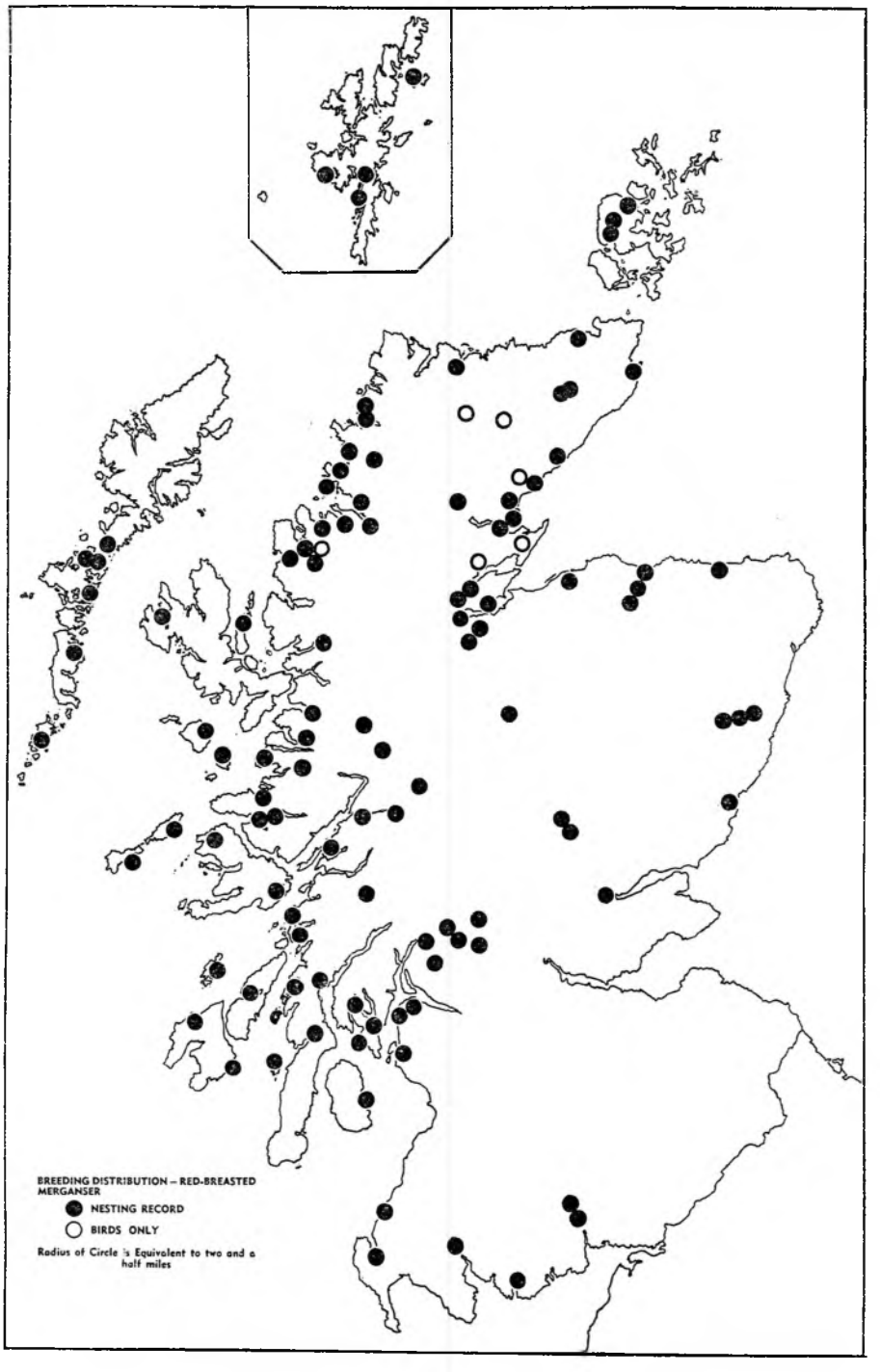

BREEDING DISTRIBUTION – RED-BREASTED MERGANSER
NESTING RECORD
BIRDS ONLY
Radius of Circle is Equivalent to two and a half miles

Figure 2

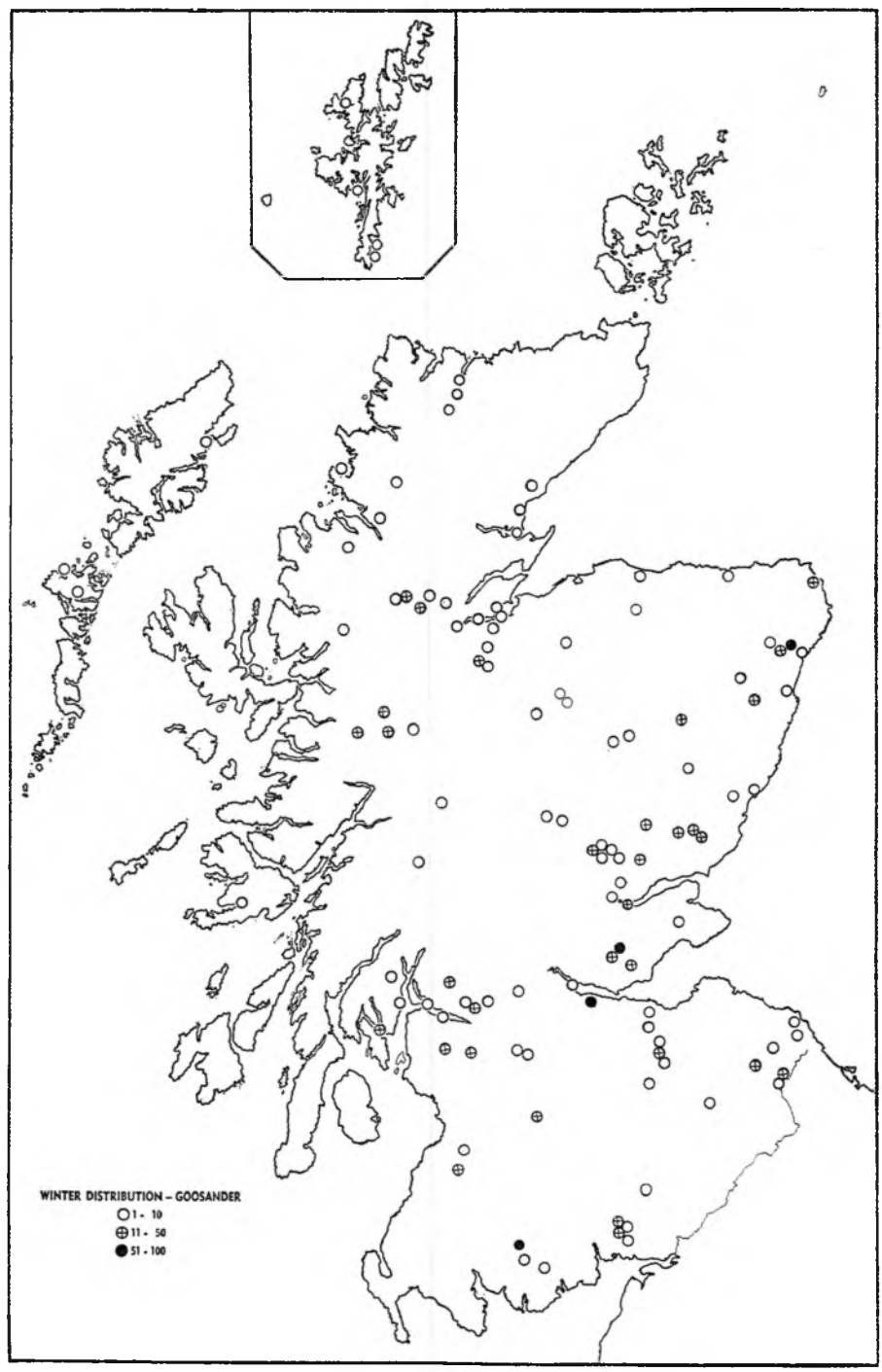


Figure 3

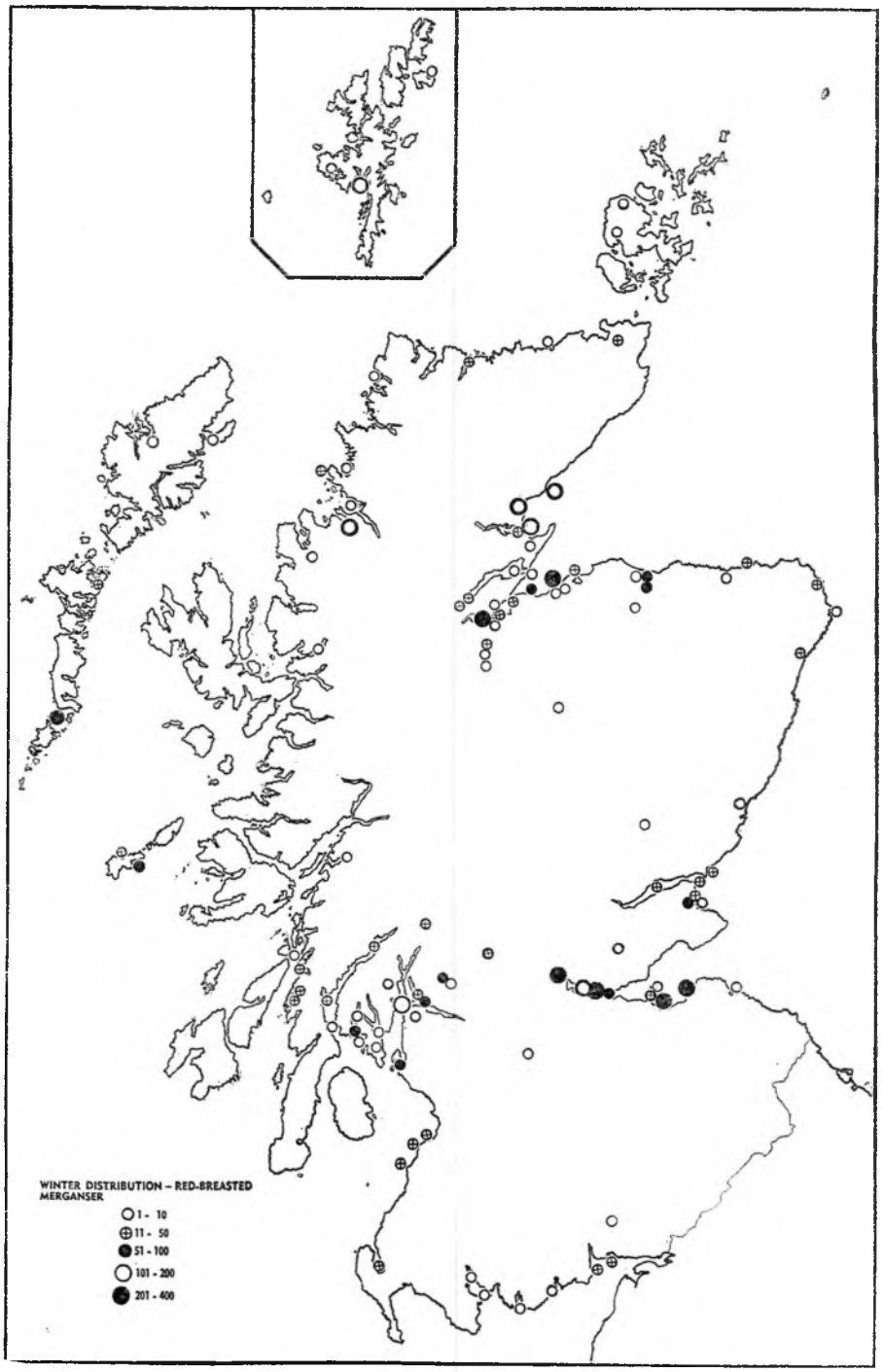

WINTER DISTRIBUTION – RED-BREASTED MERGANSER
1 - 10
11 - 50
51 - 100
101 - 200
201 - 400

Figure 4

for Ornithology; (3) information kindly supplied by fellow regional representatives for the British Trust for Ornithology; (4) extracts from Arthur Whitaker's diary; (5) personal observations; (6) information given with young birds sent in for examination and (7) records of broods seen by Boyd and Eltringham (personal communication) during their aerial survey of Caithness, Sutherland and Ross during the period 27th May to 4th June, 1959. The radius of the symbol indicating a breeding record represents two and a half miles so that in some cases one symbol may indicate more than one pair of birds breeding in the area. This method has been adopted for this reason, and where only broods have been recorded this is also necessary to allow for some movement from the breeding site. Furthermore the breeding site may change slightly from year to year although Baxter and Rintoul (1953) mention that the same hole was used by Goosanders as a nesting site for 40 years. Figures 1 and 2 can only represent the main breeding areas, as records of the breeding status in certain districts are still obscure. However, it is felt that the figures do give a reasonably accurate picture of the distribution of both species.

Figures 3 and 4 show the distribution of these birds during the autumn, winter and early spring. The information used to compile them has been abstracted mainly from Wildfowl Count data, most generously made available by George Atkinson-Willes. Further information was forthcoming from Baxter and Rintoul (1922 and 1953); Berry (1939); Darling (1947); "*Scottish Birds*"; regional representatives for the British Trust for Ornithology; and personal observations. The information from the Wildfowl Count data was for the years 1948 to 1961, and the other information refers to observations over a number of years. These figures therefore do not depict the distribution in any one year or at any one time but only show the areas where these species generally congregate during the autumn, winter and early spring and the areas are not all necessarily occupied at one and the same time.

(1) Breeding Distribution

(a) Goosander

Prior to 1870 the Goosander was a scarce winter visitor. In 1871 it was first recorded as breeding in Scotland, and four years later, in the winter of 1875-76, there was a mass influx of Goosanders. Within twenty years of this invasion it had become a common nesting species in the north of Scotland, especially in the western watershed from Eddrachillis to Loch Awe, the upper Tay, Argyll and the Moray Basin. Since then there has been a gradual dispersal over the mainland of Scotland to the counties of Aberdeen, Angus, Dunbarton, Stirling, Renfrew, Selkirk, and lastly the Galloway country in the south-west corner of Scotland in the late 1940s (McLure, 1949), where it now breeds in the upper waters of the rivers in Dumfries, Kirkcudbright and Wigtown. It has still not been recorded as a breeding species in Kinross, Fife, Clackmannan, Lanark, the Lothians, Peebles and Roxburgh. Its breeding status in Caithness is obscure and, while there are reasons for believing that it nests in that county, there are no known records of its breeding there. Baxter and Rintoul (1953) mention it being resident in Banffshire but give no breeding records. A ghillie on the River Tweed mentioned its nesting at Coldstream in Berwickshire up to fifteen years ago, since when regular shoots have resulted in its disappearance as a breeding species. In the Outer Hebrides the only breeding record is near Loch Maddy, while in the Inner Hebrides it has only been known to nest on Loch Scridain in Mull.

One apparent change in its distribution is in the north-west, in south-west Sutherland and Wester Ross, where its numbers appear to have declined considerably, judging from earlier records. In Wester Ross it is now most often seen as an occasional visitor in the autumn, although Boyd and Eltringham recorded a duck with nine young on Feur Loch in north-west Ross in 1959. In Sutherland it still occurs on the rivers Inver, Assynt, Hope and Naver but its numbers are kept down, it has been said, by " super-efficient river keepering."

The Goosander is generally a bird of the upper reaches of the rivers and frequently nests near the smaller tributaries, building its nest in holes in trees and banks or dense undergrowth. Baxter and Rintoul (1922) describe it as colonising the upper reaches of the river and gradually extending its range downstream. Similar habits were noted in Sweden by Lindroth (1955) and in eastern Canada the American Merganser was recorded by White (1957) as frequenting the upper parts of the rivers.

(b) **Red-breasted Merganser**

The Red-breasted Merganser was known to have inhabited Scotland for many centuries from the evidence of its remains being found in an early Neolithic or Azilian kitchen midden on Oronsay, a small island off the coast of Argyll. In the nineteenth century it was known to breed on the Outer and Inner Hebrides, Shetland, Orkney and on the west coast of Scotland from northern Sutherland to Dunbartonshire. On the east coast it bred in Caithness, Sutherland and Ross. In central Scotland it occurred in Perthshire. The species spread rapidly from these areas, and possibly also as a result of overseas migration, to colonise the Moray Basin, Banff, Aberdeen in the east and Renfrew and Galloway in the south-west from about 1890 to 1920 (Figure 2). It has not been recorded as a breeding species in Lanark, Clackmannan, Fife, Kinross, the Lothians or the border counties of Peebles, Selkirk, Roxburgh and Berwick.

This species tends to be more marine in its habits, especially on the west coast, where it nests in thick heather or bracken on islands in the many sea lochs, inlets and firths. In the east and the south-west it is an estuarine species nesting on the lower reaches of the rivers. However, there is an overlap in the habitat of this species with the Goosander, and the Red-breasted Merganser nests far inland on the larger river systems of the Ness, Spey and Tay. Birds with young broods have been seen on the Tummel near Pitlochry and on the upper reaches of the Rivers Moriston and Garry in Inverness, an area where Berry also recorded them in 1936. On Speyside, they have been recorded nesting on Loch Gynack near Kingussie and Loch Morlich near Aviemore.

(2) " Winter " distribution

(a) **Goosander**

During the summer and early autumn there is a dispersal from the breeding sites and the ducks usually bring their broods downstream from the upper tributaries. On the River Meig in Ross-shire broods, some still covered with down and others with their first feathers, have been traced over a period of days moving down the river and eventually observed congregating on Meig Loch. This has also been observed on the River Bran in Ross-shire and Mr. Donald Watson has noticed the assembly of broods on Loch Ken on the Kirkcudbrightshire Dee. An increase in the numbers of Goosanders in autumn

has also been noticed on the Tay and Ness. White (1957) observed the same pattern of behaviour in the American Merganser, the birds assembling on the lakes and estuaries. He noted that by mid-August when the ducklings are well-grown all the broods are on the main streams and have deserted or been deserted by the moulting females. He also found that the broods tend to gather and form large flocks, which range for miles up and down the river. A comparison of Figure 1 and Figure 3 gives an indication of this dispersal, as the latter figure shows that concentrations of Goosanders are to be seen near the coast and are generally spread over other areas of Scotland where they do not breed, especially in the south-east. Many of these concentrations have been counted on lochs during the Wildfowl Count periods only (September to March, inclusive, in recent seasons), so that it is not known whether Goosanders are definitely absent at other times. However, observations on certain lochs throughout the year confirm that these gatherings are only seasonal and usually at a time covered by the Wildfowl Counts. This downstream dispersal does of course bring the birds into non-breeding areas, as is obvious in Figure 3. Large concentrations have been noted on Loch Leven and the Edinburgh reservoirs, particularly Gladhouse. This reservoir is under almost constant observation by members of the Scottish Ornithologists' Club and the autumnal appearance of Goosanders is confirmed here among other places. Numbers also occur on the River Tweed from Dawyck in Peebles to Coldstream in Berwick. As well as a dispersal of residents there is believed to be an increase in the winter population produced by an influx of winter visitors from Scandinavia (Venables and Venables, 1955) and Boyd (1959) records a bird ringed in Sweden being recovered in Perthshire.

(b) **Red-breasted Merganser**

From late autumn to early spring this species is almost entirely marine. Those birds breeding on the lower reaches of the river bring their broods down to the estuary (Berry, 1933; Baxter and Rintoul, 1953) and large flocks are to be seen on the firths on both sides of the country. On the west coast Darling (1947) has recorded a flock of 123 on Little Loch Broom and Baxter and Rintoul (1953) recorded one of about 200 off Nairn on the southern shore of the Moray Firth in July. Flocks of up to 400 have been counted in the Beauly Firth and *Scottish Birds* (1960, 1961) gave details of large numbers in the Firth of Forth in 1960 and 1961. In 1960 over 250 were counted at Aberlady Bay in July and more than 300 in August; off Musselburgh flocks had increased from 100 birds in July to 400 in October and in the same month over 250 were counted at Skinflats, east Stirling, on the upper reaches of the Firth of Forth. Again, in 1961 200 Red-breasted Mergansers were counted at Musselburgh in September and at Barnbougle, West Lothian there were 300 on 14th October and 350 on the 22nd October. At Longannet in Fife 14 were counted in July and these were described as 'summering' birds; by 29th September 320 were counted here and Hoy (1961) suggests that this is a 'moult' area.

Those flocks occurring in July and August most probably consist of birds which have dispersed from their breeding sites elsewhere in Scotland but by October these have been supplemented by an influx of migrants from abroad. Boyd (1959) records five recoveries of ringed birds in Scotland, all of Icelandic origin. Venables and Venables (1955) describe autumn flocks gathering in the Shetland voes in early September and reaching a considerable

size (up to 130) in October, which they believe strongly suggests a passage migration from elsewhere. Salomonsen (1950-51) states that there is no doubt that the greater part of the east Greenland population winters in the British Isles. The flocks in the Shetlands are considerably smaller after October and the birds remaining gradually break up into pairs. Similarly the flocks occurring from July to September in the Kyle of Tongue (30-50), Loch Fleet, Golspie Bay, Dornoch Firth (150-200) and Kintradwell Bay, Brora (40-50) break up into small parties at the end of this period. However, the large flocks of up to 400 occurring in the Beauly Firth are present throughout the winter: this may be due to the presence of the 'Kessock' herring which provides a fishery for local boats. Munro and Clemens (1939) described the Red-breasted Merganser feeding on the herring on the western seaboard of Canada; Berry (1939) records small herring from birds shot in the Firth of Tay, where flocks of these birds occur during the winter; and Brooks (1934) gives a description of these birds feeding on spawning herring shoals.

In the spring these large flocks disperse to their breeding sites. Slight evidence for a northerly movement in the spring was obtained from a numbered salmon smolt tag found in the stomach of a drake shot on the River Ness in May 1960. The tag had been attached to a hatchery-reared smolt released a month previously in the River North Esk, about 80 miles to the south-east " as the crow flies."

Mr. Peterson (personal communication) of the Bergeforsen Salmon Rearing Station, Sweden, describes a similar recovery from the Goosander. A " diving duck " was shot in the White Sea and examined by a Russian biologist in Petrozavodsk. The bird contained salmon smolt tags which had been attached to smolts released in the Swedish River Indalsälven a few weeks previously. Mr. Peterson was able to confirm that the " diving duck " was a Goosander.

Population Density

It is difficult to determine the numbers of both species occurring at times on Scottish rivers. However, it would appear from the information for the Rivers Oykell (Sutherland) Conon, Meig, Bran (Ross and Cromarty) and Dee (Aberdeenshire) that there are, on an average, from one to two pairs of Goosanders per 10 miles of river and perhaps considerably more on the Tay system. More detailed observations have been carried out on the Goosander population on the Rivers Bran and Meig and the information is summarised in Tables 1 and 2. Both the stretches of river concerned were approximately

Table 1. Goosanders on the Rivers Bran and Meig, Ross-shire, 1959.

Period	No. of visits		No. of visits on which Goosanders were seen		Average number of Goosanders seen	
1959	Bran	Meig	Bran	Meig	Bran	Meig
24th February-30th April ..	30	15	9	12	3(4)[a]	4(10)
1st May-31st August	16	40	1	6	1	2(6)
1st September-30th September ..	4	10	2	3	6(7)[a]	3(5)
1st October-30th November ..	20	8	6	3	2(3)	1(2)
	70	73	18	24	3.0(7)	2.5(10)

Figures in brackets indicate the largest number seen at any one time.
[a] Two birds shot.

Table 2. Goosanders on the River Bran, Ross-shire, 1960-61.

Month	No. of visits		No. of visits on which Goosanders seen		Average no. of Goosanders seen	
	1960	1961	1960	1961	1960	1961
January	6	10	1	4	2(2)	2(6)[c]
February	3	4	0	2	0	2(2)
March	11	6	5	3	2(5)	1(2)
April	26	21	15	11	2(5)[a]	3(7)[d]
May	26	31	x	3	x	2(3)
June	23	15	9	0	0	0
July	24	5	9	0	0	0
August	19	6	9	0	0	0
September	13	8	3	3	4(5)	4(10)
October	14	8	6	2	4(7)	3(4)
November	12	10	7	1	1(2)	1(1)
December	9	8	2	3	2(2)[b]	2(2)
	160	132	39	32	2.4(7)	2.2(10)

Figures in brackets indicate the largest number seen at any one time.
[a] 4 birds shot; [b] 1 bird shot; [c] 2 birds shot; [d] 3 birds shot; x No information.

10 miles long with an average width of 20 yards and were almost completely free from tree cover. Further their physical nature—the type of rock formation, river bed, flow and surrounding vegetation—was similar. These tables show that Goosanders occur on these two rivers for most of the year although none were observed in June, July and August. The average number seen on these two 10 mile stretches of river was of the order of two to three.

Feeding Methods

(a) Goosander

The Goosander is primarily a fish eater and has a bill well-adapted for seizing and holding fish and which, being long and tapered, makes for ease in extracting small fish from under stones. White (1957) describes the American Merganser fishing successfully by swimming on the water but with its eyes and most of its head below the surface; when a fish is sighted it pursues the prey by swimming on the surface with head submerged. The bird will then submerge, return to the surface and swallow the fish. Lindroth and Bergstrom (1959) describe the feeding technique of the Goosander and confirm this method of feeding, also noting that the fish is seized across the middle and swallowed under water. Salyer, Clark and Lagler (1940) also describe the fish being swallowed under water. Both White and Lindroth and Bergstrom describe the bird diving to hunt fish and probing beneath stones with its bill. White describes the method of swallowing fish in detail and notes that, while herons, bitterns and cormorants all stretch their necks when swallowing large fish, an American Merganser can swallow a large fish and still retain the neck in a sigmoid shape. In the birds examined by Mills (in the press) all undigested fish were found to have been swallowed head first with the exception of one perch. This had been swallowed tail first and the spiny dorsal fin rays had become lodged in the oesophagus wall.

