ASPECTS OF SOCIAL BEHAVIOUR IN THE BLUE DUCK

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SUMMARY

The social behaviour of the aberrant Blue Duck is reviewed. The bird is territorial and aggressive, except towards its own mate and offspring. The male's "territorial call" — a loud whistle delivered in a special posture — appears to be the main signal keeping pairs apart, but fights do occur, and a pronounced carpal knob on the wing is used in attack. As the Blue Duck appears to pair for life, courtship is not easily observed. Repeated acts of copulation, early in the breeding season, probably serve to synchronise the reproductive states of the pair. Copulatory display and the pre-flight signal have elements similar to those of perching and dabbling ducks.

Both adults care for the young, although this may not involve more than keeping them together, since anti-predator behaviour is not conspicuous. Family life seems to continue until adult plumage is attained at five months, at which time young birds probably leave their parents' territory.

The Blue Duck *Hymenolaimus malacorhynchos* is one of the most interesting and yet least studied of the waterfowl group. Phillips (1926) reported that since the earliest writers, almost no good field notes had been made and nothing of its behaviour recorded. Although healthy birds were maintained at the London Zoo for some years (Mitchell 1911), no observations on them were published and, unfortunately, of the captive birds at the Wildfowl Trust only males survived for any time (one for as long as ten years). Johnsgard (1965) studied unpaired birds there, but never saw a female.

Delacour (1956) thought the Blue Duck one of the most puzzling of waterfowl as to its affinities, and Phillips (1926) was of the opinion that it had no near allies anywhere in the world. It is in the species' social display, such as that shown at pair formation and, especially, at copulation, that clues to its evolutionary relationships are likely to be found (Delacour and Mayr 1945; Johnsgard 1965). With this in mind, M. Williams (1967) watched Blue Duck among a flock of New Zealand waterfowl kept at Mount Bruce Native Bird Reserve, Wairarapa, North Island. These were, however, relatively inactive and showed little other than aggressive interest in the other birds.

The following preliminary account of social behaviour is based on captive birds in England and New Zealand, on a brief study of wild birds by J.K., and on the analysis of cine films taken by T.H.S. in the wild. Most of the observations were made on the rivers Waipoa, Rere, Ruakituri and Hopuruahine.

PRE-FLIGHT MOVEMENTS

Like most waterfowl, the Blue Duck has a social signal which synchronises the pair or the family for take-off. This headflick is performed without calls and may be repeated a number of times before flight occurs. Figure 1 traces the slightly rotary movement from cine film frames and times the various phases. Shelducks, Hartlaub's Duck *Pteronetta* and some *Aythya* use similar repeated upward movements of the bill which McKinney (1953) called "chin-lifting," although in *Aythya* at least, the neck and head are fully stretched up. Several perching ducks (such as *Aix* and *Cairina*) perform slower craning movements of the head and bill upwards and forwards (Johnsgard

