Salvadori's Duck of New Guinea

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When Phillips published the fourth volume of his Natural History of the Ducks in 1926, he noted that Salvadori's Duck *Salvadorina (Anas) waigiuensis* was 'the last to be brought to light and perhaps the most interesting of the peculiar anatine birds of the world'. It was still practically unknown in 1926; the first recorded wild nest was not seen until 1959 (H. M. van Deusen, in litt.), and even today the species has been little studied.

The first specimen was called *Salvadorina waigiuensis* in 1894 by the Hon. Walter Rothschild and by Dr Ernst Hartert, his curator at the Zoological Museum at Tring. The name was to honour Count Tomasso Salvadori, the Italian taxonomist who specialized both in waterfowl and in the birds of Papua New Guinea. The bird was said to have been collected in Waigeo, an island north-west of New Guinea (hence the specific name); however, some doubt about the accuracy of the original label exists, and the mountains of Vogelkop (Figure 1) are thought more likely to have been the type locality (Mayr, 1941). Today, Salvadori's Duck ranges throughout the mountain areas of north-eastern, central and south-eastern New Guinea, never descending to the lowlands.

At the outset, the systematic position of *Salvadorina* was far from clear. Usually, the species was placed with *Merganetta,* the Torrent Duck of South America, and *Hymenolaimus,* the Blue Duck of New Zealand, in a tribe called Merganettini, close to the diving ducks and mergansers. Then Mayr (1931a) was able to examine a dead specimen and found that the sternum and trachea of the male were, although smaller, similar to those of the Mallard *Anas platyrhynchos.* As a result, Salvadori's Duck was moved to the genus *Anas.* However, as Niethammer (1952) and Kear (1972) later pointed out, the trachea of the Torrent and Blue Duck are also *Anas*-like, so that, on this character, the genera *Merganetta* and *Hymenolaimus* could also be eliminated, and all three species put with the typical dabbling ducks.

The present author had already studied the Blue Duck in New Zealand (Kear, 1972), and was lucky enough to be able to watch Salvadori's Duck briefly in New Guinea during July and August 1974. Two localities, both close to 6°S and 144°E, were selected: at an altitude of about 2,135 m on the River Kaugel, and on the Baiyer River at about 950 m (see Figure 1). This paper aims to bring together as much as possible of the published and unpublished observations on an unusual bird, and to serve as a basis for much fuller research.

Description

Table 1 lists weights and Table 2 measurements of adult specimens. The duck is small —about half the weight of the average Mallard—and the sexes are similar in plumage

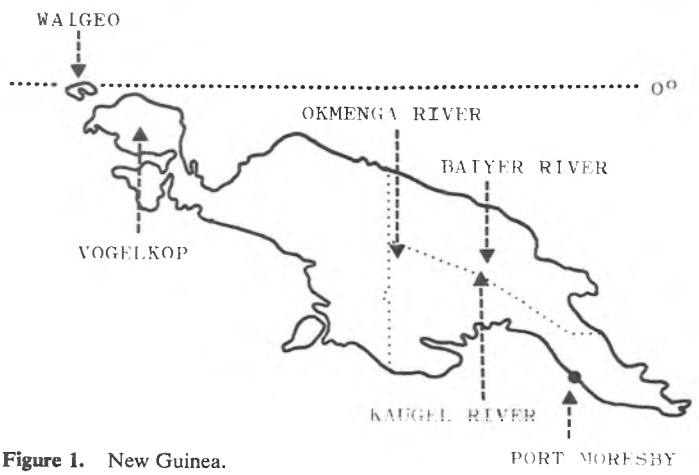

Figure 1. New Guinea.

and in size, the males being only slightly larger than the females. Diamond (1972) has suggested that the birds at higher altitudes might have longer wings, and certainly the male with the longest wing recorded, 207 mm, was shot at 3,850 m (Mayr & Rand, 1937). On the other hand, the shortest, at 179 mm, was taken at 3,225 m (Rand, 1942).