On the River Bran, flocks of Goosanders have on a number of occasions been watched fishing in an apparently organised way. The flock swims downstream stretched out in line abreast across the whole width of the river, then

works into one shore in an arc in much the same way as a sweep-net is operated. After reaching the shore they swim out in line abreast and repeat the operation. White (1957) describes a similar method in the American Merganser and Tebbutt (1961) describes a flock of Goosanders acting coherently, all the birds moving in the same direction and diving at the same moment.

In deep and turbid water sight might well be of no use to the bird while fishing and Heard and Curd (1959) have suggested that hypersensitivity to motion in the water may enable the Goosander to locate its prey. The workers have recovered these birds, caught in gill nets, 35 ft. below the surface of turbid water.

(b) **Red-breasted Merganser**

Curth (1954) describes the Red-breasted Merganser fishing like the Goosander by swimming on the water with its head partly submerged. Saxby (1874), Seebohm (1885) and Venables and Venables (1955) have observed these birds also using their wings under water.

Enemies

Man appears to be the only serious enemy of the Goosander in this country. This is because of the amount of damage it is believed to do to salmon and trout stocks and not because of any culinary interests. Seton Gordon (1959) saw an unsuccessful attack on a Goosander by a Golden Eagle. Greater Black-backed Gulls probably take the young occasionally. Berry (1959) believes that gulls are the most serious enemies of Red-breasted Mergansers and predation of eggs and young by Great and Lesser Black-backed Gulls has been recorded by Gray (1871), Collier (1904) and Phillips (1926). A Great Black-backed Gull was seen taking a young bird from a brood on Loch Carron in Ross-shire. Glegg (1945, 1947) records the angler fish *Lophius piscatorius* taking the Red-breasted Merganser.

Discussion

Before 1870 the Goosander was a rather scarce winter visitor to Scotland and there was no record of breeding before 1871. Berry (1939) says that there was evidence of drift immigration from 1870 which increased rapidly, and throughout the autumn and winter of 1875-76 it amounted to a mass immigration. He thought it probable that the immigrants came from Scandinavia or north Russia and that possibly a cycle of dry, warm seasons had allowed an unusually high number of ducklings to survive. These conditions, however, would also have tended to reduce their food supply. Thus emigration or starvation might be the only alternatives in the following breeding seasons. However, another explanation, perhaps equally speculative, might be that unusually severe conditions on the Continent caused more birds to move to this country, and the prolonged winter in the British Isles prevented birds from returning north at their usual time and when conditions became favourable the advanced stage reached in the breeding cycle led some birds to nest in this country. It is clear from Veryard (1962) that the winters were severe over the whole of the period under discussion and the information given by Fisher and Lockley (1954, p.124) gives some idea of the effects of such climatic conditions. They point out that in King Charles Land, east of Spitzbergen, only nine species of sea and shore birds were

present in 1889, when the ice conditions were severe, whereas twenty-one species were reported in 1898, when ice conditions were less severe.

A similar rapid increase in the spread of the Red-breasted Merganser, which was already a breeding species in this country, was noted from 1885 onwards. The reasons just put forward for the start of breeding in this country by the Goosander could also explain the spread of the Red-breasted Merganser. The " starvation " hypothesis of Berry (1939) would not, as this species lives in a more marine environment where shortage of food is less likely. Indeed, a marine environment should be capable of maintaining a very high population of these birds and the rapid spread after 1885 seems best explained by the nesting of winter migrants in this country. Berry (1939) suggests that the Wild Birds Protection Act may have helped the increase of this duck, for it was not until the Merganser had become locally plentiful that efforts were made to destroy it at all seasons. Further, he agrees that " the available data are complicated in several ways. The increasing popularity of trout fishing in remote Highland lochs led to reports from many districts in which formerly this and other species may have been overlooked. Then to judge only from lists of records, it would appear that a sudden increase of Goosanders and Mergansers had occurred in districts where this was not the case, owing to the much larger number recorded when a reward of half-a-crown was offered for their beaks by proprietors of fishings."

Neither the Goosander or the Red-breasted Merganser are protected in Scotland by the Protection of Birds Act, 1954, and both species are shot on most salmon rivers. In the north the local estates are responsible for their control, while on the larger rivers, with active District Fishery Boards, control is carried out by bailiffs and angling clubs and organised drives are held. Rewards are given to individuals sending in the corpse or beak of either species. The rewards are of the order of two shillings or two shillings and sixpence. Berry (1939) quotes a similar price being paid in the late 1930s, so that the value of these birds has dropped, perhaps unintentionally. Baxter and Rintoul (1953) refer to 250 Red-breasted Mergansers being shot on the Ness estuary in the course of a year and numbers of the order of 100 may be shot in the Tay area each year. Unfortunately, other birds are sometimes killed in " Merganser drives." These have included the Red-necked Grebe *Podiceps griseigena,* (Mills 1960), the Goldeneye *Bucephala clangula,* the Black-throated Diver *Gavia arctica* and the Red-throated Diver *G. stellatus.*

Although numbers of Goosanders and Red-breasted Mergansers are shot each year their status remains unchanged, with the exception of a possible decline in the number of Goosanders in the north-west and an increase in this species on rivers in Dumfries and Kirkcudbright. White (1957) is against the institution of a bounty system with its inherent abuses and Munro and Clemens (1939) and Sayler, Clark and Lagler (1940) believe that control is only necessary during the presence of " unusual " numbers on salmon and trout waters and should only be a corrective measure for a temporary condition. It seems unwarranted that a bird should be killed because it may be a predator at some time or place.

The Goosander and Red-breasted Merganser are both fish eaters and, as they occur on many salmon rivers in Scotland where few other species of fish occur in the particular habitats frequented by these birds, salmon will obviously be taken. Mills (in the press) has shown to what extent they are

eaten. Lindroth believes that Goosanders show a preference for young salmon as in areas where other fish, such as grayling, were more abundant, the birds had eaten mainly salmon. White (1957) suggests a preference for young salmon and that they are selected by the American Merganser as food. He qualified the suggestion, however, by the fact that Mergansers feed by sight and need clear water which is just the kind that is typically salmon and trout habitat. Where other species of fish are more abundant these are taken more frequently than salmon (Munro and Clemens, 1937 and 1939); and Aass (personal communication).

A detailed study of the feeding behaviour of these birds would be of great value. Furthermore, the migrations of these birds need closer investigation as the possibility arises that if birds are killed at certain times of the year their territories may be filled by migrants. Little is known of the factors that caused the Goosander to become a breeding species in Scotland in the first place and control at the wrong time of the year may only make room for birds which might normally return to breeding areas outside Scotland.

Acknowledgements

I should particularly like to thank George Atkinson-Willes for so generously allowing me to abstract information from the Wildfowl Count data; Hugh Boyd and Dr. S. K. Eltringham for making available the results of their aerial survey of northern Scotland; the Nest Records Sub-Committee of the British Trust for Ornithology for use of the nest record cards; and Dr. P. Aass and Hans Peterson for their personal communications. I am also most grateful to the following for their kind help: Dr. J. W. Campbell, R. N. Campbell, G. Dick, T. Douglas, Sir Arthur Duncan, Miss W. U. Flower, Miss E. A. Garden, Seton Gordon, J. Gunn, Dr. D. Jenkins, the late Rev. J. Lees, Dr. T. G. Longstaff, H. Mayer-Gross, C. E. Palmar, Dr. I. D. Pennie. Rev. F. Routledge-Bell, Dr. Maeve Rusk, D. Watson and J. Wood.

References

BAXTER, E. V. & RINTOUL, L. J. 1922. *Some British Breeding Duck : their Arrival and Dispersal*, pp. 90. Edinburgh : Oliver and Boyd.

BAXTER, E. V. & RINTOUL, L. J. 1953. *The Birds of Scotland*, Vol. 2, pp. 407. Edinburgh : Oliver and Boyd.

BERRY, J. 1933. Notes on birds seen in the River Ness area, May-June, 1932. *Scot. Nat.*, 1933 : 105-08.

BERRY, J. 1936. British mammals and birds as enemies of the Atlantic salmon (*Salmo salar*). *Annual Report Avon Biological Research*, 1934-35 : 31-64.

BERRY, J. 1939. *The Status and Distribution of Wild Geese and Wild Duck in Scotland*. pp. xii + 190. Cambridge : University Press.

BOYD, H. 1959. Movements of marked sea and diving ducks in Europe. *Wildfowl Trust Tenth Annual Report* : 59-70.

BROOKS, A. 1934. Far-flying wildfowl and their foes. *Nat. geogr. Mag.*, 46 : 487-528.

COLDWELL, C. 1939. The feeding habits of American mergansers. *Canad. Field Nat.* 53 : 55.

COLLIER, C. 1904. The birds of the Island of Raasay. *Ibis*, 1904 : 490-522.

CURTH, P. 1954. *Der Mittelsäger*, pp. 102. Wittenberg : Zeimsen.

DARLING, F. FRASER. 1947. *Natural History in the Highlands and Islands*, pp. xiv + 303. London : Collins.

EDITORS. 1960. Unusually large numbers of Red-breasted Mergansers seen in Forth in late summer and autumn. *Scottish Birds* 1 : 340.

EDITORS. 1961. Large numbers of Red-breasted Mergansers. *Scottish Birds* 1 : 500.

FISHER, J. & LOCKLEY, R. M. 1954. *Sea-Birds*, pp. 320. London : Collins.

GLEGG, W. E. 1945. Fishes and other aquatic animals preying on birds. *Ibis* 87 : 422-33.

GLEGG, W. E. 1947. Fishes and other aquatic animals preying on birds. *Ibis* 89 : 433-5.

GORDON, SETON. 1959. Eagle and goosander. *Scotsman*, Edinburgh, 21st March. (Nature Notes).

GRAY, R. 1871. *Birds of the West of Scotland*, pp. 520. Glasgow : Murray.

HARVIE-BROWN, J. A. & BUCKLEY, T. E. 1887. *A Vertebrate Fauna of Sutherland, Caithness and West Cromarty*, pp. 344. Edinburgh : Douglas.

HARVIE-BROWN, J. A. & BUCKLEY, T. E. 1892. *A Vertebrate Fauna of Argyll and the Inner Hebrides*, pp. 262. Edinburgh : Douglas.

HARVIE-BROWN, J. A. & BUCKLEY, T. E. 1895. *A Vertebrate Fauna of the Moray Basin*, Vol. 1, pp. 306, Vol. 2, pp. 309. Edinburgh : Douglas.

HARVIE-BROWN, J. A. & MACPHERSON, H. A. 1904. *A Fauna of the North-West Highlands and Skye*, pp. 372. Edinburgh : Douglas.

HARVIE-BROWN, J. A. 1906. *A Fauna of the Tay Basin and Strathmore*, pp. 377. Edinburgh : Douglas.

HEARD, W. R. & CURD, M. R. 1959. Stomach contents of American mergansers, *Mergus merganser* Linnaeus, caught in gill nets set in Lake Carl, Blackwell, Oklahoma. *Proc. Oklahoma Acad. Sci.* 39 : 197-200.

HOY, J. 1961. *Scottish Birds* 1 : 500.

JACKSON, H. R. 1937. Birds of Atholl. *Trans. Perths. Soc. Nat. Sci.* 9 : 173-81.

LINDROTH, A. 1955. Mergansers as salmon and trout predators in the River Indalsälven. *Rep. Inst. Freshw. Res. Drottning.* 36 : 126-32.

LINDROTH, A. & BERGSTROM, E. 1959. Notes on the feeding technique of the goosander in streams. *Rep. Inst. Freshw, Res., Drottning.* 40 : 165-75.

MCLURE, J. 1949. Goosander nesting in Kirkcudbrightshire. *Brit. Birds* 42 : 153.

MILLAIS, J. G. 1913. *British Diving Ducks*. Vol. 2, pp. 164. London : Longmans, Green.

MILLS, D. H. 1960. Hooded crow and red-necked grebe as predators of salmon. *Scottish Birds* 1 : 286.

MILLS, D. H. (*in the press*). The goosander and red-breasted merganser as predators of salmon. *Sci. Invest. Freshwat. Fish Scot.*

MUNRO, J. A. & CLEMENS, W. A. 1937. The American merganser in British Columbia and its relation to the fish population. *Bull. Fish. Res. Bd Can.* 55 : 1-50.

MUNRO, J. A. & CLEMENS, W. A. 1939. The food and feeding habits of the red-breasted merganser in British Columbia. *J. Wildlife Mgmt.* 3 : 46-53.

PHILLIPS, J. C. 1922. *Natural History of the Ducks*. Vol. 4, pp. 489. Boston : Houghton, Miffein.

SALOMONSEN, F. 1950-51. *Grønlands Fugle* (*The Birds of Greenland*), pp. 609. Copenhagen : Ejnar, Munksgaard.

SAYLER, J., CLARK, I. I. & LAGLER, K. F. 1940. The food and habits of the American merganser during winter considered in relation to fish management. *J. Wildlife Mgmt.* 4 : 186-219.

SAXBY, H. L. 1874. *The Birds of Shetland, with observations on their Habits, Migration and Occasional Appearance*, pp. 398. Edinburgh : Maclachlan & Stewart.

SEEBOHM, H. 1885. *A History of British Birds*, Vol. 3, pp. 684. London.

TEBBUTT, C. F. 1961. Black-headed gulls feeding in conjunction with goosanders. *Brit. Birds* 54 : 284.

VENABLES, L. S. V. & VENABLES, V. M. 1955. *Birds and Mammals of Shetland*, pp. 891. Edinburgh : Oliver and Boyd.

VERYARD, R. C. 1962. The changing climate. *Discovery* 23 : 8-15.

WHITE, H. C. 1937. Local feeding of kingfishers and merganser. *J. Biol. Bd Can.* 3 : 323-38.

WHITE, H. C. 1939. The food of *Mergus serrator* on the Margaree River, N.S. *J. Fish. Res. Bd Can.* 4 : 309-11.

WHITE, H. C. 1957. Food and natural history of mergansers on salmon waters in the maritime provinces of Canada. *Bull. Fish. Res. Bd Can.* 116 : 63 pp.

Brent Goose population studies, 1960-61

P. J. K. Burton

Summary

THE numbers of Dark-bellied Brent *Branta b. bernicla* wintering in England in 1960-61 were the highest for at least ten years. The total population of this subspecies in Europe was between 21,000 and 26,000. The number of Pale-bellied Brent *B. b. hrota* wintering in Ireland was nearly 12,000 and there were at least another 7000 of this form on the North Sea coasts of Europe.

The Dark-bellied population had had a good breeding year in 1960, the proportion of young birds being about 45% in Essex and similarly high elsewhere in England and in Holland and France. The Irish Pale-bellied stock also included many young birds.

Introduction

The winter of 1960-61, the seventh season of research on the numbers and productivity of European Brent Geese, was a particularly successful one, owing to the large number of observers who contributed observations. Counts of first-winter birds were made in a large number of areas in several countries and, in addition, a large amount of information on total numbers has been received. Details of observations made in various areas are given below, followed by a discussion of results. Except where stated, all records refer to the Dark-bellied race *Branta b. bernicla.*

England

Devon. Numbers in the Exe estuary were the highest for several years, reaching a maximum of 111. A count of 51 young out of 110 was obtained (P. W. C. Ellicott).

Dorset. No remarkable numbers were seen on Poole Harbour. The largest party reported was of 15 (J. V. Boys & A. Bull).

Hampshire & Sussex. Numbers were higher than usual in both Langstone and Chichester Harbours. The maximum recorded was on 28th February, 1961, when the combined total for both harbours exceeded 1000 (M. Bryant & D. F. Billett). Age-group counts made in both harbours during the winter totalled 373, with 159 young — 43% (B. W. Renyard).

Kent. Numbers higher than for several years—the combined maximum for South Medway and Swale was of the order of 250. A party of 200 was seen at Cliffe on 30th November, 1960 (D. Musson). On the Medway on 1st March, 1961, 41 young were counted out of 70 (J. G. Harrison). Brent were seen passing Dungeness in March and early April in larger numbers than usual, despite unfavourable winds for observation (R. E. Scott).

Essex. The Wildfowl Count totals were the highest since thorough counts were first made in 1950-51. The December and January counts both exceeded 10,000, and over 7000 were seen at Foulness alone (Miss E. Drake & R. V. A. Marshall). Age-group counts made by the writer totalled 3742, of which 1683 (45%) were first-winter birds (see below).

Norfolk. Some 550 birds were present at Scolt Head by 12th December, 1960. In counts totalling 304, 165 young (54%) were observed (R. Chestney). At Blakeney, the flocks reached a maximum size of 1500, lower than in some winters. In a party of 91 feeding at Cley on 3rd February, 1961, 64 young were obsreved (R. A. Richardson).

Wash. A count by members of the Cambridge Bird Club on 15th February, 1961, gave the relatively large total of 2900, only once exceeded in the last ten years, in 1958-59. 56 young were counted in a flock of 99 on 5th February, 1961 (S. Martin & I. C. T. Nisbet).

Yorkshire. On the Humber, the largest party observed was of ten, which is not unusual (P. J. Mountford & H. O. Bunce). On the Tees, 17 were seen on 29th January, 1961, the largest party reported for several years, and apparently containing birds of both races (P. J. Stead).

Northumberland. A large influx occurred at Holy Island during February, 1961, reaching a maximum of about 2000, but nearly all were gone by the end of the month (F. Stabler). Holy Island is visited principally by birds of the Pale-bellied race (*B. b. hrota*).

N.W. England. All reports negative, except for records involving not more than 5 birds (3 certainly *B. b. bernicla*) on the Dee (Cheshire) and Leven estuaries from February to late April, 1961 (E. Hardy).

Wales

Gower. Unusually large numbers wintered on the Burry Estuary, with a maximum of 44 on 12th February, 1961 (H. Dickinson).

Mid-Wales. None reported from the Dovey estuary (D. J. Williams).

North Wales. None reported (A. A. Williams).

Scotland

One Pale-bellied bird at Caerlaverock, 4th-8th February, 1961 (E. L. Roberts). 5 Dark-bellied at Tyningham, East Lothian on 29th January, 1961—not an unusual record (A. T. Macmillan). None in Dornoch Firth and Loch Fleet (I. D. Pennie).

Channel Islands

Guernsey. Approximately 80 on Herm—about average, but fewer than in 1959-60 (W. Burridge).

Jersey A marked increase over numbers recorded in recent years. 350 wintered at Grouville Bay, and slightly smaller numbers at St. Aubin's Bay, though there may have been some interchange (E. D. H. Johnson).

Ireland

Two censuses of the Pale-bellied Brent wintering in Ireland were made in 1960-61 (Major R. F. Ruttledge, and see *Irish Bird Report,* 1960, p.9). Just under 12,000 were found on 19th-20th November, 1960 and about 11,000 on 21st-22nd January, 1961. These are much larger numbers than those given by Salomonsen (1958) and Ruttledge and Hall-Watt (1958) and the population in 1960 was perhaps half as big again as it had been four or five years earlier. Observations in Strangford Lough, near Dublin, in Wexford Harbour and at Dungarvan showed 308 young in 787 geese (39%) with no significant variations

Dungarvan showed 435 young in 1087 geese (40%) with no significant variations from place to place. 44 broods seen near Dublin averaged 2.9 (H. Boyd & R. F. Ruttledge).

Continental Europe

Denmark

Tipperne. In spring first seen 19th March, 1961. First large numbers seen 8th April (1500); maximum 1600 (20th April and 1st May); last seen 20th May, 1961. More young were noticed than usual, though the only count possible gave 12 young out of 41 on 30th March (H. Klausen).

Jordsand. In the autumn, the first seen were 70 on 20th September. The maximum was 3000 from 4th-8th October and the last were seen on 7th December, 1960. A count on the mainland from Jordsand to Esbjerg on 6th November, 1960 gave a total of between 1950 and 2250, in addition to the 2000 still present on Jordsand Island at that time.

In spring, first seen on 12th February, 1961, with a maximum for the island of 600 in mid-March, when about the same number were present on the mainland. The maximum for the mainland was 1080 on 1st May. Last seen on 26th May, 1961.

50 Brent were caught and ringed on Jordsand during the winter. 35 of them were first-year birds (Dr. Knud Paludan).

København. Up to 16 on several occasions in October, 1960—more often seen than for several years (Svend Christoffersen).

Blåvandshuk. High numbers seen on autumn coastal passage—up to 321 on one day, 9th October, 1960 (Carsten Mürmann).

N. Jutland. Few wintered in N. Jutland in 1960-61 (Jens Poulsen). Brent wintering in N. Jutland are predominantly Pale-bellied.

Nissum Fjord. An area favoured by Pale-bellied Brent in spring and autumn. 1200 counted on 13th May, 1961, by Dr. Finn Salomonsen, who received the following reports from local wildfowlers: - No Brent wintered on Nissum in 1960-61. The Brent began to arrive there in early March, 1961 and soon built up to a peak estimated at 7000, the largest number they had ever seen. Numbers decreased considerably during April.

France

Golfe du Morbihan & Anse du Pô. An estimated maximum of about 5000 was recorded in 1960-61, a marked increase. In age-group counts totalling 793, 482 first-winter birds were seen (61%) (R. Bozec).

Vendée. 250-400 present at Pointe d'Arçay, as against 50-100 in 1959-60. 50% young estimated (F. Spitz). Large numbers were also present at Baie de Bourgneuf.

Counts from other areas in France do not show whether there was an increase in the total wintering in 1960-61 (F. Roux).

Holland

Zeeland. Counts of total numbers and age-groups have been made on the Ooster Schelde. On 26th February, 1961, 5-600 were observed near Middelplaten—the largest flock since 1947-48. Counts of young birds made throughout the winter gave 229 young out of 443 birds (52%) and 145 out of

299 (48%)—counts by T. Lebret and Mrs. Vaas-van Oven respectively. The combined total is 374 young out of 742 (50%).

Terschelling. Maximum numbers in mid-December, 1960 were 1400—not particularly high—and in early May, 1961, 2300, which is high, but not exceptionally so. A few counts in autumn, 1960 gave first-winter ratios of 36-58% (J. Tanis).

Germany

On 11th May, 1961, P. Kramer examined a flock of 600 Brent off the island of Mellum. Of about a quarter of these which could be distinguished with certainty, 45% were young birds.

Finland

Finnish observers organised by P. Saurola made a most valuable series of counts of Brent and Barnacle (*B. leucopsis*) Geese migrating past islands in the Gulf of Finland in spring 1961. Only about a third of those observed could be definitely assigned to one species, but of those definitely identified 88% were Brent. The largest numbers were recorded from 2nd to 19th May, on Rönnskär (59°56′N, 24°24′E) and from 20th to 29th May on Sommarö (59°55′N, 24°15′E) by the same team of five observers. 29,111 black geese were counted during this period (2nd-29th May, 1961); 5542 Brents were identified with certainty, but assuming that approximately 80-90% of the total were Brent, the true figure would appear to be in the range 23,000-26,000.

The proportion of young birds in the Dark-bellied Brent population

Although data are available from several areas, it is not possible to arrive at a reliably representative figure by merely totalling them, owing to the differences in the numbers of birds and in sample sizes in various regions. A fairly accurate figure can be obtained for Essex by weighting counts and number of samples used according to the number of birds present throughout the winter in the different areas. However, the same method cannot give more than a fairly rough approximation when applied to the population as a whole. Table I only includes Essex data; a comparison of these and figures from other areas is made in the discussion which follows.

Table I. Proportion of first-winter birds in sample counts of Dark-bellied Brent in Essex, 1945-55 to 1960-61.

Season	Total count	No. of first-winter birds	Mean no. per sample of 50	S.D.	S.E. of mean	No. of samples
1954-55 ..	776	314 (40%)	--	—	—	—
1955-56 ..	2020	522 (26%)	13.3	6.40	1.19	29
1956-57 ..	1484	97 (7%)	3.5	3.90	0.78	25
1957-58 ..	1810	955 (53%)	26.3	5.53	0.95	34
1958-59 ..	Hardly any young observed					
1959-60 ..	1664	379 (23%)	11.7	7.05	1.31	29
1960-61 ..	3742	1683 (45%)	23.2	6.23	0.67	54

Family Sizes

Counts of small parties, of 8 or less, seen in flight have been continued, as this method appears to give a good estimate of family size (Burton 1961). In Table II the results of counts of flying parties and families identified on the

ground by the writer and by T. Lebret are included, with the results of the previous season's counts. The difference between the mean brood-sizes for the two seasons is not statistically significant.

Table II. Mean brood-size and frequency distribution of brood-sizes among Dark-bellied Brent in England and Holland, 1959-60 and 1960-61.

Season	Number of young in brood						Total no. of broods	Mean	S.E. of mean
	1	2	3	4	5	6			
1959-60 ..	10	13	19	15	9	5	71	3.21	0.17
1960-61 ..	13	18	33	28	26	10	128	3.52	0.12

Discussion

It is quite clear that 1960 was a successful summer for Dark-bellied Brent throughout their range. The high proportion of young must also have been due partly to the two poor breeding years preceding, reducing the number of immature birds in adult plumage. The mean brood size is high, and these and brood counts made in previous years are now showing some evidence of correlation between brood size and the proportion of young in the flocks.