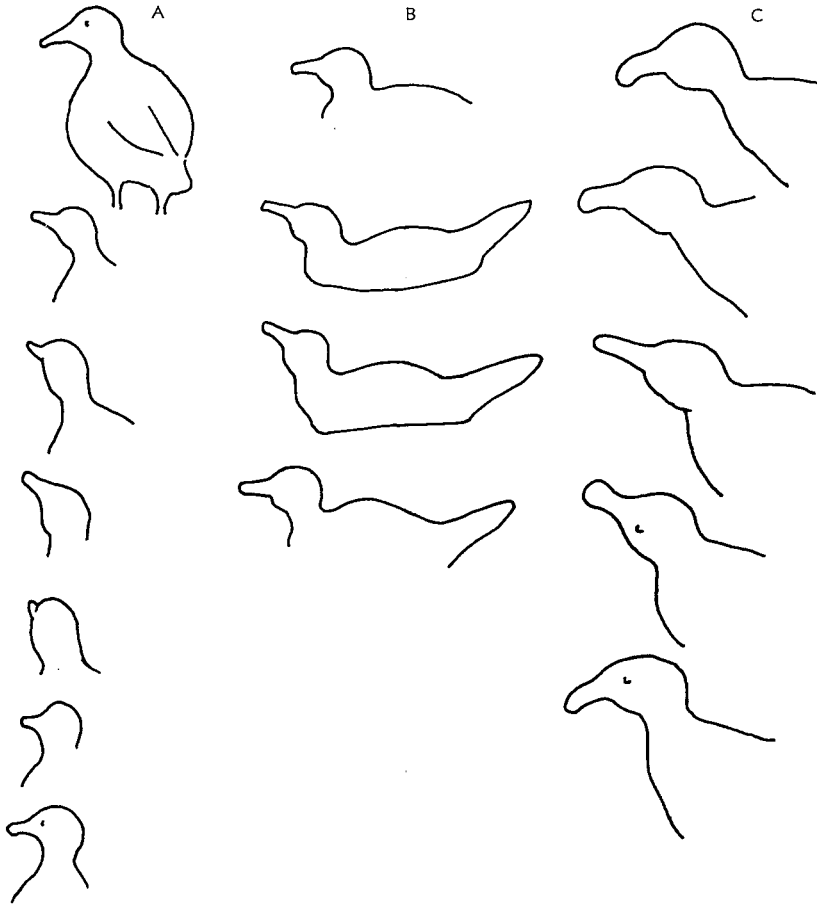

FIGURE 1 — Preflight signals from three different Blue Duck traced from consecutive frames of super-8 cine film (18 frames per second). Note the slightly rotary movement in (a) and (c). The downward component is performed more rapidly than the initial " chin-lift."

1962), while in other perching ducks and typical dabbling ducks *(Anas)* a faster " neck-jerking " is employed (McKinney 1953). Lateral head-shakes which are typical of most *Anas* species in a pre-flight situation, seem to be absent in the Blue Duck.

INTRASPECIFIC AGGRESSION

Mr. J. R. Forster, the naturalist who accompanied Captain Cook in 1773, noted that Blue Duck were always found in pairs. Indeed, *Hymenolaimus* is unusual among ducks in being highly territorial, possibly in relation to its insectivorous food supply (Kear and Burton

1971). Each male typically demands and defends a stretch of river into which he allows only his family, presumably as long as any ducklings are less than five months old and have not, therefore, attained adult plumage. The drake's voice appears to be the main signal keeping birds apart, but fights sometimes occur if individuals transgress each other's boundaries (Douglas, in Pascoe 1957; Steel 1970). Douglas recalled how he once walked four miles of a creek and, for the fun of it, drove every Blue Duck ahead of him. " On reaching the flats there was 13 pair of ducks with their numerous offspring engaged in a sort of Donnybrook. They fight with their wings trying to hit with a spur on the tip, but with all their fighting they don't appear to hurt each other much. On going up the same creek next day, I found . . . . every pair was back to their own ground and with all their young with them."

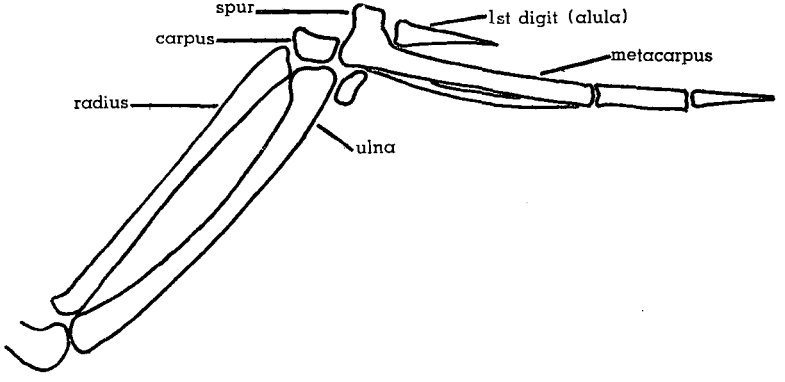

FIGURE 2 — Wing bones of adult male Blue Duck showing metacarpal spur. Traced from an X-ray.

The carpal joints of all birds examined, of six months and over, possess blunt bony knobs and those of adult males are frequently bare of feathers as well. These spurs are extensions of the first metacarpus (Figure 2) and thus comparable with, although larger than, those of many other waterfowl (Rand 1954). Wing knobs of only slightly smaller size are found in the African Black Duck *Anas sparsa* (Figure 3), which has a rather similar ecology and is also territorial (W. R. Siegfried pers. com.). Better developed, sharper spurs occur in the Torrent Duck *Merganetta* (Figure 3) which again is a territorial inhabitant of mountain streams. Johnsgard (1966) and Weller (1968) have stated that in *Merganetta* the use to which the spurs were put was still unknown. The bird is well protected from most terrestrial predators, " and no intraspecific fighting among males has been noted to my knowledge. There is no evidence that the spurs are used as an aid in climbing rocks, as has been suggested " (Johnsgard 1966). Travers (1872), however, interpreted their function in the Blue Duck thus: " they use their wings like hands, to cling to the stones in order to assist them in overcoming the rush of the water." Buller (1873) wrote " it climbs the slippery face of the rocks with facility, assisting itself in the ascent by its wings, which are armed at the

