

Victorian coast. The Department of Zoology at Monash University already is beginning to work in co-operation in a number of ways with the Fisheries and Wildlife Department, and it is envisaged that further co-operation will arise in the case of the Cape Barren Goose. Thus, for example, research workers making observations regularly on the islands could assist with policing, while their transport difficulties might be eased by the Department vessel. Again, while research workers catch geese for banding and other purposes, X-ray examination of the birds (for determination of shooting pressure, as already in progress for ducks) could be carried out. Also, at the Department's wildfowl study area at Lara a breeding programme for geese is planned; studies complementary to those in the islands could be made, and birds reared for release in the islands.

Other ecological studies for the islands are in the planning stage: a new Monash University Research Scholar will, it is hoped, undertake work on the ecological inter-relations of burrowing sea-birds (petrels, penguins) and rabbits. Rabbit and Citadel Islands are particularly suitable for this purpose. A study of the regeneration and rehabilitation of seabirds following removal of rabbits (a project already discussed with the Vermin and Noxious Weeds Destruction Board) is proposed; the relevance of this to geese is that restoration of the habitat would almost certainly result in re-occupation of these islands by geese. Approach has been made to the

National Parks Authority and to the Director of Lighthouses, Commonwealth Department of Shipping and Transport, for permission to make plans for such research work in areas under their jurisdiction.

Research is the basis of any conservation programme. The research discussed above, together with the protection measures, would constitute such a programme. Since the Cape Barren Goose, like most waterfowl, is a potential game bird, a conservation programme for it is the same as a game management programme. Eventually, any successful game or wildlife management programme comes to include some controlled cropping. This would no doubt be appreciated by sporting interests in the State. In addition, a successful programme would earn world-wide respect in the field of conservation research, a field in which present successes are few and when they occur highly acclaimed and remarkably popular (as, for example, the Koala in Victoria and the return of the Osprey to the Scottish Highlands). The World Wildlife Fund and the International Union for the Conservation of Nature would undoubtedly lend approval and support to this project, although their commitments elsewhere are already too great to make financial support probable. The State of Victoria has the reputation of being a leader in Australian conservation matters. It seems highly desirable that the chance to preserve one of the country's rarest birds should be seized while it yet remains.

## **The ecology and numbers of aquatic birds on the Kafue Flats, Zambia**

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### **Introduction**

The Kafue Flats in southern Zambia are located at about 15°30'S and between 27 and 28°E. They are flooded annually by the Kafue River, and extend for some 140 miles along the river with a width of between 10 and 30 miles. The total area of the Flats is some 2,500 square miles. The area is at an elevation of about 3,100 ft; it has an average rainfall of 32 inches per annum and a mean annual temperature of 70-75°F. The flood water rises, after the rains have begun, in November and December and the flood peak occurs between April and June. At times of peak flood the level of water on the Flats varies

between a few inches and 10 feet. The rise and fall of the flood water is a gradual process.

The Kafue Flats area, with its striking concentrations of Lechwe antelope and birds (including wildfowl, shorebirds, wading and some fish-eating birds), has long been considered one of the greatest spectacles in Africa. Many distinguished ornithologists have expressed the opinion that the variety and numbers of aquatic birds on the Flats compare favourably with the best wetland areas in the world. The preservation of this area for all time has long been advocated. Two of the most important sectors of the Flats remain

under private ownership. Although considerable protection has been afforded by the owners of Lochinvar Ranch (on the south side of the Kafue River) and of Blue Lagoon Ranch (on the north side) – primarily to conserve Lechwe – anything short of the creation of a National Park must be considered unsatisfactory if this unique spectacle is to survive.

Little is known about the ecology and movements of aquatic birds in Central Africa. The Kafue Flats provide perfect conditions for the study of wildfowl breeding, habitat and movements. Scientific names of all species mentioned in the text will be found in Appendix 2. The nomenclature used is that of C. W. Benson and C. M. N. White *Check List of the Birds of Northern Rhodesia*, Lusaka, 1957.

