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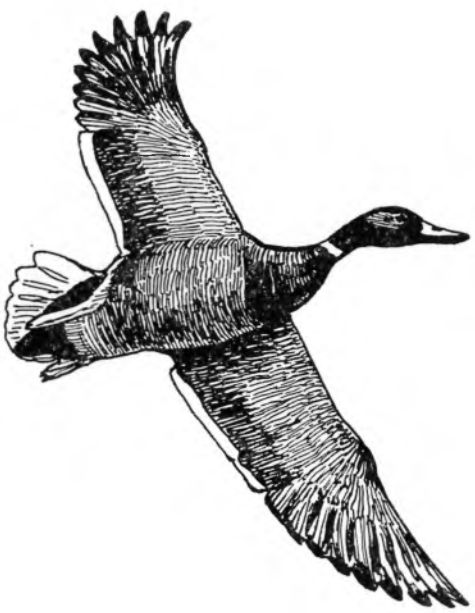

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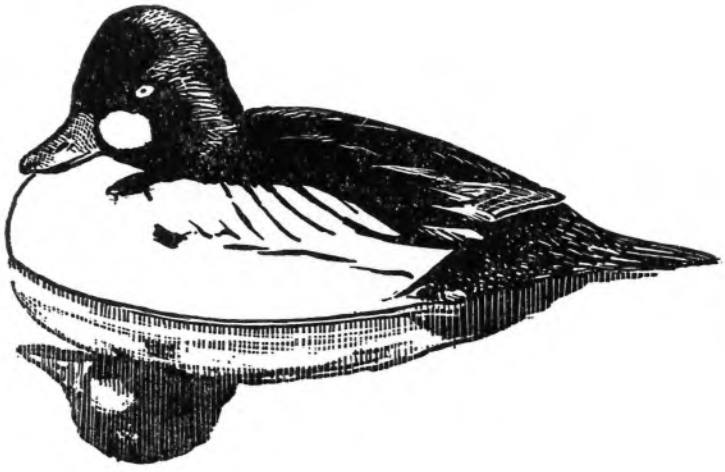

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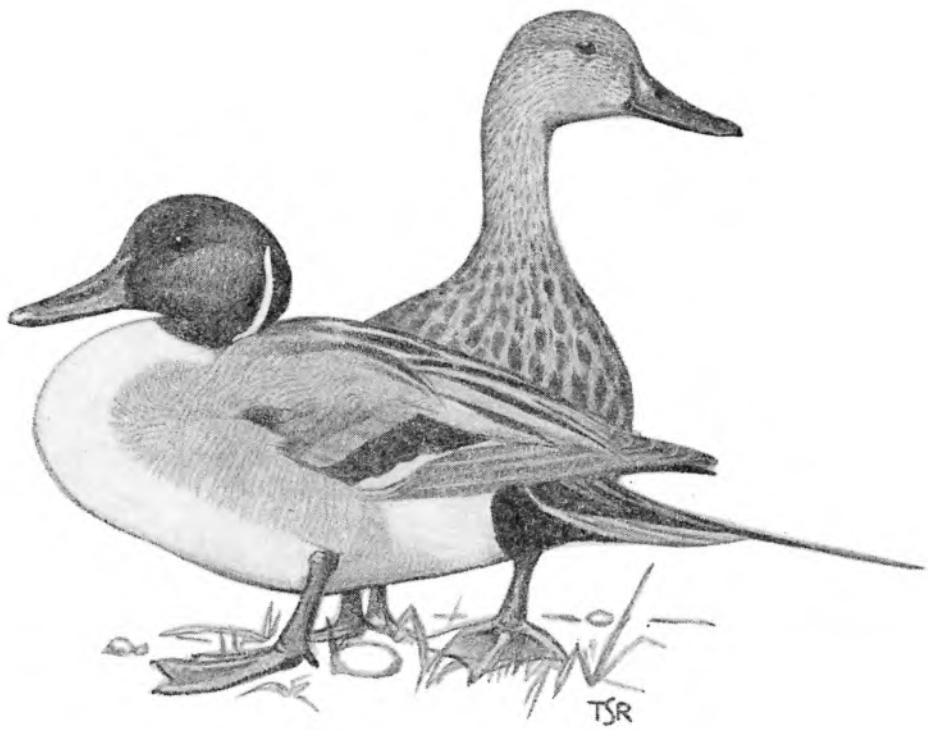

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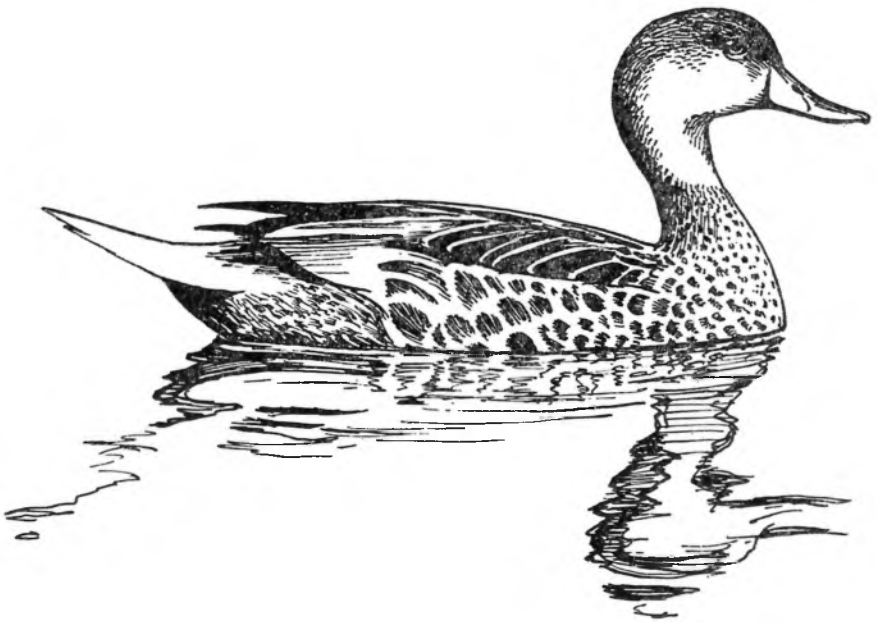

The endemic ducks of remote islands

DAVID LACK

Introduction

This paper is concerned with all those ducks which have formed distinctive subspecies restricted to one particular small and remote island or archipelago. Only dabbling ducks in the genus *Anas* are involved. Many species in this genus have an extremely wide range, but the average number of subspecies *per* species is as low as 1.9 for the 38 species recognised by Delacour (1954-64). Hence the fact that nearly all the ducks on remote small islands are separate subspecies means that, for ducks, they belong to relatively isolated populations. In contrast, on some of the archipelagos concerned, notably the Hawaiian Islands and Galapagos, various of the land birds are distinctive species or even genera. Ducks evidently wander widely and frequently, being helped by their powerful flight and their ability to settle on the sea.

The islands and species concerned

The islands concerned, all either tropical or subantarctic, are set out in Table I, with the names and measurements of the resident forms of *Anas*. On large islands and on islands near continents many species of ducks coexist. For instance, 13 species, 7 in the genus *Anas*, breed regularly in Britain (Parslow 1967), 16 species, 6 in the genus *Anas*, in Iceland (F. Gudmundsson pers. com.), 8, 5 in the genus *Anas*, in the Falkland Islands (Cawkell and Hamilton 1961) and 7, with 2 more in the nineteenth century, 4 in the genus *Anas*, in New Zealand (Williams 1964). Some of the Falklands and New Zealand forms are endemic, not so those of British or Iceland. Although the various species of ducks look superficially alike, especially when seen together in a collection of living waterfowl, they have in fact evolved an adaptive radiation within the limits imposed by their aquatic life, and even the species of *Anas* evidently differ sufficiently in feeding habits for up to six to coexist in the same area (Olney 1965).

In contrast, on the remote small islands set out in Table I, only a single species of duck breeds, on Hawaii, Laysan, Washington (in the Line archipelago), the

Table I. Ducks in the genus *Anas* on remote islands.

		male wing length in mm.	*male culmen in mm.*	*female body weight in gm.*	*clutch*	*weight of egg in proportion to body weight*
TROPICAL ISLANDS						
A. platyrhynchos MALLARD						
A. p. laysanensis	LAYSAN	201	39.5	450	5	10.9%
A. p. wyvilliana	HAWAII	220	46	500	8	8.5%
nominate	northern	265	53	1000	11	5.4%
A. strepera GADWALL						
A. p. couesi	WASHINGTON (Line Is.)	199	37	—	—	—
nominate	northern	271	41.5	—	—	—
A. bahamensis BAHAMA PINTAIL						
A. b. galapagensis	GALAPAGOS	203	42.5	—	—	—
nominate	S. America	214	43	—	—	—
A. gibberifrons GREY TEAL						
A. g. remissa	RENNELL (Solomon Is.)	187	33	—	—	—
A. g. gracilis	Australasia	202	39	—	—	—
SUBANTARCTIC ISLANDS						
A. acuta (NORTHERN) PINTAIL						
A. a. eatoni	KERGUELEN & CROZETS	218	32	450	4-5	—
nominate	northern	271	54	700	8	—
A. georgica CHILEAN PINTAIL						
A. g. georgica	SOUTH GEORGIA	217	34	465	5	8.0%
A. g. spinicauda	S. America	245	42	706	8	6.0%
A. castanea CHESTNUT TEAL						
A. c. aucklandica	AUCKLANDS & CAMPBELLS	(136)	40	400	3-4	c.18.0%
A. c. chlorotis	New Zealand	199	44	590	6	10.5%
A. c. castanea	Australia	218	41.5	500	9	8.0%

Notes: *A. s. couesi* is now extinct. Delacour (1954-64) admitted a separate subspecies near to *A. a. eatoni* on the Crozets and another near to *A. c. aucklandica* on Campbell Island, but these cannot be sustained. He also treated *A. aucklandica* (including the form *chlorotis* in New Zealand) as a separate species from *A. castanea*, but I have followed Frith (1967) in regarding them as conspecific.

These are the only breeding ducks on the islands concerned except for the Grey Duck *A. superciliosa*, of which the New Guinea-Polynesian form *A. s. pelewensis* (male wing 245 mm., culmen 20.5 mm. and female weight 670 gm.) breeds on Rennell, and the New Zealand form *A. s. superciliosa* (male wing 259 mm., culmen 51.5 mm. and female weight 1000 gm.) breeds on the Aucklands.

The measurements of male wing length and male culmen are the middle points between the extremes given by Delacour (1954-64) and the weights are from Lack (1968), assembled by J. Kear.

Galapagos, Kerguelen, the Crozets and South Georgia, and only two on Rennell and the Aucklands. The second species on the two latter islands is the Grey Duck *A. superciliosa*, which is not endemic on either, and which ranges widely over Polynesia, New Guinea and Australasia, and has recently colonised the only important subantarctic island, Macquarie, which does not have an endemic duck (Carrick 1957). *A. superciliosa* is decidedly larger than the other species with it on Rennell and the Aucklands (see note to Table I).

At least in Hawaii, Laysan, the Line islands and the Galapagos, the existence of only one resident species of duck is not due to the failure of other species to get there. Twelve other species, 8 in the genus *Anas*, have occurred in the Hawaiian archipelago, usually in winter, namely Pintail *Anas acuta* (regular), American Wigeon *A. americana*, Green-winged Teal *A. crecca*, Shoveler *A. clypeata* (regular), Blue-winged Teal *A. discors*, European Wigeon *A. penelope*, Northern Mallard *A. p. platyrhynchos* (the presumed ancestor of the resident endemic), Garganey *A. querquedula*, Lesser and/or European Scaup *Aythya affinis* and/or *A. marila*, Canvasback *A. valisineria*, Bufflehead *Bucephala albeola* and Ruddy Duck *Oxyura jamaicensis* (Udvardy 1961a, b; Clapp and Sibley 1967), while one migrant duck, *Anas discors*, is regular in the Galapagos (Leveque *et al.* 1966). That, despite these periodic visitors, there is only one resident species of duck in each of these archipelagos presumably means that there is an ecological niche for only one and that, once established. it can exclude the rest. The resident Gadwall *A. strepera* on Washington Island is now extinct, and it will be interesting to see whether one of the other six species of *Anas* recently recorded from the Line archipelago will become resident there.

The mainland species from which each of these island forms evolved are named in Table I. The only uncertain identification is that of the Laysan duck as a form of the Mallard *A. platyrhynchos*, but the Hawaiian form is intermediate between them in appearance, and some males of the latter have the characteristic plumage pattern of the northern race of the Mallard. The latter point suggests that the Hawaiian form is derived from the Northern Mallard, not the Mexican subspecies, as the latter lacks distinctive male plumage. The Laysan form could well be derived from the Hawaiian form, rather than from one of the continental forms independently.

Delacour (1954-64) followed other authors in treating the Auckland Island Teal as a separate species from the Australian Chestnut Teal *A. castanea*, but this is a purely taxonomic decision, and it is generally agreed that these two forms are closely related; following Frith (1967) they are here regarded as conspecific, together with the intermediate New Zealand Brown Teal, which is presumably the immediate ancestor of the Aucklands form. Each of these island ducks belongs to a species resident on the nearest mainland, except for the unlikely occurrence of the Northern Pintail *A. acuta* on Kerguelen and the Crozets, but this island form at times shows the male plumage pattern characteristic of *A. acuta*, so the identification can hardly be doubted. The Galapagos form of the Bahama Pintail *A. bahamensis* and the Rennell form of the Grey Teal *A. gibberifrons* are much less distinctive than the other island ducks discussed in this paper.

Perhaps the most striking point brought out by Table I is that, while there is only one endemic form on each of the archipelagos concerned, it is in each case derived from a different mainland species (except that both Laysan and adjacent Hawaii have the Mallard *A. platyrhynchos*). This state of affairs has perhaps arisen through the historical factor of which species happened to arrive and to become established first.

Differences in ecology and feeding

The continental species of *Anas*, including those from which the island forms were derived, live primarily in fresh waters and eat primarily vegetable matter, and all except one of the island forms do likewise. Most of them, however, appear to have a wider range of feeding habits than their respective mainland forms. Thus the *A. platyrhynchos* of Hawaii eats not only plant foods but many molluscs (Delacour 1954-64). The *A. acuta* of Kerguelen feeds mainly on inland waters and lagoons but also on the sea shore, and takes a much higher proportion of animal food, chiefly crustacea, than the mainland form (Paulian 1951; Milon and Jouanin 1953). The *A. georgica* of South Georgia likewise feeds partly on the shore and takes more animal food than the mainland form (Murphy 1936), and *A. castanea* of the Aucklands often feeds on the sea, in the areas of kelp (Oliver 1955). The exceptional form is *A. platyrhynchos* of

Laysan, which often swims, but which feeds almost entirely on land, on lepidopterous larvae, adult Diptera and other insects picked from the vegetation. Hence it has a different and more specialised niche than continental *A. platyrhynchos* (Warner 1963).

Size and proportions

As also shown in Table I, the five island ducks for which the weight is known are much lighter than their presumed mainland ancestors, the reduction being to just under a half in the *A. platyrhynchos* of Laysan, to one-half in the *A. platyrhynchos* of Hawaii, and to two-thirds in the *A. georgica* of South Georgia and the *A. castanea* of the Aucklands. Similarly the wing of the insular form is in every case shorter than that of the presumed ancestor, the reduction being to two-thirds in *A. castanea* of the Aucklands, three-quarters in *A. platyrhynchos* of Laysan and *A. strepera* of Washington, four-fifths in *A. platyrhynchos* of Hawaii and *A. acuta* of Kerguelen, and 93-95% in *A. bahamensis* of Galapagos and *A. gibberifrons* of Rennell. The shorter wing length at least in part reflects the overall reduction in size already mentioned, except for a disproportionately short wing in the *A. castanea* of the Aucklands which is usually described as flightless (though Oliver (1955) has questioned this).

All these island ducks are about the same size. Their mean weights vary only between 400 and 500 grams (but several have not been weighed) and their mean wing lengths, omitting the flightless *A. castanea* of the Aucklands, vary only between 187 and 220 mm. Some forms have undergone a much greater proportionate reduction in size than others, but this is probably due, not to the length of time for which each has been isolated, but simply to the size of their respective ancestors. A medium-size *Anas* is evidently the most efficient kind of duck where it is the only resident species on a remote island, and this size has been evolved irrespective of the size of the ancestral form.

In most of these island ducks, the culmen and tarsus are smaller than in the mainland form, roughly in proportion to the overall reduction in size. However, the culmen is proportionately shorter in the *A. acuta* of Kerguelen than in the mainland form (0.15 of the wing length as compared with 0.20 in the mainland form), which might be adapted to this form's habit, already mentioned, of taking many small crustacea. Again, the Auckland duck has a narrower beak than the Australian and New Zealand forms of *A. castanea*, but whether this is related to its diet is not known. The *A. platyrhynchos* of Laysan has, as might be expected from its terrestrial habits, a proportionately longer tarsus than the mainland form, the Hawaiian form being intermediate (the tarsus is 0.19 of the wing length in the Laysan, 0.17 in the Hawaiian, and 0.16 in the mainland form; measurements from Delacour (1954-64)).

Colouring

The females of the island ducks have generally similar colouring to the females of their mainland ancestors, though sometimes with a minor difference in shade. In addition, the brightly coloured mirror or speculum on the wing is less glossy and/or has smaller white outer bars than in the respective mainland forms, in the *A. platyrhynchos* of Hawaii and Laysan, the *A. strepera* of Washington, the *A. castanea* of the Aucklands and probably the *A. georgica* of South Georgia. The speculum is thought to help in specific recognition, so it is probably less needed in island forms living away from other species than in mainland species living alongside several congeneric species. Sibley (1957) ascribed a similar function to the head markings of *A. bahamensis*, which are likewise less clear-cut in the Galapagos form than in that on the mainland, and the same applies to the Auckland Islands as compared with the New Zealand *A. castanea*.

The distinctive male plumage of many species of *Anas* is likewise attributed to the need for the female to select a male of her own species (e.g. Sibley 1957). Hence it is suggestive that while mainland *A. platyrhynchos*, *A. strepera*, *A. acuta* and *A. castanea* have distinctive male plumage, such plumage is entirely absent in both *A. platyrhynchos* of Laysan (though some males retain a curly tail) and in the single collected male of the *A. strepera* of Washington, while it is absent in many adult males of the *A. platyrhynchos* of Hawaii, the *A. acuta* of Kerguelen and the *A. castanea* of the Aucklands, while others have a dull version of the male plumage pattern. In the other species concerned, the male and female plumages are alike in the mainland form, so it is of no special significance that this also holds for the island form.

There is a general tendency for male birds to lose their distinctive plumage on remote islands, presumably because the reduced number of resident species means that specific recognition is less critical there (Mayr 1942; Lack 1947). The position is complicated in waterfowl, however, because most tropical ducks and many in the southern hemisphere, also lack distinctive male plumage. The reason is not known, but a similar reduction in distinctive male plumage is found in various passerine genera in the tropics compared with northern America (Hamilton 1961; Hamilton and Barth 1962).

Breeding

Also set out in Table I is another example of convergent evolution among the island ducks, their common tendency to have proportionately larger eggs and smaller clutches than the related mainland forms. The smaller clutch might be necessitated by the larger eggs, and the latter might be advantageous because the young are larger at hatching and so survive better if feeding conditions are less favourable than on the mainland. Ripley (1960) noted the unusually large eggs and ducklings of *A. platyrhynchos* of Laysan.

Other island waterfowl

To complete this account, two more endemic island forms of *Anas*, *A. theodori* on Mauritius and *A. pachyscelus* on Bermuda, perhaps also *Pachyanas chathamica* on the Chatham Islands, are known from subfossil remains but are now extinct (Howard in Delacour 1954-64). This author also listed various extinct island forms in other genera of Anatidae. The only other living anatid on a remote island is the Hawaiian Goose *Branta sandvicensis*, which is largely terrestrial and has specialised feeding habits (Miller 1937). It is probably derived from the Canada Goose *B. canadensis*.

Discussion

The ducks on small remote islands provide a striking parallel with the land birds of such islands discussed elsewhere (Lack 1969a). First, there is a big reduction in the number of resident species compared with the nearest mainland. Secondly, this cannot be attributed to difficulties of dispersal, since many ducks, in addition to the resident species, have been recorded on all the islands which have been frequently visited by ornithologists. The only reasonable explanation, as for the land birds on islands, is that many visiting species are prevented from establishing themselves through competition by the resident species. This is presumably because remote islands provide much more limited ecological opportunities than the mainland, so that a species with a broad niche is, in general, more efficient than a greater number with more specialised niches (*cf.* MacArthur and Levins 1967). Hence the adaptive radiation of the genus *Anas* on the continents goes into reverse, so to speak, on small and remote islands, and the end result is one medium-sized form with an unusually wide range of foods. In the same way, there are fewer species of Darwin's finches in the genus *Geospiza* on the small and remote than the large and central Galapagos islands, and some of these combine feeding niches filled by two separate species on the large central islands (Lack 1969b).

On small and remote islands, the niche for a duck is evidently filled most efficiently by a species of *Anas*, and, as just mentioned, this is of medium size, irrespective of the size of the presumed mainland ancestor. That the ancestral species is different on seven of the eight island groups concerned is presumably due to the historical accident of which species first colonised. That, nevertheless, all these species are of similar size is presumably due to convergent evolution.

The fact that two species of *Anas* coexist on Rennell and the Aucklands requires study; one is decidedly larger than the other, so they presumably differ sufficiently not to compete. There are parallels to this situation in land birds on islands, notably in White-eyes (Zosteropidae). Where ducks are exceptional is in having many species on certain larger islands, notably Iceland, and to a smaller extent the Falklands, both of which have relatively few land birds. Presumably the ecological opportunities for ducks are unusually favourable there; certainly this seems to be the case in Iceland. However, this suggestion needs testing by comparative measurements of the richness and diversity of the inland waters on the islands and on the adjoining continents, and until this has been done, the views put forward here are speculative.

Acknowledgements

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Summary

1. Eight endemic subspecies of ducks *Anas*, derived from seven mainland species, occur on remote tropical or subantarctic islands.
2. On most of these islands there is only one species, which is of medium size, irrespective of the size of the mainland form, and except in one case has a generalised diet. The males, and some of the females, tend to lose their specific recognition marks.
3. Many other species of ducks have reached the islands concerned, and they are presumably prevented from establishing themselves because, where ecological diversity is reduced, one species with a broader niche excludes a greater number of specialists.

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Dr. D. Lack, Edward Grey Institute, Botanic Garden, Oxford.

The swans and geese of Alaska's Arctic Slope

JAMES G. KING

Description of the area and a comparison with the Yukon Delta (Plate III, p. 48)

North from the Brooks Range, rolling hills blend into an uneven upland and finally a flat plain. Water areas increase in number the lower and flatter the terrain becomes until some areas near the coast are more than 50% water. Some 50 streams and rivers cross the plain, known locally as the Arctic Slope, lying between 70° and 71° North.

The area appears superficially to be very similar to the more productive waterfowl habitat of the Yukon Delta along the Bering Sea coast, lying between 60° and 63° North. Like the latter, the entire area is treeless tundra underlain by permafrost. Sedges *Carex* spp. and *Eriophorum* spp. are the dominant feature of the vegetation and shrubby willows *Salix* spp. and alders *Alnus* spp. are found along the streams. Detailed descriptions of the habitat near Wainwright are given by Maher (1959) and of that along the Colville River by Kessel and Cade (1958). There are approximately 23,000 square miles of waterfowl habitat on the Arctic Slope compared with some 26,000 square miles on the Yukon Delta. The mean tidal variation at Point Barrow is only six inches (compared with nine feet in the Yukon Delta) and lack of tidal action is evident in the estuaries and along the ocean shore.

Weather on the Arctic Slope tends to be cooler and drier in summer than on the Yukon Delta (Table I). Because the greatest known density of Whistling Swans *Cygnus c. columbianus*, Black Brants *Branta bernicla orientalis* and White-fronted Geese *Anser albifrons frontalis* nest on the Yukon Delta, we assume that weather and habitat conditions there are optimum for these species (Brandt 1943; Spencer *et al.* 1951; Hansen and Nelson 1957; Smith *et al.* 1964). The Arctic Slope conversely seems to be near the outside fringe of usable habitat for all species. Open water first occurs in the lakes on the Arctic Slope in late May or early June and the thaw progresses more rapidly a few miles inland than it does on the coast. Snow cover is so light that the first thawing day produces patches of bare ground. Sea ice is often visible from shore during the entire nesting season although there is usually enough open water for boat travel.

Table I. Comparative weather data, Arctic Slope and Yukon Delta.

	May	*June*	*July*	*Aug.*	*Sept.*	*Av. summer*	*Av. annual*
Barrow							
Av. precipitation (in.)	0.13	0.28	0.83	0.80	0.55	2.59	4.11
Av. temperature (°F.)	19	34	40	38	31	32	10
Bethel							
Av. precipitation (in.)	0.89	1.20	2.29	4.02	3.01	11.41	18.17
Av. temperature (°F.)	40	53	55	53	45	49	30

Methods

From 28th July to 2nd August 1966 survey flights totalling 24.3 hours flying time were made east and west from Point Barrow. The object was to (1) learn the species composition and abundance of geese, (2) explore possibilities for future study, and (3) determine if the habitat is threatened by the activities of man.

An amphibious Cessna 180 aircraft piloted by one of the two observers was used on this project. Observations were recorded on an IBM tape recorder. Because fog can blanket the coast, where all communities are located, for long periods, while just a few miles inland skies are clear, a complete camping outfit was carried as essential equipment in the aircraft.

Observations were made from 150 to 250 feet above ground level. The flight path included the entire coastline, the river deltas and all the principal lake areas from Barter Island on the east to Point Lay 360 miles to the west and up to 80 miles inland (Figure 1). All swans and Snow Geese *Anser caerulescens* accompanied by broods were actually counted. Other geese were counted or estimated depending on the flock size (Table II). As with all air surveys it is certain that some birds within the field

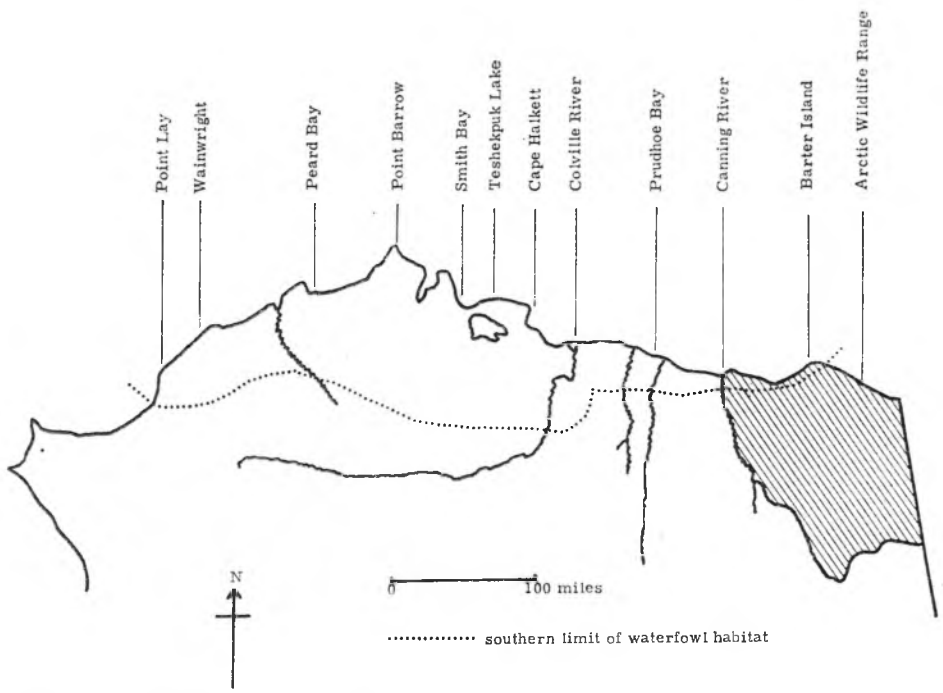

Figure 1. The Arctic Slope of Alaska.

Table II. Arctic Slope geese and swans—1966.

	Moulters	*Breeders*	*Young*	*Total*	% *Young*	*No. broods*	*Av. brood size*
Whistling Swan	117*	20*	22*	159*	13.8	10*	2.2*
Canada Goose	10,278			10,278			
Black Brant	18,365	1,308	1,308	20,981	6.2		2.0
White-fronted Goose	4,412	725	1,594	6,730	23.7	67*	4.4*
Snow Goose	343	38*	77*	458	16.8	19*	4.1*
Total geese	33,563	2,088	2,979	38,630			

* Starred numbers are actual counts. Other figures are estimates.

of vision of the observers were not seen but without concurrent ground studies this factor could not be evaluated. Rough estimates of total population were derived by estimating the number of square miles actually scanned in relation to total square miles of habitat and expanding bird observations accordingly.

Whistling Swan *Cygnus c. columbianus*

We observed 159 swans in the survey and estimate these to be about one-fifth of the Arctic Slope population of probably not over 800 birds. This area is near the ecological limit of swan habitat but enough cygnets were observed to indicate this is a self-perpetuating population. All young observed were in Age Class I with a mean brood size of 2.2 (Table II). We gathered no data on phenology in 1966 but local residents described spring on the Arctic Slope as being late. By way of comparison a late season on the Yukon Delta results in a reduced clutch and brood size of Whistling Swans. Yukon Delta broods averaged 3.4 young in July 1963, an average year, and 2.8 in July 1964, an extremely late season. The Arctic Slope brood size of 2.2 indicates a lower productive rate than has ever been observed farther south, even in the poorest years (King 1964). There may be some natural compensation for low productivity in the Arctic, for instance a lower density of predators.

Canada Goose *Branta canadensis*

The Arctic Slope Canada Geese are probably the *B. c. taverneri* identified by Kessel and Cade (1958). Moulting flocks were seen along the coast from Smith Bay to Canning River, most being in the area north of Teshekpuk Lake. We saw no broods, probably because we concentrated our search on the lakes and along the ocean shore. Canada Geese are known to nest on the bluffs of the Colville River where an estimated 200-300 breeding pairs were observed in 1952 (Kessel and Cade 1958). They probably nest along several other rivers. Our estimate of 15,000 Canada Geese for the area included moulting, non-breeding birds only. It is doubtful whether production on the Arctic Slope could maintain the large unproductive flocks observed. Probably most of these birds were produced on breeding grounds south of the Brooks Range and were exhibiting the northward wandering trait of sub-adults that has been observed among other races of Canadas (Hansen and Nelson 1964).

Black Brant *Branta bernicla orientalis*

Bailey *et al.* (1933) found Black Brant the most common nesting anseriform near Barrow. Hansen (1957) reported some 10,000 apparently unproductive Brant near Cape Halkett. Other references to Brant on the Arctic Slope are of very small numbers. Our count of 20,981 Brant fell into two groups, that of non-productive moulting adults or sub-adults and that of flocks with broods. We speculated there were at least 35,000 Brant on the Arctic Slope this year, 5,000 of which were goslings.

The non-productive Brant, which made up nearly 90% of our count, were found exclusively north of Teshekpuk Lake, by Cape Halkett. In this area there are some thirty elongated lakes of a mile or more in extent. Flocks of flightless Brant numbering from 50 to 1,500 birds were present on most of these lakes. As geese without nests or young invariably fly if they can at the approach of an aircraft, it was easy to identify and estimate numbers in the flightless flocks. We covered this moulting area fairly intensively and estimated that there were at least 25,000 Brant here. There did not seem to be enough productive Brant on the Arctic Slope to maintain indefinitely so many unproductive birds. Possibly Brant produced farther south or east in Canada congregate in the Cape Halkett area during non-productive years. It is also possible that we failed to find a substantial number of the brood flocks or that in some years a much larger portion of the Arctic Slope population is productive.

Small flocks of downy young and adults in about a 50:50 ratio were observed from Peard Bay to Barter Island on the river deltas and up to 20 miles inland in areas of larger lakes. Thus, one-third of the area surveyed appeared to be Brant habitat. About 40% of the broods were adjacent to salt water and tidal estuaries on habitat similar to that which they use on the Yukon Delta. The rest of the Brant broods were near freshwater lakes some distance from the influence of the sea in a type of habitat never used on the Yukon Delta. The largest brood flock consisting of about 40 young and 40 adults was on Teshekpuk Lake. Many single broods were seen away from any others of their kind. This is also contrary to conditions on the Yukon Delta where Brant are more typically colonial (Hansen and Nelson 1957).

The presence of substantial Black Brant production widely scattered on Alaska's Arctic Slope opens a new area of speculation. The breeding range of the Black Brant has been described as from the Yenisei River, Siberia, to Melville Island, Canada, and south to Nelson Island, Alaska (A.O.U. 1957). The Black Brant is thus distributed along more than 4,000 miles of coastline with an unknown acreage of suitable habitat.

Manning *et al.* (1956) reported 80,000 Brant on Banks Island and Uspenski (1964) reported some 14,000 Brant on Wrangel Island. There could well be a much greater portion of Black Brant produced north of the Yukon Delta than previously thought. Circumstantial verification of this theory has been made by Robert D. Jones, Refuge Manager of the Aleutian Islands National Wildlife Refuge. Virtually the entire Black Brant population is present in Izembek Bay near the tip of the Alaska Peninsula during October each year. Jones has made extensive population composition counts on the basis of plumage at Izembek Bay since 1963 (Table III) (Jones 1964, 1968).

Table III. Autumn Black Brant age ratios —Izembek Bay (from Jones 1968).

Year	*No. counted*	% *Young of year*
1963	5211	23.0
1964	15159	29.3
1965	31124	22.1
1966	21194	40.3
1967	19362	17.5
1968	21278	17.6

The almost total nest failure caused by flooding on the Yukon Delta in 1963 was not particularly obvious at Izembek that fall. It is likely that a late spring reduced Arctic production in 1964, 1965 and 1967 when the Yukon Delta production was fair. Production in 1966 must have been fairly good throughout the breeding range as indicated by the large percentage of young in the population at Izembek Bay. Hansen and Nelson (1957), discussing some 8,000 Brant banded in mid-summer on the Yukon Delta, reported eight recoveries from northern Siberia and 28 recoveries from northern Alaska and Arctic Canada. More than an accidental exchange between breeding areas is indicated, possibly as a result of pairing on the wintering grounds.

Considering these circumstances, it seems unlikely that Black Brant would ever suffer a complete production failure throughout their range even though individual flocks may fail somewhere almost every year. Thus, the vast, undescribed, low density breeding areas may be extremely important to survival of the Black Brant.

White-fronted Goose *Anser albifrons frontalis*

White-fronted Geese are fairly evenly distributed throughout the lake areas of the Arctic Slope. Although their density is low they appeared to be the commonest breeding species of goose present. We saw some 6,700 White-fronted Geese but we covered only about 12% of the usable habitat. Thus, there could be as many as 50,000 present on the Arctic Slope.

A fairly complete census of White-fronted Geese in this area could be made during the moulting period using an aircraft to search random plots. They would be fairly easy to count accurately because the flocks seldom include more than 100 birds. This method would be better than using line transects because positive boundaries could be established for each plot; visibility problems due to wind or sun could be eliminated by circling; it would be possible to remain in the area until all geese had entered the water, as they tend to do; and as much time as necessary could be devoted to counting each flock. A somewhat smaller area might be surveyed in the same fashion for Black Brant production.

Snow Goose *Anser caerulescens*

We saw 19 broods of Snow Geese and 343 flocked, moulting adults east of Barrow. The broods were widely scattered on lakes within two or three miles of the coast from Barrow eastward to the Colville River. Usually there was just a single brood on any one lake. The non-productive Snow Geese were with flocks of Brant near Cape Halkett. These birds could be a remnant of what was once a much larger population or they could be drop-outs from large flocks of spring migrants. We thought we may have seen approximately half the Snow Geese present and that there were probably not more than 1,000 on the Arctic Slope in 1966.

Reports of the odd Snow Goose brood are not unusual in coastal areas north of the Yukon Delta. Hansen (1957) reported 1,300 moulting adults near Cape Halkett. Gabrielson and Lincoln (1959) indicate that nesting Snow Geese were much more common east of Barrow in the past and that depredations by Reindeer *Rangifer taranda* and Reindeer herders may have wiped out nesting concentrations. Reindeer are known to eat eggs and nests of waterfowl as well as causing nest damage by trampling (Nelson and Hansen 1959).

On Wrangel Island it has been observed that Snow Geese nest successfully in two situations. First, small numbers succeed in the vicinity of nesting Snowy Owls *Nyctea scandiaca* because the Owls will drive away all avian predators and can actually dispatch a persistent fox. Second, large colonies succeed by sheer weight of numbers in spite of some predation on the periphery of the colony (Uspenski 1964). Snowy Owls were common along the coast where the Snow Goose broods were seen and possibly there is some relation. Also possibly a Snow Goose can nest successfully if isolated far from any other attractions for predators.

Probably a Snow Goose colony reduced to a certain threshold can no longer succeed because of predation except as a scattered remnant. If nesting colonies did exist in this area it seems entirely possible that Reindeer could have upset the colonial structure and caused their destruction. Obviously Snow Geese can reproduce here successfully even in very small numbers.

The domestic Reindeer are now gone from the Barrow area although Caribou *Rangifer arcticus* are common. Snow Geese might re-establish former nesting abundance naturally as the loose bands of unherded Caribou pose far less threat than Reindeer. Cooch (1964) described the development of a Snow Goose colony in Ontario. In 1947 several hundred birds

dropped out of migrant flocks and nested at Cape Henrietta Maria. During the next ten years this colony grew to exceed 15,000 birds.

Uspenski (1963) suggests that former Snow Goose colonies in Russia might be re-established by releasing juvenile birds with White-fronted Geese or by placing eggs in the nests of White-fronted Geese. If the Russians succeed in re-establishing nesting colonies of Snow Geese in Siberia, it is likely the same thing could be done on Alaska's Arctic Slope.

Ducks

Because our survey was directed mainly at geese, we did not devote much attention to ducks. Ducks, of course, are more difficult to see and identify from the air in mid-summer. A comparison of breeding duck populations on the Arctic Slope and the Yukon Delta is possible from aerial surveys by Hansen and King in 1957. A density of 3.1 ducks per square mile, 68% of which were Long-tailed Ducks (Old Squaws) *Clangula hyemalis*, was recorded on the Arctic Slope whereas the Yukon Delta had 16.1 ducks per square mile (Hansen 1957).

We observed occasional flocks of diving ducks on the lakes and lagoons during the survey in 1966. Some Eider broods *Somateria* sp. were observed in the lakes along the lower Colville River. On 26th-27th July 1966 a steady stream of Eider flocks passed Point Barrow, headed west, with a favourable tail wind. Every few minutes a flock of 20 to 200 Eiders would cross the point east of the airfield at an elevation of about 50 feet. On 28th July the wind swung around to the west and the Eider migration ceased. These are a portion of approximately one million King Eiders *Somateria spectabilis* that migrate along the Arctic Coast each year (Thompson and Pearson 1963).

Snowy Owl *Nyctaea scandiaca*

Snowy Owls seemed to be quite numerous within two or three miles of the coast from Smith Bay to Prudhoe Bay. They sit by themselves on little hummocks on the tundra but frequently as many as five would be in sight from one side of the plane at a time. Because large gulls, probably Glaucous Gulls *Larus hyperboreus*, occupy the same type of hummocks it was necessary to fly directly over them to make a positive indentification. We identified only 79 owls but there must have been some hundreds in the area.

Discussion

Waterfowl are not very abundant nor greatly concentrated on the Arctic Slope of Alaska as reported by numerous observers, going back to whaling days before the turn of the century (Gabrielson and Lincoln 1959). There are several other places in these high latitudes where spectacular concentrations of waterfowl, particularly geese, are found. Most waterfowl studies in the Arctic have been directed toward these concentration areas. There is virtually no quantitative waterfowl data on what may be an enormous amount of low density habitat such as occurs in Arctic Alaska.

By use of the aircraft we were able to get a more comprehensive picture of the goose populations of the Arctic Slope than have ground-bound observers in the past. Our observations, though scattered over a wide area, when totalled indicated that this area is making a valuable contribution to the continental goose population. The value of such low density habitat may be underrated. Such dispersed production may be of real value in years when the high density production areas fail. There is also a possibility that because of depredations and habitat damage in the wintering grounds as well as on the breeding range, goose populations using the Arctic Slope are now considerably reduced from what they once were or still could be.

Obviously further study is needed. Population counts from the air, using a plot sampling method, would be practical from mid-July to early August when geese are flightless. It would likewise be possible by use of aircraft for transport to catch adequate numbers of young and moulting geese and diving ducks for banding studies. Very likely small nesting colonies could be located from the air in June for the purpose of production and ecological studies. Although the numbers of geese present on the Arctic Slope may not warrant a crash study programme now, we should regard it as a valuable piece of habitat which may have a greater potential for goose production in the future. The tracks and litter of oil development are much in evidence in many places. Most of the waterfowl habitat is outside the protection of the Arctic Wildlife Range, on public lands subject to commercial development or within the Naval Petroleum Reserve No. 4. The Naval Reserve covers all the lowlands from the Colville River almost to Point Lay and includes well over half the Arctic Slope waterfowl habitat. No

serious conflict between waterfowl and oil development was noted but this industrial activity is increasing rapidly.

If proper precautions are taken there is no need for oil development or Reindeer production to interfere with the bird resources. There is a danger, however, that the old concept of 'Arctic waste land' is leading to inadequate observance of normal procedures for safeguarding the habitat. Arctic habitat, once damaged, takes generations to recover so every care should be taken to preserve it in its present condition. The moulting area between Teshekpuk Lake and Cape Halkett in particular may well need special protection. Perhaps this area should be included in the National Refuge system.

Oil spills in the sea lanes between the ice pack and the shore line could be devastating to the huge numbers of eider, geese and other water birds that migrate along the Arctic Coast. Every effort should be made to see that oil is kept out of any of the waters. An active programme of pollution surveillance and control should receive a high priority in management of this area.

Supplement

In 1966 several small oil prospecting crews were on the Arctic Slope. Most of the litter referred to was on the Naval Petroleum Reserve and had resulted from rather extensive seismic and drilling operations conducted by the Navy between 1944 and 1953.

In the summer of 1968 a major oil strike was reported near Prudhoe Bay. The rush was on immediately. Now roads, tractor trails, airfields, gravel pits and drilling pads litter the tundra from the Arctic Wildlife Range to the Colville River. A winter road has been built from Fairbanks to Prudhoe Bay, a tanker has pioneered a shipping lane across the top of Canada and the State of Alaska has received 900 million dollars for additional oil leases near Prudhoe Bay. Construction has started on a 48-inch diameter pipeline and a permanent highway from southern Alaska. And this is just the beginning.

Experts estimate there are 10 to 50 billion barrels of oil in the Prudhoe Bay area and up to 400 billion barrels in the region including the Arctic Slope and adjacent parts of Canada.

No one was prepared for the magnitude of developments now occurring in the Arctic. Dr. Robert Weeden of the Alaska Conservation Society made a pertinent observation: 'My main conclusion from seven months of thinking about Prudhoe Bay is that neither science nor government was—or is—prepared for discovery of oil in the Arctic. Science cannot predict the quantitative effects of the industry's disturbance of arctic soils and vegetation on biological communities, nor can science estimate the economic and social costs of these disturbances. Partly in consequence, government has not equipped itself with laws or funds to meet fully its responsibility to protect public values on public arctic lands.'

It is impossible at this point to predict the full extent of the oil boom or what its eventual impact on waterfowl will be. We can assume it will not be good and we can only hope that science, government and industry will be able to join in preventing it from being overly destructive.

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Summary

A mid-summer aerial waterfowl survey was made in 1966 on the 23,000 square miles of Alaska's Arctic Slope. Birds observed included 159 Whistling Swans *Cygnus c. columbianus*, 10,278 Canada Geese *Branta canadensis taverneri*, 20,981 Black Brants *Branta bernicla orientalis*, 6,730 White-fronted Geese *Anser albifrons frontalis* and 458 Snow Geese *Anser caerulescens*. An extensive goose moulting area near Cape Halkett was searched. Expanded population estimates are given. Discussion includes: better census methods; the relation of these birds to areas of greater nesting concentration; possibility for banding and other

studies; and the possibility of increasing the abundance of Snow Geese, including the control of Reindeer *Rangifer taranda.* It is concluded that this large block of habitat could be representative of a vast Arctic area of low production that may be of considerable importance to the species involved. Measures to protect the habitat from industrial damage are warranted.

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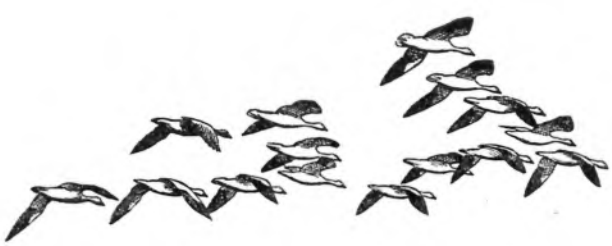

Distribution and numbers of the Pink-footed Goose in Central Iceland, 1966-69

C. J. K. BULSTRODE and D. E. HARDY

Introduction

This report is based on the work of three expeditions to Central Iceland, which have extended the study of the biology of the Pink-footed Goose *Anser brachyrhynchus* begun by the Wildfowl Trust in 1950. In 1966, a Radley College Expedition investigated the region from 31st July to 5th September, spending ten days in Þjorsarver. In 1969, an Oxford University Expedition was based in the area from 1st July to 30th August, where they were assisted by a second Radley College Expedition from 28th July to 14th August.

During the period covered by the 1969 expeditions, an area of some 800 square kilometres, from Miklumyrar in the south to Gudlaugstungur in the north, was checked for evidence of breeding Pinkfeet. In addition to this, the river gorges of the Kerlingarfjoll, and Þjorsarver itself, were also investigated (Figure 1).

We were attempting to provide up-to-date knowledge about the Pinkfoot breeding distribution and numbers in view of the reported threat to inundate the Þjorsarver oasis in the course of hydro-electric developments. In 1969, both expeditions encountered almost continuous, unpleasant weather conditions.

Distribution outside Þjorsarver

In the two years visits have been made by our expeditions to every area of meadow of significant size in the central highland region where Pinkfeet could breed, and the sides of many gorges have been examined. This represents the most likely overflow area from Þjorsarver, there being no serious barriers to the movement of geese and goslings from Þjorsarver to the west. To the east and south-east of Þjorsarver lies a huge tract of lava desert terminating in the Vatnajokull glacier. Although this area was not surveyed by our expeditions, it seems unlikely that Pinkfeet could breed in any significant numbers in this region, owing to lack of suitable habitat.

To the north and north-east of Hofsjokull, small numbers of breeding Pinkfeet have been reported from localities in the headwaters of the rivers Skjalfandafljot, Jokulsa a Fjollum and Jokulsa a Bru but it is probable that the total numbers of nests in these systems does not exceed 400, although most of these areas have not been examined for over 20 years (Scott, Fisher and Gudmundsson 1953; Yeates 1955). The Pinkfoot is restricted in Iceland to the Central Highlands, and is replaced as a breeding species in lowland and agricultural areas by the Greylag *Anser anser*. Pinkfeet belonging to the same population also occur in East Greenland. The number of breeding pairs is unknown but it is unlikely to exceed 1,000 (Christensen 1967).

Within the area between Hofsjokull and Langjokull glaciers from Miklumyrar in the south to Gudlaugstungur in the north, the following localities have been examined.

The Kerlingarfjoll and southern meadows

Jokulfall: 70 nest sites of which a maximum of 50% are occupied in any one year. In 1966, an estimated 35 nests were occupied; in 1969, about 10, an apparent decrease. Small isolated Pinkfoot breeding colonies are known to be subject to wide and rapid fluctuation (Yeates 1955).

Kerlingaralda: five nests found, all occupied (1969) but only the northern third of this gorge system was covered.

Kisubotnar: evidence of breeding, in small numbers only, cited by Blurton Jones and Gillmor (1955) and our expedition (1966). Not examined in 1969.

Miklumyrar: surveyed only in 1969 (7th July). Twenty-one pairs with goslings counted. No nests were found.

Hrafntoftaver: surveyed only in 1969, when 11 pairs with goslings were found. There was one old nest on a roof of a kofi (hut).

Pinkfeet in both of these areas are presumed to have bred in the gorge systems of Kerlingarfjoll and to have moved down to the richer vegetation in these meadows. A walk of up to fifteen miles for a goose family does not appear to be unusual (J. Kear pers. com.).

Hvitarnes: on 6th August 1966, about 300 non-breeders were present. On 10th July 1969, no Pinkfeet were recorded and examination of the possible breeding sites in the river Froda gorges provided no evidence of breeding (Oxford Expedition).

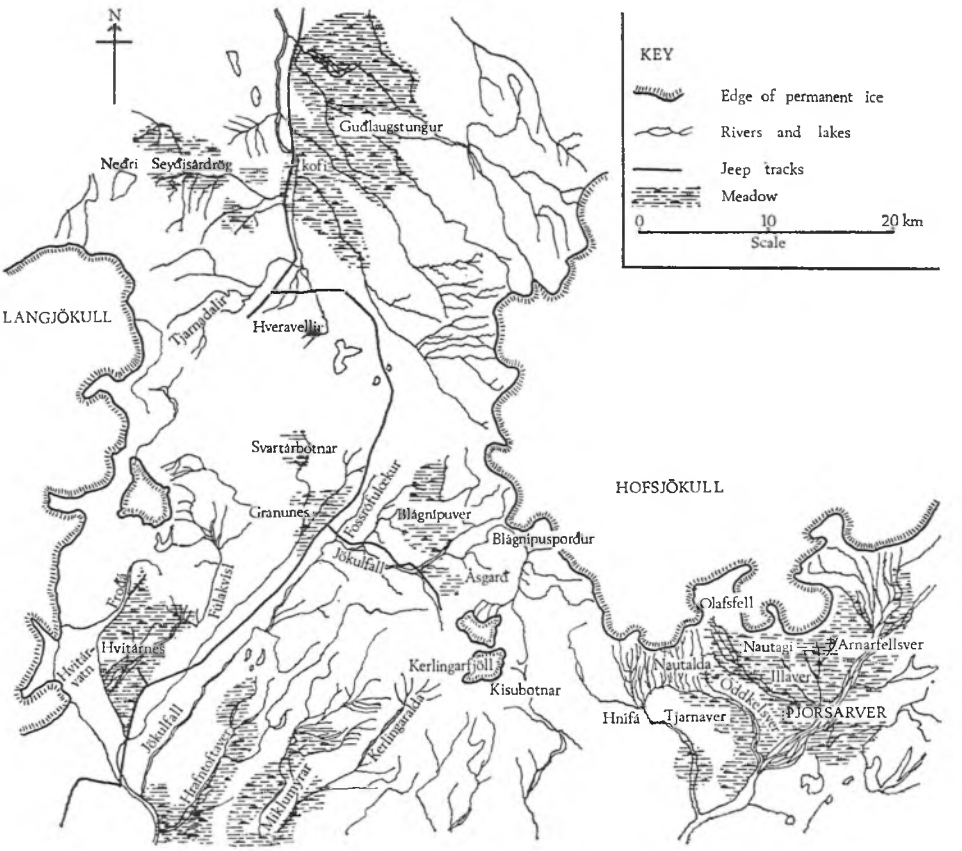

Figure 1. Central Iceland

The central meadows

Blagnipuver: in 1966, 70 flightless Pinkfeet were reported in early August, without goslings. On 3rd July 1969, 32 geese and goslings present, but were not seen after 7th July (Oxford Expedition), nor on 29th July (Radley College Expedition).

Granunes and the Svartarbotnar meadows: in 1966, four flocks totalling approximately 100 birds were seen in late August, possibly non-breeders. An eggshell was found but no nests or other evidence of breeding. In 1969, 7th-12th July, no geese were reported (Oxford Expedition). On 30th July, 31 geese; 12 large goslings, 14 flightless adults, and 5 flying adults which were probably non-breeders. Two eggshells found suggested breeding here (Radley College Expedition).

To the south-west of Granunes nine well-grown, flightless and apparently orphaned goslings, and one freshly killed bird, were found.

The relationship between numbers of Pinkfeet present in Blagnipuver and Granunes in 1969 suggests that the families and non-breeders moved from Blagnipuver to Granunes during early July.

Blagnipuspordur: in 1969, two pairs, each with three goslings, were present during the whole of July. Five nests (3 new, 2 old) were found along Jokulvisl gorge. Five presumed non-breeders were on moraine lakes at the head of Jokulvisl (Oxford Expedition).

The northern meadows

Tjarnardalir: no evidence of geese was found in 1966 nor on 21st July 1969 (Oxford Expedition).

Nedri Seydisardrog: there were 13 adult Pinkfeet on 11th August 1966, but

none on 21st July 1969 (Oxford Expedition).

Gudlaugstungur: on 12th-13th August 1966, four separate flocks totalling 39 flightless adults, were seen and one nest found on the roof of a kofi. On 21st July 1969, no Pinkfeet were recorded. The old nest on the kofi was still present. The entire area was covered completely between 10th and 12th August. Two hundred Pinkfeet were recorded, all fully flighted and presumed non-breeders, there being no goslings (Oxford Expedition).

The total area of the Seydisardrog and Gudlaugstungur meadows exceeds that of Þjorsarver, and would appear to be the only possible alternative breeding ground for the Þjorsarver colony. Why this region has not been colonised by Pinkfeet, despite the increasing number of adult birds apparently unable to breed (Boyd and Ogilvie 1969), remains uncertain. Þjorsarver, being in the precipitation shadow of the Hofsjokull, may provide more settled weather conditions and earlier snowmelt. This may be critical, especially during the early part of the breeding season in May and June. Gudlaugstungur appears to be drier and its vegetation to differ from that of Þjorsarver, but an extensive botanical survey, such as that made for the latter by Sladen (1960), would be required to establish this. No vegetation maps for Gudlaugstungur have yet been published but the sedges and mosses (*Carex/Rhacomitrium* association), so abundant in Þjorsarver, may well not occur in sufficient quantity to support a large breeding population of Pinkfeet.

The population in Þjorsarver

Since 1951 this area, which includes Hnifarver, Þufuver and Eyvindarkaver, has been known to hold the largest breeding population of Pink-footed Geese in the world (Scott, Fisher and Gudmundsson 1953). The 1953 Wildfowl Trust expedition (Scott, Boyd and Sladen 1955) estimated that it held at least 18,400 geese, comprising 8,200 adults and 10,200 goslings. That Þjorsarver remained of paramount importance as a breeding ground was confirmed, in general terms, by an aerial survey in 1964 (H. Boyd unpublished) and by the expedition of 1966 (Hardy 1967). In 1969 the opportunity arose to make a round quantitive assessment of numbers.

One of the objects of the Oxford expedition was to obtain a series of blood samples for esterase analysis. A comparison of the types and quantities of these enzymes with those from Pink-footed Geese in Spitsbergen might then throw light on the degree of genetic separation that had taken place between these two isolated populations (which do not even mix on the wintering grounds). Towards the end of our stay we therefore arranged a drive of the flightless birds, using the techniques developed with such success by the 1953 expedition. Since we only needed a few hundred birds at most, we confined the drive to a small area of approximately eight square kilometres on the northern outskirts of Þjorsarver. Even so, from this relatively small area we rounded up 3,000 birds. We decided that with such a large sample we should attempt to make as accurate estimates as we could both of the total and of the proportion of goslings. About 1,000 birds were penned for the purpose of blood sampling, while the remainder were allowed to disperse. The age ratio in the penned sample was approximately 8 adults to 10 goslings. These figures have since been confirmed from both ciné and still photographs.

The total area of Þjorsarver, calculated from a 1:50,000 map (AMNS. U.S. Army 1949) is about 120 sq. km. The area covered by vegetation (Iceland Survey Department 1967) is about 82 sq. km. If we make the assumption, admittedly unproven, that the geese were evenly distributed over the vegetated area, then our catch would represent 8/82 of the total population. This latter would thus be estimated at approximately 30,700, comprising 13,600 adults and 17,100 goslings.

Age ratio counts made during the November 1969 census of Pinkfeet in Britain revealed 24.4% young birds and a mean brood size of 2.2 (Ogilvie pers. com.). The total count was 74,000 geese, so the number of successful parents in the population was 16,400. Britain forms the sole wintering area for the Iceland and East Greenland Pinkfeet, so we can say that Þjorsarver held over 80% of the breeding pairs in 1969, and thus remains by far and away the most important breeding area. Despite the increased pressure there must be on the resources of Þjorsarver, with a breeding population increased 66% over the 1953 level, there appears, as we have seen earlier, little indication of spilling over into the vegetation oases to the north and west. This further strengthens the conclusion that those areas are in some way unsuitable for breeding Pinkfeet.

It is to be expected that the percentage of young found in Britain in November should be much lower than we found in Þjorsarver (55.7%) because the non-breeders from elsewhere would be included in the wintering flocks. They are now four times as numerous as breeders (Boyd and Ogilvie 1969), another suggestion that breeding sites are scarce. The mean family size accords well with that for Þjorsarver, 2.5 young per pairs, especially as further young would obviously be lost between August and November. Many of those in Þjorsarver were still so small that they would be unlikely to attain sufficient size and strength to migrate out when the first snows fell in September. The cooling and general deterioration of Iceland's summer climate (Kristjansson 1969) is is undoubtedly a factor in reducing breeding success, and one that may become increasingly serious.

Conclusion

Þjorsarver remains the vital breeding headquarters of the British-wintering Pink-footed Geese. It is ecologically unique and its use as a breeding ground could easily be jeopardised by any permanent alteration of water levels brought about by hydro-electric dams on the Þjorsa River. At present the geese find their necessary dry nesting sites only a foot above the general water level. Certainly the ultimate proposal, reported to be currently under consideration, to turn the whole of Þjorsarver into a vast storage lake would be disastrous. Even if the geese retreated to higher ground to build their nests, they would be deprived of the feeding meadows into which they lead their young.

Acknowledgements

We wish to express our thanks to the many individuals and organisations who have helped our expeditions in so many ways and also to Radley College and the University of Oxford for their support. Dr. Geoffrey Matthews and Malcolm Ogilvie kindly read and criticised the manuscript.

Summary

In the summers of 1966 and 1969 members of Radley College and Oxford University Expeditions spent a total of thirteen weeks in Central Iceland, primarily working on the Pink-footed Goose.

Possible breeding areas to the north and west of the main concentration in Þjorsarver were found to hold only a few, mainly non-breeding, geese. A sampling technique gave a rough estimate of the population of Þjorsarver as comprising 13,600 adults and 17,100 goslings. The increase over 1953 estimates is in accord with that of the whole British-wintering population. The Þjorsarver area remains of paramount importance to this population and its proposed flooding under a hydro-electric scheme would be disastrous.

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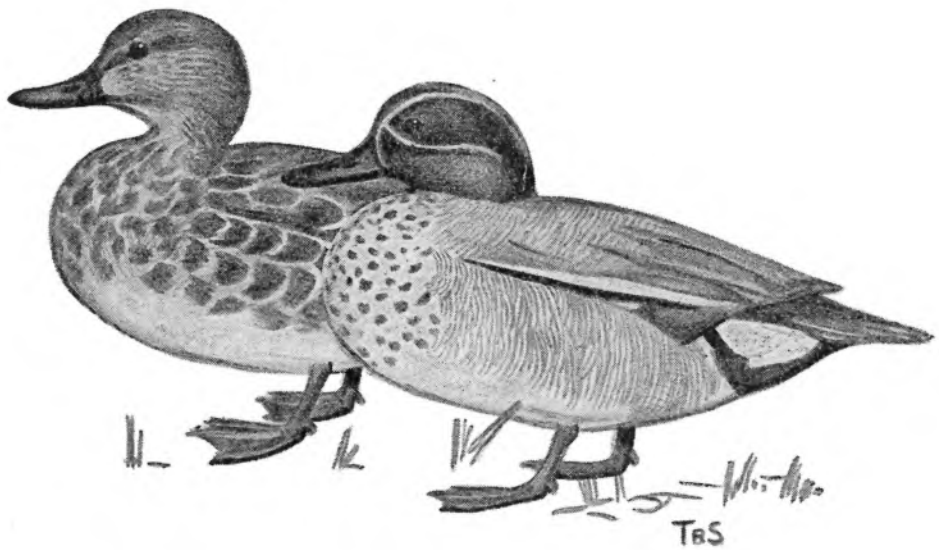
C. J. K. Bulstrode, University College, Oxford.
D. E. Hardy, Radley College, Abingdon, Berkshire.

Footnote:

A helicopter survey of Þjorsarver in June 1970 revealed about 10,700 nests, proving the area to be of even greater importance than hitherto suspected. The full results will be published in WILDFOWL 22.



Winter wildfowl counts in south-east Europe and western Turkey

ALAN JOHNSON and HEINZ HAFNER

Introduction

In the last decade the International Wildfowl Research Bureau began special efforts to make wildfowl counts in the circum-Mediterranean area. It was known that large numbers of Anatidae were wintering in this area and that rapid changes were taking place in their habitats. The future of a large proportion of the European migratory wildfowl populations seemed, therefore, to depend on the way the situation around the Mediterranean developed.

With very few ornithologists, amateur or professional, residing in these countries, and in view of the extent of many of the wetlands, it would obviously not be possible to organise at once the monthly counts practised in several west European countries over more than twenty years. So it was thought desirable to start by carrying out one annual mid-winter count, at a time when the wildfowl populations are most stationary. Mid-January was thought to be the best time (though the possibility of cold-weather movements could not be ruled out), during the fortnight around the nearest Sunday to the 15th January.

Although fragmentary data over several years are available from some of the countries, it was not until the winter of 1966-67 that regular missions were undertaken, to Rumania, Greece and Turkey. This work has been carried out mainly by a small but increasing number of reliable ornithologists, experienced at estimating numbers of wildfowl, whose deep interest has assured fairly regular visits. These missions have sometimes only been made possible by special grants but not a small contribution has been made by counters themselves.

The area under review lies between latitudes 36°N. and 46°N. and between longitudes 14°E. and 36°E., is bordered in the north by the Soviet Union, Hungary and Austria, and in the south, east and west by the Mediterranean, Black and Adriatic Seas respectively. Only the western half of Turkey, with its abundance of lakes, and deltas is reviewed, the few lakes in the east being situated at high altitudes and usually frozen over for two or three months of the year.

Regarding Albania it is unfortunate that no data are available, either on the status of the wetlands or the wildfowl visiting

them. Although the interior of the country is for the greater part mountainous, it would appear from maps that the deltas and wetlands along the coast might well be suitable to important numbers of ducks and geese, particularly during hard winters.

The time appears ripe for the results so far obtained to be made available in the form of an interim report. This paper then, is based on an accumulation of the data gathered by 27 missions, mainly during the period of the mid-winter counts, a full list of these being given at the end of this paper.

Although we only attempt to reveal the distribution and approximate numbers of the species of wildfowl visiting the area under study, a mass of information has also been collected on other aquatic species: grebes, herons, waders, and also on birds of prey.

Each winter new findings come to light concerning the numbers, distribution and movements of the Anatidae through these countries, and new wetlands are sometimes discovered. Thus in Greece in January 1970 a relatively small area comprising four lakes, the existence of which was seemingly unknown to ornithologists, revealed a total of 266,000 Anatidae and Coots. Often, because of the absence of roads and the necessity to have a vehicle capable of crossing difficult terrain, certain areas might be counted effectively one year but not another.

In view of this the data drawn up will be subjected to many corrections in future years. It does, however, serve to show the important rôle which the wetlands in these countries play for these migratory birds who know no frontiers, and whose future is an international responsibility.

Rumania

Although there are several wetlands situated along the River Danube which are of importance to wildfowl either on passage or for breeding, these are generally frozen over during the winter. This leaves, then, the delta of the Danube and the complex of lakes to the south (Razelm, Sinoie), comprising a total surface area of some 435,000 ha. Not only is this the most important wetland area on the Balkan Peninsula but one of the most, if not the most important in the whole of Europe.

Situated roughly between latitudes 44°N. and 48°N. and longitudes 21°E. and 30°E., Rumania is subjected to a moderate continental climate, the summers being hot and the winters generally cold. However, influence from the Black Sea over the delta and coastal regions is very marked, the winters being less severe here than throughout the rest of the country. There are strong winds and it is often cloudy or foggy. Although the greater part of this region may be completely frozen over for certain periods each winter, the cold spells, though sometimes severe, are not generally of long duration. At such times there is no doubt an exodus of wildfowl, as can be seen from the figures below, but the majority of birds can rest and feed on the sea.

The delta proper covers some 5,640 sq. km., of which 4,350 sq. km. are on Rumanian territory, the rest belonging to the Soviet Union. After the delta of the Volga it is the largest in Europe, 87% being water. The dominant vegetation over the major part of the delta area is reed *Phragmites communis* intermingled with common sallow *Salix cinerea.* These extensive reed-forests are interspersed with open stretches of water, many of them taking on the form of lakes, some, like Lake Rosu, being as much as 9 km. long and 4 km. wide. Being generally more than a metre deep they do not attract many surface-feeding ducks, but are the stronghold of Pochard *Aythya ferina* in particular.

To the south of the delta a series of lakes extends as far as the Bulgarian border. All of these are brackish or salty, the complex Razelm/Sinoie being in direct contact with the sea. It is in this latter complex and also around the island of Sahalin in particular, that most of the surface-feeding ducks are to be found. Lake Techirghiol has a salt content of between 80 and 110 g./l. and even during the coldest spells never freezes. This lake is important for wintering Shelduck *Tadorna tadorna* and White-headed Duck *Oxyura leucocephala.* Having a depth of between one and ten metres, it is extremely rich in Arthropoda and Crustacea, and the density of brine shrimps *Artemia salina* may reach around 100,000 per cubic metre, an important source of food which is possibly taken by the Shelducks.

Along practically the whole of the coastline there exists a shelf where the sea is little deeper than a metre. About 150 metres wide over the major part, this shelf broadens out to at least 500 metres in the whole of the delta and to as much as a kilometre around the island of Sahalin. This condition gives rise to a proliferation of eel grass *Zostera marina* and about 150 species of algae, of which the commonest are: *Enteromorpha linza,*

Laurenzia corcoronopus, Ceramium elegans, Ulva lactuca, etc. This abundant flora is without doubt the principal food of the wildfowl during severe cold spells.

It is understandable that such a vast region, much of which is difficult of access, should have remained little explored by the ornithologist, particularly during the winter. The first indications of the numbers and species of wildfowl wintering here date back to 1958-59. The following is an extract from the report by J. Vielliard, made available by M. Talpeanu.

1958-59: 940,000 birds in the delta and lagoons in November. During the first two weeks of December with a light frost, 530,000 in the delta and the lagoons and 1,000,000 on the sea. In January 159,000 in the lagoons, the delta being frozen. In the last two weeks of February 250,000 on the sea, the delta and the lagoons being frozen.

1959-60: No permanent frost; total census (delta, lagoons and sea) 133,500 in October, 128,700 in November, 119,400 in December, 103,900 in January, 140,800 in February and 320,100 in March (of which 255,600 in the lagoons).

1960-61: Frost in January; total census 219,500 in October, 229,500 in November, 693,000 in December, 305,500 in January, 828,000 in February (of which 610,500 on the sea) and 324,500 in March.

Ranked according to their numbers, the most common species are: (1) Teal *Anas crecca,* (2) Mallard *Anas platyrhynchos,* (3) White-fronted Goose *Anser albifrons,* (4) Coot *Fulica atra.* Red-crested Pochard *Netta rufina* stay the whole year, whilst Shelduck and White-headed Ducks have not been mentioned.

We can see that many ducks do retire to the sea during severe weather, as in the winter of 1958-59. In 1959-60, however, with no permanent frost, the total of Anatidae on the sea is much reduced.

In 1967 Vielliard and Talpeanu saw no more than a few hundreds of wildfowl, but their visit was done on foot and by car and they only reached the lakes to the south of the delta. Moreover, the count coincided with a spell of severe weather (15th-22nd January) and the masses of wildfowl were presumably out on the sea.

In January 1968 Hoekstra and Johnson also ran into similar unfavourable weather conditions, not even permitting the eastern part of the country to be reached. The missions of the autumn and winter of 1968-69, however, met with more success. During much of November and December Hoekstra and Hafner, with the assistance of the Commission for the Preservation of Natural Monuments in Rumania, were able to cover the greater part of this region by car and by boat. Also two flights were made on 9th and 13th January 1969, when practically the whole of the delta area and complex of lakes was covered. A cold spell had just begun and many of the lakes had started to freeze. By the 13th there was very little open water remaining and this influenced the distribution of the Anatidae (Figure 1). However, a thaw set in the following day.

The results obtained give a rather different view from that gained from previous missions and the most abundant wintering species were diving ducks. Full data are given in Table I. There is a striking difference in the numbers of Pochard *Aythya ferina* and Red-crested Pochard seen in past winters and the vast quantities recorded in 1968-69. The total of Pochard seen in November/December 1968 approached a million, and during the two flights in January 1969, 308,000 and 136,000 respectively. A total of 30,000 Red-crested Pochard was seen in November/December and also in January. Only about 12,000 Tufted Duck *Aythya fuligula* were seen in November/December but no less than 180,000 were counted in January. It is possible, however, that this species was well represented in the large numbers of unidentified ducks seen in December.