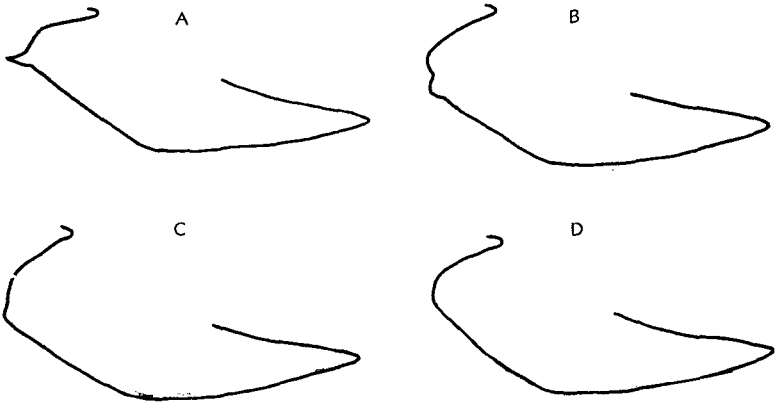

FIGURE 3 — The carpal joints of four species of duck: (a) *Merganetta,* (b) *Hymenolaimus,* (c) *Anas sparsa,* (d) *Anas penelope.* The last species is non-territorial.

flexure with a hard protuberance or knob," and Moncrieff (1957) went further in saying that the bird burrowed and climbed by aid of its wings. The present authors confirm that the wings are sometimes used in fighting and, although they have not seen the behaviour noted by Travers and others, suggest that further observation is required.

Described territories vary greatly in size. Douglas (Pascoe 1957) wrote " every pair keepts 2 or 300 yds. of the river to themselves," while in Guthrie-Smith's (1927) opinion three or four miles were required to support a pair on some rivers. On the Waipoa, an apparently well-stocked stream, five pairs are found in approximately 2½ miles. In other places, territories are obviously larger, but banding would be necessary in order to establish the maximum length of river that can be defended in its entirety. Boundaries often seem to be marked (to the human eye) by some prominent feature of the landscape such as a log or large boulder, and here the birds interact mainly by calling. The " territorial call " (M. Williams 1967) is a piercing drawn-out whistle, rendered by Johnsgard (1965) as *whee-ooo* and in the Maori name for the bird as *Whio.* It is delivered, sometimes from the water and sometimes from a rock, with the head and neck stretched out and the bill partly open (Figure 4). M. Williams (1967) noted, in addition, that the tail is slightly raised, the neck feathers ruffled and the call itself usually uttered twice. The whistling voice, although not the posture, develops in males at about 14 weeks of age (Pengelly and Kear 1970). It is loud enough to carry over the roar of waterfalls and differs markedly from the rasping quack of the female. Apart from the voice and a slight size difference, males weighing about 890 gm. and females 750 gm., the sexes appear identical.

The territorial call is heard in the early morning, and especially in the evening when birds emerge to feed. At this time they often fly the length of their territory and presumably interact with their neighbours. Two pairs on the Waipoa usually arrived at their common

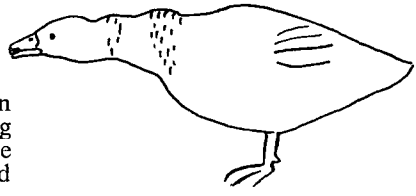

FIGURE 4 — The posture of an adult male Blue Duck giving the territorial call. Note the stretched and ruffled neck and the open bill.

boundary at dusk, whistled and quacked, and then spent the night within "shouting distance," sometimes no more than eight feet apart. Their visits seemed friendly rather than otherwise; fights were not seen here, even when one pair was deliberately driven into the territory of the other. All four birds merely became very excited in their calling. Perhaps as in swans (Kear 1972), it is only strangers that provoke full threat and attack, and neighbouring territory owners become well tolerated since they are not "expected" to move from their domain.