Counts made in Essex in previous seasons had revealed a tendency for the proportion of young in sheltered waters to be higher than that on exposed coasts. In 1960-61, a special effort was made to investigate this by collecting enough counts from the various areas throughout the season to give statistically valid results. The results were as follows:

Foulness:	November:	213 in 450 (47%)
	Dec.-Jan.:	602 in 1468 (41%)
	Total:	815 in 1918 (42%)
Ray Sands:	March:	105 in 252 (42%)
St. Peter's flats:	Dec.-Mar.	344 in 764 (45%)
Blackwater estuary:	Dec.-Feb.:	419 in 708 (59%)

The means of samples of 50 obtained from the exposed coasts of Foulness and Ray Sands on the one hand and the Blackwater estuary on the other are respectively 21.75 (40 samples) and 27.83 (12 samples). $\sigma^d=2.02$, $t=3.01$ and $P<0.01$, indicating a significant difference between the two groups. Taken in conjunction with similar differences in previous years, this result suggests that the flocks which disperse from Foulness to other parts of the coast after their arrival there early in the season, contain a greater proportion of young than those which stay behind. The highest proportions of young birds are reached in estuaries. It is likely that this pattern of movements reflects a tendency on the part of geese without families to avoid landlocked, and potentially more dangerous, waters.

Differences between areas outside Essex in the proportion of young birds reported are quite wide. In view of the differences which have been shown to occur even within one county, caution must be exercised in interpreting these. However, the counts made by l'Abbé R. Bozec in Morbihan and Anse du Pô probably give a good estimate for this area. The mean for 15 samples of 50 is 30.33. In a comparison with the 54 Essex stamples, $\sigma^d=1.72$, $t=4.18$ and $P<0.01$—a clearly significant difference. It remains to be seen whether this difference will persist over several years, but it is possible that some differential migration of age-groups may occur in view of the results of Hansen and

Nelson (1957) who showed from ringing recoveries that a greater proportion of young Pacific Black Brant *B. b. orientalis* tend to winter in the southern part of their range.

The total number of Dark-bellied Brent in the winter of 1960-61

The exceptionally high numbers of Brent in Essex in the winter of 1960-61 prompted an attempt to assess the total size of the Dark-bellied Brent population. The situation was complicated by conflicting reports about movements of Pale-bellied birds, but reasonable figures are available for the period about mid-February, 1961. The estimated total was between 21,000 and 23,000. This does not include counts from Germany, and some numbers may easily have been missed in Denmark; so the true total may well have been rather larger. This estimate is consistent with the figure, given above, of 23-26,000 Brent passing through the Gulf of Finland in spring.

The picture of the status of the Brent continues to be one of gradual but irregular increase. Influxes such as that experienced in Essex in the winter of 1960-61 give a rather exaggerated impression of the magnitude of increase unless considered in conjunction with counts from other areas. However, it is significant that the influxes which have occurred in Essex during the past eight years have been successively larger. The population in England, and probably in Europe too, during 1960-61 was the largest since protection of this species in Great Britain was afforded in 1955. That this occurred despite two poor breeding years is a tribute to the evidently low natural mortality of the species and the benefits of protection.

Acknowledgements

Sincere thanks are due to all observers named above for their most valuable co-operation, which has greatly increased the scope and possibilities of this study. Thanks are equally due to all those who have helped in any way, either by sending negative reports, or by collecting data from other observers.

References

BURTON, P. J. K. 1958. Brent Geese in Essex. *Wildfowl Trust Ninth Annual Report* : 73-9.
1959. Brent Geese in Essex, 1957-58. *Wildfowl Trust Tenth Annual Report* : 91-2.
1960. Brent Goose Population Studies, 1958-59. *Wildfowl Trust Eleventh Annual Report* : 94-8.
1961. Brent Goose Age-group Counts 1959-60. *Wildfowl Trust Twelfth Annual Report* : 113-115.

HANSEN, H. A. & NELSON, U. C. 1957. Brant of the Bering Sea—Migration and Mortality. *Trans. 22nd N.A. Wildl. Conf.* : 237-254.

RUTTLEDGE, R. F. & Mrs. R. HALL WATT. 1958. The distribution and status of wild geese in Ireland. *Bird Study* 5 : 22-33.

SALOMONSEN, F. 1958. The present status of the Brent Goose (*Branta bernicla* (L.)) in western Europe. Int. Wildfowl Research Bureau, Publication No. 4 *Vidensk Medd. dansk. naturh. Foren.* 120 : 43-80.

Wildfowl research on the White Sea Coast

V. N. Karpovitch & N. N. Skokova

(No reply to a request for details of current research in the U.S.S.R. has yet been received, other than Professor Kumari's valuable accounts of work in the Estonian S.S.R. (see pp. 33 *and* 108). *However, a recent publication* Communications of the Baltic Commission for the Study of Bird Migration, *No.* 1 (*Tartu,* 1961, 77 *pp.*) *included two short papers from a research station on the White Sea which is largely concerned with wildfowl : V. N. Karpovitch, " The activities of the Northern Ornithological Station," pp.* 43-52, *and N. N. Skokova, " Notes on visible bird migration in the region of the White Sea,* 1958-1959," *at pp.* 53-9. *We are indebted to Mr. D. D. Harber for translating the Russian texts, from which these notes have been drafted).*

The Northern Ornithological Station was established in 1958 in the Kandalaksha State Nature Reserve, on the north-west coast of the White Sea.

The main object of conservation and research in the Kandalaksha Reserve has always been the Eider *Somateria mollissima.* Its ecology has been studied in all parts of the Reserve—on the Gulf of Kandalaksha, the Seven Islands, the Ainov Islands and on Novaya Zemlia where, until 1951, there was a branch of the Seven Islands Reserve. The ecology of the Eider during the nesting period has been investigated in detail and proposals for the rational exploitation of Eider colonies have been based on twenty year's research.

Recently attention has been concentrated on the ecology and behaviour of Eiders outside the nesting period: their migration routes, moulting and wintering areas. In the summer of 1959 an important moulting area was discovered on the Tersk shore of the Kola Peninsula, where 5000 drakes were present at one time.

On the basis of sample counts of 4,400 birds, it appeared that the total wintering population of the Murmansk coast from Petchenga Bay to the Gulf of Nokeuv was 10-12,000 in the winter of 1959-59. The Eiders winter in small flocks of up to 100 birds, larger concentrations occurring only in the moulting and migration periods. Very few winter in the Dvinsk Gulf, which usually freezes over. The Gulf of Onega, which does not normally become wholly frozen, is used regularly. At the end of February, 1960 more than 600 Eiders were counted on small patches of open water to the south-west of the Solovetski Isles and in early April an examination of all the open water in the Gulf showed that 2000 Eiders were present.

A number of questions have yet to be answered, such as the amount of annual variation in the size of the nesting population and the extent to which the numbers in each locality depend on breeding success there and in the surrounding area. Such problems can only be solved by large-scale ringing. " Since the best method of trapping Eiders has not yet been worked out, it is planned in 1960-61 to try out different methods which are sufficiently safe for the population."

The other main field of research is the study of migration. This is not confined to wildfowl, but ducks and geese are abundant and regarded as the most interesting group. Seven observation points have been manned, lying between 64°N. and 67°N. on a line about 330 kilometres long, on the western shore of the White Sea. The four southern stations are on the mainland, the three northern ones on islands.

Visible migration was more intense in the south than the north but even there was weak by comparison with that seen on the Baltic coasts. The number of species seen was also larger in the south (92 at Virma, 109 at Pingoma) than in the north (63 on the Kem-Ludy islands, 56 on the Kandalaksha skerries).

Among the wildfowl there were marked differences in the species seen at the different stations. Listing them from south to north: at Virma the Bean Goose, Mallard, Wigeon and Long-tailed Duck were all seen in abundance; at Pongoma, the Scaup and Red-breasted Merganser predominated; at Kemludy, the Eider and Red-breasted Merganser; and on the Kandalaksha skerries the Eider, Common Scoter and Goldeneye.

The numerous small bays of the Karelian coast and the archipelago of the Reserve serve as nesting places and feeding grounds for migrating flocks of Goldeneye, Common Scoter and Red-breasted Merganser and as an assembly place for the local Eiders before their move to winter quarters. The Eiders migrating from the Gulf divide into two streams, one going south into the Gulf of Onega (mentioned above), the other east along the Tersk coast. The majority follow the eastern route and winter in the Barents Sea.

Pongoma Bay and those to the north of it serve as resting and feeding areas for migrating Brent Geese in August, for diving ducks and sawbills in September and October and for swans later in the year.

In Virma Bay, autumn assemblies of dabbling ducks, especially Wigeon and Mallard, are characteristic. The majority of the wildfowl, divers and gulls leaving the White Sea in autumn fly south west from Virma across the lakes of Karelia and Finland to the Baltic.

In 1959 the numbers of wildfowl seen on spring passage were much smaller than those recorded in autumn. At Virma they comprised about 75% of all birds seen in autumn but only 22% of those in spring; at Pongoma about 28% in autumn and 12% in spring. At Virma 57 times as many wildfowl were seen in autumn as in Spring and at Pongoma seven times as many. Two waves of duck migration were found at Virma in the autumn in both 1958 and 1959, the first at the end of September, mainly Mallard and Wigeon, the second in the middle of October, mainly sea-ducks and particularly Long-tailed Ducks.

It is worth recording that, although the Wildfowl Trust is not directly concerned with studies parallel to these in the White Sea, other British ornithologists are actively engaged on similar lines. Population research on Eiders is being undertaken by workers from the Universities of Durham (on the Farne Islands) and Aberdeen (on the Ythan estuary). The migration of sea-ducks and Brent along the coast of the English Channel has been watched for many years.

A gravel pit wildfowl reserve*

James Harrison, Jeffery Harrison & Peter Olney

FIVE years ago, Mr. George Wallis of the Kent Sand and Ballast Company gave permission for his two gravel pits to be used as a local wildfowl reserve and since then it has been managed by the first two authors on behalf of the Kent Wildfowlers' Association, with special advice from the third author on behalf of the Wildfowl Trust regarding wildfowl foods and their propagation.

The lakes are situated in the Darenth Valley, near Sevenoaks, and are surrounded by grazing land and water meadows, with some small peat bogs and boggy woods. Prior to 1935 sand and gravel had only been extracted down to water level, but in that year the company installed a modern plant with suction pumps to win material below water level, which in the low ground on each side of the river is about three feet below field level.

Three lakes have been formed during the past 26 years, one of which, comprising about 15 acres, has been reclaimed. The other two will remain lakes and they cover some 50 acres and will ultimately extend a further 40 acres. The winning of material from the face is now carried out by floating grabs and the depth of the water reaches a maximum of 80 feet.

Improving Wildfowl Habitat

(a) *Mechanical*

These particular gravel pits suffered from two disadvantages—a lack of shallow water with its associated vegetation, and a lack of islands—and our efforts have been planned to alter this situation. To be worthwhile, any habitat improvement schemes require the use of modern mechanical methods and it goes without saying that but for the enthusiastic help of Mr. Wallis and his Company, we could have accomplished very little.

The drag-line has now been used to construct four shallow pools, giving us in all about 800 square yards of water about 18 inches deep. One such pool of about 200 square yards took only four hours to dig, including the construction of two islands with stony bases covered with peat soil, the material for this being delivered by dumper.

The drag-line has also been used to slope the vertical banks of the smaller west lake (now disused) in preparation for tree planting and to divert the course of the river from the east lake, involving over half a mile of new river bed. This was to prevent silt from being washed down river, as it was seriously interfering with water-plant growth and with trout cultivation.

To overcome the lack of islands, the Company has designed two types of raft, of which we now have six in all at anchor. These are of two types: the first consists of three metal float tanks welded together to make a square raft 12 x 12 feet. The edges are lined by poles held with metal straps and these retain the soil in which vegetation grows well. Such rafts have about a foot of freeboard, are completely stable and are capable of withstanding the full force of winter gales. They serve a dual purpose, for in winter they are greatly favoured by duck and geese as resting islands and in spring they are popular with nesting Canada Geese, as already described in a previous report (Harrison 1959). That paper featured our original wooden rafts, but this design is now obsolete, not being sufficiently strong.

*In April, 1962, this gravel pit was designated as a Wildfowl Trust Experimental Station, with the full approval of the Wildfowlers' Association and the Kent W.A.

The other type of raft now used was originally designed by Mr. Wallis and consists of a float tank at each end with railway sleepers in between, so that the centre part is almost at water level with the ends about a foot above. A Canada Goose has nested on one end for each of the three years since the raft was made and in 1961, after the goslings had gone, a pair of Great Crested Grebes built their nest of sticks on the low central part of the raft, hatching off two young on 5th September. We believe that this is the first time that this species has nested on a raft and this model is now familiarly known as " the Wallis triple purpose raft " in honour of the event.

(b) *Planting*

The objects of any planting programme are to provide food and cover for both adult and young wildfowl and there is no doubt that cover is almost as important as food. There is unfortunately no easy mechanical answer to planting—it calls for plenty of hard and often muddy work—but it is great fun for picnicing and a day out.

It is a fact well worth remembering in planning the planting of newly dug ponds that frequently those plants which occupy the area first and produce a good growth may effectively exclude their more vigorous competitors. Hence the type of *initial* planting will determine the composition of the pond's vegetation for years to come. Since plants have fairly definite environmental requirements, food species should be selected which would be expected to do well under the conditions which already prevail in the area. They should therefore, where possible, be taken from the immediate vicinity or from areas where the habitat is the same.

In these gravel pits the species of plants used have been those which by viscera-analysis of locally shot duck have been shown to be favourite food plants.

1. *Trees*

As food and cover for adults, trees lining the water's edge are invaluable. On these gravel pits the trees being used are Alder *Alnus glutinosa,* Silver Birch *Betula pendula,* Oak *Quercus robur,* and Willow *Salix* sp., the first three all providing food seeds, while all except Oak are quick in growing. Alder and Willow are planted close to the water's edge, Oak and Birch a little back on drier soil. The Company is planting large numbers of Birch, Alder and Willow around the banks of the main waters, both from our point of view and as part of their landscape work and we have concentrated on planting around the new shallow pools. As an example of what can be done, 7 hard-working adults planted 51 Alders and 57 Silver Birch saplings, up to 5 feet high, in one and three-quarter hours, the trees having to be dug up from nearby.

2. *Pond-side plants*

A most successful pond-side plant of known food and cover value to local ducks is the Common Bur-reed *Sparganium erectum.* At first we planted this in the autumn, but many of the roots were washed out of the sand during winter storms. Spring planting on the other hand is excellent—almost all the plants taking and even seeding well in the following autumn, by which time they have spread considerably. We have found that this species grows best just in the edge of the water and particularly where some shelter is provided, as in the lee of a bank. Transplanting Bur-reed is hard and wet work, but two people working for six hours dealt with 206 roots. A nice hot day is best, for

" the coolie method " can be used, in which one wades about clad only in shorts, planting by hand as in a paddy field! Other food plants successfully established around the pools include Reedgrass *Glyceria maxima,* Hairy Sedge *Carex hirta,* Persicaria *Polygonum persicaria,* Knotted Persicaria *Polygonum nodosum,* Water-pepper *Polygonum hydropiper,* and Orache *Atriplex patula.* With all these species whole or divided plants have been used, and in the case of Water-pepper and Orache seedlings have also been successfully replanted.

3. *Water plants*

The main object in constructing shallow pools is to provide a suitable habitat for water plants, which then prove attractive to small animal life, so that a food supply is provided for young duck. All the pools have been dug in sandy soil, but as we had a good supply of peaty top soil available, some of this was first put into the bottom of the pools to enrich the growing potential. The first pool was planted in early summer with the following species, all of which were successful:- Water Crowfoot *Ranunculus circinatus,* Starwort *Callitriche* sp., Horned Pondweed *Zannichellia palustris* and Canadian Pondweed *Elodea canadensis,* while Milfoil *Myriophyllum* sp. and Floating Reedgrass *Glyceria fluitans* appeared naturally. Although the first year's growth of all these plants has been good, it is likely that certain of them will become dominant next year at the expense of the others. Insect life appeared almost simultaneously with the water plants, particularly large numbers of water boatmen *Notonecta* and *Corixa* sp. and pond-skaters *Gerris* sp. The most encouraging feature of the whole enterprise was the regular sight of twenty or more young Mallard busily feeding among the flowering Water Crowfoot in mid-summer—a sight to please the heart of any wildfowler-conservationist.

One other water plant was introduced in the autumn of 1961—Mare's Tail *Hippuris vulgaris,* a local but exceedingly good wildfowl food plant, which we found growing on Lord Stanhope's lake at Chevening. With his permission we transplanted a number of roots from this predominantly muddy lake to one of our predominantly sandy pools, where some have undoubtedly taken, changing from the narrow, pointed type of growth of the plant above water to the more proliferative underwater type. Whether it will survive the winter remains to be seen.

An interesting natural growth of Canadian Pondweed also occurred in the summer of 1961, when the west lake became disused, the plant appearing all round the edges. This will encourage animal life and should make the water a better holding ground for duck, particularly for Tufted Duck and Pochard.

It is probably useful at this stage to list some of the difficulties encountered and the reasons why failures may occur. (a) Plants may be washed away or silted over by wave action—this danger may be reduced by spring planting and by placing breakwaters (wooden planks, etc.) to the windward side of the pond. (b) Plants, rootstock or seeds may be eaten by other animals and some form of wire netting may be necessary in the initial stages. Livestock should be excluded as much as possible from the ponds. (c) The pond may be too new and requires some period of settling down in order to allow the bottom to mellow properly and for the initial turbidity to disappear. (d) To save time and money, plantings should be attempted only on a limited scale at first in order to see if they are to be successful.

Status of Wildfowl

(a) *Mallard*

Having considered the improvement of habitat, it is of interest to review the status of wildfowl using the gravel pit, in particular the Mallard *Anas platyrhynchos,* as being the commonest species and therefore the most instructive. The first complete series of counts from autumn to spring was made in 1957-8 and these have been continued annually ever since. Prior to this it was unusual to see as many as 10 Mallard, but in the previous autumn 18 feather-pinioned birds had been liberated on the water, a gift from the Wildfowl Trust. In 1959, 113 full-winged young were liberated, 114 more in 1960 and 112 in 1961, all carrying Wildfowlers' Association rings. From the autumn of 1957, the number of wild-bred birds visiting the reserve has steadily increased and in this way the hand-reared birds have been successfully infiltrated into the wild population. A comparison of the 1957-8 and 1960-1 graphs with that for 1961-2 shows what has been accomplished in the establishment of a local population.

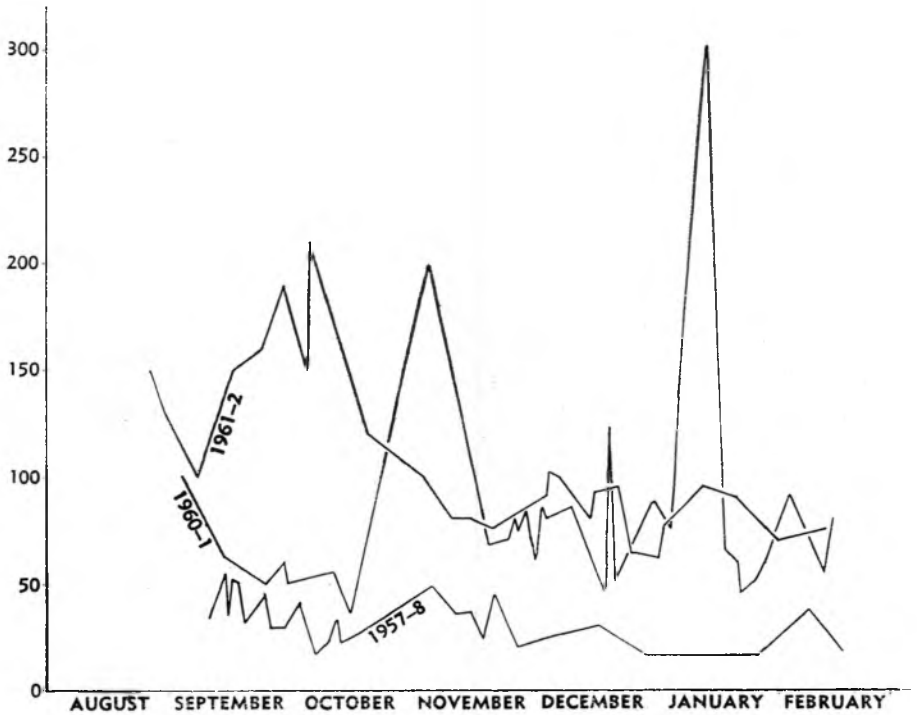
That there is considerable movement is indicated by the peaks. The fall in number in early autumn demonstrates the dispersal of the hand-reared birds with the wild-bred ones and this is followed by a late autumn peak. Whether the peak of 300 in January, 1961 will be repeated remains to be seen, but as would be expected, the severe frosts of December 1961 appear to have driven many of the local Mallard away. These peaks probably indicate little more than local movements and concentrations, for ringing recoveries have all been within 10 miles, except for one bird, which was shot on the Thames Estuary. It will be noted that there has been a definite increase in the average population present during these years.

By early spring the number of Mallard using the reserve falls sharply as they disperse for nesting. At this time it is extremely difficult to estimate the nesting success, but in the summer of 1961, approximately 160 young were known to have been reared within five miles of the water, mostly along the Darenth. These were the offspring of some 30 pairs of Mallard, half of which were hand-reared birds. This represented a 50% increase over any previous summer.

In winter there has been a definite change in flighting habits associated with the increased food supply available around the water. Thus, flighting from the ballast water at dusk began to decrease during the winter of 1960-1, more birds remaining to feed during the night. In the autumn of 1961, birds were observed for the first time flighting on to the ballast water at dusk and counts made soon after dawn were the highest during the 24 hours. It must be remembered that during the daytime two tugs with their barges are at work on the water, so that some disturbance is inevitable.

It might be said that it was a pity to have liberated any hand-reared birds on the gravel pit, and that it would have been more interesting to study the effect of habitat improvement without the presence of hand-reared birds. Be this as it may, we wished to bring about as rapid an increase in local population as possible but, even so, it is quite apparent that the holding potential of the gravel pit has been greatly improved by our efforts.

In the autumn of 1961 a considerable number of Mallard, both wild and hand-reared, have been found to contain thorny-headed worms of the species *Polymorphus minutus* and this outbreak is being carefully studied.



(b) *Other duck*

It is difficult to say whether the increased number of Mallard on the reserve has attracted an increased number of other duck, but it is reasonable to suppose that this might happen. Certainly the list of species recorded is now quite impressive: Wigeon *Anas penelope,* Teal *Anas crecca,* Tufted Duck *Aythya fuligula* and Pochard *Aythya ferina* are regular each winter in small numbers and again on spring migration. There has been a definite increase in Pochard and Tufted Duck in November and December, 1961 and the latter are sometimes seen in summer and have nested in the area, but not on the ballast water as yet. Shoveler *Anas clypeata* are seen occasionally, usually on spring migration, but in 1961 small numbers including a family of five appeared for the first time in July. Their arrival coincided with big decreases in the remarkable summer population on Stodmarsh, near Canterbury, so that it is possible that some of these were moving through westwards. A drake Gadwall *Anas strepera* was shot with a Mallard on nearby floods in December, 1958 and a duck Gadwall has now returned to some lakes half a mile away for the sixth winter running, accompanied by a drake in 1960, which left after two weeks. Shelduck *Tadorna tadorna* have been seen on three occasions; a pair of Goosanders *Mergus merganser* were present for four weeks in February-March, 1961 and there are single records of Garganey *Anas querquedula,* Mandarin *Aix galericulata* and Common Scoter *Melanitta nigra.* Another nearby gravel pit produced first records in the area of Long-tailed Duck *Clangula hyemalis* and Goldeneye *Bucephala clangula* in the easterly gales of November, 1961.

This then, was the position up to the severe cold spell from 23rd December, 1961 until 5th January, 1962, which provided us with many exciting records. All the waters in the district became icebound with the exception of our own and the neighbouring mile-long Chipstead ballast water. This is used for yachting and does not as a rule provide many interesting records, but the cold spell kept the water deserted by boats and there was a constant interchange of fowl between the two waters.

As already mentioned, the only duck to decrease were Mallard, as their feeding grounds became ice-bound. Initially both Tufted Duck and Pochard increased to peaks of 49 and 28 respectively, but counts were changing almost from hour to hour and it was evident that many were on the move through the area, but numbers fell considerably from New Year's Day and eventually all the Pochard left and most of the Tufted Duck.

A large scale weather migration took place between 26th December and 1st January and notable arrivals on the ballast waters included small numbers of Shoveler, Wigeon and Teal, an adult drake Goldeneye and the first Smew *Mergus albellus,* a "red-head" on 31st December and a party of six adult drakes next day. The first Goosander appeared on 27th December and 10 were present next day, all being "red-heads." One or two observations of fowl on the move indicated an east-west migration route. A duck Teal shot nearby on 27th December had been ringed on Texel, Holland, in September 1961.

Coots *Fulica atra* increased to 130 and many have remained and an immature Great Northern Diver *Colymba immer* was present from 26th December to 2nd January.

Following the thaw at the end of the first week of January, three of the Goosanders remained until 3rd February and a single drake Smew was present until 27th January, when it was last seen in close association with a duck Goldeneye. These two species occasionally hybridise in the wild and it is interesting to speculate that it may be in exceptional circumstances like this that pairing is encouraged.

Up to the end of February, numbers of Pochard and Tufted Duck remained slightly lower than last year, but there have been no fewer than six more records of Goldeneyes, another duck Goosander, which arrived on the north gale of 12-14th February and remained until 5th March; a flock of 23 Wigeon on 26th January (the largest party so far) and several Teal. About 25 Coots remain on the west lake in March, feeding largely underwater, so food supplies must be becoming adequate and it will be interesting to see if they colonise the lake, having arrived as weather migrants.

The cold spell of late February and early March was not productive of any further weather migration, but Pochard reached a peak of 21 on 7th March and an adult drake Goldeneye and duck Goosander were seen next day.