These enormous differences from the results from previous missions might be explained by the fact that the principal concentrations of these species are to be found in those places difficult of access and which have not been visited in the past: Lake Rosu within the delta, the eastern part of the complex Razelm/Sinoie, and, when the weather is severe, on the sea. It must not be forgotten that there are no roads in the delta.

Only by further counts can we find out if these figures represent an average winter population or if there is some change taking place. It is difficult, however, to explain the absence of the Teal in January, which was previously considered to be the most abundant wintering duck. Of the 150,000 seen in November/December, very few remained in January, 1,340 on 9th and 90 on 13th. The only surface-feeder which was seen in large numbers in January was the Mallard. This species is also abundant on migration in Rumania; about 200,000 were seen in November/December and about 100,000 in January.

Important passage has also been noticed

in November/December of the Pintail *Anas acuta* 10,000, Wigeon *Anas penelope* 13,000 and Shoveler *Anas clypeata* 40,000, but very few birds of these three species stay to winter.

It is clear then that this area is of prime importance as a wintering ground for diving ducks, and as a feeding and resting place for the masses of surface-feeders originating from the Soviet Union and

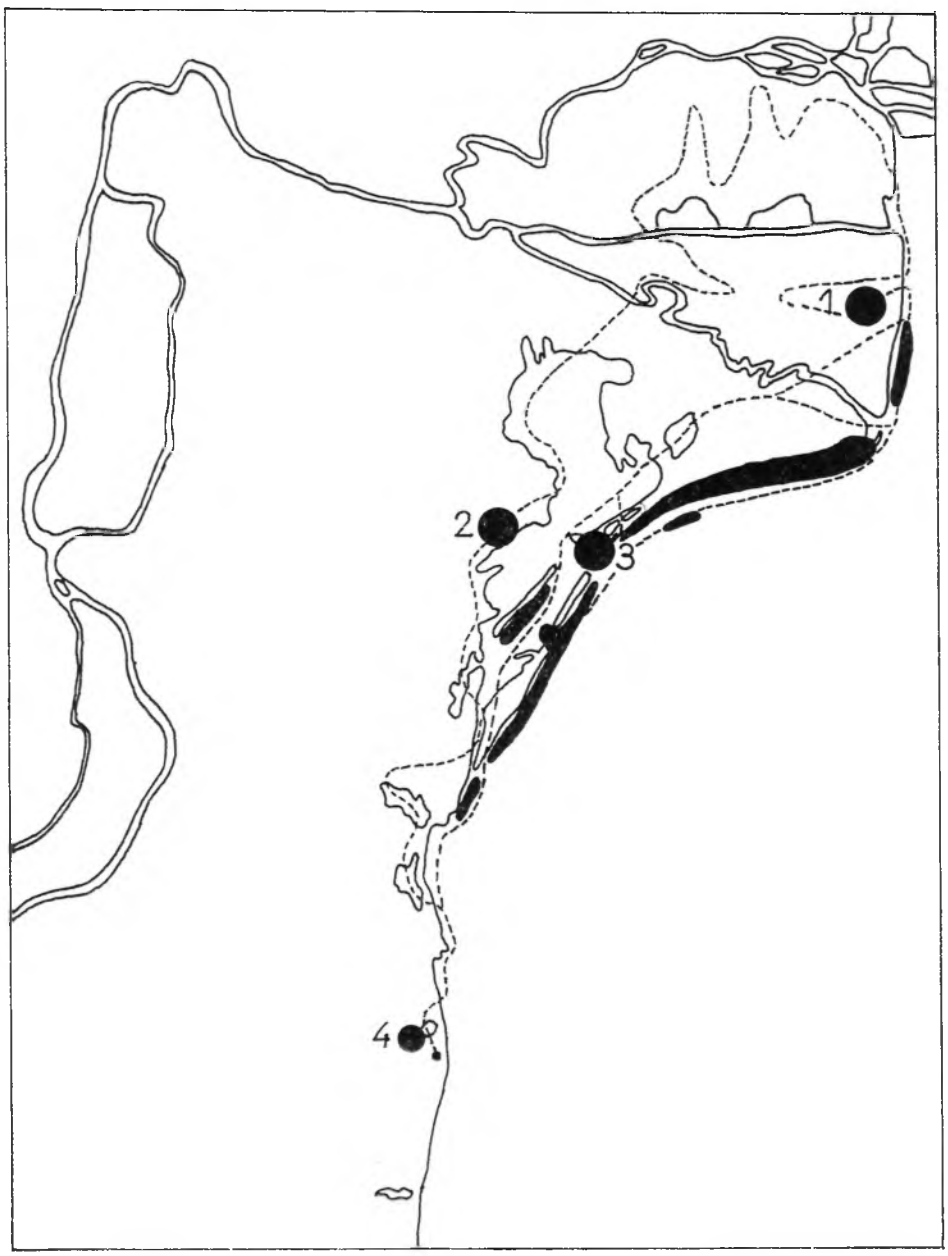


Figure 1. The most important concentrations of wildfowl in the Danube delta and the complex of lakes to the south in January 1969. - - - - - - = itinerary of two flights 9th and 13th January 1969. (1) Lake Rosu; (2) cultivated plains of the Dobrudja; (3) sector Bisericuta; (4) Lake Techerghiol; other black areas are coastal concentrations of Mallard and diving ducks.

Table I. The numbers of Anatidae and Coots counted in the Danube delta region winter 1968-69. The November/December counts were made from the ground or by boat, whilst in January two flights were made over the same area.

Species	*Ground counts 12th Nov. to 19th Dec.*	*Flight of 9th Jan. (still much open water)*	*Flight of 13th Jan. (effects of cold spell)*
Mute Swan	750+	2,850	1,850
Whooper Swan	300+	2,600	2,900
Bean Goose	28	—	—
White-fronted Goose	500,000	20,000	40,000
Greylag Goose	2,000	760	2,330
Red-breasted Goose	25,000	—	2,000
Ruddy Shelduck	50	—	—
Shelduck	1,500	1,200+	700
Marbled Teal	1	—	—
Pintail	14,000	46	76
Teal	150,000	1,340	90
Mallard	200,000	105,500	97,000
Gadwall	2,000	60	—
Wigeon	13,000	20	—
Shoveler	40,000	2,000	450
Red-crested Pochard	30,000	32,420	2,000
Pochard	970,000	308,790	136,000
Ferruginous Duck	13,000	1,040	15
Tufted Duck	12,000	182,000	175,250
Goldeneye	500	140+	80
Smew	50	30+	90
Red-breasted Merganser	400	570	220
Goosander	12	—	1
White-headed Duck	100+	20+	—
Unidentified ducks	270,000	50,000	20,000
Coot	90,000	22,000	3,250

wintering in the Mediterranean basin.

The coastal lakes south of the delta give place to the fertile rolling plains of the Dobrogea. These plains form the granary of Rumania and Bulgaria and much of the wheat grown there is winter-wheat, which is just sprouting when the huge flocks of geese move south in the autumn.

A small number of Greylag Geese *Anser anser* breed in the delta. Previous to 1968-69, however, they were not recorded as wintering, yet a flock of 2,300 was present in January. Even more striking data have been gathered for the White-fronted Geese and Red-breasted Geese *Branta ruficollis*. In December 1968 one flock seen between the villages of Istria and Sinoie was estimated at 500,000 Whitefronts and 25,000 Redbreasts, of which 50,000 Whitefronts and 2,000 Redbreasts were still present in January. This large number of geese is quite outstanding for any area. Where the bulk of the geese wintered is uncertain. It is unlikely that they moved east to the Caspian; Bulgaria has many suitable areas.

The Red-breasted Goose, having its main wintering grounds to the south of the Caspian Sea, usually passes to the east of the Black Sea (Sterbetz and Szijj 1968). However, its presence in Rumania has been known since 1910, when the first specimen was collected. From then up to the 1940's its occurrence was only sporadic. Since then Talpeanu (1963) describes it as wintering in tens or hundreds between October and March. Over 25,000 were counted in the Soviet Union in January 1967, but only 13,300 in January 1968 (Isakov 1968). The world population was thought to be between 30,000 and 50,000 (Uspenski 1965). A change may have taken, or is taking, place in the migration routes and wintering grounds of this species. Such a change might be brought about by a habitat loss further east. The presence of at least several thousands in Rumania was confirmed again in December 1969 (see pp. 37-41). Closer studies of this beautiful species are clearly needed.

Yugoslavia

There is no scarcity of wetlands in Yugoslavia and many of them are rich in breeding pelicans, herons, ducks and

geese. The extensive lowlands along the valleys of the Sava, Danube and Tisza, with an abundance of marshes, provide for the requirements of many wildfowl on spring and autumn migration. Subjected as it is to a typically continental climate, few of the wetlands, excepting those bordering the Adriatic or in the extreme south, stay free of ice during a normal winter.

Most geese are driven south in late autumn by the snow, which often falls heavily. When driven by wind, even during periods of heavy snowfall, tracts of cereal fields may sometimes remain exposed, or the covering may be thin enough to allow the geese to feed. As compared with the Dobrogea, however, snowfall in the north of Yugoslavia is not always accompanied by moderate or strong winds, at such times the cover is uniform. A slight thaw during the day will melt the surface of the snow, this freezes again at night, resulting in an impermeable covering of ice. Under such conditions geese cannot feed and are forced to move to other areas, as in Bosnia and Serbia in December 1969.

At such times it might be presumed that most birds cross the mountains south of the river Sava to winter along the Adriatic in Yugoslavia, Albania and Greece, while some may cross the sea to reach the Manfredonia region in south-eastern Italy. This might also be the route taken by the Greylags which winter regularly in Tunisia and NE. Algeria.

Prior to the mission of December 1969 few ornithologists seem to have counted wildfowl on autumn migration through Yugoslavia. The most abundant species is almost certainly the Whitefront, probably followed by the Bean Goose *Anser fabalis*. Greylags would also be involved and there might well be small numbers of Lesser White-fronted Geese *Anser erythropus* and Red-breasted Geese as well.

Before reaching Yugoslavia in autumn these birds probably pass through the famed Hortobagy on the Hungarian Puszta. This area, bordering along the river Tisza, was in former times host to hundreds of thousands of geese. More recently, however, because of the transformation of the Puszta, an important decrease has taken place in the numbers of geese passing through (Philippona 1967). This is not explained by a decrease of the population on the breeding grounds, for those wintering in western Europe have not shown such a decrease. The explanation probably lies in a change of the migration route. An important increase was noted in Austria (Neusiedler See) between 1950 and 1962, but in more recent times these numbers have fallen back again. It is quite possible, as Philippona suggests, that much of this population now passes through Rumania, explaining the huge concentrations there in autumn 1968.

In view of this it is possible that the numbers of geese passing through Yugoslavia has dropped in recent times. In December 1969 the mission found only 500 White-fronted Geese in the north and only 15 in the south in the Skutari region on the Albanian border. This is said to be a wintering area, but at the time of our visit the lake was in flood and the goose feeding grounds inundated.

Ducks and Coots winter on the wetlands along the Adriatic, which probably seldom freeze, but the numbers during our visit did not exceed 25,000 birds. Several thousand Ferruginous Duck *Aythya nyroca* may be involved, though probably only a few hundred winter, in the south. Goldeneye *Bucephala clangula* exceed a thousand on spring migration.

Bulgaria

Lying in the path of the wave of migrants along the west of the Black Sea and situated between Rumania and Greece, two countries very rich in wintering wildfowl, it is evident that Bulgaria must be traversed by many thousands of ducks and geese each year. However, the extent to which the wetlands and goose-grounds in this country act as host to these birds in autumn and winter seems for a long time to have passed unnoticed.

To understand the climatology of the country we must look at its geographical situation. Elongated in an east-west direction, it is divided roughly along the 43°N. parallel by the Balkan Mountains. Running the whole length of Bulgaria, they play a very important rôle in stopping much of the cold weather in a normal winter, particularly in the eastern part of the country.

Most of the frontier with Rumania is formed by the Danube, which in the east turns north into the region of the vast Dobrogea. All along the Black Sea coast, and for a considerable distance inland, temperatures are noticeably higher than elsewhere, being influenced by the sea. In the south and west are the Rhodopes and other ranges of mountains, the majority of the land being above a thousand metres and devoid of wetlands.

This leaves, then, three distinct areas

of lowlands: the Danubian Plain in the north, the Dobrogea between the Danube and the Black Sea and the plain extending inland south of the Balkans from Burgas as far as Plovdiv. In all these three areas there are extensive fields of cereals, much of this being winter-wheat and maize. All are probably frequented by wildfowl in autumn but, as the winter advances, the wetlands in the Danubian plain freeze and much of this part of the country disappears under a mantle of snow.

Except for periods of really heavy snowfall, however, the influence of the sea would appear to keep free much of the eastern Dobrogea. This phenomenon, and the fact that the Burgas-Plovdiv plain is shielded from the north by the Balkan Mountains, allows this area to escape the effects of cold spells for much of the winter. In this plain are the valleys of two important rivers: the Maritsa (Evros) and the Tundzha.

The Danube during most winters is probably a mass of blocks of ice on the move, as it was in January 1970. Parties of tens of Mallard standing on the ice drifting downstream were observed at two places over fifty kilometres apart, Tutrakan and Silistra. The longer one observed the more birds one saw. If such concentrations occurred, as they might well do, along much of the lower reaches of the Danube, then there would be at least several thousand Mallard.

Bulgaria is not rich in lakes, only a few such as Varna, Gebedzensko and Zrebcevo holding a few thousand ducks each, mainly Mallard, and the salines of Pomorie and Burgas with a variety of ducks, including Shelduck, and Coot. Concentrations of ducks and Coots also occur on the sea. For geese, however, Bulgaria appears to be much more important.

The passage of geese and the places frequented during the winter would appear to be fairly well defined. In autumn, or when forced south by hard weather, they move from the Dobrogea down the Black Sea coast. In the region of Burgas some may continue south along the coast to Turkey, but the majority probably turn west and disperse in the plain between the Balkan and the Rhodope Mountains, where there is ample room for thousands of geese to rest and feed.

If they are obliged to move on from here, then two routes are probably taken, the most westerly would reach the Maritsa (Evros) in the region of Plovdiv-Stara Zagora, then head south-east, whilst others would follow the extensive marshy valley of the Tundzha south to the Maritsa, then on to Turkey and Greece. This route was taken by the mission in January 1970, when geese were seen throughout, though only in relatively small flocks because of the mild winter.

Two species are mainly involved, White-fronted and Red-breasted Geese, though some of the Greylags wintering in north-eastern Greece probably also take this route. The expeditions of winter 1969-70 were the first to spend any time searching for wildfowl in this country, so most of the data are based upon their findings.

Greece

Greece has long been known to the ornithologists as having a great variety and richness of birds. However, most people visiting the country have done so between spring and autumn and for a long time the potential of the Greek wetlands in winter could only be guessed. Swift and Nisbet counted over several areas in January 1963, but it was not until the mission of January/February 1964 that a first real assessment was made of the value and importance of these wetlands to wintering wildfowl. The mission was able to visit the majority of the most important areas and could thus indicate the urgently needed measures for the conservation of certain threatened areas, and also lay a foundation upon which future visits could build.

Since this mission, one particular event overshadows the Greek waterfowl picture —the drainage of the huge Lake Karla or Voiivis. Now a near-fertile plain, this shallow lake originally extended over some 12-15,000 hectares. It had already been reduced to about one-third of its original size in 1964, when this lake held a concentration of over 430,000 ducks, a spectacle to be witnessed at few other places in Europe.

The mission of January 1970 was alarmed to find that two lakes on the Peloponnisos, the Lakes Mouriya and Agoulinitsa were being drained. Other wetlands have also lost much of their former importance through transformation and drainage, mainly for agricultural purposes, and if measures of protection are not undertaken many more will suffer the same fate.

Much of the interior of the Greek mainland and of the Peloponnisos is mountainous with few wetlands, attracting only small numbers of wildfowl. This,

however, is fully compensated for by the abundance of deltas and coastal lakes, extremely rich in aquatic birds. On the Ionian coast the Gulf of Arta is host to well over 100,000 Anatidae each winter. To the south the lagoons around Messolongion and the lakes in the north-west of the Peloponnisos together hold over 50,000 wildfowl. From the Turkish border west and south around the Aegean coast there are no less than six deltas or delta complexes and some fourteen lakes, all of vital importance to wildfowl.

The Evros delta not only attracts huge

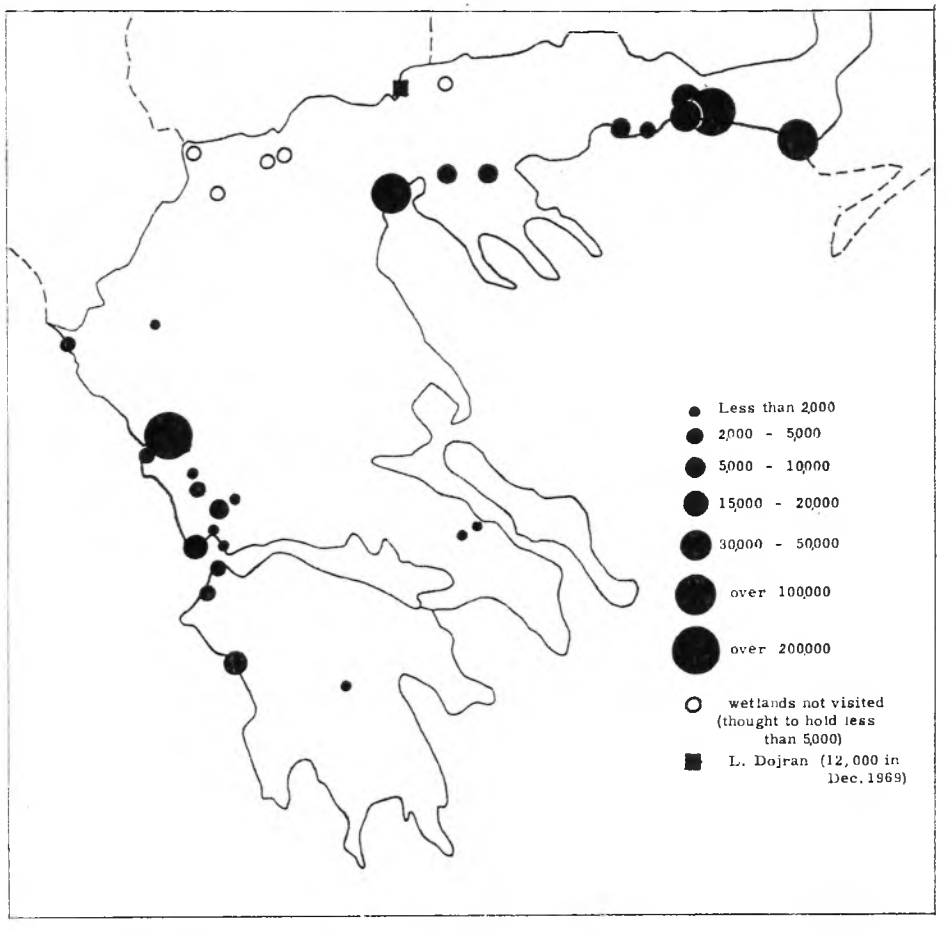


Figure 2. Distribution of Anatidae and Coots on the Greek wetlands, January 1970.

1. Kalamas Delta
2. Lake Ioannina
3. Gulf of Arta
4. Lake Salini
5. Lake Amvrakia
6. Lake Ozeros
7. Lake Lissimachia
8. Lake Trichonis
9. Lake Aitolikon
10. Messolongion; West lagoon and delta of the river Acheloös
11. Messolongion: East lagoon
12. Lake Araxos
13. Lake Kotichi
14. Lake Agoulinitsa
15. Lake Taka
16. Lake Iliki
17. Lake Paralimni
18. Lamia (small delta, lagoons)
19. Axios/Loudias/Aliakmon deltas
20. Lake Koronia
21. Lake Volvis
22. Kavala (coastal lagoons to E. of)
23. Nestos Delta
24. Lake Bourou
25. Porto Lago
26. Complex of 5 lakes: Fanarion, Arogi, Messi, Karakatzali, Mitrikou
27. Evros Delta

numbers of ducks, but is the principal goose wintering ground in Greece and the only place where swans occur regularly in large numbers, excepting the introduced Mute Swans *Cygnus olor* breeding on Lake Agras.

There is rather a striking difference in the climate between the north and the south of Greece. Central and southern parts of the country are largely free from severe winters, whilst much of Thrace, Macedonia and Thessalia may be subjected to cold spells of varying duration. If these are prolonged the wildfowl are forced to move on south and west.

Figure 2 shows the most important wetlands and the minimum for which it would be desirable to have counts, if a true picture is to be gained on the trends in the populations of wildfowl using the Greek wetlands as their winter quarters.

The huge concentration of birds seen on Lake Karla in 1964 may have been exceptional for some reason, such as abundant food supply because of shallow depth. But where do these birds go now? The Gulf of Arta would be one possible answer. This area held some 100,000 wildfowl in 1964. In 1968 the total was about the same but in both 1969 and 1970 over 200,000 were seen, and at a time when wetlands further north still had their usual populations, not being frozen over.

The January 1970 census was the most complete so far. Thirty-two wetlands were visited and a total of nearly 630,000 ducks and 340,000 Coots counted.

Turkey

In a provisional check-list of the wetlands of Turkey which are of international importance, drawn up for the I.W.R.B. in 1967, no less than 63 are mentioned. All but one of these lies to the west of longitude 36°E., the area under review. These wetlands, all of which are favoured by wildfowl at one season or another, are of very varied nature and structure: deltas, freshwater lakes, salt lakes, lakes fed by hot springs, etc. Some are permanent, others may dry out partially or completely during the summer.

Such a complex of wetlands presents problems to the counter. The winters there may be characterized either by extreme cold and deep snow, or by milder weather with much rain and a profusion of mud, so many of the wetlands are particularly difficult of access by conventional means. The distribution of wildfowl on them is governed largely by the weather. If the winter is severe, then many of the lakes and marshes on the Anatolian Plateau freeze, being situated around 1,000 metres above sea level. The wildfowl then move to the coastal wetlands which always have open water. To appreciate the differences that the weather can cause, we need only to look at the totals of wildfowl and Coots in the January censuses on the delta of the Menderes in the south-west. In 1969, 650,000 were recorded, as against only 98,000 in the very mild winter of 1970.

In view of this, and the fact that sometimes very large concentrations of wildfowl have to be listed as unidentified (900,000 in 1969, 480,000 in 1970), it has been particularly difficult to assess the status of the various wildfowl species in Turkey, and these data will be particularly susceptible to modification in the future. Several species deserve special mention as they occur in relatively good numbers in Turkey, whilst in Europe they are becoming increasingly rare and their future seems rather in the balance, for example Ruddy Shelduck *Tadorna ferruginea*, Marbled Teal *Marmaronetta angustirostris* and White-headed Duck.

The Ruddy Shelduck occurs over much of the country. Its liking for streams and ditches, in fact any expanse of water even only small and temporary, makes it a particularly difficult species to census. In the autumn of 1969, before the onset of the annual rains, concentrations of a considerable size could be seen: over 6,800 at Gölbek in mid-November, and several others exceeding 1,000 birds. The total was more than 13,000. These dispersed, however, when the autumn rains created numerous puddles and water-holes.

The rarest of the three, the Marbled Teal, occurs only in the south, in the region of Adana. Its future would seem rather insecure for two reasons. Firstly, the loss of one of its favoured localities where the species probably bred, the Aynas Swamp. Secondly, it is shot in rather large numbers. It is doubtful if the winter population exceeds 2,000 birds. This total was nearly reached in 1968-69, but in 1969-70 only a fraction of this number was located.

White-headed Ducks were first discovered in the winter of 1966-67 in Central Anatolia, on Lake Burdur. Each winter since there has been an increasing number reported, and in December 1969 over 4,000 were recorded on seven different waters. This does not imply an increase in the population, but perhaps better coverage by the counters in these last winters. It is interesting to note that

this species is also seen in good numbers in Tunisia (M. Smart in litt).

The number of geese wintering may in some years approach 100,000, the dominant species being the Whitefront.

Several areas are of outstanding value as they attract really large concentrations of wildfowl. Amongst these are the deltas of the rivers Meric and Menderes on the Aegean Sea, at least six lakes in central Anatolia and four around the Bay of Iskendurun south of Adana. From all these areas concentrations of more than 100,000 wildfowl have been reported.

As in other countries, the threat to wetlands is great, and the list of those drained or scheduled for drainage, partial or complete, is long and alarming. Fortunately, the Turkish Society for the Conservation of Natural Resources is well aware of this and steps are being taken in order to set aside as wildfowl refuges some of the most important wetland areas.

Systematic list of the species and numbers of wildfowl wintering in South-eastern Europe and Western Turkey

This list has been compiled from the data gathered by the missions listed for the I.W.R.B.

Mute Swan *Cygnus olor*

The Danube delta, where the species breeds, is the most important wintering area, there being nearly 3,000 on 9.1.69. Also common in the north of Greece, particularly Evros: 440 in 1967-68, 270 in January 1969. Was introduced on Lake Agras in 1967 where the species now breeds, the number of birds exceeding 150. In Turkey occurs locally and breeds, the total for the country in January 1970 being 217. It appears that this species moves south from Rumania during severe cold spells, at which time birds may be able to rest and feed along the Bulgarian coast, or perhaps go as far south as the Evros delta.

Bewick's Swan *Cygnus columbianus bewickii*

The region is outside the normal range of this species, the only records are from the Evros delta, Greece: 1 on 23.12.68, 6 on 17.1.69.

Whooper Swan *Cygnus cygnus*

Of similar winter distribution to the Mute Swan, the Danube delta being the most important area with ca. 3,000 in January 1969. In Greece occurs regularly only in the north, particularly Evros: 400 in January 1969. In Turkey only a few individuals are recorded, mostly in the north-west.

Bean Goose *Anser fabalis*

Occasionally seen in small numbers in Rumania: 28 on 17.11.68; and in Turkey: 7 in NW. on 16.1.67. Is regular migrant through Yugoslavia in hundreds or thousands, some staying to winter. Small numbers sometimes reach northern Greece: 300 in February 1963.

White-fronted Goose *Anser albifrons*

An exceptionally large concentration of ca. 500,000 on 6.12.68 between the villages of Istria and Sinoie in the Rumanian Dobrogea, 50,000 remaining in mid-January 1969 in the same locality. In winter 1969-70 only 40,000 seen here, and several thousands along Black Sea coast in Bulgaria and in valleys of Maritsa and Tundzha. This would appear to be main migration route from the north to Greece and Turkey during severe weather. It is interesting to note that unusually large numbers were recorded in Greece and Turkey in January 1969, compared with previous winter counts: 35,500 in Greece (7,000 in 1964, 3,800 in 1967-68, 1,330 in January 1970). In Turkey over 96,000 were seen compared with about 30,000 in winters 1967 and 1968. It is not impossible that in former times many of the birds now passing along the Black Sea coast wintered further west, i.e. in Hungary/Yugoslavia, as suggested by Philippona. In December 1969 only 500 birds were located in Yugoslavia.

Lesser White-fronted Goose *Anser erythropus*

Although this species has not been recorded by the various missions during the past few years, it is still thought to occur in small numbers in most winters in Rumania, NE. Greece and NW. Turkey. Swift and Nisbet saw 1,630 in Evros delta area in 1963; Bauer recorded 155 in the Evros in January/February 1965.

Greylag Goose *Anser anser*

Not thought previously to winter in Rumania (Talpeanu) but over 700 were seen in the delta on 30.11.68 and 2,300 in January 1969. Winters regularly in northern Greece and in smaller numbers along the Ionian coast, south in hard winters as far as Peloponnisos. Winters regularly throughout Turkey, particularly in the south. Total for Greece and Turkey probably does not exceed 10,000 birds.

Red-breasted Goose *Branta ruficollis*
First recorded in Rumania in 1910 from whence sporadic records up to ca. 1940. Talpeanu (1963) gives it as present from October to March in tens or hundreds. On 17.11.68, 650 were seen in a flock of 20,000 Whitefronts on the Dobrogea near Lake Sinoie. On 6.12.68 no less than 25,000 were estimated along with 500,000 Whitefronts. Two thousand were still present in the same locality in January 1969. In winter 1969-70, 3,750 were recorded in Rumania and over 300 in Bulgaria. In Greece (Evros) up to 75 may occur most years unless the winter is very mild, as in January 1970 when none were recorded.

Ruddy Shelduck *Tadorna ferruginea*
The small Rumanian breeding population migrates south in winter: 50 on 13.11.68, 4 on 7.12.68, 68 on 30.11.69, 50 on 8.12.69 and 3 on 17.12.69, most having gone by mid-December. Does not winter in Greece either. Is abundant in Turkey: over 13,000 recorded in November 1969.

Shelduck *Tadorna tadorna*
Known to be wintering in Rumania for at least the past five years, on Lake Techerghiol in particular: 1,500 November/December 1968, 1,200 on 7-9.1.69, 680 on 16.1.69, similar numbers again recorded November/December 1969. Up to 185 recorded along Black Sea coast in Bulgaria (December 1969-January 1970), the favoured locality being salines near Burgas. In Greece occurs over much of country, largest concentrations being in Gulf of Arta and wetlands of Macedonia and Thrace. Total for whole of country varies between 1,500 and 2,500, but Swift and Nisbet saw 5,000 in the Messolongion area in February 1963. In Turkey also has a wide distribution, the salty lakes Tuz and Aci-Göl and Seyfey being favoured localities. Total in January 1970 over 3,500.

Marbled Teal *Marmaronetta angustirostris*
Accidental to Rumania (1 on 19.11.68) and Greece. In Turkey very important concentrations occur locally in the south (Adana region). First recorded there by Zahavi in January 1967 (20). In January 1968 not less than 1,950 were seen on two marshes in the same region, but in 1969 and 1970 much smaller numbers seen (maximum 350 in January 1970).

Pintail *Anas acuta*
On passage through Rumania (10,000 in November/December 1968). This species does not usually winter (50 in January 1969). A few hundreds may stay in Bulgaria (400 in January 1970) and in the south of Yugoslavia. In Greece, however, it is the most abundant surface-feeder after Wigeon and occurs as far south as the Peloponnisos. Numbers very variable but in normal winter there appears to be at least 100,000. Of similar distribution throughout Turkey, with largest concentrations in south, particularly the Adana region. In an average winter the total exceeds 100,000.

Teal *Anas crecca*
Important passage through Rumania (150,000 in November/December 1968). Previously recorded as commonest winter duck (Talpeanu) but in January 1969 only 1,340 on 9th and 90 on 13th. Only a few tens seen in both Yugoslavia and Bulgaria in 1969-70. Abundant in Greece: 88,000 in 1964, 50,000 in 1968 and 1969, and 97,000 in January 1970. In Turkey is also abundant, the total recorded in 1968 was 130,000 and in 1970 over 200,000.

Mallard *Anas platyrhynchos*
Important passage through Rumania, 200,000 in November/December 1968) and the most abundant surface-feeder wintering: ca. 100,000. Most abundant duck in Bulgaria, over 21,000 in January 1970. Several thousands may winter in Yugoslavia, 10,000 recorded in January 1970. In Greece the number found wintering up to 1969 was about 25,000, but in 1970 five new areas in the north were visited and over 71,000 counted in the whole of Greece. The total for Turkish wetlands in 1967 was 117,000, but this includes two wetlands, the deltas of the rivers Yesil and Kizil in the north, together holding 52,000. The numbers recorded in 1969 and 1970 on these two deltas was much less. Taking into account the large numbers of unidentified ducks, the true number of Mallard probably exceeds the 56,000 counted in January 1970, in most winters.

Gadwall *Anas strepera*
Mainly on passage through Rumania: 2,300 in November/December 1968, a few staying to winter (60 in January 1969). In Yugoslavia and Bulgaria numbers are also unimportant. It is more abundant throughout Greece, maximum 6,100 in the winter 1967-68. In Turkey occurs in small numbers over most of western half. Normal winter population between 200 and 400, but in 1969, 5,000 on one lake.

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Plate I. Island ducks (see pp. 5-10). (a) The male Kergeulen Pintail *Anas acuta eatoni* illustrates well the tendency of island forms to become smaller than the mainland forms, and to lose their sexual dimorphism. (b) Pelew Island Grey Duck *Anas superciliosa pelewensis* likewise show little difference between the sexes. Compare the face pattern with that of the New Zealand Grey Duck *A. s. superciliosa* in Plate VII of WILDFOWL 20.

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Plate II. Some mainland species near the tropics also show a lack of sexual dimorphism. (a) Florida Duck *Anas platyrhynchos fulvigula.* (b) The closely related Mexican Duck *A. p. diazi.* The latter is a rare and endangered species now being bred at Slimbridge.

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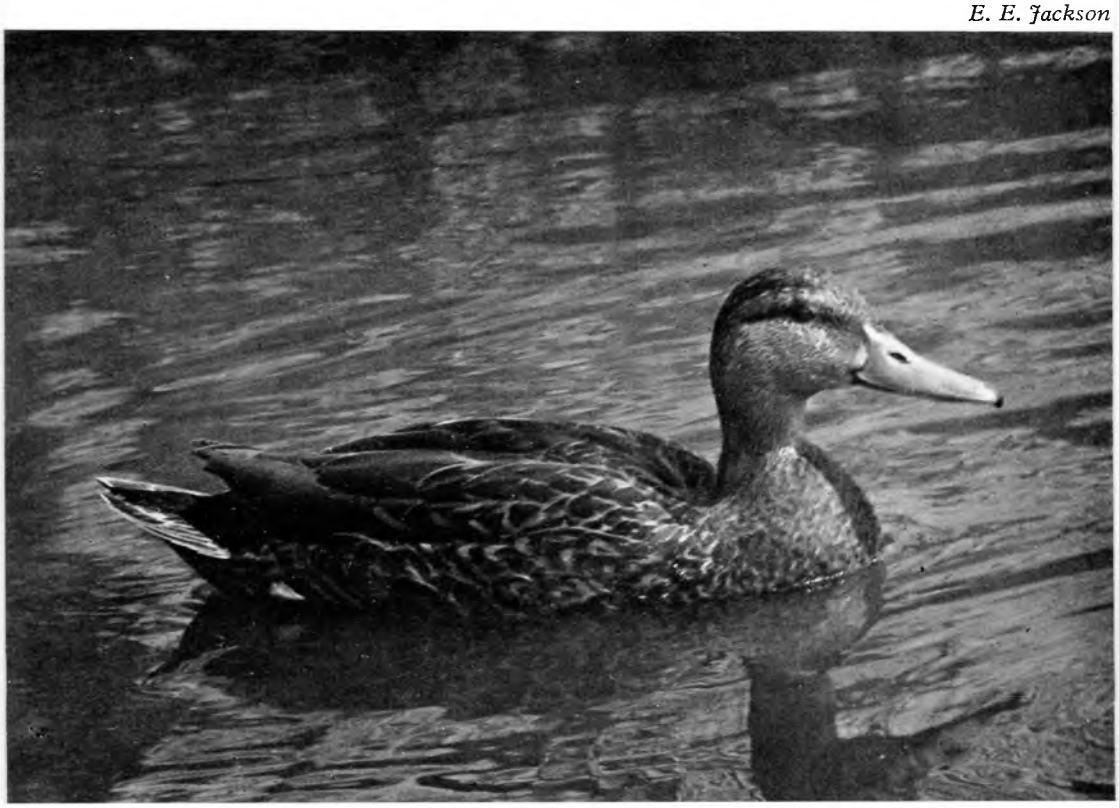

Wigeon *Anas penelope*

Mainly on passage through Rumania: 13,000 in November/December 1968, rare in winter: 20 in January 1969. In Bulgaria and Yugoslavia occurs only in small numbers. In Greece, however, it is the most abundant duck throughout the whole of the country: 159,000 in 1964, 42,400 in 1968 and 96,000 in 1969 (in 1964, 120,000 were on the now drained Lake Karla). In January 1970 over 225,000 recorded. Of similar status throughout Turkey, the total varying between 50,000 and 200,000.

Shoveler *Anas clypeata*

Some 40,000 were recorded in Rumania in November/December 1968, but only about 500 stayed to winter. None were seen in Yugoslavia in December 1969 and numbers in Bulgaria in January 1970 just exceeded 100. Is common in Greece, though the number wintering is subject to fluctuations: in 1964, 73,700; in 1967-68, 9,450; in 1969, 21,200; and in 1970, 19,400. As in the case of the Wigeon, Lake Karla constituted the most important wetland for this species. The total for Turkey fluctuates between 5,000 and 12,000 birds.

Red-crested Pochard *Netta rufina*

Previously considered as being rather rare in Rumania, it is remarkable that some 30,000 were recorded both in November/December 1968 and in January 1969. Like the Pochard, with which they associate, the concentrations were in areas difficult of access. In Yugoslavia and Bulgaria only a few individuals have been recorded. Up to 1969 the population of the Greek wetlands in winter was considered to be in the order of 1,000 to 3,000, but in 1970, 4,650 were counted. It was not recorded in 1963 by Swift and Nisbet nor in 1964 by the I.U.C.N./I.W.R.B. mission. Bauer (1965) saw 5 birds on Lake Bourou and 38 in the Nestos delta. The missions of 1968 and 1969, however, recorded this species in several localities, the most important concentrations being found on the wetlands along the Ionian coast from Arta in the north to Pygros in the south. Numbers for Turkey seem rather variable: 10,800 in 1967, 700 in 1968, 9,300 in 1969, and 2,800 in January 1970.

Pochard *Aythya ferina*

By far the commonest species of the Anatidae in Rumania, both on migration and wintering. In November/December 1968 nearly one million seen in the Danube delta region, 300,000 staying on into January. Like the Red-crested Pochard this species was not formerly known to winter in Rumania but was reported to be present only from February to November. In Yugoslavia it is also one of the commonest ducks: 4,140 being recorded in December 1969. In Bulgaria only a few hundreds seen. It is the most abundant diving duck wintering in Greece, though the concentrations do not approach those in Rumania. Occurs as far south as the Peloponnisos where some of the largest gatherings are to be found. Total for whole of country exceeded 100,000 in January 1970. Again, it is the most abundant diving duck in Turkey: 70,000 in 1967, 15-20,000 in 1968, 160,000 in 1969, and 40,000 in 1970.

Ferruginous Duck *Aythya nyroca*

Of the 13,000 seen in November/December 1968 in the Danube delta only a few stayed to winter: 1,040 and 15 on the 9th and 13th January 1969 respectively. In Yugoslavia over 120 seen in December 1969 in the south. It is a difficult species to census owing to its liking for cover; on Lake Agoulinitsa in Greece none were observed yet it was the commonest duck in hunters' bags! Occurs throughout Greece, 60 being the maximum total in winter 1967-68, but the true total must be considerably higher. In Turkey maximum total was 435 in January 1969.

Tufted Duck *Aythya fuligula*

The Danube delta represents an important wintering area for this species, 180,000 being recorded in January 1969. In Yugoslavia 4,000 were seen on Lake Skutari in December 1969, whilst only a few tens have been seen in Bulgaria. The total for the Greek wetlands indicates a winter population of around 7-10,000 birds and in Turkey between 10,000 and 20,000.

Scaup *Aythya marila*

The area is outside the normal winter-quarters of this species, there being only a few observations on the Black Sea coast in Rumania, one in NE. Greece and a few in NW. Turkey.

Velvet Scoter *Melanitta fusca*

Occurs regularly only along Black Sea coast of Rumania and Turkey: 35 on 8.12.68 Rumania, 2 at Izmit, Turkey, January 1969. Is rare in Greece, one observation of 27 in January 1968 in the north.

Goldeneye *Bucephala clangula*
Is commonest in Rumania where in November/December 1968 a total of 750 were seen. In January 1969, however, numbers had fallen to 140 on 9th and 83 on 13th. In Yugoslavia over 50 recorded in December 1969 in the south, particularly Lake Dojran. Occurs in small numbers in northern Greece, maximum of 90 in January 1970. In Turkey in small numbers, mainly in the north, but 80 in January 1970 in Central Anatolia.

Smew *Mergus albellus*
A small number winter along the Black Sea coast in Rumania: 90 in January 1969. Also recorded in Yugoslavia in small numbers between November and February, both in the north, and on Lake Dojran in the south: total 40 in December 1969. In the same month in Bulgaria, 16 were seen near Burgas. In Greece it is regular in the north, where the total approaches 300. Occurs in NW. Turkey around the Sea of Marmara, particularly on Lake Apolyout. The totals seen were 312 in January 1967 and 1,300 in January 1970.

Red-breasted Merganser *Mergus serrator*
The commonest of the sawbills in Rumania and Greece, the total for each country being between 500 and 600. Also up to 25 in Bulgaria in January 1970 and 20 in southern Yugoslavia (Lake Skutari). Is rare in Turkey.

Goosander *Mergus merganser*
Is regular in winter along the Black Sea coast in Rumania, but not more than 10-15 birds seen. In Greece is restricted to the lakes in the north where single birds can be seen. Small numbers were recorded in Yugoslavia, 50 in the north in January 1969, 200 in February 1970. There are no observations of this species from Bulgaria or Turkey.

White-headed Duck *Oxyura leucocephala*
Only recently proved to be wintering in Rumania, particularly on the salty Lake Techerghiol: between 13 and 19 in January 1937. On a neighbouring lake, 108 in November 1968, 29 still being present in mid-January. Not recorded Yugoslavia or Bulgaria, and in Greece occurs only as a vagrant. In Turkey is confined mainly to Lake Burdur where in 1967 a very important concentration of 740 was found. In 1968, when only part of the lake was visited, more than 60 were seen, and in 1969 about 2,000. Also in 1969 it was noted on two other neighbouring lakes, Yarisli with 25 and Cavuscu with 20. Even larger numbers recorded in November/December 1969, a total of 4,220 on seven lakes, of which 3,880 were on Lake Burdur. When the latter was visited in January 1970, only 618 were seen.

Coot *Fulica atra*
Nearly 100,000 in Rumania in November/December 1968. Absent over much of the delta, they form large flocks in one or two favoured localities, often with Pochards and Red-crested Pochards. Many move on south and in January 1969 only 22,000 were seen on 9th and 3,240 on 13th. In Yugoslavia nearly 18,000 were recorded in December 1969, and 23,000 in Bulgaria, where concentrations occur on the Black Sea. In Greece 154,000 were seen in 1964 and over 100,000 in 1968 and 1969. However, in 1970 nearly 340,000 were counted, of which 157,000 were on lakes not previously visited. Is also very abundant in Turkey, being the most numerous aquatic species. It occurs on practically all waters throughout the country and the total probably exceeds 1,000,000 birds.

Conclusion

Although it is hardly necessary to stress the fact that much still has to be learnt regarding the movements and numbers of wildfowl wintering in south-eastern Europe and western Turkey, a considerable amount of knowledge has been acquired over the past four winters. An attempt has been made to outline the distribution of the Anatidae and Coots, and an idea can be obtained of the carrying capacity of many of the wetlands in the area studied, and of their vital importance.

It is to be hoped that soon, with an increasing number of observers, more time can be spent over counting. It can be seen that some of the concentrations of ducks are vast. The more brightly-coloured species such as Red-crested Pochard are fairly easily picked out in a large group, whilst the more sombre birds like Gadwall call for closer examination, and must often be overlooked if the flock is distant. In really big concentrations, or where birds are continually flighting, it is not possible to count species individually. In such cases an estimate is given for each species as a percentage of the total population. When far out to sea, some have to be recorded simply as duck spp. or even duck/Coots.

Missions from western Europe will continue, but the countries concerned must play a part. Already Rumanian, Turkish and Soviet ornithologists are carrying out mid-winter counts in their respective countries, and it is to be hoped that other countries will soon participate, and that efforts will be made to undertake monthly counts.

The various missions have not only gathered data, but contributed greatly to the aims of research and conservation on an international scale by making contacts and stimulating interest, and pointing out the urgent need for the conservation of wetlands.

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We would like to thank the following colleagues in each of the countries concerned, their suggestions and collaboration having contributed greatly to the task of visiting many of the wetlands. Moreover, censuses carried out for several years now on the initiative of our colleagues themselves have provided indispensable information. Rumania: Comisia Monumentelor Naturii of the Rumanian Academy of Sciences, and the Station of Marine Biology, Prof. J. Borcea in Agigea. Yugoslavia: Mr. J. Mikuska, Osijek, Mr. D. Rucner, Zagreb, and Mr. S. Peterlin, Ljubljana. Bulgaria: Prof. M. Dakov, Minister and President of the Committee of Forests and Wood Industry, Sofia, Mr. N. K. Boev, Zoologiceski Institute, Sofia, and Mr. T. Mitchev, Ornithocentre, Sofia. Greece: The Minister of Northern Greece and the members of his recently formed working group. Turkey: The Turkish Association for the Conservation of Natural Resources, Ankara.

We are greatly indebted to all those ornithologists, too numerous to list, who have participated in the various census missions, often under conditions which require good physical stamina, and without whose enthusiasm the accumulation of so much material in so short a period would not have been possible.

Special thanks go to the International Wildfowl Research Bureau, for their suggestions and help both in visiting the wetlands and in the compilation of this article. Also for having put the I.W.R.B. files at our disposition.

Finally, we are most indebted to Dr. L. Hoffman, Director Emeritus of the I.W.R.B. and Director of the Station Biologique de la Tour du Valat, France, for his help in planning many of these missions and the encouragement he has given the participants in carrying out their tasks.

Summary

This paper sets out the results of more than two dozen missions, made in the last decade, to Rumania, Bulgaria, Yugoslavia, Greece and western Turkey, with the object of ascertaining the numbers and distribution of wildfowl wintering in the region. The main wetland areas are described in outline.

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Wildfowl census missions to south-eastern Europe and western Turkey

Country	*Participants*	*Period*	*Area covered*
Rumania	J. Viellard	Nov./Feb. 1958-59	Danube delta
	J. Viellard	Nov./Mar. 1959-60	„ „
	J. Viellard, M. Talpeanu	Jan. 1967	„ „
	H. Hoekstra, A. R. Johnson	Jan. 1968	„ „
	H. Hoekstra, H. Hafner	Nov./Dec. 1968	„ „
	H. Hafner, V. Ciocchia	Jan. 1969	„ „
	E. Kuyken, R. Mooser	Nov. 1969	Dobrogea
	R. Visser, A. Dijksen	Nov./Dec. 1969	„
	P. Scott, T. Lebret	Dec. 1969	„
	J. Philippona, E. Smith	Dec. 1969	„
Yugoslavia	A. R. Johnson, H. Hafner	Dec. 1969	9 wetlands
Bulgaria	J. Philippona, E. C. Smith	Dec. 1969	coastal wetlands
	A. R. Johnson, H. Hafner	Jan. 1970	eastern wetlands
Greece	J. J. Swift, I. C. T. Nisbet	Jan. 1963	several areas
	L. Hoffman, J. J. Swift, P. J. S. Olney	Jan./Feb. 1964	15 wetlands
	W. Bauer	Jan./Feb. 1965	5 wetlands Macedonia/Thrace
	F. Koning, R. Visser	Dec./Jan. 1967-68	NE. wetlands
	L. Hoffmann, M. Hodge	Jan. 1968	western wetlands Peloponnisos
	M. Hodge, A. R. Johnson	Jan. 1969	25 wetlands
	A. R. Johnson, H. Hafner	Jan. 1970	32 wetlands
Turkey	J. Szijj, H. Hoekstra	Jan./Feb. 1967	7 NW. wetlands 2 Black Sea deltas 11 Anatolian lakes Menderes delta
	A. Zahavi	Jan. 1967	20 southern deltas
	H. Hoekstra, A. R. Johnson	Jan./Feb. 1968	23 wetlands
	H. Hoekstra, F. Koning	Jan. 1969	23 wetlands central Anatolia; Menderes delta
	R. Porter, M. J. Helps, A. R. Kitson	Jan. 1969	19 western wetlands
	F. Koning, A. Dijksen	Dec./Jan. 1969-70	49 wetlands
	R. Porter, M. Shrubb, I. R. Willis	Jan. 1970	22 western wetlands

Many of these missions have produced reports that have been duplicated and circulated. Others have reported more informally. All the data is on file at I.W.R.B. headquarters.

A. Johnson and H. Hafner, Station Biologique de la Tour du Valat, par Le Sambuc, Bouches du Rhone, France.

Redbreasts in Rumania

PETER SCOTT

On 15th November 1969 I flew from London via Beirut to Qatar. I spent four days in and around Doha, the capital, and in discussions with Sheikh Qassim bin Hamad al Thani, the Minister of Education, who is also Chairman of the Oryx group of my Survival Service Commission of the International Union for Conservation of Nature (I.U.C.N.). Then I flew to Abudhabi to see the ruler, His Highness Sheikh Zaid bin Sultan al Nahayyan, on behalf of the World Wildlife Fund. I continued my journey to Delhi for the ten-day General Assembly of the I.U.C.N. Then on to Nagpur to visit Kanha National Park. From there to Bombay en route for the Gir Forest reserve.

These exotic wanderings were exciting enough but the real high spot of my trip turned out to be an interlude in Rumania on my way home. I landed in Bucharest on 8th December and was met by Professor Valerius Puscariu of the Rumanian Academy of Sciences who keeps Rumania in touch with the International Wildfowl Research Bureau (I.W.R.B.). Also there was my old friend Tom Lebret from the Netherlands with whom I was to spend some of the most exciting days goosing that I have known. We motored, not without some tribulations, to the Marine Research Station at Agigea, 8 km. south of Constanta on the Black Sea coast. There we were well received by Dr. Tonel Andriescu, the Station Director. Eventually, on the 10th December we met up with two other Dutch ornithologists, Rens Visser and Adriaan Dyksen, who had been carrying out observations since 28th November in the rota arranged by the Goose Research Group of the I.W.R.B. In 14 days they had counted 38,000 geese, mostly White-fronted, and estimated the total population to be about 50,000, from five roosts. They had only seen some hundreds of Red-breasted Geese, but Eckhart Kuyken of Belgium, who had been in the rota from 3rd to 13th November, had seen 3-4,000. So our appetites were well whetted.

We stayed in the cottage of an archaeologist in the Histria ruins, a pleasant, wild place among the excavations of the ancient citadel. On 11th December we saw little because of fog, but the next three days were quite fantastic and I quote directly from my diary:

Friday, 12th December. What a day of days! Tom and I were up at 5.0 a.m. Rens and Adriaan were starting later for Turkey and we had said goodbye to them the night before. We motored to Sinoie, meeting a torrential rainstorm so that the turning down from the main road was a raging milky river. The middle of the road was still mostly above water but the ditches on either hand were rising. About two kilometres before Sinoie we stopped and made ourselves a breakfast of bread and cheese. At 7.15 the flight began. The geese came in great masses about 1½-2 km. to the north of the road and went down in two principal places, one just over the hill and the other just below a communal tractor and farm machinery station (apparently with no road access) on the hill beyond. The geese made a dark patch on the green of the sprouting wheat in the middle of a field of perhaps 500 acres. Could Whitefronts sit so thick? Such sounds as we could hear gave no conclusive indication of the species though we felt that some at least must be *Branta ruficollis*. The weather seemed to be improving with the light. By the end of the flight we thought that between 6,000 and 7,000 geese had settled in about three places. None was less than half a mile from us. To give the weather time to improve we moved, when the flight was over, down into the village of Sinoie, where we met the young man with whom Prof. Puscariu had left a note asking for accommodation in the former Mairie should it be required. We bought a water bottle to supply the little squeegee which cleaned our car windows —the most essential feature for goose-watching and goose-finding in these parts. Then we returned to the geese, and parked the car beside a Communal Farm. There was nothing for it but a long, muddy walk. We started walking across plough and quickly discovered that it was simply not on. Fortunately I spotted a road over to the east which would take us north towards the geese. We plodded up this road in the mud, slipping backwards half a pace at every step. The geese were mostly out on the young wheat on our left, but some were going in to some maize 'stubble' from which the main stalks had been cut and stooked. Our objective was a walnut tree standing by

the road. If we could reach it and use Tom's two telescopes, one of which I carried, we should know whether these geese that we had watched flighting in were in fact in significant quantity Red-breasted.

So we came to the walnut tree and looked out over the young wheat and the nearer maize 'stubble'. The telescope could just be rested in the lowest fork of the tree, and through it I could see that the main flocks on the green wheat field were Red-breasted Geese. There were at least thousands of them. Perhaps three thousand. In total there were certainly more Redbreasts than Whitefronts. Many Whitefronts and perhaps some Redbreasts were flitting into the maize field where they were very hard to see. In front of us on our right was a field in which the maize stems still stood, affording us cover for a potential approach to the geese in the 'stubble' ahead, where the stalks had been cut and stooked. So, as we walked up the hill, we bore right through the standing maize stalks, into dead ground. Heavy rain was approaching, and we sat on some stooks for a while to let it pass. Then we plodded on through the maize. We came upon the fresh tracks of a wild boar which had run out of the maize ahead of us. Presently we swung left towards the ridge and towards the geese, and came almost at once to the edge of a sand quarry. We jumped down into it and walked across. It offered shelter from the now continuous rain under its upwind overhanging cliff. We moved to the edge overlooking the geese, and it was from this point that our most valuable observations were made. Already there were Whitefronts within 100 yards of us in the maize stubble. These were constantly being joined by Redbreasts. They were often below us so that we could see the tops of their wings as they flitted in and landed in the thick cover and this demonstrated what was something of a surprise to me—the conspicuousness of the white edges to the secondary and primary coverts making a great hoary bar along the top of the wing. This paleness was especially noticeable in the young birds, of which there were a great many. The next surprise was the fact that they were prepared to drop into the relatively thick cover of the maize field among the Whitefronts. To be sure, they were never at ease there and parties kept flushing and flying out to the green wheat beyond. But large numbers in thick clusters could be seen from our sand pit vantage point from which we looked slightly down on them. Only their backs showed above the maize stalks and among the stooks. Then came the business of assessing their numbers which was difficult as many were far out on the lower end of the wheatfield. It was now drizzling steadily and using Tom's two telescopes was quite difficult—added to which I found I had dropped one of my gloves somewhere in the tall maize on the way up the hill. But in spite of these handicaps the same total was reached three times over. It was between 3,800 and 4,000 Red-breasted Geese.

By this time the geese had fed up the hill towards our sand pit, and there were Redbreasts and Whitefronts within 60 yards of us as we peered through the grass. There was much coming and going of Redbreasts and one bird with the first five primaries of its left wing pure white was seen twice. There seemed to be a high proportion of young birds with their conspicuously pale cheek pattern. The total experience of all this was so absorbingly exciting that we scarcely noticed the continuous rain. For looking at the geese I had to take off my tall fur caciula (hat) so as to show as little as possible against the sky. From time to time low flying Whitefronts would detect us and squeak. After one such there was a flush from our corner of the field. A final estimate of numbers confirmed almost 4,000 Redbreasts and 3,000 Whitefronts mostly now down in the green wheat below us, though some were still hidden among the maize stubble and stocks.

During the final approach and discovery of the strategically placed sand pit I had lost a Constanta-bought glove. By dint of tracking ourselves in reverse we came upon the glove. It was now 1.0 p.m. and we had been with the Redbreasts since dawn—a magical morning, especially when I recall my Redbreast hunts to Hungary, Rumania, Iraq and Persia in the 1930's.

After bread and ham and bread and jam in the car, and a final overall count from the road angle which confirmed the earlier figures we headed N. to look for more geese. Just east of a village called Lunca we saw geese flying low over a sprouting wheatfield between the road and Lacul Golovita. They were Whitefronts and they landed at the far corner of the field among 30 other Whitefronts and 197 Redbreasts which were milling around in the corner of the field almost like Lesser Flamingos. They were 300 yards away, but we had a quite good view of them with seven roe deer in the same field. Beyond the ruined hilltop fortress

of Enisala (Heraklia) we crossed a beautiful marsh in the failing light and saw about 20 Red-breasted Geese rounding up into the wind and heading back towards a green wheatfield, while several Whitefront skeins went out to roost.

It was *in every way* a superbly eventful day.

Saturday, 13th December. Our second marvellous day among the Redbreasts. We spent the night at the modern tourist Hotel Delta at Tulcea—vast and imposing with quite interesting decor. We had about 35 km. to motor back to the marsh between Enisala and Saricharíol for the morning flight. There was a fresh N. wind and about 2,000 geese came, very late, having plugged upwind from a fairly distant roost. We watched them coming past the ruined fortress on the hilltop at Enisala. There was a group of 20 Greylags and another of four. Redbreasts were scattered through the skeins and there were two or three groups of 20—but no great mass of them. From the hillside at Enisala we saw a Peregrine and far out over Lacul Babadag was an adult White-tailed Sea Eagle. We drank coffee, restocked with food and refuelled the Volkswagen at Babadag and then headed south for Sinoie, calling at Lunca on the way. The field to the east of the village between the road and the lake now held more Redbreasts—352 instead of 197 but fewer Roe (five instead of seven). After doing a juvenile ratio count (84 ad. 60 juv. = 41%) with the telescope, and watching them for a while, we set off for Sinoie. Up by the tractor station on the hill were about 2,800 Redbreasts. Some were flighting half a mile to a green field on the skyline. There were virtually no Whitefronts with them. One flock of nearly 1,000 had one Whitefront—the opposite of what can be seen at Slimbridge when we have a stray Redbreast.

We noticed a man walking down from the tractor station (where farm machinery in vast quantity is stored) and it soon became evident that he was chasing the geese off the land. They rose and settled about three times—losing a few each time, and finally split into two flocks of 1,200-1,400. One went off to the south and could be seen breaking formation about three km. away. The others disappeared to the W. and NW. inland. We sought in vain for the southern group when all had gone, and it seemed unlikely that the geese would go back to that complex of fields. We finally went rather late to a point on the road half way between Sinoie and Histria and walked down towards the lake past a group of tumuli. This we believe to be the area where Hafner and Hoekstra saw the half-million Whitefronts and the 25,000 Redbreasts just a year ago. This year it is straight plough. We walked about two miles down (almost to the lake edge) and the evening flight came out over us, including odd Redbreasts among many hundreds of very high Whitefronts and one bunched, low rushing group of about 60 Redbreasts tearing the air with their wings. We walked home in the dark. It took 1 hr. 20 mins. to drive back to our huge hotel.

I forgot to record a snowfall as we drove to Tulcea after dark on Friday. By Saturday the hills were snow covered and there was snow on the northern side of the trees in Babadag Forest. In the morning on our way to Lunca we had skidded on a bend and done a 180-degree ground loop, ending up facing the lorry that was following us. There was still some snow causing caution as we motored back. We had seen one fox, running for a mile across country past nine roe deer, in daylight and four more in the headlights on the return drive.

Sunday, 14th December. We returned to our old spot on the road between Mihail Viteazu and Sinoie, as about the best vantage point—and the geese predictably overflew it and went into the great hinterland beyond the main road. We did not see more than a few hundred Redbreasts though about 3,000 Whitefronts. After

the rain of our first days, we had regarded the farm roads as impassable, but now we decided to risk it and headed inland from a farm just south of Mihai Viteazu. We had seen some geese milling in there but it was a long way in, on a mud track. Eventually we saw the geese far ahead, and now came another big surprise. On a patch of maize stubble between two very narrow strips of plough were about 400 Redbreasts. We had seen them in the maize up near the sand pit, but that was next door to a sprouting wheatfield. Here they were in the middle of a great sea of maize stems and stubbles. They were almost directly ahead of us and clustering on the farm road where perhaps a maize cart had been loaded. We approached by stages but the weather was dull and the birds were always on the crest ahead of us. Eventually they flushed out, on the arrival of a farm cart with two horses. They all landed on an open plough—3,000 Whitefronts and 400 Redbreasts. We motored past them but the light was poor and soon they were flighting even further inland. So we turned and retraced our tracks back to the main road without mishap. So northward to Baia, turning down to Lunca. The lakeside field was empty. No Redbreasts, no Roe, but a little further on a man with a gun, two dogs and three children. We turned sadly but after passing back through Lunca we stopped and spotted some geese on the landward side of the road. We tried a side turning, but after 200 yards the road between two ploughed fields was totally blocked by a puddle of soft mud. We walked on down to an electric supply pole which made a good rest for the telescope and watched 360 Redbreasts, 250 Whitefronts and four very large, very pale Greylags. These must surely include the 352 Redbreasts and 150 Whitefronts of the day before. After watching them for half an hour we withdrew and went back to Sinoie to walk out to the NE. down to the lake's edge. From the furthest we could get the car it was about 1½ miles by the route we took to the water's edge. We saw a young White-tailed Sea Eagle go over just as we started. Later new birds were Jack Snipe, Snipe, Grey Heron, Gadwall and about 50 Shelduck. There were hundreds of Shoveler and Mallard. One lot of 20 Whitefronts from the nearby fields landed at the water's edge, there were two Whoopers and a Mute flew by. As we walked out the earliest skeins of very high Whitefronts began to come out and tumbled into monumental whiffles. Even then we could not see them landing, and many flew on to the north without losing height. We had reached a small point below the main cliffs of the shore line when the main skeins of Redbreasts appeared from directly inland. Hitherto there had been odd birds scattered along the Whitefront skeins. What came into sight now was something entirely different. The first skein had 600 birds, flying in closely spaced lines at half the height of the Whitefronts. I noticed that they were not calling very much. The second skein was 200 yards behind the first—450 birds—then a little group of 80 and then 850 stretched across the sky. The whole lot passed directly over us. It was one of the most stirring sights that an anserophile could imagine. The Redbreasts did not whiffle, but planed down to land on Insula Lupilor about half a mile from us. Another long but happy walk back in the dark—but only 1,980 Redbreasts. We seem to have lost 2,000 and the total number of Whitefronts was only about 2-3,000. One fox on the homeward drive to Tulcea.

Monday, 15th December. Morning flight beside a high survey pylon about a mile west of the main road and a mile north of Mihai Viteazu. This necessitated tackling one of the now reasonably dry mud roads which had had no traffic on it since before the rains of the previous weekend. Near the pylon the road had some puddles and in one of these we stuck. It was still only 7.0 a.m. and the geese do not start to come much before 7.15. The objective was to get unstuck and to turn the car where there was no turning place but the plough which is incredibly soft. However, with the aid of Tom's little collapsible spade, and with me pushing, the little Volkswagen came out and we got it turned. The flight was very disappointing. By my calculations we should be overlooking the area where the 1,980 Redbreasts had spent yesterday. It was an

overcast morning with visibility rapidly falling as it became light. No great waves of geese came in—only about 1,700 Whitefronts in skeins up to 100. Two lots of Redbreasts came—one of 80 and one of 70 flying tightly bunched again at less than half the height of the Whitefronts. Where had the rest of the Redbreasts gone?

We went down into Sinoie for breakfast of bread and jam and apples. One of the farmers produced the bread and refused payment for it. We made an unsuccessful search of an area where Kuyken had seen geese five or six miles S. of Histria with a roost at the S. end of L. Sinoe.

So back we went to Lunca. The weather had cleared a lot and the sun was trying to shine thinly. The geese were again in the inland field and again the approach by car was precluded by the puddle. But as we decided to walk down we came to a cross road which promised an alternative approach. So back we went to the car and came down another side road through the farm. Thus we could approach to within about 300 yards. We sat watching the geese through telescopes. Yesterday there had been 360 Redbreasts and 250 Whitefronts (the former counted, as on the two previous days, bird by bird —though with the tight walking formations it is quite difficult and some error must creep in). Today there were 371 Redbreasts and 255 Whitefronts. For some of the time they walked towards us, and we had a bread, jam, apple and chocolate lunch in their company. Then the Whitefronts began to flight away. The only improvement they seemed able to find—after a fairly wide circuit—was the far end of the same vast field. After a while the Redbreasts also flitted along the field. Along the road ahead was evidently a puddle round which the geese clustered in an incredibly thick mass—two-thirds Whitefronts, one-third Redbreasts. We moved up in the car to within about 200 yards. The sun was now out. Immediately beyond the geese were two Roe does—directly behind them. Through the 60× Japanese telescope one seemed to be wandering among the geese. It was superb—light behind us, a good rest and adequate height in the car—the geese and the deer against the green of the field with the snow dappled hills of Babadag forest beyond.

Except for the rain-soaked view from the sandpit this was the closest we had been to Redbreasts on the ground. Their chestnut breasts shone in the sun. It was an exquisite finale for my wild goose chase for the time soon came for the return journey to Constanta to put me on the train for Bucharest.

As we drove south we passed a road I had seen on the way up which promised a view, from the opposite side, of the slopes to the north of the tractor station. We tried it and it did just that. As we watched a small party of a dozen extremely distant Red-breasted Geese came in from the lake flying bunched and low. They flew along the belt of trees beside the railway, and then went down most purposefully below the tree line. At that range there was no way of knowing which side of the trees they had landed. They were at least a mile away. So the Redbreasts kept their secret. They had beaten us on the whereabouts of their biggest flocks on the last three days of our visit and more than ever we valued our good luck of Friday, even though once more today had been a golden day.

In four days with the Redbreasts I shall never forget the unparalleled thrill of discovering that we had thousands of them in front of us on Friday, I shall never forget their closeness to us from the sand pit. Nor shall I forget the skeins of them high overhead on Sunday night. The tight bunch of them in the maize on Sunday morning was memorable too, but the Lunca flock were perhaps the most beautiful of all in the sunlight this afternoon.

This wonderful interlude owed much to the pleasant and undemanding companionship of Tom Lebret whose enthusiasm for *Branta ruficollis* matched my own. We were, of course, dependent on the arrangements and facilities made available by the Romanian authorities and scientists and would like to express our thanks and hopes that it will be possible to safeguard for the future the international treasure that winters in their country, the geese they know as Gîska gît rosu.

The cover painting for this volume of WILDFOWL attempts to recapture something of the splendour of the spectacle that we were privileged to share.

Peter Scott, Wildfowl Trust, Slimbridge, Gloucester, GL2 7BT.

Ecology of the Danube, with particular reference to waterfowl in Lower Austria

ANTAL FESTETICS and BERND LEISLER

Introduction (Plates IV and V, between pp. 48 and 49)

Research into the biology of a river is much rarer than into that of a lake, not only from an ornithological but also from a limnological point of view. After the Neusiedlersee, the Danube is the most important Austrian water area for waterfowl. The former is exceedingly important as an area for breeding, resting and passage, yet has hardly any waterfowl in winter (Festetics and Leisler 1968); the free flowing river, on the contrary, forms the only possible wintering place for many species. The basis for the following work is the winter counts instigated by the International Wildfowl Research Bureau. Although it has been shown that the Austrian section of the Danube is of international importance for certain species of birds, only a 128 km. stretch in Lower Austria, the transition from the upper course to the middle course, will be dealt with thoroughly. This stretch seemed suitable for ecological comparisons and to serve as a testing area over the years. It is first necessary, however, to sketch the most important biographical characteristics of the total course of the river, using data of the International Research Group for limnological research of the Danube from 1956 onwards (Liepolt 1967; Valkanov, Russev and Naidenow 1968).

PART I. THE DANUBE AS A WHOLE

The Danube is, after the River Volga, the second longest river in Europe and the only one that flows eastwards (WNW.-ESE.). It crosses 22 degrees of longitude, and runs through no less than eight States. Of its 2,858 km., 2,578 km. (80%) are navigable, although sea-going vessels can only sail as far as Budapest (1,639 km.). It has approximately 120 tributaries (of which about 34 are navigable) coming from totally different climatic regions. The river characteristically carves into the right bank after each narrowing, depositing vast mud flats through which the river branches. These are to be found after the breach through the Sauwald into the Eferdinger Basin, after the Linzer breach into the Machland, after the Wachauer Pforte into the Tullnerfeld, after the Wiener Pforte into the Lobau, after the Ungarischen Pforte into the Schüttinseln, after the Ungarischen Mittelgebirge into the Csepel-Insel and after the Eisernen Tor into the Calafat region.

A. Course (Figure 1)

Hardly any other river can be so clearly divided into three stretches of almost equal length. The 900 km. long Upper Danube reaches from the source down to the Porta Hungarica, with an alpine catchment area; the 925 km. long Middle Danube is delimited by its entry into, and exit from, the Karpathenbecken, and by its crossing of the Pannonicum area; finally, the 885 km. long Lower Danube reaches from the Eisernen Tor down to the mouth, thereby touching the Balkans. The Danube is the only European river that is measured backwards from the mouth (km. 2,858 lies at Furtwangen in the Black Forest, for the real source of the Danube is not in Donaueschingen (km. 2,810) as it is generally thought).

The Upper Danube in Germany is a summer cold brook in its mountain region. In this highest section (up to km. 2,750) occurs its steepest gradient, 101 cm./km. In Austria it becomes an alpine mountain stream, considerably narrower and more regulated, with a gradient of 50 to 40 cm./km. The river so far is characterized by a continual movement of coarse boulder detritus. While the flooded plain in the mountain region is narrow even at highwater, it can be 1 to 5 km. wide. The normal widths in this sector are 40 to 95 m. between Ulm and Regensburg (km. 2,379), 224 m. at Passau (km. 2,203) and 300 m. at Pressburg (km. 1,873). The height of the banks is 3 to 4 m. The Danube river has the greatest water capacity in Europe. It pours 203 milliard cu.m. of water into the Black Sea every year. At Passau the average rate of flow is 673 cu.m./sec., at Vienna (km. 1,925) 1,920 cu.m./sec. The river's depth is on average 5 m. at Passau, 3 m. at Vienna, but in general in the Upper Danube it is 8 to 12 m.