Except in this context, and when in family groups, Blue Ducks are not gregarious. They will, however, occasionally congregate at the mouths of rivers after flooding (Travers 1872), or in winter (Potts 1871; Soper 1965), when food shortage presumably drives them to leave their own ground.

AGGRESSION TOWARDS OTHER SPECIES

All the Blue Duck territories visited also contained Grey Duck *Anas superciliosa*, and signs, such as hatched nests and ducklings, of occasional breeding. Observations in the rivers Aniwaniwa and Rere indicated that Blue Duck were very aggressive towards, and had ascendancy over, Grey Duck. They may even have been responsible for the disappearance of a number of Grey ducklings. On the Aniwaniwa, they also put Mallard *Anas platyrhynchos* to flight. Male and female Blue Duck are both aggressive towards these other birds, rushing and finally flying at them over the water, with neck extended and head low, bill open and scapular feathers raised.

Neither species is likely to compete with the Blue Duck for food, except perhaps at the duckling stage; the main potential dietary competitors seem likely to be native eels (Burnet 1952) and other fish, the introduced trout (Kear and Burton 1971), and possibly insectivorous birds, many introduced, which feed on imagos. A shortage of nest sites is unlikely to be a problem since these are relatively numerous, and Grey Duck at least frequently nest in tree sites which are not selected by the Blue Duck. The antagonism is probably incidental to a territorial system of great selective advantage.

Paradise Shelduck *Tadorna variegata* are also occasionally seen in Blue Duck country. This species is, however, generally avoided. A single threat posture from a male Paradise Shelduck can produce flight, although at other times apparently undemonstrative birds are merely whistled at (Child 1961). Subordination to Shelduck and dominance over other New Zealand waterfowl accords with observations

made by M. Williams (1967) in captivity. Domestic Muscovy Duck *Cairina moschata* have also once been seen to threaten wild Blue Duck and produced a typically "frightened" response. The male gave a short, sharp whistle, both he and his mate made for the bank and were chased about 12 feet up it.

It is a commonplace that human beings invoke a territorial response from Blue Duck rather than frozen silence or flight. This is especially true when feeding birds are encountered early or late in the day. Indeed, in summer, they are not often visible at other times and when disturbed from their hiding places, are usually quite quiet and fly away to hide once more beneath the bank or under a log. However, if already in the open, the male stands his ground and whistles repeatedly at the intruder. In the past, this reaction was interpreted as mere stupidity (Phillips 1926) as, of course, it was until man came to appreciate the aesthetic value of a "tame" avifauna. Thus it is frequently possible to approach Blue Duck closely before they slip into the water and drift downstream. Douglas (Pascoe 1957) wrote "I have . . . . walked within a foot of them . . . , and on looking round there they were, stretching their necks, whistling and hissing."

Sometimes the birds' reactions to man do look ambivalent, as though they were undecided as to the best course of action: to stay or to flee. In this situation, the bird gives jerky, forward-and-backward movements of the head and neck (Scott 1958), which probably enable it to see any intruder, and to judge distance and direction, better. Cocking of the tail, by both sexes and all ages, is also often apparent in the presence of humans, and is common when the adults have ducklings, or during courtship and aggressive display. The significance of this tail cocking is not known; perhaps it usually serves to make the duck more conspicuous to its offspring, parent, mate, or the object of its aggression.

Blackburn (1963; 1967) reported that he once disturbed a bird from hiding and was surprised to see that the usually white bill (often a pale pink in the breeding season) was a brilliant "shocking" pink. He suggested that, as in some other avian species, confusion or fright caused a rush of blood to the bill. He pointed out that such an observation would be unusual, as this species is normally so completely unafraid of man. M. Williams (1967) has recorded the same reaction from a captive Blue Duck which was being handled.

PAIR FORMATION

Very little information is available on pair formation. The situation in which it takes place seems obviously different from that in gregarious ducks where males display together around the females. Perhaps further observation will reveal that courting parties of unattached juveniles do occur. Unpaired Blue Duck at the Wildfowl Trust called at dusk, using a sound indistinguishable from the territorial call. It is possible that some element of this cry attracts unmated females to a drake which already has an established territory. On the other hand, in New Zealand, captive drakes have more than once attracted wild males into their pens. And it is possible for humans

to bring Blue Duck males "out of the sky" by imitating the whistle (L. Ross pers. com.). Interestingly, a decidedly unbalanced sex ratio in favour of males seems normal in adult Blue Duck (B. A. Vercoe in litt. 1963). A higher female death rate at hatching and in early life may be typical of all ducks (Kear 1965). Females are, in addition, exposed to risk during egg-laying and incubation. So an uneven sex ratio in Blue Ducks may be unexceptional, although of no advantage to an apparently long-lived, monogamous and unpromiscuous species.