The voices of the sexes differ—the male whistling, although not often, and the female having a harsh two-syllabled quack. Reports that the male lacks the barring on the tail of the female (De Vis, 1897) and the juvenile (Mayr & Rand, 1937) are now considered doubtful (Ripley, 1964). The head and neck are greyish black, the underside white or pinkish buff, and the back and flanks are black but strongly marked with narrow white

Table 1. Weights of adult Salvadori's Duck

MALES		
g	Month	Source
500	February	Mayr (1931b)
525	March	„
450	March (in wing moult)	„
400	March (immature plumage)	„
440	April	CSIRO (Schodde, pers. com.)
324	May (captive)	Mayr & Gilliard (1954)
445	July	CSIRO (Schodde, pers. com.)
450	„ (testis enlarged)	„
460	„	„
429	November	„
462	average (excluding the captive and immature specimens)	

FEMALES		
g	Month	Source
500	February	Mayr (1931b)
500	March	„
420	July (oviduct developed)	CSIRO (Schodde, pers. com.)
430	„	„
435	„	„
480	„ (oviduct developed)	„
520	September (in wing moult)	Ripley (1964)
469	average	

Table 2. Measurements in mm of adult Salvadori's Duck

	Bill			Head			Tarsus			Wing		
	Mean	Range	No.	Mean	Range	No.	Mean	Range	No.	Mean	Range	No.
Males	37·2	34·9–39·1	10	83·0	80·7–85·5	7	39·7	35·1–42·6	7	194	185–207	18
Females	36·1	34·0–37·8	7	78·7	76·4–81·0	4	39·2	36·0–40·7	4	185	179–196	16

Individual measurements from Diamond (1972), Mayr & Gilliard (1954), Mayr & Rand (1937), Rand (1942) and Sims (1956) were used, plus those of 7 males and 4 females at Slimbridge.

bars. The body is slim and the tail long and pointed. Full descriptions are given in Phillips (1926) and Delacour (1956). Our observations differed from theirs in only one respect: the bill is, at least in many wild specimens, a conspicuous bright yellow. This colour intensity varies, however, and birds in captivity tend to have bills that are paler, or tinged with brown and black. Possibly bills are brightest yellow just before or during breeding. One melanistic female specimen has been described which had the whole of the underparts brownish black, including the undertail coverts which are normally pale (Rand, 1942).

The bird flies low and fast, keeping no more than 5 m above the surface, following the line of the river. It often runs along the water before taking off, and Bell (1969) wrote that birds crossing a fast-flowing stream bounced over the water-covered rocks with great agility, wings flapping and with legs slightly beneath the surface. When walking or swimming, the head is jerked, an adaptation for observing the environment more closely (Johnsgard, 1965). This jerking results from keeping the head motionless much of the time while the body is moving. Like the Blue Duck, Salvadori's Duck has forward-looking eyes, which presumably allow for binocular vision and the better detection of small, moving prey. When the bird is alarmed or excited, its tail is cocked so that the white underside becomes conspicuous, and this probably acts as a social signal to the mate and family.

Habitat

The species is found in New Guinea in three habitat types: rushing mountain torrents; rather sluggish muddy streams; and alpine lakes. The bird is structurally well adapted to, and very much at home in, turbulent water, but is clearly not confined to cascading rivers. This is a particularly puzzling feature. One wonders whether originally there was some other waterfowl species in stiller waters which is no longer present, and its disappearance allowed the already specialized Salvadori's Duck to take over less rigorous environments. The only sympatric waterfowl seen were Black Duck *Anas superciliosa* and these were relatively uncommon. An alternative hypothesis suggested by Dr C. M. Perrins (pers. com.) is that until recent geological time, New Guinea was extremely precipitous and there were no high altitude lakes, only rapidly flowing rivers. In these circumstances there would only be room for a duck such as Salvadori's, and not for a still-water duck as well. Salvadori's Duck has taken over the 'new' habitat, perhaps because it is better adapted to high altitude living than any other 'available' species.

Salvadori's Duck occurs between the extreme altitudes of 500 m and 3,850 m, and Rand (1942) found footprints as high as 4,000 m. They are common at around 3,700 m and are normally found in pairs or families. Observations on the Baiyer River indicated that something like 1,500 m of stream separated each pair of birds, but on the Kaugel, territories seemed much smaller, and Bell (1969) in his survey of the Ok Menga River (Figure 1) found at a height of 600 m, a pair to every 160 m. Fights, using bill and wings, were seen on the Kaugel between males of adjacent pairs, and a male specimen examined had (like the Blue Duck) blunt spurs on the wrist of its wings worn bare of feathers. The females did not engage in actual combat but apparently incited their mates by rushing about giving up-and-down neck movements and double-noted quacks. As might be expected, it is difficult to keep more than one captive pair on a single pond (Delacour, 1956; Hallstrom, 1956).