(c) *Canada and Greylag Geese*

In June, 1956 12 Canada Geese *Branta canadensis* were liberated on the reserve and a further 24 in the following June, all obtained from the Wildfowl Trust. This species quickly established itself, nesting freely on rafts provided for the purpose. Nesting successes have been notable for the fact that in five years only one gosling hatched has failed to reach maturity—this being a late-

hatched bird, the parents swimming off with the remainder of their goslings before it had dried off.

Yearly figures were as follows:-

1957 2 pairs reared all 13 goslings.
1958 2 pairs reared all 6 goslings.
1959 5 pairs reared 22 out of 23 goslings.
1960 6 pairs reared all 24 goslings.
1961 4 pairs reared all 13 goslings.

This gives a total of 19 pairs rearing 78 out of 79 goslings with an average of 4.1 goslings reaching maturity per pair. These figures would have been higher but for the fact that in 1958 poachers broke into a boathouse and raided five clutches off nesting rafts when they were within a week of hatching and only two pairs renested to rear six young. In 1960 all the goslings together with their parents were caught up and redistributed, hence the lower figures for 1961.

We intend in future to catch up and remove the majority of Canada Geese and to replace them with Greylag Geese *Anser anser*, of which three pinioned birds were placed on the water in 1960 and one more in 1961. On 31st March, 1961, a full-winged and wary Greylag flew in to join our birds. It settled down and has remained ever since, becoming reasonably tame. It is unringed.

It is worth mentioning that we have found it extremely easy to alter the feeding grounds of the Canada Goose by the use of "bangers" fired half-hourly.

Other Nesting Species

The effect of such an area on bird life in general is bound to be considerable. Mention has already been made of the nesting of the Great Crested Grebe. One pair of Little Ringed Plover *Charadrius dubius* has nested annually since 1957 and in 1961 we had two pairs out of four nesting in the whole of Kent. Marsh Warbler *Acrocephalus palustris*, Sedge Warbler *Acrocephalus schœnobœnus*, Grey Wagtail *Motacilla cinerea*, and Tree Sparrow *Passer montanus* have all been proved to nest successfully for the first time in the past five years. A flourishing colony of Sand-Martins *Riparia riparia* is being ringed, 71 being caught during the first attempts last summer. One of these was caught and released two weeks later near Orleans, France.

Migrants, etc.

The various species, particularly terns and waders, now for the first time proved to be regular in West Kent are too numerous to list. A paper dealing with the considerable change in status of gulls in the district has been published recently (Harrison 1961), but since this was written the water has become a night roost for considerable numbers of Black-headed Gulls *Larus ridibundus* during rough weather, when they are loath to fly back to the North Kent coast. At times like this, the rafts are packed with sleeping gulls, which is yet another use for them.

The distinctive habitat of the gravel pit appears attractive to a number of interesting passerines, particularly both races of Wheatear *Oenanthe œ.*

œnanthe and *Oe. œ. leucorrhoa,* Winchat *Saxicola rubetra,* Stonechat *Saxicola torquata,* Black Redstart *Phoenicurus ochruros,* Yellow Wagtail *Motacilla flava* and Snow Bunting *Plectrophenax nivalis.* A male Bearded Tit *Panurus biarmicus* was seen in the valley on 10th December, 1961.

Poachers and Vermin

Considering that the reserve is within easy reach of the outskirts of London, we have little trouble from poachers, largely owing to the fact that the Company's men are almost always about and there is a night watchman. The two poachers who raided the rafts made a safe escape although chased, but a further poacher in March, 1958 was successfully caught after an exciting chase. He was armed with a .22 rifle, the registration number of which was filed off and which he had " found in a field " and for which he had no police permit. He had the rifle confiscated and was fined £5. That was our last poacher, but in summer roaming parties of children, often with uncontrollable dogs and catapults, are far more of a nuisance.

At all times we try to keep the vermin under control. The Company deals with the rats, while we endeavour to control the winged vermin, particularly Carrion Crows *Corvus corone.* It may be that by taking first clutches of duck eggs, second broods stand a better chance, and some people even maintain that crows are useful, but this cannot apply when ducklings are taken one by one off the water or when a pair of Great Crested Grebes loses three consecutive clutches. We regard them as a menace and our best year so far was 1958 when 44 were killed. We do not anticipate that numbers will ever reach these heights again. At least two Hooded x Carrion Crow intergrades have been seen in the area in this time. It should be noted that Canada Geese are well able to protect their young from the crows' attentions, always swimming in formation with the young between their two parents.

This, then, is a brief description of a local wildfowl reserve on an industrial ballast water. Its particular interest is that it shows how valuable such places are for the establishment of new wildfowl habitat, even though the water is still being worked for sand and gravel. As the water continues to enlarge, so we hope will the scope of our activities.

Acknowledgements

We would like to express our thanks to Mr. George Wallis for permission to use his gravel pits. Without his help and enthusiasm we could have accomplished very little. His nephew, Mr. Angus Meikle, is also a great help to us, particularly over the construction of the pools and the planting programme, and without exception all the men at the works take the keenest interest in our activities. We would also like to thank Mrs. Pamela Harrison for the photographs which illustrate this article.

References

HARRISON, J. M. & J. G. 1959. Establishing Canada Geese in West Kent and their use of Nesting Rafts. *The Wildfowl Trust Tenth Annual Report* 1957-58 : pp. 89-91.

HARRISON, J. M. & J. G. 1961. Changing Status of Gulls in the Sevenoaks Area. *Kent Bird Report* 1959. pp. 46-51.

The Wildfowl in the Matsalu National Park

Erik Kumari

THE Matsalu National Park is situated at the mouth of the R. Kasari on the west coast of Estonia, facing the Baltic Sea. For nearly a hundred years Matsalu Bay, with its rich population of marsh and sea birds, has attracted the attention of ornithologists, both native and foreign; and, indeed, this vast, sheltered expanse of shallow water, only faintly brackish, constitutes a unique breeding ground for waterfowl, which is not confined to the bay itself but extends along the surrounding flats and shallows, and embraces part of the island-dotted straits known as the " Väinameri " or " Muhu Väin " (Muhu Sound). Nearly all the local breeding birds of the East Baltic area are represented here, while legions of northern migrants break their flight at Matsalu in the spring and autumn.

Today we may speak of an established tradition of ornithological study, forged in the course of long years of observation and experiment. When the present national park, covering 60,000 hectares (about 232 square miles), came into being in 1957, it was already backed by nearly a century of scientific research and a large number of interesting investigations into various problems of faunistics and ecology.

Matsalu is not only the largest nature reserve in the Baltic area. With its dense bird population and great variety of species, it may be regarded as possessing far more than a mere local importance. For this reason it was felt that a brief survey of the wildfowl reserves of the Park might be of interest to readers of the present Annual Report. Before embarking upon his subject, however, the author feels it incumbent upon him to acknowledge his indebtedness to Mr. Hugh Boyd, to whose initiative the present article owes its existence and without whose encouragement it would never have been penned.

A history of research in the Park

The bird haven at Matsalu Bay, often called the Matsalu " bird paradise," was first discovered by Valerian Russow, curator of the Museum of Zoology of Tartu University, in 1870. Russow returned to the site in several succeeding summers and published a series of articles containing the results of his investigations in various publications of the Tartu Naturalists' Society. At the end of the 19th and beginning of the 20th century, research expeditions were conducted here by two prominent Baltic ornithologists — E. von Middendorff, whose collections are at present preserved in the Leningrad Museum of Zoology, now controlled by the Academy of Sciences of the U.S.S.R., and F. E. Stoll, whose materials have been incorporated in the stocks of the Natural Sciences Museum at Riga.

From the first decade of the present century the investigations at Matsalu acquired especial impetus. In the spring of 1907 the bay was visited by S. A. Buturlin and Baron Loudon, while the latter returned to the spot in the spring of 1909. These investigations produced two more articles, which duly appeared in German ornithological magazines. In the summer of 1924 the Tartu University Museum of Zoology organised a new expedition, one of the members of which produced an extensive article on the bird population of the bay (M. Härms, 1926). Round about the same time R. F. Meiklejohn, of the British Consulate at Tallinn, paid a number of visits to Matsalu with the

object of collecting oological materials, and published his findings in another article, printed in the same year. From 1900 to 1925 a large number of other ornithologists, amateurs and collectors investigated the bird population of the bay, contributing numerous reports and articles to the press and gathering materials which are now preserved in various private collections and local museums.

Research work on a broad scale may be said to have begun in 1928, when the author of the present article made his first trips to the neighbourhood of the bay. His studies of the local bird population were continued till 1936 (incl.) and yielded materials for a comprehensive survey which was printed in the following year (Kumari, 1937). A number of local investigators also visited the bay for purposes of research during the years immediately preceding and following the second World War.

In 1953 the Puhtu Bird Station, which belongs to the Institute of Zoology and Botany of the Academy of Sciences, was set up in the immediate vicinity of the bay. All pre-conditions for the further development of ornithological research were now fulfilled, and results were soon forthcoming. Members of the Institute began to pay regular visits to the bay and soon, on the basis of the draft projects they submitted, the Matsalu National Park was set up, equipped with its own custodians, managing staff and scientific personnel. From the moment of its formation the reserve became a permanent theatre for field operations by specialists of the Institute, who pursue their researches here every summer, working in close collaboration with the local staff. Special mention should be made of the studies of waterfowl carried out over the past five years by Sven Onno, of the Institute. Another investigator, Valdur Paakspuu, employed on the staff of the reserve, has chosen the ecology of the Greylag Goose as the subject of his degree thesis. Onno has also published a preliminary review of the latest developmnts in local research (1958), while further papers are nearing completion.

Such is, in bare outline, the history of the Matsalu National Park, particularly with regard to the study of the local ornithofauna.

Description of the National Park

Matsalu Bay is protracted in a westerly direction, with a maximum length of 21 kms, while the greatest breadth of the shallow inner bay is 6.8 kms from north to south. In the eastern reaches of the bay the water is not more than about one metre deep, while that of the western part, farther out to sea, rarely exceeds 4 metres. To the eastern section are attached the water-meadows and delta of the R. Kasari, stretching 13.5 kms from east to west, and 4.5 kms from north to south. The delta and the inner stretches of the bay itself are overgrown with huge beds of tall reeds several sq.kms. in extent, the largest of their kind in the Baltic area. It is these reed-beds which form one of the most characteristic wildfowl habitats in the reserve. Another typical habitat is provided by the extensive water-logged hayfields lining the coast, where the whole of the grass is mown down in the summer for fodder. Yet a third basic habitat-type may be distinguished in the broad pasture lands running down to the sea, where large herds of cattle are turned out to graze every summer. While the hayfields and water-meadows are covered with tall grasses, the turf of the pastures is sparse and the surface trampled hard underfoot, with the result that well-defined differences may be discerned in the species groups represented.

Matsalu Bay is dotted with tiny islets, for the most part overgrown with grass and encircled with belts of reeds. There are also large numbers of islands in the seaward part of the reserve, scattered over the Sound. Some of these are overgrown with grass and junipers, but others are barren and stony, almost, if not quite, denuded of vegetation. Most of these outlying islands are frequented by maritime species which prefer to keep aloof from the coast and rarely venture into the inner parts of the bay.

There are few woods in the park, as oversaturation of the soil does not permit the growth of bushes and trees. Isolated copses and thin strips of woodland are to be found only on the crests of the humps and along the steep banks of the rivers. On the other hand there are fine deciduous forests sprinkled with oaks and other valuable industrial species in the outlying parts of the reserve.

In addition to the natural advantages derived from its geographical position and from distinctive features of the landscape, the site possesses plentiful reserves of food. Both bay and river are well stocked with fish, and large quantities of invertebrates are to be found not only in the water but also in the surrounding hayfields and pastures.

From the latest investigations the open expanses of the reserve are known to be inhabited by 75 nesting species, to which should be added 13 other local breeders which haunt the thickets fringing the river banks. Between 1928 and 1935 the main channels of the Kasari, as also of the other streams flowing into the bay, were dredged and deepened. Within a short space of time the mud banks thrown up on each side of the river were overgrown with trees and shrubs. This in its turn has greatly contributed to the drainage of the water-meadows, and clumps of stunted willows may be seen scattered here and there in districts where thirty or forty years ago no tree could grow on account of the extreme humidity of the soil. At the same time those habitats which were formerly confined to the delta and the inner section of the bay have during the past thirty years tended to invade the central and outer zones of the reserve, carrying with them their own specific bird populations. As a result the avifauna of the delta has spread slowly but surely in a westerly direction. Thus the locality affords exceptional opportunities for studying the changes that are gradually taking place in the lives of the waterfowl, partly as a result of natural factors, and partly of human activity.

The Anatidae of Matsalu

At the present time the reserve is inhabited by 29 species of waterfowl, of which 16 are local breeders, 22 migrants (including those species of which the southernmost colonies nest in Estonia, while the remainder move farther on to the north), and 2 errant species (the Mute Swan and Red-crested Pochard). We shall now briefly discuss each species in turn, before going on to mention one or two general ornithological problems concerning the waterfowl population as a whole.

Whooper Swan *Cygnus cygnus*. An extremely common migrant from March to May (the peak falling in April), and to a somewhat lesser extent in October and November. During the spring transit thousands of individuals alight on the Bay (especially in the central parts), and flock here for several weeks feeding and resting. The species shows a marked preference for certain shallows, rich in nutrients. As many as 40,000-50,000 Whooper-Swans may halt at Matsalu in one day, while the larger parties are several hundreds

strong. In all, many hundreds of thousands pass in the spring. The autumn flight is much feebler and the halts of shorter duration.

Matsalu Bay has been for centuries the most popular hunting ground for swans in the Baltic, and hundreds of these birds used to be shot down every year. Now, with the implementation of the new protection regulations which forbid the hunting of swans throughout Estonia all the year round, the importance of the Bay as a halting-place during migration has steadily grown, and the reserve can claim with little fear of dispute to be regarded as one of the chief swan reservations in the whole of Northern Europe.

Bewick's Swan *Cygnus columbianus bewickii.* All the above remarks concerning halting-places and times of transit are also valid for Bewick's Swan, with the sole difference that it occurs in far lesser numbers than the Whooper. During their sojurn in the bay the flocks of both birds freely intermingle, but when flight is resumed the species usually separate off once again. On favourable days thousands of Bewick's Swan may be seen, and the total for the spring transit runs into tens of thousands.

Mute Swan *Cygnus olor.* From 1928 this species had ceased to breed in Estonia, where it was no longer to be found in a wild state. It returned, however, in 1959, and in 1961 nests were traced at a number of points on the west coast and in the adjoining archipelago, while a few individuals have already been spotted in the Bay. There is every chance that these are " scouts," and that in the course of time the Mute Swan will settle down permanently in the bay, which should provide it with a breeding ground admirably suited to its habits and requirements.

Greylag Goose *Anser anser.* This is one of the most valuable breeding birds in the reserve, where it keeps mainly to the bay, though it also occurs to a somewhat lesser extent on the islands in the Sound. Indeed it was one of the reasons why the bay itself was placed under protection. At the present time about 200 pairs nest on the territory of the park, roughly the same number as used to nest in the inner reaches of the bay alone about thirty years ago. During the last hundred years the numbers of Greylags at Matsalu have sharply fallen, most probably as a result of the intensive hunting of former times, and partly also of the indiscriminate plundering of the nests. At any rate there seem to be no grounds for assuming that natural causes, such as changes in the landscape, are to blame.

The Greylag arrives in March and nests mostly in the reed beds, occasionally even in quite small clumps of reeds, thus earning its popular nickname: " roohani " (" reed goose "). The first eggs may be deposited in the nest about the middle of April, and the young are mostly hatched between the 15th and 20th of May. After all the young are hatched the majority of the birds nesting in the inner reaches of the bay move out into the Muhu Sound. Here, in the vicinity of the islands and sandbanks, where the sea is shallower, the fledglings grow up and the old birds moult. Ringing and marking have been begun, and up to the present about 40 individuals (all of them pulli) have been fitted with wing marks. One of these (marked on 15th May, 1959) was traced on 9th October of the same year on the Neusiedlersee, Austria.

The Greylag is of minor significance as a migrant, since the extreme northern limits of its range are not far distant from its breeding haunts at Matsalu.

White-fronted Goose *Anser albifrons.* An ordinary visitor in both migratory seasons. Occasionally alights in the open hayfields and the water-

meadows of the Kasari. The spring-transit takes place in April and May; the autumn passage in September and October. The migratory parties usually comprise a few dozen birds, larger flocks (up to 300) occurring somewhat rarely, though as many as 2000 individuals have been known to assemble at suitable halting-places.

Lesser White-fronted Goose *Anser erythropus.* Migratory habits similar to above, but less numerous. The largest single count yielded about 2500.

Bean Goose *Anser fabalis.* A common and in some years even a mass migrant. April and May in the spring, September and October in the autumn (especially the end of September and beginning of October). At the turn of the century the Bean-Goose frequently alighted in the cultivated fields at the back of the bay. Now that these have been somewhat more densely built over, it prefers to break its flight in the pastures and hayfields along the shore. Although the species is a frequent visitor to the reserve during the migration period, it is by no means so numerous here as at certain points farther inland (the environs of Lake Peipsi and Lake Võrtsjärv).

Brent Goose *Branta bernicla.* Passes in small numbers down the Sound and seldom appears in the reserve.

Barnacle Goose *Branta leucopsis.* A common migrant in April and May, somewhat less prominent in September and October. Towards the end of April and during the first half of May thousands of individuals alight on the treeless shores on the outskirts of the bay (near Metsküla, Saastna and Puise), more rarely on the islands in the Sound. This species is hardly ever to be seen in the inner recesses of the bay, but is restricted by its feeding habits to the grassy mudflats, made slightly saline by periodic inundations, lining the outermost segments of the littoral.

Shelduck *Tadorna tadorna.* A rare local breeder, which nests here and there on the islands in the Sound.

Mallard *Anas platyrhynchos.* Common both as a breeder and as a migrant throughout the whole of the reserve, though relatively few winter on the spot, as the surface normally freezes over. During the last thirty years the numbers of this species as a breeding bird have considerably diminished, probably as a result of hunting in its migration and wintering haunts. As late as 1935-36 the Mallard still nested in thousands on the land round the bay. Huge congregations of males used to flock from the second half of May, when they gathered for the moulting season. Flocks of males numbering several thousands were by no means rare at the end of May or the beginning of June, and the total number in the bay might run into many hundreds of thousands. The present number of males mustering at Matsalu for the moulting season has been estimated by Onno at about 10,000 individuals.

Teal *Anas crecca.* Nests in small numbers on the inland parts of the reserve. Passes *en masse* in April, and again in September and October, the largest parties containing thousands of birds. Large numbers of males make their appearance in midsummer to moult.

Garganey *Anas querquedula.* Occurs chiefly in the inner reaches of the bay, as a common, though not particularly numerous, breeding species. The local birds moult in the bay, and there is no considerable influx from outside. Represented more or less sparsely even during the migration period.

Gadwall *Anas strepera.* Formerly known only as a stray visitor; but has produced a few isolated pairs almost every year during the last five years, and has even been shown to nest locally in exceptional cases.

Wigeon *Anas penelope.* Does not breed in the locality. Occurs as a mass migrant (thousands strong) in April and May, and again in September and October. A few mateless males remain to moult in the bay, where they spend the whole of the summer.

Pintail *Anas acuta.* A rare local breeder, the numbers of which are slowly but steadily increasing (about 15 pairs in 1935-36; now about 45 pairs). Present in abundance during the spring and autumn flights, when thousands of individuals alight at suitable spots, but on the whole less numerous than the Teal, which passes at much the same time and halts in much the same places.

Shoveler *Spatula clypeata.* One of those waterfowl which have shown a consistent upward trend over the last thirty years. In 1935-36 at least 55 breeding pairs settled in the inner part of the bay (figures for the outer zone were incomplete). In 1940 and 1941 an invasion-type immigration of the Shoveler, which made itself felt over the whole territory of Estonia, left its mark also on Matsalu Bay. At the present time, according to data gathered by Onno, at least 180 pairs nest in the park. Both transit and moult migrations are relatively inconspicuous.

Red-crested Pochard *Netta rufina.* A stray visitor, recorded on only one occasion.

Pochard *Aythya ferina.* Has sharply decreased as a breeder in Matsalu Bay, during the past thirty years. In 1935 and 1936 at least 225 pairs nested in the inner parts of the bay, while a strong influx of moulting males took place in the summer (June and July). Now the number of Pochard in the reserve has dropped to 150 pairs, and the parties of moulting males do not, in Onno's opinion, exceed 100 individuals. Frequency of occurrence rises abruptly during passage in April, when the males far outnumber their companions.

Tufted Duck *Aythya fuligula.* A common breeder and mass migrant (in April and May, and again in September and October). During the past thirty years the numbers of birds nesting in the interior have fallen from 100 to about 75 pairs. At the same time drainage of the inmost recesses of the bay following dredging of the river has given rise to an outward drive, and the species has begun to settle more densely in the islands of the central and outer zones. A common moulter at Matsalu, probably immigrating from the outside.

Scaup *Aythya marila.* One of the most prominent migrants, passing in tens of thousands along the outer verge of the bay and down the Muhu Sound in April and May, and returning between September and November. Rarely breeds in the reserve, only a few isolated pairs having been recorded in recent years (Onno, 1959).

Goldeneye *Bucephala clangula.* Also appears in hosts during migration season, skirting the outer bay and advancing along the Sound in tens of thousands in October and November, and again from the breaking of the ice till the end of April, the numbers falling off in May. In the middle of the summer huge flocks of males gather to moult in the neighbourhood of some of the islands in the Sound. Has been known on occasion to occupy the nest-boxes set up for the Goosander (Onno, 1959).

Long-tailed Duck *Clangula hyemalis.* Passes in hundreds of thousands along the Sound and the outlying parts of the bay in April and May, and again in October and November. The peak of the spring transit through the Sound usually falls during the second half of May, together with that of the

Common Scoter (Kumari, 1958). Occasional solitary birds may be met with on the sea all through the summer, and parties may also be found in the winter, when the bay is not ice-bound.

Velvet Scoter *Melanitta fusca.* A common breeder on the outskirts of the bay and all the islands of the Sound (over 100 pairs), and well to the fore as a migrant in both spring and autumn.

Common Scoter *Melanitta nigra.* General characteristics much the same as those of the Long-tailed Duck. A particularly impressive feature of the spring transit is the mass departure from the Muhu Sound during the second half of May, when tens of thousands of individuals take wing together to continue their flight to the North. Moulting males arrive on the spot already in the middle of the summer (the second half of July), the females and young not following till September or October, when the migration is also very brisk.

Eider *Somateria mollissima.* Represented in the reserve as a local breeder by almost 100 pairs scattered over the islands in the Sound. Occurs in small numbers during the migration season.

Goosander *Mergus merganser.* A familiar breeding species all over the reserve, where it nests freely in natural hollows (cavities under boulders, hollow trees etc.), as well as in artificial nests erected by human agency (such nest-boxes used to be widely used by the local inhabitants, who collected the eggs for food). The Goosander is also prominent during the migration period.

Red-breasted Merganser *Mergus serrator.* Breeds readily in the outer zone and on the islands in the Sound, but avoids the inner parts of the bay. A common migrant,

Smew *Mergus albellus.* Visits the park in both spring and autumn, but only in small quantities. During halts associates most readily with the Goldeneye.

Investigations carried out in recent years by Sven Onno point to marked divergencies in the species represented and in the numerical strength of certain species in different parts of the reserve. Thus the chief breeding birds on the islands in the Väinameri, the most seaward part of the reserve, are the Velvet Scoter, Eider and Shoveler; on the islands in the middle of the bay—the Tufted Duck, Mallard and Shoveler; and in the meadows and hayfields round the delta—the Mallard and Pintail.

If we compare the present population of the bay with that which existed from twenty-five to thirty years ago, we cannot fail to note the profound changes that have taken place both in the habitats themselves, and in the distribution and numbers of the species they shelter. These are partly due to changes that are gradually taking place in the natural environment, especially as a result of the dredging of the river. On the whole there is a general tendency for certain landscape types to shift slowly in a westerly direction, carrying with them the species groups with which they are associated.

Throughout the bay, and especially in the inner reaches, the numbers of Mallard, Pochard and Tufted Duck are steadily decreasing, while the last has wandered farther west and now nests in abundance round the islands in the centre of the bay and in the Väinameri. This latter tendency has undoubtedly been encouraged by the new protection regulations, introduced in 1957. Of recent years the Pintail, and especially the Shoveler, have consistently increased, though this can hardly be explained by the influence of local factors. Recently, too, isolated pairs of the Gadwall, Scaup and Goldeneye, all of which were formerly absent from the reserve, have begun to put in an

occasional appearance. The Shelduck threatens to drop out of the picture altogether, whereas, thanks to the protection regulations, the Eider appears to be increasing rather than diminishing.

A young Estonian ornithologist, Rein Saluri, has investigated the commencement of the breeding period in the park. The date when the first egg was laid was counted as the absolute beginning of the nesting season for each species, while the average beginning was fixed as the date by which 50 per cent of the clutches had been initiated. Gathering data on these lines from 1957 to 1960, the author was able to generalise from extensive materials, the species most poorly represented being the Pintail (37 clutches) and Red-breasted Merganser (48 clutches), while the most numerous species were the Tufted Duck and Velvet Scoter (with 411 and 244 clutches respectively).

In this way the average beginning of the nesting season for the waterfowl at Matsalu was determined as follows: the Pintail—May 11th, Mallard—May 14th, Shoveler—May 15th, Goosander—May 20th, Garganey—May 20th, Eider—May 21st, Pochard—May 29th, Tufted Duck—June 2nd, Red-breasted Merganser—June 14th, and Velvet Scoter—June 16th. The dates for the species at the ends of the list reveal a difference of more than five weeks.