The age of pair formation is not known but it probably occurs after the bird is five months old. At the Wildfowl Trust, a six-month old female (that is, one in adult plumage) was placed in the pen of a male at least eight years of age. He pursued her closely, often with his tail cocked, giving a quiet three or four syllabled whistle. This the young female seemed to regard as a threat; she rushed to hide in the bushes and repeatedly escaped from the pen. Two weeks later, they were again put together, this time in an unfamiliar pen. Here they both hid, spending most of the first 24 hours in the same box, and emerged apparently firmly mated. Thereafter they were never far apart, although except for frequent soft calling, were undemonstrative. Unfortunately, the female died before the next breeding season and no observations could be made on their subsequent courtship.

Johnsgard (1965) reported on a male Blue Duck at the Wildfowl Trust which became associated with a female Common Shelduck *Tadorna tadorna* that was already paired. The Blue Duck followed this bird constantly, although he was often chased by the drake Shelduck. The Blue Duck would face her with his chest low in the water and tail and hindquarters lifted as he uttered a whistled *zweee* repeatedly, each note rising in pitch towards the end. As he called he lifted his chin and bill strongly and repeatedly in a manner resembling the chin-lifting display of wigeon. He showed no tendency to Turn-the-back-of-the-head toward the female, as wigeon and other dabbling duck do, but a general body shake, similar to the Introductory shake, was observed several times during display. Johnsgard (1965) interpreted this as courtship; however Williams (1967) reported similar chin-lifting and calling in both male and female Blue Duck, the female producing staccato, low-pitched rasping notes rather than the whistle. These head-flicking calls were recorded in two situations: when a pair was chasing a third Blue Duck (probably a female) and in response to intraspecific fighting and Inciting among the Paradise Shelduck. In the latter instance, one or both of the Blue Ducks would race to the vicinity and dart about continuously uttering the head-flick call. If they were responding to an Inciting display, they were frequently charged by the Shelducks. Williams was uncertain as to the correct interpretation of this display, but did not accept that it was courtship.

PAIR MAINTENANCE

It is likely that Blue Ducks pair for life (Buddle 1951), although banding would be necessary in order to prove this. Pairs are certainly found throughout the year and except during egg laying and incubation, male and female seem never far apart. Cohesion is probably maintained partly by voice since, in captivity at least, the pair call softly

to each other for much of the time. This repeated vocalisation seems typical in the wild also, although it is often difficult to approach near enough to hear it without disturbing the birds.

In the breeding season, which is extended so that egg-laying includes any part of the period from August to January (Kear, in prep.), the bills of both sexes may turn pinkish in colour. Repeated acts of copulation apparently function to synchronise the reproductive condition of male and female, since it occurs much more frequently and over a longer period than would be necessary to fertilize the clutch.

Before copulation, the male follows the female more closely than usual, often carrying his tail slightly higher than she does. The pair finally face each other and bob their heads a number of times (between two and six), as is typical of all surface-feeding ducks.