The Middle Danube includes a small part of the hill region and about half the flat region. At Gönyü (km. 1,791) there is a striking decrease of the river's

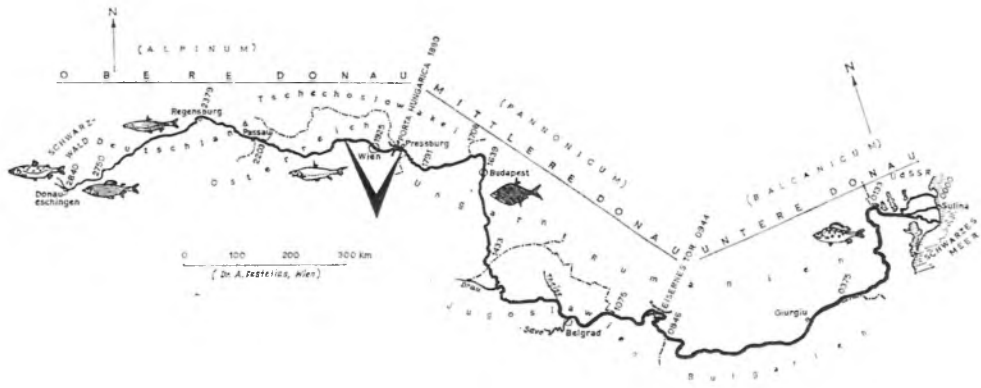


Figure 1. The course of the River Danube. The six fish represent, from source to mouth, the respective regions of Trout, Grayling, Nasling, Barbel, Bream and Pope (see p. 45). The arrowed section indicates the Lower Austrian counting stretch (see p. 50 and Figure 2).

gradient to only 6 cm./km., characteristic for the Pannonicum section. Only at the end of the Middle Danube, in the Katarakten stretch (km. 1,040-0,941) does the gradient increase again to 28 cm./km. From Vienna down to the Eisernen Tor the Danube is already characterized by many sedimentary islands, which are, in part, covered with rich vegetation. In many places the Middle Danube shows the most original landscapes on both sides of the Hungarian border, in the area of the sedimentary islands (from Pressburg to Gönyü) and along the Mohacs island (about km. 1,433), with water meadow belts of 8 to 10 km. wide. To the south of the Hungarian-Yugoslavian border, down to the mouth of the Drave there is a flood area of 35,000 hectares. After the slackening of the strong current, 0.8 to 1.1 m./sec. in the Hungarian lowland, the bottom has more gravel and sand. After crossing the Porta Hungarica the width of the river, when flowing through the Little Hungarian plain, broadens to 300 to 450 m. After narrowing at the Donau-Knie the river takes a north-south course and widens to the south of Budapest in the Great Hungarian plain, where it has an average water-flow of 3,300 cu.m./sec. and a width of 562 m. (km. 1,639). Later in its course it has steep loam, clay or mud banks of 1 to 6 m. In the second (Yugoslavian) part of the Middle Danube the river gets its greatest inflow from the tributaries Drave, Theiss and Save. The width of the river after the Theiss mouth is 600 m. At the Yugoslavian-Rumanian border, which is formed by the Bazias river (km. 1,075), the river is squeezed between cliffs having a sub-Mediterranean flora and fauna. Its narrowest stretch is in the Eisernen Tor (km. 944) with a width of 151 m. and rock gorges up to 240 m. deep. Here the current picks up speed to 5 m./sec. and a maximum depth of 70 m. is reached.

The Lower Danube comprises the second half of the plain area, along the Rumanian-Bulgarian border, and the extensive delta area in Rumania. The gradient lessens from 3.9 cm./km. to only a few mm./km. As a steppe river with a normal width of 800 to 1,800 m. it crosses the Wallachei, where during high water it can frequently flood over 5 to 10 km. At the middle stretch between Giurgiu (km. 480) and where it leaves Bulgarian territory (km. 375) its average width is 3,500 m., the average depth 7.5 m. and the speed of the current 1.1 m./sec. Over 100 sedimentary islands, flooded at high water, are a characteristic. Turning to the north the Danube flows through the Balta district, a wide, amphibious belt of subtropical character, an expanse of water 20 km. wide at high water, including all its tributaries. The so-called 'Lacus' Danube lakes are typical of the flood plains of the left bank along almost all the Lower Danube. They include:

(1) independent spring-fed lakes with a total area of about 7,300 hectares and a maximum depth of 3 to 4 m.;

(2) ox-bow lakes and dead river branches with depths of 9 to 10 m.;

(3) river 'limane' which were formed by pleistocene incursions of the sea and

by overflowings of the Danube cut off by sand bars.

In this region there are two high water periods during the early and late spring when up to one million hectares are flooded. A feature of this landscape is its succession of extensive sand dunes, woods, marshes and reed areas and the rows of lakes connected by canals. Finally the delta area in the Dobrudscha forms an equilateral triangle with sides of about 70 km. Here, three main branches enclose a flood plain of 500,000 hectares. Every year, because of the great amount of sedimentation, the middle (Sulina) branch pushes the delta 70 to 80 m. into the brackish Black Sea. Along its extensive lower course, the Danube loses, through evaporation and into the marshes, lagoons and limane, as much water as it receives from the lower tributaries. So its waterflow is just the same as at the Eisernen Tor, 900 km. upstream.

B. Regulating Works

Until the first half of the nineteenth century the Danube was a strongly meandering river with large numbers of side streams, dead river branches, islands, peninsulas and wide flood plains. In the second half of the century, two million of the 2,800,000 hectares of land liable to flood were reclaimed. Because of this regulation the current greatly increased and the water table sank with the rapid deepening of the river. Exchange of nutrients between the dead river arms and the river was also prevented, the most important result from the point of view of biological productivity. The second main alteration is the present building of dams in the river. The first such dam was the Bavarian one at Kachlet (km. 2,230) in 1956. In Germany, eight hydro-electric plants already exist, and a total of 24 have been planned. In Austria there are four in existence and altogether 14 have been planned. A total of 59 will eventually exist along the length of the river.

C. Ecological factors

The river is, in contrast to a lake, an open system, yet limnological terms such as littoral (bank area), benthal (bottom area) and pelagic (free water area) can be used for both (Ruttner 1962). The most important ecological factor, from the point of view of waterfowl, is the water's speed. Turbulence also changes during its course, because of projections of the banks, gravel and sand banks as well as objects in the river bed, which frequently cause whirls and eddies, not to be found in a lake. Turbulence is also the cause of the high oxygen content; an oxygen deficit only occurs in places polluted by Man. Owing to turbulence, approximately the same temperature will be found at any point of a cross-section, though, of course, a continuous rise in temperature is to be noted along the river's length. In contrast to this, equality of temperature in a lake is only possible after complete circulation in autumn and spring. Because of the strong current in the river little ice-formation occurs. It starts first in the slow flowing parts where mud particles act as crystallizing centres. The floes then grow together from beneath into a solid covering. The freezing over of the river takes 20 to 40 days, the thawing 12 to 15 days. The river is frozen for the least time at Melk (km. 2,036) with 14.2 days and the longest at Braila (km. 170) with 38.9 days. Stretches with exceptionally heavy ice formation are the Bavarian Danube, the sector between Aschach and Linz (Upper Austria) and the stretch between Vienna and Budapest. Light transmission is generally good owing to the relative shallowness and the lack of organic matter. However, it is poor, owing to mineral turbidity, in both the upper and lower courses. This has a direct influence on diving waterfowl. The sequence of various geological sedimentary terraces is characteristic of the Danube. The type of bank, a great part of which is man-made stone slopes, quays and groynes, is a crucial ecological factor. Rows of groynes were built to narrow the river and deepen the channel. In the bends of the river the banks are steep on one side and slope gently on the other, with a stagnant water area. On the steep side the bank is eroded by the main stream and eddies occur. Ice floes crowd together here. On the sloping side, sand and gravel is deposited and waterfowl may feed and rest. River barrages not only serve the production of electric current, but are an essential part of the regulation of the river. They improve water management and the navigability of the river and act as natural purification works. The dams increase the surface area and the depth, and reduce the speed of the current. An impoundment is not on a par with a lake from the limnologist's point of view (Reichholf 1966). The river impoundment lacks stratification, its pelagial is devoid of organisms, and there is no great variation in temperature. The relatively high water temperature near the bottom, together

with the high oxygen content cause a rapid conversion of deposited organic matter.

D. Flora and fauna

Current and detritus pressure do not allow the growth of floating or rooted vegetation; the sparse growth is limited to the banks. River plankton can only develop when the average speed of the current is 0 to 1 m./sec. Moreover, only after the spring high water will the formation of a plankton of this type occur, which is characteristically represented by diatoms. The typical forms are *Cyclotella*, *Melosira* and *Stephanodiscus* (Wawrik 1962). With a reduction in the speed of the current and an increase in eutrophication there is an increase in blue-green algae *Cyanophyceae* and green algae *Chlorophyceae*. Like phytoplankton, zooplankton is generally poor in species and number. Rotifers are typical, with *Brachionus* dominant. The strips of forest that grow along the alluvial banks are the most productive of all European woods. Depositing of organic matter occurs mainly in the dead water of old river arms. Decomposition may be incomplete and under extreme conditions can lead to the formation of flat peatland. Silting (inorganic matter, sand and mud) in the area of the slow-flowing branches offers sites for various pioneer vegetation. As there is so little light in these waterside woods, many climbing plants are to be found, such as guelder rose *Viburnum opulus*, hop *Humulus lupulus*, wild vine *Vitis vinifera*, honeysuckle *Lonicera*, *Physalis* and woody nightshade *Solanum dulcamara*. Deposition of organic matter and silting also leads to the formation of water meadows. Low water meadows are formed in the immediate proximity of the river and are flooded for a lengthy period every year, which causes over-fertilization and also prevents the roots from getting any air. Further silting raises the ground and enriches the soil, leading to the development of high water meadow, still within the reach of the flowing ground water, but flooded only occasionally and then for short periods. Willow *Salix* spp. and poplar *Populus* spp. are characteristic of the low water meadow, and ash *Fraxinus excelsior*, elm *Ulnus* spp. and oak *Quercus* spp. of the high water meadow. These water meadow woods are distinguished by their great ecological instability. The second botanical characteristic of the river is the islands in the delta area, built up out of floating plants rooted in a mass of reed rhizomes *Phragmites communis*, about 90 cm. thick, which have become rather peatlike, rising and falling with the water level. This is not strictly a marsh because the plants do not root in the ground.

Of the vertebrates, fish can be used as indicators of the ecological regions of a river, namely Brown Trout *Salmo trutta*, Grayling *Thymallus thymallus*, Barbel *Barbus barbus*, Bream *Abramis brama* and Pope *Acerina cernua*. The 'Trout region' is rich in oxygen, with very fast-flowing cold waters and large boulders. The next region downstream, the 'Grayling region', has banks with a fringe of water plants but still a small volume of water. In the 'Barbel area' the brook has grown into a river with warmer water and deposits of sand and pebbles but no mud. The 'Bream area' has leafy vegetation because of a great nitrogen deposit, often poor in oxygen, with sand and silt on the bottom. The 'Pope area' is the most varied one, with a maximum water temperature and volume, a minimum speed and a very muddy bed. The Danube shows a division into three parts, the mountain, hill and plain districts, covering two fish regions each, for in our case an extra region, the 'Nasling region' *Chondrostoma nasus*, can be distinguished in between the 'Grayling' and 'Barbel' regions. The mountain district includes the 'Trout' and 'Grayling' regions. The hill sector covers the 'Nasling' and 'Barbel' regions. The plains sector is also called the 'Carp' region on the Danube, as it is especially characteristic for Carp *Cyprinus carpio*. It includes the 'Bream' and 'Pope' regions.

Shoalfish that occur in the greatest numbers and are therefore important as food for the waterfowl are Bleak *Alburnus alburnus*, Chub *Squalius cephalus*, Zährte *Vimba vimba*, Silver Bream *Blicca björkna* and Roach *Rutilus rutilus*. The Danube takes a midway position between the Western European rivers (like the Rhône or the Rhine) with Trout (*Salmonidae*) and Bullheads (*Cottidae*) and the Eastern European rivers (like the Volga or Don) with Carp (*Cyprinidae*) and Sturgeon species (*Acipenseridae*).

Along the total length of the river the Common Sandpiper *Tringa hypoleucos* and the Little Ringed Plover *Charadrius dubius* are characteristically typical pluvial forms. From Ottensheim in Upper Austria (km. 2,150), where the water meadow belt begins, downstream we find isolated colonies of Grey Heron *Ardea cinerea*, from the Tullnerfeld in

Lower Austria (km. 2,000/1,974) the Cormorant *Phalacrocorax carbo*, the Black Kite *Milvus nigrans* and the River Warbler *Locustella fluviatilis* breed. From Vienna (km. 1,925) down, the Saker Falcon *Falco cherrug* breeds and so did the Thrush Nightingale *Luscinia luscinia* in the last century, and the Rook *Corvus frugilegus* and the White-tailed Eagle *Haliaaetus albicilla* a few decades ago. The last two species still breed regularly on the sedimentary islands of the Czechoslovakian-Hungarian Danube sector (from about km. 1,860 down). Here the first colonies of the Night Heron *Nycticorax nycticorax* are also to be found. In the vicinity of the Hungarian-Yugoslavian border (about km. 1,433) the Black Stork *Ciconia nigra* and the Lesser Spotted Eagle *Aquila pomarina* breed; in the mouth area of the Theiss (about km. 122) the Little Egret *Egretta garzetta*, Squacco Heron *Ardeola ralloides* and the Olivaceous Warbler *Hippolais pallida* breed. The Pygmy Cormorant *Phalacrocorax pygmaeus*, as an indigenous breeding bird, is characteristic of the district of the Lower Save (about km. 1,140). For the Balta and Dobrudscha region (from about km. 180 down) the following birds are typical: the White Pelican *Pelecanus onocrotalus* and the Dalmatian Pelican *Pelecanus crispus*, Mute Swan *Cygnus olor*, Shelduck *Tadorna tadorna*, Ruddy Shelduck *Tadorna ferruginea*, Glossy Ibis *Plegadis falcinellus* and Spoonbill *Platalea leucorodia*, as well as a lagoon fauna of Black-winged Stilt *Himantopus himantopus*, Pratincole *Glareola pratincola*, Gull-billed Tern *Gelochelidon nilotica* and Slender-billed Gull *Larus genei*.

PART II. THE AUSTRIAN DANUBE

The River Danube is of great importance for the waterfowl in Austria, it being the only large water area that is open in winter. The 350.5 km. long Austrian stretch (Pietschmann 1939) from km. 1,872 to km. 2,223, is well delimited by the alpine river Inn and the pannonic March. In this course it shows a total drop of 156 m.

A. Course

Below the mouth of the Inn at Passau, the Danube cuts through the wood-covered slopes of the Bohemian Massif with a deep-lying valley, about 300 m. wide and with many exaggerated meanders. Here, at Jochenstein (km. 2,203), is the first Austrian power station. Then follows the entrance to the Eferdinger Becken, with the second power station, at Aschach (km. 2,163). Thereafter water meadows of 1 to 2 km. wide accompany the main river down to the mouth of the Traun. Next, the Danube flows through a wide valley with spurs of the Bohemian Forest on the left and gravel terraces of the Alpine foreland on the right. The latter widens to the Machland along the long Upper and Lower Austrian border, a vast gravel deposit at the southern edge of the 'Mühlviertels', formerly often covered with moorland pastures. Recently the Wallsee power station (km. 2,093) was put into operation. The Danube leaves Upper Austria through the crystalline rocks of the Strudengaues, a narrow valley with steep rock ridges and, formerly, feared whirlpools, which were cleared away between 1777 and 1791. In general, the Danube follows the precipices of the left bank in an easterly direction from Ybbs to Melk, beginning at the great power station of Ybbs-Persenbeug at km. 2,060, which was temporarily included in our waterfowl counts. From Melk to Krems it flows in a north-easterly direction through a narrow valley in the Wachau, which has a very beautiful landscape. From the Wachauer Pforte (km. 2,001) the Danube, formerly greatly ramified, flows through the Tullnerfeld, on the left bank of which the water meadows and dead branches may have a width of 3 km., and comes, after breaking through the outgoing parts of the Wienerwaldes (Wiener Pforte km. 1,939), into the Weiner Becken, with the plain of the Marchfeldes. With the mouth of the March on the left bank and passing through the Ungarische Pforte (km. 1,880), the river leaves Austria.

For the greater part of the Austrian stretch the Danube has the character of a mountain river/stream, with a maximum water flow in summer (June) and a minimum in winter (October to December). There is an obvious correlation between the melting of the snow in the Alps and the degree to which boulder detritus is carried along. The main maximum in March is caused by the melting of the snow in the relatively low drainage area, from the mountains of the Schwäbischen Alb to the Bayerischen Wald. The melting of the snow in the high drainage area of the Alps, however, causes a sub-maximum in July. The Danube owes its mountain river character especially to the Inn. Before the confluence it is still a lowland stream, then with double the water passage, it becomes

an Alpine river which is cold and turbid. One million tons of debris are transported each year. The river bed is continually moving, which makes it impossible for anything to grow except along the banks in a narrow belt of 3 to 8 m. The current's speed is 2.2 to 2.5 m./sec. Until the beginning of summer the water temperature is about 15°C., rising on a few days in mid-summer with low water level, to about 20°C.; the average is 15° to 18°C. Fourteen days is the yearly average with ice-floes. The average water flow is 1,600 cu.m./sec. Although the Danube is the main sewage drainage for 1,705,000 people from the towns along the river, the quality of the Austrian stretch is relatively good. The width of the river at the Wiener Pforte is 285 m. on average, 1,000 m. at high water. The average depth of the water there is 6 m. The difference between extreme low and high water is 7 to 8 m.

B. Regulation

Formerly the Danube spread into three branches before Vienna. The smallest on the right is now the Donau-Kanal, the middle one formed what is now the Kaiser-Wasser and the left, the Floridsdorfer Donau, was the main stream. Most of the work in regulating the Austrian Danube was done between 1850 and 1927. It was exceptionally drastic in the Vienna area, where the stream is now straightened and embanked. Formerly, after breaking through the Wiener Pforte, it spread into many branches between islands with large water meadow woods and meadows. These branches used to be most important spawning places for fish during the spring high water period. Between 1869 and 1874 the Alte Donau and many other branches were cut off. Many of these were filled in and only the deeper places still exist today. From 1885 to 1889, the Hubertus dam was built between Bisamberg and Floridsdorf to prevent the overflow of the high water into the Marchfeld. In the same period dredging took place at shallow places and groynes were built. While these past operations resulted in an increase in the speed of the current, the power stations have just the opposite effect. In the vicinity of the power station the enlargement of the cross-section brings the speed of the current down from about 2.5 m./sec. to 0.4 m./sec. Besides the four existing power stations, all of which were built in the last 15 years, another eleven have been planned along the Austrian stretch. Some of these will affect the following biologically valuable environments: the Grey Heron colony at Ottensheim (km. 2,145), an exceptionally well-structured water meadow environment for several waterfowl species at Grafenwörth (km. 1,985), the Grey Heron colony and deer environment at Petronell (km. 1,890), and the mouth of the March with its pannonic water meadow at Wolfsthal (km. 1,872).

C. Biotope

Five environments can be recognised:

1. The river. The Danube in Austria can be considered a waterway which is poor in food material and oligotrophic. The production of plankton is low and, in addition, can decrease even more as a result of the influence of nitrogen, which causes serious poisoning of the phytoplankton, as for instance in the Linz area. The production of plankton is increased by organic fertilization, as downstream from Vienna. In Vienna itself it may result in algal blooms. The groynes are important bank structures which, have major functions as resting sites for example for Cormorants, and as slack water areas for grebes, diving ducks and mergansers, and as feeding areas.

2. Dead waters that have been cut off from the river. They are important production areas because of the rich growth of underwater plants, floating plants, sedges *Cyperaceae* and reeds, and are thus important resting and feeding sites.

3. Impoundments. The most important ecological factor is the reduced gas exchange of the water with the air. The mud lacks oxygen but this is offset by the river water, rich in oxygen, passing over it. Notwithstanding the depth (10-15 m.) visibility is good because of the sedimentation. The new plant/animal growth in the depths is opposed by a sharp retrogression in that of the bank. Impoundments are characterized by an increase in animals coming to feed, an increase in fish production and a decrease in migratory fish. Frequently a tenfold increase in production will take place; Einsele (1957) counted 100,000 individual animals per cu.m. According to Weber (1961) the biological production at Ybbs-Persenbeug is 124 to 218 gm./cu.m., which corresponds with that of the Lower Danube in Bulgaria. Many plants grow in the calm shallow places of the impoundments.

4. The water meadow woods along the Austrian stretch are usually cut off from the river by a sandy bank with poplars.

Those of the western stretch and the narrow places are chiefly low water meadows (Wendelberger-Zelinka 1952). We only find the high water meadow well developed in the Tullnerfeld and east of Vienna (Marchfeld). The low water meadows, with a growth of willow, offers the bird world a rich supply of food and shelter, but rather little possibility for nesting. However, the intermediate phases and the high water meadows offer nesting, resting and feeding sites because of the pronounced stratification (the undergrowth being intertwined with lianas), the lack of long-lasting floods, the abundance of large and small hollows and especially because of the loose park landscape with 'edge effect' in the vicinity of water. A peculiarity of the Austrian water meadow woods, especially in the pannonic sector, are the so-called 'Heisslands', dry places that occur like islands and show characteristics of a steppe (dry shrubs with hawthorn *Crataegus monogyna*, privet *Ligustrum vulgare*, sea buckthorn *Hippophae rhamnoides*, black poplar *Populus nigra*, the roses *Rosa micrantha* and *canina*, and grasses, like upright brome *Zerna erecta* and the fescue *Festuca pilosa*). They were especially encouraged as the ground sank during the regulation of the Danube. In the last century the use for forestry was small, but as hunting grounds the water meadow woods were greatly valued and often fenced. Only during the last few decades have several fast growing species of tree been planted, which give a considerable yield. This led to a great change because of the introduction and promotion of ash, willow and especially the hybrid black Italian poplar *Populus* × *canadensis*. The short growth cycle and deforestation severely disturb the water meadow wood and encouraged the infiltration of goldenrod *Solidago serotina*.

5. The meadows that have been formed by mowing, have oat-grass *Arrhenatherum elatius* and cock's-foot *Dactylis glomerata*, besides the yellow thistle *Cirsium oleraceum*. The most typical are swamp meadows that are still flooded once a year, while dry meadows were formed after a warmth-loving water meadow wood had been cleared.

D. Fauna

The following forms of invertebrates have importance in biological production and as food for waterfowl. Because of the unstable river bed we find hardly any organisms on the bottom except near and along the banks. These form exceptionally good environments, because the bank growth is very uniform with water mosses, like *Fontinalis*, *Fissidens*, *Hygrohypnum* and *Hygramblystegium*. Here, only current-loving (rheophile) forms can develop, with about ten kinds of flatworms, for example *Planaria torra* and *Dendrocoelum lacteum*. The areas near the banks also form important refuges for young fish. It is precisely these bank areas, which are so important biologically, which are being greatly endangered by waste water and sewage and in places show devastation or accumulation of dirt organisms, as the sewage is sucked out of the pipes into a narrow strip along them. Important animals used as food are the larvae of stoneflies (Plecoptera, 10 species, for example *Perla*) that predominate especially in the Austrian Danube above Vienna, of mayflies (Ephemeroptera, 7 kinds) and of caddis flies (Trichoptera, especially *Hydropsyche*). At the sewage outlets there is an accumulation of the mollusc *Radix peregra* and the zebra mussel *Dreissena polymorpha*, which have only immigrated quite recently and have come as far as Ingolstadt (Germany). In all, 10 mollusc species are to be found. On the stones of the bank we find the leeches *Herpobdella octoculata*, *Haemopis sanguisuga* and the shrimp *Carinogammarus roeselii*, all especially near sewage outlets; in these places the crustacean *Asellus aquaticus* is also very common in the mud. Richer animal life is to be found at the bottom of the reservoirs. Besides the sewage forms, the following are to be found on sand and mud, the crustacean *Gammarus pulex*, blood worms *Tubifex* and pea shells *Sphaerium*. On the rock detritus are the leech *Glossosiphonia*, larvae of the caddisfly *Rhyacophila*, stone-flies and mayflies. Partly in the river, but especially in the tributaries and dead waters there are many molluscs, like *Limnea ovata* and *L. auriculata*, *Vivipara fasciata*, *Valvata*, *Ancylus*, *Neritina danubialis*, *Theodoxus fluviatilis*, *Lithoglyphus naticoides*, and great numbers of *Unio* and *Anodonta*. In the mud, chironomid larvae are to be found in great abundance. The zooplankton is also well developed with masses of *Cyclops strenuus* and *Bosmina longirostris*, of which up to 13,000 per litre can be found in May (Grohs 1943). In the dead waters the phytoplankton also shows a vertical stratification. Of the vertebrates, the fish fauna in particular has changed with the regulation. Before regulation there was a sharp boundary at Vienna where the pontic species never crossed

Philippa Scott

Plate III. Alaska's Arctic Slope. (a) Aerial view showing frost polygons. The many small islands and ridges are nesting sites for geese. (b) Black Brant *Branta bernicla orientalis* at its nest on such an island. (See pp. 11-17).

Philippa Scott

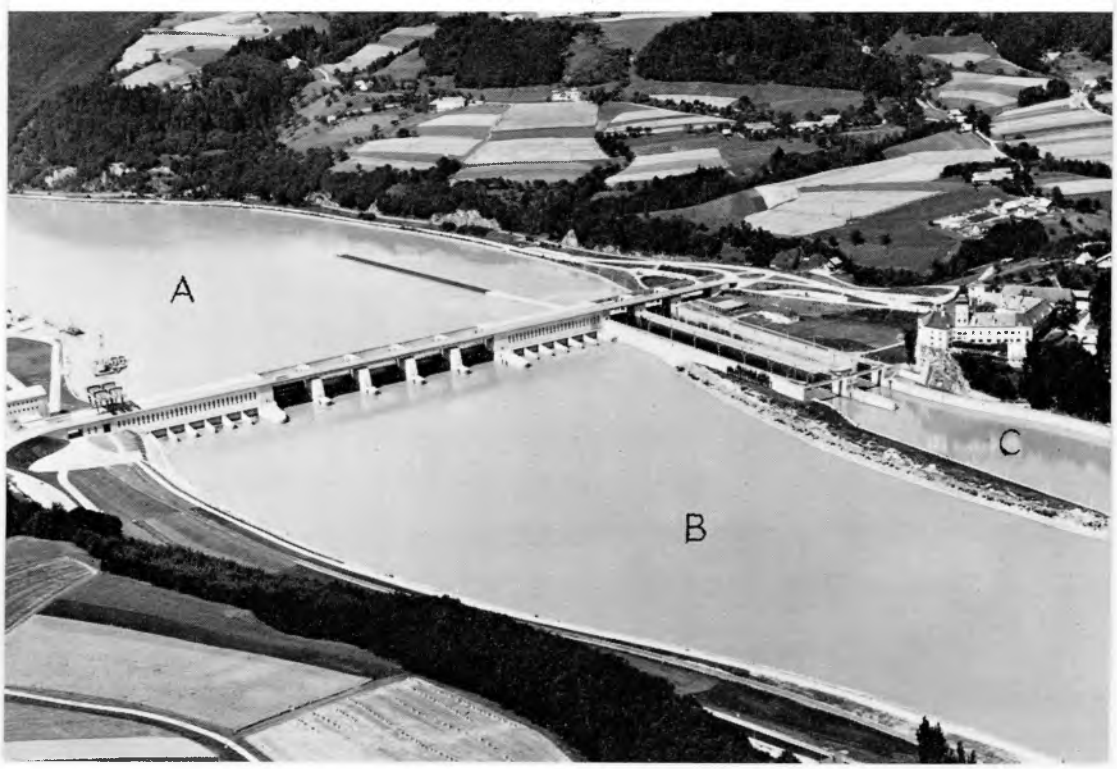
A. Festetics

Plate IV. The Danube. Goldeneye *Bucephala clangula*, Goosanders *Mergus merganser* and a winter scene. (See pp. 42-60).

A. Festetics

Plate V. The Danube. (a) Typical biotope of the river. A backwater overhung with dense woodland. (b) The hydro-electric works at Ybbs-Persenberg, west of Vienna, with the broad area of still water (A) behind the dam, the lower water (B), and the slip lock (C).

A. Festetics



A. Festetics

Plate VI. (a) Lake Char-us-nur in the plain of the big lakes in Aimak Chovd, Mongolia. (See pp. 61-68).
(b) Lesser Snow Geese *Anser caerulescens caerulescens* on the Reifel Island Refuge, British Columbia, Canada. In the background are the mountains of Vancouver Island. (See pp. 112-114).

Brian Gates

the Upper-Middle Danube border. This was caused by the fact that this reach came as far as the mouth area of the Miozän. Remarkably, this invisible boundary remained until only recently, in that the Danube was inhabited by Trout and Miller's Thumb to the west of Vienna and mostly by Carp and Sturgeon *Acipenser* spp. to the east. A hundred years ago at Vienna there was still a regular catch of Huchen *Hucho hucho* on one side and Sturgeon *Acipenser huso* and Sterlet *Acipenser ruthimus* on the other. Nowadays in fishing, the Pike *Esox lucius* occurs in the greatest numbers in the dead waters. Fish present in large numbers in the Austrian stretch are the sedentary forms like Silver Orfe *Idus idus*, Bream and Chub, besides the migratory forms like the Barbel and the Nasling, and the Bleak, Rudd *Scardinus erythropthalmus* and Roach (Balon 1962). Of the amphibia, the Common and Swamp Frogs *Rana temporaria* and *arvalis* are typical and very numerous in the water meadows. Of the reptiles only the Tesselated Snake *Natrix tesselata* is to be looked upon as an aquatic form. Of the mammals—besides the amphibious small mammals—the Red Deer *Cervus elaphus* is worth mentioning as a characteristic Danube ecotype. Of the birds we will first mention some characteristic ones, though it must be said that no bird species are typical of the Danube. The following species no longer breed along the river: Little Tern *Sterna minuta*, Stone Curlew *Burhinus oedicnemus*, White-tailed Eagle, whose last eyrie (1960) was in the water meadow region of the Lobau, Purple Heron *Ardea purpurea*, Roller *Coracias garrulus* and Bee-Eater *Merops apiaster* (Marschall and Pelzeln 1882). Nowadays, only very few breeding pairs are to be found of Common Tern *Sterna hirundo* in the Upper Austrian Machland, Kingfisher *Alcedo atthis*, Cormorant and Saker Falcon. Finally, mention must be made of *Laro-limicolae* in passage and 12 breeding colonies of Grey Heron totalling about 130 pairs.

E. Web-footed birds

Here, brief statements are made about the breeding populations, which refer to the whole of the Austrian Danube, and winter populations ascertained by means of the 'mid-winter counts' of the last three years. The counts on our experimental stretch, worked thoroughly for five winters, will be dealt with in Part III.

1. Breeding stock along the Austrian Danube

No quantitative research on the breeding ducks of the Danube exists so far, and there are also gaps in our qualitative knowledge. The breeding population is characterized by the great lack of diving ducks; Ferruginous Duck *Aythya nyroca*, which could be found breeding at Vienna until the turn of the century, is not now to be found; there is only a suspicion of breeding on the March. Of the dabbling ducks, Mallard *Anas platyrhynchos* are the commonest. They breed in large numbers at all suitable places from water meadows around Linz, their great adaptability being useful in choosing a nesting place. As a new phenomenon they have noticeably increased on the impoundments, especially those upstream. Teal *Anas crecca* are sporadic breeders in the water meadow forest areas of the Upper Austrian Danube, the meadow bogs area of the Machland, and other places in the Danube valleys (Firbas 1962). They bred in great numbers between Vienna and Hainburg until the nineteen-twenties, then decreased sharply (Abensperg-Traun 1960). Although this species does not exist in the pannonic part of Lower Austria, it has recently been identified as a sporadic breeder along the March. Gadwall *Anas strepera* bred between Vienna and Hainburg until 1920. In the years after, a decrease occurred around Petronell (km. 1,890). Garganey *Anas querquedula* breed sporadically along the Lower Austrian and probably also along the Upper Austrian Danube and in the Machland. Shoveler *Anas clypeata* were rare breeders near Vienna in the first half of the last century; Abensperg-Traun (1960) still called this species a rare breeder at Petronell in 1932. Its status nowadays is unknown. Pintail *Anas acuta* are occasionally suspected of breeding along the Lower Austrian Danube and bred sporadically in the Upper Austrian Machland around 1930. The last three species bred here only as an exception, the decrease of the first three species is an effect of the Danube regulation. Cormorants *Phalacrocorax carbo sinensis* find here, in contrast to the Neusiedlersee area, the desired combination of breeding-trees in quiet woods, and water feeding areas. This species breeds frequently only to the east of the Wachau, in the Tullnerfeld. Occasionally, nesting occurs further west, for example at the Enns-Traun mouth (Upper Austria) in the years 1944-54 (Merwald 1955). Of the

grebes, only Little Grebes *Podiceps ruficollis* are typical breeders of the water meadow. Coots *Fulica atra* breed in the dead waters with reed growth.

2. *Winter conditions on the Austrian Danube*

The stretch of the Danube in Austria forms a remarkable inland concentration area during wintertime for three species. Mallard number about 10,000, the mid-January values being: 1967, 9,122; 1968, 9,641; and 1969, 9,701. Of these, 82% were in Lower Austria. The greater numbers there can be explained by the greater availability of food and the larger areas of suitable living space (gravel banks, dead river branches) to the east of Vienna in the pannonic district. Goldeneye *Bucephala clangula* numbers were 628, 1,239 and 1,326 in the three winters. Of these 99% were in Lower Austria. The Danube flows more slowly through the plains of the Tullnerfeld and the Marchfeld, between banks with a richer structure, both factors that are favourable for the feeding of the Goldeneye. The Goosander *Mergus merganser* concentration is one of the most renowned and easterly on the Continent. Values of 169, 420 and 551 were recorded, 85% in Lower Austria.

PART III. WINTER WATERFOWL POPULATIONS ON A STRETCH OF THE LOWER AUSTRIAN DANUBE

The counting of waterfowl throughout the winter along the Danube round about Vienna (Festetics 1968) was the first large co-operative work of this kind. These 'national' counts were carried out on the days appointed by the International Wildfowl Research Bureau every month during the winter half year since 1963-64 along a 128 km. stretch in Lower Austria. Leisler (1964) gave a provisional report; the detailed analysis of the results of the last five years (1964-65 to 1968-69) has been made by Scherzinger and Böck (in press).

A. Methodology

A river is an open system, so a new method was used, distinct from that used in counts on the Rhine (Kramer 1964), Elbe (Dien and Lippert 1965) and the Moldau (Urbanek 1962). There is relatively good going along the Lower Austrian Danube, and river kilometre signs, conspicuously situated on the banks for shipping, enable exact locating. In order to obtain maximum synchronization and comparability, eleven counters covered the river from Krems to Wolfsthal, so that each counter had to walk along 10 to 15 km. of bank. Each observation was registered while in the field, with a note about the location on the river (correct to 100 m.), the time in the case of larger concentrations, the birds' behaviour and the constitution of the banks. In order to avoid double counts, it was noted whether the birds passed the counter flying upstream or downstream. The total of the separate species follows from the sum of all the stationary birds plus those flying in the direction the observer was going, but minus those flying in the opposite direction. The total errors did not exceed 15%. In addition to the counts made from the banks, control trips were made with an assault boat. Restless bird species, like gulls, cormorants and White-tailed Eagles could then be followed at 40 to 60 km./hour, small species which often stay hidden in bays, like grebes and individual ducks, could be located, and finally, in cases of unfavourable light, those parts which are difficult to see from the bank could be examined (with the motor turned off).

B. The counting stretch (Figure 2)

Our experimental stretch forms the last part of the Upper Danube, where the river changes from a mountain stream into a lowland stream while passing through the Vienna Gap, with a decrease in the river's gradient. As a result the river's carrying capacity drops perceptibly and we find here one of those big sedimentations which occur downstream of each such narrowing. This switch is also apparent in the plant and animal distribution, because of which it is advisable to draw the biological border of the Middle Danube, and with it also that of the Pannonicum, further to the west near Vienna instead of coinciding it with the geographical border (Porta Hungarica). This stretch is most varied in landscape, from the impoundments and the steep mountain slopes in the west, via the large industrialized city of Vienna in the middle, to the pannonic lowland in the east.

We divide the counting stretch into three sections: the 62 km. long West section from Krems (km. 2,001) to Klosterneuburg (km. 1,939) which in spite of the effluents of two chemical factories

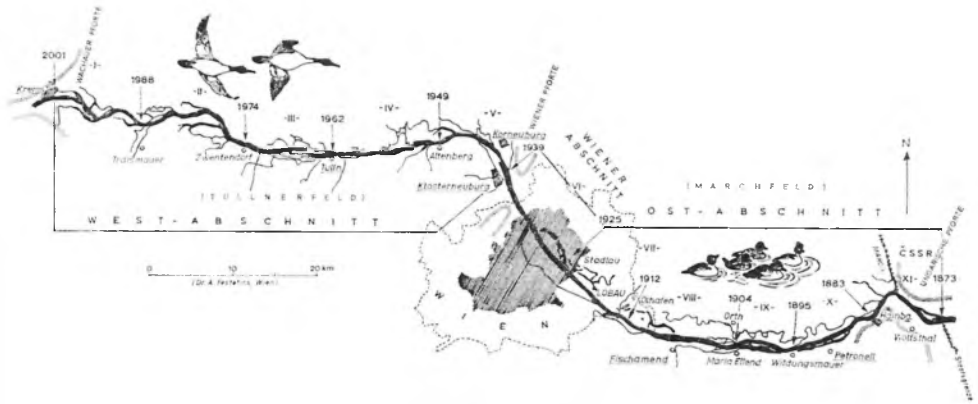


Figure 2. The Lower Austrian Danube counting stretch.

in Krems and Zwentendorf has water of biological quality grade II. Following Liepolt (1967) we can distinguish seven grades from I to IV with intermediate stages. The water deteriorates suddenly over the 14 km.-long Vienna section, between Klosterneuburg and Stadtlau (km. 1,925), as the Danube canal and nine main sewage canals together bring 4,325 cu.m. of waste water per second into the Danube. This leads to such a strong eutrophication and pollution that the Danube takes on the quality grade IV. Almost all sewage pipes empty directly into the Danube without any purification. As a result this sector is the most polluted of the total course of the river. This effect continues at least 20 km. into the 52 km.-long East section from Stadtlau down to the border (km. 1,873), and the lowest oxygen content and the highest phosphate and nitrate values are found at about Haslau (km. 1,901). For more sensitive species of food animals (for example mayfly larvae) a stretch 30 km. downstream from Vienna can be considered as being poisoned. The next stretch down to Wolfsthal generally shows values between II and III. Locally, however, especially along the left bank the situation is made worse by the outlet of the Russ-Bach (quality grade IV) and the March (quality grade III to IV). This pollution is mainly a result of the oil refineries and sugar factories of the Marchfeld. Oil especially enters at high water. Almost every year between October and December there is fish mortality in the March. This difference between the two sections of the river around Vienna is illustrated by the distribution of birds adapted to certain types of food: in the West section are found birds fishing by diving for healthy fish, like the Osprey *Pandion haliaëtus*, Kingfisher and terns. The East section mainly accommodates birds like the White-tailed Eagle, the larger gulls, Rooks and Hooded Crows *Corvus corone cornix*, which find a rich feeding ground in sick and dead fish and in the refuse.

In the Vienna region, the river picks up speed significantly (2.5 m./sec.) in an artificial channel, then follows the old course below Vienna. The high water level is reached in June and reaches its minimum between November and February. The average water flow is 3.8 million litre/sec., the slowest at Vienna 245,000 litre/sec., the fastest 10 million litre/sec. According to Scherzinger and Böck (in press), the rising of the water is slowest in the region of dead rivers and abundant water meadows downstream from Vienna, which helps to stabilise the waterfowl population. When the dead waters and the bays freeze over, only the ice-free current of the river remains for the ducks. At high water the first species to be forced out are those preferring shallow, calm water, like Teal (but also Goosander, Tufted Duck *Aythya fuligula* and Pochard *Aythya ferina*). The most important disturbance factor is the river traffic, the Danube being navigable for an average of 300 days. The prevailing banks are sloping, built up with rough cut stones; only in the town area have they been smoothed by plastering. In the Vienna area, industrial works and storage yards extend along the right bank, while along the left bank is a 450 m. wide flooding area, where a second artificial Danube channel will be built to ensure absolute security. Rough banks are mainly found after the Vienna Gap and especially after confluences. The vegetation of our counting stretch is exceptionally rich in four areas, where vast

and undisturbed water meadows and dead rivers accompany the river. These are at Zwentendorf (km. 1,974), at Stockerau (km. 1,949), at Marie-Ellend (km. 1,904) and at the March mouth (km. 1,879). These water meadows, especially below Vienna, are two to three km. wide along the left bank, while to the right is only a narrow water meadow strip, squeezed between the river and 30 to 40 m. high, steep cliffs.

C. The waterfowl species

As in our work on waterfowl of the Neusiedlersee (Festetics and Leisler 1968) we again will include in this term all species which are 'swimming' species. The 39 species discussed here, which form an ecologically well-characterized group, are representatives of the families Gaviidae (3 species), Podicipidae (5 sp.), Phalacrocoracidae (1 sp.), Anatidae (29 sp.) and Rallidae (1 sp.). In the group of Anatidae are 2 swans, 7 geese, 7 dabbling ducks, 10 diving ducks (in a broad sense) and 3 mergansers. They will be grouped according to their frequency or their ecological importance to the region, and they will be described according to the situation during the counting period between November and March (5 counts).

Group A: birds to be found regularly and in large numbers (over 100), see Table I.

1. Mallard *Anas platyrhynchos.*

This has a maximum of 7,000 to 15,000. It is the dominant species of our stretch and accounts for about 92% of the total waterfowl population in November, 94% in December when it reaches its maximum, 85% in January, reducing to about 75% in March. The aggregate counts of the Mallard counted in the five winter periods 1964-65 to 1968-69 (5 counts each time) and the maximum in each winter are shown in Table I. In addition, the Ybbs-Persenbeug reservoir to the west of our counting stretch holds a flock of 4,000 per winter, and the dead waters of the Danube at Vienna an average of 4-5,000. The maximum figures for the latter region are 1,300 to 1,500 between December and March. It is clear that this species reaches its peak in the height of winter (December to January), which justifies the timing of the international mid-winter counts. This also holds for Goldeneye, Goosander and Tufted Duck (see below). The fluctuations of Mallard along the Danube below Vienna are exactly opposite to those in the Seewinkel 20 km. away (Festetics and Leisler 1968). Early in November the number of Mallard along the Danube is still quite insignificant; while by the end of the month it rises considerably. Around mid-December (after the frost period has usually set in in Seewinkel, where the small shallow lakes freeze solid) as many as 5,500 birds can be counted at a point below Vienna. In mild winters this concentration at the mouth of the Fischa amounts to 2,500 to 2,800. The decline of the winter population usually begins by the end of January, only exceptionally does this species reach a maximum in February. The month of March is marked by a rapid decrease.

The total counts for the five winters can be divided among the three sections of our count stretch already mentioned, the West, Vienna and East sections, though these are, of course, not of an equal length. The percentages distribution is shown in Table II. The stretch between the Schwechat and Fischa mouths accommodates 28% of the total Mallard population. Here we find the ideal combination for this adaptable omnivorous species of large rubble flats as resting sites with a water rich in food. Above Vienna, only three constant large concentrations exist, all distinguished by a similar favourable combination of resting site and feeding site, below Krems, above

Table I. Aggregate and maximum counts of waterfowl wintering regularly and in large numbers (Group A) on a stretch of the Lower Danube, 1964-65 to 1968-69. The aggregate total is the sum of five counts each winter.

	1964-65		*1965-66*		*1966-67*		*1967-68*		*1968-69*	
	Agg.	*Max.*	*Agg.*	*Max.*	*Agg.*	*Max.*	*Agg.*	*Max.*	*Agg.*	*Max.*
Mallard	20558	7484	18028	11502	13216	8509	24959	11137	27769	13359
Goldeneye	3065	1191	1773	984	1035	593	2973	1204	2741	1328
Goosander	459	268	495	324	282	157	661	339	973	425
Tufted Duck	512	197	217	147	88	82	483	331		
Pochard	207	110	143	131	96	71	376	120		
Teal	258	81	227	136	250	106	260	88		

Traismauer and below Klosterneuburg. Interesting changes in resting sites of the Mallard at the time of an average water height (November) and at the time of the ice-drift (January) were shown by Scherzinger and Böck (in press). The shallow waters and reservoirs frequented by 52% of the Mallard freeze and then the ducks are forced to rest on sand and rubble banks (rising from 28% to 66%), the movement generally being favoured by the simultaneous dropping of the water level, making extra rubble flats available. Ice floes and ice along the edges are also used as resting sites, while the stone slopes hold constant numbers (11% in November and 13% in January).

Table II. Distribution of the commoner waterfowl species in the three counting sections of the Lower Danube, shown by percentages of total aggregate counts for the winters 1964-65 to 1968-69.

	West Section (above Vienna)	*Vienna Section*	*East Section (below Vienna)*
Length of section (km.)	62	14	52
Mallard	45	2	53
Goldeneye	63	2	35
Goosander	72	1	27
Tufted Duck	12	83	5
Pochard	34	46	20
Teal	97	1	2
Little Grebe	69	3	28

Mallard have a very specific type of feeding behaviour on flowing water, the 'conveyor belt'. They let themselves be carried along by the current, searching for food from the surface and then fly upstream again, only to let themselves be carried down again. Often up-ending occurs, especially near the banks and in shallow waters and impoundments, and they also feed by swimming with their heads under water, wading, or from loose floating ice-floes. The sewage drainage of the city greatly benefits the Mallard, especially because the refuse (particularly kitchen refuse) floats on the surface. An important food source may be the floating seeds of sedges *Cyperaceae* and pondweeds *Potamogetonaceae*. The Mallard also feed extensively on mollusca, especially *Dreissena polymorpha*.

Mallard have established themselves in the Vienna town region in the past ten years, showing clear signs of self-domestication. The birds will breed in the smallest parks and are fed all through the year. Especially in the winter, densely crowded flocks of several hundreds are found on the dead river branches of the town region. Of these ducks a minority are full-winged domestic ducks with the appearance of an eastern Asiatic race. They have longer bodies, the brown breast colouring continues irregularly along their sides, and the plumage is very variable. During the winter they will tolerate people within a metre or two.

2. Goldeneye *Bucephala clangula.*

One thousand to 2,000 birds reaching in the middle of winter a share of 13 to 15% (March) of the waterfowl population of the Lower Austrian Danube (Table I). A striking immigration begins in the last third of October, only exceptionally is the peak reached in December, and the population falls off very gradually in March. Mild winters are marked by a strikingly low population. The distribution pattern (Table II) is probably due to the insect larvae, on which the birds prefer to feed, being sensitive to pollution. Another factor could be the greater number of groynes on the West section. This species rests only in the shallow waters and impoundments and usually feeds in the vicinity of the banks. Stomach analysis of four specimens from the Danube showed the main food to be larvae of crustacea, such as Gammaridae, and stone-flies. The latter could come from the littoral zone, the former mainly from the bottom.

3. Cormorant *Phalacrocorax carbo.*

The third most numerous species, 500 to 700 occurring along the Danube between November and March. The totals of the five counts for winter 1964-65 were 873; 1965-66, 332; and 1966-67, 176. By the end of December the last big flocks of the species are seen. Much larger numbers may be seen during migration, outside the main counting period, for instance 946 birds in March 1965. Around this time they occur regularly in the relatively clean section, rich in groynes and dead river arms, between the water pollution zone of Vienna and the no less polluted mouth of the March. Here, at Sections X and XI, there are two roosting sites on old, high poplars on the left side, one along the Austrian bank with about 250 birds, and one along the Czechoslovakian bank with 400 to 600. As resting sites, however, the stone groynes and rubble banks are preferred. As purely

fish-eating birds they hunt mainly for bigger Cyprinidae, especially 20 to 40 cm. long Rudd, with a day's ration of up to 1 kg. per bird. These migrants, like the Austrian breeding population, are usually classed under the continental race *P. c. sinensis.*

4. Goosander *Mergus merganser.*

Total counts of 300 to 600 (Table I). The mid-winter percentage of the total number of waterfowl of the Danube reaches 5%, in the middle of March. The species appears in the middle of November, reaches a maximum in January, decreases slightly in February, and reaches a migration peak in March. Those present from the middle of March to the beginning of April considerably outnumber the maximum winter population. Their numbers are, however, difficult to determine, as the main flock withdraws into the calmer and now ice-free dead river arms. This species reflects very precisely the weather and the water level, with low numbers in mild winters and at high water. The preponderance of Goosanders west of Vienna (Table II) results from the water there being unpolluted, the quantity of live fish being much greater, and the presence of many groynes. For resting sites this species makes few demands, using shallow water and reservoirs, rubble and sand banks, and occasionally ice. The main food is 10 to 20 cm. long Cyprinidae; Keve (1969) also found Sturgeon *Acipenser* sp. up to a length of 35 cm. as being taken in the adjoining Hungarian section of the Middle Danube.

5. Tufted Duck *Aythya fuligula.*

This species numbers about 100 to 200 birds (Table I). The fast flowing water is unsuitable as a feeding site for these diving ducks. The values in Table I refer to the river to which the birds also moved from the Vienna dead river arms. Individuals stay to the end of April. Migration is hardly noticeable. Table II shows a striking phenomenon, namely that the lion's share of this species concentrates on the 14 km. long Vienna section. This can be explained by its commensalism with Man. In the Vienna town region the dead river branches, totally separated and stagnant waters, have been converted into sporting areas and swimming pools. Here the Tufted Duck are abundantly fed by the people. In this case they profit by their adaptability (Busch 1964) and their talent for safeguarding bits of food from the sponging Black-headed Gulls *Larus ridibundus* (Scherner 1967). Because of underground springs, parts of the water areas generally remain unfrozen. Flocks of them move to the river and seek their food there mainly below sewage inlets. It is clearly an omnivorous feeder, with a slight domination of molluscs in its food.

6. Pochard *Aythya ferina.*

This is represented by about 100 birds (Table I). The maximum values fluctuate from December to February. By the middle of November as many as 150 birds can be counted at the Old Danube and the record for this region was 310, at the beginning of February. The population decreases in March when a clear but weak migration can be noticed. The Pochard shows a somewhat similar division pattern to the Tufted Duck (Table II).

7. Teal *Anas crecca.*

About as numerous as Pochard (Table I). The constant size of the small winter population is striking. A site on sector I (between Krems and Traismauer) accounts for more than half (53%) of the total population, thus explaining the distribution shown in Table II. Here dead river branches lie in a district rich in water meadows on the right hand bank. The West section is more suitable for this species which avoids human settlements (Bezzel 1963), because of the numerous river mouths and the absence of towns or villages. The principal food is especially the floating plant seeds in the dead river branches, next to the animal food from the silted bottoms. As resting sites this species prefers stagnant water and it is exceptionally sensitive to high water and the ice break-up.

Group B: birds to be found regularly but in smaller numbers (less than 100)

1. Coot *Fulica atra.*

The maximum is 70 birds. They are difficult to record, as most stay on the dead river branches except when these freeze. The aggregate for 1964-65, 125; 1965-66, 8; and 1966-67, 58. The winter population in Vienna on the Old Danube, where the birds are fed by the people, appears when the frost sets in an early winter (on 13.11.66 there were 1,603 birds in Vienna) and remains unchanged until the middle of February. Along the river proper a few small flocks will occur only in severe winters. The food in the river is floating plant seeds, especially near the groynes and banks, submerged vegetation in the dead river arms and, according to Keve (1969), in the Hungarian Danube stretch

also molluscs and fish spawn. They prefer firm ground as sleeping sites, often in the company of Black-headed Gulls. Our winter populations are extremely small in comparison with those of the Voralpenseen. A not insignificant migration occurs over our area (Keve 1969).

2. Little Grebe *Podiceps ruficollis.*

Winter numbers are very variable. In the winter 1964-65 the aggregate was 93; in 1965-66, 60; and in 1966-67, 18. The maximum count was 55 in March 1965. The preponderance above Vienna (Table II) can be explained by the many river mouths and groynes. Sector II (Traismauer-Zwentendorf) holds nearly a third of the total. Within the East section, sector VIII (Ölhafen-Maria Ellend) has 18% of the total. As resting sites the shallow waters, reservoirs, groynes and river mouths are mainly used.

3. Red-breasted Merganser *Mergus serrator.*

In the winter 1964-65 an aggregate of 16; in 1965-66, 49; and in 1966-67, 51. The maximum count was 35 in February 1967. From that it follows that larger numbers of the species in the area (about 50) are only migrants. The first observations date from the middle of October, the migration and general maximum follows in mid-November. A clear decrease follows in December, in January and February there are only a few. The spring migration takes place in March and often extends into the middle of May. This species occurs regularly along the river, though there seems to be a preference for stretches with many groynes. Individual winter visitors show surprising constancy in the sites they occupy on the water.

4. Smew *Mergus albellus.*

In the winter 1964-65, an aggregate of 88; 1965-66, 20; and 1966-67, 17. Peak counts were 35 in January and February 1965. The very first appear as early as the middle of November. The numbers increase slowly and reach a maximum in February, departure occurring in March. The relative depth of the river (shipping channel) determines its distribution.

5. Great Crested Grebe *Podiceps cristatus.*

In the winter 1964-65 an aggregate of 14; 1965-66, 8; and 1966-67, 28. Maximum: 23 in January 1967. Migration in November and beginning of December. They are mainly found in areas with groynes, river bends and river mouths.

6. Red-throated Diver *Gavia stellata.*

In 1964-65 a maximum of 5 birds in November; 1965-66, 7 in November; 1966-67, 2 in November.

7. Black-throated Diver *Gavia arctica.*

The maximum numbers, always in November, were in 1964-65, 6; 1965-66, 4; and 1966-67, 2. The migration begins by the end of October and continues until the middle of December, reaching its maximum by the middle of November. Under certain circumstances, 10 to 15 birds have been counted. According to Keve (1969) they will eat, on the Danube, fish and molluscs. They prefer to search for their food close to the banks.

8. Velvet Scoter *Melanitta fusca.*

The species is a winter visitor in varying numbers. In mild winters they are only represented by a very few individuals, as in the winter 1965-66, aggregate 24. Yet the maximum of this species lies in December with about 20 to 25 specimens, and as an exception, 46. This species is found on the stretches with groynes, not in their slack water but in the rapids below.

9. Mute Swan *Cygnus olor.*

In the Vienna town region semi-tame birds are kept, and for the winter they are taken from the parks to the Old Danube which rarely freezes and where the birds are fed. Individuals or smaller groups are also found on both sides of Vienna, where they up-end near the banks in the shallow water regions. The maximum count is 46 birds in the middle of February 1965.

10. Wigeon *Anas penelope.*

It is found regularly with an aggregate of 5 to 35 and a maximum of 10 (November to January). It is a scarce wintering bird, but may be more numerous during migration, from the second half of August to the middle of November and from the beginning of March to the end of May.

11. Gadwall *Anas strepera.*

It is to be found in this area with a maximum of less than 20 birds. The aggregate for the winter 1964-65 is 16; 1965-66, only 1 bird in November; 1966-67, 9; and 1967-68, 18. The highest count was 15 in March 1968.

12. Pintail *Anas acuta.*

In the winter of 1964-65, an aggregate of 18; 1965-66, 5 (in January); 1966-67, 3 (in February).

13. Common Scoter *Melanitta nigra.*
Found regularly but in small numbers, especially in November and December (a maximum of 7 birds on 8.12.63). The predominance of females is striking.

14. Scaup *Aythya marila.*
Only a few birds are regularly recorded, especially in January to February. It is, however, characteristic of this species that larger groups may suddenly turn up (for example in December 1967, 37 birds on sector IV).

15. Long-tailed Duck *Clangula hyemalis.*
Surprisingly, this species is a regular guest on our Danube stretch, with a maximum of 5 birds per winter. The migration period lies between November and December, a very few separate individuals also occur in January, the species being more numerous again during the spring migration, from the end of February to the beginning of April. The striking fact that they are found within the town areas of, among others, Krems, Tulln and Vienna is connected, by Bauer and Glutz (1968), with the mass occurrence of *Dreissena polymorpha* which is not affected by pollution and is stimulated by eutrophication. Some individuals will stay for an extraordinarily long time. The observations refer mainly to females and juveniles.

16. Black-necked Grebe *Podiceps nigricollis.*
The maximum numbers are about 5, mostly in November. They are also found regularly along the Danube in March, especially in the groynes of the Vienna town area.

Group C: species to be found irregularly and in small numbers.

1. Garganey *Anas querquedula.*
It is totally absent in winter and during the counting period it is only found regularly in March. According to other observations, the spring migration in March to the end of April seems quite notable. This agrees with Impekhoven's (1964) supposition that an important spring migration may go through the pannonic part of Austria and Hungary.

2. Shoveler *Anas clypeata.*
It is only recorded irregularly in the area during the counting period, with a maximum of 10 in January 1965. Especially found on the dead river arms along the river.

3. Red-crested Pochard *Netta rufina.*
To be found irregularly during the counting period but also at other times.

4. Ferruginous Duck or White-eyed Pochard *Aythya nyroca.*
This species does not winter on the river. The main migration is during April and the first ten days of May. In autumn, especially the end of October, individuals are seen. Some appear on the Old Danube, a maximum of 6 in mid-December 1964.

5. Eider *Somateria mollissima.*
Almost every year some individuals appear, especially from the beginning of November, being mainly females and juveniles.

6. Red-necked Grebe *Podiceps griseigena.*
This species was recorded almost every year. Maximum in November 1965: 3 birds. Strikingly, it has a preference for the slack water behind the groynes.

7. Slavonian Grebe *Podiceps auritus.*
Usually absent but under special circumstances it reaches a maximum of 5 birds, as in November 1964.

Group D: rare and accidental visitors.

1. Great Northern Diver *Gavia immer*; 2. White-headed Duck *Oxyura leucocephala*; 3. Shelduck *Tadorna tadorna;* 4. Ruddy Shelduck *Tadorna ferruginea*; 5. Pink-footed Goose *Anser brachyrhynchus*; 6. Brent Goose *Branta bernicla;* and 7. Whooper Swan *Cygnus cygnus.*

Group E: temporary visitors

1. Bean Goose *Anser fabalis.*
The winter population is restricted to the two basin landscapes of Eastern Lower Austria, the Tullnerfeld to the west of Vienna and the Marchfeld to the east. Here grazing is available because of the short duration of snow cover, the open water of the river is available for drinking, and roosting sites exist on the large rubble areas resulting from the low water level in winter. As the possibilities for grazing and roosting are also present at the Neusiedlersee but no large winter population of the Bean Goose is found there, the availability of drinking water (at Neusiedlersee the lake and the 'Lacken' freeze completely) seems to be the most important condition for the wintering of

this species (see Leisler 1969). In all, the Austrian winter population is less than 1,000. In the main migration month of October, a spectacular movement takes place along the Danube. In spring, especially in February and March, the species again migrates, more quickly, through the region. The Austrian population is small in comparison with the winter population of the upper sector of the Middle Danube where at least 15,000 could be counted at the Czechoslovakian-Hungarian border sector in the mild winter of 1963-64 (Hudec, Nagy and Randik 1967). The populations of the Marchfeld link with the Slovakian population at the March. Whether the decrease in the formerly impressive winter population in the Tullnerfeld is connected with the general decline of the species in recent times or with a decrease in the growth of buckwheat *Fagopyrum* in the area, as the sportsmen assume, cannot be answered here. As for the choice of roosting sites, the species is rather adaptable, thus in the winter of 1964-65 big flocks passed the night on large ice sheets along the banks of the Danube.

2. White-fronted Goose *Anser albifrons*.
The small population, less than 500 birds, is mainly found on the East section. This species does not show such a striking migration at the Danube. More common, however, are smaller groups which come to the Danube to drink and bathe and which let themselves be drifted downstream.

3. Greylag Goose *Anser anser*.
This species is almost totally absent in winter. However, in autumn, especially in the second half of October, a strong migration occurs in the Tullnerfeld. There seems to be a regular exchange between the population of the southern Mähren and that of the Neusiedlersee, possibly along the March.

PART IV. ECOLOGICAL PROBLEMS OF WATERFOWL ON A RIVER

We shall now try to analyse the river as habitat for waterfowl and to show how it differs from a static lake. The lake district in the Burgenland is of significance in Europe as a breeding and migration area for waterfowl (Festetics and Leisler 1968). In the Seewinkel alone, 12 species of waterfowl breed with a total of 1,200 pairs and during the autumn migration a maximum of 50,000 waterfowl can be observed. However, when the lake area freezes in high winter the Danube in Lower Austria, 20 km. away, is the only large, ice-free water area, forming an important refuge area for the Mallard and the Bean Geese, amongst others. Yet hardly five species of waterfowl breed on the Danube in small numbers, whereas 23 species are found as regular migrants and winter visitors with a winter maximum (January) of 14,200 birds.

A river can be considered an 'open system', in that it has practically no boundaries upstream or downstream. The surroundings, created by the river itself, form a communicating environment. That means that a river, in contrast to a lake, is not only an open system, but also a dependent one, not a self-sufficient habitat in which important nutrients are retained, but one in which they are constantly supplied and carried off.

A. Breeding site

Because of the current, there are no breeding waterfowl on the surface of a river, nor on the banks, especially where it is regulated. Steep banks and a constantly changing water level are also unfavourable. Dead river branches, however, especially when they are silted up, begin to resemble woodland ponds and provide breeding sites for some species (for example Teal, Little Grebe or Coot). The water meadow woods provide nest sites (for example for Mallard and Cormorant). Notwithstanding its relatively short shore line a lake, because of the much more favourable ecology of its shores, produces much larger breeding populations of waterfowl.

B. Feeding site

Flowing water is a permanent source of food, as there is always open water and in addition various substrates are exposed by water level fluctuations, such as rubble, mud or sand. The length of the banks is much greater in relation to water surface in the case of rivers than in almost round lakes, though with very indented shores and transitional vegetation the proportions of a lake can be easily improved (Kalbe 1967). However, the water surface forms the largest feeding area for birds. The strongest unfavourable factor in a river is the current, which often makes it very difficult to reach the food. Only the divers, which are extremely adapted, can hold out here, like the three merganser species, the group of diving ducks, the

Goldeneye and the Cormorant. An adaptable species, like the Mallard, may develop ways of feeding which are specific for these special circumstances ('conveyor belt'). Except for the large schools of fish, the water itself produces very little food. Organic residues, floated into the river from the natural production sites or poured in as sewage, are of importance. Thus in a river outside factors dominate in food production, while a lake produces its own food sources. Therefore lake types (oligotroph, eutroph or dystroph) can only be compared with river sectors (for example the Grayling zone and Barbel zone) in a limited way. Moreover a river, because of its capacity for self-purification, never shows the same degree of pollution over long distances as does a lake. In our middle sector the lack of any inorganic turbidity or organic colouring and the shallowness assists many waterfowl in their search for food. But transparency can decrease in places as a result of industrial effluents. Ice-formation can also be of decisive influence on the intake of food of various species (for example Teal).

Notwithstanding its relative expanse the littoral of a river is not a suitable feeding site. Here the food supply is made up of what is washed ashore and of the few small current-loving animals living among the stone blocks, and also the plant growth with its inhabitants. An important food source are the driftlines (carcasses, rubbish, parts of plants, seeds, grains) yet they can only be reached where the banks are sloping and the water is shallow. Only a few species (Coot and some dabbling ducks) will also feed along dried-out driftlines.

On the bottom of a river it is especially characteristic that vascular plants are absent in contrast to a lake. On the other hand, the animal populations are well developed in places. Of the fishes of the Danube, the endemic fish population is notable and, in comparison with a lake, quantitatively dominant. The bottom, especially the channel being the deepest part, is unsuitable as a feeding site for diving birds because of the strong current and moving pebbles. A moderate food supply is then found only in the dead water spaces and current shadow behind obstacles, such as the groynes.

We must refer to the importance of the adjacent dead river branches. As a result of the warm stagnant water, a rich supply of nutritious substance and low turbidity, these become important production sites and thus are, from an ecological point of view, comparable with ponds. Because of a richly developed bottom-rooted, floating and transitional vegetation, because of the rich population of animals living on the bottom, often in the mud, and because of the great quantity of fish (introduced species as well as endemic ones), the dead river arms form an ideal feeding site, for plant- and animal-feeding, swimming and diving species. They can, however, only be used for a short period as, in contrast to a river, they freeze regularly. For short periods also, the further surroundings of the river, such as the stubble fields at Marchfeld, can offer an important feeding site for certain dabbling ducks, especially Mallard (Abensperg-Traun 1960). The feeding conditions at the river are thus favourable, notwithstanding the above-mentioned limitations, so the Danube, together with its accompanying biotopes, could hold a still larger waterfowl population than it does.

The wide range of types of food for the waterfowl at the Danube in wintertime clearly favours the animal-feeders: six species (the three mergansers, two divers and the Great Crested Grebe) are, as pure piscivores, represented in the region with a total of 590 in the high winter population of January. To this group, the 700 to 1,000 Cormorants in spring could be added. A group with seven species (Goldeneye, Velvet Scoter, Common Scoter, Long-tailed Duck, Scaup, Little Grebe and Black-necked Grebe), with 1,548 birds, feeds mainly on animal food. One single species, the Mallard, forms the biggest group, as omnivores, with 11,500 birds. Mixed animal- and plant-feeders are the three species, Pochard, Tufted Duck and Teal, with a total of 595 birds. Finally, five species, which are mainly vegetarian, comprise only 55 birds: Coot, Mute Swan, Pintail, Wigeon and Gadwall. Consequently the Danube shows a clear difference in its winter population from the Neusiedlersee region (breeding and migratory populations), where the plant-eating species very clearly dominate.

C. Resting site

The river itself seldom offers, and then only for short periods, a resting place for those species which will allow themselves to float downstream. Waterfowl will often roost on ice-floes. More often, shallow waters and impoundments are used for resting. At the stagnant dead river branches the roosting possibilities are the same as those at a lake, although their width is restricted in places by the water

meadow woods. Of the hard substrates in the water, sand and rubble banks, and also the groynes, are of the first importance. Along the banks and rarely on stretches of grass and high water dikes there are occasional resting sites. At high water rubble banks and groynes are lost as such. In all, the supply of resting sites at the river, compared with that of a lake, is more varied, but less favourable.

A river has far more disturbances than a lake, although this varies greatly in places. The most permanent but most innocent disturbance is certainly shipping. This is relatively slight on the Danube compared with western European rivers (Rhine, Elbe or Rhône) and is of influence both from the actual disturbance and from the wash of the waves. When a ship comes along the birds can fly away parallel to the river (Goldeneye), move to the dead river arms (Mallard), or wait, while circling high overhead, until the disturbance is past (Cormorants). Mergansers and divers will often get out of the way by submerging. A really notable disturbance is created by the anglers, because they occupy, often for several days, potential resting sites (especially the groynes). Shooting has a much greater influence on the waterfowl of a lake than on those of a river, which is topographically less favourable to the shooter. In the vicinity of towns, recreational pressure is felt strongly along the banks of the Danube, especially at weekends. Finally, in the East section of our counting stretch, the wintering White-tailed Eagles constitute a not insignificant disturbance. In between Vienna and the Czechoslovakian border up to 13 individuals may be found (Spitzer 1966). When they appear they flush the resting waterfowl flocks; if they sit quietly they are accepted. A disturbance is generally greater than on a lake, where there are usually reasonable 'buffer zones'. In the case of a lake, which has a relatively larger water surface in comparison with the length of its shore, the refuge possibilities are, in general, more favourable.

Finally, we would like to point out the various nature conservation problems: human interventions at a river do not fundamentally reduce the water surface, as they do in the case of static water (by drainage). On the contrary, the dams enlarge the water area. The banks, however, have been fundamentally changed by slope improvement. The dead water areas, not only as an important supplement to the river, but also as an independent biotope, are no less in danger than peat bogs, marshes or small lakes. A great part of these environments along the Austrian Danube has been lost and the conservation of those still in existence is the most urgent task of nature conservation along the river.

Acknowledgements

For financial aid we thank the municipal council of the city of Vienna, the Lower Austrian national record office and the Austrian ornithological station. K. Mazzucco placed the mid-winter counts on the Austrian Danube at our disposal. The Federal Ministry of Home Defence made available an assault boat from the military training school at Klosternenburg. W. Scherzinger and F. Böck did most of the organising of the counts on our special stretch of river and we are especially grateful to about 20 counters from the Austrian ornithological station and from the Zoological Institute of Vienna University, who, often under difficult conditions and at their own expense, laid the foundations of this work.