### Numbers

Between August and November 1964 the authors made preliminary attempts to obtain an estimate of the numbers of aquatic birds (i.e. cormorants, pelicans, herons, egrets, storks, ibises, ducks and geese) on the Flats. This was done by

means of numerous observations on the ground, a number of sample transects and an aerial flight. The numbers obtained are necessarily approximate due to limited time available, but these figures provide a basis for future research.

Numerous observations were made during the period August to November on Lochinvar and Blue Lagoon Ranches, mainly by the senior author. A good deal of ground was covered. Sixty-three days were spent in the field in 1964 and about one quarter of this time was spent on ornithological work (the remainder being devoted to Lechwe studies). The approximate area in which aquatic birds were censused was 50 square miles on Lochinvar, and 8 square miles on Blue Lagoon. Within these areas most aquatic birds were concentrated in a few places where the habitat was suitable. Each of the concentrations was counted at least once. The figures in Table I, which are totals of birds counted in the concentrations, may be taken as the totals for the whole census area of 58 square miles.

**Table I. Numbers of aquatic birds found in censuses of 58 sq. miles within the Kafue Flats, August–November, 1964**

	range	counts mean	av. no. per sq. mile
Reed Cormorant	301–348	325	5.6
Darter	74–106	90	1.6
White Pelican	1719–1999	1859	32.1
Grey Heron	32–46	39	0.7
Goliath Heron	32–37	35	0.6
Purple Heron	32–38	35	0.6
Great White Heron	124–141	133	2.3
Little Egret	42–55	49	0.8
Yellow-billed Egret	102–260	181	3.1
Cattle Egret	73–129	101	1.7
Squacco Heron	129–164	147	2.5
Rufous-bellied Heron	32–39	36	0.6
Openbill	1019–1247	1133	19.5
Saddlebill	26–28	27	0.5
Marabou	41–57	49	0.8
Wood Ibis	104–116	110	1.9
Sacred Ibis	107–129	118	2.0
Glossy Ibis	119–229	174	3.0
African Spoonbill	25–33	29	0.5
Hottentot Teal	52–72	62	1.1
Red-billed Teal	3114–5660	4387	75.6
White-faced Tree Duck	2227–3031	2630	45.3
Fulvous Tree Duck	1227–6327	3777	65.1
Knob-billed Goose	539–668	604	10.4
Spur-winged Goose	3770–4362	4066	70.1
Fish Eagle	30–36	33	0.6
African Jacana	261–597	429	7.4
Crowned Crane	106–196	151	2.6
Wattled Crane	260–264	262	4.5
Blacksmith Plover	262–574	423	7.3
Long-toed Plover	125–143	134	2.3
Stilt	97–130	114	2.0
Grey-headed Gull	437–1062	750	12.9

Several of the species listed are known to wander quite extensively on the Flats, but it has been assumed that movements on and off the two ranches are likely to be equal.

It is necessary to point out that some species appeared more prone to wandering than others, and this explains the fluctuations in numbers of such species as Red-billed Teal, Fulvous Tree Duck and Grey-headed Gull. Some species might have escaped notice on occasions, especially skulking Squacco Heron, African Jacana and nesting Blacksmith Plover. Counts of the more conspicuous species, such as Goliath Heron, Saddlebill, Spur-winged Goose, Fish Eagle and Wattled Crane show reasonable agreement between the several counts made, and hence their range as shown in the table is limited. Fluctuations in some other species cannot be explained. No worth-while counts could be made of the smaller species of shorebirds.

In the absence of more intensive observations it is not possible to make any estimate of numbers on the Kafue Flats as a whole. However, the areas censused probably carried as high a density as anywhere on the Flats; by taking an average density over both suitable (concentration areas) and unsuitable areas (dry grassland surrounding the watered zones) as has been done in the foregoing table, figures are obtained that might be taken as representative of the entire Flats area until more detailed surveys are possible. To give some idea of the potential of the area as a major wildfowl centre, the average

density per square mile of 75.6 given for the most numerous local duck, the Red-billed Teal, would give a total of 189,000 individuals in the 2,500 square miles of the Flats.