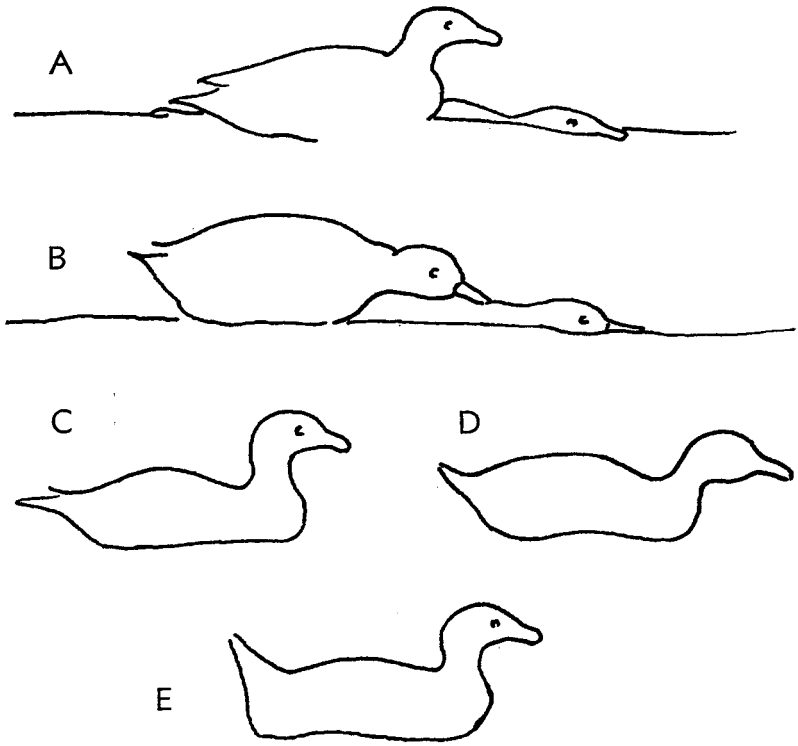

FIGURE 5 — Copulation in the Blue Duck: (a) the female takes up a prone posture, (b) the male grasps her neck quite far back, (c - e) after mounting, the male holds an erect posture, moves his head slightly forward and back, and raises his tail; he is positioned sideways on to the female and does not move his body forward. If a call is made, it would be expected at (d). Traced from a super-8 cine film.

She lowers her body in the water and extends her neck. He then swims round to her side and may nudge her a number of times with his chest before mounting crossways, turning and grasping her neck in his bill. He shakes his tail a number of times and intromission is achieved with a fast sideways movement. Treading lasts from four to eight seconds, after which the male slips off — in all cases observed he mounted on her left and climbed off on the right. He then raises his head and stays erect for a moment, sideways on to his mate; he may extend his neck forward slightly, withdraw it and then raise his tail. He does not obviously Bridle or Nod-swim, as many *Anas* ducks do, and no calls have been heard from either bird, although a note might be expected from the male at stage (d) in Figure 5. The female always washes and preens, sometimes merely head-dipping but at other times plunging deep, wings flapping and tail wagging. The male may occasionally join her in bathing.

The whole performance is rather variable, especially between presumably long-mated birds. The preliminary close following, tail erection and even head-bobbing, do not always occur, in particular when, as sometimes happens, the birds copulate a number of times in rapid succession.

Before head-pumping, the female may flap her wings on the water in front of and around the male, dragging her body low at the surface with the wings held slightly out. In other ducks, the behaviour would probably be interpreted as rather intense bathing, unritualized into display. In the female Blue Duck, however, this particular performance has only been observed at pre-copulation (it is interesting that M. Williams (1967) reported that bathing was noticeably infrequent in Blue Ducks). Johnsgard (1965) described a possibly similar display in *Anas sparsa*. " During intensive mutual display, the female will sometimes suddenly flatten out almost prone on the water and swim rapidly round the male once or twice. The performance reminds one at once of Nod-swimming, but it lacks any " nodding " and does not occur in a typical Nod-swimming situation. I believe it must represent a primitive form of Nod-swimming rather than a copulation solicitation display."

The only other behaviour of the pair possibly involved in pair maintenance, is the male's occasional touching or pecking of the female on the back. This is too rapid to be allopreening and may merely be the first stage of attempted mounting (although it was never seen to be followed by copulation). It is probably similar to the behaviour shown by male *Aix sponsa* and *Anas sparsa* (Johnsgard 1965). Guthrie-Smith (1927) mentioned a possibly corresponding observation in which he did not enlarge. He wrote that the parents of a brood of feeding Blue ducklings floated motionless or paddled slowly about, " every now and then one of them in play making hostile feints at the other."

PARENTAL CARE

As in many other tropical or near-tropical ducks, which have extended breeding seasons and long pair-bonds, only the female incubates but both adults share parental duties after hatching (Kear 1970). Presumably because of a lack of ground predators, the species has evolved no injury-feigning display to draw potential enemies from its young. (It is remarkable that the Paradise Shelduck with apparently