Editorial Note

This paper is condensed from a German text translated into English by Miss Miek Harmsen, to whom we are most grateful.

Summary

The environment and winter population of the waterfowl of a section of the Danube are discussed in detail, based on co-operative work over five years. In the first part, the course, environments and life of the whole Danube, from its source to its mouth, are sketched. In the second part the breeding and winter populations of the waterfowl (based on three years' mid-winter counts) are mentioned in relation to the characteristics of the whole Austrian stretch. In the third part we describe the 128 km. long counting stretch in Vienna and Lower Austria as a waterfowl biotope and analyse the counting results from five winters. The individual species are discussed in terms of population size, phenology, distribution, feeding and roosting. In the fourth part the river as a waterfowl biotope is contrasted with a lake.

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Dr. A. Festetics (I. Zoologisches Institut).
cand. phil. B. Leisler (II. Zoologisches Institut) Universität Wien, Austria.

The waterfowl of Mongolia

EUGENIUSZ NOWAK

Introduction

From 27th September to 3rd October 1969 the author was in Ulan Bator seeking on behalf of the International Wildfowl Research Bureau to establish co-operation with Mongolia over wildfowl research and conservation. With the assistance of Mongolian colleagues this general report on waterfowl and their habitats in that country was compiled.

General description of the country

This paper deals with the territory of the Mongolian People's Republic, often called Outer Mongolia by geographers, and subsequently referred to as 'Mongolia'. This geographic region ought not to be confused with the northern province of China, often called Inner Mongolia, or with the autonomous Mongolian region of 1922, now the autonomous Buriat Republic in Soviet Eastern Siberia. The area of Mongolia comprises 1,565,000 sq. km. and extends 2,400 km. from east to west and 1,260 km. from south to north. The country is divided into 18 aymaks or provinces, and each of these into some 20 to 30 samons or districts. Mongolia has at the present time only 1,120,700 inhabitants, of whom very nearly 80% are Mongols. The average density of population is thus about 0.7 per sq. km., but in practice is less, as there are about a dozen towns, the capital city of Ulan Bator being inhabited by 240,000 people. In the past the Mongolian region was never densely inhabited and for that reason has kept until the present day the most unaltered aspect among all countries of Asia.

The configuration and physiography of Mongolia are very interesting. There are no regions at an altitude less than 500 m. above sea level, the average altitude is 1,580 m., the highest mountain peak attains 4,653 m. From the physiographic point of view there are five zones running in the direction of parallels of latitude, intergrading, of course, to some extent (Figure 1): A — mountain forests (some 7% of the country), B — mountain steppes with sparse forests (25%), C — grassy steppes (26%), D — arid steppes (27%) and E — desert (15%). The mountain ranges of the country are the Mongolian Altai and the Gobi Altai, which merge one into the other; the Khangai, situated in the centre of the country; and the Sayan and Kentei bordering on Siberia. The climate of Mongolia is decidedly continental. In the north of the country the average January temperature is −34°C, and in the south −19°C; the respective July temperatures are, however, 15° and 23°C. The whole year round there is much sunshine, and the total yearly precipitation varies between 220 and 260 mm., less in the south, more in the north. The climate of the country often exhibits irregularities, for example an early spring, strong ground frosts accompanied by

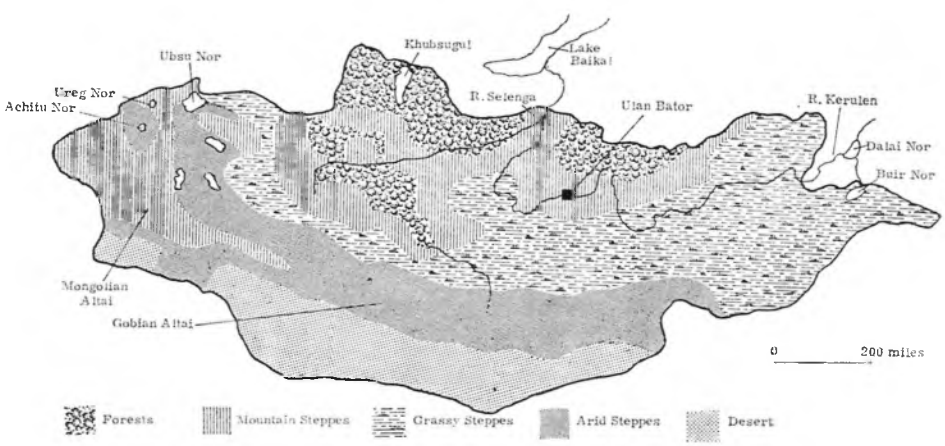


Figure 1. The five physiographic divisions of Mongolia.

snowfall in April or May, or a sudden drop in temperature in autumn. According to the most recent investigations, in Mongolia there are 2,050 species of plants (belonging to 102 families and 258 genera), 127 mammals, 340 birds, 70 fishes, 17 reptiles, 6 amphibia and more than 500 insects.

Habitats of water birds (Plate VIa, p. 49)

The Mongolian territory abounds in biotopes suitable both for waterfowl nesting and for the resting and feeding of migratory flocks. The most important area of this kind is in the west, in the Basin of Great Lakes. This group of water bodies belongs to the largest of this kind in Asia and includes, among others, Lake Ubsu-nur (3,350 sq. km.) and Khirgis-nur (1,760 sq. km.). Some of these lakes have brackish, and others fresh, water. Their shores, particularly the freshwater ones, are overgrown with exuberant vegetation, and in part surrounded by large marshes. In spring, because of the scourge of gnats, the inhabitants abandon the lakes for other regions; thus for ages nothing has disturbed the breeding of birds here. Apart from this large concentration of water bodies in the west, thousands of other lakes are dispersed over the whole of Mongolia. The second largest lake, Khubsugul (2,620 sq. km.) is situated on the border with Siberia. Hundreds of small, generally brackish, lakes or marshes are scattered all over the Gobi and the eastern plateau. Also the rivers, with natural banks generally overgrown with vegetation and often with swampy margins, and numerous old river beds, are excellent biotopes for water birds. The largest rivers of the country are the Orkhan (1,124 km. in length) and the Kerulen (1,090 km.), while the Siberian Selenga flows through Mongolia for 593 km. Other important rivers are the Dzabkhan (808 km.), Tola (704 km.), and Tes (568 km.). Soggy and wet habitats are quite numerous and are good for waterfowl breeding. These regions have for ages not been changed by man's hand and probably will remain so for a long time. Of considerable importance for the presence of high numbers of the Common Shelduck *Tadorna tadorna* in Mongolia, is the activity of numerous burrowing mammals, foxes, marmots, badgers, etc. The Common Shelducks nest in great numbers in the abandoned burrows of these animals, even at a great distance from water.

There are now eleven wildlife sanctuaries in Mongolia, of which two include nesting places of water birds. The first comprises the Galut nuur lake and, situated closely to its bank, the rocky height of Galut chijacaa in the aymak of Bajan-Changorin, a breeding place of the Bar-headed Goose *Anser indicus*. The other, the lake of Borolzurt nuur in the Tow aymak, is the breeding place of various species of ducks.

Thus there are numerous excellent biotopes in Mongolia for breeding and migratory water birds. However, because of its climate and hard winter, Mongolia is not, in general, a wintering place for these birds. Some water birds, nevertheless, spend the winter on the unfrozen rivers, just as cases are known of ducks wintering in great numbers on the rivers of Siberia, for example the Angara. This matter requires further study.

The relation between Man and water birds in Mongolia

The breeding population of Mongolia's waterfowl is exceptionally interesting from the scientific point of view, for it is a natural population, on whose species composition and numbers man has, until the present day, not been exerting any influence. This is both because their biotopes have remained primitive and because for thousands of years the peoples inhabiting Mongolia did not use wild animals or birds for culinary purposes, differing in this respect from many other primitive tribes of the world. A basic cause was that this country was always sparsely inhabited and eminently suitable for shepherding. Therefore there was always plenty of good, easily available meat, mainly from breeding sheep. In the 13th century, when the hunting of waterfowl began to spread in many European countries, the ruler of Mongolia, Kublai Khan, enacted a law forbidding hunting any kind of game from April to October, that is, in the period of reproduction. An infringement of this ban was punishable with death! In practice, therefore, this meant that water birds were not hunted at all, for they left Mongolia for the winter season. This custom was, in principle, valid until the 18th century. Meanwhile, buddhism, introduced from Tibet to Mongolia in the 16th and 17th centuries, provided a new, exceptionally strong, wave of influence, protecting the animals of the country, and waterfowl in particular. In the eyes of the Tibetan buddhist philosophy the killing of animals is a great sin. Only specially designated

people, who were never monks, could kill even domestic animals for culinary purposes. There were very few infringements of this rule, as 70% of males spent many years of their life in buddhist monasteries. The buddhist monks, lamas, did not even carry arms. The Ruddy Shelduck *Tadorna ferruginea,* on account of the similarity of the colouring of its plumage to that of the monks' robes, was declared a holy bird. Birds' nests were under particular care, as the killing of their nestlings or taking or destruction of eggs was an exceptionally serious sin. Only in the Middle Ages, when the Mongolian state had a numerous and warlike army, were special bird hunts organised to provide feathers for arrow shafts. These were mainly wing and tail feathers of predatory birds and of Sand Grouse *Syrrhaptes paradoxus*, the feathers of water birds being only substitutes. In the Middle Ages falconry was widespread in Mongolia among the ruling classes and rich people; this sometimes, but not too often, involved hunting wild ducks, geese or herons. The wives of very rich Mongols also wore outer garments made partly of skin from the heads of Mallard drakes *Anas platyrhynchos* in breeding plumage. Such a caftan is on view in one of the Ulan Bator museums. Thus the former use of water birds for military, falconry and clothing purposes was likewise insignificant. The Pelican *Pelecanus* sp. is the only water bird which, despite bans by formal law and custom, has for ages been seriously exploited by the Mongols. The dried upper part of the Pelican's bill is used for scraping sweat and foam off the body of a tired horse. The view is widespread that this method is particularly advantageous for the horses' health. Such bills were found in prehistoric ritual burials of the Mongols and even today they are found among the nomad arats.

All these circumstances for centuries enabled the fauna of water birds of Mongolia to remain in its primary state. Only after 1921, following the Revolution, when the importance of the buddhist religion considerably declined and the authorities of the republic began to utilize game animals, did the situation change. As we shall see later, the impact of these great events in the life of the country on the waterfowl population of the country continues to be slight.

Waterfowl in Mongolia

Waterfowl are represented in Mongolia by 50 species of breeding birds, namely, 2 swans, 4 geese, 17 ducks, 26 waders and plovers, and the Coot *Fulica atra.* There are 35 species of non-breeding birds, 1 swan, 2 geese, 8 ducks and 24 waders and plovers.

To date, zoological investigations on Mongolia's fauna have provided a relatively accurate list of birds occurring and information on their distribution, and the dates of breeding and migration. We owe these data to Russian and American expeditions, as well as to the latest publications on research by Mongolian, Soviet and German scientists. There is, however, scanty information on the numbers of the various species and their migratory routes and wintering places. No bird ringing has taken place as yet. However, the main species of breeding water birds are present in very great numbers and their breeding populations certainly amount to several hundred thousand pairs each. Thus Mongolia is one of the major producers of waterfowl in Asia.

Mute Swan *Cygnus olor*

Nests rarely and locally in the centre and south of the country. There are no data on its migrations.

Whooper Swan *Cygnus cygnus*

Nests in quite large numbers in suitable biotopes all over Mongolia. The birds arrive from the end of April through May. Breeding occurs through June and the beginning of July. Departure is prolonged, some birds leaving as early as August, others at the end of September or in October, and some of them stay through the winter. This may often end in their freezing; in the winter of 1967-68 several dozen died in the northern part of the Khirgis-nur lake. Migrates in flocks of sometimes 100 birds.

Bewick's Swan *Cygnus columbianus bewickii*

Bird of passage. No precise information on dates of stay or numbers.

Greylag Goose *Anser anser rubirostris*

The most numerous goose species, nesting in the western and central parts and, in smaller numbers, in the east. The spring flight begins at the end of March and lasts until April. Many birds nesting in Siberia also fly through Mongolia. Breeds in May and June. Moulting occurs from the end of July until the end of August, large flocks being found in the west. The local geese depart in mid-September, the passage of Siberian geese continuing until the end of September.

Bean Goose *Anser fabalis*
It is not clear whether this species nests at present in the northern part of the country, in very small numbers. Bean Geese do, however, pass in great numbers, mainly through central Mongolia. Numerous flocks, of up to 1,000, alight on wheat fields but no measures are taken against them, apart from frightening them away by a sentry on horseback. The spring passage lasts from mid-April until the end of May, and the autumn passage from the end of August through the whole of September.

White-fronted Goose *Anser albifrons albifrons*
Lesser White-fronted Goose *Anser erythropus*
These species have so far not been found in Mongolia, but the probability exists that they pass through as they were found in Eastern Siberia. Mr. A. Bold has oral reports from hunters of shooting geese resembling these species, but it is still necessary to acquire specimens to confirm this information.

Bar-headed Goose *Anser indicus*
Nests in suitable biotopes all over the country, but is most numerous in the central and western aymaks. After the Greylag Goose it is the second commonest goose in Mongolia. In Siberia this species has already completely ceased to nest, or appears only locally. It nests in May and at the beginning of June. Moulting time varies widely in various populations, lasting from the end of July to the end of August. It departs in the first half of September.

Swan Goose *Anser cygnoides*
Nests in large numbers in the west of the country, less so in the centre. Locally it is more numerous than other nesting geese, but as it does not spread over the whole area of the country it is the third most numerous goose. In Siberia this species still nests, but in very small numbers. It arrives from the middle to the end of April, nests typically in colonies in May, moults in August, rarely as early as July, and departs at the beginning of September.

Ruddy Shelduck *Tadorna ferruginea*
A characteristic, very numerous, nesting bird over nearly the whole country. It arrives as early as March and April, and is one of the first species of waterfowl to start breeding in the spring. But the period of reproduction is very protracted and lasts from April until the beginning of June. Probably large concentrations of moulting birds occur, but so far they have not been located. They depart in large flocks, the entire water-surface of small lakes sometimes being covered with Ruddy Shelducks, in the second half of September.

Common Shelduck *Tadorna tadorna*
Also a very numerous nesting bird over the entire country; its numbers, however, are slightly smaller than the former species, probably because of its special requirements—burrows for nesting. It comes somewhat earlier than other ducks, in May, and immediately begins to build nests. Moulting occurs at the end of July and August, but there is no data on places of concentration. It departs in mid-September.

Mallard *Anas platyrhynchos*
A nesting bird occurring in great numbers in suitable biotopes all over the country. The southern border of the breeding area of this duck passes through the south of Mongolia. This species is not so conspicuous as the two preceding ones, but it is probably the most numerous duck nesting in Mongolia. It arrives in the second half of April, nests in May and June, and begins to depart in mid-August, continuing to do so through September. It is very numerous on passage, as the flyway of Mallard coming from the north leads through Mongolia.

Gadwall *Anas strepera*
Nests in relatively large numbers in the northern and eastern part of the country, somewhat scarcer in the west. Passage and nesting times as for the Mallard.

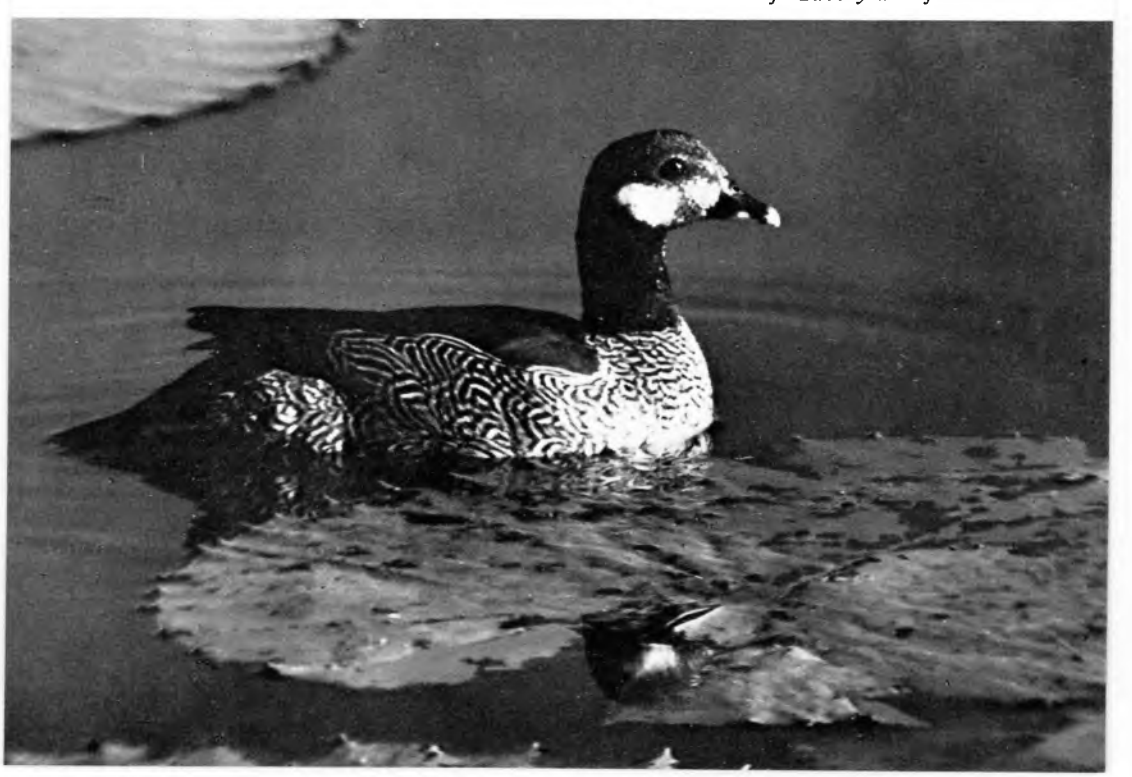
Garganey *Anas querquedula*
Teal *Anas crecca*
Both species nest in scattered pairs all over the country, but in somewhat greater numbers in the north. The periods of passage and nesting are the same as for the Mallard, but the Garganey comes back to the nesting places in spring as one of the last water birds.

Shoveler *Anas clypeata*
Somewhat less numerous than the Gadwall as a nesting species; appears in the entire country excepting the Gobi. The southern border of their range passes through Mongolia. The periods of migrations and breeding as for the Mallard.

H. J. Lavery and J. G. Blackman

Plate VII. The two pygmy geese of northern Australia. (a) Green Pygmy Goose *Nettapus pulchellus* dabbles for food on the surface of deep water. (b) Australian Pygmy Goose *Nettapus coromandelianus albipennis* feeds like the Green, but the species' centres of distribution are in different areas of northern Australia. (See pp. 69-77). Both these weak-legged species make great use of waterlily leaves for much behaviour.

H. J. Lavery and J. G. Blackman



Philippa Scott

Plate VIII. (a) Common Eider *Somateria mollissima mollissima.* (b) American Eider *S. m. dresseri* showing the larger extent of the shield and the incipient bumps on the back. The latter race is a recent addition to the Slimbridge collection.

Philippa Scott

Chinese Spotbill *Anas peocilorhyncha zonorhyncha*
Falcated Duck *Anas falcata*
Wigeon *Anas penelope*
All three species nest only in small numbers; the Wigeon, however, is fairly numerous on passage.

Baikal Teal *Anas formosa*
Pintail *Anas acuta*
Both species are seen only on passage.

Red-crested Pochard *Netta rufina*
The Red-crested Pochard is the most commonly nesting pochard, but none attain the numbers of the Mallard, Ruddy Shelduck or Common Shelduck. Breeding is patchy, most numerous probably in the west. The northern limit of the Red-crested Pochard's breeding area passes through Mongolia. It comes in April and at the beginning of May and immediately starts nesting. At the end of June large flocks of moulting Red-crested Pochards are seen in the west. They depart at the beginning of September.

Pochard *Aythya ferina*
Tufted Duck *Aythya fuligula*
Ferruginous Duck *Aythya nyroca*
All three species nest in small numbers; the most frequent being the Pochard. The first two species nest all over the country, the third only locally in the west. The passage and nesting is similar to the Red-crested Pochard, except that the Tufted Duck comes somewhat later than the other species.

Scaup *Aythya marila*
Baer's Pochard *Aythya baeri*
The first species rarely passes through Mongolia, and the presence of the second has so far not been ascertained but is probable.

Goldeneye *Bucephala clangula*
Mandarin Duck *Aix galericulata*
Both species nest very rarely in Mongolia, in particular the second. The first is more often seen on passage.

Harlequin Duck *Histrionicus histrionicus*
A rare bird of passage.

Asiatic White-winged Scoter *Melanitta fusca stejnegeri* (syn. *M. stejnegeri*)
Rare, on passage. There are unconfirmed reports that it sporadically nests in the north-west. Also requiring confirmation are reports of migrating Velvet Scoter *M. f. fusca* and of Common Scoter *M. n. nigra* and of Eiders *Somateria* spp.

Goosander *Mergus merganser merganser*
Nests in fairly appreciable numbers all over the country. It comes in April, breeding in May and June. Flocks of moulting birds gather on the great lakes in July and August. They depart in September.

Red-breasted Merganser *Mergus serrator*
Smew *Mergus albellus*
Birds of passage. There is still no Red-breasted Merganser specimen in collections acquired in Mongolia; it is not yet excluded that it nests sporadically.

Coot *Fulica atra atra*
Among three species of rails breeding in Mongolia, the Coot is the most common, nesting in great numbers on all waters all over the country. It is somewhat less frequent on brackish waters, probably only because these lakes have a poorer vegetation. Despite being widespread it does not attain the numbers of the most common duck species in Mongolia. It comes at the beginning of April and in May, nests in June, and departs in September.

Waders

The order of waders (Limicolae) is one of the less studied groups in the Mongolia avifauna. There are relatively few data on the numbers of the various species, and only lists, divided into breeding and non-breeding species, can be provided.

A — Breeding species
Little Ringed Plover *Charadrius dubius curonicus*
Kentish Plover *Charadrius a. alexandrinus*
Geoffrey's Plover *Charadrius leschnaultii*
Oriental Plover *Charadrius varedus*
Dotterel *Eudromias morinellus*
Lapwing *Vanellus vanellus*
Temminck's Stint *Calidris temmincki*
Asiatic Dowitcher *Limnodromus semipalmatus*
Redshank *Tringa totanus eurhinus*
Marsh Sandpiper *Tringa stagnatilis*
Green Sandpiper *Tringa ochropus*
Wood Sandpiper *Tringa glareola*
Grey-rumped Sandpiper *Tringa brevipes*
Common Sandpiper *Tringa hypoleucos*
Terek Sandpiper *Xenus cinereus*
(This species was hitherto considered to be a bird of passage, but according to Bold (1966) it nests rarely in the north.)
Black-tailed Godwit *Limosa limosa melanuroides*
Bar-tailed Godwit *Limosa lapponica baueri*

Common Curlew *Numenius arquatus*
Eurasian Woodcock *Scolopax rusticola*
Common Snipe *Gallinago g. gallinago*
Great Snipe *Gallinago media*
(So far not ascertained, recently it has spread widely in Eastern Siberia, so its appearance in Mongolia is very probable.)
Swinhoe's Snipe *Gallinago megala*
Solitary Snipe *Gallinago s. solitaria*
Black-winged Stilt *Himantopus himantopus*
Avocet *Recurvirostra a. avosetta*
Eastern Collared Pratincole *Glareola maldivarum*

B — Non-breeding species

Painted Snipe *Rostratula b. benghalensis*
Ringed Plover *Charadrius hiaticula*
Mongolian Plover *Charadrius mongolus*
Asiatic Golden Plover *Pluvialis dominca fulva*
Golden Plover *Pluvialis apricaria*
(A species so far not included in Mongolia's fauna; in September 1959, near the locality of Sachoi Sarai, Transaltai Gobi, Mr. Bold shot for Professor Dementiev a bird which was identified as a Golden Plover; the prepared specimen was, however, lost from the collection of the Ulan Bator University.) The presence of this species in Mongolia needs confirmation.
Grey Plover *Pluvialis squatarola*
Turnstone *Arenaria interpres*
Little Stint *Calidris minuta*
Red-necked Stint *Calidris ruficollis*
Long-toed Stint *Calidris subminuta*
Sharp-tailed Sandpiper *Calidris acuminata*
Dunlin *Calidris alpina sakhalina*
Curlew Sandpiper *Calidris ferruginea*
Knot *Calidris canutus*
Ruff *Philomachus pugnax*
Broad-billed Sandpiper *Limicola falcinellus*
Spotted Redshank *Tringa erythropus*
Greenshank *Tringa nebularia*
Far-eastern Curlew *Numenius madagascariensis*
Whimbrel *Numenius phaeopus variegatus*
Little Whimbrel *Numenius minutus*
Pintail Snipe *Gallinago stenura*
Jack Snipe *Lymnocryptes minimus*
Red-necked Phalarope *Phalaropus lobatus*

Waterfowl hunting regulations in Mongolia

The open season lasts from 15th August to 15th May, but will probably soon be shortened to end on 30th April. Waterfowl are not named by species in the law, but in general only geese and, to a lesser extent, ducks are hunted. Coots are pursued with great reluctance and waders not at all. Whooper and Bewick's Swans, along with pelicans, the Great White Heron *Egretta alba* and the Spoonbill *Platalea leucorodia* are fully protected by law.

In principle there are no professional hunters in Mongolia, as there are in the eastern parts of the Soviet Union. Hunters voluntarily become members of the Hunting Society of the Mongolian People's Republic (Mongolyn Ancdyn Nijgemlegijn Tow Zowlol—abbreviated MANTZ—founded in 1958) and then automatically receive a licence to hunt any form of game provided they are at least 14 years old and have given evidence of hunting ability. There is an inscription fee of 5 tugriks and an annual fee of 12 tugriks (6 tugriks = $1 U.S.). Members of the Society, now numbering 30,000 and increasing every year, undertake both 'industrial' hunting—involving the sale of game and skins to the State—and sport hunting for their own purposes. The Society lays down general plans, for the taking of game and skins, which are fulfilled by local hunting collectives. In the case of certain especially good and active hunters the State purchasing centres may establish contracts for the delivery of specified amounts of game or skins. The issue of membership cards is controlled by the regional boards of the Society in samons (townships). There is provision for the issuing of temporary licences to Mongolians who are not members of the Society (several thousand at 7 tugriks a month) and to foreigners (at 13 tugriks a week). In Mongolia there is no private ownership of land and licences are valid throughout the aymak of residence, though this restriction may be eased or abolished. Temporary licences are always restricted, even to the samon in which it is issued. Annual licence fees are retained by the Society and are used in the implementation of its statutory tasks. Of temporary licence fees the Society retains 10%, the rest going to the State.

Hunting is forbidden at night but otherwise there are no temporal restrictions within the open season and there are no bag limits. The use of poison in hunting is forbidden. Certain hunting methods such as the use of live decoys, artificial decoys, bird calls, flight netting, projectile nets, duck decoys and artificial lights are forbidden but are in fact techniques which are in any case not used. The use of punt-guns and of baiting is unknown in Mongolia and the legislation

makes no provision regarding them. Two hunting methods, forbidden in a number of countries, are permitted in Mongolia, namely the use of covered butts and of motor boats in direct pursuit of game. In practice the latter method is not used as there are few outboard motors available.

It is the Council of Ministers that issues legislation on hunting and on conservation after examination by the Great Horal (Parliament). The Main Forest Administration, Hunting Section, is responsible for the enforcement of hunting legislation. There is no corresponding organisation for conservation legislation which therefore remains the direct responsibility of the Council of Ministers. The local authorities supervise the application of legislation at aymak and samon level.

The extent of waterfowl hunting

The State only purchases game for meat in the winter. This is because the use of refrigerators is not yet widespread. As waterfowl have left Mongolia by the winter, this effectively means that there is no market-hunting of waterfowl. As in the past, the meat of birds plays little part in the diet of the Mongolians and it is estimated that only between ten and twenty thousand waterfowl are probably shot each year. A considerable part of these is accounted for by foreigners working in Mongolia. Rather more than half the kill is of geese, the rest almost entirely duck. Compared with the numbers of waterfowl present in Mongolia these figures are insignificant. For instance, it has been calculated by Mr. A. Bold that in the southern part of Lake Khara-us-nur 5,000 geese and 15,000 ducks could be taken every year without impairing the local population.

Acknowledgements

The International Wildfowl Research Bureau's invitation to co-operate was favourably received by the Director of the Institute of the Academy of Sciences of the Mongolian People's Republic, Dr. O. Sagdarsuren, who was a former pupil of the late Professor G. P. Dementiev. He and his colleague, Mr. A. Bold, and Mr. J. Das of the Ministry of Forestry's Hunting Administration, offered me much information on the waterfowl of their country. This consisted mainly of oral information on recent ornithological investigations and of translations from the Mongolian language into Russian of publications and unpublished manuscripts, including extensive reports on scientific expeditions. In addition my informants prepared a synthesis of information, published and unpublished, on the waterfowl of Mongolia.

I am most grateful to my Mongolian colleagues for this assistance and I am also indebted to the Polish Chargé d'Affaires in Ulan Bator, Mr. S. Jawdoszuk, for his assistance in carrying out my mission.

Summary

The main physiographic features and waterfowl habitats in Mongolia are described, also the, relatively small, impact of Man on the birds. Data on the distribution and times of breeding and migration of each species are provided. The hunting regulations are set out and it is concluded that the kill is insignificant compared with the numbers present, which make Mongolia one of the major producers of waterfowl in Asia.

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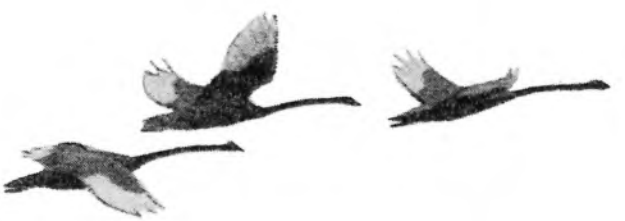

The comparative ecology of waterfowl in north Queensland

H. J. LAVERY

Introduction

While the ecology of waterfowl in temperate Australia has been investigated by Frith (e.g. 1961), less is known about the tropical species. Indeed relatively few studies have been made on waterfowl in the tropics. From 1958 to 1964, therefore, detailed investigations were made on each of the species of Anatidae occurring in Queensland north of the Tropic of Capricorn.

These investigations have been the subject of a series of detailed papers (Lavery 1966a, b, c, d; 1967a, b, c, d, e; 1969a, b; 1970a, b, c, d; Lavery *et al.* 1968). The present paper seeks to summarise this work and to point out the main ecological conclusions that can be drawn from it.

The study region (outlined in Figure 1) is that around Townsville (19°18′S., 146° 49′E.) from Ingham extending 200 miles south-eastwards to Bowen and westwards to Powlathanga, approximately 100 miles inland across the Great Dividing Range, which was used to separate the region into Coastal and Inland areas.

The species studied

Fifteen species inhabited the study areas during the period of investigation. Four were vagrants, namely: Black Swan *Cygnus atratus*, Chestnut-breasted Teal *Anas*

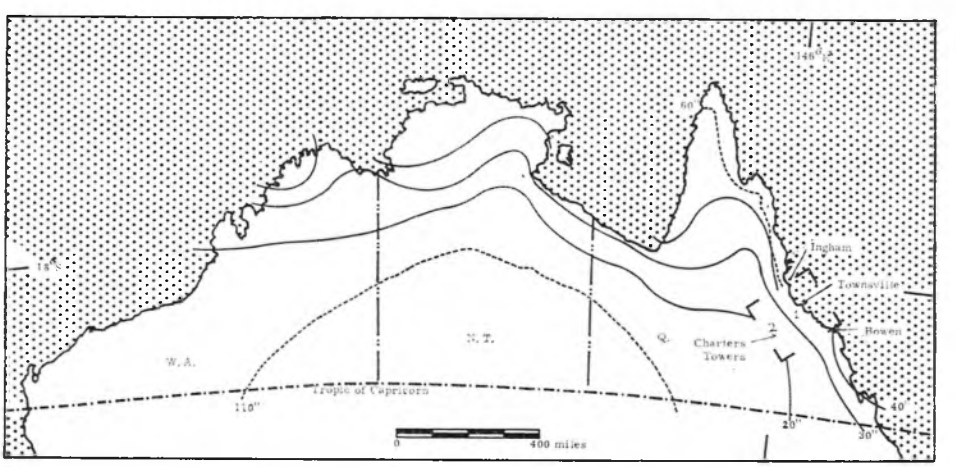

Figure 1. Map of northern Australia showing locations of Coastal Study Area (1) and Inland Study Area (2) and relationships of these to rainfall (—) and evaporation rates (- - -).

castanea, Australian Shoveler *Anas rhynchotis rhynchotis* and Freckled Duck *Stictonetta naevosa*, with only the Black Swan breeding at a few new artificial wetlands. One species, the Australian Black Duck *Anas superciliosa rogersi*, was found nesting throughout the region. The rest fell predominantly into two breeding groups, inland and coastal. The inland breeders were Australian Grey Teal *Anas gibberifrons gracilis*, Pink-eared Duck *Malacorhynchus membranaceus*, Australian White-eyed Duck *Aythya australis* and Maned Goose *Chenonetta jubata*. The coastal breeders were Magpie Goose *Anseranas semipalmata*, Plumed Whistling Duck *Dendrocygna eytoni*, Australian Wandering Whistling Duck *Dendrocygna arcuata australis*, Australian Radjah Shelduck *Tadorna radjah rufitergum*, Green Pygmy Goose *Nettapus pulchellus* and the Australian Pygmy Goose *Nettapus coromandelianus albipennis*. The last named has such a limited distribution that comparative studies involving it could only be undertaken in north-eastern Queensland. (Plate VII, p. 64.)

The English names are those used by Scott (1961). However, other vernacular names are preferred in Australia, particularly for the Whistling Ducks. Lavery (1965) proposed the names Grass for the Plumed and Water for the Australian Wandering Whistling Ducks.

Habitat

Within the study region there were 161 separate localities frequented by waterfowl. These can be grouped as nine habitat types (Table I), essentially similar to those in southern Australia (see, for example Frith 1961). The greater part of the habitat was available only seasonally. The rainfall of the tropics is regular, 80% occurring during the late summer (November-April), emphasising the changes in wetland acreage. Rather surprisingly the decrease during the dry season was more marked in the artificial wetlands (mainly cattle watering impoundments) which lost 95% of the 6,585 acres; natural wetlands only lost 70% of 4,725 acres. In most parts of northern Australia the inland areas show the greatest loss, having lower rainfall and higher evaporation rates (Figure 1).

The coastal breeding species have phylogenetic affinities with the largely tropical forms, for example Dendrocygnini and Cairinini, while the remaining species have affinities with the largely temperate-zone forms, for example Anatini. The peculiar but common Magpie Goose (Anseranatini) of northern Australia was more or less confined to the bulkuru sedge *Eleocharis dulcis* swamps which were the largest single areas of waterfowl habitat in the tropics. On the other hand, the uncommon Radjah Shelduck, with temperate-zone Tadornini affinities, occupied no widespread habitat type. The widespread distribution of the Black Duck suggests the potentially more aggressive and successful nature of temperate-zone forms; nevertheless the Black Duck in northern coastal Queensland remained dispersed and utilized marginal habitat types such as creeks. The Black Swan in recent years has also invaded brackish-water swamps of coastal club rush *Scirpus littoralis* on impounded saltpans while the Grey Teal has increasingly invaded inland breeding grounds formed by stock watering dams.

Table I. Waterfowl habitat types, their abundance and seasonal fluctuations, in the north Queensland study areas.

Type	*Permanency and water nature**	*Number of localities*		*Total acreage*	
		Inland	*Coastal*	*Wet (April)*	*Dry (November)*
Grassland	P.	—	8	200	200
Lake	P. F. St. D.	3	—	1225	620
River	P. F. R. D.	6	6	135	75
Lagoon	P. F. St. Sh.	14	35	595	310
Bay	P. S. Td. D.	—	1	2	2
Tidal Flat	P. S. Td. Sh.	—	4	100	100
Creek	T. F. R. Sh.	3	6	6	3
Swamp	T. F. St. Sh.	11	60	8940	430
Meadow	T. F. St. Vsh.	—	3	7	—
Saltpan	T. S. St. Sh.	—	1	100	—
		37	124	11310	1740

* Temporary (T) or Permanent (P); Fresh (F) or Saline (S); Static (St.) or Running (R) or Tidal (Td.); Deep, >10 ft. (D), Shallow, <10 ft. (Sh.) or Very Shallow, <2 ft. (Vsh.).

Breeding

In north Queensland waterfowl nest almost entirely during and immediately following the wet season (Lavery *et al.* 1968).

Within the breeding ranges all species, with the exceptions of the colony-nesting Magpie Geese and Black Swans, were widely distributed and intermingled on the almost unlimited breeding grounds, having similar simple nesting requirements.

In nearly all species except the longer-maturing Magpie Geese and Black Swans, most pairs laid eggs annually and did so repeatedly within each year until a single clutch was successful or until breeding conditions ceased to be suitable. The timing of reproduction in all instances coincided with a number of factors obviously important for success which developed with the rains. These were water depth, percentage of vegetation cover and food production (measured by the number of awnless barnyard grass *Echinochloa colonum* seed heads per square yard). All these, and gonad size, increased sharply with the rains. The relation between the last two for the Wandering Whistling Duck and the Black Duck over a number of years is shown in Figure 2. A severe drought, such as that

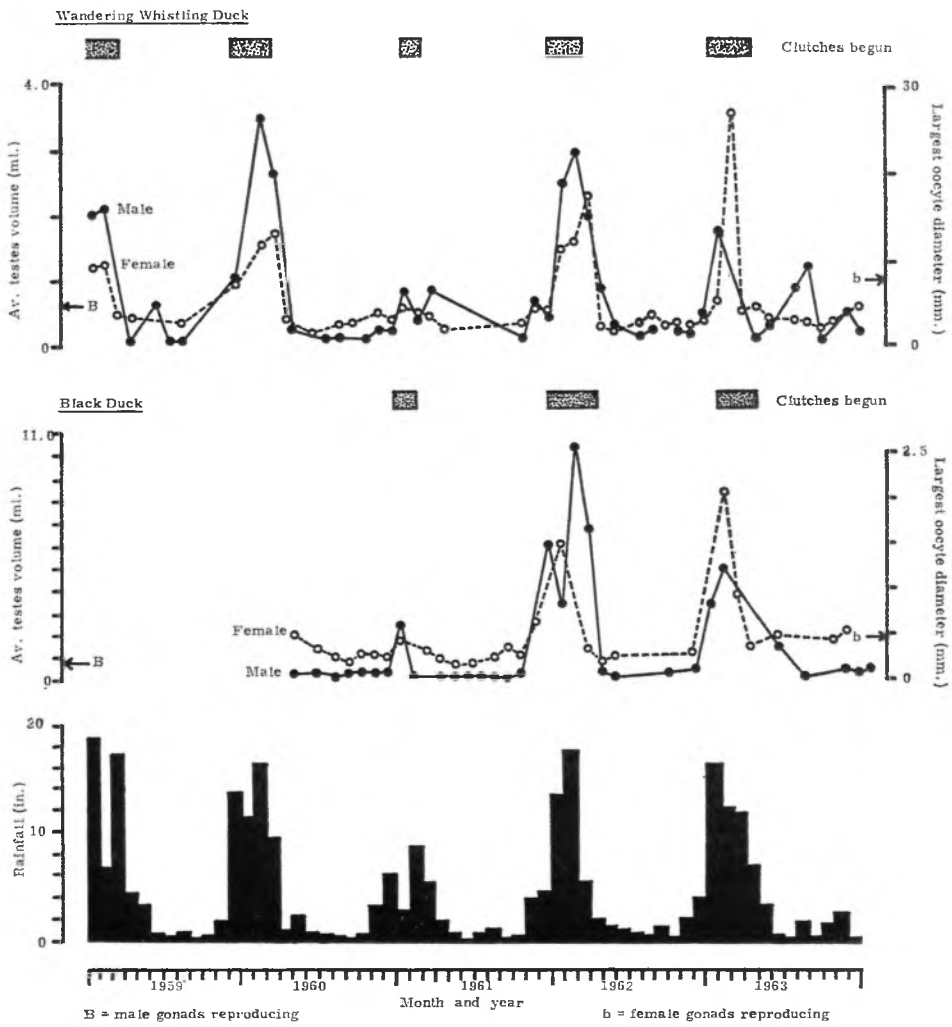

Figure 2. Relationship of reproduction of Wandering Whistling Ducks and Black Ducks to rainfall in north Queensland study areas, where 1961 was a year of severe drought (after Lavery 1970a).

experienced in 1961, results in the absence of any of these favourable factors and in the complete cessation of reproduction.

Clutch sizes varied somewhat from year to year. Thus for 1961, 1962 and 1963 the Black Swans averaged 3.50±0.38 (24 clutches); 5.12±0.24 (58 clutches); and 4.25±0.18 (101 clutches). The 1961 clutches were significantly smaller (P= 5%). The Black Swan and the other colonial breeder, the Magpie Goose, tended to fledge a higher proportion of the young hatched than did the solitary-nesting Wandering Whistling Duck and Black Duck (Table II). However, the colonies were sometimes completely destroyed by flooding. Thus after four inches of overnight rain on 25th February 1962, 20 out of 32 Magpie Goose nests forming a colony at Thornley Park, Townsville, were abandoned. The remainder, all floating, were saturated and eventually these were also abandoned.

The growth curves of the above four species were also investigated by using birds raised under aviary conditions at Townsville. The three northern species reached fledging in rather similar times; Magpie Goose in 76 days (20 birds), Wandering Whistling Duck in 98 days (two birds) and Black Duck in 100 days (three birds). The southern Black Swan, however, did not take flight until 171 days (two birds).

Table II. Reproductive success of some waterfowl species breeding in north Queensland, 1959-63.

	Young downy broods		*Old flapper broods*		
Species	*No. examined*	*Average size*	*No. examined*	*Average size*	*Ratio*
Magpie Goose	3	8.67±1.67	11	5.82±0.87	0.67
Wandering Whistling Duck	26	10.66±0.65	14	4.64±0.89	0.44
Black Swan	40	4.38±0.24	11	4.09±0.46	0.93
Black Duck	21	6.95±0.52	5	2.00±1.06	0.29

Movements

Parents which had nested in grasslands led their young to the adjacent temporary wetland habitat for feeding. Sooner or later these evaporated, causing birds, including the young which were mostly fledged, to move again. The major habitat utilization change then was from swamp to lagoon type. This was studied by means of fortnightly counts, supported by some band recoveries.

Concurrently, the numbers of inland-breeding and vagrant waterfowl were increased by flocks from southern Australian populations. The sizes of these influxes were related to breeding and post-breeding conditions there, and were readily discernible from resident population patterns. Thus the White-eyed Ducks in June 1969 soared to approximately 1,800 birds, whereas the usual population was less than 200. Many of these nomadic flocks continued to move through north Queensland along fairly well-defined paths (Lavery 1966b).

Parasites and predators

Parasitism and predation are liable to increase when birds become concentrated. For the Black Duck (collected 1959-63) 13 out of 42 of those taken in the wet seasons had intestinal helminths, while 102 out of 143 collected in the dry seasons were similarly parasitized, i.e. relatively more than twice as many.

Various parasite groups occurred on and in all waterfowl species and many of these parasites had specific hosts (Lavery 1967a). High incidences of certain potentially debilitating forms, such as intestinal helminths, were probably a consequence simply of the hosts' feeding habits in relation to the parasites' life cycles (Table III). Thus deep-water divers were most prone to infection.

Natural predators were varied but uncommon and non-specific; these were thought to have little primary effect on the size of waterfowl populations.

The most extensive single method of predation was duck shooting. From 1952 to 1963 total annual harvests varied enormously, from none in years of extreme drought, such as 1961, and of flooding, 1953, to 100,000 - 150,000 birds in years immediately after those of widespread flooding when populations were largest and dispersed (1954). During 1963 an estimated 70,000 birds were harvested in north Queensland.

After investigating the proportions taken and numbers remaining, and the habits of both species and shooters, it was concluded that such harvesting had no

Table III. Incidences of intestinal helminths in common north Queensland waterfowl species collected in 1959-1963.

Host species	*No. of birds examined*	*No. of birds parasitized* No.	%	*Host species' main feeding habits*
White-eyed Duck	58	55	95	Deep-water diver; foods commonly include freshwater gastropod molluscs
Wandering Whistling Duck	221	193	87	Deep-water diver; foods include freshwater gastropod molluscs
Black Duck	160	100	62	Shallow freshwater dabbler; foods include gastropod molluscs
Magpie Goose	11	4	36	Shallow-water digger
Grey Teal	58	18	31	Shallow fresh- and saltwater dabbler
Maned Goose	22	3	14	Dry-land grazer
Australian Pygmy Goose	30	2	7	Deep-water dabbler
Plumed Whistling Duck	122	9	7	Dry-land grazer

Table IV. Foods of young Australian Wandering Whistling Ducks collected in north Queensland study areas, 1959-1963.

Food	*Percentage volume in various age groups (weeks)* 0-6	7-10	11-14
Number of gizzards examined	44	18	10
Plants (seeds)			
From temporary wetlands e.g. *Echinochloa colonum*	64.1	30.2	27.5
From seasonal wetlands e.g. *Polygonum lapathifolium*	33.5	57.5	61.0
From permanent wetlands e.g. *Nymphaea ?gigantea*	Nil	5.5	10.6
Animals (insects)	2.4	6.8	0.9

Table V. Major wet season food sources of waterfowl species commonly in north Queensland study areas, 1958-1964.

Species	*Number of gizzards examined*	*Food sources* *Plant family*	*Volume (%)*	*Frequency of occurrence (%)*
Magpie Goose	40	Cyperaceae	62.3	72
Plumed Whistling Duck	72	Cyperaceae	50.9	93
Wandering Whistling Duck	774	Gramineae	26.2	47
		Cyperaceae	17.4	54
Black Duck	26	Cyperaceae	81.2	81
Grey Teal	49	Cyperaceae	53.9	55
Australian Pygmy Goose	12	Hydrocharitaceae	37.0	8
		Cyperaceae	24.1	25

discernible effect on total population sizes within north Queensland (Lavery 1969a).

Foods

The young birds took some insects in their diets, increasing the proportion as they became more adept at catching these (Table IV). Otherwise the young and the adults of all species ate only aquatic foods, that is those inundated by water at least once a year; mostly plant seeds were taken and the plant species involved were all of those commonly occurring in tropical wetlands (Lavery 1970b). In the wet season there was little difference in the diets of the different species (Table V).

There was a seasonal change in diet from shallow water to deep water plant material during the dry season (Figure 3).

This involved major divergences of habit; specialized feeding methods became apparent and foods differed markedly (Table VI). The birds' movements and distributions were also different in consequence. Thus the Grey Teal showed successive peaks on swamp, lagoon and tidal flats each year (Figure 4).

Discussion

The characteristic ecology of all resident waterfowl species in north Queensland (i.e. coastal, inland and widespread species) was governed by their feeding habits during the prolonged dry seasons. Each species then ultimately became

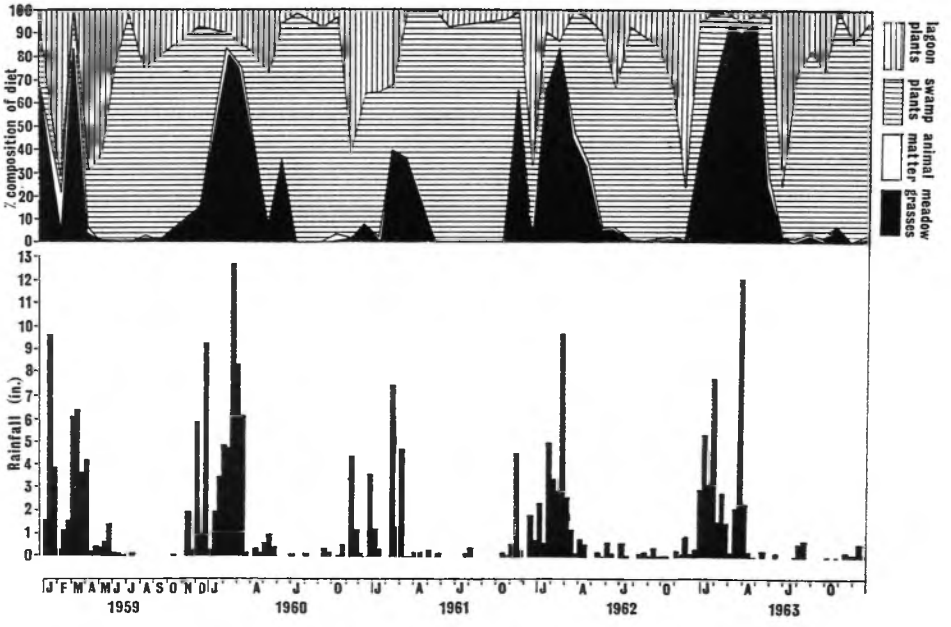

Figure 3. Seasonal diet of 1,087 Wandering Whistling Ducks from north Queensland study areas in relation to rainfall (after Lavery 1970b).

Table VI. Major dry season food sources of waterfowl species commonly in north Queensland study areas, 1958-1964.

Species	*Number of gizzards examined*	*Food sources* *Group*	*Volume (%)*	*Frequency of occurrence (%)*
Magpie Goose	40	Cyperaceae (tubers)	62.3	72
Plumed Whistling Duck	279	Gramineae	68.4	93
Wandering Whistling Duck	19	Gentianaceae	32.6	74
Black Duck	2346	Cyperaceae (seeds)	29.3	61
		Polygonaceae	24.6	33
Grey Teal	258	Gentianaceae	23.1	29
		Cyperaceae (seeds)	22.7	69
		Animal material	18.5	20
White-eyed Duck	214	Polygonaceae	25.5	33
		Nymphaceae	21.8	21
Maned Goose	46	Gramineae	60.7	88
Green Pygmy Goose	32	Nymphaceae	29.9	28
		Potamogetonaceae	11.2	25
Australian Pygmy Goose	77	Potamogetonaceae	53.9	43

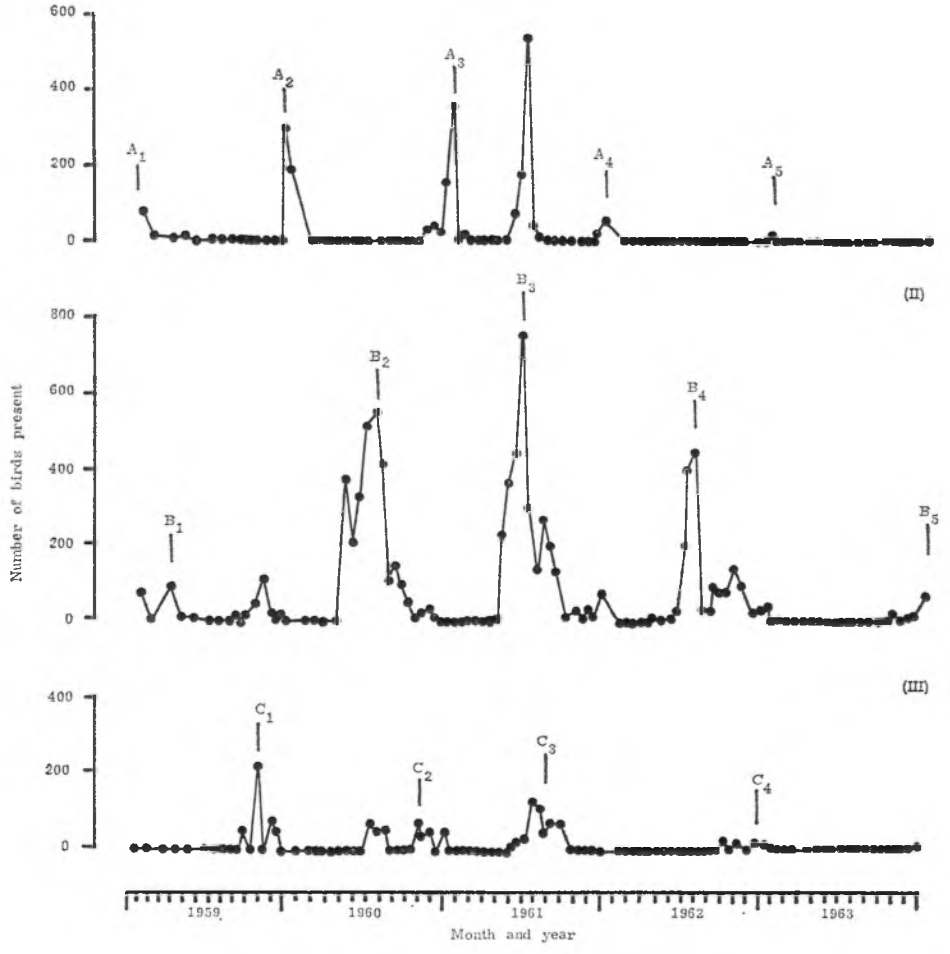

Figure 4. Numbers of Grey Teal counted fortnightly at (i) swamp, (ii) lagoon, and (iii) tidal flat habitat types in the Townsville district of north-eastern Queensland, 1959-63. Peaks (A, B, C) respectively show annual sequence of utilization by birds at these localities (after Lavery 1970c).

Table VII. Breeding ranges of the northern waterfowl species relative to dry season habitat types.

Dry season food habitat	*Species*	*Main breeding range*
Grassland/meadow	Plumed Whistling Duck	Coastal
	Maned Goose	Inland
	Black Duck	widespread
Lake/river/lagoon		
—sub-surface	Wandering Whistling Duck	Coastal
	White-eyed Duck	Inland
—surface	Australian Pygmy Goose	Coastal
	Green Pygmy Goose	Coastal
	Pink-eared Duck	Inland
	Black Duck	widespread
Tidal flat	Radjah Shelduck	Coastal
	Grey Teal	Inland
	Black Duck	widespread
Swamp		
—sub-surface (only coastal)	Magpie Goose	Coastal

isolated as a result of food specialization. Moreover, species closely associated in the dry season were least closely associated during reproduction in the wet season (Table VII). Breeding habitat was then sufficiently widespread to permit species of similar habits to nest over the whole of north Queensland and the birds became abundant. Later, all species had to utilize limited, mainly coastal habitat and invariably only one of each of the similar-habit species remained common. It is thus not surprising that inland species in north Queensland are generally less common than their coastal ecological counterparts. In this respect also it is noteworthy that the Green Pygmy Goose is distributed primarily in north-western Australia and the Australian Pygmy Goose occurs only in north-eastern Australia (Lavery 1966c; Frith 1967). This geographic subdivision occurs in other water birds; for example the Magpie Goose and the Brogla *Grus rubicundus*, both highly specialized to utilize bulkuru sedge, were likewise separated (Lavery and Blackman 1969). The existence of a 'Carpentaria Barrier', i.e. a barrier between the Flinders and Leichhardt Rivers blocking gene exchange among passerine species of the Torresian sub-region (Macdonald 1969), perhaps also applies to water birds.

These distributions can be used to indicate priorities for species' conservation. In northern Australia the coastal species should receive attention before the more aggressive cosmopolitan, inland and southern vagrant forms even though these may be less common at present. There is a danger that these latter species may eliminate completely the restricted northern species when they are likewise seeking refuge from drought. Such a situation is possibly already well under way (as a consequence of direct and indirect interference by man) between Grey Teal and Black Swan on one hand and the Radjah Shelduck on the other.

Because of its primitive and peculiar nature the Magpie Goose should be conserved before others; its management could most effectively be undertaken in north-western Australia rather than in north Queensland. The Radjah Shelduck should receive next attention but management anywhere to preserve this uncommon species may be rather difficult. In north-western Australia and north Queensland respectively the Green Pygmy Goose and Australian Pygmy Goose are of limited distribution and numbers, but both make important use of artificial habitat that is plentiful after rain. Wandering Whistling Ducks and Plumed Whistling Ducks also utilize this artificial habitat and are widespread in distributions and numbers at present. Habitat manipulation for any of these species will benefit the other Australian waterfowl that do not require perennial deep-water habitat, which is more or less confined to the temperate zone.

The fundamental divergence of feeding habits of Australian waterfowl has led elsewhere to other conclusions. For example it is generally supposed that the stresses which instigate divergent behaviour, such as competition for the obviously limited food supply, continue during drought, since the differences are maintained throughout a dry season. In north Queensland, evidence contrary to this conclusion was noted for species at drought refuges. Since the important artificial habitat referred to above is less permanent than the natural habitat (Table I), specific investigations related to conservation are being undertaken. The objectives are to determine the precise nature of, and the extent and causes of mortality at, an ultimate drought refuge in north Queensland.

Summary

Ecological investigations of all the waterfowl species occurring in north Queensland during 1958-1964 are reviewed.

Habitat types were similar to those of southern Australia but the area available varied more markedly between the well-defined wet season (November-April) and the prolonged dry season. Artificial wetlands, nowadays predominating, did not increase seasonal stability of the habitat.

Birds bred during most wet seasons in the coastal region (six species), in the inland region (four species) or throughout (one species). Habitat then was abundant and requirements for breeding and results of reproduction were similar.

Parents and fledged young moved from the temporary breeding habitat types to more permanent localities, mostly coastal, as wetlands evaporated in the dry seasons. Large concentrations occurred, with some readily discernible influxes of more distant breeding populations.

Populations were unaffected by either parasitism, disease, or shooting.

Habitat became extremely limited by drought and birds annually became isolated according to characteristic feeding habits. Such isolation provides the basis for practicable conservation priorities.

In north Queensland special care should be taken of four coastal species — the Radjah Shelduck *Tadorna radjah rufitergum*, Australian Pygmy Goose *Nettapus coromandelianus albipennis*, Wandering Whistling Duck *Dendrocygna arcuata australis* and Plumed Whistling Duck *Dendrocygna eytoni*. Artificial impoundments are used widely, but are less stable than natural habitat and the species may remain susceptible to drought.

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H. J. Lavery, Department of Primary Industries, Animal Health Station, P.O. Box 1085, Townsville, Queensland 4810, Australia.

The Auckland Islands Merganser

JANET KEAR and R. J. SCARLETT

Of the ducks that have become extinct within the last hundred years (Pink-headed Duck *Rhodonessa caryophyllacea*, Labrador Duck *Camptorhynchus labradorius*, Coues' Gadwall *Anas strepera couesi*, Auckland Islands Merganser *Mergus australis* and Crested Shelduck *Tadorna cristata*), only the Merganser inhabited the southern hemisphere. During the 60 or so years between the first and last sightings of living birds of this species, few observations were made or specimens collected. The most readily available account, in Delacour (1959), contains some errors and was not intended to be detailed. In addition, the illustration of the downy young in the same work is inaccurate. The object of this paper, like that of Salim Ali's on *Rhodonessa* (1960), is to review the literature, to consider the species' original distribution, and to list for future workers the specimens preserved in world museums.

Description

Adult (Plate XIIb, p. 97)

Sexes alike but males distinguished by their larger size, longer bill and crest, and some slight plumage characteristics. Head, crest and neck very dark brown with chin and throat somewhat lighter. Mantle, scapulars, back, rump and tail very dark bluish-black. Breast dull grey with a few lighter crescentic markings; remainder of lower surface grey and white except for the flanks which are uniform dark blue-grey. Wing-coverts slate-grey, like the sides of the breast, with the lower row darker and banded white. Middle secondaries white on the outer web and black on the inner web and tips. Primaries and inner secondaries black. Males are perceptibly more rufous in the plumage of the crown, and have two white wing bars instead of one (R. A. Falla pers. com.).

Iris dark brown. Culmen and tip of lower mandible black; cutting edge of upper mandible and rest of lower mandible yellowish-orange; legs and feet orange; joints and webs (above and below) dusky (Gray 1844-45; Hutton and Drummond 1905; Phillips 1926).

Males: wing 186-220 mm., culmen 60-61 mm., tarsus 42-44 mm., tail 85-90 mm., crest 5.6 mm., mid-toe 77 mm.

Females: wing 176-180 mm., culmen 53-55mm., tarsus 40-42 mm., tail 74 mm., crest 4.6 mm., mid-toe 56 mm. (Ogilvie-Grant 1905; Phillips 1926; Oliver 1955; Delacour 1959; and original).

Immature

A shorter crest or no crest at all, no crescentic markings on the breast; the middle of the lower breast and abdomen conspicuously white with few dusky mottlings (Salvadori 1895).

Downy young (Figure 1)

Dark, almost black, above with only a trace of pale wing, scapular and dorsal rump-spots. Chin, throat and upper breast rusty chestnut, with a spot of chestnut beneath the eye and no white streaking on the face. Remaining underparts yellowish-white. Bill dark olive, brown on the ridge and tip. Feet olive brown.

Distribution

When first collected by Monsieur Jacquinot in 1840 (Hombron and Jacquinot 1841), the Merganser was confined to the Auckland Islands (latitude 51°S. and 166°E., about 200 miles SSW. of New Zealand; 234 sq. miles in extent). However, a subfossil mandible was found in 1945 among ancient kitchen refuse (middens) of moa-hunting Polynesians at Wairau Bar, Marlborough, in the South Island of New Zealand. Seven years later a premaxilla and cranium were discovered among dune deposits, probably wind-blown from middens, at Lake Grassmere. A number of other subfossil limb bones, certainly attributable to *Mergus* and listed in Appendix I, have been found at or near the same sites, and on Stewart Island. Until more material is available the specific status of the New Zealand bones must remain in abeyance. The skull elements are virtually identical to recent material from the Auckland Islands. The measurements of two *M. australis* skeletons in the British Museum (Humphrey 1955) also compare well with those of mainland limb bones, except for the humerus (Museum number AV 19563). This has a length of 82 mm. compared with 70.9 mm. for the male and 67 mm. for the female *M. australis*. The greater

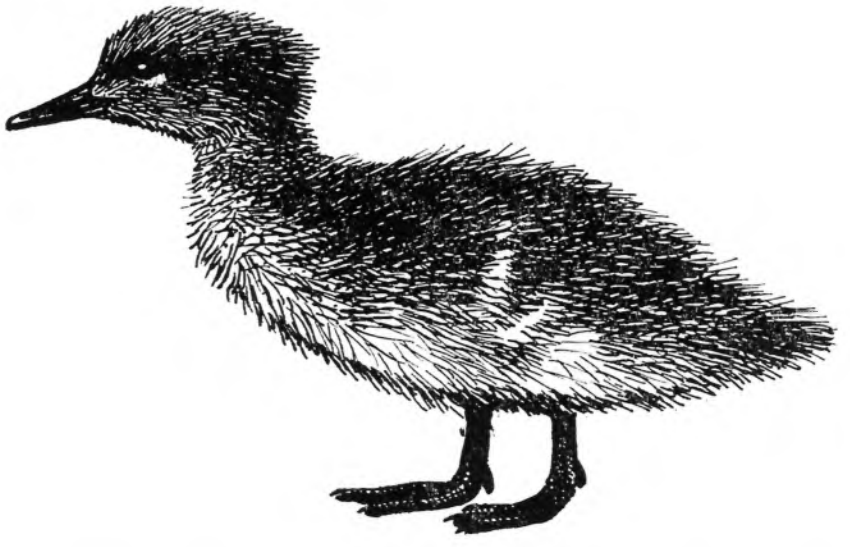


Figure 1. The downy young of *Mergus australis*. Drawn by Peter Scott from photographs of the skins in the Canterbury Museum and the American Museum of Natural History.

length suggests that the New Zealand form may have been a larger bird, possibly ancestral to the Auckland Islands species.

Figure 2 shows the localities in New Zealand and adjacent islands from which *Mergus* has been reported. Oliver (1955), quoting McCormick (1842), stated that Mergansers had also occurred on Campbell Island, 200 miles east of the Aucklands. Westerkov (1960) found McCormick's wording, that the water birds of Campbell Island 'consist of a New Zealand species of duck, a Merganser, a species of *Phalacrocorax* . . .' insufficient evidence that the Merganser ever existed and thought it resulted from confusion with Mergansers seen on Auckland Island. It is certain, in any case, that the species had not the very restricted distribution sometimes suggested (Johnsgard 1968).

Food and habitat

Information on the normal habitat of the bird is scanty. Captain J. Bollons (in Waite 1909) had not seen the bird on the coast, but had found it occasionally at the head of the estuaries and especially on the island watercourses 'picking about in the creeks'. J. S. Myers (quoted in Phillips 1926) also thought the bird an inland species, occurring on the considerable rivers of the interior and rare on the coast. Hutton and Drummond (1905), on the other hand, called it New Zealand's only sea duck, although 'it does not frequent the coast and open waters but only the sheltered harbours'. They instanced the occasion, presumably in January 1901 (since Hutton was not on the second trip in January 1902 (Ranfurly unpub.)), when Lord Ranfurly was collecting birds in the Auckland Islands and an old drake Merganser flew out from the shore to the steamer where it was anchored close in for the evening. It settled on the water within a few yards of the vessel and swam calmly about 'quacking like a domestic duck' (which suggests a misidentification of the sex, since in northern mergansers only the female quacks). The account of Reischek (1889), in which he recorded the sighting of six Mergansers, also suggests that they were near the coast, as he mentioned them in association with obviously marine birds. McCormick (1884) saw Mergansers in Laurie Harbour, at the north end of the main island, in November 1840. All the specimens for which a habitat is given came from Carnley Harbour, usually off the north shore of Adams Island, or the inlets along the eastern coast. Dr. R. A. Falla (pers. com.)

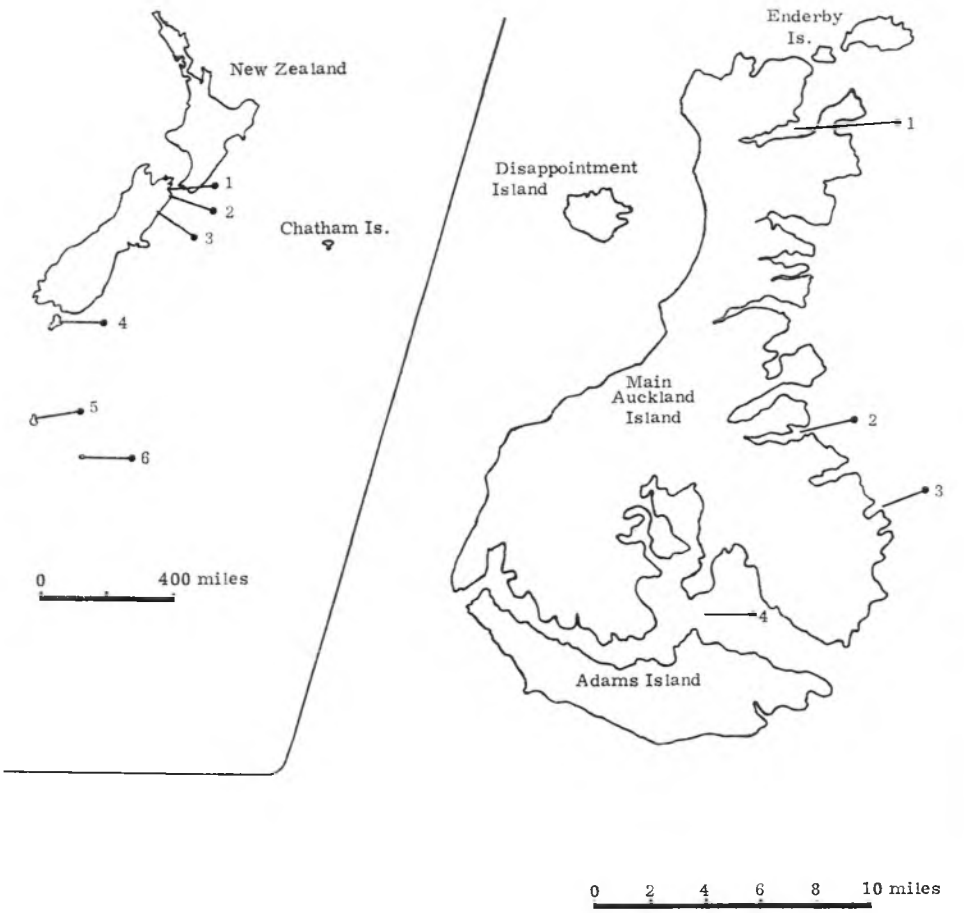


Figure 2. The distribution of subfossil bones of *Mergus*, and of *Mergus australis* records, in New Zealand and adjacent islands. In the left-hand map: 1. Wairau Bar, 2. Lake Grassmere, 3. South Bay, 4. Old Neck, Stewart Island, 5. Auckland Islands, 6. Campbell Island (reported by McCormick (1842)). In the right-hand map of the Auckland Islands: 1. Laurie Harbour, 2. Waterfall Inlet, now called Hanfield Inlet, 3. McLennan Inlet, 4. Carnley Harbour.