A number of sample transects were taken. Water levels dropped so rapidly during this period that in most areas aquatic birds frequently had to move from one suitable locality to another. These transects therefore scarcely reflect a true pattern of movements. Nevertheless, it seems worthwhile discussing a few general aspects that arise from the data. Between August and November 1964 there were far more aquatic birds per acre of suitable habitat on Lochinvar than on Blue Lagoon. This is especially true for ducks, and less so for egrets, herons and Spur-winged Geese. However, parts of Blue Lagoon did hold especially good numbers of egrets and herons. These differences are apparently the result of differences in the habitat requirements of various species, which will be discussed more fully.

Five counts along transect I at Lochinvar between 19th August and 3rd September showed that although ducks and geese may move around a great deal, the majority of egrets and herons may remain in one area for as long as it suits their needs. However, Spur-winged Geese and White Pelicans fluctuated greatly in the two counts over transect I at Blue Lagoon.

Transect II at Lochinvar on 4th August was part of a count made by the junior author of some species along 165 miles of

**Table II. Numbers of aquatic birds seen along 165 miles of the Kafue River, 4th and 5th August, 1964**

	<i>total seen</i>	<i>ave. per mile of river</i>
Reed Cormorant	4144	25.1
Darter	282	1.7
White Pelican	50	0.3
Grey Heron	8	0.05
Goliath Heron	30	0.2
Purple Heron	3	0.02
Great White Heron	24	0.1
Little Egret	280	1.7
Yellow-billed Egret	84	0.5
Cattle Egret	4	0.02
Squacco Heron	91	0.6
Rufous-bellied Heron	2	0.01
Openbill	4354	26.4
Marabou	60	0.4
Wood Ibis	10	0.06
Sacred Ibis	275	1.7
Glossy Ibis	6	0.04
Fish Eagle	72	0.4
Spur-winged Goose	79	0.5
Crowned Crane	3	0.02
Wattled Crane	3	0.02
Grey-headed Gull	1553	9.4

the Kafue River upstream from the Kafue Rail Bridge. The 165 miles were censused on 4th and 5th August in a motor-powered boat, and an attempt was made to record all birds present on the river. The counts of the main species are shown in Table II.

From this census it was evident that the 13 mile stretch of the Kafue River along the Lochinvar boundary, and some 30 miles to east and west of it, contained some 80% of the aquatic birds recorded on the whole trip. Within this area of concentration there was a fairly even distribution of aquatic birds: for example, the overall average number of Reed Cormorants per mile was 25, with 2 Darters and 9 Grey-headed Gulls, and these figures differ little from the number per mile along the boundary of Lochinvar (30, 3 and 2 respectively). This census also confirmed that several fish-eating species such as Reed Cormorant and Grey-headed Gull occur in very large numbers on the river although they may be scarce on the Flats. Other species, such as Skimmers (of which a party of 10 was observed on the river, and which does occur at both Lochinvar and Blue Lagoon in flocks of up to 100), also occur in suitable habitat on the river, but not on the flood plain itself.

When water levels on the Kafue Flats are dropping steadily, transects have a dubious value. However, transects along the edge of the flood line either at peak flood or in a year when the water level drops slowly, might give useful results.

On 19th September one of us (A. de Vos) took part in a flight over a section of the Kafue Flats. Estimates of total numbers of some species present were as follows: White Pelican 350 (would include a few Pink-backed); Great White Heron 1,500 (might include a few Yellow-billed and Little Egrets); Openbill 7,000; Wood Ibis 500; African Spoonbill 200; Red-billed Teal 5,000; White-faced and Fulvous Tree Duck 15,000; Spur-winged Goose 3,500; Crowned Crane 50; Grey-headed Gull 500.