Rein Saluri also finds that the breaking up of the sea-ice has some effect on the beginning of the season in such early-nesting species as the Eider and Goosander. At the same time differences can be observed between the breeding periods of the bird populations in the inner, central and outer parts of the bay (including the islands in the Sound), though these are less pronounced in the ducks than in the gulls and waders.

Matsalu as an international asset

In view of the remarkably favourable conditions obtaining in the reserve and the exceptional density of the bird population, not to speak of the importance of the site as a halting-place for northern waterfowl during migration, it has been proposed that the Matsalu National Park should receive the status of a permanent European Reserve (Europe-reservat). It seems to us that the imposing flocks of swans, the endless skeins of Long-tailed Ducks and Common Scoters, and the huge masses of other migrants which assemble here year after year during the spring and autumn transits are composed of more or less the same birds. If this is so, it follows that they remember the bay as a much-needed haven, where they are assured of shelter and protection now that hunting has been prohibited in the reserve. It is this that makes Matsalu a sanctuary of an importance transcending mere local bounds.

But the park is far more than the breeding ground of a rich population of waterfowl, including a number of rare nesting species. It is a unique open-air museum for wild bird life, of which the significance, both as a nature reserve and as a centre for scientific research, may be expected to last for many years.

References

HÄRMS, M. 1926. The bird fauna of Matsalu Bay and its environs. *Reports of the Naturalists' Society* 32 : Tartu (Estonian).

KUMARI, E. 1937. *Materials on the bird fauna of Matsalu Bay*. Tartu (Estonian).

KUMARI, E. 1958. Visible migration in the East Baltic area. *Ibis* 100 : 503-14.

MEIKLEJOHN, R. F. 1926. A nesting expedition in Estonia. *Oologists' Record* 6 : 75-83.

ONNO, S. 1958. Recent ornithological research in Matsalu Bay. *Articles on Ornithology (Ornitoloogiline kogumik)*, I : 246-55. Tartu. (Estonian, with English summary).

ONNO, S. 1959. New nesting birds on the Matsalu Bay. *Faunistic notes* I, 1. Tartu (Estonian).

ONNO, S. 1961. Problems of investigating the bird population of the Matsalu National Park. *Theses of reports delivered on the VI Estonian Naturalists' Day*. Tartu (Estonian).

The food supplies of Essex Brent in the winter of 1960-61

P. J. K. Burton

THIS short paper is a sequel to an account of surveys of Brent Goose *Branta b. bernicla* food supplies which appeared in last year's Report (Burton 1961). It has been necessitated by the exceptionally high numbers of Brent which wintered in Essex during 1960-61, which put to the test the suggestion that " the highest winter average which could be comfortably maintained would be in the region of 6000."

A comparison of the Wildfowl Counts of Brent in Essex during 1960-61 with those of previous years shows a rather unusual pattern, characterised by an early arrival of large numbers. Accordingly, the simple procedure of averaging counts through the winter to provide a measure of goose numbers has been abandoned in favour of a method in which the count totals are plotted on graph paper, and the area under the best curve that can be drawn through them is measured to estimate " goose-days "—the product of numbers and duration of stay. Both methods are very approximate, but this one involves rather less error.

A survey of *Zostera* cover at Foulness and Wakering was made on 23rd April, 1961, to assess the impact of the large numbers which had wintered there. It was found that the cover had been very strikingly reduced; of 250 quadrat throws made over a four mile stretch of coast, 67 landed on bare mud, and in 127 only trace quantities of *Zostera* were recorded. A large amount of this was recently regenerated and could not have been exposed to grazing; an estimate of 70% regeneration was made by recording the state of the plants touching a 12 inch stick thrown randomly on the mud at the same time as the quadrats. An estimate of depletion arrived at from this survey was in the region of 850 metric tons—much greater than in April, 1959, when the last spring survey was made.* Re-assessing the numbers present by the method explained above, the figure for daily consumption by one goose has been re-estimated for the winter of 1958-59 at about 18% of the body weight in dry weight of food, while a similar figure based on the results of the winter of 1960-61 gives 16%. This is a good agreement considering the approximate nature of the method and the many possible sources of error. (In Burton 1961, an estimate of 20-25% was given, from apparent consumption in the season 1958-59, but this was based on less abundant data and is regarded as less reliable than the later figures).

Using the average of these figures, 17%, as a basis, the amount of food expected to have been consumed by Brent throughout the county during the winter was calculated to be 1500-1600 metric tons. This represents a high utilisation of food resources. The total of food reserves at Foulness and in the Goldhanger-Osea area has been previously estimated at 1300 metric tons. In practice, the food supplies in the latter area were not fully used, but a feature of the winter was the very wide scattering which occurred during February, 1961, so that Brent were distributed in numbers round the whole coastline of the county. A point of some interest is that, for the first time, the large supplies of *Zostera* in the Leigh area were used by some 7-800 geese. The

*In the *Twelfth Annual Report*, p. 110, the sentence reading " At Foulness, surveys indicated that some 650 metric tons of *Z. noltii* were removed during the winter of 1957-58 " should have referred to 1958-59.

coastline of this area is very built up, and experience in previous winters had indicated that in consequence these food reserves would not be used to any great extent.

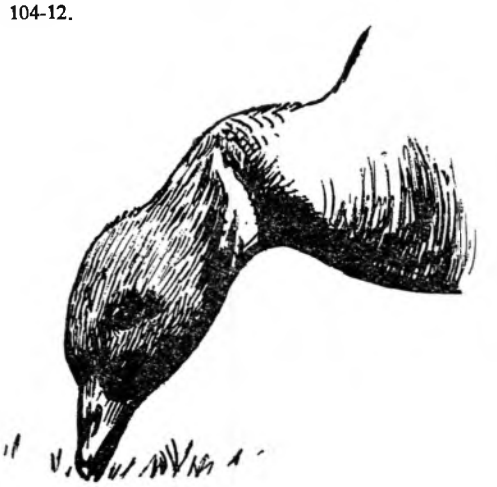
Although it is very unlikely that any Brent actually went short of food in the county in 1960-61, some symptoms reminiscent of food shortage were noted. In the St. Peter's area, by the beginning of February, Brent were staying close to the saltings long after the tide had ebbed, feeding on the *Enteromorpha* which grows thickly at these high levels; by mid-February, they were to be seen feeding in numbers on the saltings themselves even at low tide. Similar behaviour was observed at Steeple Creek on the Blackwater, where Brent fed regularly on the saltings throughout the winter, and appeared particularly fond of the area right at the foot of the sea-wall. Interestingly, no such observations were made at Foulness, where grazing on the mud was most intensive; and in the Steeple area, supplies of food on the mud showed no sign of running out. Perhaps such behaviour may be provoked by crowding before a genuine shortage actually occurs.

A record of 12 Brent grazing on winter grain comes from Zeeland (T. Lebret). The food supplies for Brent in this area have recently been considerably reduced by the damming of the Zandkreek estuary. This is the closest Continental wintering area to Essex, and although its population is not large, it is possible that the change in this area may have some influence on the movements of Brent to Essex and be connected with the early arrivals noted in autumn 1960 and again in autumn 1961.

To sum up. A feature of the winter of 1960-61 in Essex was the high level of Brent numbers maintained over a considerable period. This involved very high utilisation of resources, and some symptoms of overcrowding were noted in the form of unusual feeding behaviour. Such a high use of food reserves depends to a large extent on the present very tame behaviour of Brent resulting from protection. Removal of Brent from the legal protection at present afforded by the 1954 Bird Protection Act would make such full use of food supplies difficult if, as is likely, the birds became wilder. This should be borne in mind in any discussion on the future of the Brent.

Reference

BURTON, P. J. K. 1961. The Brent Goose and its Food Supply in Essex. *Wildfowl Trust Twelfth Annual Report* : 104-12.



The food habits of a hand-reared Mallard population

P. J. S. Olney

Summary

A STUDY of the food habits of a hand-reared Mallard population was made after they had been released into the wild. This was based on 77 birds obtained during the four shooting seasons of 1958-62 from a 6 acre lake within a private estate near North Frith, Kent. A number of conclusions were reached. a) From a survey of the flora of the immediate vicinity and from stomach analyses it became obvious that a good deal of their diet was made up of naturally occurring plant seeds, even though grain was being fed to them throughout the period of observation. b) Three species, oak *Quercus robur*, bur-reed *Sparganium erectum* and hornbeam *Carpinus betulus* were eaten more frequently and in greater volume than any other food item. c) Yearly differences in feeding habits became apparent, particularly in 1959 when virtually no *Quercus* seeds were produced and in consequence comparatively more grain was eaten. d) There were also obvious differences in feeding habits as the season progressed. Cereal grain formed the principal food item during September, when the main naturally-occurring plant species had not yet ripened seed, and during the latter months of the survey when the bulk of the natural foods had been eaten. During October, November and December *Quercus* formed the main food, with *Sparganium* seeds being taken in each month though proportionally more were eaten during October and November, and *Carpinus* seeds only being eaten from October onwards. This corresponds to their periods of greatest abundance. e) The amount of seed production can be roughly ascertained in September, and then if necessary the amount of grain to be fed can be increased or decreased. It is suggested that the three main plant species, which are the same for similar areas throughout the country, can be actively encouraged and managed.

Introduction

There is virtually no information available on the food habits of artificially-reared Mallard *Anas p. platyrhynchos* after they have been released. Yet the ultimate success of rearing schemes depends to a large extent on the ability of these birds to adapt themselves to finding and feeding on natural foods.

This survey, based on a sample of artificially-reared Mallard which were released into the wild, shows that a considerable proportion of their diet was obtained from the immediate vicinity, even though grain was still being fed to them.

Methods and materials

The birds were all obtained from a 6 acre lake within a private estate in North Frith, Kent. From ringing returns this appears to be mainly a sedentary population—at least for the period of sampling, which was confined to the shooting-season months from 1st September to 31st January, and covered the four years of 1958-62. The lake, which has a thick organic mud over clay bottom, has an average depth of three-and-a-half feet (about 1.07 metres) and is divided by a narrow pathway into one large area of 5½ acres and a small pond of ½ acre. The vegetation is typical of a damp oak/hornbeam (*Quercus robur/Carpinus betulus*) wood on a clay soil, with a fairly rich shrub layer dominated by hazel *Corylus avellana* and a rich field layer. The main plant constituents are shown in Table 1, though this must not be accepted as a complete list. The tree layer is dominated by oak, with a smaller number of hornbeam, birch *Betula pubescens* and alder *Alnus glutinosa* trees. The shrub layer has in places a nearly pure stand of hazel, with a number of other species varying in frequency. The field layer has a wide variety of species the frequency of which varies considerably from area to area within the wood. In places bramble *Rubus fruticosus* agg. is dominant, and in other areas stinging nettle *Urtica dioica* and creeping buttercup *Ranunculus repens* with

Table 1

Plant species occurring at North Frith, Kent

Tree layer:	*Quercus robur*	d	Shrub layer:	*Corylus avellana*	d
	Carpinus betulus	1a		*Crataegus monogyna*	f
	Betula pubescens	o		*Prunus spinosa*	o
	Alnus glutinosa	o		*Sambucus nigra*	o
	Ilex aquifolium	r		*Viburnum opulus*	o
				Salix spp.	o
				Frangula alnus	r
				Thelycrania sanguinea	r
				Rosa canina	r

Field layer (including number of different 'habitats' — pathways, wet and drier areas, banks, etc.):

Rubus fruticosus agg.	1d	*Cirsium palustre*	
Filipendula ulmaria		*Galium aparine*	
Ranunculus repens		*Juncus effusus*	
Deschampsia cespitosa		*Juncus bufonius*	
Urtica dioica		*Juncus inflexus*	
Ajuga reptans		*Polygonum convolvulus*	
Carex sylvatica		*Polygonum persicaria*	
Carex pendula		*Scrophularia aquatica*	

Lake:	*Sparganium erectum*	1d	
	Polygonum amphibium	1d	
	Elodea canadensis		(Key to symbols: d=dominant; a=abundant; f=frequent; o=occasional; r=rare; l=locally.)
	Callitriche sp.		
	Potamogeton sp.		

meadowsweet *Filipendula ulmaria* and tufted hair-grass *Deschampsia cespitosa.* The vegetation of the lake is sparse, though in places there are good growths of common bur-reed *Sparganium erectum* and amphibious bistort *Polygonum amphibium.* The submergent vegetation is mainly starwort *Callitriche* sp. and Canadian pondweed *Elodea canadensis,* with some pondweed *Potamogeton* sp. The nomenclature of all seeding plants follows that of Dandy (1958).

The viscera were extracted from the birds, preserved in formo-saline and despatched to the Trust where they were analysed for food content. The method of analysis has been previously described in full (Olney 1961, 1962).

There was no apparent difference in feeding habits between males and females or between first-year and older birds.

Results

The frequency with which food items were found during the four years of sampling is shown in Table 2. The volume and volume percentage of the main food items are shown in Table 3.

The seeds of *S. erectum* were taken more frequently than any other species, though the number taken and their total volume was never large. The smallness in volume is probably due to the small quantity available as most of the *Sparganium* is confined to the smaller pond and covers an area of less than a quarter of an acre. The highest number of seeds found in any one gizzard was 250, from a bird shot in October. The fact that *Sparganium* seeds are eaten by Mallard does not appear to have been noted for this country before, though they are known to form an important part of the diet of wildfowl in America (Martin & Uhler 1939, Stroudt 1944, Yocom 1951, Anderson 1959) and in Russia (Dementiev & Gladkov 1952, Dolbik 1959). It has been stated by a number of authors (Guppy 1894, Cook 1962) that the seeds of this species can be dispersed by wildfowl both internally and externally, yet of the 39 birds examined and found to have fed on *Sparganium* seeds, not one had

Table 2

Food items taken expressed as percentage of total frequency

	1958-59	1959-60	1960-61	1961-62	1958-62
No. of possible occurrences	15	16	19	27	77
Seeds:					
Bur - reed (*Sparganium erectum*)	60.0	37.5	52.6	51.9	50.6
Oak (*Quercus robur*)	60.0	—	31.6	25.9	28.6
Hornbeam (*Carpinus betulus*)	46.7	18.8	52.6	3.7	27.3
Barley (*Hordeum* sp.)	6.7	25.0	15.8	33.3	22.1
Bramble (*Rubus fruticosus* agg.)	26.7	18.8	10.5	14.8	16.9
Alder (*Alnus glutinosa*)	6.7	18.8	26.3	7.4	14.3
Wheat (*Triticum* sp.)	6.7	—	10.5	18.5	10.4
Rose (*Rosa canina*) ..	26.7	6.3	5.3	3.7	9.1
Hawthorn (*Crataegus monogyna*)	26.7	—	—	7.4	7.8

Other species with number of occurrences:

Plant material:

Seeds: Birch (*Betula pubescens*) 7. Creeping buttercup (*Ranunculus repens*) 4. Goosegrass (*Galium aparine*) 4. Pondweed (*Potamogeton* sp.) 3. Dock (*Rumex crispus*) 2. Sedge (*Carex* sp.) 1. Vetch (*Vicia* sp.) 1. Marsh bedstraw (*Galium palustre*) 1. Clover (*Trifolium repens*) 1. Redleg (*Polygonum persicaria*) 1. Bugle (*Ajuga reptans*) 1. Amphibious bistort (*Polygonum amphibium*) 1.

Vegetative material: Amphibious bistort (*Polygonum amphibium*) root-stock 3. Grass 2. Pondweed (*Potamogeton* sp.) tubers 1. Starwort (*Callitriche* sp.) leaf and stem 1.

Animal material: Midge-fly larvae (Chironomidae) 2. Alder-fly larvae (*Sialis lutaria*) 1. Horse-fly larvae (Tabanidae) 1. Earthworm (Lumbricidae) 1. Waterlice (*Asellus* sp.) 1.

whole seeds below the gizzard and only the very smallest pieces were found within the rectum. Preliminary tests with hand-reared Mallard produced no evidence that these seeds are normally passed through the alimentary canal.

Sparganium seeds were taken in each of the four seasons and within each month, though proportionally more were found in those birds shot in October and November (Table 4 and Figure 1). This corresponds to the time when most of the seeds have ripened and fallen.

The seeds of *Quercus robur* formed the main bulk of the food taken and were found in 29 per cent of the 77 birds examined. The total absence of acorns in the 1959-60 season (Tables 2 and 3) is a reflection of the almost complete failure of the acorn crop in the study area during 1959. That oak is exceptionally erratic in its seed production is well known (Jones 1959) and years of nearly complete failure are frequent. In this wood in years of heavy crop there were trees which though of seed bearing age produced no fruit and, conversely, in years of no crop by the majority of trees a few produced seeds. In years of general seed production it was obvious that Mallard were taking acorns in greater volume than any other food, even in apparent preference to the wheat or barley which was being regularly fed to them. A number of birds were shot which were so distended by the number of acorns they had eaten that the whole neck was swollen to almost twice its size. In November 1958, for example, a bird had over 28 acorns within the oesophagus alone.

Table 3

Main food items taken

	1958-59		1959-60		1960-61		1961-62		1958-62	
	Volume in ml.	% of total vol.	Volume in ml.	% of total vol.	Volume in ml.	% of total vol.	Volume in ml.	% of total vol.	Volume in ml.	total vol. % of
Seeds:										
Quercus robur	54.90	80.4	—	—	81.00	81.0	89.20	49.8	225.10	59.9
Triticum sp.	2.20	3.2	—	—	1.80	1.8	57.80	32.2	61.80	16.4
Hordeum sp.	0.50	0.7	24.00	84.9	8.40	8.4	27.80	15.5	60.70	16.2
Sparganium erectum	2.40	3.5	1.45	5.1	5.05	5.1	3.70	2.0	12.60	3.4
Carpinus betulus	2.70	4.0	0.40	1.4	2.40	2.4	0.05	—	5.55	1.5
Alnus glutinosa	0.05	0.1	0.40	1.4	0.40	0.4	0.15	0.1	1.00	0.3
Rosa canina	0.90	1.3	trace	—	0.40	0.4	trace	—	1.30	0.3
Rubus fruticous agg.	0.10	0.2	0.10	0.4	0.10	0.1	0.10	0.1	0.40	0.1
Crataegus monogyna	0.40	0.6	—	—	—	—	0.10	0.1	0.50	0.1
Total plant material	66.85	97.9	28.05	99.3	99.9	99.9	179.20	100.0	374.0	99.5
Total animal material	1.45	2.1	0.20	0.7	trace	0.1	0.05	—	1.7	0.5

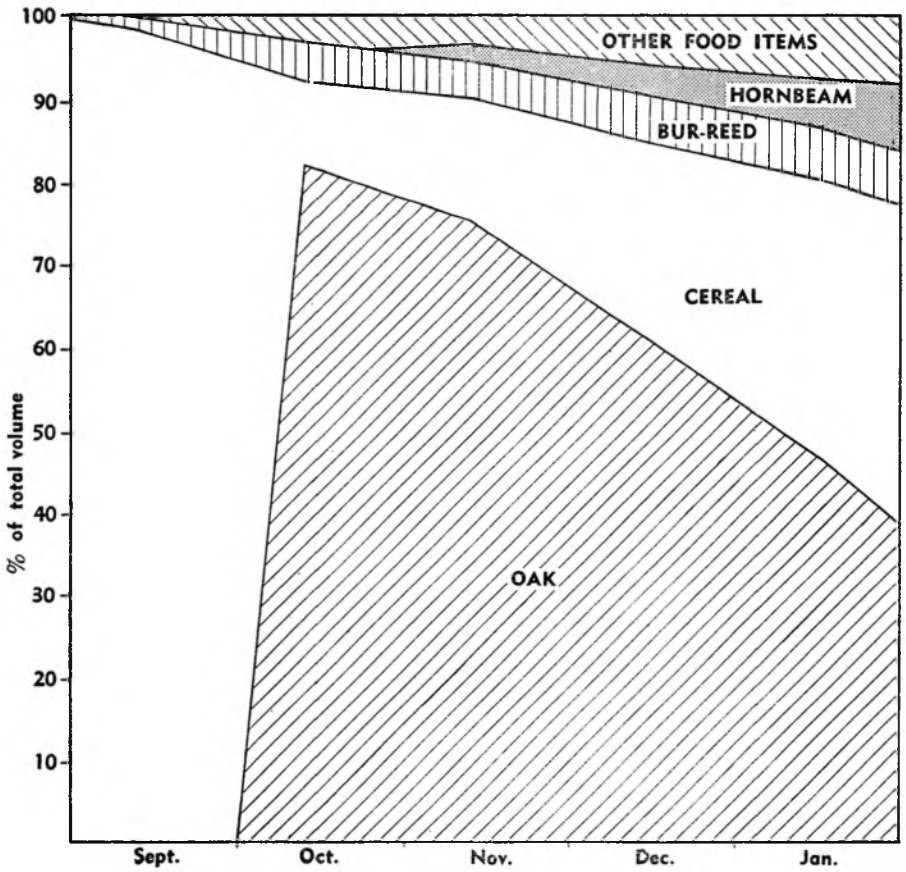


Figure 1. Main food items eaten per month expressed as percentage of monthly total volume

Acorns begin to fall in late September and early October and it was during October and November when the greatest number would be available that most of the acorns were eaten (Table 4 and Figure 1). That acorns are an excellent food for Mallard has been noted by a number of authors including Millais (1902), Coward (1910), Berry (1939) and Witherby *et al.* (1939).

During October and November relatively less cereal (*Hordeum* and *Triticum*) was eaten, even though it was still being fed to the birds and had formed the main constituent of their diet prior to their release. There appeared to be a definite preference for the seeds of *Sparganium* and *Quercus* and it was only in periods when these were less available, either because they had not yet ripened and been shed (September) or because the bulk of the supply had been eaten (December, January) that the birds took grain. In October and November, 1959, when few acorns were produced, comparatively more cereal was eaten than in the same months of the other years.

The seeds of hornbeam *Carpinus betulus* occurred in 21 of the 77 birds examined, though the total volume only amounted to 1.5 per cent. They did not occur in any of the birds shot in September or October, but were found in the three months following, with a relatively higher proportion in November. This is to be expected for the seeds are usually retained until later in the year, often remaining on the tree until late November and even until January.

Table 4
The frequency of the main food items from 1958-62 expressed as a percentage of the monthly total

	Sept.	Oct.	Nov.	Dec.	Jan.
No. of possible occurrences	10	18	18	11	20
Quercus robur ..	—	61.1	33.3	18.2	15.0
Sparganium erectum ..	60.0	66.7	66.7	36.4	25.0
Hordeum + *Triticum*	80.0	33.4	16.7	18.2	15.0
Carpinus betulus ..	—	—	50.0	27.3	45.0
Rubus fruticosus agg.	20.0	11.1	22.2	27.3	10.0
Alnus glutinosa ..	—	5.6	22.2	45.5	5.0
Rosa canina	—	11.1	5.6	9.1	15.0
Betula pubescens ..	—	11.1	11.1	9.1	15.0
Crataegus monogyna .	—	11.1	16.7	27.3	—

Only four other species (*Rubus, Alnus, Rosa* and *Betula*) were found in any number or volume and even then the number of occurrences was too small to reflect any significant differences in yearly or monthly availability.

Conclusions

The results of this survey, though admittedly based on rather small numbers, reflect well the availability of the main food species—as one species became less abundant, another was taken (Table 4 and Figure 1) and in this area, where there is a large population of birds in a comparatively small area, some form of artificial feeding was necessary. This was particularly so during September, when few of the main food plant species have seeds which have ripened, and during January and February, when the bulk of the natural food had been eaten. From October to January most of the foods eaten were seeds of naturally occurring species from the immediate vicinity. The plants which were utilised were the same species taken by wild Mallard from similar areas throughout the country.

This survey also shows that artificially-reared Mallard, whose diet up to the time of release has been composed mainly of grain, adapted themselves quickly and with apparent efficiency to naturally occurring foods, often taking such foods in preference to grain which was still being fed to them. During the periods when natural foods were most abundant, surplus grain could be found at the feeding places.

One surprising omission from the diet was the seeds of hazel *Corylus avellana*, as this is particularly common in certain parts of the wood. It seems to have been recorded only once as a food of Mallard (Spencer 1960). It was thought that the seeds of *Polygonum amphibium*, which are known from other parts of the country to figure highly in Mallard diets, would have been eaten more frequently. It was however noticed that Coot *Fulica atra* were feeding within the *P. amphibium* areas during and after the period of flowering, and two Coot which were later examined were found to have been feeding on the

stem and leaves of this species. The amount of seed available would probably therefore be very small.

It is obvious that in the area under survey and in similar areas the main natural food species *Quercus, Sparganium* and *Carpinus* could be actively encouraged and managed. Experimental propagation of *Sparganium erectum* has indicated that the most successful method is to use rootstock or young rooted plants taken from similar habitats and transplanted in early spring. It was found that autumn planting was less effective and seeding has so far proved to be unsuccessful. When replanting or altering the environment it should be borne in mind that the optimum conditions for growth and fruit production of this species seem to be bright sunlight, a loose substratum and about 10 cm. of standing water (Cook 1962). It is also essential that the water table should be above the root level, although short periods of lower levels in summer can be tolerated.

A rough guide to the carrying capacity of the area can be made in early September when the amount of seed production of the three main food species can be ascertained.

Acknowledgments

I am most grateful to Mr. George Horne and to his farm manager, Mr. Ross Young, for allowing me to use the area under discussion. I am also much indebted to Drs. J. M., J. G. and D. Harrison for collecting the birds and particularly to Dr. J. G. Harrison for helpful advice and criticism.