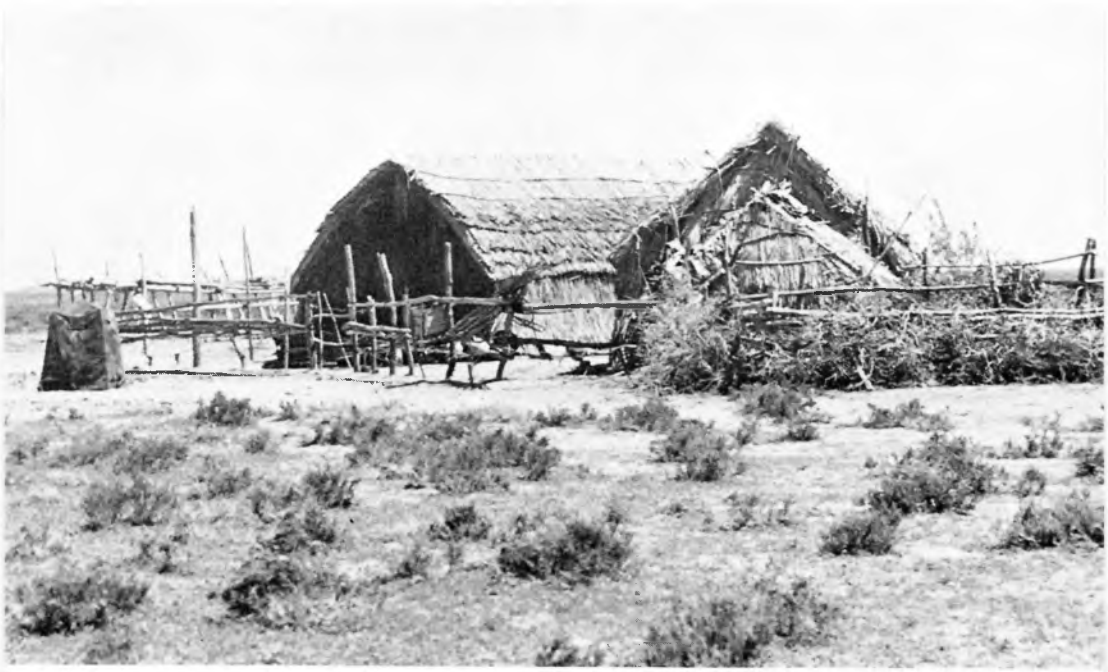
obtained precise locality data from Major Wilson who shot two Mergansers in 1891 in a steep gully which came to the sea through low forest. 'Wilson told me that he actually climbed up the stream bed for some distance and came across the two birds on a deep pool where the stream course was partly dammed on a rocky terrace. There is very high and year-round precipitation and the larger streams which come out in the heads of inlets debouch into estuaries of much reduced salinity, where Mergansers could get a range of suitable food. In general, I think the evidence for believing the Merganser a marine species is very tenuous.'

Almost the only clue to the food of the Merganser is the repeated statement that it took freshwater shrimps (Phillips 1926; Delacour 1959; Greenway 1967). Phillips and Greenway attributed the original report to Waite (1909) and Delacour to Wayne (undated). Waite (1909) made no reference to shrimps; he did however mention an earlier paper by Hutton (1902) which described an Auckland Islands fish *Galaxias bollansi* (= *brevipennis*) 90 mm. long and 14 mm. wide, taken from the mouth of a Merganser in January 1901, and assumed to be marine. Waite thought a marine habitat unlikely and quoted Bollons (after whom the fish was named) as saying that he had never seen the duck feeding close to the sea. Hutton and

M. L. Gorman

Plate IX. Extremes of family care. (a) A 'crêche' of Common Eider ducklings looked after by just two females. (b) Brood of Chiloe Wigeon *Anas sibilatrix* defended against an immature male Common Eider by both parents. In most duck species, particularly where the male is brightly coloured, he deserts the female early on in the nesting cycle.

Ray Stefanski



Brian Hawke

Plate X. Marbled Teal *Marmaronetta angustirostris* nesting in the marismas of the Guadalquiver, Spain. (a) Nests were found in the roofs of old huts. (b) Female on the roof of a hut. (See pp. 87-88).

Brian Hawkes

Drummond (1905) again stated that the Merganser was a fish-eater and added that it caught its prey by diving.

The gut of the preserved Auckland Islands Merganser at the British Museum contains only macerated fish bones, the mandibles of an errant polychaete (*Nereis*?) and an unidentified gastropod (P. J. K. Burton pers. com.). The presence of the polychaete tends to suggest a brackish water environment.

Breeding biology

The Auckland Islands Merganser showed a number of features, besides tameness, common to waterfowl isolated on relatively remote islands. There was no trace of a conspicuous male plumage (both sexes resembling the female Red-breasted Merganser *Mergus serrator* or Goosander *M. merganser*) and therefore no male eclipse. In body size the species was small; smaller than any other merganser. It also differed in having a more slender bill and shorter toes (Mathews and Iredale 1913; Humphrey 1955).

The pair bond may have been a long-term one, extending beyond the only recorded egg-laying period which, extrapolating from the date when 7- to 10-day-old ducklings were 'seized' (Chapman 1891), must have been at the end of November or beginning of December. Both parents were present when these ducklings were taken, and adult birds were apparently shot in pairs in October (R. A. Wilson 1959), in November (Hügel 1875), in January (Reischek 1889), and perhaps in May (Buller 1905) and July (Ogilvie-Grant 1905). No moulting specimens seem to have been taken. The nest site, the egg and the clutch size were never described. The only brood ever seen apparently consisted of four ducklings.

The downy duckling shows the same darkening and loss of pattern typical of other island species (for example Laysan Teal *A. platyrhynchos laysanensis* and New Zealand Brown Teal *A. aucklandica chlorotis*) when compared with their supposed ancestral types. The adaptive advantage of the normally patterned down is not entirely understood. Possibly it is disruptive and so helps in concealing the animals from ground and aerial predators.

Reasons for extinction

The disappearance of the Merganser from what was probably its centre, mainland New Zealand, can perhaps be ascribed to pre-European man, especially as *Mergus* bones have been found at middens of the moa-hunting Polynesians. Remains of four other extinct New Zealand waterfowl species are associated with early Polynesian artifacts, and hunting has usually been assumed as a contributing factor in their extinction (Williams 1964). Destruction of habitat by fire and the introduction of 'Maori' dogs and rats (Fleming 1962a, 1969) may also have taken their toll. Years of isolated evolution in a land with no mammals except seals and bats must have produced a 'tameness' and lack of guile that proved disastrous after ground predators arrived. Two adults shot in 1888 did not even attempt to dive to escape (Reischek 1889). The species was probably not without natural predators, even on the Aucklands. Rails may have taken eggs. Skuas, falcons and large fish, especially eels, might have taken ducklings. Sea lions were almost certainly predatory; unlike the other wildlife they were not 'tame'. One of them made a 'vicious attack' on Lord Ranfurly, and he and his party were out on a 'Lion Hunt' for a particularly dangerous animal when the last pair of Mergansers was shot (Ranfurly unpub.). Dr. R. A. Falla (pers. com.) believes that the only real hazard for young Mergansers would have been to spend too much time on water deep enough for sea lions to operate. They continue to take a large toll of the prolific shags, 'especially of immature birds early in their swimming and diving careers. As they cough up the indigestible feet and beaks I imagine that the serrated bill of the merganser would not have worried them.' The fact that the downy Merganser retained a pale belly while the upper parts darkened so much, perhaps indicates some value in camouflage from beneath. On the other hand, the simple counter-shading of dark above and light below may also have been adaptive to a fish-catching habit.

The Auckland Islands were discovered on 18th August 1806 by Captain Abraham Bristow and named after Lord Auckland, an English politician. The islands were granted by the British Government to a private company as a whaling station which was, however, abandoned in 1852. Other European and Maori settlements, numbering two or three hundred persons at times, were started on the main island but did not last long (McLaren 1948; Wright 1955); some inhabitants died of starvation in 1864 (Ranfurly unpub.). Pigs were introduced in 1807 (Waite 1909), sheep and goats later (Chapman 1891)

and mice came ashore with the many wrecks that occurred after sealing and whaling stations were established (Greenway 1967). Rats may have been introduced in the same way, although they are absent now (C. A. Fleming pers. com.). Sailing ships, which took the great circle route to Tahiti, also passed close and some came to grief on the rocks. There were three shipwrecked parties in the 1860's alone (R. A. Falla pers. com.). Reischek (1889), during his visit in January 1888, noted not only numerous rabbits but also wild dogs, and Lord Ranfurly's party in January 1901 shot 30 rabbits on Enderby Island and a couple of pigs on the main island. At the Earl's second visit in January 1902, the steamer brought a few men and one woman with three small children, one in arms. 'She had not the vaguest idea what she was going to and thought she would find shops on the Islands. Her husband at the time was alone there with a Maori looking after sheep. We also carried a cow, calves and some sheep' (Ranfurly unpub.). Cats likewise became fairly common after 1850 and are still widespread. Thus, Delacour's statement (1959) that the islands were seldom visited and, because no dangerous animals had been introduced, primitive life conditions were unchanged, seems unduly optimistic. However, the Merganser's last refuge, Adams Island, which has an area of 35 sq. miles and borders Carnley Harbour on the harbour's southern side, has always been uninhabited (Williams 1964), although sealers' huts seem to have existed (Chapman 1891). No predators were introduced as far as is known, but ships were wrecked there and, of course, mice and dogs do swim. Martin (1886) advised that the Aucklands be set aside as a reserve but it was by then probably too late to remedy the situation.

The total Merganser population was not great, even in pristine times. The main island has more than thirty suitable streams, many with waterfalls and terrace pools, a few even with small lakes along their courses. Adams Island has ten streams, more restricted in size and area, and no estuaries. From this, Dr. R. A. Falla (pers. com.) suggests that, with two or three breeding pairs on each watercourse, a few hundred birds all told would have been an optimum population under original conditions.

The Auckland Islands were probably at the extreme edge of the Merganser's range; it had reduced wings (Humphrey 1955) but, according to Hutton, could fly well. (The statement of Luther (1967) that it was flightless is an error, perhaps arising from Gray's curious use of *Nesonetta aucklandica* as a synonym for *Mergus australis* (Gray 1844).) On the islands it may have met conditions of climate or food supply to which it was relatively ill-adapted, and the isolated colony perhaps succumbed to 'natural causes', greatly accelerated by man's interference with the habitat. Populations of New Zealand Shoveler *Anas rhynchotis variegata* (Williams 1964) and Shelduck *Tadorna variegata* have likewise disappeared from the Chatham Islands (400 miles ESE. of New Zealand), although the species still hold their own on the mainland of New Zealand. The ultimate reason for the Merganser's extinction may well have been the relatively large number of individuals that was shot during 1901 and 1902.

A restricted food supply is another possible cause for the Merganser's extinction, since it had specialised feeding habits, although in Humphrey's opinion (1955) no more specialised than other mergansers. No other diving duck occurred in the Aucklands to provide competition (there is a doubtful record of the Blue Duck *Hymenolaimus malacorhynchus* (Waite 1909) which in any case failed to survive and is not a fish-eater). Plenty of fish-eating birds, especially cormorants, do occur however. *Galaxias bollansi*, the largest known food item, is found only in New Zealand and neighbouring islands, where recorded sizes range from 73 to 210 mm. (Regan 1905; Scott 1935). There is no record that its populations were low enough to affect the numbers of any predator, and all the streams are still well stocked (R. A. Falla pers. com.).

Nest sites are not likely to have been a problem. Other mergansers are either tree-hole nesters or build among rocks on the ground, and natural cavities of both kinds would be common on the Aucklands. However, if *M.australis* were a ground nester, and Humphrey (1955) had good reason to believe it was, the many introduced mammals would have been a real danger during the breeding season. Waite (1909) emphasised that 'there can be small doubt that the introduction of pigs to the Auckland Islands has already resulted in considerable havoc among the ground-nesting birds, by destroying both eggs and young'. There are areas on the main island which, because of difficulty of access, are pig-free, but with the worse hazard of cats, it is remarkable that

there were still Mergansers left to be shot in McLennan Inlet in 1901.

Origin of the species

The only other merganser in the southern hemisphere is the Brazilian *M.octosetaceus*, which, according to Johnsgard (1965), has an earlier origin than the northern species, with several unusual features. Here also the pair bond appears to be long and the sexes are alike, but both resemble the *males* of northern forms, having shiny green plumage. Ducklings have the incomplete breast band and streaked cheeks typical of all other mergansers except *M.australis*. The Auckland Islands species, on the other hand, is best thought of as an isolated derivative of a northern form which secondarily lost dimorphism and bright plumage in the drake. The Goosander, Chinese Merganser *M.squamatus* and *M.australis* are indeed very closely related — much more closely related to one another than to any of the other mergansers (Humphrey 1955). Humphrey based his assertion principally on the structure of the male trachea, but other features such as plumage characteristics, position of the nostril and skeletal proportions were also considered.

At present, *M.squamatus* in China most closely approaches New Zealand (although still many thousands of miles away). Unlike much of the native New Zealand avifauna, there is no suggestion that the Merganser arrived via Australia (Falla 1953; Fleming 1962b). Two of the seven present day indigenous waterfowl, New Zealand Scaup *Aythya novaeseelandiae* and the Blue Duck, likewise have no close relatives in Australia, and even the New Zealand Shelduck may more nearly resemble the species occurring in South Africa (Johnsgard 1965).

Specimens collected

Some 26 skins exist in ten museums and are listed in Appendix II. These include four ducklings and at least 12 males and nine females of which four may be juveniles in first plumage. Three nearly complete skeletons, various skeletal parts and one carcass in pickle are also available.

The first specimen was collected in 1840 (not 1839 as stated in Oliver (1955)) probably between 11th and 20th March (d'Urville 1846). There seems to be considerable disagreement about the date of the last sighting. Greenway (1967) gave 1901, while Jouanin (1962) wrote that the bird had not been collected or seen since the expeditions of Lord Ranfurly in 1901 and 1902. Fleming *et al.* (1953) stated that the bird has probably been 'extinct since 1905'. Fisher and Peterson (1964) and the I.C.B.P. list (1966) gave 1905 as the last record, while Delacour (1959), Howard (1964) and Johnsgard (1968) indicated that a bird was taken in 1909. Delacour indeed identified Waite as the 1909 collector. However, during his trip in 1907 he kept a sharp look-out but saw no Mergansers (Waite 1909), and no skin presented by him exists today in the Canterbury Museum of which he was Curator from 1906-14, in succession to Hutton. Edward Wilson visited the Auckland Islands in March 1904, with Captain Scott, on the *Discovery*'s return from Antarctica. During a fortnight's stay, he made an intensive study of the island's natural history and attempted to make as complete a collection of birds as possible. When the ship sailed, however, he had to note that none of the company had seen Mergansers (E. A. Wilson 1967).

After Waite's visit, the next thorough search seems to have been made in 1927 by Oliver (1955). Dr. R. A. Falla reports similar unsuccessful investigations by himself and fellow coast watchers from December 1942 to January 1944. It seems almost certain that the Merganser is extinct and the last sighting was either of a pair shot by Mr. Shattock on 9th January 1902 (Ranfurly unpub.), now probably skeletons in the British Museum, or of the specimen in the Dominion Museum, Wellington, labelled 'June 1902'. There is, however, some possibility that this latter bird was collected earlier.

Acknowledgements

The authors are especially grateful to the Earl of Ranfurly, for permission to examine his grandfather's diaries, and to Dr. P. J. K. Burton, who investigated the gut contents of the pickled Merganser at the British Museum. Particular thanks are also due to Dr. R. A. Falla who read the manuscript and suggested many improvements. Dr. P. S. Humphrey very kindly allowed the use of unpublished skeletal measurements. Others who were generous with unpublished information and photographs include Dr. K. Bauer, Mr. C. W. Benson, Miss J. M. Coldrey, Mr. J. Darby, Dr. E. Eisenmann, Dr. C. A. Fleming, Dr. R. Hertel, Mr. F. C. Kinsky, Dr. K. C. Parkes, Dr. G. W. Potts, Dr. J. Prevost and Dr. D. W. Snow.

Summary

The paper summarises what is known of the extinct Auckland Islands Merganser *Mergus australis*. It was a small, short-winged bird, with little sexual dimorphism except in size, distributed at one time in at least the south island of New Zealand, the Auckland Islands and perhaps Campbell Island. Its habitat seems to have been sheltered inlets and streams, and the principal item of diet was small fish. The egg-laying season included the period of November/December and the pair bond seems to have been a long-term one. The ducklings were dark in colour except for the belly and were unpatterned, as in many island forms. The species' extinction is considered to have been largely due to Man. Specimens taken between 1840 and 1902 and now housed in world museums are listed.

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Appendix I. Subfossil *Mergus* bones from New Zealand. (In the collections of the Canterbury Museum.)

AV 11600: Premaxilla from sand-dunes, Marfell Beach, Lake Grassmere, Marlborough. Coll: J. Britton, 1952.
AV 11532: Cranium, same site. Coll: R. J. S., 1952.
AV 12977: R. tarso-metatarsus, same site. Coll: R. J. S., 1952.
AV 13512: Two R. and one L. tibio-tarsi from moa-hunter midden, Old Neck, Stewart Is. Coll: R. J. S., 1954.
AV 13548: R. tibio-tarsus, same data.
AV 13649: L. tibio-tarsus from moa-hunter midden, Marfell Beach, Lake Grassmere. Coll: J. and R. Britton, 1954.
AV 14249: Part L. tibio-tarsus from moa-hunter midden, Wairau Bar, Marlborough. Coll: E. R. Eyles, c.1945.
AV 11007: Mandible, same data.
AV 1963: R. humerus from Maori settlement site, Te Hiku o te Waeroa, South Bay, Kaikoura, Marlborough. Coll: Canterbury Mus. Arch. Soc., 1963. (Probably the most recent bone, dated later than A.D. 1500.)

Appendix II. Specimens of *Mergus australis* in world museums.

Canterbury Museum, Christchurch, New Zealand.
Skin AV 1580 ♀ May 1894. Sir Walter Buller coll. (Probably the one mentioned in Buller (1905).)
Skin AV 1581 duckling 1891. (Probably taken by a crew member of N.Z.G.S. *Hinemoa* about 14th or 15th Jan. 1890 in Carnley Harbour from a cove in Adam's Island. Culmen 19.5 mm., tarsus 23 mm., mid-toe 28 mm., wing approx. 30 mm. Thought by Buller (1892) to be 7-10 days old. (Chapman 1891; Buller 1905).)
Skin AV 1583 Adult, no other data. (Wing 200 mm., culmen 61 mm., tarsus 44 mm., therefore a male. Toes missing. Shot 30th Oct. 1891 by R. A. Wilson (1959) either in Carnley Harbour (= Adams Island) or Waterfall Inlet. Given to E. F. Stead, and by him to Canterbury Museum on 14th Sept. 1920.)
Skin AV 2944 ♂ Jan. 1901. Earl of Ranfurly coll.
Bones AV 5716 pelvis, sternum and 3 caudal vertebrae ♂ Jan. 1901. Earl of Ranfurly coll. (Probably from Skin AV 2944.)
Bones AV 1582 part cranium, premaxilla, mandible and quadrate, no data.
Bones AV 7157 L. scapula and L. coracoid. (Labelled 'merganser', apparently by Hutton.)
Dominion Museum, Wellington, New Zealand.
Skin (mounted) DM 1357 June 1902. (The date is somewhat suspect since Buller in 1892 and again in 1896 and 1905 mentioned the 'good specimen in the Colonial Museum'. Wing 181 mm., culmen 54.2 mm., tarsus 44.5 mm., tail 75 mm. and toe 58.5 mm., therefore probably a female.)
Otago Museum, Dunedin, New Zealand.
Skin (mounted) A51.50 ♀ 1890. F. R. Chapman coll. (A specimen fully described in Buller (1905). Possibly collected in Jan. 1890, as were the ducklings, although Chapman (1891) stated that their mother escaped. Indeed, as the bird has almost no crest and a short tail, it seems to be a juvenile. Culmen 55 mm., wing approx. 177 mm., tail 69 mm., tarsus approx. 38 mm., mid-toe 56 mm.)

Spirit specimens A51.51 two ducklings 1890. F. R. Chapman coll. (Presumably siblings of AV 1581 in Canterbury and 744347 in New York (Chapman 1891).)

Otago Museum was also presented with a female specimen shot on 30th Oct. 1891 (R. A. Wilson 1959). This skin apparently no longer exists unless A51.50 is incorrectly attributed.

British Museum, London, England.

Skin 1875.11.6.14 Dec. 1874. Baron von Hügel pres. (Taken during the latter end of November 1874 by a man from (?) Invercargill. It is said to be a female and the mate of the bird in the Cambridge Museum (Hügel 1875; Sclater 1881; Buller 1888; Salvadori 1895). However, Dr. R. A. Falla thinks that on plumage characters and dimensions (wing 185 mm., culmen 57 mm.) it is a male.)

Skin 1901.21.57 ♀ 4th Jan. 1901 McLellands Inlet, Auckland Islands, Capt. Hutton coll. Earl of Ranfurly pres. (Ranfurly, unpub.; Ogilvie-Grant 1901, 1905). The date was probably 5th Jan., and the Inlet should be McLennan. Again Dr. Falla has noted the bird, wing 183 mm., culmen 61 mm., as a male.)

Skin 1901.21.58. All details as for 1901.21.57 above. (Wing 180 mm., culmen 55 mm., therefore female.)

Skin 1902.8.6.1 ♂ Lt. Kennett Dixon, R.N. pres. (Lt. Dixon was on board H.M.S. *Archer* which visited the Aucklands in July 1901 (Ogilvie-Grant 1905).)

Skin 1904.4.30.1 Lt. A. F. Stewart, R.N. pres. No other data. (Culmen 55.7 mm., therefore female but, according to Dr. Falla, has indeterminate plumage and could be young.)

Skin 1904.8.4.1 ♀ 9th July 1901 Carnley Harbour, Auckland Islands. Earl of Ranfurly pres. (The collector was apparently Commander J. P. Rolleston of H.M.S. *Archer* (Ogilvie-Grant 1905).)

Skeleton 1904.8.4.2 ♀ 9th July 1901 Carnley Harbour. Part of lower jaw missing. From skin 1904.8.4.1 above (Ogilvie-Grant 1905).

Skeleton 1904.8.4.3 ♂ Earl of Ranfurly pres. Part of legs missing. Trachea and bulla present. ((Ranfurly unpub.; Ogilvie-Grant 1905; Humphrey 1955). Probably shot on 9th Jan. 1902 near Carnley Harbour. A note says 'belongs to standing mounted specimen'; the skin has not been traced.)

Skeleton 1904.8.4.4 ♀ Earl of Ranfurly pres. Complete skeleton, neck vertebrae slightly shot. (Probably shot with 1904.8.4.3 above. A note says 'belongs to lying mounted specimen'; again the skin has not been traced, and no museum claims to have a lying mount.)

Carcass, skinned ♂. (A note states 'belongs to the one standing on the upright. Tibia and tarsus left in the stuffed specimen'.)

University Museum, Cambridge, England.

Skin Dec. 1874 Baron von Hügel pres. (Hügel 1875; Sclater 1881; Buller 1888). (Actually shot in Nov. 1874, male, the mate of 1875.11.6.14 in the British Museum; wing 193 mm., culmen 60 mm.)

Carnegie Museum, Pittsburgh, U.S.A.

Skin 24509 ♂ 1894. (This was purchased in 1905 with the 'Third Buller Collection', and is thought to be the adult male mentioned in Buller (1905). If so, it is probably the mate of AV 1580 at Christchurch. A separate tag bears Buller's no. 125.)

American Museum of Natural History, New York, U.S.A.

Skin 734364 ♂ no other data. (Original label in handwriting of the commercial collector Dannefaerd. (Buller 1905).)

Skin 734365 ♀ no other data. (Dannefaerd's label says 2/1895. (Buller 1905).)

Skin 734366 ♀ no other data. (Dannefaerd's label again says 2/1895. A note by R. A. Falla 5.8.66 says 'This is clearly a ♂'. (Buller 1905).)

Skin 734367 Dec. 1901 Travers coll. (Wing 192 mm., according to Dr. Falla, therefore a male.)

Skin 744347 duckling. (Presumably a sibling of AV 1581 in Canterbury and 151.51 in Otago (Chapman 1891; Phillips 1926).)

All these skins came from the 'Second Buller Collection' via the Rothschild Collection at Tring and according to Salvadori (1895) a male and female at Tring were immature birds in first plumage. Rothschild (1907) mentioned four specimens at Tring, one mounted and three skins.

Museum National d'Histoire Naturelle, Paris, France.

Skin (mounted) 360/1841 ♂ M. Jacquinot coll. (The type specimen, taken during the voyage of the *Astrolabe*, in March 1840 (Hombron and Jacquinot 1841, 1853; Gray 1844-45; Jouanin 1962).)

Naturhistorisches Museum, Vienna, Austria.

Skin ♂ 26th Jan. 1888 A. Reischek coll.

Skin ♀ 26th Jan. 1888 A. Reischek coll. (Possibly from Waterfall Inlet (Reischek 1889; Sassi 1940, 1947).)

Staatliches Museum für Tierkunde, Dresden, D.D.R.

Skin C 5730 ♂ 1874 Wing 190 mm., Carnley Harbour, H. Krone bought and pres.

Skin C 5731 ♀ 1874 Wing 185 mm., Carnley Harbour, H. Krone bought and pres.

Dr. J. Kear, The Wildfowl Trust, Slimbridge, Gloucester, GL2 7BT, England.
R. J. Scarlett, Canterbury Museum, Christchurch, N.Z.

The Marbled Teal

BRIAN HAWKES

In the summer of 1969 I paid a visit to the Marismas, the famous marshes of the Guadalquiver delta in south-west Spain, in order to photograph birds, among them the Marbled Teal *Marmaronetta* (= *Anas*) *angustirostris*.

I saw my first Marbled Teal in the bird market at Coria del Rio, a small town on the edge of the Guadalquiver delta, surely a strange place for an ornithologist to add to his life-list. White-headed Ducks *Oxyura leucocephala* were also being sold here. The birds are shot or trapped in the nearby Marismas.

There is plenty of ideal habitat for Marbled Teal in the Marismas. Very large areas are under water during the winter but the floods dry up in spring leaving smaller areas of shallow water with luxuriant growths of sedges *Carex* spp. and bulrush *Scirpus* sp. Here there is ample food for the birds and a safe area for rearing the young. The parts which dry out in summer are covered in glasswort *Salicornia fruticosa* and *Anthroznemum marcrastachyum*. Higher places in the *Salicornia* heath form islands in the winter floods, known locally as vetas. These have been colonised by sea blite *Suaeda maritima* and by various grasses and thistles. It is on the vetas that many species of birds, including waders, pratincoles, and ducks, breed.

Although the textbooks state that Marbled Teal generally nest in clumps of grass or reed, on the Marismas they often choose a more artificial site. On many of the vetas there are reed and grass huts and it was in the roofs of these that I found a number of nests. As I approached one veta, six Marbled Teal flew off and landed on some nearby water, where they swam about anxiously. I quickly found three nests in the roof of a hut. One was under a cowskin laid on the roof to dry, and had no less than 20 eggs. The other two nests were in the thatching and each contained 16 eggs. I retreated a short distance and soon the females came back to the hut. They circled the hut twenty or thirty times before finally landing and walking to the nests. During this time the males stayed together on the water and only came back to the hut when the females were incubating again. Incidentally, the wall of the same hut contained two nests of Mallard *Anas platyrhynchos*.

The photographs facing page 81 show one of the nest sites, and the female standing on the roof nearby. I believe this is the first time this species has been photographed at the nest.

Brian Hawkes, 55 The Street, Newnham, Sittingbourne, Kent.

Editorial comment:

The Marbled Teal is nowhere very common although it occurs in north-west Africa, the Middle East, the southern Soviet Union and northern India and Pakistan. The Guadalquiver delta is the sole regular breeding locality in Europe and Valverde (1964) estimated that population as having no more than 100 pairs. In West Pakistan its near-extinction as a breeding species has stimulated the restoration project at Lal Suharna, using birds raised at Slimbridge (see over). There have been objections to such re-introductions, on the grounds that different genetical stocks to the local ones are used. However, the Slimbridge stock derives from four pairs and an odd drake sent to us by Mr. R. Angorly of Basra, Iraq, in 1948, the first time for 30 years any had been in Britain. An interesting account of the first breeding from this stock, at Leckford, was given by Jones (1951).

The large clutches recorded by Mr. Hawkes fall within the limits compiled by Bauer and Glutz (1968) although clutches of 10 and 11 are most common at Slimbridge. The eggs are quite small, Dr. J. Kear weighed 62 fresh ones at Slimbridge which ranged from 25.5 gm. to 34.5 gm. with an average of 29.9 gm., but the total mass is enormous compared with the weight of the female. Bauer and Glutz give an average for the latter in May of 348 gm. which would be almost matched by a clutch of 11. The possibility of more than one female contributing to the larger clutches cannot be excluded. The newly hatched downy young appear minute, 100 weighed by Dr. Kear ranged from 14.0 gm. to 22.0 gm. with an average of 17.5 gm. Nevertheless this is

5.3% of the female weight, high compared with, for instance, the Mallard (3.4%), but less so compared with diving ducks, 4.3-6.4% (see p. 123). Possibly this is another indication of its intermediate evolutionary position between dabbling and diving ducks already suggested by the courtship display patterns and the structure of its tracheal bulla (Johnsgard 1961; von der Wall 1962).

Mr. C. D. W. Savage writes:

Marbled Teal project at Lal Suhanra, West Pakistan

Within the last fifty years the Marbled Teal was not uncommon, both as a wintering and as a breeding bird in suitable habitats in many parts of south-west Asia from the Nile Delta through Palestine, Jordan, Mesopotamia, Fars, Sind and Baluchistan. Possibly half the winter populations were locally bred, while the rest were visitors presumably from the breeding grounds of Uzbekhestan and Turkestan. Since then, however, the wetland geography has changed profoundly, as a result of which there are no longer the prolific breeding grounds in the south of the U.S.S.R.; local breeding places from the Nile Delta through to Sind have been affected by development of irrigation projects, by greater water utilisation for agriculture, but above all by increased disturbance. Small pockets of breeding birds have recently been observed between the Tigris and Euphrates, and also in Fars, Iran, while occasional birds have been seen in Pakistan during the summer but without evidence of breeding. The former breeding colonies described by Zarudny in Seistan have, however, definitely disappeared.

In this context the Marbled Teal appeared to be a candidate for the Red Data Book on Endangered Species, but then large wintering flocks of up to 2,000 birds were reported in southern Turkey in 1967-68. Recent estimates have been smaller but it is apparent that the species is holding its own, if only just, in southern Europe. Nevertheless in Pakistan where formerly it was both a resident and migrant the species was virtually extinct.

The Wildfowl Trust meanwhile had bred so many in 1968 they had difficulty in placing them. In 1969 with the help of the British National Appeal of World Wildlife they offered all their year's production for reintroduction in Pakistan. In November, 24 Marbled Teal arrived in Pakistan. Their destination was the Lal Suhanra sanctuary situated near the Sutlej river in Bahawalpur division. It straddles the Desert branch canal, and seven to twelve square miles of low lying land is flooded every year during the monsoon season by releases of surplus water from the canal. In winter much of this is drained back into the canal for irrigation use. This huge area is studded with islands and creeks, lotus pools, reed beds, tamarisk bushes and reed mace. Although dependent on the canal for water, there is permanent water in low lying areas at all times of the year and the richness of the bird life vouches for the variety and wealth of the food supply. In winter nearly a hundred species can be viewed in a few hours including six species of eagle and the nearly extinct Houbara Bustard. The sanctuary is supported by World Wildlife project 474. For the Marbled Teal the habitat appears to be ideal for the purpose of reintroduction; the species occurred there before, the tamarisk covered islands are typical breeding habitat in Baluchistan, and natural food supplies and official protection are available throughout the year.

The Wildfowl Trust birds have initially been placed in a covered enclosure in the sanctuary. In due course they will be released into a larger open enclosure which includes all habitat types and from which young unpinioned birds will be able to leave as they wish to colonise other parts of the sanctuary. Supplementary food supplies will, however, always be available at the enclosure and this it is hoped will encourage them not to wander too far before population density requires them to spread out from Lal Suhanra.

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Wildfowl distribution, conservation and research in southern Africa

W. R. SIEGFRIED

Introduction

It is not generally known that the African Wildfowl Enquiry (A.W.E.) was formed in 1954, the year that the International Wildfowl Research Bureau (I.W.R.B.) came into being. The object of this paper is to provide a general background document and to focus international attention on some of the accomplishments and needs of wildfowl conservation and research in southern Africa.

Physiography

Southern Africa is taken to include the territories of South Africa, Lesotho, Swaziland, Botswana, Rhodesia and South West Africa, as well as south-western Angola and southern Mozambique. Zoogeographically southern Africa embraces the whole of the African landmass situated south of the Cunene and Zambesi Rivers.

The main features of the subcontinent's topography are a relatively flat plateau, averaging 1,000 metres above sea level and occupying most of the central area, a steep escarpment and a narrow coastal plain.

The considerable elevation of the central plateau, especially in the east where mountainous country rises to above 3,000 metres, lowers the temperature, so much of the tableland interior has an annual mean of less than 18°C. The area is thus cooler than might be expected from its latitude, and can be regarded as temperate. By contrast, the eastern coastal plain as far south as Natal, and the lowlands of the Limpopo and Zambesi valleys are subtropical and tropical. In the south and west the subcontinent is washed by the cold Benguella current which maintains a cool coastal belt with annual means of the order of 16°C.

Semi-arid conditions are normal over most of southern Africa. Mean annual precipitation is about 60 mm. in the west and increases from west to north-east, exceeding 1,000 mm. in parts of Mozambique. Over the whole region, however, the mean is about 475 mm. In the extreme south-west the rainy season is in winter, with 75% of the annual fall (577 mm.) occurring between April and September. This south-western Cape area, also known as the Winter Rainfall area, covers some 15,000 sq. miles and roughly 1% of the whole subcontinent. Over most of the rest of the region, the winters are cool and dry; the rains falling chiefly in summer. In between the winter and summer rainfall areas is a relatively narrow band of country that receives rain at all seasons.

Droughts, often enduring for years, are common. Dry periods may be succeeded by unpredictable years of over-abundance of rain. For the region as a whole, an average 20% deviation from the normal rainfall prevails. As the rainfall increases from west to east it becomes more reliable and predictable from year to year. Over much of the summer rainfall area the fall is in the form of heavy, short-lived thunder showers, often very local in effect. The average annual run off of the rivers is not proportionate to the average rainfall. In South Africa 91% of the precipitation is returned to the atmosphere by evaporation and transpiration; only 9% reaches the rivers. Evaporation generally exceeds rainfall by about three times. As a comparison between the semi-arid south and the well-watered north, total annual run off from all rivers in South Africa is about 42 million acre feet (272,368 Imp. gals.=1 acre ft.); this is exceeded by the Zambesi River alone.

Habitat

Relatively few permanent natural waters thus exist in southern Africa. In the south and east, rivers draining the escarpment flow all year round, but the narrowness of the coastal plain and the mountainous country militate against the formation of wetlands for wildfowl. Such wetlands that do exist have a low overall biological productivity; a result of acidity, excessive silt-loading and other factors originating from the peculiar soil and rock formations affecting the watersheds. Only in north-eastern Natal and northwards into Mozambique does the well-watered coastal plain widen and flatten sufficiently to allow the formation of extensive, suitable habitat, such as permanent lagoons, estuaries, deltas, shallow lakes, marshes and temporary 'vleis', which are shallow depressions in which water collects during the rainy season (but see Downing (1968) for information on the use of the word 'vlei'). These areas support a rich com-

munity of subtropical and tropical water birds. Penetrating inland are the wide flood plains of the Zambesi and Limpopo, and lesser rivers. The few permanent rivers that empty into the Atlantic provide little of real consequence to wildfowl.

Situated in the north-central area of the subcontinent is the vast Okavango swamp —a complex inland delta covering some 6,000 sq. miles of *papyrus* and *phragmites* beds with open lanes of water. This swamp is fed by the Okavango River which normally dissipates its entire annual flow of 7.5 million acre feet through evaporation and transpiration from the swamp. Nearby the extensive marshes in the Caprivi Strip and the flood plains of the Chobe and Okavango Rivers provide additional thousands of square miles of prime wetlands. Farther to the north, and just beyond the geographical limits of our area, are the Barotse and Kafue Flats where the wildfowl population is to be counted in the hundreds of thousands—truly one of the greatest 'duck factories' and spectacles in the world.

Thus the major area of permanent natural water available to wildfowl exists in the north-central and north-eastern parts of the subcontinent. For the rest, there are no more than ten individual permanent natural waters each capable of supporting no more than a few thousand birds. However, the overall area of permanent water has been greatly increased by man, and continues to grow. In South Africa, for instance, artificial waters exceeding 200-1,000 acre feet in size alone account for some 4.7 million acre feet of water. And, among new impoundments and barrages the Orange River project will add another 6 million acre feet. When those on the Orange and the Pongolo are completed the dams in the country's rivers will contain 35% of the run off. When they are all full (a rare phenomenon), South Africa's 100 biggest dams have a surface area of close on 200,000 hectares and a combined shoreline of over 3,000 kilometres, longer than the country's total coastline. The creation of artificial lakes has been vigorous in Rhodesia as well — for instance, Lake Kariba.

These large-scale, man-made habitats have benefited particularly the so-called geese (*Alopochen*, *Tadorna* and *Plectropterus*) which, in the agricultural areas, do most of their feeding away from water. What is not generally recognised is that some of these river impoundments, and especially some of the future grandiose schemes, destroy extensive natural flood plains which are seasonally of considerable importance to wildfowl.

Except in the north-central and north-eastern parts of the region, ducks are dependent almost entirely upon temporary and semi-permanent waters. These are mainly natural shallow-water vleis, but artificial habitat, primarily in the form of earth dams, for watering livestock and irrigation storage, is growing in importance. The dams improve in quality as they 'mature' with age and provide increased shelter and food for wildfowl. Much of the temporary habitat south of the Limpopo is reliable only in the better watered areas east of about 28°E., and in the winter rainfall area. In this connection, the highveld 'pan country' in the Transvaal, and to a lesser extent in the Orange Free State, is an important wildfowl breeding area. Essentially, pan country is grazed native grassland supporting many rain-filled shallow depressions. In the semi-arid Karoo, Namaqualand and the southern parts of South West Africa and Botswana temporary habitat is created erratically and mostly locally. Furthermore, the vleis generally are brackish and hence attractive mainly to species such as the South African or Cape Shelduck *Tadorna cana* and Cape Teal *Anas capensis*. In years of exceptionally good rainfall, however, much 'new' land is inundated and since the soils in many of these semi-arid areas are alkaline, the temporary waters are highly productive and capable of sustaining quite dense concentrations of species like the Cape Shoveler *Anas smithi*. Due to differences in run off and soil composition and structure, the vleis in southern and eastern South Africa are generally not as productive as those farther north. In the north-west, in northern South West Africa, a combination of favourable soil and fairly dependable rainfall makes for some productive, temporary habitat. The vast, and shallow, Etosha Pan (*ca.* 3,000 sq. miles) in addition to being very brackish, only fills completely in years of exceptionally heavy rainfall; it is thus not of very much importance to wildfowl (flamingos excluded, of course). Lake Ngami and the saline Makarikari Pan, in Botswana, also become full only in years of high flood. This happened in 1954 when Lake Ngami reached nearly the level recorded by David Livingstone in 1849. Irwin (in Smithers 1964) reports congregations of up to 500,000 Red-billed Teal *Anas erythrorhyncha* there in October 1954.

Most wildfowl habitat and wildfowl in southern Africa are thus found in a moderately broad band of country, with relatively high and seasonally dependable rainfall, extending from northern Natal up through Mozambique to the Zambesi River and from there westwards along the river plain and across to northern South West Africa. The greatest concentrations of birds occur in coastal Mozambique, northern Botswana and southern Zambia.

Wildfowl

Of the 21 species of Anatidae indigenous to the Ethiopian faunal region, 16 breeding species occur in southern Africa. These are:

Fulvous Whistling Duck *Dendrocygna bicolor*
White-faced Whistling Duck *Dendrocygna viduata*
South African (Cape) Shelduck *Tadorna cana*
Egyptian Goose *Alopochen aegyptiacus*
Cape Teal (Wigeon) *Anas capensis*
Hottentot Teal *Anas punctata*
Red-billed Teal *Anas erythrorhyncha*
Yellow-billed Duck *Anas undulata*
Black Duck *Anas sparsa*
Cape Shoveler *Anas smithi*
Southern Pochard *Netta erythropthalma*
Pygmy (Dwarf) Goose *Nettapus auritus*
Comb (Knob-billed) Duck *Sarkidiornis melanotus*
Spur-winged Goose *Plectropterus gambensis*
Maccoa Duck *Oxyura maccoa*
White-backed Duck *Thalassornis leuconotus*

In addition, European Shoveler *Anas clypeata*, Pintail *Anas acuta* and Garganey *Anas querquedula* occasionally reach the region, during the austral summer, as vagrant migrants from the north.

A small population of about 120 feral Mute Swans *Cygnus olor* has become established, mainly on two estuaries, in the southern Cape Province of South Africa. These birds stem from a few introduced from Europe into the area some 50 years ago. Apparently no other exotic wildfowl introductions have succeeded in southern Africa, though reports come in from time to time about wild Mallard *Anas platyrhynchos*.

There are, of course, no true geese — the vacancy being occupied by *Alopochen*, *Tadorna* and *Plectropterus*. There are no specialised fish-eaters (for example mergansers). In short, the wildfowl community is entirely a freshwater one (though the Shelduck and the Cape Teal do make extensive use of saline estuaries). One species, the Black Duck, is virtually confined to streams and rivers. As a whole, the wildfowl feed on plants and invertebrate animals. It is possible that southern Africa's rich cormorant community (four marine, two freshwater forms), one *Anhinga*, one Finfoot (*Podica*) and a battery of kingfishers precludes the presence of fish-eating ducks. One final point is that southern Africa is not used by Palaearctic anatids. This is in marked contrast to the Palaearctic waders (Charadrii) whose migratory populations winter there in colossal numbers in both freshwater and marine habitats.

Winterbottom (1967) shows that the avifauna of the major marshes and lakes from Lake Edward in Uganda to St. Lucia in Natal, must be considered as a unit and that Ngamiland has the closest affinities with St. Lucia and with the Kafue Flats. Lake Chad and the Niger flood plain, however, appear to support a different and separate West African aquatic avifauna. In the extreme south of the continent the avifauna is again quite distinct. Winterbottom also distinguished an East African Tropical Aquatic Avifauna, having the following characteristic species: *Dendrocygna viduata*, *Thalassornis leuconotus*, *Plectropterus gambensis*, *Sarkidiornis melanotus* and *Nettapus auritus*. Other species are notably *Anas punctata*, *Anas erythrorhyncha* and *Dendrocygna bicolor*.

Thus it is evident that the major wetland areas in southern Africa are populated by a primarily tropical community of ducks. Over the rest of the region, and especially in the south and west, an essentially temperate community prevails. The dominant species are: *Tadorna cana*, *Anas capensis*, *Anas undulata* and *Anas smithi*. Also essentially a bird of cooler areas, but somewhat local in distribution, is the Maccoa Duck. It should be noted that where some of these species occur beyond our region to the north, they are also primarily inhabitants of temperate areas.

Comparing the tropical and temperate wildfowl communities in southern Africa, it emerges that the tropics have the largest number of species (and individuals). This is in contradistinction to the northern hemisphere where the tropical regions generally have fewer species. This serves to underline the relative paucity of

aquatic habitats in temperate southern Africa.

Finally, we are left with the Egyptian Goose, Black Duck, Red-billed Teal and Southern Pochard. In these species the tropical/temperate affinities are not quite as clear-cut. The Egyptian Goose, while perhaps more tolerant of low than high temperatures, is probably the most adaptable and catholic of all our wildfowl — it is the only species which breeds both north and south of the Sahara. The Southern Pochard, like its South American form apparently, is not as common in the warm tropics as in cooler areas. The same would seem to apply in the Black Duck. The Red-billed Teal is probably southern Africa's most abundant duck, occurring fairly commonly over the whole of the subcontinent, but attaining maximum abundance in the tropical and subtropical zones; it is out-numbered by the Yellow-billed Duck, Cape Shoveler and Cape Teal in the extreme south.

Whether thermal effect has a direct or indirect bearing on limiting range is not known. In fact, many ecological conundrums await answer. For instance, the Pygmy Goose, belonging to an essentially tropical genus, is reported to feed mainly on the plants and seeds of the waterlily *Nymphaea.* This plant, while widely distributed in southern Africa, is only really common and abundant in the warmer, wetter climatic zone. Further, in southern Africa at least, the Pygmy Goose has a clear preference for tree-hole nesting (Zaloumis in prep.), and woodland suitable for this habit is predominant only in the tropical areas. It is, of course, known to the aviculturist that *Nettapus* is sensitive to cold, but what is not known is whether temperature rather than food or nest site availability limits its range in southern Africa. Thus in Nigeria the species apparently must nest mainly on the ground (Pitman 1965). The Spur-winged Goose, while also a dominant member of the tropical community, does not display the same conservative attachment to the warmer and wetter areas. It is a common breeding resident in some of the coldest parts of South Africa, particularly the high altitude grassland areas fringing the Drakensberg mountains. In recent years it has increased and spread over much of the region. This relatively modern change in status is due to pastoral and agricultural practices which have created new feeding grounds for it and also for *Alopochen.*

The Shelduck also has undergone a considerable alteration in range. Until recently the species was confined to South Africa, but during the last decade it has invaded South West Africa where it is spreading and becoming a common, albeit locally, breeding resident. Latest reports indicate that the Shelduck has reached as far north as the Okavango. Here again, undoubtedly, man's influence, through dam-building and irrigation farming, has been responsible for the spread.

Conservation

It is probably fair to say that there are more wildfowl in southern Africa today than there were before the first arrival of Europeans. This is most true for *Alopochen, Plectropterus, Tadorna* and *Anas undulata* in South Africa; and barring effective artificial control, the numbers of geese will continue to show a rising trend. For the rest, it is my considered opinion that the tide is turning. The artificial benefits (dams, sewage ponds, etc.) are now being more than offset by the increasing destruction of prime natural habitat. In South Africa especially, in the developed farming areas drainage and reclamation of marshland are proceeding apace. The summer rainfall pan country suffers through drainage, ploughing, burning, overgrazing and trampling by domestic livestock. In the winter rainfall zone vleis have been disappearing one after the other. In many areas natural waters are choked by silt or pumped dry. Exploitation of subterranean water for irrigation has caused the water-table to drop by hundreds of feet in some areas. The net effect has been steady progress towards the irreversible disappearance of much high quality wildfowl habitat.

The plight of certain species is more acute than others. For instance, the Cape Shoveler may be regarded as potentially the most vulnerable: because it is virtually confined to the more temperate areas (which are the most developed); because its total population is relatively small (Siegfried 1965); and because its somewhat specialised feeding habits demand just that type of habitat which is disappearing most rapidly.

The subtropical and tropical areas in South Africa, especially in Natal, are on the threshold of intensive sociological, industrial and agricultural development. Silting has already assumed alarming proportions in some of the Natal rivers. St. Lucia, a proclaimed nature reserve and formerly one of the finest water bird areas in the world, is dying as a wildfowl

refuge — the result of a combination of decreased inflow of fresh water, silting and build-up of salinity (van der Merwe 1967; Forrest 1969). Schemes in progress to impound rivers such as the Pongolo will result in the disappearance of thousands of acres of valuable wildfowl habitat.

Although other territories have not yet experienced the same magnitude of change, engineering and sociological projects are either already underway or mooted. Much of northern South West Africa, including Ovamboland and Okavangoland, is faced with overpopulation (human and domestic livestock) and consequent degradation of the land. In Mozambique the Portuguese began draining the Limpopo delta (about 140,000 acres) for rice-fields in 1956. In northern Botswana developers plan for some 'use' to be made of the abundant water and marshes. Schemes to grow rice and pulp papyrus have been proposed, as well as barrages, dykes and canals to lead the water elsewhere. Attwell (1970) has drawn attention to some of the deleterious effects on the ecology of the mid-Zambesi floodplain as a result of the control imposed by the Kariba impoundment.

In parts of northern Botswana, and also in areas along the Zambesi and Okavango Rivers, human activity over the last 100 years has had a marked effect on the natural ecosystem. The swamp grassland and grassy pans are important in providing grazing for domestic livestock and also for cultivation, crops being sown in the moist soil left after flooding. Too frequent burning and over-grazing have resulted in widespread deterioration and in the suppression of perennial grasses; in many areas bush encroachment has proceeded vigorously. One final point is that logging, and particularly the ruthless exploitation of mature trees, might lead to a shortage of nest-sites for hole-nesting species.

To sum up: natural habitats for wildfowl are degrading and disappearing relatively rapidly in temperate southern Africa; and while the main strongholds (including Mozambique) of the tropical habitats are still in a comparatively healthy state, there are widespread signs of general deterioration of conservation values which cause concern for the future.

What is being done to conserve wildfowl habitat? In South Africa and Rhodesia various government agencies are bringing home to the general public the need to conserve water resources. (In the early 1960's South Africa was already using 50% of her available surface water resources.) It is doubtful, however, whether the average citizen understands water conservation to mean much more than a need to build bigger and better dams and river impoundments. He does not appreciate that water conservation in the urban and industrial sectors rests in the multiple re-use of water from river impoundments and that the landowner needs to conserve vleis and marshes to maintain *inter alia* the ground water, much of which ultimately discharges into rivers.

Thus very little of immediate practical value has been done to conserve vleis generally, and in South Africa there are only five natural waters which have been made reserves on a basis of their importance to water birds. Although southern Africa has a comparatively good record in establishing nature reserves and national parks, these generally contain little in the way of water bird habitats. Fortunately, in Zululand a fair amount of the land originally reserved for the conservation of the mammalian fauna, includes much prime wildfowl habitat. In Botswana this applies especially in areas where special efforts are being made to arrest the decline of the Lechwe *Kobus leche* and Sitatunga *Tragelaphus spekei* by protecting their habitats in the Chobe-Okavango area.

At least in South Africa and Rhodesia almost all the artificial waters under control of national or local government agencies are nominally reserves, and all birds are nominally protected. There is also a fair body (but still a definite minority) of enlightened progressive opinion in the private sector. Of late it has become quite common to see islands being built, especially for wildfowl, as part of construction of new earth dams.

Although wildfowl occurring on most of the larger artificial and natural waters may not be hunted there, they face other man-made hazards. Chief among these is the rapidly growing popularity of watersport. In South Africa this form of recreation, mainly speed-boating and water-skiing has boomed during the last decade. This is particularly so in summer in the southern Cape estuaries, a number of which are important moulting and refuge areas for Shelduck at this time of year. At present there is little effective control over these activities although proposals for draft legislation are being considered.

Finally, it remains to mention, very briefly, a few of the more insiduous processes contributing towards adulteration and grave degradation of wetlands.

Pesticides are used throughout southern Africa, and aerial spraying and other extensive methods for broadcasting chlorinated hydrocarbons and other chemical poisons are common. One specific example can be cited here: the Ndumu wildlife reserve in northern Zululand contains some of the most fertile small lakes in Africa which have been contaminated by DDT and other mixtures aerially sprayed on to cottonfields (Dutton 1968). Carp *Cyprinus carpio* introduced into South Africa about 100 years ago are today found in most of the country's major river systems and other inland waters; the deleterious effects sometimes brought about by these fish are well known. In addition to the Carp, other exotic fishes have been introduced, and some of the plant-eaters have altered the ecology of a number of natural waters. The slaughter of the crocodile for its skin over much of its range has brought about profound changes in the fish fauna due to reduced predation (Cott 1961), and so ultimately in the aquatic vegetation and microfauna. The introduction of the exotic water plants *Myriophyllum braziliense*, *Salvinia auriculata*, *Elodea canadensis* and *Eichornia crassipes* (proclaimed noxious weeds in most territories in southern Africa) and even some of the exotic paspalums (for example *P. vaginatum* in marshes in the winter rainfall area) have choked and modified many inland waters. A cause for some concern is the possible effect of the spread of *Salvinia* in the Botswana wetlands; it is spreading in the Chobe system, is close to Lake Liambezi and could get into the Okavango swamp.

What the precise effects of all these changes to the natural ecosystem will be on water birds and their habitats are not known. They are adulterations none the less, and provide sufficient reasons for the setting aside of further natural wetlands to be kept as nature reserves in the strict sense of the term.

In southern Africa shooting pressure on wildfowl is not heavy, though some local areas are intensively shot over. McLachlan (in press), employing comparative data derived from ringed birds, has estimated that in the ducks the rate of mortality caused by shooting is generally well below that in certain northern hemisphere countries. For the African 'geese' the rate is a little higher, but still well below European figures. Certainly it is true to say that by North American and European standards wildfowl shooting is not popular and lacks tradition. Hunting methods have nowhere near reached the degree of refinement and sophistication (pseudo or real) practised in the northern hemisphere, and there is little or no 'status' to be gained from wildfowling. Hunting is directed mainly at mammals and to a lesser extent upland gamebirds. Properly organised shooting of wildfowl is virtually absent. In a way this is unfortunate, since the geese constitute a natural resource yielding a surplus which could be legitimately harvested, and so help towards controlling their numbers and reducing damage to agricultural crops. There are no commercial decoys in southern Africa, and the use of traps, snares, etc., for taking wildfowl is illegal, unless done under special permit. In South Africa the provision of properly controlled public shooting areas on state-owned land would be a constructive measure in a multi-use conservation policy.

There are six separate hunters' associations in southern Africa whose combined total membership does not exceed 5,000 individuals; the wildfowling element comprises a distinct minority group. In the Transvaal, for instance, Mr. P. le S. Milstein (pers. com.) has estimated, on the basis of numbers of hunting licences sold in 1968 and 1969, that interest in wildfowling rates about 7% compared with 93% for upland gamebirds. It is difficult, if not impossible, at present to get any sort of reliable figures for the numbers of ducks and geese shot every year. In South Africa wildfowl belong to the landowner and not the State. In effect, this means that the landowner is in control of wildfowl on his land and is not obliged to take out a licence to shoot on his own property. (His shooting is, however, subject to regulations governing seasons and bag-limits and he may not hunt species accorded special legal protection.) Non-landowners require licences to hunt, but are not bound to render any form of report on their hunting activities (plans exist, however, to rectify this omission). Revenue earned by the State (or local authority) through the sale of licences does not go directly into promoting the hunters' interests.

In South Africa, South West Africa, Botswana and Rhodesia adequate provision has been made to meet the requirements of sound, balanced conservation legislation. Excluding relatively minor anomalies, the setting of hunting seasons, bag-limits and the issuing of licences and special permits are all regulated according to the latest available information

concerning the bio-ecology of the birds. Conservation laws in Lesotho and Swaziland are antiquated and inadequate, and outside the Mlilwane Sanctuary (in Swaziland) there is no enforcement.

Mozambique has poor laws and scant respect is paid to birdlife. According to Mr. R. D. Jacka (pers. com.), shooting pressure is high. Ducks and geese may be bagged in unlimited quantities. In spite of a so-called closed season (January to March), hunting takes place all year round but is heaviest in winter. Any resident may purchase a R10 (£6) unlimited hunting licence for ducks, geese, doves and hares. Herons, egrets, Spoonbills and Hammerkops are usually used as target practice before and after duck shoots.

Even in the areas with reasonable conservation laws, the big problem is enforcing the regulations. It is certainly not a rare phenomenon for parties of hunters to enter remote areas by 'plane or overland vehicle, to slaughter hundreds of ducks in the space of a few days. In the developed areas small scale poaching by peasant farm workers, using snares and traps is of common occurrence, and the cumulative 'take' of wildfowl and their eggs is quite large. Especial problems are posed in the Bantu homelands, trust areas and tribal reserves. A full discussion of these would, as a matter of course, necessitate the introduction of a whole range of complicated sociological factors. It suffices to say that wildfowl are hunted with impunity quite relentlessly the whole year round; fortunately the number of firearms is still small. Nevertheless, the combined onslaught brought to bear in certain over-populated, protein-starved areas (the Transkei for instance) is a vicious circle and enough to ensure the virtual disappearance of nearly all passerines let alone wildfowl.

Parts of southern Africa, like most areas in the world where wildfowl and agriculture come together, experience crop-damage. The main offenders in South Africa are the Egyptian Goose, Spur-winged Goose and the Shelduck — in that order. Damage is chiefly on cultivated land and in three areas: the winter rainfall area where mainly wheat is damaged and the chief culprit is the Egyptian Goose; the maize growing districts of the summer rainfall highveld where the Egyptian Goose and the Spur-winged Goose operate; and the northern Transvaal and other areas where tuberous and groundnut crops are attacked by both species. For the most part, crop-damage is local, but can be severe, and is almost invariably on farms near large reservoirs providing the birds with shelter during the day. Most of these big dams are the property of the State (Department of Water Affairs) which allows no hunting whatsoever on its premises. Congregations of up to 5,000 Spur-winged Geese and over 8,000 Egyptian Geese have been counted on single dams respectively in the maize and wheat growing districts (Siegfried 1967; Milstein 1968). Permits may be issued to individual landowners allowing them to attempt at any time to control geese on their lands when sufficient cause can be shown. Similarly, in any local area where a species becomes a serious problem, a proclamation can be issued declaring it temporarily open for hunting. Complaints are also made by farmers in parts of South Africa that geese compete with sheep and cattle for grazing. Damage to permanent pasture is hard to assess, but these complaints are not very common and the problem is not a serious one. In the tropical areas the Knob-billed Duck is regarded as a pest in certain areas where it damages maize plants, and it and other species damage rice crops in parts of Mozambique.

In southern Africa there are nine statutory bodies entrusted with matters relating directly to conservation of wildlife resources, including the control and management of nature reserves. In South Africa each of the four provinces has its own independent nature conservancy; in addition, a federal body — the National Parks Board — provides for the establishment of national parks. Similar organisations exist in South West Africa, Botswana and Rhodesia, but Lesotho and Swaziland lack governmental nature conservancies.

Research

In southern Africa as a whole, the combined conservancies currently provide employment for some 110 university-trained biologists. Many are obliged to perform mainly administrative tasks, another substantial part is concerned with management—the practical application of research. For the rest, original research is directed mainly at practical problems relating to inland fisheries, mammals and plants. In all, the conservancies currently offer directed employment for six biologists engaged chiefly in ornithological research, which includes, *inter alia*, attention to wildfowl, upland gamebirds, cagebirds, pests, and rare and endangered species. There is no single conservancy

post in southern Africa devoted solely to wildfowl research; and, furthermore, most of the existing ornithological employment opportunities were created very recently.

This is not criticism, merely statement of fact. Small conservation agencies must of necessity establish priorities within their programmes of research. Both protectionist and shooting interests, being most concerned with big game, have exerted relatively little pressure for specific research aimed at conserving wildfowl. Yet the South African conservation bodies generally have given wildfowl far more attention than terrestrial (upland) gamebirds, although the latter are at least ten times more popular with hunters.

Other governmental agencies (such as agricultural and public health departments) also employ a small research staff on control of wildlife which are pests or vectors and reservoirs of disease. Such research on wildfowl may be on crop depredation or on bilharzia snails, for example. However, in these cases little actual work on wildfowl has been done.

Scattered in the museums, universities and other scientific institutions in southern Africa are some 18 professional biologists who give a major part of their working time to ornithological research. Only one of the present incumbents is by personal inclination, more than moderately interested in duck biology.

Summarising, it can be said that there are at present in the whole of southern Africa only two university-trained biologists who profess wildfowl as a major research interest. Among professional and amateur ornithologists who have received no formal biological training, there are fewer than six persons of whom it can be said that they have carried their interest in wildfowl to a level at which they can, and do, undertake independent research of a reasonable standard.

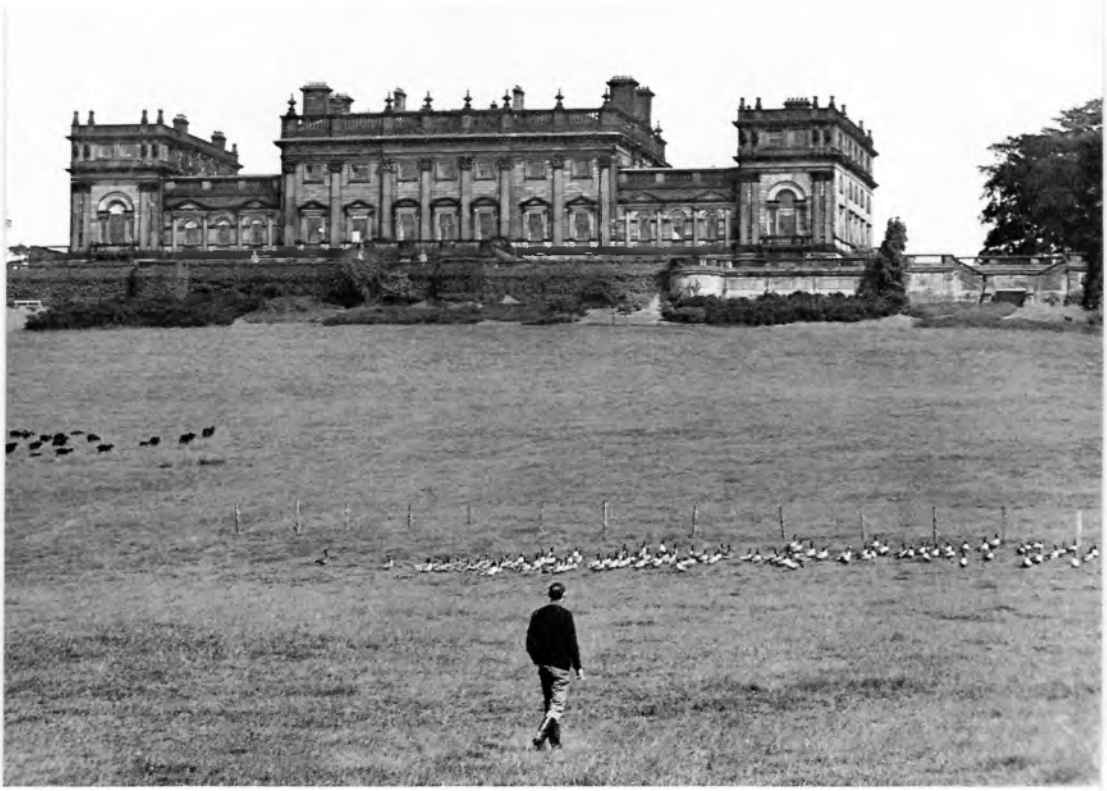
This is not to deprecate the efforts of that large body of enthusiasts who are content to remain observers and enumerators of wildfowl. These field observers play an exceedingly important role in the advancement of research and the gain in knowledge relating to the bio-ecology of wildfowl in southern Africa. Amateur workers are spread all over the subcontinent, but their efforts are organised and co-ordinated by the African Wildfowl Enquiry.

The A.W.E's primary object is to obtain fundamental scientific knowledge regarding the biology, movements and status of indigenous ducks and 'geese'. The organisation comprises an advisory panel, regional committees or representatives and associate workers. At present there are about 100 associate workers. They function through regional representatives who organise field-work — mainly censuses—and submit records and reports to a central organiser at the Percy FitzPatrick Institute of African Ornithology, University of Cape Town, where all records are housed.

To date, close on 10,000 census record forms have been accumulated of which about 90% are from South Africa and the balance from South West Africa and Rhodesia with a small amount of extra-limital data from Central and East Africa. In addition many notes on display and reproduction have been filed. More than 50% of the records are owed to about 5% of the Enquiry's workers.

These records have been consulted and used by private individuals, government departments (agricultural and nature conservancies) and the Percy FitzPatrick Institute. A number of reports have been produced in which workers have used A.W.E. material to supplement their own research, or which deal exclusively with analyses of such records. Four reports have been compiled bringing together all that is known of the African Pochard (Middlemiss 1958), Yellow-billed Duck (Rowan 1963), Cape Shoveler (Siegfried 1965) and Cape Teal (Skead, in press). In addition, a number of papers dealing with certain species in restricted areas or with aspects of the species' biology have been published; these include reports on the Maccoa Duck (Clark 1964; Siegfried 1969), Hottentot Teal (Clark 1969), and Black Duck (Siegfried 1968). Winterbottom (1964b) has used A.W.E. censuses to report on the numbers of South African wildfowl. These references are not a complete bibliography of reports incorporating A.W.E. material; they indicate the use that has been made of raw data accumulated over the last 15 years. The A.W.E. has stimulated research on, and conservation of, wildfowl in southern Africa and has contributed much on which the official conservancies and other government departments can base sound legislation and management practices.

The A.W.E. is an independent voluntary organisation, financed through donations. All members of the advisory panel serve in their personal capacity. The A.W.E. serves as the Southern African Wildfowl Survey of the I.W.R.B. but pays for its own research and publications. It receives no government aid or subsidy



Morley Hedley

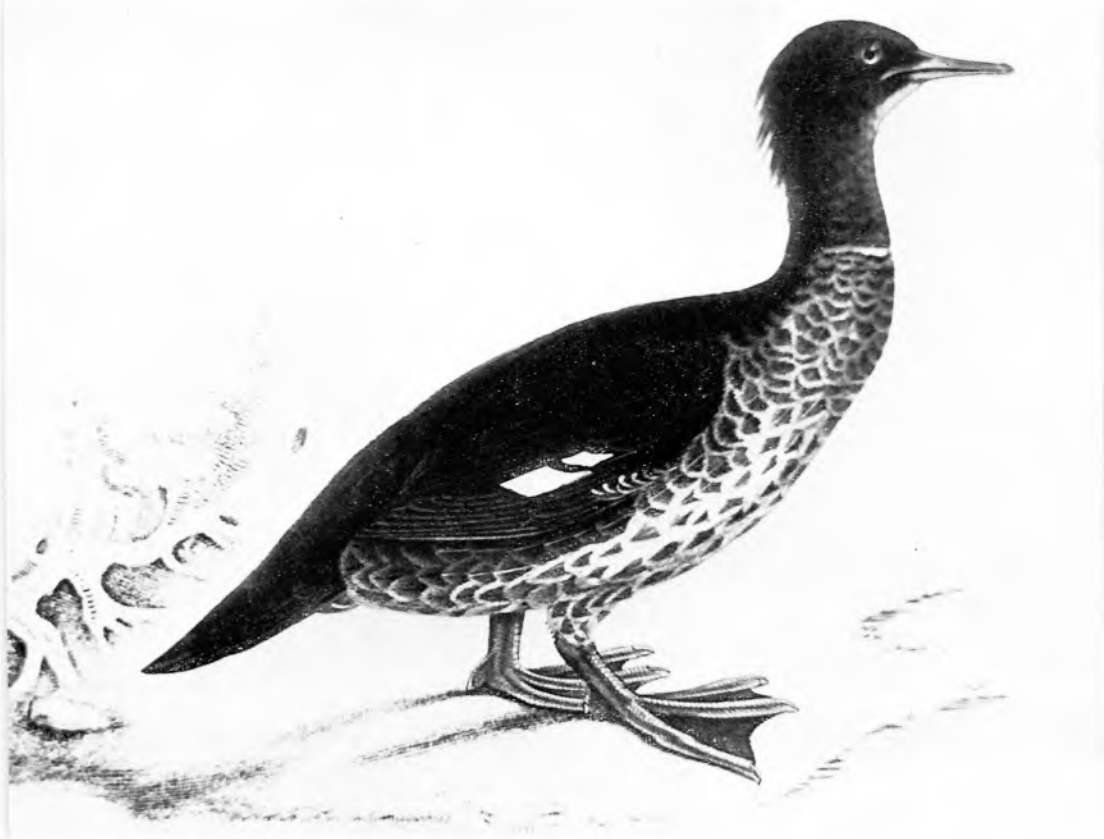
Plate XI. Round-ups of Canada Geese *Branta canadensis*. (a) In the park in front of Harewood House, Yorkshire. (b) Part of the same population having undertaken a moult migration to the Beauly Firth, Inverness-shire. (See pp. 99-104).

C. G. Booth

Russ Kinn

Plate XII. (a) A female Blue Duck *Hymenolaimus malacorhynchos* at eight months old. One of three hand-reared birds brought back from New Zealand by Dr. Janet Kear. (See pp. 115-121).
(b) Auckland Islands Merganser *Mergus australis*. A photograph of a plate in *Voyage au Pôle Sud* (Hombron and Jacquinot 1853). (See pp. 78-86).

Bodleian Librar



—in spite of its proven record of research, and potential for undertaking management-orientated projects of value to the conservancies. At present there is only one government sponsored wildfowl biologist (and his work is not restricted to wildfowl) in the whole of southern Africa. This lamentable state of affairs could be considerably improved if the relatively rich conservancies could convince their governments (provincial or national) that financial investment (in the form of grants-in-aid) in privately organised, reputable wildfowl research will yield good dividends. It is not only paid staff, but basic equipment that is lacking. The accumulated census records are heavily biased in favour of the smaller and more accessible waters. To obtain a truly representative picture, more censusing of wildfowl must be done on the larger sheets of water. However, this can only be done by boat or 'plane. Very few censuses of this type have been carried out in southern Africa.