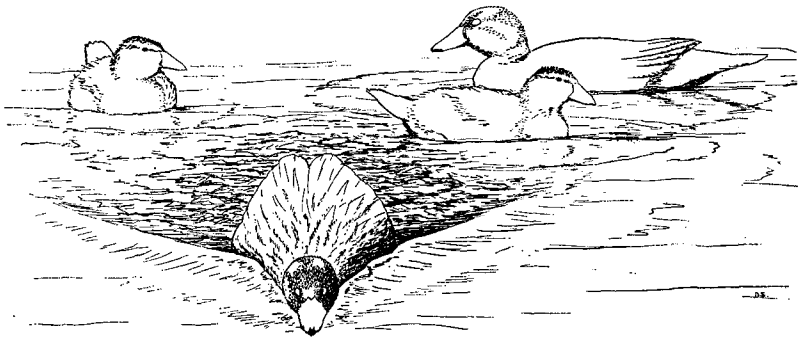

FIGURE 6 — Aggressive rush by drake Blue Duck in defence of his brood. Drawn by D. Scott from a photograph by C. Roderick.

the same absence of predation, does give one of the most spectacular broken-wing displays seen in the Anatidae.) However, a male Blue Duck with small ducklings has on rare occasion been seen, and photographed, rushing at a human intruder over the water in a similar posture to that used in chasing other birds (C. D. Roderick pers. com.; G. R. Williams 1963). Predators may be more numerous than at first appears likely. Circumstantial evidence indicates that the fresh-water eel takes ducklings (large eels are known to have strongly developed carrion-feeding tendencies (Burnet 1952)), and raptors could also be predatory. It is not known whether special behaviour patterns have been evolved to reduce underwater attack, but Soper (1965) stated that to escape danger from the air the Blue Duck flattens itself on the rock on which it is standing, stretches its head forward and freezes. Possibly a special alarm call makes the ducklings rush for cover. Blue Ducks with young may take up the posture described by Soper when approached by man, if the family is already on the rock.

Unfortunately, against the introduced rats, stoats, weasels and polecats, as well as dogs and cats, the Blue Duck seems to have little defence except to keep their young on the water (Potts 1871) or to hide them beneath the bank (Buddle 1951). While they have a family, the adults themselves do not retire during the day except for short rest periods. Presumably this is because their offspring must feed more or less constantly through the hours of daylight. Blackburn (1967) suggested that the young were taken to the bank to be brooded, where they would be, of course, particularly vulnerable. They have, however, also been seen under the female on rocks in mid-stream.

To move downstream through their territory, the whole family launches itself over the rapids and the young seem to come to no harm from the buffeting of the water. In order to go upstream again, the ducklings may have to come ashore. Buddle (1951) recalled one such incident: " the drake led them to the bank, where they climbed out on to a little shingly beach, then in single file the whole

party threaded its way through a mass of boulders and broken rocks a distance of twenty yards till they were able to take to the water again in the pool above, the duck following behind." Potts (1871) described a similar occurrence although he thought it was the female who led: "the duck marches in front, with her low wailing call, the small brood follow, whilst the drake protects the rear, or rather offers himself as the first victim to the pursuer."

The family stays together while the young are in juvenile plumage, which lasts until five months of age and is described in Pengelly and Kear (1970). Possibly it breaks up as in some other waterfowl, when the parents eventually chase away any Blue Duck which appears to be an adult, and therefore a potential rival.

DISCUSSION

Much remains to be learnt about *Hymenolaimus*. This paper describes a very preliminary study to serve as a basis for future investigation. The species remains a puzzle with regard to its evolutionary relationships, since many of its behaviour patterns obviously adapt it to an exceptional environment. Territoriality seems at a premium and sexual activity is probably directed towards a single, life-long partner. It is difficult therefore to distinguish between adaptive and more basic, "primitive" characteristics. The *Anas* type pre-copulatory head-pumping seems to place it with that group; however the male's post-copulatory posture is not typical (especially as he appears to make no sound), nor are pre-flight signals. Complex post-copulatory displays are lacking. Other behavioural elements suggest affinities to the most "generalised" species of *Anas*, the African Black Duck *A. sparsa* (Johnsgard 1965), and to some of the perching ducks. The species is for the moment probably best thought of as deriving from an early stage in the evolution of the dabbling ducks from their perching duck-like ancestors.

A number of questions about the birds' biology cannot be answered until a population has been banded. This will confirm their life-long pairing, and enable an assessment of longevity. Where are the "spare" young birds waiting to fill the inevitable gaps? Do Blue Ducks ever move to more desirable territories or ever feed outside their own? Other points particularly worthy of research are the mechanisms of family break-up and the repertory of vocalizations — an obvious social feature barely touched on in this study.