The flight was carried out at a height of about 400 feet, in good visibility and with an airspeed of 185 miles per hour. Further flights, at a reduced height and with slower airspeed, would probably produce reasonably accurate data about the numbers of most species present.

#### **Habitat preferences**

Without the seasonal rise and fall of water level on the Flats, much of the area would be far less favoured by aquatic birds than it is. During the rains the shallow inundation of much of the Flats provides extensive and suitable feeding for most species

of aquatic birds. Much of the semi-waterlogged anthill zone, and the pans in the woodland area, provide suitable conditions for several species to nest in considerable numbers. Unfortunately, the Flats are little visited during the rains, and knowledge of the breeding birds of the area is sparse. Towards the end of the rains pelicans, some herons and egrets probably breed out on the Flats, but again few data have been collected. As the water level drops steadily, new food supplies are continually uncovered for the considerable numbers of various species that feed in shallow water and along the water's edge. In a really dry year permanent streams and lagoons will provide suitable feeding until the flood waters begin to rise again.

The following notes indicate habitat preferences of certain species during the second half of the dry season, as noted during August to November 1964.

#### **Reed Cormorant and Darter**

Present in rivers, lagoons and permanent streams, numbers fluctuating as numbers of fish vary locally. Reed Cormorant more likely than Darter to be found on small, reedy streams and inundated areas, and on permanent water the former seems always more numerous.

#### **White and Pink-backed Pelicans**

Usually in small parties, but the White Pelican may occur in concentrations of several hundreds where fish (especially *Schilbe mystus* and *Clarias mossambicus*) are temporarily numerous. The Pink-backed apparently does not occur in large numbers. Both species wander a great deal, depending on concentrations of fish, on rivers, lagoons and streams, or even shallow flood plain. A freshly dead White Pelican contained three *Clarias mossambicus*, totalling 10 lbs., on 6th October (A. T. Fuller, pers. comm.)

#### **Herons, egrets, storks, etc.**

*Shallow flood plains:* Great White Heron, Little Egret, Yellow-billed Egret, Rufous-bellied Heron, Wood Ibis, Sacred Ibis, Glossy Ibis.

*Muddy edge of inundation:* Grey Heron, Little Egret, Black Heron, Cattle Egret, Hammerkop, Openbill, Saddlebill, Marabou, Glossy Ibis, African Spoonbill.

*Vicinity of permanent water:* Grey Heron, Goliath Heron, Purple Heron, Squacco Heron, Saddlebill, Marabou.

*Reeds:* Purple Heron, Squacco Heron.

*Drying mud flats and damp plains:* Cattle Egret, Openbill, Marabou, Sacred Ibis, Black-headed Heron.

## Ducks and geese

*African Pochard*: A diving duck requiring fairly deep channels or lagoons, although A. J. Tree (*in litt.*) considers that in the North Kafue it may prefer inundated areas to perennial waters. Generally uncommon throughout Kafue basin.

*Yellow-billed Duck*: A dabbling duck usually in shallow pools or edge of inundated areas. Apparently never in any numbers on the Flats.

*Hottentot Teal*. A dabbling, feeding in very shallow water. Feeds a good deal by night, often resting during the day in deeper water.

*Red-billed Teal*: A dabbling feeding in shallow or fairly shallow water along muddy edge of streams, in inundations or small pools.

*White-faced Tree Duck*: Feeds mainly at night in shallow water or on bare mud. By day frequently resting in considerable numbers along water's edge.

*Fulvous Tree Duck*: Generally less numerous than the last species. Habitat preferences appear identical, although the Fulvous Tree Duck may prefer inundated grassland to bare mud.

*Pygmy Goose*. Sometimes inundations, usually permanent lagoons, as long as plenty of floating water lilies and grasses available.

*Knob-billed Goose*: Usually inundated flood plain or lagoons with water lilies and floating grasses.

*Spur-winged Goose*: Swampy ground, inundated grassland or dry ground with fresh flush of grass growing.