Another independent voluntary organisation which has made substantial contributions towards our knowledge of southern African wildfowl is the South African Ornithological Society. The S.A.O.S's nest record and ringing schemes have been responsible for gathering much information and placing it on permanent record. The nest record scheme, which began in 1952, provides data on breeding seasons, nest sites, clutch size, incubation periods and so on; at present there are some 2,000 separate cards covering the ducks and geese on the southern African list. The ringing scheme started in 1949, and 38,241 wildfowl had been ringed up to 1968 (Table I). The temperate-zone species in South Africa have been ringed far more intensively than the tropical species, and the recovery rates are well below those found in Europe and North America. Outside South Africa ducks have only been ringed on a very small scale in Rhodesia. Even in South Africa, the major share of the ringing is owed to Barberspan in the western Transvaal and Rondevlei near Cape Town. Of late, wildfowl ringing at Rondevlei has fallen away badly (owing to the general decrease in the numbers of birds present at the vlei), but with the reorganisation of Barberspan (Milstein, in press) there is every hope that this station's ringing activities will expand and improve. It is still the only really effective wildfowl ringing station in the whole of southern Africa.

Table I. Numbers of wildfowl ringed in southern Africa and recovered in Africa as a whole for the period 1949-1968.

Species	*Number ringed*	*Number recovered*
White-faced Whistling Duck	15	0
South African Shelduck	6550	209
Egyptian Goose	5093	226
Cape Teal	423	20
Hottentot Teal	97	8
Red-billed Teal	2814	93
Yellow-billed Duck	19164	229
Black Duck	12	0
Cape Shoveler	429	10
African Pochard	1423	14
Pygmy Goose	46	0
Knob-billed Duck	274	10
Spur-winged Goose	1870	102
Maccoa Duck	7	0
White-backed Duck	24	0
Total	38241	921

The accumulated data on ringing has been used to some extent (for example Winterbottom (1964a) and Milstein, in press) to analyse the movements of some southern African anatids, but little could be done in the way of population analysis. Recently, however, McLachlan (in press) has estimated shooting pressure, and Siegfried (1970) has analysed ringing recoveries to estimate mortality rate of the Yellow-billed Duck.

As a matter of some urgency, an inventory should be made of the available natural wetlands and their value to wildfowl. In this connection, an important problem is the lack of co-operative programmes of research and management between the nations comprising southern Africa. The development of international agreements relating to wildfowl, which are concerned with zoogeographical and not political boundaries, will stimulate nature conservation in the region.

Acknowledgements

Thanks are due to Mrs. M. K. Rowan, Mr. R. D. Jacka, Mr. P. le S. Milstein, Mr. T. E. Reilly and Mr. W. P. Stanford who provided useful items of information.

Summary

After an introduction to the physiography of southern Africa, the region's wildfowl habitat is reviewed. An account is given of the composition and distribution of the wildfowl community. Major problems facing the wildfowl conservationist are examined and discussed in relation to the need for expanded and improved research and management.

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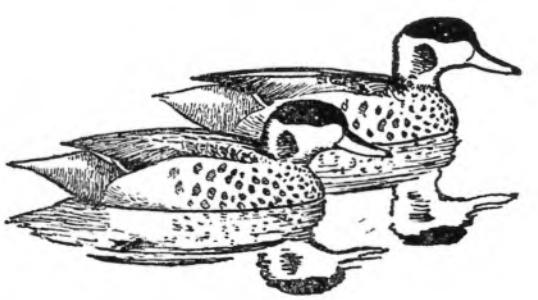
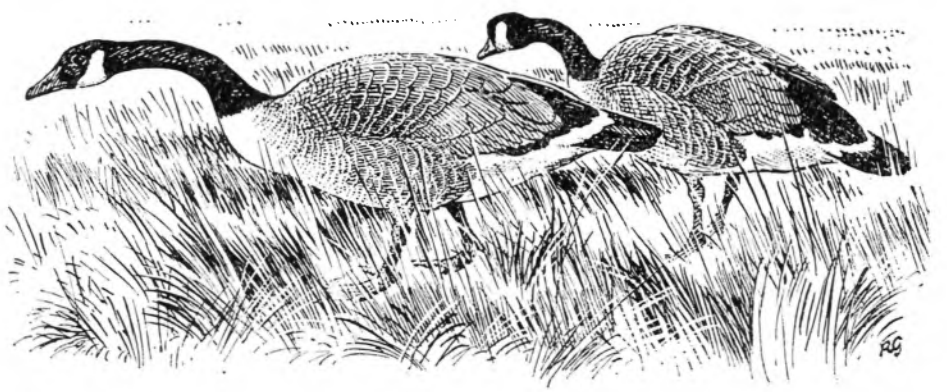
Dr. W. R. Siegfried, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, South Africa.





The moult migration of Yorkshire Canada Geese

A. F. G. WALKER

Introduction

In the course of a study of the Yorkshire population of Canada Geese *Branta canadensis* more has been learnt about their moult migration from Yorkshire to the Beauly Firth, Inverness-shire, first demonstrated by Dennis (1964).

History of the Beauly Firth flock

Salomonsen (1968) considered that as the Canada Goose was introduced to Britain, the moult migration to Inverness must be a comparatively recent phenomenon, certainly less than 300 years old and probably of much more recent origin; also that it was reasonable to assume that it was the result of ancient adaptation based on hereditary factors.

Table I indicates that the establishment and development of the moulting flock of Canada Geese on the Beauly Firth is of relatively recent origin. There are no records for 1953 and only a single bird was reported in 1954 but it could well be that such a small number of geese, moulting on so large a site as the Firth, might have been overlooked, in the early stages at least. There is another gap from 1958 to 1960 inclusive when the flock may have been present and possibly slowly increasing (about 25 geese, which had not started to moult, were in Udale Bay only 20 miles away on the Cromarty Firth on 5th May 1959).

Table I. Numbers of Canada Geese moulting on the Beauly Firth, Inverness-shire.

Summer	*No.*	*Summer*	*No.*
1947	2	1962	120
1950	18	1963	153
1951	52	1964	187
1952	50	1965	ca.160
1954	1	1966	173
1955	22	1967	183
'up to 1957'	15-30	1968	ca.250
1961	40+	1969	ca.325

It will be noted that the periods of greatest growth of the flock occurred between 1961 and 1964 (from 40+ to 187) and between 1967 and 1969 (183 to about 325). The British population of Canada Geese was estimated to be between 2,200 and 4,000 birds in 1953 (Blurton-Jones 1956) and about 10,500 in 1967-69 (Ogilvie 1969).

Status in Yorkshire

The Yorkshire population of the Canada Goose is probably of the order of 1,550 birds (Ogilvie 1969), the majority being concentrated in the north of the West Riding but extending into the extreme south of the North Riding in the vicinity of Masham. There is also an isolated colony of some 80 birds in the North Riding at Castle Howard, north-east of York, and a few smaller colonies in the East Riding near Hull.

Numbers have increased steadily in the last two decades; Blurton-Jones (1956) estimated the population in 1953 to be between 437 and 525 so that the Yorkshire three-fold increase has kept pace with the national increase demonstrated by Ogilvie. The species is mainly centred in the parkland of private estates, but has colonised reservoirs built in the Pennines in the past 50-70 years and quite frequently breeds successfully on the high moors several miles from the nearest water. Flocks of up to 200 assemble annually to moult on lakes and reservoirs in both the West and North Ridings.

In certain parts of the county the species apparently conflicts with agricultural interests, particularly when competing with sheep for grass in spring; consequently it is standard practice on some estates either to destroy all the nests or reduce the number of eggs in each nest. Shooting during the season also takes place though large bags are apparently rare. It may well be that the destruction of clutches, leaving many failed breeders with no tie to the breeding grounds, has had an important bearing on the development of the Beauly Firth flock which, it is now known, contains both adult and immature birds.

Ringing activities

The method of rounding-up moulting full-grown geese and goslings is almost too well known to describe in detail, but briefly, between late June and mid-July (when the full-grown birds are flightless) flocks are driven off the lake or reservoir where they are moulting and gently guided (in the manner of rounding-up sheep) into a V-shaped funnel leading to a small collecting pen of plastic-covered chain-link fencing. The geese are then ringed and released, previously ringed birds being carefully checked.

At Ripley, near Harrogate, 158 Canada Geese were ringed during the moult between 1957 and 1963, but up to 1963 none was recovered more than 10 miles away. During the severe winter of 1962-63, however, deep snow cover forced the geese to move, and four birds, ringed as goslings in 1962, were recovered in the Pas-de-Calais, France, in January and February 1963, the first foreign recoveries of British-ringed Canada Geese. In addition, another bird, ringed as an adult in 1958, was recovered in Carmarthenshire in January 1963 (170 miles SW.).

Thirty-nine of a flock of 153 flightless Canada Geese were caught on the Beauly Firth in July 1963 (Dennis 1964); two had been ringed at Ripley, Yorkshire (c.260 miles SSE.) in 1959 and 1962, and one of these was found dead in October 1963 at Bay of Nigg, Aberdeen (86 miles ESE.). Another round-up was undertaken in July 1964 and 93 were caught; of these five had been ringed on the Beauly Firth in the previous year and three had been ringed at Ripley.

Of the 122 birds ringed on the Beauly Firth in 1963 and 1964, 24 have been recovered dead and 20 'controlled' (recaught and released) in Yorkshire up to April 1970, a total of 36%, all but one within 20 miles of Harrogate. Two others ringed on the Beauly Firth in 1964 were recovered, one in September 1964 at Coldstream, Berwickshire (150 miles SE.) and one in September 1966 at Whitehills, Banffshire (65 miles E.).

The evidence of a link between the Beauly Firth and Yorkshire arising from the 1963 and 1964 round-ups stimulated more intensive ringing of Canada Geese and 1,020 were ringed during the moult in central and southern Yorkshire between 1965 and 1969. The localities are shown in Figure 1. Apart from controls of the birds ringed on the Beauly Firth, there was a large number of controls within the county as the birds moved round from one water to another although these are only of local interest. A new development in 1969 was the control at Harewood and Fewston of 11 birds ringed in the Midlands—eight from Staffordshire, two from Derbyshire and one from Shropshire.

Since experience in North America had shown that repeated round-ups of moulting geese could lead to their abandoning the moulting sites (Sterling and Dzubin 1967), no further round-ups were made at the Beauly Firth until July 1968. Then, as a follow-up of the intensified ringing of geese in Yorkshire, 225 were caught of the c.250 present. No fewer than 74 had been ringed in Yorkshire plus 12 ringed on the Beauly Firth in 1963 or 1964. Again in July 1969 the Beauly Firth round-up was repeated and 216 geese were caught of the c.325 present. Eighty-

five had been ringed in Yorkshire, and 58 on the Beauly Firth.

These two successive catches of the moulting flock revealed some interesting facts concerning its age composition. A total of 126 goslings were ringed in Yorkshire in 1967 and 35 of these were recaptured on the Beauly Firth in 1968. Similarly there were 19 one-year-old birds in the 1969 Beauly Firth catch from a total of 115 goslings marked in Yorkshire in 1968. Also in the 1969 catch were 27 of the 1967 crop of goslings, returning there as two-year-olds. Assuming that the already ringed proportion of the catches was representative of the whole, immature birds made up about 47% (35 out of 74) of the 1968 catch, and 54% (46 out of 85) of the 1969 catch. The remainder were clearly non-breeders but had not the excuse of immaturity for undertaking the moult migration. Studies in North America have shown that Canada Geese normally reach reproductive maturity at three years of age though a small percentage may mature at two (Wood 1964).

Whilst only relatively small numbers were involved, it is already clear that not all Yorkshire yearlings migrate to Inverness-shire to moult; of 39 goslings ringed at Harewood in 1967, 13 were moulting there in 1968 whilst 12 had moved to the Beauly Firth. Again, of the 12 goslings ringed at Allerton Park in 1967, six were moulting at Harewood in 1968, one at Fewston and three on the Beauly Firth. However, no fewer than 12 of the 15 goslings ringed at Ripley in 1968 were moulting on the Beauly Firth in 1969. Of the 35 yearlings caught on the Beauly Firth in 1968, four were back in Yorkshire for the moult in 1969, compared with the 15 which returned to the Beauly Firth. Why some Yorkshire one- and two-year-olds moult on the Beauly Firth and others stay in Yorkshire is not understood at present but this may become clear as a result of further ringing.

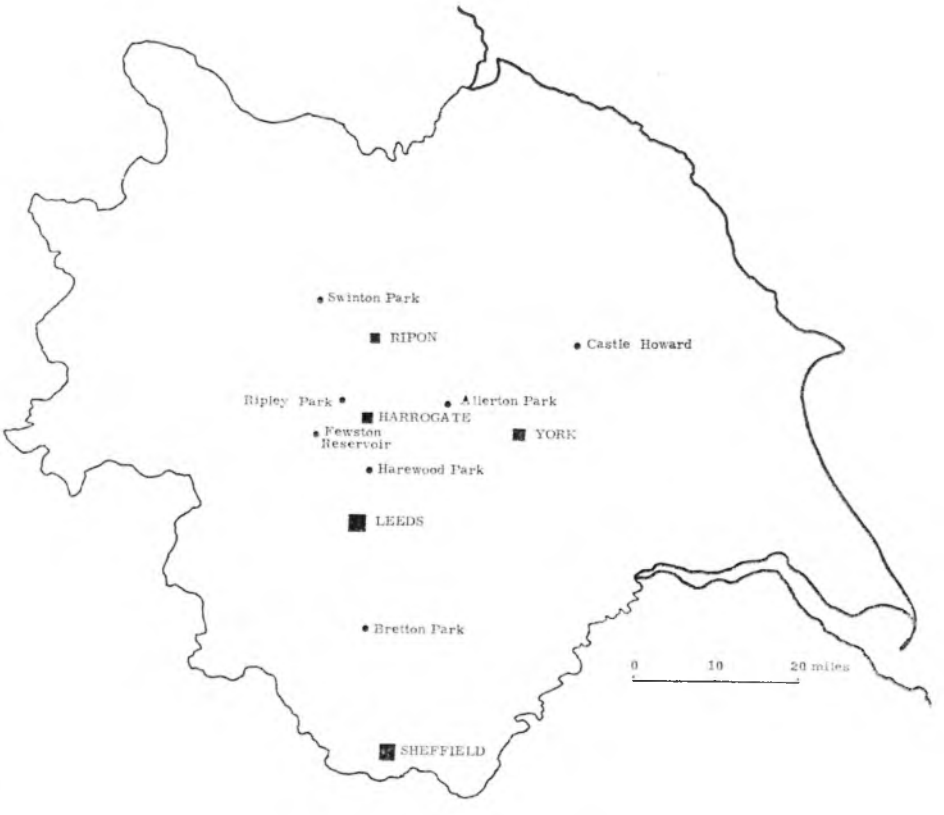


Figure 1. Locations of Canada Goose round-ups in Yorkshire.

Tables II and III indicate the origin of ringed Canada Geese caught on the Beauly Firth in 1968 and 1969. It will be noted that all controls on the Beauly Firth had either been ringed there or in Yorkshire, approximately 260 miles SE.

A number of birds have been proved to have made the double journey from Yorkshire to the Beauly Firth and back; no fewer than 14 geese ringed in Yorkshire and controlled on the Beauly Firth in 1968 were controlled back in Yorkshire during the moult in 1969. These and two others are shown in full in Table IV, whilst Table V gives the details of the five birds originally ringed on the Beauly Firth and subsequently recaptured first in Yorkshire and then back in Scotland.

Timing of migration and route

Information about the timing of the migration is still sparse. The moult normally starts in Yorkshire in mid- to late June and most birds are full-winged by the end of July, therefore it could be assumed that the northward migration should take place in May or early June and that birds would be capable of returning south in August. The following information is culled from the National Wildfowl Count Scheme, the Current Notes section of the quarterly journal *Scottish Birds*, and from personal communications.

(a) Northward migration: early observations on the Beauly Firth suggested that the flock is present from mid-April or May to September; recent counts revealed 110 present by 3rd June 1966; the following year there were 123 by 20th June and in 1968, 233 by 9th June. Additionally, three birds ringed on the Beauly Firth in 1968 and shot at Tynninghame Bay, East Lothian in May 1969 could well have been on their way back to the Beauly Firth. Another observation from Inverness indicated that between 1962 and 1966 the geese usually appeared about 20th June 'flying down the Great Glen in parties of 50-70'. Such records suggest that the northward migration takes place prior to mid-June. The following visual records of Canada Geese in places where they do not normally occur suggest that the geese indeed move up in small flocks rather than *en masse*:

33 flying over Redcar on the North Yorkshire coast, 5th June 1965;
14 on Duddingston Loch, Edinburgh, on 15th June 1966;
11 flying near North Berwick, East Lothian, 25th June 1966.

One control of particular interest, however, indicates that birds may move up remarkably late. A 1967 Harewood-ringed

Table II. Origin of Canada Geese controlled on the Beauly Firth, Inverness-shire, July 1968.

Year ringed	*Beauly*	*Ripley*	*Swinton*	*Allerton*	*Harewood*	*Bretton*	*Total*
1959	NR	1	NR	NR	NR	NR	1
1963	4	3	NR	NR	NR	NR	7
1964	8	NR	NR	NR	NR	NR	8
1965	NR	3	NR	NR	NR	—	3
1966	NR	3	7	NR	NR	2	12
1967	NR	5	21	6	23	—	55
Total	12	15	28	6	23	2	86

NR = none ringed.

Table III. Origin of Canada Geese controlled on the Beauly Firth, Inverness-shire, July 1969.

Year ringed	*Beauly*	*Ripley*	*Swinton*	*Allerton*	*Harewood*	*Fewston*	*Total*
1957	NR	1	NR	NR	NR	NR	1
1959	NR	1	NR	NR	NR	NR	1
1963	1	2	NR	NR	NR	NR	3
1964	4	NR	NR	NR	NR	NR	4
1965	NR	2	NR	NR	NR	NR	2
1966	NR	2	4	NR	NR	NR	6
1967	NR	1	18	7	11	NR	37
1968	52	15	—	NR	18	3	88
Total	57	24	22	7	29	3	142

NR = none ringed.

Table IV. Canada Geese proved to have travelled from Yorkshire to the Beauly Firth and returned to Yorkshire.

Ring No.	*Ringed Yorkshire*			*Controlled Beauly*	*Recovered or controlled*
	Year	*Place*	*Age*	*Firth*	*in Yorkshire*
130579 / 5024474	1957	Ripley	Juv.	1969	Shot Ripley, 1969
137795 / 5024142	1959	„	Ad.	1968	Controlled Ripley, 1969
5011472	1963	„	Juv.	1968	Shot near Ripley, 1969
5011478	1963	„	Juv.	1964	Controlled Swinton, 1967
5011489	1965	„	Juv.	1968	Shot near Ripley, 1969
5011755	1965	„	Ad.	1968	Controlled Ripley, 1969
5010611	1966	Bretton	Juv.	1968	Controlled Harewood, 1969
5010616	1966	„	Juv.	1968	Controlled Ripley, 1969
5010506	1967	Allerton	Ad.	1968	Controlled Harewood, 1969
5023674	1967	Ripley	Ad.	1968	Controlled Ripley, 1969
5023573	1967	Harewood	Juv.	1968	Controlled Harewood, 1969
5023580	1967	„	Juv.	1968	Controlled Harewood, 1969
5023612	1967	„	Juv.	1968	Controlled Harewood, 1969
5023658	1967	„	Ad.	1968	Controlled Harewood, 1969
5023681	1967	Ripley	Juv.	1968	Controlled Fewston, 1969
5023708	1967	Harewood	Ad.	1968	Controlled Ripley, 1969

Table V. Canada Geese proved to have travelled from the Beauly Firth to Yorkshire and returned to the Beauly Firth.

Ring No.	*Year ringed on Beauly Firth*	*Controlled in Yorkshire*	*Controlled on Beauly Firth*
5002861	1963	Harewood, 1967	1968
5020722	1964	Swinton, 1967	1968
5020765	1964	Allerton, 1967	1968
5020749	1964	Ripley, 1968	1969
5020773	1964	Harewood, 1968	1969

gosling, controlled at Harewood on 29th June 1968, was recaptured on the Beauly Firth 13 days later. Round-ups in late June usually include a few birds yet to commence moulting and which fly away on release. As this bird could never have been to the Beauly Firth before, it must presumably have been 'shown the way' by other adults familiar with the route. A much shorter post-capture movement was made by a Ripley-ringed 1967 gosling which having been controlled on the Beauly Firth in 1968 and at Fewston on 6th July 1969 was controlled again at Ripley, 8 miles NE., also 13 days later.

(b) Southward migration: there is more evidence about the timing of the southward movement. The earliest record involves 27 birds at Tynninghame Bay, East Lothian on 18th August 1968; 35 were present on Loch Leven, Kinross for about four hours on 21st August 1969; on 23rd August 1968, 50 geese (presumably Canada Geese on such a date) flew south over Perth and on the same day a bird was picked up dead under wires at Cockfield, Co. Durham (it had been ringed at Harewood in 1967 and controlled on the Beauly Firth in July 1968). Lastly, 60-70 flew S. (at 9.0 p.m.) over Arbroath, Angus on 29th August 1967.

In September the following observations were made:

1st September 1968 four at Tynninghame Bay, East Lothian;
1st September 1969 two shot Tynninghame Bay (ringed Beauly Firth 1969);
2nd September 1969 one shot Tynninghame Bay (ringed Beauly Firth 1969);
2nd September 1966 44 'over' West Hartlepool, Co. Durham;
4th September 1964 one shot Coldstream, Berwickshire (ringed Beauly Firth 1964);
5th September 1962 72 on Loch Leven, Kinross.

In 1969 about 300 Canada Geese flew in to Ripley Park Lake, Yorkshire, at dusk on 3rd September, the first large flock seen there since completion of the moult in late July. It is tempting to assume that these birds had just returned from the Beauly Firth. The latest sight records on the Beauly Firth referred to seven on 11th September 1965 and up to 22 on 16th September 1955. The earliest recovery in

Yorkshire of a bird ringed on the Beauly Firth in the same year is 12th September (Fountains Abbey, 1969).

One 1964 Beauly-ringed bird was found dead at Whitehills, Banffshire on 18th September 1966 (65 miles E.) and the remains of a Ripley-ringed bird, controlled on the Beauly Firth in July 1963, were found at Bay of Nigg, Aberdeen (86 miles ESE.) on 5th October 1963. In the latter case in particular the bird might well have died some weeks before. Lastly, a 1968 Beauly-ringed bird was shot out of a flock of six at Loch an Ordain, near Eriogie, Inverness on 23rd November that year (14 miles S.).

It would appear, therefore, that the return to Yorkshire starts in the third week of August and reaches a peak in the last week of August and the first week of September. The start of the shooting season on 1st September could introduce a bias into the records as there are no reported recoveries (apart from the Co. Durham bird — dead under wires) in August although the visual records show that birds are certainly moving south (for example Perth and Arbroath).

(c) Route: the flocks over Perth and on Loch Leven might indicate a route a little east of south in the autumn from the Beauly Firth to Yorkshire. The Banffshire, Aberdeen and Arbroath records suggest a coastal route avoiding the mountains though it is unlikely that a Canada Goose would be deterred from crossing high ground. There is a notable concentration of recoveries and sightings on the East Lothian coast.

From the above it will be apparent that much has yet to be learned about the timing of both migrations and the route. More visual records of migrating flocks are needed to supplement ringing recoveries together with more observations in May/June and late August/early September both in Yorkshire and on the Beauly Firth.

Acknowledgements

This study, undertaken in the writer's spare time, would not have been possible without the generous and willing assistance of a large number of people over the last twelve years whose enthusiasm has been a great encouragement. Without the ready co-operation of land-owners the round-ups would not have taken place. Roy Dennis (in 1963) and Doug Weir (in 1964, 1968 and 1969) ably organised the strenuous round-ups on the Beauly Firth. I am also greatly indebted to the Wildfowl Trust for its financial assistance and in particular to Hugh Boyd and Malcolm Ogilvie whose advice — and often active help — has done much to stimulate the study. To all grateful thanks are extended.

Summary

The moult migration of a part of the Yorkshire population of Canada Geese *Branta canadensis* to the Beauly Firth, Inverness-shire is recent in origin but now firmly established and involving over 300 birds. Ringing in Yorkshire has increased in recent years and round-ups on the Beauly Firth were made in 1968 and 1969 from which it has been learnt that immature birds make up 45-55% of the moulting flock. However, other immatures stay in Yorkshire. Several birds ringed in Yorkshire have been controlled on the Beauly Firth and subsequently back in Yorkshire. Visual and ringing reports indicate the timing of the northward and southward movements, and the probable route.

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A. F. G. Walker, 14 St. Helen's Road, Harrogate, Yorkshire.

The daily pattern of display in a wild population of Eider Duck

MARTYN L. GORMAN

Introduction

In most birds display is clearly related to the succession of day and night. Many song birds which are active by day begin their singing at dawn. During the morning singing gradually tapers off, reaching a low level in the early afternoon. Often there is then a resurgence of song towards dusk, but it is less vigourous than that of dawn.

Dawn and dusk display is not confined to the song birds however. Dawn crowing is typical of many game birds including the domestic Cockerel *Gallus domesticus* and the Red Grouse *Lagopus scoticus*. Lekking of Black Grouse *Lyrurus tetrix* and Sage Grouse *Centrocerus urophasianus* reaches a climax at dawn and a secondary peak of activity often occurs at dusk.

Eider Duck *Somateria m. mollissima* in captivity under non-tidal conditions are not equally active throughout the hours of daylight. Their rhythm of activity is similar to that of most *Anas* species, where after a burst of dawn display, the day is divided into many short periods of activity separated by intervals of rest.

In the wild, Eider Duck are usually to be found in situations subject to the influence of tidal change. The aim of the present work was to describe the daily pattern of display activity in such a situation.

Methods

Observations were made on the Eider population of the Ythan estuary, Aberdeenshire, between August 1966 and January 1967.

Eiders on the Ythan move down river with the ebb tide, stopping to feed at the mussel beds as they become exposed (Figure 1). Most of the birds reach the river mouth area by low water, leaving about two hours later and moving up river on the flood tide. During the period of high water they roost in the areas shown.

In order to quantify the frequency of male display throughout the day, the incidence of several movements used by male birds in pair formation ceremonies was recorded. The movements involved were coo-ing movements 1, 2 and 3, ritualised bathing, wing flapping and neck-stretch (after McKinney 1961).

The displays were counted in groups of twenty males, for periods of ten minutes. Each ten-minute period was separated by an interval of five minutes. The mean frequency of display within any ten-minute period was then expressed as displays per bird per minute.

The observations were made from nautical twilight to nautical twilight on two days per week.

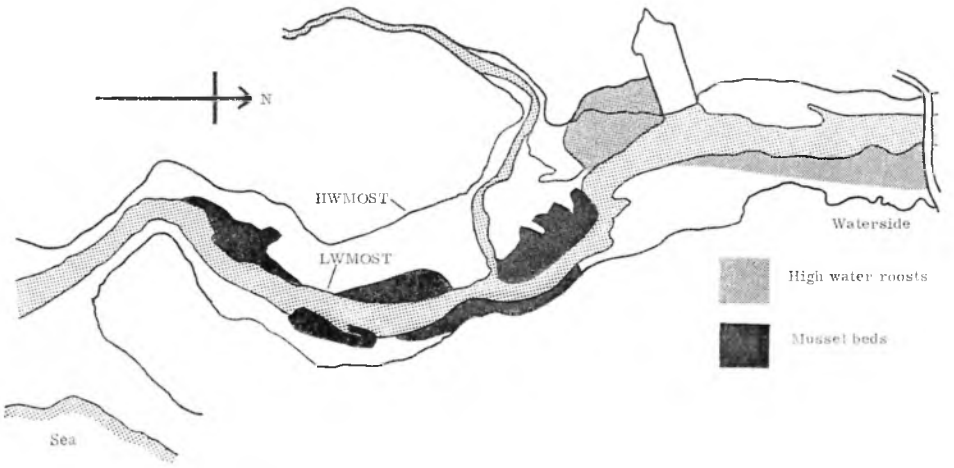

Figure 1. Map of the Ythan estuary, showing the position of the mussel beds and the areas used for roosting by Eider Duck.

Results

On any day display began just before sunrise and finished shortly after sunset (for example Figures 2 and 3). However, the frequency of display was not constant throughout the day. Generally, each day, the mean frequency on the flood tide was greater than the corresponding mean on the ebb tide (Table I). The overall mean display frequency on the flood tide, using the data from every day of observation, was significantly greater than the ebb tide mean ($t=7.7$; $p<0.001$).

Reference to Figures 2 and 3 clearly shows that the peaks of display frequency, associated with the flood and ebb tides, are separated by periods of behavioural quiescence, corresponding to low water, when the birds are feeding, and to high water, when they are roosting.

In addition to the tidal rhythm of display frequency, there is evidence of a second, diurnal, rhythm. A large peak of display is associated with sunrise, and a smaller one with sunset.

This complex of superimposed rhythms of display is analysed more fully in Table II. Each day of observation has been divided into three parts; two two-hour periods, one for an hour before and after sunrise, the other before and after sunset, and the intervening 'day' period. The tidal cycle on each day has been divided in a similar manner, but this time into four

Table I. Mean frequencies of display on flood and ebb tides.

	Mean displays per bird per minute	
Date	*Flood tide*	*Ebb tide*
10. 9.66	0.30	0.19
22. 9.66	0.20	0.16
27. 9.66	0.53	0.15
30. 9.66	0.56	0.18
5.10.66	0.62	0.53
8.10.66	0.86	0.31
12.10.66	1.46	0.53
15.10.66	1.74	0.91
19.10.66	1.43	0.84
26.10.66	1.42	0.57
29.10.66	1.12	0.47
2.11.66	1.16	0.84
5.11.66	0.71	0.92
9.11.66	1.75	0.80
12.11.66	1.40	0.53
16.11.66	1.54	0.72
19.11.66	1.48	1.33
26.11.66	0.91	0.60
3.12.66	0.77	0.65
13.12.66	1.31	0.36
17.12.66	0.94	0.54
4. 1.67	0.82	0.56
11. 1.67	0.92	0.62
18. 1.67	1.20	0.91
25. 1.67	1.20	0.83
1. 2.67	0.65	0.41
Mean	1.06	0.58
S.D.	0.21	0.09

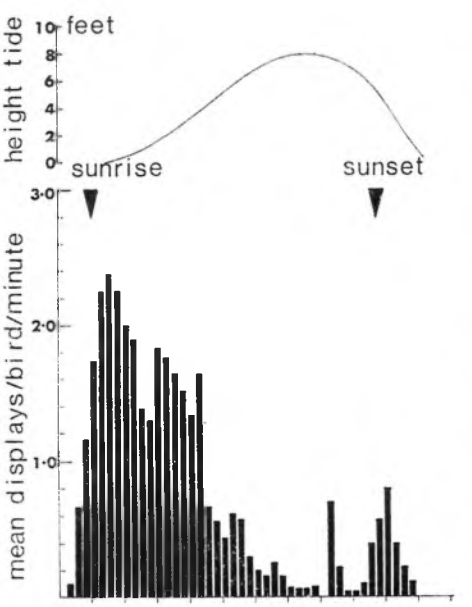

Figure 2. The pattern of frequency of display on 29th October 1966.

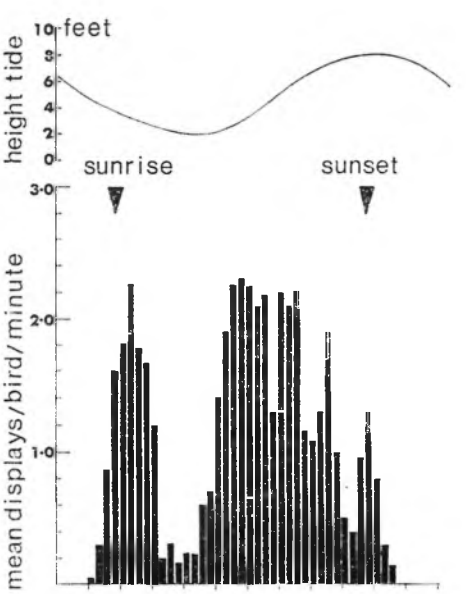

Figure 3. The pattern of frequency of display on 16th November 1966.

Table II. Mean frequencies and standard errors of display, measured in displays per bird per minute, for various combinations of tide and time.

		Flood tide	*High tide*	*Ebb tide*	*Low tide*
Dawn	mean	2.33	0.75	1.25	1.09
	s.e.	±0.15	±0.01	±0.04	±0.04
Day	mean	1.36	0.47	0.54	0.86
	s.e.	±0.08	±0.01	±0.02	±0.06
Dusk	mean	0.67	0.38	0.38	0.34
	s.e.	±0.02	±0.05	±0.08	±0.04

parts; one hour each side of low water, one hour each side of high water and the periods of flood and ebb tide. The mean frequency of display for each of the twelve possible combinations of tide and time has then been computed, using the data from every day of observation.

From this analysis it is clear that there are indeed two distinct rhythms of display involved, each of which can augment the effect of the other. Thus when the peaks of the two rhythms occur together, for example when a flood tide occurs at dawn, the resultant mean frequency of display is greater than the mean produced by one peak acting alone, as when dawn coincides with high water or a flood tide with 'day'.

In short, any combination of tide with dawn results in a greater mean frequency of display than the corresponding combinations with 'day'. In a similar manner a flood tide at any time gives a higher mean than the corresponding combinations of the ebb tide, low, or high water. Finally ebb tide combinations are always higher than their low and high water counterparts.

Every day display frequency drops shortly before sunset (Figures 2 and 3), only to rise to a peak at sunset and falling away after.

Although the peak of activity associated with sunset is discrete, and occurs each day, it is not demonstrated by the above analysis, since in magnitude it is smaller than the peaks in the 'day'.

Discussion

The dawn and dusk peaks of display shown by Eiders in non-tidal situations, are also demonstrated by their wild counterparts. However, the polyphasic periodicity of captive birds is replaced in the wild by a marked tidal rhythm resulting from the feeding behaviour of the birds.

At low water the birds are feeding and bathing, with the result that little display occurs. As they move up river on the flood tide they are comparatively satiated and presumably more free to display. High water is spent in roosting, feather maintenance and probably in digesting the food obtained at low water. As a result there is little display to be observed during this period. On the ebb tide the birds move down river and begin to feed, as mussel beds become exposed. Again there is comparatively little time available for display, consequently the mean frequency of display on the ebb tide is lower than that on the flood tide.

Acknowledgements

I am indebted to Dr. H. Milne and Dr. I. J. Patterson for their help and encouragement. Dr. J. Hinton criticised the paper in draft form and suggested many useful alterations. The work would not have been possible without the facilities which Professor V. C. Wynne-Edwards provided in his department. Financial assistance was received from the West Riding County Council of Yorkshire.

Summary

The daily pattern of display frequency among the male members of a wild population of Eider Duck *Somateria m. mollissima* is described. The birds exhibit marked diurnal and tidal rhythms. Display is more frequent on the flood than on the ebb tide. The diurnal rhythm is in the form of a peak of display at dawn and one at sunset. The two rhythms interact.

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Martyn L. Gorman, The University of the South Pacific, Laucala Bay, Suva, Fiji.

Field trials of the reactions of sheep to goose droppings on pasture

J. B. A. ROCHARD and JANET KEAR

Introduction

Farmers frequently complain that cattle and sheep avoid pasture on which there are goose droppings and that the effective loss of herbage is considerably greater than that actually eaten by the geese. In a previous trial under somewhat artificial conditions, sheep offered grass in a bare pen chose clean turves in preference to those with fresh goose droppings (Rochard and Kear 1968). They were not deterred by imitation droppings lacking the chemical constituents of excreta. The present trials were designed to test, under more natural conditions, the stability of the presumed chemical repellent factor.

Methods

Strips of pasture, 60ft. × 10ft., were fenced off at the Department of Agriculture and Fisheries for Scotland's Agricultural Scientific Station near Edinburgh. Each strip was divided into six 10ft. squares, marked by the fence posts. Half the squares were left clean (c) and half scattered, at the start of each trial, with droppings (d) in randomised sequences. In the three main trials these were c, d, d, c, d, c; c, c, d, d, c, d and d, c, c, d, d, c, respectively. Owing to priority requirements at the research station, the trials had to begin when fresh droppings of Greylag Geese *Anser a. anser* were not available. Droppings from a feral flock of Canada Geese *Branta c. canadensis*, feednear Slimbridge, Gloucestershire, were therefore collected fresh, deep frozen and transported to Scotland for use in the first trial. These droppings had a much higher average fresh weight (14.5 gm.) than Greylag droppings (approximately 4.7 gm. according to Kear (1963)). Nevertheless they were applied to relevant squares at a density of three droppings per square foot. This had been used in the previous experiments as being the highest density of fresh droppings found on natural pasture grazed by Greylag geese. In the second and subsequent trials Greylag droppings became available from the margins of Duddingston Loch, Edinburgh. To keep the 'contamination' level equivalent to the first trial, the same *weight* of droppings was scattered on the relevant squares. Thus, in the present series, the level of contamination was some three times that ever likely to be encountered under Scottish farming conditions.

Four Blackface × Cheviot ewes, individually marked and without previous experience of goose droppings, were used. They were kept in a holding pen which they had grazed bare before the trials started. In it they were provided with concentrated feed, hay and water. In each trial they were introduced into a fenced strip for two hours each day for six successive days. Feeding and resting activities, and the square occupied, were noted for each individual at five minute intervals. Between trials one and two the sheep were rested for six days, between trials two and three for 11 days.

During the three trials the sheep were thus faced at the start of the period with fresh droppings and then with droppings that had been exposed to one to five days of weathering. The series was completed by facing the sheep, after a rest period of seven days, with droppings of trial three which had then weathered for 14 days. Finally, after a rest of 33 days, the sheep were returned to the strip of trial one on which fresh droppings had been spread four days previously, in the same sequence.

Results

The total time each sheep spent in grazing and the proportion of that time spent on the clean squares was recorded. If there were no discrimination this would be around 50%. It is clear from Table I, which combines the results of the first three trials, that only on the first day, with completely fresh droppings, was there any marked avoidance of the 'contaminated'

Table I. Discrimination by sheep between clean pasture and pasture with droppings fresh at start of trial. Feeding on clean pasture is expressed as a percentage of total feeding.

Sheep No.	*Day 1*	*Day 2*	*Day 3*	*Day 4*	*Day 5*	*Day 6*
1	92	61	45	40	63	53
2	63	46	54	60	58	44
3	85	64	55	68	70	54
4	89	64	48	60	44	53
Total	82	58	53	59	58	51

squares, and one of the sheep (No. 2) did not even show this initial reaction. Subsequently none of the sheep showed any significant deviation from a chance selection of feeding site.

It might be argued that, having grazed predominantly in the clean squares on the first day, the sheep were forced by shortage of grass to graze in the 'contaminated' squares subsequently. This is not a plausible explanation of the results. In the first place, two hours grazing is unlikely to reduce the sward sufficiently. Secondly, there is no indication that the sheep were grazing preferentially in the 'contaminated' squares—only that there was a lack of discrimination. Nevertheless the point was further tested by exposing sheep to weathered droppings after periods during which both the sheep and the sward were rested (it was still in the growing season for grass). Table II shows that there was again a simple lack of discrimination.

The station's meteorological records were examined in relation to the feeding patterns. There did appear to be less feeding in wet weather, but no variation in the rate of 'weathering' of the droppings could be detected.

Table II. Discrimination by sheep between clean pasture and pasture with weathered droppings. Feeding on clean pasture expressed as a percentage of total feeding.

Sheep No.	*4-day weathered droppings*	*14-day weathered droppings*
1	50	75
2	71	46
3	50	36
4	29	43
Total	53	46

Conclusion

It would appear that only goose droppings that are completely fresh, less than 24 hours old, have any repellent effect on sheep. The repellent factor would thus appear to be rapidly volatile. The concentrations of fresh droppings used were in any case far greater than any likely to be encountered under natural conditions. The so-called 'fouling' of pasture by wild goose flocks is thus only a transient effect and not one likely to result in any real loss to the farmer.

Summary

Four sheep were required to graze on strips of pasture, half of which were scattered with fresh goose droppings in a density much greater than encountered under natural conditions. The sheep avoided the 'contaminated' areas only during the first day.

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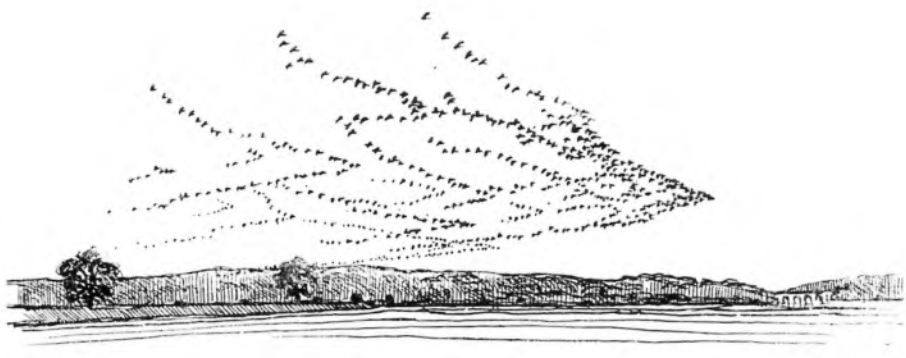
J. B. A. Rochard, Agricultural Scientific Services, East Craigs, Edinburgh, EH12 8NJ.
Dr. J. Kear, The Wildfowl Trust, Slimbridge, Gloucester, GL2 7BT.



Dispersal of phytoplankton by ducks

KATHLEEN M. ATKINSON

Introduction

The methods by which newly formed water masses are colonised by algae (and the discovery of new species in isolated water bodies) has long been of interest to algologists. Transport by wind, insects, mammals and birds are among the means investigated and it has been shown that birds form a major rôle in the dispersal of algae and protozoa over short distances (Schlichting 1960). The unicellular algae known as desmids were taken from the feet, feathers and bills of water birds by Irenée-Marie (1939), while Schlichting (1960) found many species of Chlorophyta, Cyanophyta and a few Chrysophyta. Schlichting lists 86 viable species found on the feet of water birds, and good algal growth was produced in cultures of samples taken from the gullets of birds. In contrast, samples from the faeces contained only a few viable forms. Species of Chlorophyta, Cyanophyta and desmids have been recovered from the digestive system of shot water birds (Proctor 1959, 1966). The same author has shown that when desmids are fed to water birds they can be recovered live from the faeces after being in the digestive system for at least one hour. Some desmids and Chlorophyta (for example *Pediastrum* sp.) could also be recovered viable after up to eight hours retention in the gut of a bird (Proctor *et al.* 1967) while viable *Chara* oospores could be retained for 24 hours. Freshwater algal species listed as food of wildfowl include *Chara*, *Nitella*, *Ulothrix*, *Vaucheria* and filamentous algae (not specified) — Anderson (1959), Festetics and Leisler (1968) and Olney (1963, 1967, 1968). Luther (1963) found *Vaucheria*, *Cladophora*, *Stigeoclonium*, *Oedogonium*, and filaments of Zygnemaceae and Cyanophyta in Mute Swan *Cygnus olor* faeces as well as diatoms (not specified), but did not test for viability.

The only reference to the transport of truly planktonic algae by birds is in Carausu (1968), who found *Microcystis* sp., *Pandorina morum*, *Scenedesmus quadricauda* and *S. obliquus* in cultures taken from the intestinal contents of several water birds. Schlichting (1960) states that planktonic organisms did not attach readily to birds or did not survive after exposure to air. However, Proctor (1959) suggests that ducks and bottom-feeding shore birds have a greater variety of algae in their digestive tracts than do fish-eating birds. Experiments were therefore carried out to test whether transport by such means was likely.

The experiments

The freshwater planktonic diatom *Asterionella formosa* Hass. (Figure 1) was fed to ducks to see if it could be recovered viable from the faeces. Two series of experiments were carried out at Slimbridge with Mallard *Anas platyrhynchos* (two male and two female) which were isolated in a closed room. In the first series of three experiments the culture of *Asterionella* was placed in the drinking water and also mixed with the food (grain). In the second series of four experiments, the *Asterionella* was added only to drinking water and the ducks were kept under observation until at least three had been seen to drink from the culture.

The ducks were allowed access to the alga for varying periods between ¾-hour and 29 hours and the algal culture was then removed and replaced with fresh water and food. After an interval, varied between ¾-hour and 3 hours, since the

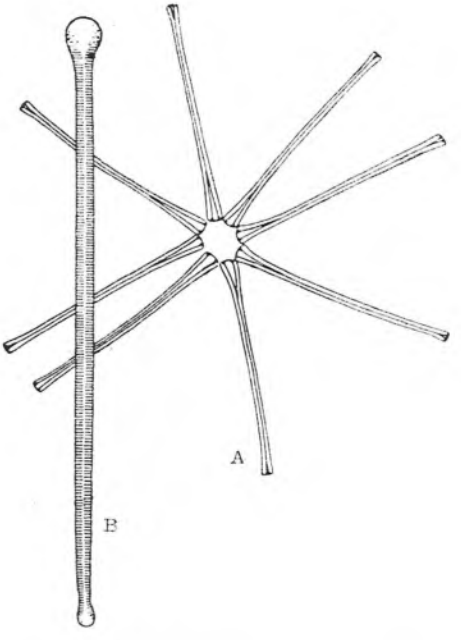


Figure 1. ***Asterionella formosa*: (A) colony (×650); (B) shell (×1950).**
(After Hustedt 1930).

algae had been removed, the birds were driven into a cage with a raised wire-netting floor, passing through a bath of water to ensure that they did not carry viable algae into the cage on their feet or feathers. The faeces were collected after 3-17 hours and made into a suspension in water. Samples of this were examined microscopically for *Asterionella* cells. Two to five millilitres were placed in culture solutions (Chu 10 and Chu 10+soil) and incubated. The remainder of the faeces were treated with nitric and sulphuric acid and examined microscopically for the silica shells of *Asterionella.*

Results

A few *Asterionella* shells were found in the faeces after acid cleaning in all cases except Experiment 1, in which the ducks had not settled down in their new surroundings and so may not have been feeding at that time. In Experiment 6 a few cells were also found before acid cleaning. In each case single cells were seen, not the colonies usually characteristic of *Asterionella* in culture and in the field.

The cultures had produced no live *Asterionella,* after 33-36 days, but, following acid cleaning, a few shells of *Asterionella* were found in them except in Experiment 1. A maximum of ten single cells was found in Experiment 6 in a 100 ml. culture. It would appear therefore that although a few *Asterionella* cells, apparently undamaged externally, could be recovered from the faeces, they were *not* viable when cultured.

The numbers of *Asterionella* cells collected from the droppings and cultures in each experiment was so small that it was not possible to relate them to the periods for which ducks had access to cells nor to the length of time the latter were in the birds' guts (i.e. faeces collected a short time after feeding did not contain more cells than those collected later).

A number of other species found in the tap water supply used were also found in the faeces or cultures, namely *Chlorella,* coccoid Chlorophyta (soil types), Cyanophycean threads (soil type) and mud diatoms. In addition, *Bumilleria* and soil diatoms were found.

Acknowledgements

I should like to thank the Wildfowl Trust and Dr. G. V. T. Matthews for the facilities provided, which enabled me to undertake this project, and I am especially grateful to Dr. J. Kear and Dr. M. Owen for their advice and help.

Summary

In the literature birds have been cited as playing a major rôle in the dispersal of algae. There is no record of the transport of planktonic diatoms.

The freshwater diatom *Asterionella formosa* Hass. was fed to Mallard *Anas platyrhynchos* and the faeces collected, examined and cultured. No viable cells of *Asterionella* were found.

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Miss K. M. Atkinson, Freshwater Biological Association, Ferry House, Ambleside, Westmorland.

A 'Slimbridge' in British Columbia

BARRY A. LEACH

The formation of the British Columbia Waterfowl Society

In June 1960, on my way to British Columbia as an immigrant, I broke my journey across Canada to spend a few days with H. Albert Hochbaum at the Delta Waterfowl Research Station in Manitoba. He casually mentioned that Peter Scott had once expressed the view that the Vancouver area was the ideal location in North America for a collection of wildfowl. On arrival I saw the truth of this remark. The climate of the Pacific coast was mild, great flocks of ducks and Lesser Snow Geese *Anser c. caerulescens* still visited the remaining marshes on their annual migration, and the pleasant farmlands of the Lower Fraser Valley offered nesting habitat for several species of waterfowl. However, it was the negative aspects of the situation which prompted me to seek support for the creation of a 'Slimbridge on the Pacific shore'.

In spite of their scenic appeal and recreational value, the coastal marshes were, and still are, being steadily reduced by urban-industrial sprawl. It seemed strange that no refuges had been set aside either to safeguard vital areas of marsh or to offer sanctuary to a proportion of the wildfowl population. During the shooting season about 15,000 guns subjected the ducks and geese to constant pressure. However, by 1960 many of those concerned with conservation in British Columbia were acknowledging the need to consider the aesthetic and educational aspects of wildlife and its habitat when assessing its value. As a result when I wrote to the *Province* newspaper suggesting the establishment of a 'Snow Goose Park' on the Fraser River Delta the proposal was received with much greater interest than I had dared to hope. Moreover, the publisher of the *Province* turned out to be Mr. F. S. Auger, who not only was President of Ducks Unlimited (Canada), but had just returned from a visit to Slimbridge. So, by a stroke of good fortune, my proposal went to the one man in British Columbia whose knowledge and position enabled him to act immediately in response. With his help, a meeting of persons anxious to save our remaining marshes was called. The result was the foundation of the British Columbia Waterfowl Society early in 1961.

The selection of a refuge site (Figure 1)

The directors of the Society agreed that their first objective should be to create a refuge which, like Slimbridge, would not only secure a significant area of

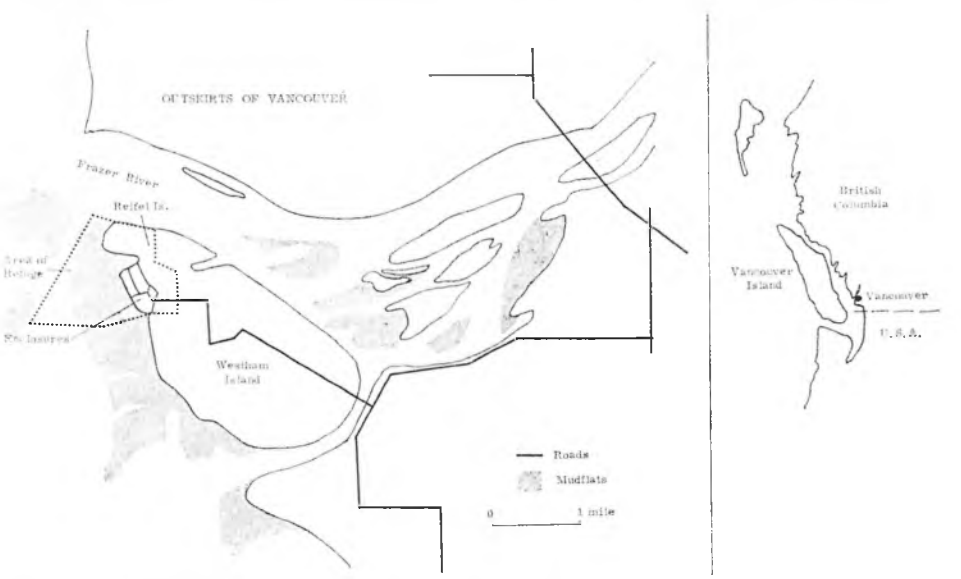

Figure 1. Sketch map showing location of Reifel Island Refuge.

coastal marsh but also offer opportunities for the observation, study and enjoyment of waterfowl, so capturing public interest and support. However, it was no simple task to select an area which was accessible to large numbers of visitors, suitable for a waterfowl collection, close to a large tidal marsh favoured by birds—especially the Snow Geese, and which could be declared a refuge without offending local waterfowl hunters. We made a survey of possible sites in the area of Vancouver and narrowed the choice down to four—Pitt River Valley, Mud Bay, Tsawwassen Bay and Reifel Island. Dr. G. V. T. Matthews, Director of Research at Slimbridge, visiting us in July 1962, confirmed our impression that Reifel Island was the best from every point of view. By our second stroke of luck, the owner, Mr. G. Reifel, welcomed the opportunity to fulfil the dream of his father, George C. Reifel, to turn part of his island home into a sanctuary. He generously leased 40 acres of foreshore land to the Society for 30 years at $1 per annum. Beyond the sea dyke lay extensive sea-marshes which were Provincial Crown Land. In 1963 the Society succeeded in persuading the Provincial Government of British Columbia to declare 700 acres of these marshes a Provincial Waterfowl Refuge.

The area thus secured is bounded to the west by the 15 mile wide Georgia Strait, running between the mainland and Vancouver Island. There the low tide exposes great sand flats, a feeding area for thousands of waders and a resting place for ducks and geese. The rising tide brings in sea birds and diving ducks: Scoters *Melanitta deglandi* and *nigra*, Long-tailed Ducks *Clangula hyemalis*, Scaup *Aythya marila* and *affinis*, Goldeneye *Bucephala clangula*, and Harlequin Ducks *Histrionicus histrionicus*. The edge of the marsh is a maze of hummocks and clumps of bulrushes *Scirpus* spp. on whose rhizomes and shoots the Snow Geese feed. The sedges *Carex* spp. fringing the broad tidal creeks provide additional food for the thousands of dabbling ducks which loaf there between their daily flights to farmland. Further inland the sea-marsh becomes a thick jungle of cat-tails *Typha* spp. tangled with immense quantities of driftwood. Behind the sea dyke of Reifel Island are meadows divided by broad drainage ditches and two large tidal creeks. The latter have now been blocked at both ends to form lakes 800 yards long and 40-60 yards wide which provide resting areas for flocks of about 2,000 American Wigeon *Anas americana* which graze on the meadows in the winter. The shallow waters of the island are almost choked with beds of sago pond-weed *Potamogeton pectinatus*, so attractive to the diving ducks. The hedges and coppices on the island add yet further to the variety of its habitat. As a result the Refuge attracts a greater number of different birds than any other area on the coast, 155 species having been recorded.

No sooner was the Refuge established than it proved its efficacy. Two thousand Canada Geese *Branta canadensis parvipes*, which previously visited the Fraser Delta only for a few weeks in October, remained on the Refuge until snow deprived them of grazing in January. Since then flocks have visited the Refuge each winter, resting on the sand flats and flying into the meadows daily until hard weather drives them further south.

We were unfortunately less successful in holding the wild flock of six thousand Lesser Snow Geese in the Refuge for long periods. The area of their favourite inter-tidal marshes within the refuge boundaries at first proved too small to give them a sense of security. However, they are now beginning to make more use of the refuge and there is hope that the boundaries may soon be extended seaward so that the Snow Geese become as permanent a part of the winter scene here as the White-fronted Geese *Anser a. albifrons* are at Slimbridge (Plate VIb, p. 49).

The development of the Refuge

Even without the Snow Geese, the spectacle of thousands of ducks moving to and fro across the tidal marshes against a background of snow-capped mountains was sufficient to justify the Society's hope of making the Refuge a public attraction. But confronted with the task of designing the waterfowl park I now regretted that I had not noted the details of construction and layout when I had helped to conduct visitors round Slimbridge ten years before. This time the *deus ex machina* was the Royal Canadian Air Force which gave me the task of studying means of reducing the hazard of bird strikes to their European based aircraft. During the course of this work it was necessary to consult the leading experts on bird migration, including Dr. Matthews. A visit to him at Slimbridge in 1964 presented the opportunity needed to study the lay-out and functioning of the Wildfowl Trust grounds and collection and to seek the expert advice of the Hon. Director, Peter

Scott, and the Curator, Tommy Johnstone. Other of our Society's directors who have since been to draw inspiration from Slimbridge are C. H. Marx and Sir L. Lennard.

With the plans completed we were still confronted with the problem of raising funds for their fulfilment. However, over the last five years many of our needs have been met. The first major contributions came from Vancouver business men. Then, in 1965, Ducks Unlimited (Canada) designated habitat improvement on Reifel Island as its first project in British Columbia, and made available a grant of $10,000 and the engineering advice of Mr. G. Campbell. The Canadian Wildlife Service immediately added $35,000. This made it possible to build a dyke 4,500 feet long enclosing part of the inner cat-tail-clogged tidal marsh which could now be cleared and converted into brackish marsh for feeding and nesting with controlled water levels. Even while the bulldozers were still at work, waders, especially Greater Yellowlegs *Totanus melanoleucus* and Long-billed Dowitchers *Limnodromus scolopaceus*, thronged the shores of the new ponds and waterways. Smartweed *Polygonum* sp. and barnyard grass *Echinochloa crusgalli* grew with amazing rapidity on the freshly dug soil and within a few weeks attracted large flocks of Pintail *Anas acuta*, Mallard *Anas platyrhynchos*, American Green-winged Teal *Anas crecca carolinensis* and American Wigeon. Sago pond-weed spread into the larger ponds and attracted a flock of 200 Canvasbacks *Aythya vallisneria*.

The habitat improvements also had marked effects on the species breeding in the refuge. By the spring of 1967 the numbers of nesting Blue-winged Teal *Anas discors* and Cinnamon Teal *Anas cyanoptera* had at least quadrupled. Mallard and Gadwall *Anas strepera* had increased too, seeking nesting sites in the newly dyked brackish marsh together with American Bitterns *Botaurus lentiginosus*, Green Heron *Butorides vivescens* and Virginia Rail *Rallus limicola*. It was also encouraging to see that Wood Ducks *Aix sponsa* were making use of many of the nesting boxes we had put up in the waterside alder and poplars. Unfortunately the breeding results were disappointing because many pairs were evicted by pugnacious European Starlings *Sturnus vulgaris*.

The waterfowl collection

By this time the society had a Warden living on the Refuge and in 1968 Mr. Stanley Devereux, from Bristol, was appointed Manager. Once the Refuge had a permanent staff it was possible to assemble a waterfowl collection. This started modestly with some Canada Geese and Mallard. But it soon grew with the donation of Trumpeter and Whistling Swans, Ross's, Snow, Blue, White-fronted and Cackling Geese, all the dabbling ducks of British Columbia plus some Black Duck from Ontario, Redhead, Canvasback, Scaup, American Goldeneye, Bufflehead, and Ruddy Ducks. We now have, at the end of 1969, some 700 wildfowl of 36 species. They live within a fenced area of 40 acres, divided into eight pens of varying sizes. The fences are only three feet high, but to keep predators out, especially Raccoons, Foxes and Mink, an electric cattle wire is placed a few inches from the top of the perimeter fence and electrified at night. A raised gravel path circuit enables visitors to see the collection, and visit the observation blind overlooking the marsh. The Manager's house has already been erected near the car park at the entrance, and as funds become available we plan to add a public display area and gallery, washrooms, library, laboratory, office and student accommodation. We anticipate an increasing flood of visitors, with the outskirts of Greater Vancouver, a city of 900,000 inhabitants, only 15 miles away.

Wild shorebirds and waterfowl join those in the pens. It was an exciting moment in March 1969 when a pair of Trumpeter Swans *Cygnus c. buccinator* flew into the lake beside the pen where our pinioned Trumpeters were calling. They stayed for a few weeks feeding on sago pond-weed and flying out to the sea-marshes for grit. But early in April they resumed the journey to their breeding haunts in northern Alberta or on some yet undiscovered lake in the interior of British Columbia. Perhaps they and their brood will return next year, duplicating the saga of the Bewick's Swans *Cygnus columbianus bewickii* at Slimbridge. But even if they don't, the 'George C. Reifel Waterfowl Refuge' will be there for thousands of other waterfowl flying, like them, the hazardous journeys between the still-wild places of North America.

B. A. Leach, Douglas College, Institute of Environmental Studies, New Westminster, B.C., Canada.

The hand rearing of young Blue Duck

W. J. PENGELLY and JANET KEAR

Introduction

The Blue Duck *Hymenolaimus malacorhynchos* of New Zealand is an isolated species of uncertain affinities and is still largely unstudied, both in captivity and in the wild. It lives in fast-moving mountain streams, is apparently insectivorous, territorial, and has a long pair-bond (the male sharing the care of the young), all unusual features in the dabbling ducks with which it is generally classified.

In September 1968 a request was made by the Wildfowl Trust to collect eggs from the wild so that ducklings could be hand-reared and later shipped to England. Permission was granted and a clutch of four was taken from near the Hopuruahine River, North Island, on 25th November. They were successfully incubated by a bantam hen and hatched a month later.

This paper deals with the development of the Blue Ducks to one year of age. Aspects of the species' ecology and sexual behaviour will be considered in other publications.

The attempt to propagate the species in captivity was a sad failure. One male duckling died at eight days and the other at seven months. The females succumbed within a few days of each other at one year old. However, valuable knowledge was gained and it is fortunate that, as the clutch would have been destroyed by a flood that swept the nest-site away, nothing was lost from the wild population.

Downy young

Of the published descriptions of the young of Blue Ducks, only that of Potts (1870) is full and accurate. Later accounts (Delacour 1956; Johnsgard 1965) erroneously state that the ducklings lack the dorsal spotting typical of many anatid species, and the illustrations in Phillips (1926) and Delacour (1956) are incorrect for the same reason. Scott (1958) had, however, noted the 'curious golden brown spot on either side of the back' of young Blue Ducks in the wild.

The following description is an amplification of Potts' (1870):

> Bill, greyish-blue lightest on the lower mandible and rosy at the tip; membranous appendage, slaty black, well overlapping the lower mandible, basal part of both mandibles furnished with interlocking lamellae. Iris, dark brown. Legs and feet, yellowish-brown with pale digits and darker joints and webs.
>
> Body, upper surface dark grey, suffused with metallic green sheen brightest on the back. Cheeks and under surface, white with a dark stripe through the eye; a vertical dark line joins the eye-stripe to the crown. Wings, dark except for a white line where the secondaries will appear. A dark band runs along the upper thighs to the heel. Tail, rather long and greenish above with, at each side, a chestnut dorsal spot; under-tail chestnut.

The predominantly green, white and chestnut colour of these ducklings is probably unique and is certainly startling. In many respects, however, their patterning resembles that of the downies of other dabbling and perching ducks (see Figure 1). The vertical dark stripe from the eye to the crown is unusual and found otherwise only in Black-headed Ducks *Heteronetta atricapilla* (Weller 1968) and Torrent Ducks *Merganetta* (Johnsgard 1966), the taxonomic positions of which are also somewhat problematical.

Sexual dimorphism of the ducklings

The young birds were sexed, by cloacal examination, and given numbered web-tags at 11 days. It was noted subsequently that the colour of the dorsal spots differed in the sexes. In the two males, the spots were a uniform dark chestnut, while in the females the down was mainly pale fawn with only a few chestnut plumules. This variability was not seen at hatching and indeed does not clearly indicate the sex of the skin of a day-old duckling in the Wildfowl Trust Museum. However, photographs of the live birds at seven days show the difference quite distinctly and a colour picture of wild ducklings reveals the same dimorphism. Further material is obviously required. This feature as an indicator of sex appears to be unique, but has probably never been looked for in other waterfowl, where in any case it would hardly be obvious as the spots are normally pale, like the underparts.

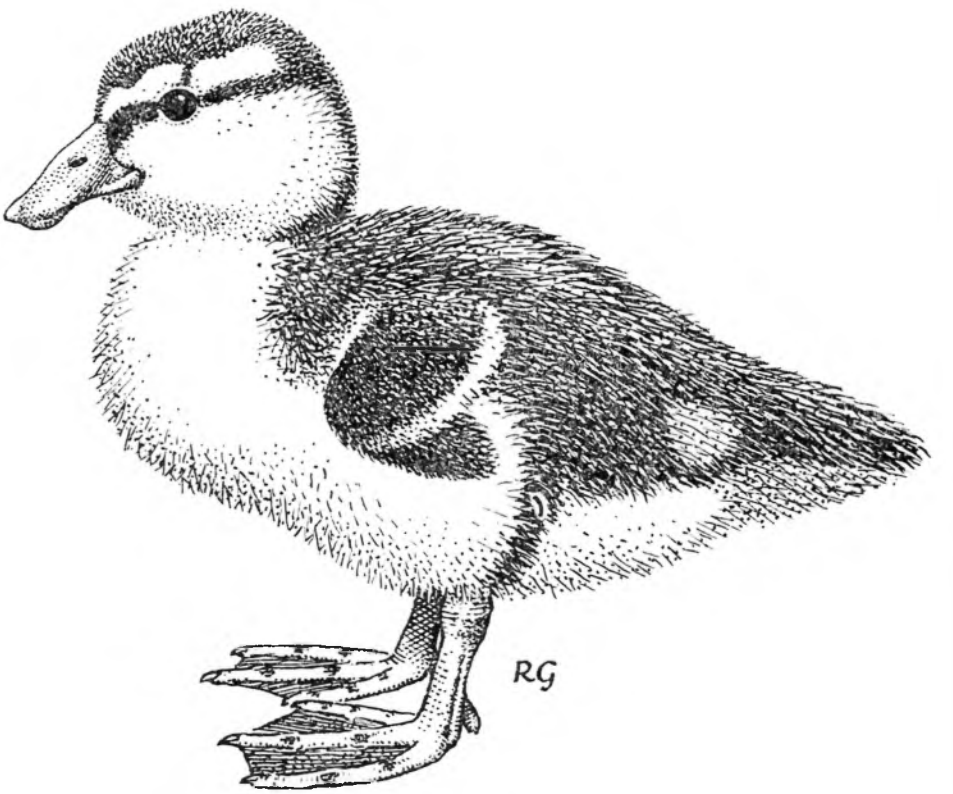

Figure 1. Downy young of the Blue Duck.

Table I. Feather growth in young Blue Duck.

Age in days	
24	Scapular feathers out of sheaths, but still beneath down.
26	Scapulars, underwing coverts and tail feathers showing through down.
29-31	Secondaries out of sheaths.
32	Feathering on face.
33	Crown of head well feathered.
36	Primaries out of sheaths. Belly almost completely feathered.
41	Head, neck and body nearly fully feathered. Down remaining on mid-back, lower neck and flanks. Primaries and secondaries not yet visible between the wing coverts.
46	Down visible only on mid-back.
48	Secondaries appearing from wing coverts. Dorsal spots losing definition.
56	Considered fully feathered, although traces of down could still be found at 97 days. Wings short, primaries barely longer than inner secondaries.
70-77	First flights.

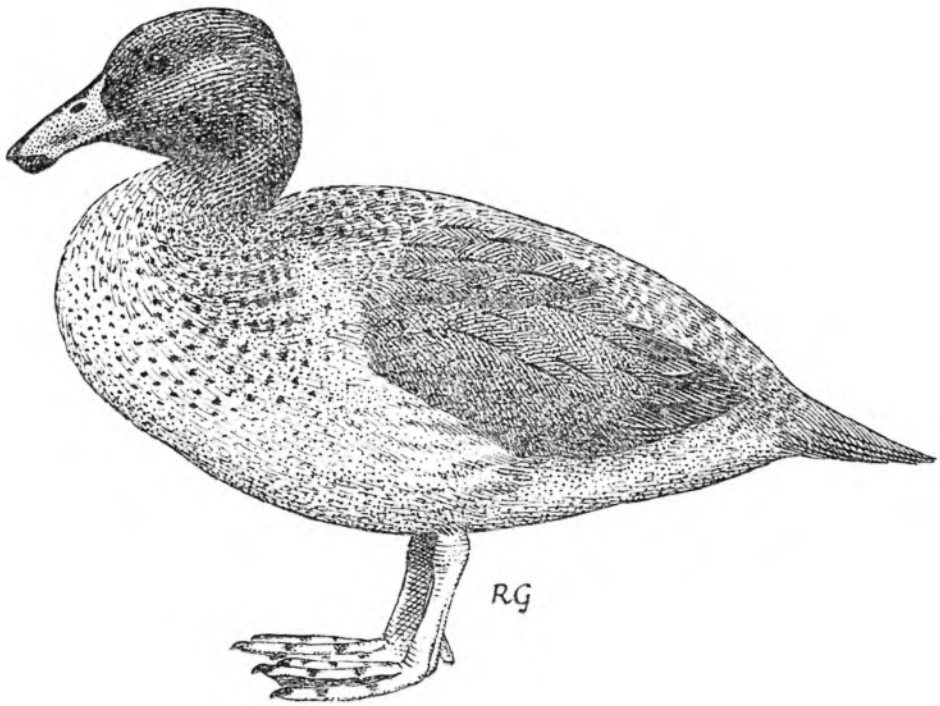

Figure 2. Juvenile Blue Duck in first plumage.

Feathering

The first contour feathers were noticed breaking from their sheaths beneath the down at 24 days. Table I shows the stages of feather growth. The juvenile first plumage (see Figure 2), which lasted from 8 to 20 weeks, was lead grey, with brownish shading on the wing coverts and heavy dark brown spotting on breast and shoulders. The undertail coverts were ginger, but otherwise the chestnut patterning of the adult was absent. The bill was light blue-grey, with a dark grey band from the culmen to the nail, and the eyes were dark brown.

At six months, full adult plumage had been attained; the bill was turning white and the iris distinctly yellow. At one year, the eyes were as golden as those of the adult, but the dark streak along the bill was still not completely eliminated (see Plate XIIa facing p. 97).