References

ANDERSON, H. G. 1959. Food habits of migratory ducks in Illinois. *Illinois Nat. Hist. Survey Bull.* 27, Article 4.

BERRY, J. 1939. *The status and distribution of wild geese and wild duck in Scotland.* Int. Wildfowl Inquiry, 2. Cambridge.

COOK, C. D. K. 1962. *Sparganium erectum* L. Biol. flora of the British Isles. *J. Ecol.* 50 : 247-55.

COWARD, T. A. 1910. *The vertebrate fauna of Cheshire,* 1. London.

DANDY, J. E. 1958. *List of British vascular plants.* British Museum (Natural History). London.

DEMENTIEV, G. P. & GLADKOV, N. A. 1952. *Birds of the Soviet Union,* 4. Moscow.

DOLBIK, M. S. 1959. *The birds of White Russia Polesie.* Publishing Office of the Academy of Sciences of the White Russian S.S.R., Minsk.

GUPPY, H. B. 1894-1897. Aquatic seeds. *Proc. roy. Soc. Edinb.* 13 : 344.

JONES, E. W. 1959. *Quercus* L. Biol. flora of the British Isles. *J. Ecol.* 47 : 169-222.

MARTIN, A. C. & UHLER, E. M. 1939. Food of game ducks in the U.S.A. and Canada. *U.S. Dept. Agric. Tech. Bull.*

MILLAIS, J. G. 1902. *Natural History of British surface feeding ducks.* London.

OLNEY, P. J. S. 1961. *The New Wildfowler.* Chapter V, pp. 85-96. London.

OLNEY, P. J. S. 1962. The food and feeding habits of teal (*Anas c. crecca*) *Proc. zool. Soc. Lond.* in press.

SPENCER, J. E. 1960. *The Field.* March 10th. p. 431.

STROUDT, J. H. 1944. Food preferences of mallards on the Chippewa National Forest. Minnesota. *Journ. Wildl. Mgt.* 8 : 100-12.

WITHERBY, H. F., *et al.* 1939. *The Handbook of British birds,* 3. London.

YOCOM, C. F. 1951. *Waterfowl and their food plants in Washington.* Seattle.

Feeding habits of the Harlequin Duck

W. Pool

THIS is a summary of observations on the behaviour of Harlequin Ducks *Histrionicus histrionicus* made by members of the Ulster North Iceland Expedition, leader J. Arnold Benington, from 7th to 15th July, 1961. We were camping on an island in the River Laxá, which flows from Mývatn to the sea, at a point some one and a half miles below the lake itself, near Helluvað Farm. This proved to be in the heart of an area favoured by Harlequins, and it will be as well to describe the habitat briefly before proceeding further.

The Laxá valley runs through wide sweeping moorland. At some comparatively recent time lava has flowed down the valley in a narrow strip, presumably occupying what was once the bed of the river itself. Once the lava had cooled the river evidently found its previous course blocked, and had to flow around or over the lava or to cut a way through it. In many parts of the valley what has happened is simply that the river has cut two parallel streams, one on either side of the lava, leaving a very long, narrow island in the middle consisting entirely of lava. In the area around our camp, however, whilst this basic phenomenon could be observed, the river had also cut numerous channels through the lava itself, so that instead of there being just one long island there was a series of small islands between the two main arms of the river. Parts of the river were slow-moving, and in one place it broadened out into a sort of small lake, but in most stretches it was very fast-flowing, with numerous rapids and small waterfalls. The volume of water hurtling down the valley appeared to be immense, and the roar of the river was always in our ears.

With few exceptions the banks were abrupt and firm. The vegetation on both the banks of the mainland and on most of the islands consisted chiefly of coarse grasses, kept in check by the cattle which grazed them, but in a few places, and especially on islands which could not be reached by the cattle, there was a much more luxuriant vegetation of scrub birch and willow. The river and its valleys are noted both for salmon and trout and also for midges, which exist in an abundance which has to be seen to be believed. Though I have no direct knowledge of the subject I presume that there are great numbers of midge larvae of one kind or another in the river, and that this may account for the abundance not only of the midges but also of the fish and the Harlequins.

At the time when we were in the area the sun went below the horizon for about two and a half hours at night, but there was no real darkness. If the sky was clear, it could be almost as light as day at this time, but with an overcast sky the effect was rather as of twilight, and it was not always easy to see exactly what a dark duck on dark water was doing in such conditions.

Most of the Harlequins we saw were females, of which some at any rate had nests on the islands in the neighbourhood. As we were living in the middle of a good Harlequin area, there was rarely a time of day or night when at least some members of our party were not in sight of some. In these circumstances perhaps the most remarkable thing about the feeding habits of the Harlequins, which should be stated before anything else, is that they were very rarely observed to feed at all. In fact many members of the expedition never once saw a Harlequin feeding. The favourite occupation of the Harlequins, as far as we could see, consisted of just simply sitting around doing nothing—commonly perched, with feet awash, on a boulder in one of the more

rapid parts of the river, or perhaps afloat on one of the calmer stretches, or sitting on the bank a foot or two from the water, or even afloat on one of the rougher streams, nonchalantly keeping position with reference to the bank despite the strength of the current. Odd birds would be seen flying up and down the river, the flight being characteristically low (even under bridges) and following the course of the water, but these flights did not seem to have any particular purpose beyond taking the bird from one place where it had been doing nothing to another where it could do nothing even better. During these long periods of little activity the birds would be, if not exactly tame, at least fairly indifferent to what was going on about them, so that they were quite easy to approach.

All this was a little mysterious, as the Harlequins had a contented, well-fed look, and obviously must have been doing some feeding at some time or other. The solution to the problem appears to be, however—all the evidence is strong on this point—that when the Harlequins do feed they do so very intensively, with an energy and persistence that give the impression of being far greater than that shown by other diving ducks. There were two distinct manners of feeding, by diving and by " head-dipping," by which I mean the immersion of the head and the neck whilst the bird is swimming on the surface. Diving would on occasions be varied with short periods of head-dipping, but head-dipping, which required much less energy, was sometimes seen to take place for very short periods unassociated with diving. For example, a bird swimming from one resting-place to another might occasionally indulge in a little head-dipping on the way; but diving, when carried on at all, was while it lasted the bird's main, indeed all-absorbing, occupation.

Diving was observed on one occasion at about 3-4 p.m., when four ducks were seen diving; on many occasions at about 10.30-11 p.m., just before sunset; and on one occasion from 12.30 to 1.15 a.m. Unfortunately the observers were asleep between 1.15 and about 6 a.m., so we have no means of knowing whether the Harlequins were feeding during that time. The fact that feeding was most commonly observed just before sunset suggests a strong possibility that it might take place just after sunrise also. So far as has been reported to me no member of the expedition ever saw a Harlequin diving between our getting-up time and the mid-afternoon.

We observed ducks diving singly and in numbers up to four, but it must be emphasised that when two or more Harlequins were diving together this meant simply that they were not far away from each other and doing more or less the same thing at more or less the same time, and not in any way that they were co-operating with each other in any direct or systematic way. I stress this because it is at variance with what is stated in the *Handbook of British Birds*.

Harlequins were seen diving in very strong and swift currents, the depth varying between about three feet and about five feet, as far as could be judged from the bank. The length of dive (checked by the second-hand on an ordinary wrist watch, not by stopwatch) varied between five and twenty-five seconds. It was remarkable that a diving Harlequin would emerge from a strong current at the same point as that at which it went down, or commonly a few feet upstream, and only rarely downstream. This argues very powerful underwater swimming or walking on the river floor, or both, as in places the current was strong indeed. On emerging after such an athletic feat a diving Harlequin would pause for only five or ten seconds—apparently just long enough to gain

breath—before diving again; and so it would go on for perhaps five minutes at a stretch, after which the duck would normally come out on to the bank for a period of about a minute (apparently to rest, though it would look very alert during this time). After this brief rest period, the duck would go straight into the water again and immediately dive, right up against the bank, although it might surface further out.

The longest period during which I observed a Harlequin feeding in this manner was 45 minutes (12.30 a.m. to 1.15 a.m.). As the time went on, the rest-periods on the bank became gradually longer and the diving periods gradually shorter. Also towards the end of the period the bird was more inclined to vary diving with the less laborious head-dipping. Other Harlequins I observed might well have carried on feeding for an equally long period if I had not disturbed them. This latter remark, about disturbing feeding birds, reminds me that I observed very clearly that feeding Harlequins were far more alert and also far more shy than those we so commonly watched doing nothing during the course of the day. In fact great stealth was required to watch feeding Harlequins at sunset or later. At about sunset, moreover, the birds were much more active on the wing than normally. They would fly very rapidly up and down the river, and even (surprisingly) overland across the islands, in tight little groups of three, four or five. These flight movements did not seem to follow any clear pattern but were indicative of the frenzy of energy and the wildness which appeared to grip the Harlequins at this time. Similar movements, on a much smaller scale, were also observed at about 7 a.m. In the course of these flights a Harlequin would occasionally utter a musical call-note which always reminded me of the distant trumpeting of a Whooper. It would be interesting to know if any extensive flight-movements take place at sunrise.

It was clearly observable on the Laxá, where many diving ducks were present, that Harlequins dived with greater vigour and persistence than the others, though their feeding periods were much more restricted. A Scaup, for example, might dive on and off throughout the day and night (I saw one diving for a short period at about 1 a.m., whilst I was observing the Harlequin), but would not keep it up for so long at a time and would certainly take a longer period on the surface between individual dives. Harlequins would habitually dive in much stronger currents than the others and definitely seemed to prefer rough water. They were not at all perturbed by the presence of waterfalls and one that I disturbed actually swam over a small waterfall about two feet high! Scaup would occasionally dive in fairly strong currents (more so, as far as I could see, than any other ducks apart from the Harlequins), but normally preferred calm water. I never saw Harlequins feeding in completely still water or in a very moderate current.

Feeding by " head-dipping " seemed to be carried on in an energetic and systematic way most often just before sunset, but was occasionally observed at other times, when something in the water would apparently catch the bird's eye and lead it to dip three or four times in a desultory way. When a Harlequin was " head-dipping " in a persistent way it would normally swim upstream in a strong current and repeatedly push its head and neck forwards and downwards in the water. When I first saw this I thought that the Harlequins were skimming the surface with their bills, but closer observation revealed that the bills were quite definitely pushed down well below surface level. The impression I got was that there was something suspended in the water (not

floating on the top) which interested them.

Most of my observations of feeding Harlequins were made in poor light. Although the July night in north Iceland seems bright enough when one is walking the heaths, visibility can be bad down by the river where the valley slopes, the banks themselves, and the bushes, all conspire to shut out the light. I was unable to see that diving Harlequins emerged with food which they swallowed on the surface, and strongly suspect that they swallow the food underwater, but there may have been above-water gulps which I could not detect in the dim light. Anne Ryan saw one Harlequin with weed in its bill in the afternoon (on the occasion when the first nest was found).

The bill of a Harlequin is short and stout in comparison with that of many other ducks, including that of the Scaup, with which its feeding area to some extent overlapped. It seems to be well adapted to prising objects from rocks and boulders and to pushing loose stones about, but less well adapted to sifting water and weed.

In comparing the observations recorded above with the information in the *Handbook of British Birds* (Vol. III, pages 324 ff., 1943, revised edition), the following points of difference emerge. The *Handbook* quotes C. E. Alford as saying that a valuable aid to identification of the Harlequin is its manner of swimming—" either so closely abreast that flank of each individual touches that of its neighbour, or in step-like formation, manoeuvre executed with wonderful precision and at once distinguishing species." This is something which I never observed. " Has habit of jerking head backwards and forwards at each stroke of legs " : this is something which I observed on many occasions, but more often than not the feeding Harlequins which I watched did not jerk their heads. " Almost entirely a day feeder " : as my notes will have shown, this is just not true as far as the Laxá Harlequins are concerned. " Frequently dives from the wing (Phillips) " : I never saw this happen, but it was noticed on several occasions that a Harlequin leaving the bank to dive would submerge as soon as it reached the water, without apparently remaining afloat even for a moment; this was made possible by the steepness of the banks, which went almost straight down for several feet at some points. I am unable to offer either confirmation or denial of the description of underwater habits given in the Handbook, as conditions of visibility were never good enough. I had, however, come to the conclusion from my observation of the dives and places of re-emergence that the Harlequins almost certainly walked Dipper-like, along the river bottom, facing upstream, as the Handbook states " Will also wade in shallow streams where they can feed by merely immersing head (Phillips) or " up-end " like surface-feeders (Michael) " : I never saw either of these feeding-methods being used, but, as I have already stated, " head-dipping " whilst swimming upstream was commonly observed. On reflection, I think that this took place most usually, though by no means always, in comparatively shallow water, which would nevertheless usually have been too deep for the bird to be able to reach the river bottom with its bill in this manner.

In conclusion I may say that the extreme industry displayed by feeding Harlequins made me feel they earned their long periods of indolence; and that there is obviously a very great deal more to be found out about these ducks. Perhaps I shall return to the Laxá some day, and perhaps by then somebody will have invented something that really does repel the midges—though I doubt if anything would!

Evolutionary trends in the behaviour and morphology of the Anatidae

Paul A. Johnsgard

(Dept. of Zoology, University of Nebraska, Lincoln)[1]

Summary

THE major evolutionary trends most clearly evident in the Anatidae are as follows:

1. A trend from monomorphism to dimorphism in plumage, voice (including tracheal structure) and displays, in association with a trend from long pair bonds to temporary pair bonds.
2. A trend from generalized nesting and feeding adaptations to highly specialized ones, with associated specializations in diving adaptations and bill structure.
3. A trend from a single yearly body molt to two molts of the body plumage yearly, usually with an associated separation of nuptial and postnuptial (" eclipse ") plumages in males.
4. A trend towards the development of elaborate, often metallic-coloured, male plumage patterns and wing specula, associated with displays that exhibit these patterns.

Introduction

During the years 1959 to 1961 I was engaged in a comparative study of the family Anatidae, which was primarily behavioural in approach. Parts of this study have been published previously or are yet to be published, but there are certain aspects of the findings which have a bearing on the broader aspects of evolution in birds which will be presented here. These deal with variations in behaviour within the Anatidae that can be traced through many or most taxa of the family and which exhibit changes that can be related to the apparent trends of evolutionary specialization within the group. In the discussion which follows, the taxonomic arrangement is basically that proposed by Delacour and Mayr (1945), as later modified by Delacour (1954-59), but with certain additional modifications indicated by my own studies (Johnsgard. 1961a).

It should be stated at the outset that the impossibility of arranging groups of contemporaneously existing species into sequences of " primitive " to " advanced " species is well recognised (Lorenz, 1951-53). However, it is entirely justifiable to evaluate the number of generalized and presumably primitive features of a species against its specialized features and thus arrange species into series which approximate the trend from generalization to specialization, assuming that no secondary reversion towards generalization has occurred. Such a sequence of intra-familial groups (tribes) of Anatidae, when so arranged, correlates well with the sequence of these groups when arranged according to probable evolutionary relationships, suggesting that in this family the evolutionary trend has been essentially unidirectional, from generalized to more specialized conditions. The sequence of tribes, as used here, will be listed below, together with collective English names for the groups that are used in this paper. The tribal sequence and composition differs only in minor respects from that proposed by Delacour (1954-59):

[1]Studies from the Dept. of Zoology, University of Nebraska, No. 340.

Subfamily Anseranatinae
Tribe Anseranatini—Magpie Goose (1 species)
Subfamily Anserinae
Tribe Dendrocygnini—Whistling (" Tree ") Ducks (8 spp.)
Tribe Anserini—Swans and True Geese (21 spp.)
(Tribe Stictonettini—Freckled Duck)*
Subfamily Anatinae
Tribe Tadornini—Sheldgeese and Shelducks (15 spp.)
(Tribe Tachyerini—Steamer Ducks (3 spp.))*
Tribe Cairinini—Perching Ducks (13 spp.)
Tribe Anatini—Dabbling (or Surface-feeding) Ducks (39 spp.)
Tribe Aythyini—Pochards (16 spp.)
Tribe Mergini—Sea Ducks (including eiders) (20 spp.)
Tribe Oxyurini —Stiff-tailed Ducks (8 spp.)
* Tentative tribe.

General Behaviour

Diving

All waterfowl share certain aspects of general behaviour that are fundamentally important to their survival. Thus apparently all species are able to dive underwater for foraging or to escape from enemies, although I have not personally observed nor read of diving in the Magpie Goose *Anseranas semipalmata*. This species is the least aquatic of all the Anatidae, and its feet are only slightly webbed. Frequent diving for food is found in only some tribes of waterfowl. All species of whistling ducks (*Dendrocygna*) dive when foraging, and keep their wings closed when so doing. However, they perform a coot-like " jump " almost out of the water as they dive vertically downwards. Apparently none of the swans, true geese, sheldgeese and shelducks dive when foraging. Steamer Ducks (*Tachyeres*), which appear to be only remotely related to shelducks, do dive frequently for molluscs and crustaceans. In captivity the Falkland Flightless Steamer Duck *T. brachypterus* uses its wings when submerging, in the same manner as do eiders and other heavy-bodied waterfowl.

Among the perching ducks, none are efficient divers, although it has been reported that in the wild the White-winged Wood Duck *Cairina scutulata* sometimes feeds on small fish and presumably dives when catching them. I have noticed that in captivity this species dives with difficulty and uses its wings when submerging. I have been informed of Mandarin Ducks *Aix galericulata* diving and have rarely observed Wood Ducks *Aix sponsa* diving for food, and the latter also opened the wings when submerging. It is doubtful if any of the anatid species which typically open the wings when diving normally use them for underwater propulsion in the manner of auks (Alcidae) or penguins (Spheniscidae). Rather, the sudden and single flap of the wings during diving seems to function solely for assistance in submerging.

Most if not all species of dabbling ducks dive occasionally in foraging, although the wigeon group appears to be an exception. Most species of *Anas* open their wings when diving, but the Cape Teal *Anas capensis* does not, nor does the small Kerguelen Island race of the Pintail *Anas acuta eatoni*. This suggests that the smaller-bodied ducks, with relatively greater foot area for their body mass, need not use their wings for extra assistance in submergence. Although Torrent Ducks *Merganetta armata* dive frequently when feeding on aquatic larvae, their major food, their manner of diving has not been described in detail to my knowledge. The Blue Duck *Hymenolaimus malacorhynchus*, another stream-dwelling species, dives well in captivity but I have noticed that it too uses its wings when submerging.

The three remaining tribes—Aythyini, Mergini and Oxyurini—are all composed of species which are predominantly diving birds. Of these, the primarily vegetarian forms (the pochards and stiff-tails) and the mollusc and crustacean eaters (eiders and scoters) are rather heavy-bodied, and eiders (*Somateria* and *Polysticta*) and scoters (*Melanitta*) typically open their wings varying amounts when diving. The more streamlined goldeneyes (*Bucephala*) and mergansers (*Mergus*) are superb divers and almost never open their wings. However, during strenuous bathing (" dashing and diving ") or when escaping from an enemy, even these species open their wings and " fly " into the water. Because of the extreme posterior placement of their large feet, the stiff-tails are perhaps the most consummate divers of all the Anatidae, and approach the grebes (Podicipidae) in their skill in submerging. In achieving this, however, they have sacrificed the ability to walk readily and are relatively helpless on land.

Trends in diving therefore, have apparently been from a semi-terrestrial existence where diving is rarely, if ever, performed, to one where adaptations for diving have precluded life on dry land.

Nesting

Nest construction and nest site selection are highly adaptive characters and, as might be expected, vary considerably in the Anatidae. Magpie Geese construct swan-like nests which may be on land or in water, the size of the nest varying with the availability of materials. Like the Anatidae, Magpie Geese lack the innate ability to carry nesting material, and so must rely on what they are able to reach and pass back over their shoulders in the immediate vicinity of the nest.

Whistling ducks are variable in their choice of nest site, which is usually a well-hidden clump of grass or reeds near water or, rarely, a tree cavity. The large heaped nests of swans, built on land, are well known, and true geese build smaller and more concealed nests on land or, sometimes, in water. Sheldgeese build simple nests on land, often with little cover, and shelducks usually nest under rocks, in ground holes and crevices, or (*Tadorna radjah*) in tree holes. Although perching ducks typically nest in tree holes, the Spur-winged Goose (*Plectropterus gambensis*) nests on the ground. On the other hand, most dabbling ducks are ground nesters, with only a few species frequently nesting in trees: two genera (*Merganetta* and *Hymenolaimus*) typically nest in crevices. Pochards are also surface nesters, the site chosen being variable and either on land, by the scaup group, or in reeds over water, by the typical pochards. Sea ducks typically nest on the ground (eiders, scoters, *Clangula*), in crevices (*Histrionicus*), or in tree holes (goldeneyes, most mergansers). The stiff-tails have abandoned ground nesting altogether in favour of aquatic nests in reed beds. Although females of several species of Anatidae sometimes " drop " eggs in the nests of other waterfowl (Weller, 1959), one species of stiff-tail (*Heteronetta atricapilla*) has apparently become an obligate nesting parasite.

It seems that ground nesting is the generalized waterfowl condition, and that nesting in crevices, holes, or over the water are more specialized adaptations that have been adopted independently by various species or groups, with nest parasitism representing a highly specialised condition.

Pre-flight Movements

As gregarious animals, waterfowl have developed numerous social signals. Among the most important of these are the pre-flight, or " flight-intention," movements and calls, which synchronize a pair, family, or flock for take-off. Magpie Geese, which are highly gregarious, call in concert and frequently shake the head laterally as they prepare to take flight. Similar lateral Head-shaking[1] in the pre-flight situation also occurs in species representing all the other tribes of the Anatidae with the possible exception of the Oxyurini.

In the true geese (*Anser* and *Branta*) and in some species of swans (*Cygnus columbianus* and *C. cygnus*) calls are apparently equally or more important than head movements as pre-flight signals, but in most other groups of waterfowl the birds remain silent. Besides lateral Head-shaking, certain waterfowl use other movements in the pre-flight situation. Several perching ducks (*Aix, Cairina*) perform repeated, rather slow, craning movements of the head and bill upwards and forwards. In other perching ducks and the typical dabbling ducks (*Anas*) these are done in a faster and more jerky manner, called " Neck-jerking " by McKinney (1953). Pochards similarly use rapidly repeated upwards movements of the bill, called " Chin-lifting " (McKinney, 1953), but the sea ducks perform only Head-shakes in alert postures, with outstretched necks and bills slightly raised, as they face into the wind ready to take flight. Perhaps because the stiff-tailed ducks are not strong fliers they seem to have lost or never evolved any conspicuously evident pre-flight signals, for in the three genera observed by me (*Oxyura, Heteronetta, Thalassornis*) I have not detected any. Rolling the cheeks on the shoulders has been observed in the pre-flight situation by Miss Helen Hays (pers. comm.), and she considers this " cheeking " to be a probable pre-flight signal in *Oxyura jamaicensis*.

In summary, the trend of evolution in pre-flight signals appears to have been from a combination of lateral Head-shaking and vocal signals to Head-shaking combined with other, usually silent, head movements.

Sexual and Agonistic Behaviour

Precopulatory Behaviour

Of all aspects of waterfowl sexual behaviour, that which is least variable over the greatest number of species is copulatory behaviour, and particularly precopulatory behaviour. The copulatory behaviour of the Magpie Goose has been only very inadequately observed, but appears to consist of the male calling the female to the nest and mounting her as soon as she has climbed on to it. In the cases observed by me the male did not grasp the female's nape during copulation. This is very different from the copulatory behaviour of other Anatidae, nearly all of which copulate on water and apparently always grasp the female's nape during treading.

Whistling ducks have precopulatory displays which range from mutual Drinking or Bill-dipping movements to mutual Head-dipping (" Neck-dipping " of Heinroth, 1911), resembling and apparently derived from feeding or bathing. Mutual Head-dipping (Fig. 1a) movements are utilized by all species of swans and true geese except the Cape Barren Goose (*Cereopsis novae-hollandiae*). Mutual Head-dipping movements are also used by at least one of the four genera of sheldgeese (*Chloephaga*), and by most if not all species of shelducks

[1]movements, postures, or calls which are clearly ritualized into displays and can possibly be homologized among related species are capitalized throughout this paper.

