterfowl collections, but its specialized adaptations for river life are likely to pose special difficulties in acclimating captive reared birds to life in the wild. In particular, this is a species in which individuals must acquire a great deal of specialized knowledge early in life if they are to compete successfully for territories and mates, and probably an intimate knowledge of the natal river is very important in this competition.

In addition to the need to protect what remains of blue duck habitat in the mountains of New Zealand (Mills and Williams, 1978), the New Zealand Wildlife Service is exploring the possibility of introduction of wild-caught juveniles to areas where the species no longer occurs, or perhaps never did occur (Murray Williams, personal communication). This seems likely to be a more profitable technique than propagation for this species.

CONCLUSIONS

Neither the Bahama pintail nor the blue duck appear to be endangered at this time but their ranges have shrunk, their total numbers are probably not large, and they face human pressures that could threaten their survival before long. Such species provide opportunities to experiment with propagation, release and translocation techniques. Studies of social behavior, in the field and in captivity, can provide information that is likely to be useful in such conservation programs.

Males of both species defend territories but a knowledge of the mating systems indicates that territories have quite different functions. Male Bahama pintails combine monogamy with opportunistic promiscuity (i.e. forced copulation) and polygyny; their territories are centered around the female, they are defended while the female is fertile, and they appear to function primarily in defense of genetic paternity. Male blue ducks appear to be strictly monogamous and they defend all-purpose territories throughout most of the year. Pair-bonds and territories are of crucial importance to blue duck reproduction; Bahama pintails have more flexible breeding strategies and opportunities to rear multiple broods.

Both species appear to be sedentary and natural expansion of their current ranges is unlikely. There appears to be little inter-island movement of Bahama pintails in the West Indies; blue ducks are restricted to their natal rivers and movement between water courses is probably very limited. In both cases there are opportunities for reintroduction of birds to areas formerly used and, since natural catastrophes (hurricanes, volcanic eruptions) may have been involved, these areas may still be suitable.

The potential for captive propagation and release programs seems quite different for these two species. For Bahama pintails, this technique could prove very successful; for blue ducks it seems most unlikely. For both species, however, translocation of wild birds might work well. Intensive behavior studies on individually marked wild birds seem essential, before such techniques are tried. Decisions on the timing of releases, number of birds, age and sex-ratio could be influenced by predictions on how the released individuals are likely to respond to one another. We suspect that behavioral information may be just as important as knowledge about the habitat and predators in planning such experiments.

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