In July, a single adult male in the Slimbridge collection, and the two juvenile females, all moulted their wing feathers. The young birds were now only six to seven months old and it seems possible that in New Zealand the first change of flight feathers would have occurred not at this stage, but when the ducks

were a year old—the normal age for temperate species. This suspected change in wing-moult pattern after a shift from one hemisphere to the other poses the question whether adult plumage may also have been acquired earlier than usual. Observation in the natural habitat will confirm or deny this interesting possibility.

The rate of feather growth is slow in comparison with temperate dabbling ducks from higher latitudes. Flight in the Mallard *Anas platyrhynchos*, for instance, is achieved between 49 and 56 days (Scott and Boyd 1953). In waterfowl, a long fledging period has a tendency to be correlated with a long incubation period (Lack 1968). Thus the Mallard has an incubation period of 27-28 days (Ogilvie 1964) and the Blue Duck of 31-32 days (Kear unpublished), making it one of the longest among dabbling ducks.

Changes in body weight and linear measurements

Until they were nine weeks old, the young birds were weighed almost daily. Immediately upon arrival at Slimbridge they were placed in quarantine and could not be handled again until they were 14 weeks old. Subsequently, a single female was weighed when she was moved to another aviary. Table II shows average body weight at weekly intervals, and Figure 3

Table II. Average weight in grams of Blue Duck.

Age (weeks)	*Males*	*Females*
Hatching	49	48
1	66*	73
2	142	143
3	246	241
4	368	346
5	450	438
6	519	519
7	612	582
8	677	619
9	708	623
14	805	710*
23	—	742
Adult	887 range 753-1,077 (8 birds)	750 range 680-850 (5 birds)

* 2 birds until this age, 1 thereafter.

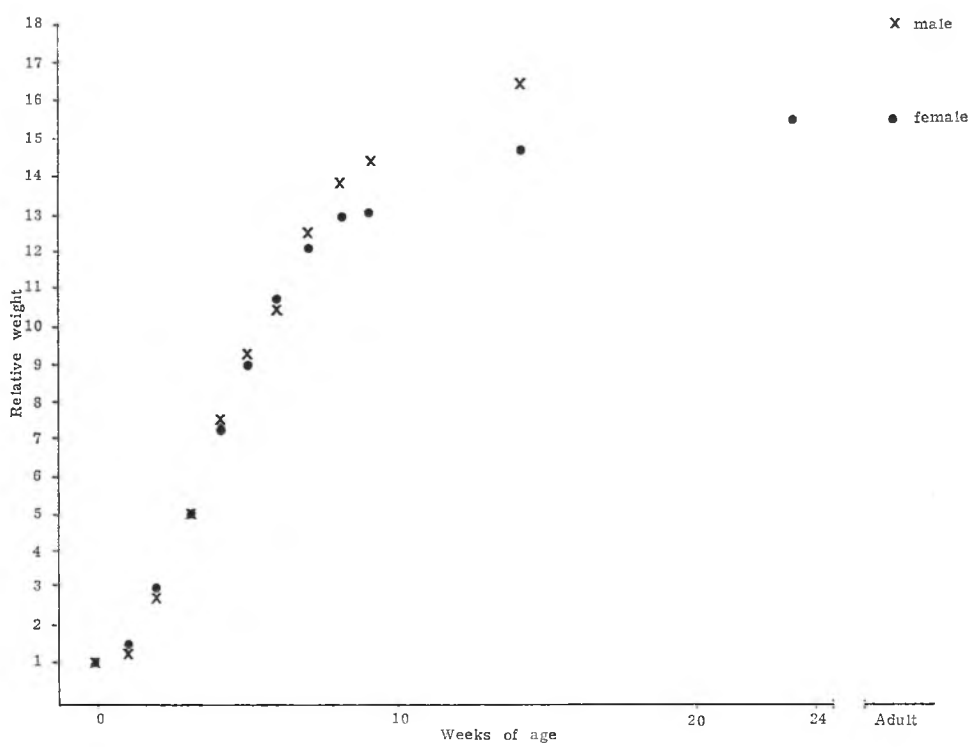

Figure 3. Relative growth curve of Blue Ducks (hatching weight equivalent to 1.0).

shows the relative growth curve, with hatching weights adjusted to 1.0. Adult weights are from Kear (unpublished).

At hatching Blue Ducklings are larger than young Mallard, which weigh about 35 gm. (Kear 1965), although adult Blue Duck average some 200 gm. lighter. This phenomenon of relatively large eggs and young is general among New Zealand waterfowl. The growth curve is, however, less steep than that recorded from higher latitude ducks, such as the Mallard (Southwick 1953) or the Tufted Duck *Aythya fuligula* (Kear 1970)—another feature common in New Zealand ducks.

Apart from the bill length, very few linear measurements were made because of the danger to the birds of prolonged handling. Some are given in Table III. As far as these go, they indicate that, except in weight, the birds are almost full-size at 14 weeks. Certainly the leg in many waterfowl develops quickly, presumably an adaptation to life on fast flowing water. Weller (1957), Dzubin (1959) and Kear (1970) all found that in diving *Aythya* species, the tarsus reaches full length between six and eight weeks.

Changes in the length of the bill (exposed culmen) are shown in Table IV. These data suggest that growth is rapid to 63 days but relatively little occurs after that, although the culmen does lengthen slightly after the flying stage is reached. Similar curves for bill growth are found in other ducks (Weller 1957; Dzubin 1959).

Table III. Average measurements in millimetres of Blue Duck.

	Hatching	*1 week*	*14 weeks*		*Adult*	
			♂	♀	♂	♀
Head (bill tip to back of skull)	44.2	48.0	91.4	84.8	91.7(4)	86.2(6)
Tarsus length	23.3	25.8	50.7	47.5	49.8(4)	47.0(4)
Tarsus thickness	1.8	2.2	4.6	4.6	4.8(4)	4.7(5)
Wing	—	—	225	215	233(4)	217(3)

Feeding

Persuading the ducklings to feed was no problem and they started gaining weight during their third day. Like other young dabbling and perching ducks, they initially pecked at small objects nearby and especially at shiny green and yellow objects which moved. The facial stripes, obscuring and protecting the small shining eyes, and pale bill tip, contrasting and attractive, both suggest a pecking habit.

For the first ten days the birds were given a turkey-starter meal, sieved egg-yolk, duckweed *Lemna* sp., chopped earthworms *Eisenia* or *Allolobophora* sp., maggots, flies, woodlice *Porcellio* sp., chopped bivalve molluscs *Amphidesma* sp., and quartz grit. From 16 days their diet consisted of earthworms (about 20 a day each until they were 30 days old), starwort *Callitriche* sp., and chick-starter 'Niblets' (a commercial meal in crumb form).

Live food was preferred but good quantities of 'Niblets' were taken, especially as the birds grew. As well as pecking, they used various other feeding methods. They 'burrowed' a great deal, even at two days old, pushing the bill into crevices (in the lawn, for instance, or under stones, or between human toes) and moving it

Table IV. Culmen length in millimetres of Blue Duck.

Age in days	♂	*Not sexed*	♀
hatching		15.3	
8		18.3	
17		24.7	
22	28.2		28.0
28	31.0		30.0
35	34.0		33.4
42	36.1		35.4
49	38.5		36.3
56	40.0		38.3
63	41.6		39.1
97	43.4		39.7
adults	44.0		40.8
range	42.3-45.1 (4 birds)		range 40.3-41.6 (6 birds)

rapidly from side to side. Woodlice were discovered beneath debris in this way. Maggots and other preferred titbits mixed with meal were found by pulling the bill *backwards* through the food. Items were also successfully sieved by sucking food and water in at the tip of the bill and squirting the water out at the sides of the mouth. The vacuum-cleaner action of sucking food off rocks, described by Scott for the adults, was not seen, probably because of the artificial rearing situation. At 10 days the ducklings were eating whole earthworms by picking up one end and shaking them from side to side as they slipped further down the throat. At 30 days, on the first of many subsequent occasions, the birds were seen doing a little grazing in a Mallard-like fashion. At 125 days they were first noticed diving to the bottom of their pond for food.

Other behavioural changes

The bantam proved an admirable foster-parent; she and her family did a great deal of travelling by car and plane before hatching and during the first two weeks and she never lost her calm demeanour. The ducklings imprinted well and responded to at least some of her calls. They froze at her alarm note, apparently without previous learning, but did not respond initially to her feeding clucks, although they were associating these with food by 16 days of age. By the fifth week the hen was losing interest and on the 44th day was seen attacking them, so was removed.

As might be expected in a species evolved in a land without indigenous mammals (except seals and bats), the ducklings were relatively tame and readily accepted the presence of human beings. Indeed, they soon learnt that people were very efficient providers of food, took many titbits from fingers and, on excursions to look for woodlice, followed the humans more closely than their foster-mother. They remained tame and frequently called to and approached visitors at Slimbridge. Their lack of fear was not absolute, however, and they were still freezing at sudden sounds at three weeks of age. On the 21st day their reaction to a stuffed and mounted Stoat *Mustela erminea* was tested (the hen having been removed). The effect was immediate and they rushed to the end of their coop in an apparently alarmed condition. Adult Blue Ducks in captivity show little response to this mammal (which was unfortunately introduced into New Zealand in 1885) and it may be a serious predator of the species in some places in the wild. On the 26th day, the sight of a visitor in a bright orange frock again apparently panicked the birds, which rushed into their coop and did not emerge until the woman had left.

The ducklings themselves were a close-knit group up to the time they were separated into pairs, in adult plumage, at 23 weeks. Aggressive action was never obvious. They did a great deal of nibbling at each other's heads and faces and were still sleeping touching each other at 10 weeks (a behaviour that normally ceases at fledging).

The voice of the young birds was typical of those of dabbling ducks (Kear 1968, and unpublished). The contact call was a rapid two- or three-syllable sound and the distress call consisted of slower notes, resonating at a higher frequency. No trills were heard, but a slurred sleepy call was given rarely, when the ducklings were under the hen at night. At 33 days the voice was starting to change, that of the females becoming more guttural. The rasping quack of the adult female was obvious at 10 weeks, at a time when the drake was still contact calling, but by 14 weeks a clear whistle was his normal greeting. As Phillips (1926) surmised, Buller (1882) was incorrect in attributing the whistle to the female, a misconception still apparent 80 years later (Child 1961).

A good part of the ducklings' day was spent preening and oiling their down and feathers, and the appearance of the various comfort movements corresponded almost exactly with that described for the Mallard by McKinney (1965). 'Dashing and diving' in water, which in Mallard appears at 13 or 14 days, was first noted in the Blue Ducks at 16 days, so it is possible that development was slightly slower at this age.

At walking, running and swimming the Blue Ducklings were as adept as any waterfowl, at jumping and climbing they were superior to most dabbling ducks. They climbed using their chins rather than their toes as perching ducks do, indeed their claws were not especially sharp. By six days they were jumping five or six inches straight up and at ten days, nine inches. In jumping, their chestnut under-tails became particularly obvious, and it seems likely that both their leaping abilities, and the flash of colour as they moved, have adaptive value in the wild where they must negotiate rock-strewn pools, their cries often

drowned by the thundering water around them.

Acknowledgements

The Wildfowl Trust is extremely grateful to the many people who assisted this study. The Wildlife Service, Department of Internal Affairs, Wellington, New Zealand, and the National Parks Authority (Head Office) gave permission for the eggs to be removed from the Urewera National Park. Mr. T. H. Steel found the nest and helped in numerous ways. Incubation by a bantam was arranged through Mr. P. R. Fisher and Mr. J. S. Standring, and Mr. C. D. Roderick allowed the birds to be cared for at Mount Bruce Native Bird Reserve, from 4th January to 26th February 1969, when they were sent by air to Slimbridge.

The drawings of the downy young and the juvenile bird were prepared by Robert Gillmor.

Summary

This paper deals with the captive rearing of a brood of Blue Duck *Hymenolaimus malacorhynchos* in New Zealand and England. The duckling is not without dorsal spots as has been previously stated and, indeed, a possible sex-linked colour difference in these structures was discovered. Development in feathering, weight and bill length was slower than in ducks which breed at higher latitudes. Feeding, preening, vocalization, locomotion and social behaviour are described. Excellent jumping abilities and the vivid undertail colouring are considered adaptive to the wild situation.

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W. J. Pengelly, Wildlife Service, Department of Internal Affairs, Wellington, N.Z.
Dr. J. Kear, The Wildfowl Trust, Slimbridge, Gloucester, GL2 7BT, England.

Double wing-moult in the Maccoa Duck

W. R. SIEGFRIED

During the past six years a captive male Maccoa Duck *Oxyura maccoa* (= *punctata*) in my wildfowl collection at Stellenbosch, South Africa, has regularly moulted its remiges twice annually, in January and in June of the same year.

Frith (1967) has reported that the male Australian Blue-billed Duck *Oxyura australis* has a complete prenuptial moult involving the wings and tail, and went on to say: 'In this period, unlike many other ducks, many males also change their wing and tail feathers again.' Besides introducing some confusion through the unqualified use of the word 'many', Frith provided no real evidence to support his brief, but important, statement. He credited another Australian oxyurid, the Musk Duck *Biziura lobata*, with a similar double moult, which led Johnsgard (1969) to comment: 'Most remarkably, Frith reports that Musk Ducks "have two moults per year and both involve the wings and tail", which, if true, would be unique in the family and notable among birds as a whole.'

The remiges of four captive Maccoa Ducks (three males and a female) were examined at bi-weekly intervals, over a period lasting two years. Artificially hatched, each egg came from a different clutch collected in the wild. The birds were kept in an out-door enclosure with a large pond. (I am indebted to Mr. R. Geldenhuys who cared for the birds.)

Six months after hatching in December (peak hatching time in the species' local breeding season (Siegfried 1969)), all four birds moulted their juvenal remiges, in June 1968. Thereafter, the new remiges were replaced in October 1968. Further complete moults of the remiges followed in January and June of 1969 and of 1970. Thus once past the age of one year, the three males and one female adopted the sequence of wing-moult shown by the older captive male. These observations confirm that sedentary Maccoa Ducks moult their remiges, when adult, twice a year. It would be of interest to know whether the migratory population of the Ruddy Duck *Oxyura jamaicensis* has a similar moulting regime.

According to Frith (1967), in Australia male Blue-billed Ducks begin the post-nuptial moult (involving body, wings and tail) in December and most have completed this by March, though the occasional bird is found still moulting in May. Male Maccoa Ducks in the south-western Cape normally assume their dull winter plumage in May (Siegfried 1968), two to three months after the post-nuptial wing-moult has taken place. In effect this means that the remiges are replaced while the bird is still in full breeding dress. By contrast, males of most anatids generally moult their flight-feathers during the time they are in 'eclipse'. The males of northern anatids (for example Mallard *Anas platyrhynchos* and Carolina Wood Duck *Aix sponsa*) hatched in the south-western Cape and allowed to breed naturally, are in eclipse from November to February when they also complete the annual wing-moult. Adult male Maccoas undergo the pre-nuptial (if, in this case, it be called that) wing-moult two to three months ahead of assuming the bright nuptial plumage. Incidentally, the three captive males served to confirm a previous finding (Siegfried 1968) that the Maccoa delays assumption of the bright breeding dress until well into its second year of life.

What selective advantage is this remarkable double wing-moult to the Maccoa Duck, and to the other Oxyurini in which it probably occurs? I can give no firm answer. The birds' diving habits might place extra wear on the remiges. However, Frith (1967) reported that in the Blue-billed Duck propulsion under water is entirely by the legs. The same applies to the Maccoa Duck, which I have observed swimming underwater.

Finally, I should mention that data on the Maccoa's tail-moult are still too incomplete to permit a definitive statement.

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Dr. W. R. Siegfried, Percy FitzPatrick Institute of African Ornithology, University of Cape Town, South Africa.

Studies on the development of young Tufted Duck

JANET KEAR

Introduction

When the Wildfowl Trust began a breeding biology study on ducks at Loch Leven, Kinross (Boyd and Campbell 1966), this became associated with the International Biological Programme's Project there. The aim of the I.B.P. was to draw up a complete energy-flow budget for the loch eco-system, which must include Tufted Duck *Aythya fuligula* feeding wholly within the loch. It was quite feasible to measure egg production, and its variation from season to season. It was much more difficult to estimate the survival of young, though this was clearly very low. It was impossible to follow their growth since this necessitated frequent recapture of the same individuals. Rearing Tufted Duck in captivity could provide growth data approximating to the wild situation, but the only previous study was that of Veselovsky (1951) based on but five unsexed birds, from a different stock (breeding in Czechoslovakia). A captive rearing programme was therefore undertaken.

It was undesirable to remove too many birds from the eco-system, so other studies were tied in with the primary one of measuring growth rate and food conversion. The internal reserves, in yolk and liver, around hatching had been studied extensively for the Mallard *Anas platyrhynchos*—the other main breeding duck at Loch Leven—by Kear (1965a). A set of comparable data was required for the Tufted Duck to indicate whether they were more likely to survive the critical period before feeding starts. The rate at which insulating fat deposits were laid down, and in which parts of the body, could have a bearing on the later survival of the birds. A comparative study of this aspect in Mallard and Tufted Duck, together with the rate of calcification of the bones, was made jointly with Dr. A. Evans and the results will be published elsewhere.

Material

Eleven clutches of near-hatching Tufted Duck eggs were collected from Loch Leven, under a licence issued by the Nature Conservancy, and hatched at Slimbridge. One clutch was taken locally and the ducklings reared with the Scottish birds. The 29 remaining at the end of the investigation, aged ten weeks, were released, with the feathers of one wing clipped, on to the main pond in the Wildfowl Trust enclosure. This was because a Ministry of Agriculture regulation did not permit their re-introduction into Scotland from England. A few bred the following spring, some probably with wild mates. All gained the power of flight that summer and joined the local wild population. Of the ducklings examined, 47 were males and 47 females, indicating an even sex ratio.

Methods

The ducklings were reared for the first 14 days in a large indoor cage. Two 250 watt lamps provided warmth, newspaper was used as flooring and terry-towelling as bedding. Initially, water was available only in small dishes and was changed frequently. At two weeks of age, the birds were moved into a shed with a wire mesh floor and a shallow, two-foot-square water tray. Overhead heating was again provided. At three weeks, they went outside on to grass with twice the quantity of water and with heat only provided in a shelter at night. At eight weeks they were moved again, to an unheated pen with a fairly large pond.

Food for the first month was chick starter crumbs (3% oil, 19.5% protein and 4% fibre) and subsequently pullet grower crumbs (3% oil, 16.5% protein and 5% fibre). A handful of duckweed *Lemna* and a small amount of quartz grit were added to the water daily. For the first seven days, some live food was offered to encourage the young birds to feed. Maggots and meal worms were the principal items, but flies, shrimps, moths and locust hoppers were given in small quantity.

Soon after hatching, the ducklings were sexed by cloacal examination and individually marked with numbered wing-tags. Weights, wing measurements and plumage changes were noted every two or three days.

Food reserves at hatching

The object of this part of the study was to assess the Tufted duckling's body, yolk and liver size at hatching. On these reserves depend in part its ability to survive until proper feeding is established.

Typically the brood spends a few hours in the nest and then follows its mother to the feeding grounds. If the weather is unfavourable, the parent may not leave until later. Extensive journeys are necessary if the nest is far from the feeding areas. As the Mallard's food reserves at hatching have been fully investigated (Kear 1965a; Markstrom 1966) indirect evidence on the survival potential of Tufted ducklings might be obtained by extrapolation.

Energy for embryonic development, for hatching, for locomotion between nest and food and for general metabolism until feeding starts, all comes from material laid down in the egg. Here, most of the calories are in the yolk. Although no tests have been made to compare the nutritive composition of eggs of waterfowl species, Lack (1968a) has established that the proportion of yolk does not vary significantly through the group. Factors that do differ quite widely are the absolute size of egg and yolk, and their size relative to that of the laying female (Lack 1968a, b).

The average fresh weight of 13 Tufted Duck eggs laid at the Wildfowl Trust was 53.3 gm. (47.5—59.0 gm.). These were produced by the released birds of Loch Leven or English stock at one year old and may have been slightly smaller than normal. Eggs laid in the wild are reported to weigh between 52.3 and 61.0 gm. (Isakov 1952), 55.7 gm. on average (49.1—60.5 gm.) for a sample of 23 (Niethammer 1938), 57 gm. (Heinroth 1922) and 56 gm. (Schönwetter 1960-61). The last figure was calculated from the linear measurements of 300 eggs and is probably the most reliable. K. F. Laughlin (pers. com.) has weighed 96 fresh eggs from Loch Leven and reports an average weight of 55.1 gm.

The average weight of females just before laying is not as easily obtained. Veselovsky (1951), combining figures from a number of sources, reported the range for adult females as 656 to 948 gm. Periods of high body weight seem to occur before laying in spring and before migration in autumn. More than 150 females have been caught on the nest at Loch Leven, but as they had already laid at least a part of their clutch, the figures cannot be used for the present purposes. Isakov (1952) gave 795 to 955 gm. as the range of May weights in the U.S.S.R., with 840 gm. as an average. By extrapolation, K. F. Laughlin (pers. com.) calculates a similar figure for Loch Leven birds just prior to nesting. If this is taken as a typical breeding female weight, each egg constitutes 6.7% of the female's body. This compares with a relative egg weight of 5.3% in the Mallard (Kear 1965b).

The weight of the egg is related directly to that of the young that hatches from it, and the size of the duckling is probably of particular importance in determining survival when conditions are rigorous. Some figures are available on the weight of Tufted ducklings soon after hatching: 37.4 gm. (35—41 gm.) n = 13 (Veselovsky 1951), 35.0 gm. (31.5—38.2 gm.) n = 4 (Smart 1955), 34.1 gm. n = 11 (Koskimies and Lahti 1962), and 35.6 gm. n = 38 (K. F. Laughlin pers. com.). During the present study, 100 were weighed to the nearest 0.5 gm. and these scaled on average 35.3 gm. (30.0—43.0 gm.). No previous investigation has had so many individuals available, and since there is no great variation between the published figures, 35.3 gm. will be taken as typical.

Table I gives average day-old weights of ducklings of nine other *Aythya* species, plus that of the Mallard. Average adult female weights are also shown. These are not of the same order of accuracy as the duckling weights since sample sizes are sometimes not known and adult weight varies through the year. Nevertheless, a ratio has been calculated between the size of the duckling and its parent, and this is given in the last column. The size of the downy Tufted relative to that of the mother is seen to be high. In continental diving ducks, the ratio of duckling to female weight seems to correlate fairly closely with latitudinal distribution (Delacour 1959) and probably, therefore, with the rigorousness of the climate. Thus, Tufted Duck, Lesser Scaup *A. affinis*, Canvasback *A. valisneria*, Scaup *A. marila*, and Pochard *A. ferina*, with relatively large youngsters, breed as far as the arctic circle or beyond to 70°N. Common White-eye *A. nyroca*, Redhead *A. americana* and Baer's Pochard *A. baeri*, with rather smaller ducklings, do not lay above 58°N., while Australian White-eye *A. australis*, with relatively the lightest offspring, nests in the warm near-tropics, not beyond 42°S. The New Zealand Scaup *A. novae-seelandiae* is a complete exception. It has presumably evolved its small clutch of large eggs and a heavy duckling in relation to features other than climate prevailing on remote islands (Lack 1970).

The procedure followed in assessing yolk and liver size in Tufted ducklings was described in Kear (1965a). Five individuals from different clutches were examined at approximately 48 hours before hatching and at exactly four, 24

Table I. Weights of captive *Aythya* and Mallard ducklings at hatching (4-24 hours old).

Species	*Number in sample*	*Mean weight in gm.**	*Mean female weight in gm.*	*Source of female weight*	*Duckling as % of female*
novae-seelandiae	82	43.9(35.5—51.5)	700	Lack (1968)	6.3
fuligula	100	35.3(30.0—43.0)	840	Isakov (1952)	4.2
affinis	34	32.1(27.5—39.0)	794	Kortright (1943)	4.0
valisneria	10	44.7(43.0—48.0)	1115	Dzubin (1959)	4.0
marila	16	39.1(26.0—47.0)	1000	Isakov (1952)	3.9
ferina	37	37.2(29.5—46.5)	947	Isakov (1952)	3.9
nyroca	82	22.0(16.5—28.0)	600	Lack (1968)	3.7
baeri	33	23.9(18.5—27.5)	640	Lack (1968)	3.7
americana	65	35.5(27.0—42.0)	993	Weller (1957)	3.6
australis	92	29.3(21.0—40.0)	852	Frith (1967)	3.4
Anas platyrhynchos	100	34.1(26.5—40.0)	1000	Lack (1968)	3.4

* *valisneria* from Dzubin (1959); all others original.

and 48 hours after hatching. They, and other sacrifices, were painlessly killed by euthanol injection. These samples were much smaller than those used in the Mallard study but large enough to indicate any major differences. Results are given in Table II.

In general, the Mallard and Tufted Duck show considerable similarity. The fresh egg of the Mallard weighs on average about 2 gm. less (Schönwetter 1960-61); as the proportion of yolk in both is initially 38% (Härms 1929-30; Lack 1968) the Tufted Duck in absolute terms has slightly more. Two days before hatching Tufted Duck still have more. At four hours after hatching, the amount and proportion of yolk in the ducklings is almost identical, and over two days of life in optimum conditions, it declines in a very similar manner.

The liver of the Tufted duckling is also initially larger than that of the Mallard, although by 24 hours of age it was identical in weight in the two species. The resources of the yolk sac are drawn on mainly during and just after hatching, when the expenditure of energy must be enormous. At the same time, much of the food material in the yolk is transferred via the blood to other stores such as the subcutaneous body fat and the liver. Thus, liver weight increases although the ducklings do not feed.

The Tufted Duck seems to be at an advantage, at least during the first 24 hours. It is slightly larger and has proportionately more yolk and liver than the Mallard. Some differences at a very early age are known between the Mallard and the Tufted Duck. For instance, Fabricius (1964) stated that young Tufted Ducks rarely leave the nest earlier than 24 hours after hatching, which is about 12 hours later than the Mallard (Kear 1965a; Bjärvall 1968). Further, Tufted Duck frequently nest far from suitable feeding areas; Hildén (1964), for instance, reported

Table II. Mean body, yolk sac and liver weights of ducklings (in grams).

Time from hatching	*No.*	*Total body*	*Yolk*	*Liver*	*Yolk %*	*Liver %*
		Tufted Duck				
−48 hrs.	5	46.1	11.5	1.0	25.0	2.2
+ 4 hrs.	5	37.5	3.4	1.5	9.1	4.0
+24 hrs.	5	32.5	1.8	1.6	5.5	4.9
+48 hrs.	5	32.4	0.5	1.7	1.5	5.2
		Mallard (from Kear 1965a)				
−48 hrs.	50	44.9	9.1	0.7	20.3	1.6
+ 4 hrs.	47	35.3	3.2	1.0	9.1	2.8
+24 hrs.	57	32.1	1.7	1.6	5.3	5.0
+48 hrs.	52	35.7	0.5	1.9	1.5	5.3

regular journeys of 4 km. across open sea by newly hatched broods. At Loch Leven itself, the main nesting island of St. Serf's affords poor conditions for duckling survival and broods are led to the loch shore 1 km. away.

In captivity Tufted ducklings do not start to feed as soon as Mallard (some, according to Veselovsky (1951), not until their third day) and begin gaining weight some 24 hours later (see Table II). This is possibly an artifact of the conditions but may imply a real difference in early feeding techniques which requires that the Tufted duckling be more mature. It is certainly less catholic in its tastes and appears to be much more dependent on live (moving) food than *Anas*, a point stressed by Veselovsky (1951), Gillham (1958) and Hildén (1964). Fabricius (1945) indeed postulated that insect food was indispensable for maintaining the waterproofing of their down. Tufted ducklings lead a particularly vigorous life, catching insects with rapid leaps and dashes (Hildén 1964) and making their first dives to the bottom at about 48 hours old (Fabricius 1951), at a time when the Mallard is still only dipping its head under the water (McKinney 1965). Koskimies and Lahti (1964) demonstrated that Tufted ducklings expend more energy and are more cold-tolerant. They exposed unfed Tufted ducklings, one day old or less, to air temperatures of 8° to 10°C. and yet the birds maintained their normal body temperature for as long as 18 hours. Their relative heat production was calculated to be 10% higher than that of young Mallard.

All these factors (together with that of rapid embryonic development in the egg probably reflected in a shorter incubation period) indicate a high metabolic rate. This is associated with good reserves of internal energy and presumably is necessary in order to cope with harsh environmental demands. The species has become adapted to a situation where feeding need not be established within the first day, but it seems likely that the duckling's condition could then deteriorate faster than does the Mallard's. Unless sound external nutrition were developed between 24 and 72 hours, high metabolism means that birds could not survive for a week without food, as recorded for Mallard (Marcstrom 1966). So weather and food availability at a rather precise period after hatching may be correspondingly more important to this species. In view of the compressed breeding season of the Tufted Duck (Boyd and Campbell 1966), the 'success' of any particular year may be based on conditions during a very few days.

Weight changes during development

Table III shows the actual weights of males and females up to ten weeks of age and the relative increases from the hatching weight (Table I). These relative weights are also plotted in Figure 1. Every two weeks five birds were sacrificed for the work on fat deposition and bone calcification. From four weeks onwards, only males were killed, in order to reduce variability in the small sample used. This study is being reported on separately by Dr. A. Evans.

Initially growth was rapid. By five weeks the birds had increased their weight 13-fold, and after another five weeks the males were over 18 times their birth-weight and the females over 16 times. At six weeks of age, the sexes were quite noticeably diverging in size and by the end of the experiment the females weighed only 90% of the males. This

Table III. Average weight in gm. of Tufted Duck reared in captivity.

	Males			*Females*	
Age in weeks	*No. in sample*	*Actual*	*Relative*	*No. in sample*	*Actual*	*Relative*
1	22	66.1	1.9	22	74.6	2.1
2	22	151.7	4.3	22	153.3	4.3
3	21	264.2	7.5	18	250.1	7.1
4	21	362.9	10.3	18	352.0	10.0
5	16	458.9	13.0	18	448.4	12.7
6	16	518.6	14.7	18	490.9	13.9
7	11	560.4	15.9	18	512.5	14.5
8	11	540.2	15.3	18	500.7	14.2
9	6	593.3	16.8	18	530.5	15.0
10	6	652.5	18.5	18	587.7	16.6

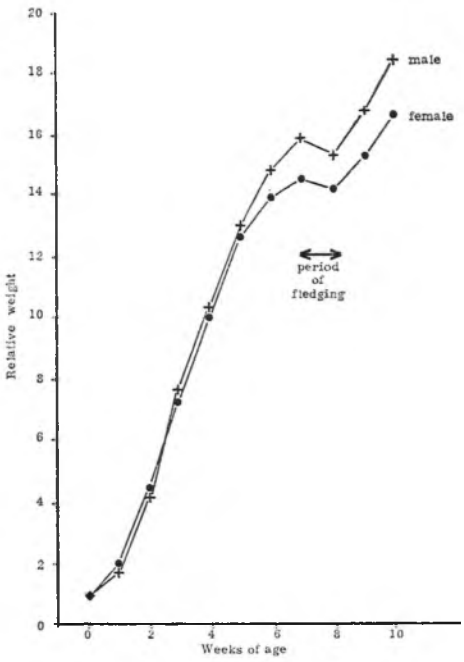

Figure 1. Relative growth indices of male and female Tufted Duck.

difference is probably about normal, at least until the females come into breeding condition (see figures in Bauer and Glutz 1969).

At fledging, already a period of probable physiological stress, the birds were moved to a more spacious pen with a large pond. Twenty-three of the 28 birds had already shown slight decreases in weight just prior to this move but after it every individual lost. Similar 'troughs' in the growth curve around fledging have been reported in Teal *Anas crecca*, Mallard, Gadwall *A. strepera*, Shoveler *A. clypeata*, Pochard, Common White-eye and Tufted Duck by Veselovsky (1953), in Redhead by Weller (1957), in Cape Shoveler *Anas smithi* and Cape Teal *A. capensis* by Brand (1961) and in Mute Swan *Cygnus olor* by Portman (1950). So they are commonplace in captivity and may occur in the wild in less than optimum conditions.

At ten weeks, the weight curves of the Tufted Duck had regained the line extrapolated from the two weeks before fledging, the recovery being particularly rapid between the 9th and 10th week. It was now early September and no further measurements were taken, but probably slow increase in weight continued. Eighty-one juvenile females caught at Loch Leven in the first two weeks of September averaged 619 gm. and 60 males averaged 666 gm. (C. Campbell pers. com.), slightly more than the ten-week-old juveniles in captivity. The weight of young wild birds during the second two weeks of September is little different: an average of 626 gm. for 23 females and 661 gm. for 28 males.

The rate of growth of the Scottish Tufted Ducks seems similar to that reported for five unsexed birds weighed to 55 days of age by Veselovsky (1951). Data on a number of other temperate or northern diving ducks have been published by Southwick (1953), Weller (1957), Veselovsky (1953, 1966), Dzubin (1959) and Elder (1954). Some weights in captivity at three weeks of age relative to those at hatching are shown in Table IV. The ratios are markedly similar to one another (varying only between 7.0 and 7.7) and consistently less than the initial weight gain found in five temperate dabbling species, also shown in Table IV. These, although often starting with relatively smaller ducklings, grow in three weeks to between 8.4 and 10.8 times their hatching weights.

After three weeks, species diverge more widely and individuals of the same species may grow at different rates depending, presumably, on such things as climate and food supply (or ability to make use of what is available). At seven weeks the Tufted Duck is on average 15

Table IV. Relative growth rates of 10 species of diving and dabbling ducklings raised in captivity, at three weeks of age. (Data from Southwick (1953), except *Netta rufina* (Veselovsky 1966) and *Aythya fuligula* (present study)).

Divers (Aythyini)		*Dabblers (Anatini)*	
Species	*Relative wgt. at 3 weeks*	*Species*	*Relative wgt. at 3 weeks*
A. americana	7.0	*Anas discors*	8.4
Netta rufina	7.1	*A. acuta*	8.9
Aythya valisneria	7.3	*A. platyrhynchos*	9.9
A. fuligula	7.4	*A. clypeata*	10.5
A. collaris	7.7	*A. americana*	10.8

times its hatching weight, Canvasback 20 times (Dzubin 1959), Red-crested Pochard *Netta rufina* 21 times (Veselovsky 1966), and Pintail *Anas acuta* 24 times (Southwick 1953). Many of the dabblers maintain their early lead in development and fledge more quickly than the diving species.

Plumage changes

Table V shows the progress of feathering; the age given is that when any bird first showed a particular feature. One female tended to be slightly more precocious than any of the males, especially in the early stages, but this may have been the result of individual rather than sexual variation.

Table V. Feathering sequence in Tufted Duck.

	First seen at Age (days)	
	♂♂	♀♀
Tail feathers starting to grow	14	13
Scapulars visible	18	15
First secondary through	22	20
First primary through	24	21
Feathers on cheek visible	25	24
Belly feathers visible	28	26
Belly completely feathered	31	30
White stripe across primaries and secondaries apparent		39
All down lost from head		40
First flights		49
Tuft obvious on head		56
All down lost from underwings and back		58

The first obvious feathers appeared on the shoulders and their growth spread downwards, around the wing. On the belly, feathering expanded rapidly from a narrow central line. Cheek feathering was first visible near the root of the bill and moved backwards over the crown and face. The last remnants of down were visible on the back of the head behind the eye, on the whole of the nape and on the dorsal part of the neck. Traces can be found on the 'small' of the back and under the wings even after fledging. The Tufted Ducks from Scotland tended to show the very early stages of plumage development before they had been observed by Veselovsky (1951). For instance, his birds grew their first contour feathers (scapulars) only at 20 days. The later stages of feathering seemed similar.

Differences between the sexes in eye colour, the males' being brighter yellow, were obvious by the 35th day. Voice was also becoming distinguishable at 37 days. By the 44th day, all females were making a recognisably adult sound (rendered by Veselovsky as 'karr'), while the males were still 'squeaking'. Further sexual differences in the juveniles are mentioned by Veselovsky (1951): the male can be distinguished from the female by a darker brown head and neck, and by his bluish-grey, as opposed to dark brown, bill. Both sexes have a short head tuft at eight weeks of age.

The very full descriptions of adult and immature plumages given in Witherby (1939) agree with observations made during the present study. The complete juvenile plumage lasts only until the birds are 14 to 16 weeks old. From then on, new feathers emerge and by the end of December, adult plumage is attained, although Tufted Ducks with notched tail feathers have been taken as late as April (R. King pers. com.).

Table VI and Figure 2 show changes in wing length from five weeks of age. The first quill to appear in the developing wing was a secondary at about three weeks, with the first primary a day or so later. From then on, growth proceeded

Table VI. Changes in average wing length in mm. of young Tufted Duck (sample sizes as in Table III).

Age in weeks	♂♂	♀♀
5	100.7	97.3
6	134.4	133.5
7	163.6	161.8
8	185.2	180.2
9	199.3	193.5
10	204.7	194.9
Range at 10 weeks	(198-209)	(189-202)

Philippa Scott

Plate XIII. Two species from Australia brought back by Dr. Janet Kear, and both new to the Slimbridge collection. (a) Australian Shoveler *Anas rhynchotis rhynchotis*. (b) Pink-eared Duck *Malacorhynchus membranaceus*.

Philippa Scott

E. E. Jackso

Plate XIV. (a) The Youth Hostel Association's Field Study Centre at Slimbridge was opened on 11th October 1969. The large window overlooking the waterfowl pond belongs to the Common Room. The two field study workrooms are on the left.
(b) The Chilean Flamingo *Phoenicopterus ruber chilensis* colony at Slimbridge in 1969. Five young, the first reared in Britain, can be seen.

Philippa Sco

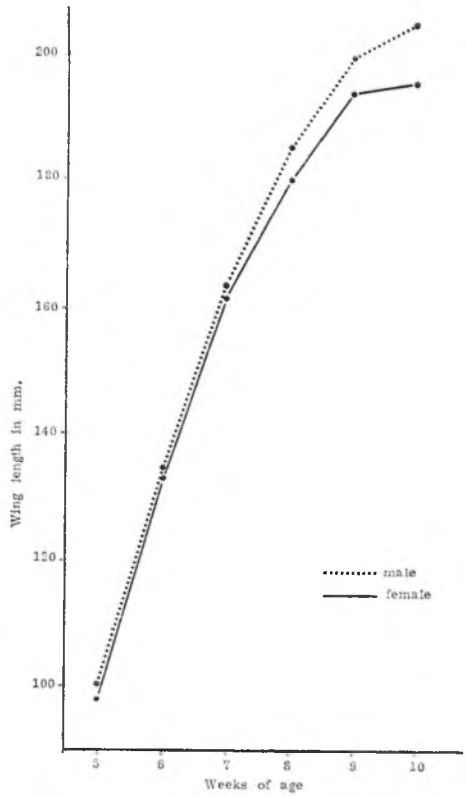

Figure 2. Wing lengths of young male and female Tufted Duck.

fairly uniformly in all quills. Wing measurement was of the standard chord, from carpometacarpus to the tip of the longest primary, the wing being closed and the flight feathers straightened but not flattened. Flattening by pressure at the carpal joint added on average 3.7 mm. (1.8%) to the length of the fully grown wing. At maximum wing length, errors of measurement did not exceed 2 mm. (1%).

The birds were capable of short flights before the wings were fully grown. The first bird (a male) seen lifting off the ground (at seven weeks) had wings measuring 177 mm., some 12% less than the average length for birds in their first winter. This was considered to have been reached at ten weeks of age. Schiøler (1926) gave an average of 197.9 mm. (190—214 mm) for 25 first year Danish males and 190.5 mm. (181—196 mm.) for 20 first year females. This is rather less than the Scottish birds reared in England but agrees well with figures obtained from wild birds at Loch Leven and Abberton, Essex. At Loch Leven 58 male juveniles caught in September had wings which averaged 198.7 mm., (162—215 mm.) and 83 females 191.9 mm. (174—204 mm.) (C. Campbell pers. com.). At Abberton 28 young males caught between September and February averaged 196.3 mm. (187—205 mm.) and 32 young females 192.8 mm. (180—200 mm.) (R. King pers. com.).

Date of fledging varies markedly between duck species with arctic and temperate forms tending to reach the flying stage earlier than tropical ones. Heinroth (1928) and Streseman (1931) also pointed out that in general dabbling ducks fledge faster than sympatric diving species. Undoubtedly, many *Anas* species do grow quickly: *crecca* flies in 5 weeks. Blue-winged Teal *discors* in 5½, Wigeon *penelope* in 6, *acuta* in 6½, *strepera* in 7 and *platyrhynchos* in 8, while Ring-necked Duck *Aythya collaris* and *ferina* are recorded fledging at 7½ weeks of age, *americana* and *valisneria* at 9 and *affinis* at 9½ (see Lack (1968) for all references). Streseman (1931) and Heinroth (1928) suggested a reason for the difference in the less aquatic life of dabblers, presumably leading to greater vulnerability to predators and pressure to shorten the period of relative helplessness. Put another way, divers can successfully exploit a 'difficult' food supply because the disadvantage of a slow growth rate is offset by a reduction in predation.

Changes in linear dimensions

In addition to wing length, a number of linear measurements were taken (with Vernier calipers, see B.T.O. (1965)) of the ducks sacrificed for the study of fat

Table VII. Average linear growth in mm. of young Tufted Duck (samples of 5).

	**1 day*	**2 weeks*	*4 weeks*	*6 weeks*	*8 weeks*	*10 weeks*
Culmen	14.1	26.3	33.7	37.2	39.2	40.2(38.9—41.8)
Head length	37.0	61.9	73.8	83.6	86.3	88.7(86.6—90.8)
Tarsus length	19.9	29.8	34.9	35.2	35.5	35.7(35.6—35.9)
Tarsus thickness	1.2	2.9	3.6	4.0	3.9	4.0(3.9— 4.1)

* mixed sex, other age groups males only

deposition and bone hardening (Evans in prep.). The averages are listed in Table VII.

The changes in body proportions were not uniform. The tarsus had reached near maximum length and thickness by the time the birds started to fly at seven weeks, while the head and bill continued to grow. Veselovsky (1951) gives the range of measurements of 15 three-month-old birds as bill 38—42 mm. and tarsus 35—40 mm., so the ten-week-old birds were probably full size. In Phillips (1926), the adult male range for the bill is said to be 38—40.5 mm., and for the tarsus 32—37 mm., and Schiøler (1926) cites an average of 39.5 (36—42 mm.) for the bill of 26 adult males in Denmark, and 36.8 (33—39 mm.) for the tarsus.

It is usual, in waterfowl, for the leg to develop quickly. The phenomenon is presumably an adaptation for life on water. Weller (1957) and Dzubin (1959) found that in two other diving *Aythya* species, tarsus length reached full size between six and eight weeks, although the bill continued to grow after the flying stages was reached. A similar finding was reported by Brand (1961) for *Anas smithi* and *A. capensis*, and Matthews and Campbell (1969) showed that in the Greylag Goose *Anser anser* the bill continued to lengthen slightly during the goslings' first winter.

Comparison of growth rates in different populations

It is possible that a population adapted to breeding at higher latitudes with a longer day length might mature faster. Results from the rather small samples (three females and seven males in the English group) did not bear this out. There was almost complete overlap in weight and wing length, at any age, with those from Scotland. Small average differences between populations breeding 5° apart might emerge from an investigation of more individuals.

Food consumption

A guide to the minimum food requirements of developing Tufted Duck in the wild can be obtained by assessing their food conversion rate in captivity. This gives the weight of food required per unit live weight gain.

An assessment based on the original study is somewhat inaccurate. No attempt was made to measure intake of *Lemna*, nor of the small invertebrates consumed, other than maggots and meal-worms. Some 'natural' food was also probably found in the outdoor pens. However, it was felt that none of these 'extras' were of great importance and they offset, to some extent, wastage due to spillage and loss to a few wild birds which managed to enter the pen.

An approximate total of 105 kg. of food was consumed by the group for a live weight gain of 26 kg., giving a factor of 4:1 to ten weeks of age. This is in close agreement with a factor for domestic ducklings (*Anas platyrhynchos* type) of 3.93:1 to eight weeks of age (M.A.F.F. 1960).

However, the calculations on food conversion made the assumption that the rate was constant. Brand (1961) showed that food consumption in *Anas capensis* and *A. smithi* declined from an average of 79 gm. per day, during a period of fast growth at four and five weeks, to 66 gm. per day (16% less) at 10 and 11 weeks when their growth curve was flattening out. Further, Holm and Scott (1954) demonstrated that on a 19% protein diet young *Anas platyrhynchos* consumed 1.76 lb. of feed per lb. gain in weight at three weeks, but 2.86 lb. per lb. at seven weeks. An exact analysis of individual intake of Tufted Ducks at various ages could not be made during the original study because all birds having reached three weeks of age were reared together. Also the total population gradually decreased as older males were eliminated. During the spring of 1970 it was possible to obtain a further clutch of eleven Tufted Duck eggs from Loch Leven. On the birds' 7th, 14th, 28th, 42nd, 56th and 70th day of age, food was restricted to a weighed amount to which only they had access. A polythene sheet enabled any spillage to be weighed with the uneaten portion at the end of the experiment. The birds were weighed at the beginning and end of 24 hours. Up to and including the 28th day, the ducklings had chick starter crumbs; subsequently pullet grower crumbs were given.

Table VIII confirms findings by other workers, that the weight gain/intake ratio is not constant during the growth period. As it is highest when the bird's intake is low, the overall rate is not the arithmetic average of the weekly values. To obtain really reliable figures it would be necessary to confine the birds in metabolism cages where total intake could be weighed daily. Such confinement might well introduce other complicating factors but should be the subject of further research.

Table VIII. Food consumption and food conversion of young Tufted Duck (average of 11 individuals, 3 males and 8 females).

Age in weeks	*Average food intake in 24 hrs. in gms.*	*Ratio of weight gain to intake*
1	23.0	1:1.99
2	34.1	1:1.8
4	57.8	1:2.3
6	87.0	1:9.6
8	48.0	1:8.8
10	74.4	1:9.0

These tests have relevance in that they allow calculation of the minimum impact of Tufted Ducklings on the ecosystem at each stage of their development. The minimum protein requirement can also be assessed. Holm and Scott (1954) found that for *Anas platyrhynchos*, *A. acuta* and *Aythya americana*, protein requirement for optimum early growth was 19%. The amount of protein in the diet fed to the Tufted Ducklings declined over the growth period, but was 18% on average. Thus, in captivity, a male Tufted duckling reaching 650 gm. weight at ten weeks consumes a minimum of 2,600 gm. of food, of which 470 gm. is protein.

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Summary

The growth period of the Tufted Duck *Aythya fuligula* is considered in a number of aspects. The size of the newly-hatched young relative to that of the mother is shown to be high in comparison with other diving duck and the Mallard *Anas platyrhynchos*. This may be related to a northerly breeding distribution. The internal food stores of yolk sac and liver were found to be marginally greater than those of the Mallard and perhaps give an advantage in very early life; however, the higher metabolic rate assumed for the Tufted probably causes more rapid depletion.

At five weeks of age birds were 13 times, and at ten weeks males were 18 times and females 16 times their hatching weight. This is slow in comparison with temperate dabbling ducks. Plumage characteristics and secondary sexual differences are described. The birds took their first short flights at seven weeks. The tarsus reached full size between six and eight weeks while the bill and head continued to grow after the bird could fly. No differences in weight or linear measures were found in birds originating from Scotland and England.

The food conversion rate over the first ten weeks was calculated to be approximately four units of food for every unit of liveweight gain. A total intake of 2,600 gm., including 470 gm. of protein, is therefore estimated to be required by a captive male Tufted Duck in that period.

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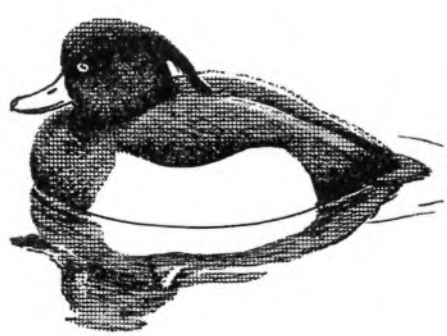
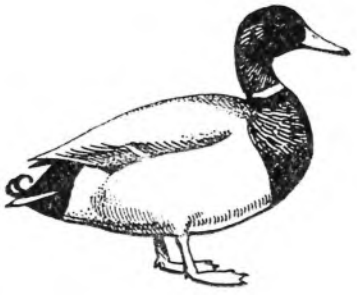
Dr. Janet Kear, The Wildfowl Trust, Slimbridge, Gloucester, GL2 7BT.





Current Reports, 1969
Slimbridge
WILD GEESE AT THE NEW GROUNDS, 1969-70

European White-fronted Goose *Anser albifrons albifrons*

The first to arrive were seven on 20th October. A month later there were still only 27, but new birds came almost daily in the last week of November, giving a total of 475 on 1st December. This rose to 560 on the 3rd, and then a larger influx took it to 1,040 on the 7th and 1,400 on the 8th. As is usual, these arrivals coincided with cold snaps. Further influxes occurred during December and there were counts of 2,650 on the 15th and 3,500 on the 23rd. There was a considerable arrival in early January with 6,300 present on the 9th. The peak came on 26th January when no less than 7,600 were counted. This easily beats the previous best count at the New Grounds (6,700 in February 1968). The peak was quite short-lived and by 6th February the total had fallen to about 6,000. It fell further to 5,400 on the 13th. There were still 5,500 on the 20th but early departures reduced the flock to 4,300 on the 25th and again to 2,100 on March 5th. Only four birds remained after the 9th, being last seen on the 24th.

A good breeding season in 1969 clearly contributed to the record numbers present. Indeed the number of two-year-old and adult birds present at the peak was actually slightly less than the total of similarly aged birds in the previous winter, when there were relatively few young. Sample counts in late November revealed 44.7% young in the flock (a very high figure) with an average brood size of 2.7. By the end of December this had dropped to 36.8% and there was a further slight drop to 34.6% in mid-February.

No Lesser White-fronted Geese *Anser erythropus* were seen this winter; the first blank year since 1964-65.

Bean Goose *Anser fabalis*

An adult, of the race *rossicus*, was first seen on 6th March. It stayed on with the last four Whitefronts until their departure on the 24th.

Pink-footed Goose *Anser brachyrhynchus*

Four, a family of two adults and two young, were seen on several occasions from 19th December to 4th January. On 16th January a pair with one young, and another pair were seen.

Barnacle Goose *Branta leucopsis*

One appeared on 9th January, and another on the 20th. Three were seen together on 8th February and a fourth bird on the 22nd. There were still three present on 5th March.

Dark-bellied Brent Goose *Branta bernicla bernicla*

A first winter bird was first seen on 14th December and remained until 13th February. An adult was also present from 16th January until mid-February.

M. A. OGILVIE

WILD SWANS AT SLIMBRIDGE, 1969-70

A pair of Bewick's Swans *Cygnus columbianus bewickii* was seen on Cheddar Reservoir, Somerset, on 31st October 1969, but none came to Swan Lake until 6th November, when eight birds arrived. They comprised two pairs that had been to Slimbridge previously and four new unpaired swans, three of which were second year birds. The numbers built up fairly steadily (arrivals between 6th and 23rd November averaged six a day) but in the last week of November the arrival rate rose to an unprecedented level. This was the period when the country was shivering under several degrees of frost, and between 24th and 30th November 176 Bewick's Swans arrived (i.e. 25 a day). Perhaps this major influx accounts for the very early date on which the maximum number of Bewick's Swans on Swan Lake in one day was reached. This was on 8th January, when 404 different swans were present (482 had by then been recorded). By comparison, in the previous six seasons the peak number occurred four times in February and twice in March. This season's peak was 38 more than the previous record, 366 in 1968-69. Similarly the previous record of different swans identified in one season was also surpassed, 570 swans being recorded, against 439 in 1968-69 (Table I). As many as 238 of these had been to Slimbridge before as adults or two-year-olds, a much better return rate than in any previous year. The full details of the number of returning birds related to the year they were first seen are set out in Table II.

The percentage of cygnets was at first misleadingly high. This was because a number of families with cygnets arrived early. By 27th November (not even one-fifth of the way through the season) more than two-thirds (i.e. 28) of the final total of cygnets had arrived and then represented 13% of the swans present. Except for one lone cygnet whose parents were unknown, all 28 were young of swans that had been to Slimbridge before. The eventual cygnet proportion of the flock was only 7%, and reports from other areas confirmed that, for the third year in succession, it had been a bad breeding season (see Table I). However, the average brood size was relatively high, indicating that the overall lack of cygnets was due to the complete failure of many pairs to produce young. This in turn suggests that weather or other conditions were adverse in some parts of their range and not in others.

Most of the swans that had been to

Table I. Numbers of Bewick's Swans at Slimbridge 1963-64 to 1969-70, and annual breeding success.

Season	*Total of different swans seen*	*No. returning from previous years (Adult/2nd yr. only)*	*Cygnets* No.	%	*Mean brood size*	*Maximum on Swan Lake on one day*
1963-64	24	—	6	25	2.0	24
1964-65	74	13	16	22	2.7	56
1965-66	148	31	43	29	1.7	125
1966-67	336	68	97	29	2.7	224*
1967-68	342	102	31	9	1.6	199
1968-69	439	130	34	9	1.6	366
1969-70	570	238	41	7	2.1	404

* 271 birds were counted on 13th January 1967, mostly on the River Severn and Dumbles.

Table II. Numbers and percentages of adult and second year Bewick's Swans returning to Slimbridge in seasons after the first sighting.

Season of first sighting	*Number seen for first time*	*Numbers, and percentages of original total, returning in subsequent seasons* 2nd No.	%	3rd No.	%	4th No.	%	5th No.	%	6th No.	%	7th No.	%
1963-64	18	13	72	11	61	11	61	9	50	7	39	6	33
1964-65	45	20	44	19	42	14	31	14	31	11	24		
1965-66	74	38	51	28	36	26	35	24	32				
1966-67	171	51	30	33	19	31	18						
1967-68	209	50	24	51	24								
1968-69	275	115	42										

Slimbridge before returned early in the season, while new swans, discounting cygnets, arrived more slowly and formed the bulk (82%) of the adults and second year swans that came after 1st January. By 24th December (one-third of the way through the season) only half of the new swans had come, but 87% of the previously recorded swans had arrived. Many Bewick's Swans that have become established at Slimbridge in earlier years therefore migrate fairly quickly to this area rather than moving on in front of the continental cold weather as the later (new) arrivals appear to do. Likewise, all the cygnets that came to Slimbridge and stayed (excepting the lone one) had arrived by 3rd January. Only the cob of the last family to arrive had not become established at Slimbridge in previous years. The two quite new families that arrived after 3rd January only stayed for a day each.

This season for the first time, three swans returned to Slimbridge having missed two winters. All three had been ringed, but they were quite recognisable without reference to the rings as Dingaan, Mouldy, and Bitsa. Dingaan, an adult in 1966-67, brought a mate. Mouldy, a two-year-old in 1966-67, also brought a mate. Bitsa, a three-year-old in 1966-67, had lost his mate. Fifteen swans returned having missed one season. Their details (and the three mentioned above also fit into this pattern) show them to be predominantly a certain 'type' of swan. In 1967-68 these fifteen were described as one cygnet, six second-year birds, three third-year, two adults and three of unknown age. Therefore most of these swans were immature; and only three were mated (one each of the last three categories). Two of these three returned alone this winter; their mates had either become lost or died. The third swan, Pouff, had the distinction of returning with its mate, Offset, which had spent the whole 1968-69 season here. They were the first pair known to become so separated and then reunited. It would be interesting to know exactly how long they had been separated; indeed how long a Bewick's Swan will wait before taking a new mate. The 'bachelor' gap may help to prevent a swan taking a second mate while the first is still alive. The possibility of a swan meeting up with a lost mate appears not to be as remote as might be supposed. Momac and Brown, for example, were a well-mated pair when Momac was injured in a flying accident in March 1969 and had to receive treatment. Brown waited five days, until most of the swans had left on migration. It was sixteen days later (on 27th March) before Momac set off. Yet on 26th November they returned to Slimbridge together.

In contrast though, John and Rachel, another firm pair, left Slimbridge together on 7th March 1969. When Rachel returned on 18th November she had a new mate. Pair forming and breeding may also take place quickly. Brimmer, an unmated swan, did not leave Slimbridge until 27th March 1969. When she returned this season, she brought a mate and cygnet with her.

The number of flying accidents was greatly reduced this winter and only eight swans (two adults and six cygnets) were ringed as a result of incompetent landings, against 47 last season. This must be a tribute to the improved floodlighting of buildings and trees, and it was fitting that it should happen in the season when catching of the swans became much less dependent on accident and more under our control. A channel leading out of a corner of Swan Lake was equipped with overlapping screens and a concealed approach. Swans feeding therein could then be driven, unable to take off because of the restricted space, up to a holding corral at the top of the Rushy Pen. This arrangement may be described as a success, although perhaps not an unqualified one—yet. There were four catches—7, 48, 53 and 13—but several birds were repeats, caught in previous drives. Altogether 97 were ringed or re-ringed with the large plastic rings that we now use. Two hundred and twelve Bewick's Swans have been ringed at the Trust since 1961.

The catch of 13 was made on 18th January. After that date only a very few swans would go up the channel. The others did not show any obvious fear of it—and indeed the catches had disturbed the pond amazingly little. However, most of the swans were in very good condition by then, and so might be less anxious to crowd up a narrow inlet to feed. They had also established preferred areas around the pond, from which they did not stray far.

Some ringed swans were seen in other places this winter. The furthest afield was in the Netherlands (see p. 152). A swan with a red and white ring was seen at Welney on 4th January but it was too far away for the number to be read. However, from the colours we know that it was ringed as a two-year-old in 1967-68, and that it has not wintered at Slimbridge since. Four ringed swans were seen at Hasfield (16 miles north of Slimbridge)

and 23 other swans were identified there. These 27 comprised 12 swans new to Slimbridge this winter that had not become established, five swans that had been firmly established at Slimbridge, and six swans that knew what Slimbridge had to offer from this and previous seasons, but chose to spend part, or almost all, of the winter elsewhere. This last group included Cheetah and Chalice (and their three cygnets) and Oliver and Denise. Both these pairs spent much of last season on the Moors, a mile from the Trust. This year, although both knew about the food, they left either because they could not stand the pressure of so many birds on Swan Lake at one time, or because they felt a need for grass, which was scarce around the Trust due to the long dry summer and late grazing by stock. The latter reason would account for the well-established five leaving—one pair for four weeks, the other three for a total of 16 days. The pair had tolerated a fortnight of 350+ swans on the pond when they left on 17th January, so it seems unlikely that population pressure was the deciding factor. The other three did not leave until February.

Reasons for absences are not always obvious. A pair in the first eight to arrive had spent a long winter at Slimbridge last year but left that same day and did not return until 3rd January. We do not know where they had been, nor why they should have left when space and food were plentiful. It has been noted that some of these more irregular swans tend to reappear at Slimbridge on Sundays. It is possible that they have been disturbed by people out at the weekend.

The season was very short. The arrival date (6th November) was the second latest by three days, and the first major departure of the swans came as early as 24th February. There was another mass exodus on 6th March, and the last three left on 18th March. Towards the end of the season, however, a novel and interesting quirk in swan behaviour occurred. The conventional behaviour has been for the swans to roost on the Dumbles and river mudbanks, and to fly between the estuary and the Trust twice daily to feed. This year there was less flying about than ever before, perhaps due to greater confidence coming from the almost disturbance-free conditions that have now been created, but in the last week ten swans used Swan Lake exclusively as a roost. They were one pair that had been firmly established in the first half of the season, one pair that had been to Swan Lake on a few isolated days, and six that had never been before. All ten would arrive in the dusk and leave again early in the morning. They were never seen to feed on the pond, and they were thought to be spending the day four miles up-river, but it was interesting that they should choose to roost on Swan Lake rather than on the river.

Only four Whooper Swans *Cygnus cygnus cygnus* came to Swan Lake this season, compared with 14 last year, and only three stayed. They were thought to be a pair and their cygnet, but like last year it was soon found that relationships were not what they appeared. First the cygnet disappeared for a week. Then it returned and 12 days later one of the adults left. The cygnet and the other adult, which incidentally had no tail feathers, stayed a further 17 days before leaving on 5th March. Few observations were made on any of the swans' behaviour, as the daily recording of so many birds left little time for anything else. However, this summer it is hoped to consolidate what has been learned from the detailed registers of the past seven years, so that next season the time spent on daily recording may perhaps be reduced, and more time devoted to other aspects of the swans' biology.

MARY EVANS

OTHER RESEARCH AND CONSERVATION

Slimbridge headquarters staff continued to co-ordinate and analyse the population and ecological studies made at the Trust's other stations and throughout Britain. These are reported on separately later in the Current Reports. This section is concerned with work in progress at Slimbridge itself.

The Decoy, operated under Mr. Ogilvie's supervision, in the autumn produced 720 duck, mostly Mallard. His small-scale breeding biology study of ducks in the Decoy Wood and on nearby Frampton Gravel Pits was continued. The Canada Goose population at the latter site was again rounded up for ringing.

The vegetation cover in relation to topographical level on the Dumbles and the slowing erosion at its edge were mapped by Dr. M. Owen. He examined agricultural management of the New Grounds and correlated variations in exploitation and disturbance with the goose usage of the different areas. Defaecation rates of geese in the field were determined so that droppings within 36 pegged plots on the Dumbles could be related to usage and preferences. Behavioural aspects of goose feeding studied included feeding time, pecking rates and walking rates, in different months and vegetation types. Related studies of feeding ecology at Bridgwater Bay, Somerset; Caerlaverock, Dumfries; and the Wexford Slobs, Ireland, were aided in planning and analysis. In conjunction with Dr. Kear, hand-reared geese were used to study the extremely rapid through-put of food and to determine preferences for different plants.

Using the Collection's facilities, Dr. Janet Kear amassed more data on clutch sizes and on weights of eggs and downy young. Returning from a four month sojourn in New Zealand, she was engaged in working up field data gathered there, particularly with regard Blue Ducks. Their growth patterns (p. 115) and those of certain waders were determined. Pecking preference trials were continued to test the rôles of object colour, brightness, shape, shading, size and movement in releasing feeding behaviour. Some further tests were made of depth perception and its maturation.

Post-mortems were carried out by Dr. Beer on birds dying within the Collections, mortality being a little lower than previously. A particular study was made of avian tuberculosis in collaboration with the Agricultural Research Council's Institute at Compton, Berkshire. Aspergillosis occurred sporadically, but could be avoided in newly arrived birds by getting them rapidly back into good condition. A paper is in preparation on amyloid disease and atherosclerosis which often occur in adult birds. Various specimens were sent to M.A.F.F. Laboratories, Weybridge; St. John's Hospital, London; and the Departments of Zoology at Cardiff and Bristol Universities.

Another room was made available for the museum collections which continued to expand, 227 items being added. Improvements were made in the technique of freeze-drying downies, using the facilities in the Department of Zoology, Cardiff. Specimens were presented to the British Museum (Natural History), the University of Florida, the Children's Hospital, Bristol, the Department of Zoology, Aberdeen, and to several individual researchers. All observations and museum specimens relating to the extinct Auckland Islands Merganser were correlated (p. 78).

A number of studies on physiology and behaviour, particularly in relation to learning, were assisted by the provision of incubated eggs, newly hatched young, or adults. These went to the Universities of Cambridge, Durham, Edinburgh, Hull, Leicester, Southampton and Stirling.

G. V. T. MATTHEWS

EDUCATION

Courses of lectures were given in the Departments of Zoology in Bristol and in Cardiff, and in the Department of Psychology in Bristol by Dr. Matthews, and field study excursions using the Collection at Slimbridge were organised from those Universities and also Aberystwyth, London, Oxford and Reading. Through Bristol University Mr. M. J. Penny completed his M.Sc. thesis on the feeding behaviour of waders on Aldabra Island in the Indian Ocean and Mr. A. Whiten began work for a Ph.D. on bird orientation, investigating the visual abilities of pigeons. Through the University College of Cardiff Mr. P. N. Humphreys continued his Ph.D. study of wildfowl fertility and sperm morphology. Through Bath University Mr. J. Mattocks completed his M.Sc. study on the flora and fauna of the goose's gut. Through Portsmouth Technological College Mr. G. H. G. Martin's Ph.D. study of the conservation and feeding ecology of wildfowl and waders in Langstone Harbour was completed.

The new 50-bed Youth Hostel Association's Field Study Hostel at Slimbridge was opened in October. Mr. Jackson supervised the equipping of the two large study rooms with apparatus and a library. Extensive use has already been made of the Hostel, its amenities being unanimously praised. More than 22,000 children visited Slimbridge in organised day

parties. Two television programmes were made. The annual Identification Competition for schools took place in March with a record number of entrants, 150. Several displays were mounted: for the Gazebo at Slimbridge, for the Gloucestershire Rural Studies Association Exhibition, for the Game Fair at Stanford, Rugby. Work commenced on the seven large boards making a permanent exhibition for the new entrance hall at Peakirk. Much photographic work was undertaken and innumerable requests for information answered.

G. V. T. MATTHEWS

1969 BREEDING SEASON

The collection at present comprises some 1,900 pinioned birds of 175 races and 134 species. There are in addition 100 full-winged birds of 26 forms. During the winter months there are 400-500 Bewick's Swans, 80 Canada Geese and at least 1,000 ducks visiting the pens. In consequence 80 tons of grain, 15 tons of poultry biscuit, 10 tons of fish and 20 tons of turkey starter crumbs are needed to support the population. This does not take into account the food for our flamingo collection. Dried shrimp are imported from Holland and these, together with maize and the prophylactic constituents of this feed, produce a bill that makes our Bursar shudder. However, kind people do buy our surplus birds and this helps to soften the blow.

The principal additions to the collection during the year comprised 2 male and 1 female Peruvian Torrent Duck *Merganetta armata leucogenis*, 2 male and 4 female Australian Shoveler *Anas rhynchotis rhynchotis*, 1 male Pink-eared Duck *Malacorhynchus membranaceus* reared by Mr. Tom Spence of Perth Zoo, and 3 New Zealand Blue Mountain Duck *Hymenolaimus malacorhynchos* reared by Dr. Janet Kear when in New Zealand. Through a purchase of Wandering Whistling Duck *Dendrocygna arcuata* the Dendrocygnini collection is once more comprehensive. Fifty Lesser, 20 Greater and 14 James's Flamingos have been added to our flock. Whilst aviculture is not the main objective of the Wildfowl Trust, it is certainly important from the conservation point of view—one wonders if the Ne-ne and Koloa would be with us today if it were not for the devoted efforts of the aviculturists. Fifty more Ne-ne were sent back for release on Maui and it is hoped to send another 56 in the summer of 1970, bringing the total to 200 returned to the Hawaiian islands from Slimbridge. Twenty-five Marbled Teal were sent to Pakistan for a restoration project at Lal Suhanra, organised by Mr. Kit Savage (p. 87). Another rescue operation has been started at Slimbridge for the White-winged Wood Duck, absent from the Collection for some years and now threatened by loss of habitat in Assam. Mr. Sam Mackenzie has sent us a consignment of 7 males and 5 females.

The 1969 breeding season at the Wildfowl Trust was not particularly sparkling, as will be seen from the tables opposite and p. 140. The Hawaiian Geese did rather better than for some years, undoubtedly due to the dissemination of wild blood amongst the breeding males. A similar picture though rather better has occurred at Pohakoloa. Mr. Jack Williams of Tunstead did well with a pair of the rare Mexican Duck *Anas platyrhynchos diazi* loaned to him, producing young. He also reared 21 Ne-nes.

Perhaps our greatest success in 1969 was with our flamingos when the Chilean *Phoenicopterus ruber chilensis* were bred for the first time in Great Britain. The Andean *Phoenicoparrus andinus* bred for the first time anywhere in captivity. The flock of 20 Andean live in a small enclosure, their nesting island being a few feet from the public. Here the first bird laid on 27th May. In all, seven birds nested and it was the seventh egg that hatched on 13th July after 29 days of incubation. The downy appeared to be identical with the young of other species of the family. The chick fell out of the nest on the second day but managed to crawl back in. After five days it was continually leaving the nest and pecking at pieces of its shell. At five months, it had ceased to feed from its parents, who had by this time been drained completely of their pink coloration.

The Chilean colony, comprising some 70 birds, commenced laying on 15th June, and 30 eggs were laid over the next four months. A number were spoiled through being rolled out of the nests. In all, ten hatched, the first on 30th July. Chicks were still hatching when the early frosts came, and five reached maturity.

S. T. JOHNSTONE

Breeding Results 1969: Slimbridge Collection.