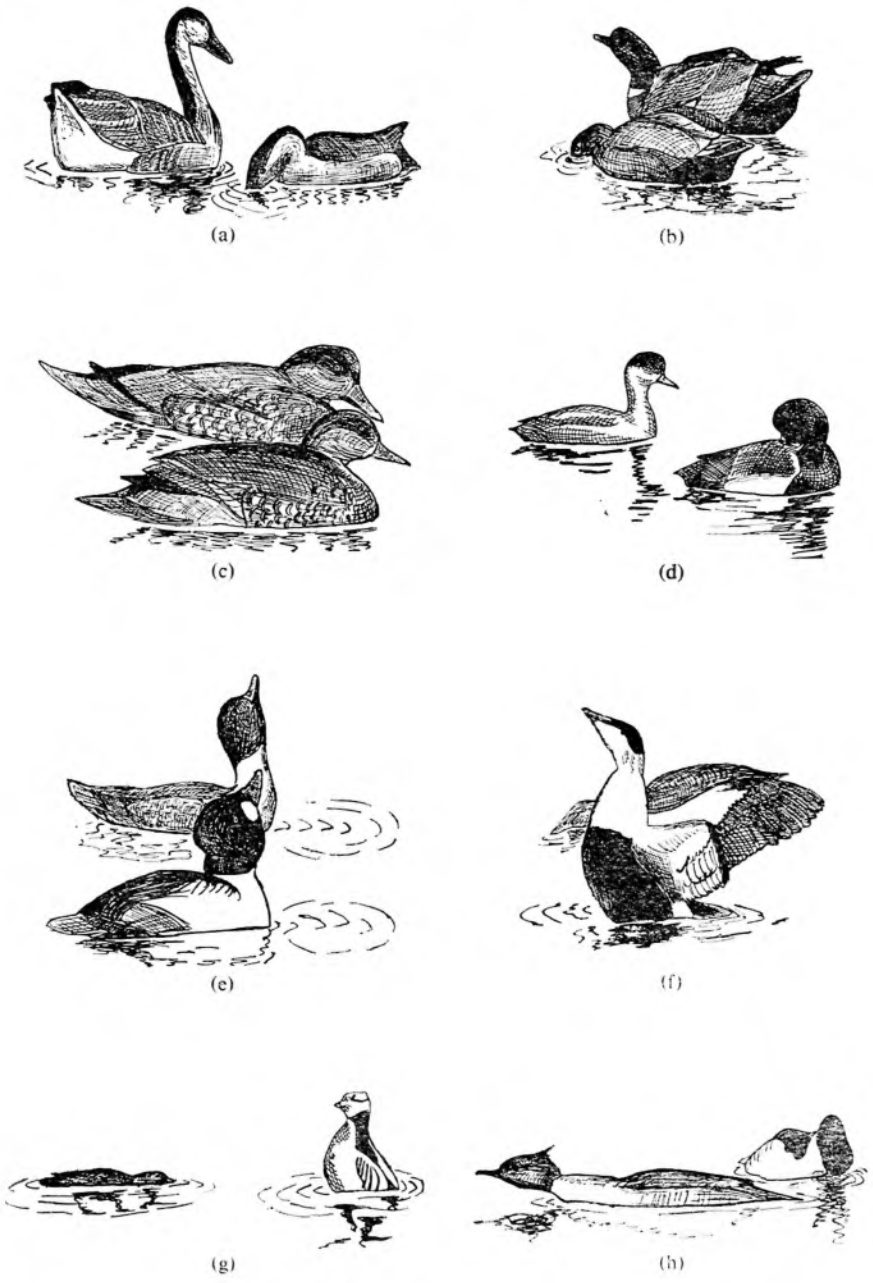


Figure 1. Precopulatory behaviour. Mutual Head-dipping, by a) Swan Geese, and b) Australian Shelducks; c) Head-pumping, by Crested Ducks; d) Head-pumping (female) and Preening-dorsally, by male Red-crested Pochard; e) Drinking, Goldeneyes; f) Wing-flapping by male Common Eider; g) shaking or Upwards-stretch, male Steller's Eider; h) Bill-dipping of male Goosander. *Drawings by P. A. Johnsgard.*

(Fig. 1b). Steamer ducks likewise perform Head-dipping movements, probably mutual, similar to those of sheldgeese and shelducks (Moynihan, 1958).

Among the perching ducks the precopulatory displays are somewhat varied. Mutual Head-dipping has been observed in only the Brazilian Teal (*Amazonetta brasiliensis*). Bill-dipping, performed mutually or by males only, occurs in several genera (*Aix, Callonetta, Nettapus* and possibly *Sarkidiornis*). In the Australian Wood Duck (*Chenonetta jubata*) and the White-winged Wood Duck vertical Head-pumping is performed by the male or by both sexes. It seems probable that Bill-dipping and Head-pumping represent stages in the reduction of the basic Head-dipping movements seen in the preceding tribes. Head-pumping is used (Fig. 1c) by both sexes in at least 32 out of 35 species of *Anas*. Preening, Bill-dipping and Drinking are not used by the typical *Anas* species as precopulatory displays, but both sexes of the Marbled Teal (*Marmaronetta angustirostris*), a " link " species between the dabbling ducks and the pochards (Johnsgard, 1961b), perform Bill-dipping, Drinking and Preening-dorsally in the precopulatory situation. Bill-dipping and Preening-dorsally are also used by all the typical pochards studied to date (13 out of 15 species); these displays are always performed by males (Fig. 1d) and sometimes by females as well. The precopulatory displays of the probably extinct Pink-headed Duck (*Rhodonessa caryophyllacea*), here included in the pochard tribe, are unknown. Mutual Head-pumping occurs in a rudimentary form in one species of pochard (*Netta rufina*), and also is performed by one sex only in at least four other species.

In the sea ducks there is no trace of Head-pumping by either sex, and the only part that the female appears to play in precopulatory display consists of Drinking (Fig. 1e) in some genera (*Mergus, Bucephala*). Otherwise, the female assumes a Prone posture (Fig. 1f to 1h), usually after the male has begun to perform his precopulatory displays. These are extremely varied within the tribe, but usually include Drinking (*Mergus, Bucephala*), Wing-flapping (Fig. 1f), (*Somateria, Mergus cucullatus*), Bathing (*Somateria, Polysticta,* sometimes *Bucephala islandica*), Preening (*Somateria, Polysticta, Melanitta, Bucephala, Mergus*), Shaking or " Upwards-stretch " (Fig. 1g) (*Somateria, Polysticta, Melanitta,* some spp. of *Mergus*), and Bill-dipping (Fig. 1h) (*Polysticta, Melanitta, Bucephala, Mergus*). In some genera (*Polysticta, Melanitta, Bucephala, Mergus cucullatus*) some of these movements are linked into definite sequences, whereas in the others no rigid sequences are apparent. The most complex sequences of precopulatory displays occur in two species of goldeneyes (Myres, 1959) and the Hooded Merganser (*Mergus cucullatus*) (Johnsgard, 1961c). Little is known of the precopulatory behaviour of the stiff-tails, but in at least one species (*Oxyura jamaicensis*) the female takes no part in precopulatory display nor does she usually assume a Prone posture, but rather is suddenly mounted by the male after he has approached her while alternately Bill-dipping and Bill-flicking.

Thus several evolutionary trends in precopulatory behaviour are apparent in the Anatidae. First there is a trend away from land copulation without grasping the female's nape (the Magpie Goose) to treading while standing or swimming in water (nearly all other species) and holding the female in position with the bill. In the species which copulate on water and tend to pair permanently there is usually a mutual precopulatory Head-dipping display involving movements apparently derived from bathing. In some perching

ducks and the dabbling ducks this Head-dipping appears to have been modified into Bill-dipping or Head-pumping movements, performed by one or both sexes. Head-pumping is lacking in most species of pochards, and is replaced by alternate Bill-dipping and Preening-dorsally by one or both birds. In the sea ducks the only mutual precopulatory display is Drinking, and this occurs in only a few species. However, Drinking or Bill-dipping and Preening (dorsally or behind the wing) is a part of the male's precopulatory behaviour in most species and is highly ritualized in a few, the ultimate being reached in two species of goldeneyes and the Hooded Merganser, in which there is a single Preening movement that is a minor part of a complex sequence of displays performed immediately before mounting and at no other time. Not enough is known of the precopulatory behaviour of the stiff-tails to fit them into these trends, but in at least one species mutual displays are lacking. In summary there is a trend away from mutual precopulatory displays apparently derived from bathing towards the evolution of special male displays usually derived from drinking and comfort movements (preening, wing-flapping, shaking, stretching), sometimes linked into special sequences.

Postcopulatory Behaviour

Although the functions of postcopulatory displays in waterfowl are by no means clear, nearly all species which have been studied are known to exhibit some form of stereotyped postcopulatory behaviour. As pairs are apparently formed gradually in swans, geese and at least some ducks, and since copulation sometimes occurs during early stages of pair formation, it seems probable to me that " incorrect " postcopulatory responses could inhibit the formation of firm pairs between distantly related species.

I have not personally seen the postcopulatory display of Magpie Geese, but have been informed that it involves mutual calling and " bowing and scraping " on the part of both birds (Johnsgard, 1961d). In most species of whistling ducks there is a mutual postcopulatory " Step-dance " (Fig. 2a), accompanied by vertical Wing-raising and calling, but in two species which copulate while standing in shallow water or on shore both the Step-dance and marked Wing-raising are lacking. Among the true geese and swans both sexes call as copulation is terminated, and both birds then rise up in the water while extending head and neck vertically, with or without lifting or extending the wings (Fig. 2b & 2c). In the sheldgeese and shelducks which have been observed (seven species), both sexes utter their very different notes as copulation is completed and the male, and to a lesser extent the female, lifts the wing on the opposite side from the partner in a similar manner to the Wing-raising of whistling ducks (Fig. 2d). Steamer ducks swim away from one another following copulation, while simultaneously " Grunting " and " Head-flagging " to each other (Moynihan, 1958).

In the perching ducks, and in the following tribes as well, there is a tendency towards the breakdown of mutual postcopulatory behaviour and the development of special male postcopulatory displays. This is correlated with shorter pair bonds, and the consequent need for efficient signals during pair-bond formation, which must necessarily be less gradual than in the preceding species. In a few of the perching ducks (*Cairina moschata* and perhaps also in *Plectropterus* and *Sarkidiornis*) no distinctive postcopulatory displays have been observed, and in the White-winged Wood Duck the male simply swims

Figure 2. Postcopulatory behaviour. a) " Step-dance " of Whistling Ducks; b) Hawaiian Geese with heads up and wings drooped; c) Trumpeter Swans with heads up and wings extended; d) lifting of far wing by Australian Shelduck; e) male Ringed Teal calling before Facing bathing female; f) male Mallard Bridling; g) " Bill-down " posture by pair of Tufted Ducks; h) male Goldeneye " Steaming " away from female. *Drawings by P. A. Johnsgard.*

about at random, calling excitedly, while the female bathes. In the Ringed Teal (*Callonetta leucophrys*) and the Wood Duck the male calls once (Fig. 2e), then turns and Faces the bathing female, while in the Mandarin Duck and Australian Wood Duck the male tends to swim away from the female for several feet, and sometimes finally turns to face her. In the 20 or so species of *Anas* that have been observed the male calls once with his neck vertically extended in the " Burp " posture or backwards in the " Bridling " posture (Fig. 2f), then faces the female or swims away from her (in some species " Nod-swimming ") and " Turns-the-back-of-the-head " towards her (Lorenz, 1951-53).

In the Marbled Teal and the pochards the postcopulatory behaviour is very uniform. The male calls once as he releases his grasp of the female's nape, then swims away from her in a rigid " Bill-down " posture. Sometimes the female assumes the same posture for a few seconds (Fig. 2g), but often begins to bathe immediately.

The sea ducks exhibit the same bewildering complexity of postcopulatory behaviour that is typical of their other displays. In at least three of the four species of eiders (*Somateria fischeri* unknown), the Surf Scoter *Melanitta perspicillata,* Smew *Mergus albellus* and probably the Red-breasted Merganser *Mergus serrator* the male performs one of its elaborate " courtship " displays immediately after treading is completed. Ritualized " Steaming " away from the female occurs in the goldeneyes (Fig. 2h), eiders, the Hooded Merganser and perhaps other species, and in some (eiders and goldeneyes) is accompanied by lateral Head-turning movements. In all cases the female normally only bathes after copulation. Postcopulatory displays in the stiff-tails are most inadequately known, but in the North American Ruddy Duck *Oxyura j. jamaicensis* the male performs his courtship or " Bubbling " display several times while parallel to or facing the female, who bathes or preens extensively.

Evolutionary trends in postcopulatory displays therefore appear to be away from mutual calling associated with mutual displays that are used only during the postcopulatory situation (species with long pair bonds) to sexually dimorphic postcopulatory behaviour, with the female usually only bathing while the male performs special displays or displays which are also used during courtship (species with short pair bonds).

Pair-forming Behaviour

Pair-forming, or " courtship," displays of waterfowl are extremely diverse and difficult to generalize upon. In most of the groups having long pair bonds (Magpie Geese, whistling ducks, swans, true geese, and perhaps sheldgeese, shelducks and steamer ducks), pair-forming displays are relatively simple. In the true geese, and possibly also in the swans and whistling ducks, the male's major courtship posture appears to consist of swimming ahead of the courted female in a " haughty " attitude (Heinroth, 1911). In the true geese and swans, pairs appear to be formed through the repeated use of the " Triumph Ceremony" (Heinroth, 1911), which is a mutual display typically done after the extrusion of an " enemy " (Fig. 3a), whether real or symbolic. Magpie Geese also appear to exhibit a rudimentary form of Triumph Ceremony (Johnsgard, 1961d), but no obvious courtship displays have been observed.

Pair-forming displays in the sheldgeese and shelducks are much more conspicuous than in the true geese, suggesting that pair bonds are not so rigid as in the latter group. There is independent evidence that this is the case in

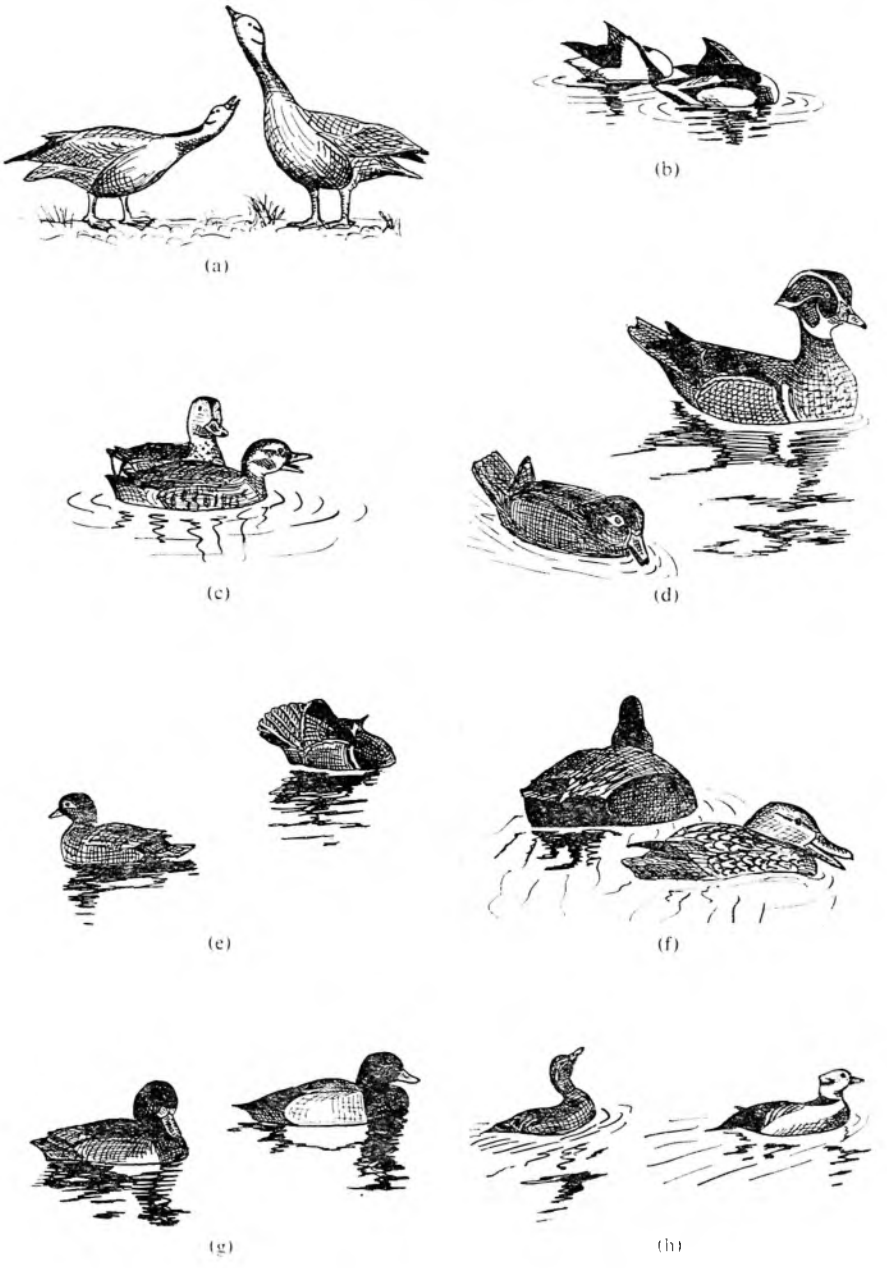


Figure 3. Pair-forming displays. a) " Triumph ceremony " of Bar-headed Geese; b) Common Shelduck Preening-behind-the-wing; c) Inciting and Facing, Ringed Teal; d) Inciting and Burping, Wood Duck; e) Preening-behind-the-wing by male Wood Duck; f) female Gadwall Inciting and made Turning-the-back-of-the-head; g) Inciting and Turning-the-back-of-the-head, Scaup; h) female Steller's Eider Inciting, male Head-turning. *Drawings by P. A. Johnsgard.*

shelducks. Correlated with this weakening of the pair bond there is a double body moult in most and probably all species of *Tadorna*. Shelducks and sheldgeese represent the first group in which the female display termed " Inciting " (Lorenz, 1951-53) or " Hetzen " (Heinroth, 1911) is encountered, and an understanding of this display's significance provides the key to interpreting the pair-forming behaviour of nearly all the species of the subfamily Anatinae. The appearance of this display marks the true beginning of sexual dimorphism in pair-forming behaviour (and in plumage and soft part dimorphism as well). Females typically Incite their actual or potential mates to attack less preferred males or other females, thus " choosing " certain males, probably on the basis of appearance, strength, or reaction to her Inciting, and so providing the basis for sexual selection favouring heterosexual male characteristics of colouration, display, and aggressiveness. Male shelducks and sheldgeese typically overtly threaten or attack the indicated victim, then return to the female and display sexually towards her. In the following tribes the female's Inciting and the male's response both become so highly ritualized that they are sometimes almost unrecognizable, with the trend being that the male's tendency towards overt attack is diminished and his tendency towards responding with elaborate sexual displays or submissive displays towards the female correspondingly increased. In the shelducks and sheldgeese the male's sexual displays usually involve calling (whistled notes in males of the species with large tracheal bullae) in a very erect attitude, sometimes accompanied by spreading or lifting the folded wings and thus displaying the wing speculum patterns (Fig. 4a), which are encountered for the first time in this group. Only one species of shelduck (*Tadorna tadorna*) is known to display its speculum by Preening-behind-the-wing (Fig. 3b), a display which is present in most of the following tribes. Pair-forming displays in the steamer ducks are still only poorly known, but Moynihan (1958) has described several postures and calls of the Flying Steamer Duck (*Tachyeres patachonicus*). One or more of these displays appears to be derived from drinking, and ritualized drinking is typical of most of the remaining tribes. Although Moynihan does not describe Inciting, Delacour (pers. comm.) has informed me that female steamer ducks also possess a true Inciting display.

Among the perching ducks, Inciting has been recorded in most species (Fig. 3c & 3d), although not in the genera *Cairina* or *Sarkidiornis*, and it may also be lacking in *Plectropterus*. In these three genera pair bonds are generally very weak and male courtship displays are rudimentary. Comb Ducks (*Sarkidiornis melanotos*), however, do exhibit in simple form some of the basic male movements of the subfamily Anatinae, namely clearly ritualized Preening-behind-the-wing and possibly ritualized drinking and turning the back of the head toward females. All of these movements are definitely ritualized in the genus *Aix* (Fig. 3e), males of which have also ritualized the general body shake into a sexual display (Lorenz, 1951-53) and which display in social fashion around unmated females. Correlated with the evolution of social courtship displays and definite pair-forming periods is the evolution of distinctly different nuptial and post-nuptial, or " eclipse," male plumages. These are present in *Aix* and one species of *Nettapus*, as well as in all the following tribes.

Pair-forming displays in the dabbling ducks are extremely varied and interesting (Table 1), and in many cases can be related to specializations in plumage or soft part colouration. Lorenz (1951-53) has studied and named the

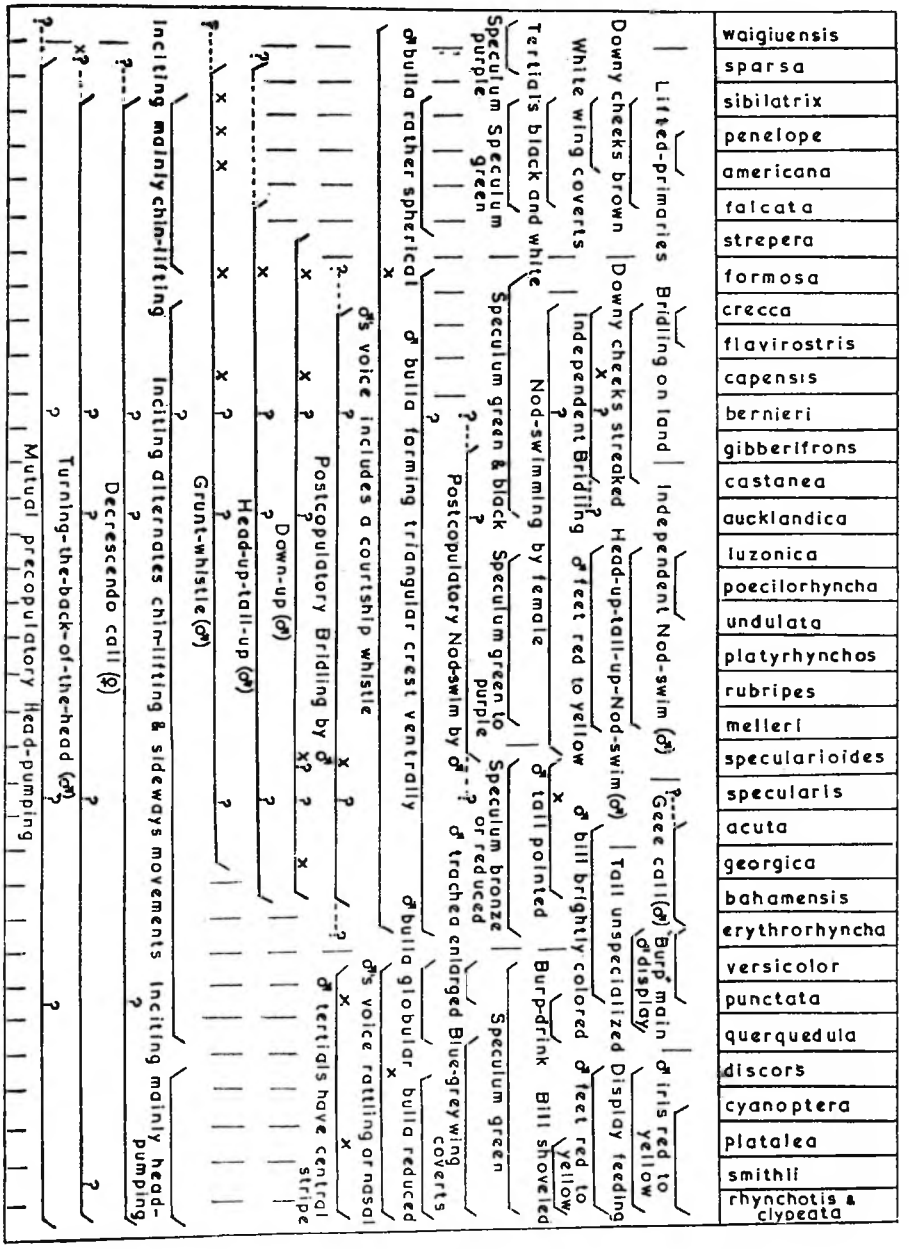


Table 1. Summary of behavioural and morphological features in the dabbling ducks, genus *Anas*. " x " indicates absence of character.

displays of about 14 species of the genus *Anas* (and Table 1 is in part based on his data), and I have been able to observe alive all but two of the 35 species. Females of apparently all species have conspicuous Inciting displays, vocalizations which include a " Decrescendo Call," and females of some species have a special display, " Nod-swimming," which functions in eliciting male displays. Males of nearly all species Turn-the-back-of-the-head and

Preen-behind-the-wing to females, and the combination of female Inciting and Turning-the-back-of-the-head by the male (Fig. 3f) seems to play a basic part in the formation of pairs in this genus as well as several related genera (Johnsgard, 1960b), thus functionally replacing the Triumph Ceremony of the Anserinae. Common male displays of many species of *Anas* include the " Grunt-whistle " (Fig. 4b), " Head-up-tail-up " (Fig. 4b & 4d), " Bridling " (Fig. 4c), " Burp " (Fig. 4e) and " Mock-feeding " (Fig. 4f), all of which have been described by Lorenz (1951-53). The taxonomic distribution of these and other displays and plumage features is of interest (see Table 1). For example, there has evidently been a secondary loss of certain displays in some species, such as the Grunt-whistle and Down-up of the Cape Teal, and the Down-up and postcopulatory Bridling in the Crested Duck (*Anas specularioides*). Secondly, except for certain species which are doubtfully distinct (e.g., *Anas castanea* and *A. gibberifrons, A platyrhynchos* and *A. rubripes*) or allopatric in distribution, there is a remarkable species differentiation of displays and plumage characters, as indicated in Table 1. Thirdly, displays or features shared by the largest number of species (near the bottom of the table) are presumably the most conservative and fundamental to the genus *Anas*, potentially functioning as intergeneric isolating mechanisms, while those found in only a few species are presumably the most adaptive and probably serve as major interspecific isolating mechanisms. Obviously, however, variations in the form or sound of such widespread displays as the Decrescendo Call and Grunt-whistle allow for specificity even within homologous displays.