The above notes show the usual habitat preferences of the major species of aquatic birds. It is not proposed to discuss preferences of resident and migratory shorebirds here, nor of the less common aquatic birds, but it should be remembered that the Flats are an important nesting and feeding area for many African shorebirds, and that at times many hundreds of Palearctic migrants pass through the area. The main prerequisite for all these species and for most of the aquatic birds discussed above is shallow water with ample feeding, and deeper water to which to retire for rest or escape from predators. The seasonal rise and fall of the water level on the Kafue Flats produces habitat ideally suited to an enormous number of water birds.

## Movements

The whole question of the migrations or wanderings of aquatic birds on the Kafue

Flats is important, and until some attempt is made to solve the many problems that arise, proper management of aquatic birds in the area cannot be hoped for.

So little is known of aquatic bird movements in Zambia that this subject can be touched on only briefly, and a few outstanding examples given. Reed Cormorant, Darters, pelicans and Grey-headed Gulls move as the areas in which fish are concentrated change. The Catfish, *Clarias mossambicus*, can often be seen moving in large schools and the wanderings of fish predators with them may be considerable. Openbills occasionally move down the Kafue River in flocks of several thousands, between July and October; such movements have been observed in the North Kafue Basin (Tree, pers. comm.) and on the Kafue Flats. Cattle Egrets, Sacred Ibis and an African Spoonbill all ringed in their breeding areas in South Africa have been recovered in Zambia in their non-breeding season.

## Associations with Lechwe

The main concentrations of aquatic birds during the period August to November 1964 were often in areas frequented by Lechwe, and this was especially noticeable during an aerial flight over part of the Flats on 19th September. There does not appear to be any other reason for this than that Lechwe and aquatic birds had similar habitat preferences during the period of observation.

Lechwe may have an indirect effect on aquatic bird numbers on the Kafue Flats in so far as fish numbers are dependent upon the fertility of the water, which may be increased by Lechwe excrement. However, information obtained by the Fisheries Section of the Department of Game and Fisheries, based on analyses carried out by the Public Analyst, suggests there is no significant difference in chemical constitution of water from Lochinvar and from other areas. Reed Cormorants, Darters, pelicans and Grey-headed Gulls do seem to be dependent upon the very large numbers of fish that occur in the vicinity of Lochinvar. Both areas, the Kafue River especially, held very large numbers of fish at this time.

The only direct associations of birds with Lechwe appear to be those species that feed on insects disturbed by Lechwe, namely Cattle Egrets and Cape and Yellow Wagtails. Cattle Egrets are seen less often with Lechwe on the Flats than with cattle: they probably avoid getting their feet wet if possible. Yellow Wagtails (palearctic migrants) feed around the feet of Lechwe, but Cape Wagtails have been

seen to climb all over a standing or bedding Lechwe, picking flies from inside its ears and off its body, the Lechwe readily submitting to such behaviour. If the 'Lechwe fly' (*Musca* sp.) is dependent upon the Lechwe for its existence, then it is worth remarking here that a great many swifts, hirundines and pratincoles and other birds appear to eat a tremendous amount of these flies at certain times of the year on the Flats.

### The need for management

The aquatic birds of the Flats are dependent upon the seasonal rise and fall of the water level to provide suitable feeding grounds. Any decrease in the amount of water at present entering the Flats, such as might be caused by a dam on the Kafue above the Flats, would seriously affect numbers of aquatic birds. The amount of suitable habitat for feeding would be reduced drastically, and if the only water available were to be restricted to rivers and lagoons, a considerable decline in wildfowl numbers would follow. Areas on the Flats suitable for nesting would be lost to many aquatic birds and shorebirds.

If properly managed the aquatic birds of the Kafue Flats can give pleasure to many tourists and sportsmen. If neglected, this magnificent spectacle will soon be just a memory. Already there are signs that all may not be well with the reproduction of aquatic birds on the Flats. Few species can be age-classified in the field. Nevertheless, sample counts on Lochinvar and Blue Lagoon suggest that White Pelican, Wood Ibis and Saddlebill numbers include no more than 5% immature birds. More research along these lines is urgently required, and a research station should be established on Lochinvar.