	Date of 1st egg	*No. of eggs brought in*	*Hatched by hen*	*Hatched in incubator*	*Hatched by parents*	*Reared by parents*	*Total reared*
Magpie Goose	4.7	11					
Eyton's Whistling Duck	21.6	5					
Fulvous Whistling Duck		77	41	10	7		35
Cuban Whistling Duck	16.5	24	16				16
Javan Whistling Duck		1					
White-faced Whistling Duck	20.5	33	23	5			21
N. Red-billed Whistling Duck	20.5	23	19		5	5	24
S. Red-billed Whistling Duck	30.5	40	39		6	3	40
Coscoroba Swan	6.3	4					
Black Swan	8.2	4					
Mute Swan		6			2		5
Black-necked Swan	6.2	3			4	3	5
Bewick's Swan	20.5	5					
Trumpeter Swan	7.5	1	1				
Swan Goose	4.4	19	5		2		2
Western Bean Goose	2.5	5	1				1
Russian Bean Goose	26.4	11	1				1
Pink-footed Goose	20.4	11	1		3	2	3
European White-fronted Goose	28.4	6					
Greenland White-fronted Goose	7.5	26	9	6			12
Lesser White-fronted Goose	3.5	8	4		4	2	5
Greylag Goose	9.4	2	2		24	23	25
Bar-headed Goose	21.4	8	3	5	2	2	9
Emperor Goose	22.4	21	9	4			9
Lesser Snow Goose	24.4	5	5		4		7
Greater Snow Goose	4.5	6	3		2		2
Ross's Goose	19.5	3	2				2
Atlantic Canada Goose	21.3	6			6	1	6
Moffitt's Canada Goose	12.4	4					
Giant Canada Goose	29.3	8			6	6	6
Lesser Canada Goose	20.4	6	4		3	3	6
Taverner's Canada Goose	27.4	4					
Dusky Canada Goose	7.4				5	5	5
Cackling Canada Goose	17.5	4					
Hawaiian Goose	30.1	72	34				32
Barnacle Goose	19.4	14	4		16	14	18
Black Brant	13.5	1					
Red-breasted Goose	4.6	5	3				2
Ruddy Shelduck	5.4	11	5				4
Cape Shelduck	5.4	6					
New Zealand Shelduck	19.4	6					
Abyssinian Blue-winged Goose	7.5	13	9	5			12
Andean Goose	23.4	15	6		6	3	9
Lesser Magellan Goose	27.4	4	4		3	2	6
Greater Magellan Goose	28.3				6	6	6
Cereopsis Goose	13.1				2		
Falkland Flightless Steamer Duck	27.3				4		
Patagonian Crested Duck	11.4	23	7		5	3	8
Andean Crested Duck	16.1	18	13				13
Marbled Teal		9	6	39			33
Bronze-winged Duck	27.3	4	2		3		1
Cape Teal	1.6	6	5				5
Hottentot Teal		2	1		3	2	3
Versicolor Teal	5.4	36	18		9		11
Red-billed Pintail	30.5	13	10				10
Bahama Pintail	16.4	28	18	28	25	9	60
Chilean Pintail				17	7	3	19

	Date of 1st egg	*No. of eggs brought in*	*Hatched by hen*	*Hatched in incubator*	*Hatched by parents*	*Reared by parents*	*Total reared*
Northern Pintail		8	8	5			12
Chilean Teal	20.3	12	7	15	6	4	22
Falcated Teal	28.5	14	3				2
Australian Grey Teal	20.5	18	5				5
Chestnut-breasted Teal	19.4	6	4		5	3	7
New Zealand Brown Teal	2.4	9	2		4	1	2
Hawaiian Duck	29.3	41	21	10	5	3	34
Laysan Teal	17.4	21	9	11	6	3	21
North American Black Duck			6				4
Indian Spotbill		14	10				10
New Zealand Grey Duck	19.5			15			15
Pelew Island Grey Duck				3			3
Philippine Duck	19.5	13	6	5			10
African Yellowbill		9	7	2			8
Abyssinian Yellowbill	9.4	7	1				
African Black Duck		4					
Gadwall	23.4			45	20	15	60
European Wigeon	9.5	30	15	20			32
Chiloe Wigeon		8	4	6	12	10	18
Blue-winged Teal	16.5	27	11	4			12
Cinnamon Teal	30.5				8		
Garganey					9		
Argentine Red Shoveler		8	7				7
Cape Shoveler	15.4	22	4				2
New Zealand Shoveler	1.6	8	3				1
Common Shoveler	3.5	8	8				7
Ringed Teal	14.4	44	12	1			10
European Eider	28.4	19	11		3		12
Faeroe Eider		11					
Red-crested Pochard	5.4	16	3	2			2
Rosybill	19.5			5			5
African Pochard		4					
European Pochard		6	5				1
Redhead	24.4	11	4	19			18
Common White-eye		15	3	15	6	3	15
Australian White-eye				24	7		18
Tufted Duck	15.6			6			4
New Zealand Scaup	2.5	17	5	22			23
Lesser Scaup	5.6	20	10				10
Brazilian Teal		5	1				1
Mandarin Duck	14.4			33	10	4	50
North American Wood Duck	10.3	10	6	32	12	5	37
Comb Duck		30	24				15
Muscovy Duck					8		
European Goldeneye	19.5	6					
Smew	29.5	5	3				3
Red-breasted Merganser	14.6	5	1				
North American Ruddy Duck	19.5				50	30	30
African White-backed Duck		2					
Crested Screamer	28.4				4	2	2
Andean Flamingo	27.5						1
Chilean Flamingo	15.6				10		5
Common Shelduck × European Eider		8	5				4

Peakirk

1969 BREEDING SEASON

Peakirk had the wettest spring in living memory. During cold spells, unidentified vermin (thought to be stoats) accounted for heavy losses in a number of the rarer species, and these unfortunately included Fulvous Whistling Duck, Versicolor Teal, Hottentot Teal, Falcated Teal, Garganey, Argentine Red Shoveler and Brazil Teal.

Results for the season were particularly poor and numbers of young reared were very low. The six pairs of Ne-ne introduced into special breeding pens constructed on the Neaverson Area in the autumn of 1968 failed to lay. The main success was the breeding of Trumpeter Swans for the first time at Peakirk. The first egg was laid on 22nd April, and out of a total of six eggs, four young were hatched on 6th June. Three cygnets were reared to maturity. Other of the more notable species bred were Cackling Canada, Black Brant, New Zealand Brown Teal, European Eider and Baer's Pochard.

P. B. VARDY

Breeding Results 1969, Peakirk Collection.

	Date of first egg	*Eggs incubated*	*Eggs hatched*	*Young reared*
Black Swan	20.3	5	5	5
Black-necked Swan	9.3	4	2	1
Trumpeter Swan	22.4	6	4	3
Swan Goose	13.4	7	4	3
Western Bean Goose	27.4	3	0	
Pink-footed Goose	29.4	20	10	9
Greenland White-fronted Goose	21.4	17	1	
Western Greylag Goose	30.3	18	17	13
Emperor Goose	18.5	6	3	2
Blue Snow Goose	2.5	10	1	1
Taverner's Canada Goose	23.5	5	1	
Cackling Canada Goose	19.4	12	8	8
Barnacle Goose	14.5	25	5	1
Black Brant	4.5	2	1	1
Red-breasted Goose	24.6	5	0	
Cape Shelduck	24.3	6	1	1
New Zealand Shelduck	10.5	1	0	
Common Shelduck	11.5	9	5	5
Greater Magellan Goose	26.4	6	4	3
Lesser Magellan Goose	13.4	3	1	
Bahama Pintail	21.5	19	8	5
Chilean Pintail	10.4	13	12	6
Northern Pintail	22.4	30	18	16
Chilean Teal	18.5	13	4	3
Chestnut-breasted Teal	17.4	6	1	1
New Zealand Brown Teal	22.4	24	7	4
North American Black Duck	9.5	1	0	
Hawaiian Duck	19.4	6	0	
Laysan Teal	22.4	26	20	16
New Zealand Grey Duck	15.6	6	2	2
Abyssinian Yellowbill	4.6	1	0	
Gadwall	12.5	6	2	1
European Wigeon	27.5	22	15	14
American Wigeon	13.6	5	1	
Cinnamon Teal	17.5	6	0	
European Eider	24.5	6	4	4
Red-crested Pochard	9.4	23	6	4
Rosybill	3.6	16	9	6
African Pochard	2.6	5	1	
European Pochard	15.5	7	6	5
Baer's Pochard	2.6	8	4	1
Australian White-eye	23.5	28	24	14
New Zealand Scaup	2.6	5	0	
Tufted Duck	28.5	31	21	11
Mandarin Duck	13.4	5	1	1
North American Wood Duck	13.4	44	19	5
North American Ruddy Duck	17.6	19	4	

Borough Fen Decoy

The hard weather that began on 22nd December continued until 7th January when the pond had thawed sufficiently to attract 130 Mallard and 750 Teal. By the 15th the latter had topped four figures, but Mallard were down to 95. Of the 153 duck caught in January 138 were Teal. It was disappointing not to have caught more Teal but they were well fed and reluctant to follow the dog. Wintry conditions, however, improve trapping at Deeping Lake where 104 were taken plus the usual crop of Moorhens and Coots. The trap was baited with bread on two occasions in an attempt to catch some of the roosting gulls. None were taken in January, and it is odd that although nearly one thousand were caught in the 1965-66 season, they have since refused to co-operate. Goldeneye and Goosander were also present on the Lake throughout the month. Although often in the vicinity of the trap, they took a hint from the gulls and stayed outside.

February was a near complete failure at the Decoy, with a total catch of only 15. Frost and then snow emptied the pond, and no catches were made after the 7th. Heavy snow mid-month damaged nets at the House and South-west pipes. Metal hoops were introduced in 1959 and 1960, so the net tears before a hoop collapses and there has been no repetition of the 1955 calamity when all the eight wooden pipes went down.

The nets were repaired by placing a ladder on the ice below the tear. The labour was in vain as no more duck were taken in either pipe up to the end of the season.

The Deeping Lake trap was fairly productive and although 2,000 diving and surface feeding water birds kept an area of water open, the trap was completely frozen from the 12th to the 20th. One catch of 54 gulls was made which included a Black-headed Gull ringed as a pullus on Jutland on 9th June 1968.

If February was a failure at the Decoy, then March was a disaster, only four duck being taken. As there were few duck on the pond a number of willows were pollarded, the better poles being used to replace dead willows in the main fence at Peakirk. Cutting reed in Norfolk on the 26th I had the misfortune to slip a disc and the Decoy and Deeping Lake trap were left open from that date; but it is doubtful whether many more duck would have been taken. Blood samples taken for the M.A.F.F. laboratory at Weybridge totalled 622 between November and March, comprising 205 Mallard, 183 Teal, 58 Coot, 26 Moorhen, 113 Tufted, 21 Pochard, 5 Great Crested Grebe, 6 Shoveler and 5 Pintail.

During April, May and June maintenance proceeded as usual. Reed was cut from the Decoy reed bed, there was a general clearing of debris, and outcrops of encroaching vegetation were cut back from the main paths and from the ends of the pipes. New net was fitted to the E. and SW. pipes. New screens built this year again incorporated one concrete post, and it is interesting to see that such posts erected last year are already coloured by lichens and leaf stains. Six hundred yards of wire netting on the perimeter fence were replaced and some repairs were carried out to the Deeping Lake trap. Frequent and heavy rain storms made the grass grow very quickly, and mowing by machine very difficult. The annual decoy open weekend was spoiled by foul weather and only 40 visitors braved the elements.

The annual round-up of flightless Canada Geese at Grimsthorpe Park on 5th July was assisted by members of the Spalding and District Wildfowlers' Association. Newly ringed birds totalled 86 and 15 retraps included one ringed in Leicestershire in 1955. Deeping trap was put into operation and three pipes fed at the Decoy. Mallard numbers there slowly increased to 65 on the 28th. Three Garganey present for a week from the 21st could not be persuaded to enter the pipes. Mallard hand-reared by the Whittlesey Wildfowlers were released on to the Decoy pond for the third successive year. They appear to integrate well with the wild stock and contain no birds of apparent doubtful ancestry.

The August lead built up very slowly and the best daily count of 230 contrasted with the flight of 2,500 leaving Deeping Lake each evening. Mallard were released for the orientation studies at Great Casterton in sunny conditions and at points half a mile from the Decoy under cloud.

September is by far the best month in the decoyman's calendar, and 975 ducks were taken at the Decoy. On one day, the 24th, 118 were taken in three separate pipes. Numbers using the Decoy also improved, peaking at 1,190 on that day. The Mallard tend to disperse into the

local drains and ponds as the cereal crops are harvested. Some difficulty was experienced in topping up the pond from the river Welland. The banks were so dry as to become porous and by the time the water reached the Decoy sluice half a mile away there was insufficient height to take it over the sill. We had to pump for four days in order to maintain the level necessary. As the bulk of the catch would be Mallard, the trap at Deeping Lake was only operated for part of the month.

October was memorable for the number of foggy mornings. On these days the duck are unable to find the Decoy and roost elsewhere. When the bad visibility continues over a few days, these new quarters become permanent and the Decoy lead is lost. The total daily count of Mallard fell from 885 to 74. Mr. A. G. Kemball (Max Planck Institute) examined 88 water birds for leeches (Hirudinea). No specimens were found on the feet, bill or feathers of any birds then or since. No leeches were found in the Decoy pond. Possibly excreta from the high concentration of duck in the autumn makes the water unsuitable. There are in fact no water plants other than *Phragmites* growing in the main pond area. At Deeping Lake a large population of the duck leech *Theromyzon tesselatum* occurs on the island and the shallow margins.

The lead in November fluctuated between 790 and 60. A nice catch of 94 was made on the 4th including some very heavy (1,400 grams) short winged males. Shoveler numbers were well up with a maximum of 65 in the early part of the month.

With December came the first real frosts, and early morning ice breaking was the order of the day. Teal began to outnumber Mallard in the daily counts, although the best count of 190 was a long way below that of January, so 1969 ended much the same as 1968 with a frozen Decoy pond, 1,817 ringed duck and acres of paper work.

Birds other than duck ringed at the Decoy, Peakirk and Deeping Lake, in 1969 totalled 963 of 45 species. At the Decoy Willow Warbler and Chiffchaff arrived on 14th April, Sand Martin on the 18th, Turtle Dove and Blackcap on the 22nd, Swallow on the 24th and a lone Whitethroat on the 25th. This bird stayed only a few days and the species was not recorded during the rest of the year.

Nest record cards were despatched to the British Trust for Ornithology totalling 326 of 29 species. Nests that had been followed to a positive conclusion showed 69% failures of 72 at Peakirk and 67% of 244 at the Decoy. Song Thrushes there had a particularly bad time, 82 nests being recorded from a population of not more than 25 pairs.

Five Swifts appeared over the Decoy on 29th August which is the latest record for this species. A new record on 25th September was a Hoopoe which called frequently from the thicket between the House and North Pipes. Wind direction and a crowded pond made it impossible to search for a sight of this rarity.

Monthly catches of duck at Borough Fen Decoy and Deeping Lake, 1969.

Month	*Borough Fen Decoy*	*Deeping Lake*
January	153	104
February	15	74
March	4	32
April	—	1
May	—	—
June	—	1
July	23	36
August	183	224
September	975	72
October	300	79
November	369	20
December	199	79
	2221	722

W. A. COOK

Welney Wildfowl Refuge, Norfolk

By the end of 1969 the Trust held the freehold of 492 acres in a contiguous block, together with the shooting rights on a further 130 acres adjoining. Two semi-detached cottages, conveniently situated half way along, below the great retaining banks, were purchased for conversion as the local headquarters and house for the Warden. Mr. G. H. (Josh) Scott took up this position full time at the beginning of the year. During the winter months he was engaged in making near-daily counts of the wildfowl and noting their distribution within the reserve. This information was compared with vegetation maps made in the summer months by a team under Dr. Owen. Their surveys also produced standing

crop and seed production estimates for *Ranunculus*, *Rumex*, *Carex*, *Eleocharis* and *Polygonum*, some of the natural foods of wintering duck. Further information was provided by the analysis of viscera that wildfowlers made available from birds they shot in the Washes on either side of the refuge area. These, with particular reference to Wigeon, were carried out in conjunction with Mr. G. Thomas of the Royal Society for the Protection of Birds. Indeed, close liaison was maintained with the R.S.P.B. and the Cambridgeshire and Isle of Ely Naturalists' Trust, both bodies owning refuge areas upstream from the Wildfowl Trust's. A joint pamphlet setting out the past and present status of the Ouse Washes was produced by the three bodies.

During the summer months the Warden reverted to his traditional occupation of 'shepherding' the several hundred horses, cattle, sheep and goats that are imported to graze the lush pastures. Such grazing is essential to maintain the washlands in their present condition which is so favourable both for the wintering and nesting birds. It also brings in a very useful grazing rental to the Trust. Despite this pre-occupation, the Warden keeps an eye on the breeding birds. One of the main excitements of the year was the breeding of two pairs of Black Terns. Both nests hatched off but the area had then dried out and afforded little refuge from predators. However, one bird is known to have survived to flying stage. By contrast, the duck nests had earlier been eliminated by an unseasonable flood just after a survey by a team under Mr. Ogilvie had indicated that there were many more nests than in the previous year. Some re-nesting took place.

Although intruders on to the washland itself are rigorously excluded, disturbance can still be produced by people walking the right of way along the retaining banks. It is planned to reduce this disturbance by screening. Osier sets are being planted along the boundaries to afford relief in the long term. The central part of the reserve is to be overlooked by a permanent observation building, entered by a footbridge across the river. It is thus especially desirable to avoid incidental disturbance, and to this end an inner bank, 10 ft. high, is being constructed along our boundary. The first 200 yards was finished during this summer. It was heartening to see the monstrous draglines in action on behalf of conservation instead of draining our remaining wetlands. The material for the bank was excavated from an area up to 20 yards wide resulting in a fine, irregular stretch of water with three large islands. It is hoped that Bewick's Swans will be attracted to this pond as they are to Swan Lake at Slimbridge. A permanent body of standing water also adds to the ecological diversity of the area and will attract many species at times when the floods are not out.

While earth-moving machinery was on the site, it was used to construct a group of six experimental plots, 100 × 25 metres, each surrounded by 0.6 metre earth walls. These will be used for testing various cutting and flooding regimes before applying them as management techniques within the reserve as a whole.

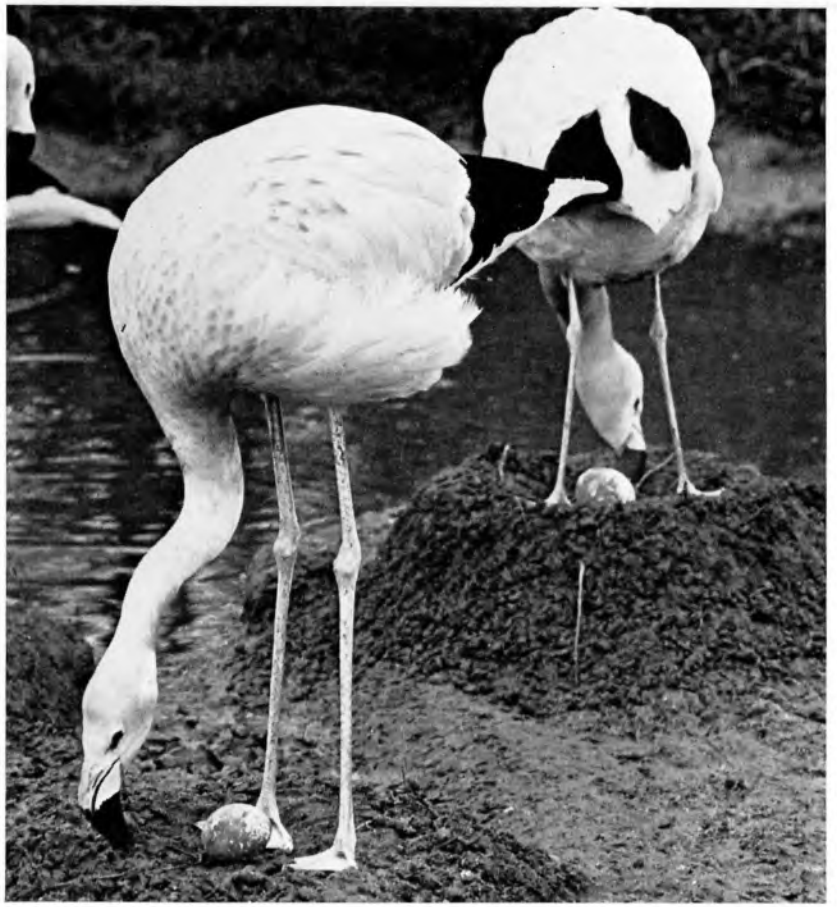
Although much remains to be done in the way of research, management and provision of observational facilities, the simple lack of disturbance is already making the Welney reserve much more attractive to wildfowl. In February more than 14,000 wildfowl were on the reserve, but this was easily surpassed on 26th December when there were at least 20,000 birds (even higher figures in the following months will be reported next year). The detailed count on 28th December gave: 15,000 Wigeon, 2,000 Mallard, 370 Teal, 293 Bewick's Swans, 200 Pintail, 30 Shoveler, 25 Whooper Swans, 17 Mute Swans, 15 Coot, 8 Gadwall, 7 Pink-footed Geese and 4 Tufted Duck.

G. V. T. MATTHEWS

Dersingham Decoy, 1969

During January and February over 200 Mallard and Teal were trapped despite the freezing temperatures and the snow that lay in early January and again in mid-February. With the onset of the milder conditions a large number of the wildfowl dispersed from the area. Breeding birds quickly arrived and reached a record total of 34 pairs of Mallard, two of Shoveler and three of Gadwall. The spring and summer were dry, resulting in the lowest duckling mortality to be recorded since records started in 1966.

During the summer a hundred bundles of reed were cut for general maintenance to both pipes. The pond between the SW.



Gloucestershire Gazette, Dursley

Philippa Scott

Plate XV. The first breeding in captivity of the Andean Flamingo *Phoenicoparrus andinus* took place at Slimbridge in 1969.
(a) Two birds turn their eggs.
(b) The single young reared being fed by its parent at about two months. During this period the parents lost much of their colour.

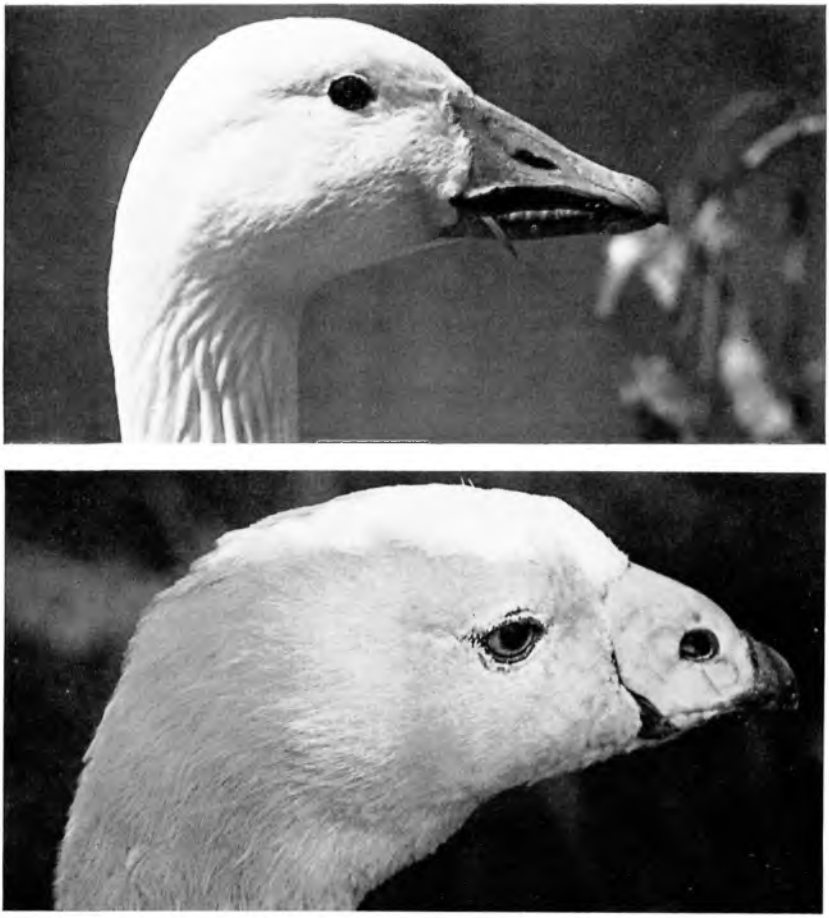


Plate XVI. Lesser Snow Goose *Anser caerulescens caerulescens*.
Cereopsis Goose *Cereopsis novae-hollandiae*.

E. E. Jackson

Richardson's Canada Goose *Branta canadensis hutchinsii.*
Andean Goose *Chloëphaga melanoptera.*

and W. pipes was also enlarged by a digger from the farm. The water dropped to a low level and pumping became necessary. Ten inches of water had to be pumped in before any number of duck arrived.

With a dog trained as a piper, we were looking forward to the coming season; it was, however, to become a disappointing one, although it started with a bang. The local wildfowlers' club released 72 duck at the Decoy in July, which brought the total to over 120 since 1968. By the end of the season five pairs had stayed, and it is hoped they will increase our local breeding population.

The first duck to be caught by using a dog was on 16th July when the pond total was six Teal and ten Mallard. By the end of August 180 Mallard, 60 Gadwall and Teal were day roosting, some of them flighting out to feed on the surrounding stubble. The piper was used at regular intervals, but no more than once during any day. Although as many as 58 duck and more were decoyed to the pipe mouth, only a small number entered the catching area.

The Teal population continued to build up and 29th September brought a peak of 495 Teal, 223 Mallard and 29 Wigeon on the pond. By this date 633 duck had been trapped.

With the dry conditions continuing, the water level again dropped and we had to pump for three days. This did not interfere with the wildfowl or catching and over 600 duck continued to frequent the pond. However, a major unavoidable disturbance did now occur and lasted until the end of October. A dragline was reshaping one of the main drains, which comes within 30 yards of the pond. A large hedgerow had to be cut down on the Decoy boundary.

For the first four days, over 500 duck arrived at the decoy at morning flight, but when work started on the drain they left. We lost our lead of duck, all except 41 Mallard, that would not leave the pond area and stayed until 28th October, when they were joined by 63 Teal. Only 80 duck were caught and ringed during October.

Over 100 Teal remained with 200 Mallard until 18th November when the first hard frost of the season covered the pond with a thin layer of ice. This cold weather was repeated several times during November, the 100+ duck that remained managing to keep part of the pond free of ice.

December was on the whole a cold month with ice on the pond most days, resulting in only 90 duck being caught for the month. The area was by no means short of wildfowl, as over 2,000 Mallard, 1,000 Wigeon and 1,000 Shelduck were counted most days on the Wash near Wolferton.

Of the year's ringing total of 1,436, only 126 were caught by dogging. It was suggested that the wildfowlers' ducks that were released and stayed during 1969 would block the pipe entrance when the dog was used, thus stopping other ducks following the dog and this did appear to happen on numerous occasions.

Acknowledgements

I wish to thank Mr. C. Knights, Gooderstone, Norfolk, and Mr. G. T. Andrewartha, Hatfield, Doncaster, for loaning the Dersingham Decoy fuel and pumps on two occasions during 1969. Without them the decoy would have ceased to operate at 100% because of the low water table.

R. BERRY

Abberton Ringing Station

Some extremely cold weather from January well into April made this a rather trying and unpleasant period to be operating duck traps. Particularly disappointing was the failure to catch the spring passage ducks, Shoveler, Garganey and Tufted.

The breeding season was also in the main a poor one, partly due to unfavourable weather and also to rising water flooding nests. For the first time since records have been kept Great Crested Grebes failed to rear any young, although some 20 pairs attempted to breed. A pair of Grasshopper Warblers bred, it is believed successfully, for the first time and three or four Shoveler reared young. A good many young Herons also fledged.

The usual large maintenance programme lasted until well into September. Generally repairs were light, but a hard worked trap on the Top Section had to be completely rebuilt. This was one of the original 1950 vintage 12 ft. square portable traps. In 1958 it was thoroughly overhauled and floated to its present position, where it caught many ducks.

Aside from the normal winter season,

regular duck counts were made throughout the summer by S. Linsell. The seasonal moulting flock of Pochard, predominantly male, reached a new level, 5,163, at the end of July; a most impressive sight. A maximum of 1,288 moulting Tufted Duck was also counted on that date. The largest duck count was made on 12th October with a total of 7,043 ducks. Mr. Linsell became permanent Warden of the Essex Naturalist Trust's Reserve at Fingringhoe Wick in October, and his services as a regular counter are greatly missed, the full burden now being on the shoulders of his associate, R. Gardiner, who has been counting at Abberton for more than twenty years.

The duck trapping, mostly of Mallard, began to regain momentum in July. It was not until August that Teal started to appear regularly in the catch, and over 40 Shoveler were taken. Always difficult ducks to procure, it was a surprise when a lead was established with a large flock, mostly young birds, on the Top Section, catching in the deep water trap. Very seldom does this happen, and for a brief period my daily visits were exciting and often profitable.

By the middle of September the duck population was nearly 7,000, mostly dabblers, the diving ducks have completed their moult and departed. The water level, which had remained high throughout the summer, owing to some very heavy rainfall, started dropping dramatically. The high temperatures over eastern England produced a huge demand for water and there was no opportunity of replacement. By 4th October the Island was just awash and thick with ducks. With massive help from the Resident Engineer and his willing assistants, three 12 ft. square 3-funnel traps were moved on to the Island, and the supporting tackle set up. They remained there until just before Christmas when the rapidly rising water level forced their evacuation. They produced a large catch of Teal but little else. A party of Snow Buntings enhanced the area for several weeks.

Throughout the autumn and until the end of the year the traps on the Top Section maintained a steady catching rate, thus continuing the precedence they have gained in recent years. Their comparative ease of access also makes them easy to operate, although the tendency for this smaller stretch of water to ice over can be frustrating.

Two 'firsts' for the Station were achieved on the same day when a 1st year male Red-breasted Merganser and a Black-necked Grebe were taken in adjacent traps. Three Scaup were the first caught since 1962.

Apart from 68 Snipe ringed, and seven Spotted Redshanks in one trap, wader trapping fared badly. Indeed, despite the fairly low water level in autumn and exposed mud, waders remained disappointingly scarce.

The over-wintering White-fronted Geese remained until early February, grazing winter wheat. A small party of Bewick's Swans stayed until the end of March, and seemed to display a positive preference for grass. In the autumn White-fronts did not return until 12th December, the first Bewick's in a snowstorm on 26th November.

Abberton appears to be just too far inland to attract influxes of rarer birds which occur at the coastal observatories, apart from some water birds. The most unusual of the visitors comprised Long-eared Owl (2), Bittern, Black Redstart, Little Ringed Plover and quite a lot of Little Gulls.

Mr. Fred Trust, who has taken on the small bird ringing at Abberton, erected a cedar hut adjacent to the ringing Caravan. Despite his professional duties he was able to spend 101 days at the Reservoir. He operated some 20 trapping sites, mostly mist-nets, along half a mile of the north shore of the Middle Section. Birds ringed for the first time at Abberton were Common Gull, Cuckoo, Coal Tit, Grasshopper Warbler, Goldcrest, Pied Flycatcher and Lesser Redpoll. Some other unusual catches included Marsh Tit, Tree Creeper, Fieldfare, Mistle Thrush, Redwing and Brambling.

The South Essex Waterworks Company started work on landscaping a seven acre Public Access Site adjoining the Main Section. They constructed a large bird hide which will enable the public to have viewing access to the reservoir birds, while enjoying pleasant surroundings with a pond for ducks, a car park and other amenities.

A memorial gate to General Wainwright, designed by Peter Scott, was made and erected at the top of the steps leading down to the ringing Caravan on the Layer Breton causeway. This fine piece of design and craftsmanship stands as a lasting tribute to the General and the enormous effort he put into establishing and operating the Abberton Ringing Station.

R. KING

Loch Leven, Kinross

Nest searching at full intensity was resumed this year, since it had become clear that Loch Leven is not a productive area in terms of fledged young, largely owing to the lack of shelter and cover after hatching. The main research interest is therefore in the early stages of the breeding cycle—nest site preferences, onset and timing of laying, clutch size, incubation time, hatching success and variations in these parameters from season to season. Altogether 864 nests were located, 84 of these being in a 100 × 100 metre control zone which was only searched at the end of the season. The fate of the nest can then still be ascertained by the presence or absence of egg membranes. In the control zone 83% of the nests had escaped predation (mainly by Jackdaws) as opposed to 59% in the areas visited once weekly in the course of our study. It should perhaps be emphasised again that this does not mean a comparable loss of fledged young. Disturbance resulted in more meals for Jackdaws rather than less fledged ducks. Nevertheless it was desirable to have some measure of the additional hazard imposed by our presence, particularly as control of the predators is envisaged next year as part of the management programme. These Jackdaws have the rather unusual habit of nesting in old rabbit burrows and no less than 356 such nests were located on St. Serf's Island on 3rd June. There are other similar colonies on the Benarty and Lomond hills and birds from there commute to St. Serf's, especially soon after dawn. Up to 121 Jackdaws have been seen in the air over the duck nesting area at one time. Almost every day a Jackdaw flying with an egg in its bill was recorded, and one nest was predated while watched in full view from only 50 yards away.

Commonly, several Jackdaws are involved, their fighting over the contents leaving a partly pulled-out nest, with broken grass stems around and with shell fragments, yolk and albumen in the bottom. Where probably only one bird was involved the nest would be intact and devoid of remains, the eggs having been pierced and carried off in the Jackdaw's bill to a favourite perch. Where trees and bushes overhang the Loch, as along the Island's northern shore, dozens of egg shells were found in the shallow water.

The nests in the study area are marked by an upright four foot cane the same distance to the north. To test whether the Jackdaws were profiting by such indications of nest sites, we set up 20 handmade nests, each equipped with five hen's eggs covered with vegetation. Half were marked with canes, half were unmarked. The Jackdaws had found nearly all the nests by the end of a fortnight, with only a slight suggestion that the marked nests fell victim earlier.

Carrion Crows are very seldom seen on the Island. We have some indications that Moorhens will take eggs occasionally on the fringes of the nesting areas. The Black-headed Gulls do not predate nests, indeed both Mallard and Tufted Duck show a preference for nesting within the gullery, which probably exceeds 9,000 pairs. This year seven pairs of Herring Gulls nested on the Island and are rather more suspect. On the Isle of May, only 20 miles to the east, there is a colony of 24,000 nests, so any tendency to increase on St. Serf's will have to be watched carefully. The only mammalian nest-predator is the Brown Rat, but this is strictly and successfully controlled by self-feed poison bait boxes, particularly effective in the winter when other food is scarce.

A total of 157 adult ducks were caught by handnet rising off the nest. Of these, 41 had been marked in previous years. Again the location of the nests in relation to the permanent grid posts was determined.

At the end of the nesting season a team combed out the unvisited control zone and also a series of transects throughout the nesting area so that estimates of the total population could be made.

In the winter months the study of the feeding ecology of Pink-footed and Greylag Geese in the neighbourhood of the Loch was continued, the 1969-70 winter probably being the final one for this project. The seasons have contrasted sharply in regard harvesting conditions, and hence grain spill, and in early spring growing conditions. This work was carried out in conjunction with Dr. Ian Newton of the Nature Conservancy, Edinburgh, who also supervised the duck breeding study.

The year was marred by the sudden death, on 8th July, of Ian Marshall, who had joined the Loch Leven team in October 1967. It was but small solace to his wife, Rosemary, left with a baby daughter, that the undetected brain tumour would have been inoperable. All his colleagues' sympathy cannot offset her tragic loss.

C. R. G. CAMPBELL

Wildfowl Ringing, 1969

Swans

Support was continued for a small number of amateur studies of the Mute Swan. The first full year's work was carried out on the Mute Swan population of The Fleet and Radipole Lake, Dorset, by the Wildfowl Trust, jointly with the Edward Grey Institute of Oxford University. Just over 200 birds were caught and ringed there. Following the development of a successful catching method, no less than 91 Bewick's Swans were caught and ringed at Slimbridge (see page 134).

Geese

Ringing of Canada Geese has continued at a high level, the Wildfowl Trust supporting the project of the Yorkshire Canada Goose Study Group. They rounded-up 350 birds, and as a part of this study a further catch, of 225, was organised on the Beauly Firth by the Hon. D. Weir (see page 99).

Ducks

The ringing totals of the Trust's various ringing stations are shown in the Table. The level of Mallard and Teal ringing is now being held close to predetermined levels, in order to monitor the populations on a reasonably systematic basis. Other species are not subject to restrictions and it is pleasing to note the good totals of Pintail, Wigeon and Tufted Duck.

Ducks ringed, 1969

	Abberton	*Nacton*	*Borough Fen*	*Deeping Lake*	*Dersingham*	*Slimbridge*	*Loch Leven*	*Others*	*Total*
Shelduck	6							2	8
Pintail	5	250	1	5		3		1	265
Teal	1258	342	297	41	402	13	1	1	2355
Malard	1146	1126	1513	446	993	729	73	21	6047
Gadwall					21	2	5		28
Wigeon	14	183		2	15		4		218
Garganey	3								3
Shoveler	50	4	6	4	4	4			72
Pochard	18			13					31
Tufted Duck	118			111			232		461
Scaup	3				1				4
Goldeneye	1								1
Red-breasted Merganser	1								1
Total	2623	1905	1817	622	1436	751	315	25	9494

M. A. OGILVIE

Wildfowl censuses and counts in Britain, 1969-70

Goose censuses

Pink-footed Goose *Anser brachyrhynchus*. The annual census held on 8th/9th November 1969, revealed a total of about 74,000 Pinkfeet, an increase of 9,000 on the previous year. The breeding success was much improved over the past two years (24.4% young birds in the flocks; average brood size 2.2). This undoubtedly contributed to the rise in numbers.

European White-fronted Goose *Anser albifrons albifrons*. The peak winter population was reached in the last half of January at a record level of about 13,000. A very good breeding season (35—40% young; brood size 2.4) was a contributory factor.

Greenland White-fronted Goose *Anser albifrons flavirostris*. This race has never

been accurately censused owing to its dispersed distribution through west Scotland and Ireland, but counts are made regularly at its major haunts in both countries and these have not shown any marked change in 1969-70. For the second winter running the breeding success from a small sample of Scottish wintering birds was much lower (14.0%) than from a much larger sample in Ireland (35.0%).

Greylag Goose *Anser anser.* About 62,000 Greylags were counted during the annual census on 8th/9th November 1969, very slightly though not significantly up on the previous year. There is a strong possibility that adverse counting conditions and movements between wintering areas during the count led to an under-estimate of the true picture. This view is reinforced by the proportions of young found in the flocks (21.2%; brood size 1.9) which would have been expected to lead to an overall increase.

Barnacle Goose *Branta leucopsis.* The Spitsbergen breeding population, wintering on the Solway reached a peak of 4,000, above the level of recent years. Breeding success was good (27%).

No census was made of the Greenland population, though there was a further slight increase in the numbers at the principal wintering haunt of Islay, where there were 14,300 in November 1969 and 13,700 in March 1970. Breeding success was moderately good (20.0% young, though average brood size was low 1.9).

Light-bellied Brent Goose *Branta bernicla hrota.* The flock at Lindisfarne, Northumberland, reached a peak of 1,500 in late January, higher than for several years. No censuses were held in Ireland this winter, but counts were made of the proportions of young birds (47%) indicating a very good breeding season.

Dark-bellied Brent Goose *Branta bernicla bernicla.* The peak population in Britain was reached in mid-February when 16,900 birds were counted. This high figure was certainly due to the excellent breeding success recorded (45%).

M. A. OGILVIE

Duck counts

Shelduck *Tadorna tadorna.* A record season, the best since 1948, with most birds arriving in January. The spring dispersal was delayed, probably by adverse weather.

Teal *Anas crecca.* This species continues to increase, with this the best season since the hard winter of 1962-63. A major influx occurred in January driven from the Continent by hard weather.

Mallard *Anas platyrhynchos.* Counts in the early winter were normal, but by November numbers were low in Scotland and unusually high in England and Wales.

Wigeon *Anas penelope.* A record season, the best since counts began in 1948. Large numbers arrived in January, with 36,000 counted on the Ouse Washes alone.

Pochard *Aythya ferina.* The record level of the 1965-66 and 1966-67 seasons was regained, with high numbers present throughout the country.

Tufted Duck *Aythya fuligula.* A satisfactory season. The population has now fluctuated slightly around the same level for the past thirteen years.

Seasonal indices, 1969-70 (1959-60=100)

Shelduck	113	Wigeon	137
Teal	59	Pochard	192
Mallard	102	Tufted Duck	104

International Wildfowl Census

The fourth census was held in mid-November 1969 and mid-January 1970. The November count was made to discover whether it gives a better representation of the winter population. In Britain 889 sites were observed in November, and 1,064 in January, the numbers of duck seen being as follows:

	November 1969	January 1970
Shelduck	13214	46450
Pintail	6604	8369
Teal	28696	37570
Mallard	122765	111684
Gadwall	1445	316
Wigeon	91904	165882
Shoveler	2758	1958
Eider	6138	8282
Pochard	22979	23572
Tufted Duck	22024	26871
Scaup	2081	14801
Common Scoter	1699	1168
Velvet Scoter	99	50
Long-tailed Duck	485	413
Goldeneye	5154	7822
Smew	8	103
Red-breasted Merganser	925	1027
Goosander	229	1588
Totals	329207	457926

G. L. ATKINSON-WILLES
BARBARA YARKER

International Research and Conservation

On 1st January the headquarters of the International Wildfowl Research Bureau was established at Slimbridge, with Dr. Matthews as Director (in addition to his Trust position). The Trust allocated accommodation for the Administrator, Mr. E. Carp from the Netherlands, and a secretary, and provided other facilities.

A five-day meeting of the Executive Board was organised in May in Vienna. The biennial Congress of the International Union of Game Biologists was attended in Moscow. This afforded invaluable opportunities to strengthen liaison with the Russian biologists, both there and in field trips to the north, south and east as far as Lake Baikal. The vast text of the Proceedings of the International Regional Conference on Wildfowl Conservation, held in Leningrad in September 1968, was prepared for publication.

Much time was spent in producing an acceptable draft of a Convention on Wetlands of International Importance to Waterfowl. It is hoped that the consideration and signing of this will be one of the main tasks of the next big meeting on wildfowl conservation. This was scheduled for Iran in early 1971 and preparations were already under way.

The Bureau's Bulletin was edited into a new form and a start made on publishing therein an up-to-date bibliography of the wildfowl and waders, covering all the world's literature.

Representations were made against the urgent threats to wetland habitat of waterfowl, especially those in the Waddensee of the Netherlands, the Thjorsarver breeding grounds of the Pink-footed Goose in Iceland, and the Foulness wintering grounds of the Brent Geese.

Also in connection with the I.W.R.B. Mr. Atkinson-Willes continued to act as Co-ordinator of the Duck Working Group and attended a meeting of east European wildfowl counters in Leipzig. Another international mid-winter census was organised in January and, as an extension of the programme, one in November.

The other Working Groups of the I.W.R.B. have their Co-ordinators based elsewhere, namely for Geese, Professor M. F. Morzer Bruijns in the Netherlands (with Mr. Ogilvie as British representative); for Waders, Mr. F. Spitz in France (Mr. P. J. K. Burton in Britain); for Habitat Management, Dr. J. Szijj in West Germany; for Hunting Rationalisation, Dr. T. Lampio in Finland. The last group was formed during the year and is working in close contact with the International Hunting Council, and through them with W.A.G.B.I. in Britain. Then there are the Regional Surveys for Southern Africa (Professor J. M. Winterbottom); West Africa (Mr. F. Roux); Central Asia (Dr. V. E. Flint); North-East Asia (Dr. A. A. Kitschinsky); and South-West Asia, where Mr. C. D. W. Savage continues his work (see below).

Other overseas matters included the attendance of Dr. Kear at the International Ethological Congress at Rennes in France, and the election of Dr. Matthews as a Corresponding Fellow of the American Ornithologists' Union.

G. V. T. MATTHEWS

Wildfowl survey in south-west Asia

Introduction

The highlight of 1969 was the receipt in Pakistan of a consignment of Marbled Teal *Marmaronetta angustirostris* for reintroduction at Lal Suhanra near Bahawaipur (see p. 87). There were the usual winter wildfowl counts, though fewer than in the 1968-69 season, and three very successful expeditions in association with I.W.R.B. A conference in Novosibirsk on bird migration and the spread of arboviruses was attended by delegates from Iraq. Informal discussions on the Wildfowl Survey took place during the General Assembly of the International Union for the Conservation of Nature at New Delhi.

Activities of the Survey were cramped for lack of funds, for although the project was placed in World Wildlife category 'A' shopping list no funds could be allocated in 1969. Ironically Rs.2,000 in Indian currency lay unused for lack of volunteers in priority areas previously not covered by the counts.

Egypt (U.A.R.)

Professor Yu. A. Isakov visited the Nile delta during the winter months and confirmed the impression gathered from others that irrigation development, canalisation of water courses and density of human population has rendered this former major wintering area of relatively small importance today. Visitors in winter to Lake Nasser on the other hand have found large flocks of wintering waterfowl which would reward an ornithological expedition.

A recent expedition to Dakhla Oasis to the west of the Nile delta has recorded Cape Teal *Anas capensis* which seems to replace the Marbled Teal in similar habitats in central and southern Africa. This is an interesting extension of its range.

Jordan and Iraq

No reports have been received although observations and ringing have been continued by the Iraq Natural History Museum.

Iran

The work of the Department of Game and Fisheries has gone from strength to strength, and since the Director, Mr. Eskander Firouz, has recently been elevated to cabinet rank conservation of wildlife in Iran is likely to continue to flourish.

The Department ringed 968 ducks during the season and recoveries received now total 1,755, mostly from the U.S.S.R. In addition wildfowl counts have again been made on the wetlands of the Caspian and in Fars. The latter were the subject of intensive study by Lindon Cornwallis who participated in the counts again and also in a reconnaissance survey of the Seistan wetlands which had last been studied by Savage in 1960. Counts in the Caspian wetlands were assisted by H. Kowalski who was kindly deputed by Dr. Hoffman from Tour du Valat.

Afghanistan

No mid-winter counts were made, but by good chance Fred Koning from the Netherlands was able to visit Lake Ab-e Istadah when on a mission to Pakistan on behalf of the Fauna Preservation Society. He made meticulous counts of the huge flocks of wildlife and waders, and, most exciting of all, discovered a party of 74 Siberian White Cranes *Grus leucogeranus*. The latter are now extremely rare and in recent years have only been seen in winter at the Bharatpur sanctuary in India. The usual numbers seen have in fact been 70-80, but in 1969-70 only twelve were present and grave fears had been expressed for the remainder. It would seem, however, that the flock may have reunited at Lake Ab-e Istadah as it would have been too much of a coincidence for there to have been two groups of similar numbers.

Pakistan and India

The 1969-70 season has been another of severe drought. Wherever there has been an expanse of suitable water the ducks have been present in their thousands. Unfortunately too few of these concentrations have been counted but in Pakistan at least two important new wetlands have come to notice to offset the disaster of losing one proposed category 'A' wetland to drainage at Kharrar Jheel. Efforts to have the Calcutta Salt Lakes made a permanent wildfowl sanctuary were supported by a resolution of the I.U.C.N. General Assembly but realisation is encountering many problems with other interests.

The almost total absence of Greylag *Anser anser* in their usual wintering grounds west of Delhi possibly explained an unusual concentration on the Ravi river near Lahore. These, however, only amounted to less than two hundred and seem to emphasise that the former bordes of Greylag which were to be found 'on nearly every large jheel' are a thing of the past, and apart from those which visit Upper Assam the Greylag may be nearly extinct in the sub-continent.

An unusual record from East Pakistan was a first year Falcated Duck *Anas falcata* shot in Sylhet and identified from relics airmailed to the writer. This was in fact the first recorded in East Pakistan though it had always been assumed that the species had been previously overlooked.

During the summer papers were submitted by Salim Ali and Savage to the symposium of bird migration and arboviruses held in Novosibirsk. M. Blondin from Tour du Valat attended on behalf of I.W.R.B. Later, however, Dr. Salim Ali was able to visit Novosibirsk at the invitation of the organisers and had the rare opportunity of visiting the central Siberian breeding grounds of many

species that winter in southern Asia. Dr. Salim Ali said afterwards that the most encouraging thing he noted was that so much of the vast duck factory was still virtually inaccessible to man. True the more accessible fringes were severely affected by human activity but there was so much more that was not. He thought that it was still possible to save the wildfowl of Asia if a concentrated international effort could be made now, before it is too late.

C. D. W. SAVAGE

Bewick's Swans in the Netherlands, March 1970

Introduction

In March 1970, I spent eight days in the Netherlands in order: (1) to examine the winter habitats of Bewick's Swans *Cygnus columbianus bewickii* and to see whether the conditions under which the swans can be observed there made future studies based on individual recognition feasible; (2) to see if any Slimbridge wintering birds could be found, as the Netherlands are on their migration route between Britain and Arctic Siberia.

Itinerary

On 22nd March, the area along the river Yssel upstream of Kampen was visited and also that along the west side of the Veluwemeer. On 23rd March, an excursion was made to the area near Nijkerk. On 24th March, the enclosure dyke of the Ysselmeer, places along the shore at Gaast and Molkwerum, and also the inland lakes north of Lemmer, were visited.

On 25th, 26th, 27th and 28th March, the areas around Kampen, along the Yssel and the Veluwemeer, were revisited, and the numbers of swans recorded and those near enough were checked with a telescope for Slimbridge swans. On 27th March an excursion was made to South Flevoland, the greater part of which is still flooded.

Numbers

A total of about 450 Bewick's Swans was seen. Everywhere there were fewer swans than there had been a week earlier, indicating that I was too late. This spring, also, the majority of Bewick's seemed to leave England earlier than usual. The largest group to leave Slimbridge went on 24th February, compared with 6th March in 1969. The weather was fairly mild while I was there, especially at the beginning of the week.

The largest numbers of Bewick's were found along the Yssel where the most seen on one day was 364 on 28th March. These were in groups ranging from ones and twos to 104 which was the largest flock I saw during my stay. The average number in a flock was about 35.

Along the Veluwemeer the most seen on one day was 49, on 22nd March; these were along the shore of the East polder just south of Elburg. I returned on three different days after that and the numbers had decreased considerably. Those remaining were scattered out in the middle of the Veluwemeer.

The only other place where there was any number of Bewick's was in fields opposite Nijkerk which I only managed to visit twice. The first time there were only 14 but six days later there were 46. Three days before I arrived there had been 150 in these fields. Up near the enclosure dyke, which is supposed to be a favourite haunt of Bewick's Swans, there were 13 birds on 24th March.

Discovery of Slimbridge birds

In my whole visit only 320 individuals were close enough for individual identification. On 22nd March I found a Slimbridge swan called Karoo in a flock of 49 on the Veluwemeer south of Elburg. Although I was doubtful of his identification at the time, not knowing the chances of seeing a Slimbridge swan in Holland, I am now sure, having since seen portrait photographs of him taken on Swan Lake.

On 24th March I found a Slimbridge pair, Peasant and Gypsy, in a flock of 67 unfamiliar swans on the floodwaters along the Yssel at Zalk, between Kampen and Zwolle. By the next evening Peasant and Gypsy had disappeared and there were only 27 swans. On 26th March in the evening, the numbers had built up again to 59, and among them was Raquello, bearing a large white plastic ring. The number, G156, was scarcely

discernible in the low light but, as I subsequently discovered, it could be read with a telescope in good light up to a distance of nearly 200 yards.

On the morning of 27th March, in the same place, I also saw a swan bearing a tall metal ring, but too far away for the number to be seen. Thirty-three of these rings were used at Slimbridge in 1966-67 and this swan must then have been a cygnet for it was not named or drawn.

On 28th March I found Peasant and Gypsy again, further along the river, just upstream of Zwolle. Here in a flock of 104, I also found another Slimbridge swan, Booster, recognised first by his bill pattern. Only after half an hour of waiting, was his numbered plastic ring seen above the water as proof of his identity.

Habitat

The Bewick's seemed to prefer the flooded areas along the Yssel to more permanent waters. The water level was rising daily while I was there, and more and more of the fields were becoming covered. Some swans were seen on shallow open water, such as that just inside the enclosure dyke.

The Bewick's also seemed to like the Veluwemeer, which is about two feet deep all the way across. But the numbers seen were small compared with the numbers which usually occur here. There is apparently a pollution problem due to the effluent and sewage from Harderwijk though it seems that this should be having little effect as far north as Elburg yet.

Swans were also seen grazing on comparatively dry grass fields in two places, near Nijkerk and in a field in the East polder roughly opposite Elburg.

Behaviour

In only one place were swans seen up-ending. Otherwise they were feeding with only their necks down below the water. This perhaps indicates that up-ending was not absolutely necessary. In many of the places along the river which gradually became flooded the swans moved as the water depth increased and dry patches changed. Along the Yssel and on the Veluwemeer the swans were feeding, preening and sleeping, and occasionally having arguments. Those on the fields were grazing. Those seen in the South polder were sleeping and some were preening. Although this area is still mostly flooded, it does not appear to have the right food for the swans.

Members of pairs and families did not stay as close to each other as they do on Swan Lake—while one sleeps the other may feed up to 40 yards away. This may perhaps be because, amongst smaller groups of swans and in less crowded conditions, they can maintain contact more easily.

It appeared that pairs and individual swans moved about independently of unrelated swans with which they may have been consorting in some other area. Only pairs and families seemed to move together. The Slimbridge swans were found singly or as a pair, not in a Slimbridge group. Many of the swans became familiar to me and I found that a known pair would move about along a short stretch of the Yssel, being with different swans in each place each day.

Possibilities for future viewing

The Bewick's Swans were surprisingly tolerant of humans, especially in vehicles. They were more wary of people on foot when it was not possible to approach within 150 yards. Many of the places where the Bewick's were on the river were close to human habitation and at one place they fed immediately beside the main traffic bridge across the Yssel in Zwolle.

I am sure a large flock of swans could be built up in one place by regularly feeding them with wheat as has been done at Slimbridge. One of the best places might be on the shore of the East polder just south of Elburg. Bewick's have been known to occur here for many years. A number of small hides with covered approaches might be put up along the shore here perhaps in front of the hedge below the dyke. It is also a good place for other birds including waders and ducks. Along the Yssel feeding would have to be done fairly close to the dyke road so that observations could be made from a vehicle. Hides would not be so good here due to the fluctuating water levels.

Acknowledgements

I would like to thank the following people for all the help they gave me during my stay in Holland: Miss Miek Harmsen, Dr. and Mrs. van Schreven, Dr. and Mrs. Harmsen, Professor M. Morzer Bruyns, Mr. van den Berg and his assistant Mr. Bouw.

DAFILA SCOTT

The Wildfowl Trust

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The Wildfowl Trust: Annual Report

Meetings

The Officers, Council and Committees of the Trust as at 31st December 1969 are detailed opposite. The Council met on 10th April, 13th May, 24th July and 18th December. Meetings were at the headquarters of the Nature Conservancy except that on 13th May which was at the Royal Society of Arts.

The Finance Committee met on 20th March, 10th July, 24th September, 13th November and 4th December. The meeting on 24th September was at Winchester House, the remainder at the Nature Conservancy. The Scientific Advisory Committee met on 2nd May at the Department of Zoology, Bristol University, and the New Branches Committee at the Nature Conservancy on 14th January.

The 21st Annual General Meeting was held at the Royal Society of Arts, London, on 13th May. The Annual Dinner was at the Hyde Park Hotel on the same day. His Grace the Duke of Northumberland presided and the speakers were the President, Lord Butler of Saffron Walden, Mr. Basil Boothroyd and Mr. Julian Slade.

Amendments to Rules

The full Minutes of the Annual General Meeting are circulated separately to Members.

The Rules were changed to give effect to the increases in subscriptions for Full Members and Associates from 1st January 1970 and to the revised terms for Corporate Members. Details are given under 'Terms of Membership' on p. 160.

Membership

Membership increased by 761 in 1969. This was in part due to the Fund Raising Campaign. Comparative figures are:—

	1968	*1969*
Life Members	345	356
Full Members	5054	5794
Associate Members	1606	1573
Parish Members	237	224
Junior Compounded Members	13	11
Goslings	642	710
Corporate Members	100	85
Contributors	32	37
	8029	8790

Swan Supporters increased from 158 to 197.

Twenty-one members very kindly opened their collections to fellow members in 1969.

The Gosling party was held on 20th December and was again filled to capacity. The Hon. Director showed slides of his trips to Alaska and Zambia and a film.

Attendances

The number of visitors to Peakirk again showed an increase over the record total of 1968. Numbers visiting Slimbridge fell by some twelve thousand. This may well have been due to the increase in admission charges which took effect on 1.1.69. Overall gate receipts increased by over £9,000.

	1967	*1968*	*1969*
Slimbridge	209243	206903	194512
Peakirk	46181	53602	55217
	255424	260505	249729

Development

During the year two new quarantine pens were erected at Slimbridge and, with the aid of an anonymous donation, a propagation and service building was erected but not completed. At the Patch, a Youth Hostel for Field Studies with accommodation for 50 was built by the Youth Hostels Association on land made available by the Trust, which laid out a waterfowl garden there.

At Peakirk two developments were made possible by the generosity of an anonymous benefactor—a Flamingo enclosure near the Goshams, and an entrance building comprising a foyer with educational displays, a shop and offices, which was nearing completion at the end of the year. Additional security was achieved by the purchase of land at Osier Holt.

Considerable extension and development of the Welney Reserve (p. 143) was made possible by generous donations of £5,000 by the Pilgrim Trust, £4,000 by the Ernest Kleinwort Charitable Trust and £1,750 by Mr. Christopher Cadbury.

Outline planning permission was received for the proposed Wildfowl Trust Reserve at Martin Mere, Lancashire.

The Trust accepted an offer from the Duke of Norfolk for the lease of 69 acres of water meadow at Arundel from 25th March 1971, and submitted an application for approval to establish a Wildfowl Trust Reserve there.

Finance

During the year the General Reserve Fund, re-named the General Development Fund, benefited to the extent of £26,913 from legacies and donations. £13,131 was spent on development. In addition £3,788 was transferred to the Accumulated Fund to offset the excess of expenditure over income in 1969. Although cash income was increased by £14,135 the continuing rise in costs inevitably led to a deficit for the second year running. Nevertheless a balance of £14,468 on the General Development Fund was carried forward.

The Fund Raising Campaign which was launched in 1968 had produced a total grossed up over ten years of £173,420 by the end of 1969, against the target of £325,000.

The Collections

New species added to the Slimbridge Collection were the Pink-eared Duck and Australian Shoveler. Fifty Ne-ne were sent to Hawaii, bringing the total repatriated to 144. The Flamingo flocks at Slimbridge were built up to 236 and a flock was started at Peakirk. Full details of breeding results are given at p. 138.

Research, Conservation, Education

The work of monitoring the British wildfowl population and their distribution and migrations, through counts, censuses and ringing, continued. The studies of feeding ecology and associated behaviour patterns were expanded. The health of the collections was kept under constant watch, and associated studies on the morphology and physiology of wildfowl proceeded. Two major threats to goose populations were strongly resisted, namely, proposals to site the Third London Airport on the Foulness, Essex, feeding grounds of Brent Geese, and to flood the main breeding grounds of Pink-footed Geese at Thjorsarver, Iceland.

The International Wildfowl Research Bureau Headquarters were established at Slimbridge.

Links with Universities were strengthened. The service available to visiting parties of school children, numbering 22,000, was greatly improved, and large numbers of lectures were delivered.

Full details of all these activities are given in the Current Reports section, pp. 133—153.

Publications in 1969

ATKINSON-WILLES, G. L. The mid-winter distribution of wildfowl in Europe, northern Africa and south-west Asia, 1967 and 1968. *Wildfowl* 20 : 98-111.

ATKINSON-WILLES, G. L. Wildfowl and recreation: a balance of requirements. *Brit. Water Supply* 11 : 5-15.

AVERY, R. A. The ecology of tapeworm parasites in wildfowl. *Wildfowl* 20 : 59-68.

BOYD, H. and M. A. OGILVIE. Changes in the British-wintering population of the Pink-footed Goose from 1950-1975. *Wildfowl* 20 : 33-46.

EVANS, M. E. Egg-carrying by female Muscovy Duck. *Brit. Birds* 62 : 384-5.

GOODCHILD, N. M. and J. F. TUCKER. Salmonella in British wild birds and their transfer to domestic fowl. *Brit. Vet. Jour.* 124 : 95-101.

HARBERD, D. J. and M. OWEN. Some experimental observations on the clone structure of a natural population of *Festuca rubra* L. *New Phytologist* 68 : 93-104.

JONES, D. R. Avian afferent vagal activity related to cardiac and respiratory cycles. *J. Comp. Biochem. Physiol.* 28 : 961-5.

KEAR, J. A brief guide to the Flamingos, Phoenicopteridae. *Wildfowl* 20 : 140-1.

LINSELL, D. E. Pre-dusk and nocturnal behaviour of Goldeneye with notes on population composition. *Wildfowl* 20 : 75-77.

MATTHEWS, G. V. T. Egg carrying by female Mallard. *Brit. Birds* 62 : 384.

MATTHEWS, G. V. T. The International Wildfowl Research Bureau. *Wildfowl* 20 : 94-97.

MATTHEWS, G. V. T. Nacton Decoy and its catches. *Wildfowl* 20 : 131-7.

MATTHEWS, G. V. T. Navigation in animals. *J. Inst. Navigation* 22 : 118-26.

MATTHEWS, G. V. T. and C. R. G. CAMPBELL. Weights and measurements of Greylag Geese in Scotland. *Wildfowl* 20 : 86-93.

OGILVIE, M. A. The status of the Canada Goose in Britain 1967-69. *Wildfowl* 20 : 33-46.

OGILVIE, M. A. and G. V. T. MATTHEWS. Brent Geese, mudflats and Man. *Wildfowl* 20 : 119-25.

SLADEN, W. J. L. Studies of the Whistling Swan, 1967-1968. *North Amer. Wildlife Conf. Trans.* 34 : 42-50.

THOM, V. M. Wintering duck in Scotland. *Scot. Birds* 5 : 417-66.

Obituary

CAPTAIN R. G. W. BERKELEY

Rob Berkeley — Vice-President, Founder Council member and friend of the Wildfowl Trust—died on 28th August 1969. Without his approval and support the Trust could not have been established at Slimbridge, for it was laid out on his land.

During the first discussion of the idea back in 1946, I well remember sitting with him on a sofa in Berkeley Castle looking at photographs I had brought with me of Jack Miner's Canada Goose Sanctuary at Kingsville, Ontario, and of a mass of Greater Snow Geese in front of the Gun Club's picture window at Cap Tourmente in the Gulf of St. Lawrence.

I had some sort of dream that people could get close to wild geese to see them and photograph them if only the right kinds of hides and screened pathways could be made. All this, I thought, might somehow be combined with a collection of tame wildfowl and set up close to the hundred-year-old duck decoy at the New Grounds. To his eternal credit this wild and unlikely scheme was accepted without reservation by the man who was to be its landlord. I do not think either of us then foresaw all that the Trust would become in the next twenty years, yet I believe what in fact it became pleased Rob as much at it pleased me.

He had a lifelong interest in wildfowl, and had considerable experience and technical knowledge of keeping and breeding them in captivity at Spetchley Park in Worcestershire—his other home.

On his last visit to the Trust the wild Bewick's Swans were flighting in to Swan Lake before dusk, and after tea they were going out again under the floodlights. As he sat in the window Rob was at the top of his form and apparently enjoying the spectacle in every detail. In spite of his illness he was as quick as ever in the acuity of his observation. He 'did not miss a trick' in the complex ornithological spectacle in front of him. I remember thinking at the time how lucky the Trust had been to have a landlord with so fine an appreciation of the beauty and romance of wildfowl.

The Wildfowl Trust must never forget how much it owes to the interest and goodwill of Captain R. G. W. Berkeley.

PETER SCOTT

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTER

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER 1969

1968 £	EXPENDITURE	£	£
	To **General Expenses:**—		
10040	Salaries and Superannuation, Administrative Staff	12107	
1600	Rent, Rates, Water Rates and Insurance	2143	
5813	General Administration Expenses	5609	
3441	Maintenance	3828	
2968	Printing and Stationery including Bulletins	3108	
185	Bank Charges	145	
7354	Advertising	10040	
31401			36980
	New Grounds and Peakirk:—		
19083	Salaries, Wages and Superannuation	23279	
1550	Purchases of Wildfowl	6236	
7569	Food for Wildfowl	9332	
7360	Maintenance, Fuel, etc.	5767	
2191	Transport, Mechanical Equipment, Travel	1736	
758	Miscellaneous	1017	
38511			47367
	Gate Houses:—		
6484	Salaries, Wages and Superannuation	8393	
2266	Miscellaneous	2086	
8750			10479
	To **Research and Conservation:**—		
16831	Salaries and Superannuation	19094	
4797	Miscellaneous Research Expenditure	5325	
2622	Printing *Wildfowl*	3253	
6461	Management and Upkeep of refuges and ringing stations	8375	
30711			36047
	Educational:—		
2255	Salaries and Superannuation	3329	
688	Miscellaneous	440	
2943			3769
	Capital Expenditure:—		
5140	Development*	—	
1174	Equipment	188	
6314			188
100	Written off Buildings		100
	**Note:*—Development Expenditure this year has been charged to the General Development Fund.		
£118730			£134930
3210	To Deficit for year, brought down		3788
£3210			£3788

1968 £	INCOME	£	£
	By **General Income:**—		
12247	Subscriptions	14555	
705	Donations	568	
—	Film Royalties	227	
2267	Income Tax repaid on Covenants	3479	
1819	Interest Received	1750	
17038			20579
	New Grounds and Peakirk:—		
59767	Takings	68854	
3083	Sale of Surplus Wildfowl	4048	
2181	Restaurant	2486	
65031			75388
	Gate Houses:—		
38666	Sales	38321	
27019	*Less:* Purchases (with Stocks adjusted)	29096	
11647			9225
	By **Research and Conservation:**—		
17129	The Natural Environment Research Council Grant	18933	
996	Donations	683	
2358	Other receipts	3526	
20483			23142
	Educational:—		
275	County Council Grants		275
1046	Increase in Valuation, 31st December 1969		2533
3210	Deficit for year, carried down		3788
£118730			£134930
1003	By Balance, 31st December 1968		—
2207	Transfer to Accumulated Fund		3788
£3210			£3788

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTER
BALANCE SHEET AS AT 31st DECEMBER 1969

1968	LIABILITIES	£	£
£			
47100	**Accumulated Fund**		47100
	Special Funds:—		
18723	Specific Projects	19564	
1022	Life Membership	2169	
4293	Special Reserve	7500	
686	General Development	14468	
24724		43701	
—	*Less:* Net Cost of Fund Raising Campaign (per Contra)	13239	
24724			30462
1350	**Mortgage on Freehold Property**		1332
	Current Liabilities:—		
16901	Sundry Creditors and Accrued Charges	20421	
2876	Unsecured Loans	4024	
19777			24445
£92951			£103339

1968	ASSETS	£	£
£			
	Fixed Assets:—		
13179	Freehold and Leasehold Properties, at Cost or Valuation (less Depreciation)		13079
	Assets, at Valuation, 31st December 1969:		
9175	Transport and other equipment	9428	
11000	Wildfowl	13280	
20175			22708
33354			35787
	Special Funds represented by:—		
24724	Investment at Cost and Cash on Deposit		30462
	Current Assets:—		
8563	Gate House and Other Stocks	11964	
7813	Sundry Debtors and Payments in Advance	8010	
8660	Cash	17116	
25036			37090
	Fund Raising Campaign:—		
9837	Campaign Expenses to date less Covenants and other Donations received	13239	
	Deducted from Special Funds per Contra	£13239	
	NOTE:—The Grossed up total of the amount contributed to 31st December 1969 amounted to approximately £173,420 over the Term of the Covenants.		
£92951			£103339

We have examined the above Balance Sheet of The Wildfowl Trust dated 31st December 1969, together with the accompanying Income and Expenditure Account and find them to be in accordance with the Books and Vouchers produced to us and the information and explanations given to us.

STROUD, Gloucestershire.
16th April 1970.

S. J. DUDBRIDGE & SONS,
Chartered Accountants.

Terms of Membership (as from 1st January 1970).

LIFE MEMBERS	A single payment of £100. Entitled to all the privileges of Full Membership (see below).
FULL MEMBERS	£3 a year. Entitled to free entry to the enclosures and observation hides at Slimbridge and Peakirk, with one free guest, and to a free copy of WILDFOWL and bulletins.
ASSOCIATE MEMBERS	£1 10s. a year. Entitled to free entry to enclosures and hides, and to a free copy of bulletins.
GOSLING MEMBERS (under 18)	12/6d. a year. Entitled to the same privileges as Associate Members. A leaflet obtainable at Slimbridge or Peakirk gives details of a scheme of grading of Goslings, with appropriate distinguishing marks, and promotion and recognition tests.
CORPORATE MEMBERS	£1 a year. Limited to educational establishments, youth clubs, and bodies which are members of the Council for Nature. Receive a free copy of WILDFOWL and bulletins. Free entry for one adult per each ten members of a party.
CONTRIBUTORS	Organisations which do not qualify for Corporate Membership may become Contributors by subscribing not less than one guinea a year. Contributors receive one free copy of WILDFOWL and all bulletins.