Feeding

Bell (1969) made a study of feeding behaviour on the Ok Menga River, where it was 35 m wide and 0·6 m deep and flowing so fast that it could only be crossed with ropes. The ducks sat in the surge of the rapids, treading water to maintain position while feeding 'like normal dabbling ducks'. They probed into eddies between the rocks and stretched their necks round corners in their search, occasionally diving for a few seconds. They appeared to dive, emerging up or down stream, when the current was too strong for surface swimming. Large concentrations of water fleas were gathered in the eddies of the stream and Bell had no doubt that these were the food of the ducks. Scott (1958) recorded captive birds frequently upending to feed, as other dabbling ducks do, but diving more readily and going under from a low position in the water without raising a ripple. The birds on the Baiyer and Kaugel Rivers were accomplished divers, giving a little forward spring before submerging, and this was their main method of feeding. Thirty-one dives averaged 12 seconds and ranged from 7 to 18 seconds. During a bout of diving, time spent on the surface varied between 2 and 45 seconds, and 16

'intervals' averaged 18 seconds. Between dives, the bird often shook itself while reaching forward and treading water (presumably to remove excess moisture from the plumage), and also frequently flapped its wings before diving again. The Blue Duck dives in a similar manner and remains submerged for much the same length of time (Kear & Burton, 1971).

Mayr & Rand (1937), Shaw Mayer (in Sims, 1956), Bell (1969) and Diamond (1972) all examined stomach contents of dead birds, but merely recorded aquatic insect remains, including those of water beetles, and also river gravel, and a little green vegetable matter. Some gut contents are preserved at the Commonwealth Scientific and Industrial Research Organization (CSIRO) centre at Canberra (R. Schodde, pers. com.), which should be available for future study. From samples taken in the territory of a pair with ducklings on the Baiyer River, caddis fly larvae, dragon fly nymphs, water beetles, and tadpoles could be important food items. Tadpoles are, indeed, considered by F. W. Shaw Mayer (in litt.) to be a major food in the wild, and ducklings bred in captivity at Nondugl took these readily during the first few days of life (in addition to small minnows, ants' eggs and soaked dog biscuit). Shaw Mayer also mentioned that his birds were largely nocturnal.

Breeding biology

Males and females probably mate for life (since they are seen in pairs year round) although this needs confirmation. One courtship display was described by Scott (1958) who saw a captive male stretch his neck, move his head slightly and utter a whistle. The female responded by quacking and pumping her head up and down violently. Johnsgard (1965) suggested that the male's posture was similar to the Burp of some *Anas* ducks, such as A. *castanea* and the pintail group. It is noticeable that the male's whistle is used only in courtship and not, apparently, in fights nor as a territorial signal as in the Blue Duck.

The nesting season is a long one (Table 3). Eggs were laid in captivity at Nondugl (at 1,580 m) as early as May; many clutches there hatched in June, and the breeding season in the wild continues through August and September to mid-October, when four week-old ducklings were brought into the Baiyer River Bird of Paradise Sanctuary (G. George, pers. com.). Edward Hallstrom is reported by Delacour (1956) to have written in a letter that three ducklings hatched at Nondugl in January 1956; and Ripley (1964) found males in breeding condition in February and March. It is possible, therefore, that the species has two breeding seasons —Ripley thought the evidence inconclusive —or that birds at higher altitudes typically breed at a different time than those at lower ones. The data are, at the moment, too limited to suggest a trend. Diamond (1972) pointed out that breeding in the dry season would be desirable for birds inhabiting small highland streams; otherwise sudden flash floods would destroy their nests.

Nest sites are always near water and often on islands in a depression concealed within grass clumps or shrubs. A large boulder in a stream may supply sufficient cover for a nest. Bulmer (1966) was told by the natives that nests were also found in riverside 'gardens' (mostly sweet potato patches). The structure itself is lined with grass, and probably also with down.