### Acknowledgements

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### Appendix 1

#### Breeding records of aquatic birds from the Kafue Flats

(Original records of all data used are on file with Mr. C. W. Benson, Rhodes-Livingstone Museum, Livingstone, Zambia.)

Reed Cormorant: March (2 records, mixed colonies, with eggs), April (6, mixed, eggs and young), May (1 mixed, eggs) and

Aug. (1 mixed, eggs). All in colonies with Darter, which it outnumbers; sometimes various herons and egrets also present. Darter: Details as for previous species, than which less numerous.

White Pelican: Two records of small colonies (one with Crested Crane) in March and April.

Grey Heron: March, 12 nests in a mixed colony of cormorants, herons and Openbills.

Purple Heron: August, at least 100 nests in a mixed cormorant and heron colony. Except for one nestling all contained eggs.

Great White Heron: Mixed colonies, August (1) and March (2).

Squacco Heron: 50 nests in a mixed cormorant/heron colony, August, all with eggs.

Night Heron: Details as for Squacco Heron.

Openbill: A large colony of this species, October. 24 nests in a mixed colony, with cormorants and herons, March.

Saddlebill: Four records of nests or fledged birds in April (1), May (2) and August (1). Egg laying apparently in April. A solitary nester.

White-faced Tree Duck: At Lochinvar lays in February and March in woodland often  $\frac{1}{2}$  mile from water. A female shot in February contained an almost fully developed egg.

Fulvous Tree Duck: One record of a pair with 4 ducklings on October 1st.

Pygmy Goose: One record of ducklings less than a week old in late October.

Knob-billed Goose: At Lochinvar hatches regularly February and March at temporary pools in woodland.

Spur-winged Goose: 12 records of eggs or young in February (4), March (1), April (1) and June (6) – in this latter month most records refer to goslings. Also a record of a number of broods in late December. At Lochinvar, eggs laid regularly January to March, often on anthills.

Crowned Crane: A record of many nests near a White Pelican colony in mid-April. Apparently nests in some numbers in the flooded anthill zone at Lochinvar in the second half of the rains (A. T. Fuller, pers. comm.).

### Appendix 2

#### List of scientific names of species mentioned in text

##### Mammals

Lechwe (Kafue Flats form) *Kobus lechwe kafuensis*

## Birds

Reed Cormorant *Phalacrocorax africanus*  
 Darter *Anhinga anhinga*  
 White Pelican *Pelecanus onocrotus*  
 Pink-backed Pelican *Pelecanus rufescens*  
 Grey Heron *Ardea cinerea*  
 Black-headed Heron *Ardea melanocephala*  
 Goliath Heron *Ardea goliath*  
 Purple Heron *Ardea purpurea*  
 Great White Heron *Egretta alba*  
 Little Egret *Egretta garzetta*  
 Yellow-billed Egret *Egretta intermedia*  
 Black Heron *Egretta ardesiaca*  
 Cattle Egret *Ardeola ibis*  
 Squacco Heron *Ardeola ralloides*  
 Rufous-bellied Heron *Butorides rufiventris*  
 Hammerkop *Scopus umbretta*  
 Openbill *Anastomus lamelligerus*  
 Saddlebill *Ephippiorhynchus senegalensis*  
 Marabou *Leptoptilos crumeniferus*  
 Wood Ibis *Ibis ibis*  
 Sacred Ibis *Threskiornis aethiopicus*  
 Glossy Ibis *Plegadis falcinellus*  
 African Spoonbill *Platalea alba*  
 Fish Eagle *Haliaeetus vocifer*  
 White-backed Duck *Thalassornis leuconotus*  
 African Pochard *Aythya erythrophthalma*  
 Yellow-billed Duck *Anas undulata*  
 Black Duck *Anas sparsa*  
 Cape Wigeon *Anas capensis*  
 Hottentot Teal *Anas punctata*  
 Red-billed Teal *Anas erythrorhynchos*  
 White-faced Tree Duck *Dendrocygna viduata*