ACKNOWLEDGEMENTS

Mr. M. Williams was kind enough to comment on an early draft of the manuscript, and Dr. P. Johnsgard and Dr. D. F. McKinney advised on behavioural aspects. We are also grateful to Miss D. Fowler for help with the preparation of diagrams, and to Miss D. Scott, who drew Figure 6 from a photograph taken in the wild by Mr. Colin Roderick. The print was very kindly supplied by the Department of Internal Affairs.

REFERENCES

BLACKBURN, A., 1963: Does the Blue Duck blush ? Notornis 10: 356.

BLACKBURN, A., 1967: New Zealand's Blue Duck. Animals 9: 620-623.

BUDDLE, G. A., 1951: Bird Secrets. Wellington: Reed.

BURNET, A. M. R., 1952: Studies on the ecology of the New Zealand Long-finned Eel, **Anguilla dieffenbachii** Gray. Aust. J. Mar. Freshw. Res. 3: 32-63.

CHILD, P., 1961: Female Blue Duck apparently paired with Paradise drake. Notornis 9: 170.

DELACOUR, J., 1956: The Waterfowl of the World Vol 2. London: Country Life.

DELACOUR, J., and MAYR, E., 1945: The family Anatidae. Wilson Bull. 57: 3-55.

GUTHRIE-SMITH, H., 1927: Birds of the Water, Wood and Waste. 2nd ed. Wellington.

JOHNSGARD, P., 1962: Evolutionary trends in the behaviour and morphology of the Anatidae. Wildfowl Trust Ann. Rep. 13: 130-148.

JOHNSGARD, P., 1965: Handbook of Waterfowl Behavior. Ithaca: Cornell University Press.

JOHNSGARD, P., 1966: The biology and relationships of the Torrent Duck. Wildfowl Trust Ann. Rep. 18: 66-74.

KEAR, J., 1965: The internal food reserves of hatching Mallard ducklings. Journ. Wildl. Mgmt. 29: 523-528.

KEAR, J., 1970: The adaptive radiation of parental care in waterfowl. In Social Behaviour in Birds and Mammals, ed. J. Crook. London: Academic Press.

KEAR, J., 1972: Reproduction and Family life. In The Swans, ed. G. L. Atkinson-Willes. London: Michael Joseph.

KEAR, J., and BURTON, P. J. K., 1971: The food and feeding apparatus of the Blue Duck **Hymenolaimus.** Ibis (in press).

McKINNEY, D. F., 1953: Studies on the behaviour of the Anatidae. Unpublished Ph.D. thesis, University of Bristol.

MITCHELL, P. C., 1911: On longevity and relative viability in mammals and birds; with a note on the theory of longevity. Proc. Zoo. Soc.: 425-549.

MONCRIEFF, P., 1957: New Zealand Birds. Wellington: Whitcombe and Tombs.

PASCOE, J., 1957: Mr. Explorer Douglas. Wellington.

PENGELLY, W., and KEAR, J., 1970: The handrearing of young Blue Duck. Wildfowl 21: 115-121.

PHILLIPS, J. C., 1926: A Natural History of the Ducks, Vol. 4. Boston: Houghton Mifflin.

POTTS, T. H., 1871: On the birds of New Zealand. Part 2. Trans. N.Z. Inst. 3: 59-109.

RAND, A. L., 1954: On the spurs on birds' wings. Wilson Bull. 66: 127-134.

SCOTT, P., 1958: Notes on Anatidae seen on world tour. Wildfowl Trust Ann. Rep. 9: 86-112.

SOPER, M. F., 1965: More New Zealand Bird Portraits. Wellington.

STEEL, T., 1970: The New Zealand Blue Mountain Duck. N.Z. Wild Life 29: 9-11.

TRAVERS, W. T. L., 1872: Notes on the habits of some of the birds of New Zealand. Trans. N.Z. Inst. 4: 206-213.

WELLER, M. W., 1968: Plumages and wing spurs of Torrent Ducks **Merganeta armata.** Wildfowl 19: 33-40.

WILLIAMS, G. R., 1964: Extinction and the Anatidae of New Zealand. Wildfowl Trust Ann. Rep. 15: 140-146.

WILLIAMS, M., 1967: Observations on the behaviour of New Zealand Anatidae in captivity. Unpublished B.Sc. (Hons.) thesis, University of Wellington.