Measurements of four eggs are available: one, 55·5 mm × 42 mm, was originally described by De Vis (1897); an egg in the museum at the Wildfowl Trust, laid in captivity at Nondugl, measures 61·5 × 41·1 mm; and two fresh eggs collected on the Al River in August 1974 measured 57·6 × 44·8 mm and 55·7 × 42·5 mm. These give an average figure of 57·6 × 42·6 mm. The latter two eggs weighed 60 g and 56 g which is about 13% of the weight of the average female (Table 1). This figure is not unlike that of 10% for the Blue Duck (Kear, 1972) nor that of 16% suggested by Lack (1968) for the Torrent Duck, but is very high for dabbling ducks in general—the egg of the Mallard represents only 5·3% of its body weight. In colour, the eggs are creamy white with a slight greenish tinge. Tyler (1964) gave the shell weight of a single blown egg as 3·68 g (the one in the Wildfowl Trust's museum is 3·76 g), and found that the shell's structure and chemistry were typical of the subfamily anatinae.

The clutch normally consists of only three eggs; one clutch of four is reported to have been laid in captivity (F. W. Shaw Mayer, in litt.) and two wild broods of four ducklings have been recorded (Table 3). This is a particularly small clutch (the Mallard lays an average of ten or eleven), although that of the Torrent Duck is similar at three or four eggs, and the Blue Duck has an average of only five.

The incubation period is unknown, but according to Shaw Mayer's notes it must last at least 28 days.

The young are said to be carried on the back of the female (Hallstrom, 1956)—an in-

Table 3. Breeding data on Salvadori's Duck

	Date	Locality	Source
3 ducklings hatched	8 June	Nondugl (captive)	F. W. Shaw Mayer, pers. com.
3 ducklings hatched	15 June		
1 duckling hatched	29 June		
3 ducklings hatched	30 June		
Nest found with bird incubating	14 June	Mt. Wilhelm	H. M. van Deusen, pers. com.
Female shot containing egg nearly ready to lay	24–28 July		Diamond, 1972
3 ducklings seen	20 July	Nona River	CSIRO collection
3 ducklings seen		Minj River	(R. Schodde, pers. com.)
(three other adults were taken in breeding condition in July—see Table 1)			
Nest found containing 3 eggs	27 July	Wi River	Diamond, 1972
Nest found containing 3 fresh eggs	4 Aug	Al River	
Males and females taken with enlarged gonads	August	Central New Guinea	Ripley, 1964
4 ducklings seen about month old	6 Aug	Baiyer River	
2 half-grown ducklings taken	17 Aug	Mt. Tafa	Mayr & Rand, 1937
2 ducklings taken, a few days old	9 Sept		Ripley, 1964
1 duckling taken, a few days old	12 Sept	Nondugl (wild)	Gylenstolpe, 1955
4 ducklings brought in about 1 week old	17 Oct	Baiyer River	G. George, pers. com.
3 ducklings hatched	January	Nondugl (captive)	Hallstrom in Delacour, 1959
Male adults taken with enlarged testes	February and March	Central New Guinea	Ripley, 1964

teresting observation which merits further investigation, as the habit is unusual in ducks (Johnsgard & Kear, 1968). A small brood might make the carrying of young that much more likely, and the only other duck regularly to do so is the Musk Duck *Biziura lobata,* which also lays only three eggs. Newly-hatched Salvadori's young appear black (or dark brown) and white, with a white patch on the wing and two pairs of white spots on the sides of the back. The sides of the head, throat, and the underparts are white with a dark line from the back of the eyes to the neck and a darkish patch on the ear coverts. The bill of the young duckling is pink and grey and the voice is typical of other *Anas* species (or *Hymenolaimus*) at that age. They are almost full-grown, but with dark bills, at two months and are still with their parents on the territory. Their behaviour in surging water is similar to that of young Blue Duck and that reported for downy Torrent Ducks: they seem equally capable of negotiating a fast-flowing stream, and dive with ease.

Moults

Data on moult are limited and more information will be needed before any trends are clear. Males are reported to be in general body moult in April, November and July (CSIRO collection, R. Schodde, pers. com.), and specimens taken by Mayr & Rand (1937) in June and July also showed some body moult. A male was in wing moult in March (Mayr, 1931b) and a female in heavy wing moult while accompanying young ducklings in September (Ripley, 1964). A captive male at Slimbridge was noted to be growing new primaries at the end of October.

Threats to survival

Territorial ducks are nowhere very numerous since they automatically space themselves out along river systems of suitable size. However, at the moment, the species is not rare. One factor which might affect future numbers is the recent introduction of trout and other in-

sectivorous fish into the rivers of New Guinea in order to provide a source of protein for the native population. These fish could compete with the birds for food, as it is suggested introduced trout do with Blue Duck in New Zealand (Kear & Burton, 1971).