Fulvous Tree Duck *Dendrocygna bicolor*  
 Pygmy Goose *Nettapus auritus*  
 Knob-billed Goose *Sarkidiornis melanotos*  
 Egyptian Goose *Alopochen aegyptiacus*  
 Spur-winged Goose *Plectropterus gambensis*  
 Red-knobbed Coot *Fulica cristata*  
 African Jacana *Actophilornis africanus*  
 Lesser Jacana *Microparra capensis*  
 Crowned Crane *Balearica pavonina*  
 Wattled Crane *Grus carunculatus*  
 Kittlitz's Sandplover *Charadrius pecuarius*  
 Three-banded Plover *Charadrius tricollaris*  
 Caspian Plover *Charadrius asiaticus*  
 Long-toed Plover *Hemiparra crassirostris*  
 Blacksmith Plover *Hoplopterus armatus*  
 Ethiopian Snipe *Gallinago nigripennis*  
 Curlew-Sandpiper *Calidris ferruginea*  
 Little Stint *Calidris minuta*  
 Ruff *Philomachus pugnax*  
 Common Sandpiper *Tringa hypoleucos*  
 Marsh Sandpiper *Tringa stagnatilis*  
 Greenshank *Tringa nebularia*  
 Wood Sandpiper *Tringa glareola*  
 Curlew *Numenius arquata*  
 Whimbrel *Numenius phaeopus*  
 Stilt *Himantopus himantopus*  
 Pratincole *Glareola pratincola*  
 Grey-headed Gull *Larus cirrocephalus*  
 White-winged Black Tern *Chlidonias leucoptera*  
 Whiskered Tern *Chlidonias hybrida*  
 Cape Wagtail *Motacilla capensis*  
 Yellow Wagtail *Motacilla flava*

## Observations on some aberrant Australian Anatidae

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### Summary

Field observations on the Pink-eared Duck, Freckled Duck, Musk Duck and Blue-billed Duck generally confirm earlier conclusions regarding the affinities of these birds. The Pink-eared Duck's vocalisations and displays suggest that it is an aberrant dabbling duck having surprising behavioral similarities to the typical shovelers that are probably the result of evolutionary convergence. The Freckled Duck exhibits a curious mixture of swan or goose-like anatomical and behavioral features that must be weighed against a duck-like bodily form. These conflicting and unusual features of the species suggest that it should be given tribal status in the subfamily Anserinae, or at the very least should be removed from the dabbling duck tribe, with which it shares almost no features. Observations on flight, sound production and sexual behaviour of the Musk Duck, and on molts and vocalisations in the Blue-billed Duck are included.

<sup>1</sup> Studies (No. 366) from the Department of Zoology and Physiology of the University of Nebraska.

### Introduction

It is difficult to describe the waterfowl of Australia without resorting to such terms as 'unique', 'remarkable', or 'incredible'. Although only 19 species are regularly found on that large continent, these include representatives of all the sub-families and tribes accepted by Delacour (1954-1964) except the sea ducks.

Of the 13 genera represented, six (*Anseranas*, *Cereopsis*, *Chenonetta*, *Biziura*, *Malacorhynchus* and *Stictonetta*) are essen-

tially limited to Australia and are monotypic. The taxonomic positions of several of these have been disputed at various times. Thus, the Magpie Goose *Anseranas semipalmata* is generally regarded as representing a distinct tribe and subfamily, a conclusion supported by abundant anatomical (Boetticher, 1943, Miller, 1919, Delacour, 1954, Woolfenden, 1961), biochemical (Sibley, 1960, Tyler, 1964) and behavioral (Johnsgard, 1961) evidence. However, Davies and Frith (1964) have