Hunting with guns may become increasingly important: we were told of areas where the birds no longer occur because they had been shot out. The natives usually employ more primitive hunting methods, Mayr & Gilliard (1954) reporting that they are 'switched' out of the air as they fly below bridges, and they are certainly taken occasionally with spears or bows and arrows. Salvadori's Duck has been fully protected throughout Papua New Guinea since November 1968 (Shaw, 1969), but enforcement of its legal status must be difficult. Probably of considerably greater importance to the species than direct killing is disturbance by any intense human activity along the river banks. Surprisingly, Mayr & Rand (1937) mentioned an occasion when they attracted a pair within gunshot range by waving a handkerchief at them, 'a method formerly employed on the North American coast for decoying waterfowl'. We, however, were impressed by the great shyness of the birds, especially in comparison with Blue Duck.

No information on natural predation is available. Birds of prey were seen, but we had no evidence that Salvadori's Duck were ever taken. The only underwater enemy might be eels (known to frequent these rivers) which are more likely to take ducklings than adults. The very small clutch size probably implies that the natural predation rate is low (and that adults are fairly long-lived). The forward-looking eyes, with associated loss of all-round vision, also suggest that predators are uncommon.

Systematic position

Although Mayr (1931a) stated that the Torrent Duck, the Blue Duck and Salvadori's Duck were members of an unnatural group with only one thing in common, that they all inhabited mountain streams, and Delacour (1956) later wrote that Salvadori's Duck was just a distinct *Anas*, the three species share a large number of features. They all live in fast moving streams for which they are anatomically well adapted; male and female remain together year-round, the pair bond seems long term, there is no eclipse plumage, and the mates share parental duties (all unusual features in dabbling ducks). They are highly territorial and have spurs or knobs on their wings with which two species at least fight their neighbours. They are insectivorous in places where insectivorous fish are naturally uncommon, and aquatic larvae, obtained by diving, are probably the principal item of diet. They all have small clutches of relatively large eggs, presumably reflecting a low level of natural predation and the need for large ducklings at hatching, able to cope with a food supply that is not easy to obtain (Lack, 1968). The downy young are basically black and white (Figure 2), unlike *Anas* ducklings which are brown and yellow, and the Torrent Duck and the Blue Duck have ducklings with a dark stripe that goes vertically from the eye to the crown (an unusual character). As Neithammer (1952) pointed out, the wing specula of Salvadori's and Torrent Duck are similar, namely metallic green bordered in front and behind by white (the Blue Duck, however, lacks a speculum altogether); and immature Torrent Duck have barred flanks like Salvadori's Duck and unlike other *Anas* (Johnsgard, 1965). The male's voice in all species is a whistle and the tracheal bullae are

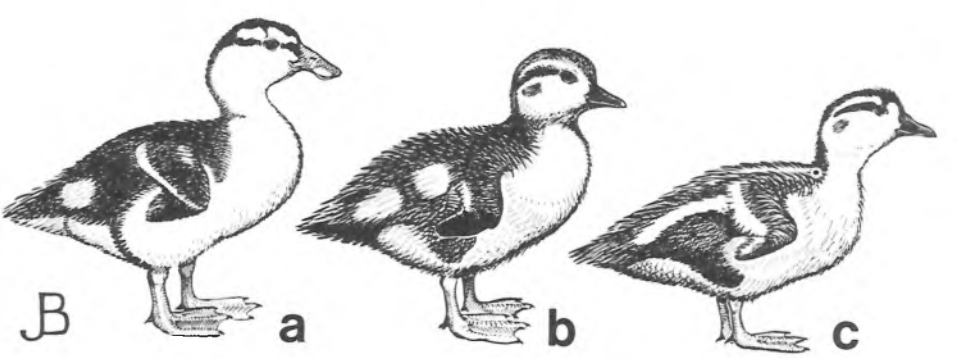

Figure 2. Newly hatched ducklings of (a) Blue Duck, (b) Salvadori's Duck, and (c) Torrent Duck (J. Blossom).

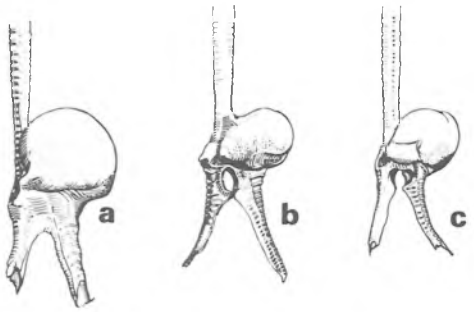

Figure 3. Male tracheal bullae of (a) Blue Duck, (b) Salvadori's Duck, and (c) Torrent Duck (*J. Blossom*).

similar (Figure 3), although smaller in Salvadori's Duck than in the others. An interesting similarity which is, however, rather difficult to interpret is that they have conspicuous bills which make the birds easy to pick out (to the human eye) against a background of water. In the case of the Blue Duck the bill is white, in Salvadori's yellow, and in the Torrent Duck (the only species where male and female plumage is different) the bill is the same bright red in both sexes (Johnsgard, 1966).

Many of these features are undoubtedly adaptive to torrent living and an insect diet, but some, such as the speculum and downy young colour, may be more basic. Salvadori himself was of the opinion that 'his' duck was actually nearest allied to *Merganetta* (Rothschild, 1895). Whether or not the three species are taxonomically very close, they 'fit' at the same general level of waterfowl development and could all derive from an early stage in the evolution of the dabbling ducks from their perching duck ancestors. They are certainly not near the diving ducks and mergansers, where all three were originally put by Phillips (1926). It was *this* unnatural placing that caused Mayr (1931a) to remove Salvadori's Duck from merganettini after an examination of its tracheal structure. However, had Mayr at the same time looked at the trachea of the Blue and Torrent Duck, *Merganetta* and *Hymenolaimus* might have been placed in the genus *Anas* as well. Until more extensive studies are made, it seems that *Salvadorina* should be resurrected. Johnsgard (1965) has stated that there is no reason to believe that Salvadori's Duck is closely related to the Versicolor Teal *Anas versicolor* and the Cape Teal *A. capensis* as Delacour (1956) suggested, and Scott (1958) also was of the opinion that it was 'certainly not just another teal'.

Future research

Salvadori's Duck is still, as it was in Phillips time, one of the world's least known anatines, and more research is needed into many aspects of its biology. Field studies could investigate the food taken at various seasons (especially before and during breeding). Territory size in different parts of the range, the length of time the family remains together, and where the young birds then go, are also unknown. It is a territory defended year round, even in the wet seasons? Has predation any significance in the species' survival? The relationship of the Black Duck and the Salvadori's Duck in those parts of their range where the two species overlap also needs investigation.

Captivity seems ideal for an examination of social behaviour. Two or three pairs could be held at a wildlife reserve in New Guinea. Pinioned birds bred many times at Nondugl, but were always parent-reared, so that precise information on such matters as growth rates was not collected. At Slimbridge in England, Salvadori's Ducks, in particular the females, did not settle well. Eleven birds died within a year of arrival, although the remaining two males lived for five and six years. Deaths were due mainly to gut parasites, probably acquired after arrival, in particular *Acuaria*. Aspergillosis, TB and lead poisoning were also found at post-mortem examination. Thus, unlike Blue Duck and Torrent Duck, Salvadori's do not seem prone to die of generalized bacterial infections (which are difficult to guard against in a large waterfowl collection) and should be easy enough to maintain for captivity studies if birds were acquired in the future. Perhaps their rather unspecific habitat requirements are linked to their generally robust constitutions—the other two species seem to require much 'cleaner' conditions. Feeding does not appear to be a problem. Shaw Mayer considered that in order to breed, his captive birds needed animal food: they could survive on soaked dog-biscuit alone, but would not lay. A diet of poultry pellets, puppy biscuit meal, grain or seeds, and some freshwater animal food such as minced eel, should be adequate.

Finally, laboratory and museum studies could investigate the structure of the bird's bill (and the head and limb muscles) in relation to food and in comparison with Blue and Torrent Duck. This should provide valuable information on the convergence or otherwise of their various life styles.

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Summary

This paper reviews the biology of Salvadori's Duck *Salvadorina (Anas) waigiuensis,* the only waterfowl species endemic to New Guinea. The bird appears to be physically adapted to living in mountain torrents, but is also found in other habitats. Pairs probably stay together year round and are highly territorial. Nesting occurs mainly from May to September; the eggs, at about 58 g, are very large in relation to the size of the female and the clutch of three eggs is small.

It is suggested that the species shows affinities with the Torrent Duck *Merganetta armata*, and possibly the Blue Duck *Hymenolaimus malacorhynchos*, which are not merely the result of convergence. Further research is needed.

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