Pair-forming displays in the pochards are slightly less varied than those of the dabbling ducks, and several behaviour patterns are shared by both of these closely related groups. Preening-behind-the-wing and Turning-the-back-of-the-head (Fig. 3g) by males to Inciting females are of equal importance in both groups. Interestingly, grey or white wing speculum patterns are exhibited by most pochard species when Preening-behind-the-wing, rather than the metallic-coloured specula of dabbling ducks. Pochards perform the " Introductory Shake " (Lorenz, 1951-53) in the same manner as dabbling ducks and some perching ducks, although except in the Red-crested Pochard *Netta rufina* this movement does not function as an " introductory " signal. Although males of nearly all species of pochards share homologous display patterns such as the Kinked-neck (or Courtship) Call (Fig. 4g), the Sneak, Head-throw (Fig. 4h) and Neck-stretching (Hochbaum, 1944), the speed and intensity of these displays differ greatly in various species, as do also the associated vocalizations. Of these displays, the Kinked-neck Call is probably homologous to the Burp of *Anas*, but the more specialized courtship patterns are doubtfully homologous to any of the *Anas* displays. As Lorenz (1951-53) has pointed out, there is no reason to believe that the Head-throw of the Canvasback is homologous to the Laying-the-head-back of the Garganey *Anas querquedula* or the similar postures of the sea ducks. Only the more generalized displays are unquestionably homologous in both tribes and these patterns in the pochards exhibit no evolutionary trends not evident in the dabbling ducks.

Pair-forming displays in the sea ducks culminate the evolutionary trends that have been developed in the preceding tribes. Females of most and perhaps all species have Inciting displays, but these are so highly ritualized and distinct from the basic Inciting movements of female shelducks that at times they are almost impossible to recognize (Fig. 3h). The male displays are so

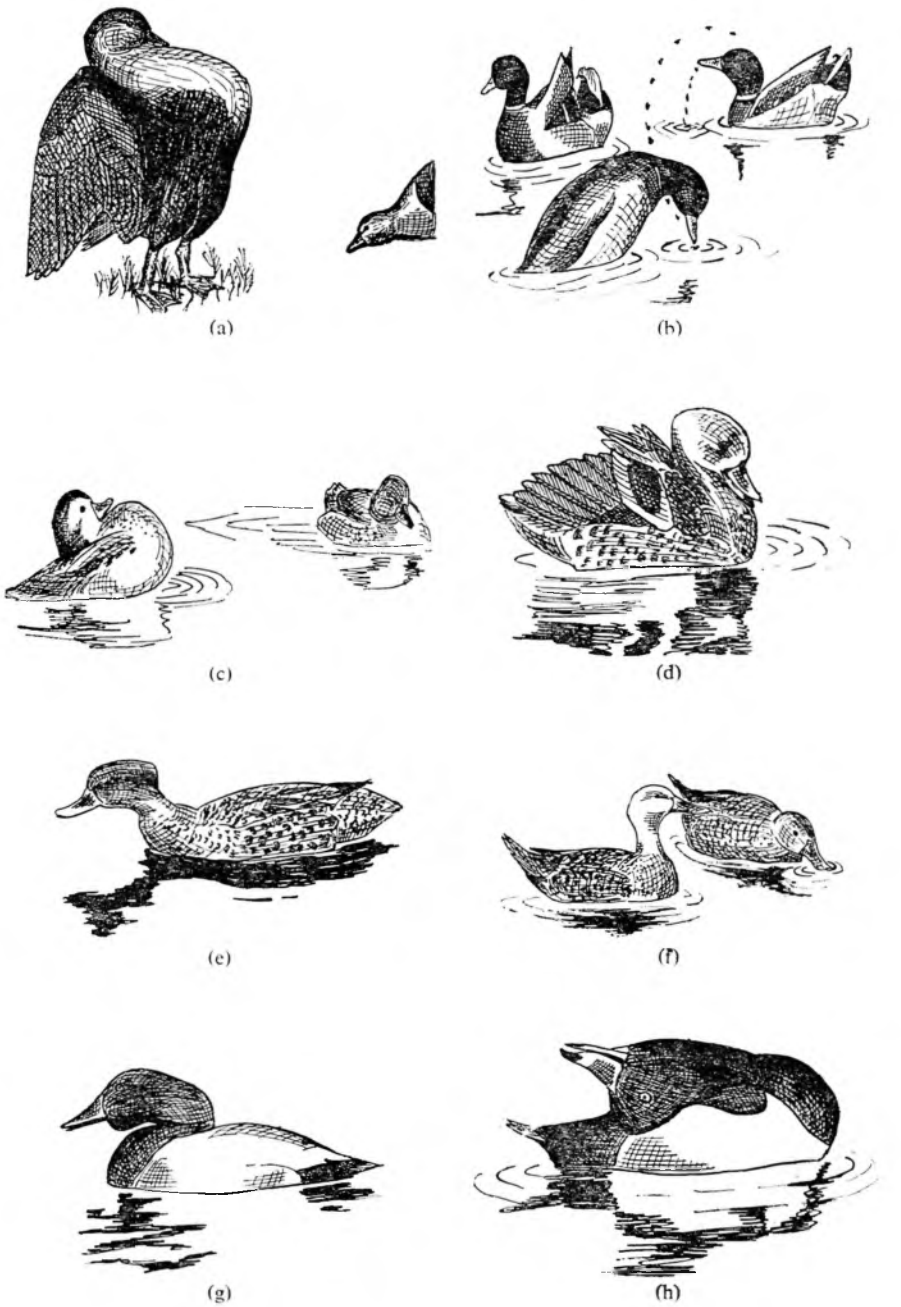


Figure 4. Male pair-forming displays. a) Orinoco Goose lifting folded wing; b) Head-up-tail-up, Grunt-whistle and Down-up of Mallard; c) Bridling of Sharp-winged Teal; d) Head-up-tail-up of Cape Teal; e) Burp of Cape Teal; f) Mock-feeding of Red Shoveler; g) Kinked-neck call of Canvasback; h) Head-throw of Ring-necked Duck. *Drawings by P. A. Johnsgard.*

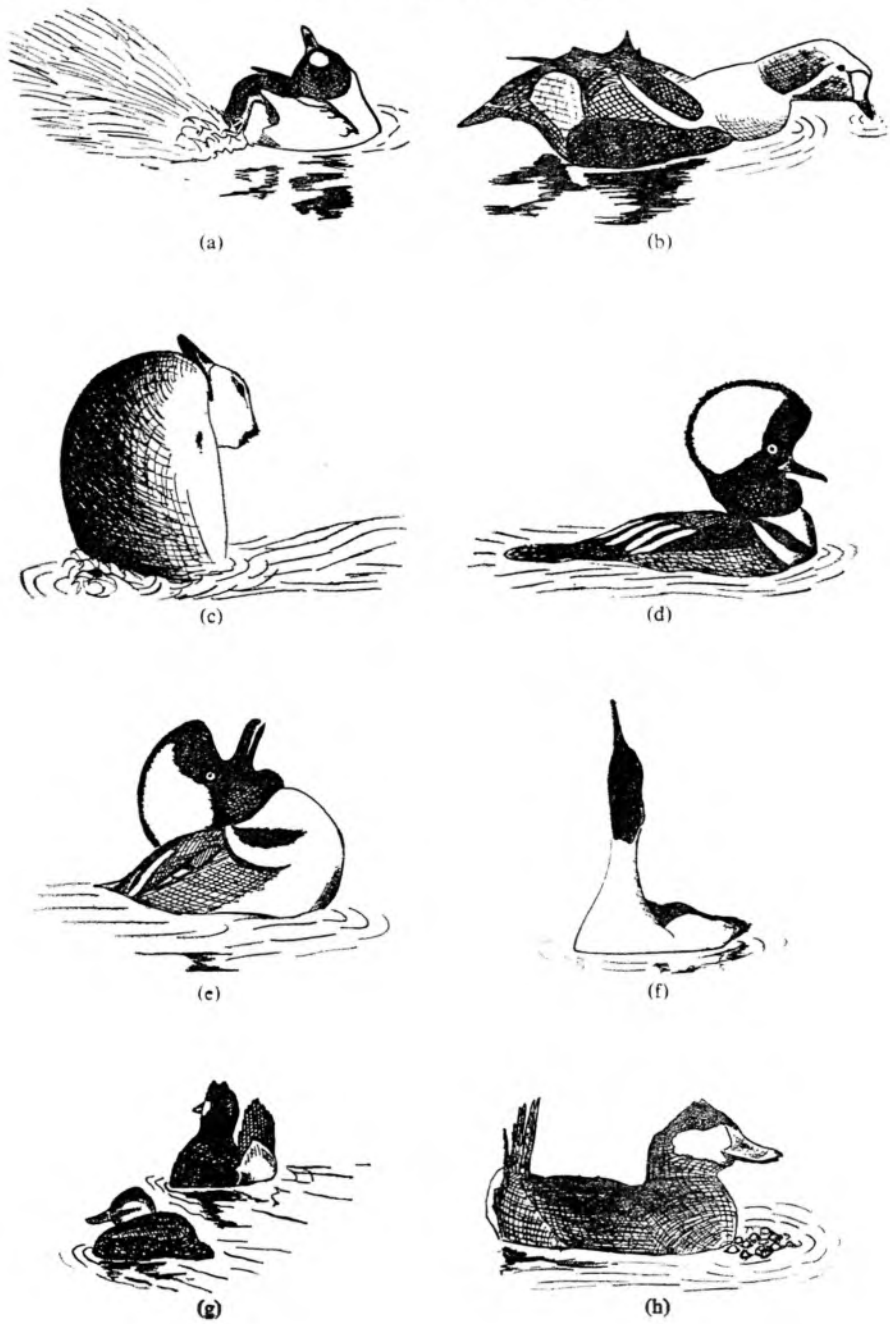


Figure 5. a-f) Pair-forming displays of male sea-ducks: a) Goldeneye Head-throw-kick; b) King Eider Reaching display; c) Steller's Eider Rearing display; d) and e) Hooded Merganser Crest-raising and Head-throw; f) Goosander Salute; g) and h) Ruddy Duck: Male Tail-cocking while swimming ahead of female, and male finishing Bubbling display. *Drawings by P. A. Johnsgard.*

diverse and elaborate (Fig. 5a to 5f) that it is not only difficult to homologize display movements between genera but also within genera, and sometimes different races of one species exhibit qualitively different male displays (e.g., *Somateria mollissima,* McKinney, 1961). Even the more generalized displays are affected by this trend. The general body shake has been ritualized into the Upwards-stretch display (Myres, 1959) in at least some species. Ritualized preening is absent as a courtship display except in scoters, and has been incorporated into the precopulatory displays of several species. Turning-the-back-of-the-head occurs in unmodified form only in some species such as the Long-tailed Duck *Clangula hyemalis* and some mergansers, while in the goldeneyes, eiders, and possibly the Surf Scoter it is functionally replaced by lateral Head-turning. Wing-flapping is highly ritualized in the large eiders (*Somateria*) and is less certainly so in some other species. Short flights to the female are frequent in the Steller's Eider *Polysticta stelleri,* scoters, goldeneyes, and probably other species (McKinney, 1959). The other male pair-forming displays are so diversified that it is impossible to generalize upon them or even, in many cases, to suggest the origins of the movements. Myres (1959) has described many of these displays and has attempted to judge possible homologies among them.

A discussion of the stiff-tails is again hampered by inadequate information regarding most species, although a few generalities are clear enough. In the species studied by me (*Oxyura jamaicensis* adequately, *Heteronetta atricapilla* and *Thalassornis leuconotis* very incompletely) or reported on by others (*Biziura lobata, Oxyura australis*), almost no behaviour patterns have been seen which can be readily homologized with those of other tribes. Male Black-headed Ducks *Heteronetta atricapilla* do Turn-the-back-of-the-head towards courted birds in a typical anatine manner, but Ruddy Ducks tend to hold the head immobile and direct the long axis of the body toward the female, with tail cocked and the under tail coverts exposed to her view (Fig. 5g). Preening-behind-the-wing has not been observed in any species, nor does the general body shake appear to be ritualized. Females of most species are relatively silent, and no behaviour patterns which functionally resemble Inciting have been seen to my knowledge. Male pair-forming displays appear to have been evolved from head and neck movements required for producing sounds from the air sacs or inflatable oesophageal structures that are present in males of most species (Fig. 5h). Ritualized preening of the breast feathers is apparently a major display in two species (*Oxyura australis* and *O. vittata*), although these may be simply sound-producing movements rather than movements derived from preening.

In summary, pair-forming displays in waterfowl species with long pair bonds appear to be mainly Triumph Ceremonies performed by both sexes. In species with less permanent pair bonds the Triumph Ceremony is either replaced by or modified into Inciting on the part of the females and a tendency in males to display sexually towards the female rather than to overtly attack or threaten other individuals. These sexual displays become increasingly more elaborate in the tribes of Anatinae, but are mainly derived from maintenance activities such as drinking, comfort movements such as shaking, preening and wing-flapping, and apparent submissive gestures such as turning the back of the head toward the female. Displays which are associated with vocalizations usually have their origin in the stretching of the neck (and trachea) in order to

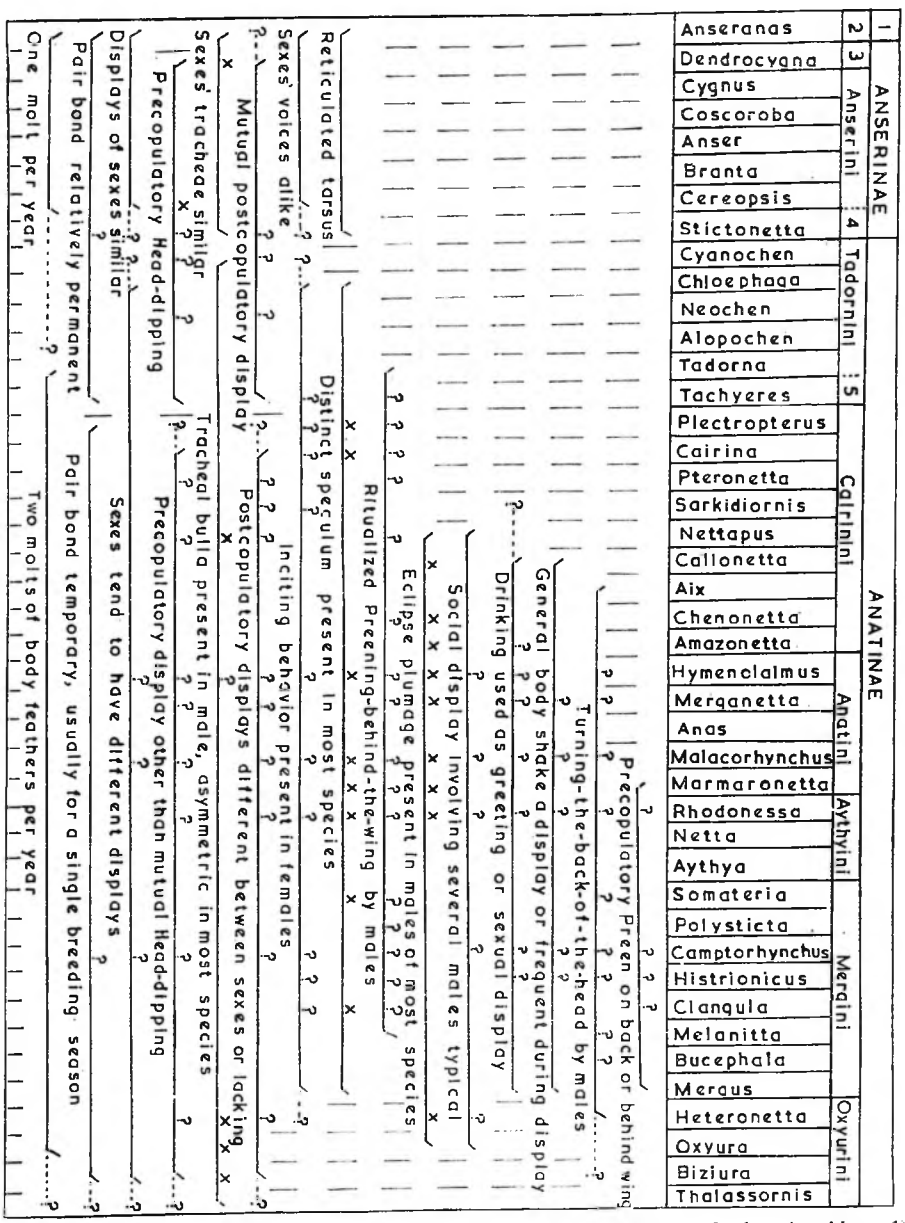


Table 2. Summary of trends in the behaviour and morphology of the Anatidae. 1) Anseranatinae; 2) Anseranatini; 3) Dendrocygnini; 4) Stictonettini; 5) Tachyerini.

produce special sounds. Together with the tendency towards elaborate displays in males, there is also a corresponding tendency towards social display involving several males "courting" one or more unmated females. Wing-preening movements form an important part of the pair-forming displays of the Anatinae, and are usually associated with white or metallic-coloured speculum patterns. The general body shake occurs in essentially unmodified form during courtship display of perching ducks, dabbling ducks, and pochards,

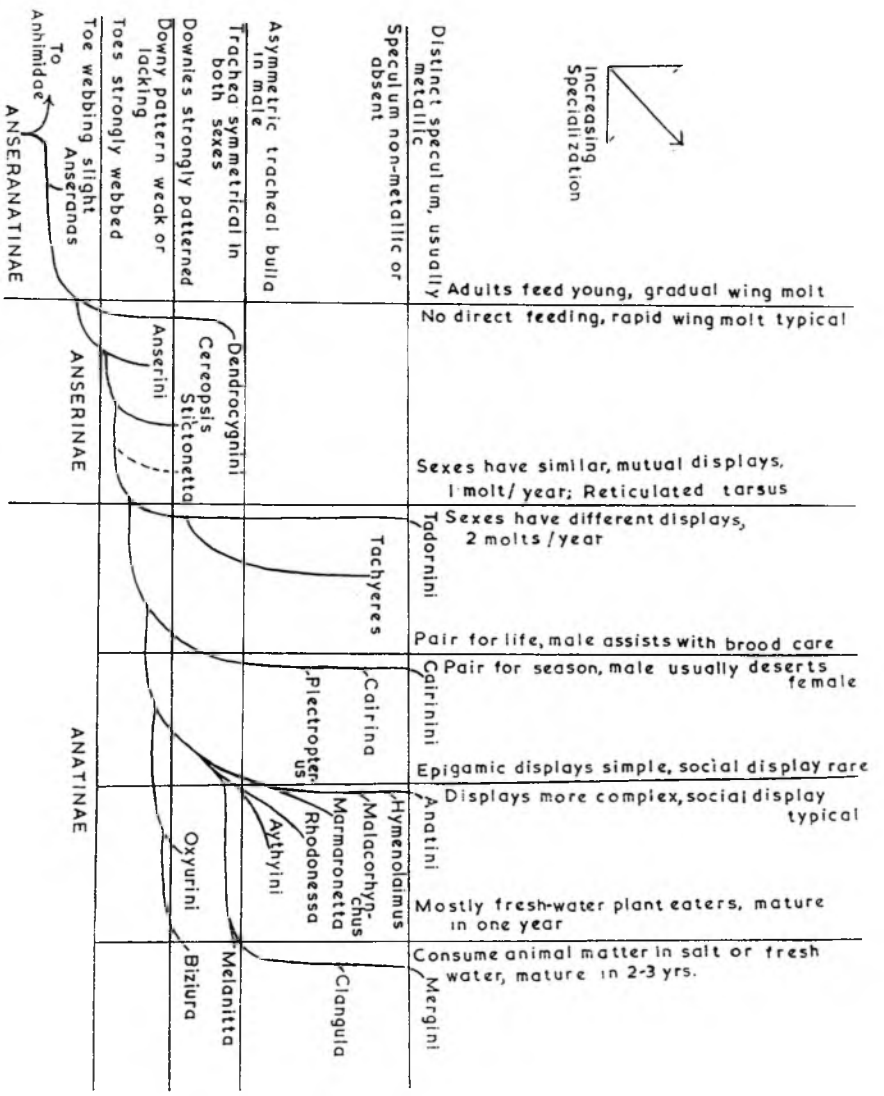


Table 3. Trends in behaviour and morphology of the Anatidae superimposed on a simplified evolutionary tree.

but is ritualized in some of the sea ducks. Drinking, which functions mainly as a greeting, appeasement or courtship display in the perching ducks and dabbling ducks becomes, in pochards and especially in the sea ducks, primarily a precopulatory display. Although Turning-the-back-of-the-head is an important display in many perching ducks, dabbling ducks, and pochards, in some sea ducks it is supplanted by lateral Head-turning and in the typical stiff-tails has been apparently lost.

Discussion

An attempt has been made to summarize in graphic form as many as possible of the trends discussed above, the result of which is shown in Table 2.

As in Table 1, the taxa are arranged vertically across the top of the diagram in what I consider to be the most suitable linear sequence. Behavioural or morphological characters shared by several species or genera are indicated and bracket the appropriate forms, with exceptions or questionable cases noted. Unfortunately, a surprising number of questionable points still remain, some of which can and no doubt will be resolved in the foreseeable future. Nevertheless, the major trends of evolution in the family are clearly evident, and even with additional study it does not seem likely that the concepts presented here will need to be drastically altered.

An alternative means of summarizing the behavioural and morphological trends in the family is presented in Table 3, in the form of a simplified evolutionary tree over which has been superimposed a two-dimensional key of morphological and behavioural characters. This tree is basically the same as was used for illustrating tracheal trends (Johnsgard, 1961e), but both are highly simplified and are not intended to replace the more comprehensive diagram published earlier (Johnsgard, 1961a).

Acknowledgements

This paper was written while the author was being supported by a Public Health Service postdoctoral fellowship. The data were collected at the Wildfowl Trust, Slimbridge, and I would like to state my deep appreciation to these organizations for making the study possible.

Literature Cited

DELACOUR, J. 1954-1959. *The Waterfowl of the World*. 3 vols. Country Life, London.

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

HEINROTH, O. 1911. Beiträge zur Biologie, namentlich Ethologie und Psychologie der Anatiden. *Ver. V. Int. orn. Kongr.*, Berlin, 1910. pp. 598-702.

HOCHBAUM, H. A. 1944. *The Canvasback on a Prairie Marsh*. Amer. Wildl. Inst., Washington. 201 pp.

JOHNSGARD, P. A. 1960a. Comparative behaviour of the Anatidae and its evolutionary implications. *Wildfowl Trust Eleventh Annual Report* : 31-45.

JOHNSGARD, P. A. 1960b. Pair-formation mechanisms in *Anas* (Anatidae) and related genera. *Ibis*, 102 : 616-8.

JOHNSGARD, P. A. 1960c. Classification and evolutionary relationships of the sea ducks. *Condor*, 62 : 426-33.

JOHNSGARD, P. A. 1961a. The taxonomy of the Anatidae—A behavioural analysis. *Ibis*, 103a : 71-85.

JOHNSGARD, P. A. 1961b. The systematic position of the Marbled Teal. *Bull. Brit. orn. Club*, 81 : 37-43.

JOHNSGARD, P. A. 1961c. The sexual behaviour and systematic position of the Hooded Merganser. *Wilson Bull.*, 73 : 226-36.

JOHNSGARD, P. A. 1961d. The breeding biology of the Magpie Goose. *Wildfowl Trust Twelfth Annual Report* : 94-103.

JOHNSGARD, P. A. 1961e. The tracheal anatomy of the Anatidae and its taxonomic significance. *Wildfowl Trust Twelfth Annual Report* : 58-69.

LORENZ, K. Z. 1951-1953. Comparative studies on the behaviour of the Anatinae. *Avic. Mag.*, 57 : 157-82; 58 : 8-17, 61-72, 86-94, 172-84; 59 : 24-34, 80-91.

MCKINNEY, D. F. 1953. Studies on the behaviour of the Anatidae. Ph.D. Thesis, Univ. of Bristol, England.

MCKINNEY, D. F. 1959. Waterfowl at Cold Bay, Alaska, with notes on the display of the Black Scoter. *Wildfowl Trust Tenth Annual Report* : 133-40.

MCKINNEY, D. F. 1961. An analysis of the displays of the European Eider *Somateria mollissima mollissima* (Linneaus) and the Pacific Eider *Somateria mollissima v. nigra* Bonaparte. *Behaviour*, Suppl. VII. 123 pp.

MOYNIHAN, M. 1958. Notes on the behaviour of the Flying Steamer Duck. *Auk*, 75 : 183-202.

MYRES, M. T. 1959. The behaviour of the sea-ducks and its value in the systematics of the tribes Mergini and Somateriini, of the family Anatidae. Ph.D. Thesis, Univ. Brit. Columbia.

WELLER, M. W. 1959. Parasitic egg-laying in the Redhead (*Aythya americana*) and other North American Anatidae. *Ecol. Monogr.*, 29 : 333-65.

Salmonella sp and Clostridium botulinum in waterfowl and sea-birds

F. Steiniger

Niedersachsisches Landesmuseum, Hannover

Food poisoning deriving from duck-eggs provides a well known consequence of the infection of wildfowl by Paratyphoid bacteria. At the present time we can distinguish five hundred to a thousand different types and subtypes of the causative organism, *Salmonella*. It is therefore comparatively easy to ascertain the origin of an infection by typing the organisms concerned.

In the last fifteen years it has been increasingly shown that waters polluted by sewage contain salmonellas which are able, under suitable conditions, to multiply exceedingly. The questions are, therefore, may water birds be infected by salmonellas in these conditions and do they spread the infection to clean waters?

In addition to domestic duck eggs, the eggs of gulls have been especially concerned in outbreaks of food poisoning in human populations. Gull droppings from the harbours on the north and east coasts of Schleswig-Holstein were examined between 1947 and 1951. Salmonellas were found in about one in twenty to fifty samples. In several breeding colonies of gulls and terns in Scheleswig-Holstein, numerous eggs left at the end of the breeding season were found to contain salmonellas.

It is the rare exception for the eggs to be infected while in the ovary. More usually the eggs are contaminated with infected faeces when being laid. During incubation the salmonellas can usually be detected inside the shell after six days. They increase very rapidly and usually kill the embryo between the eleventh and fourteenth day from the start of incubation. This timing evidently depends solely on the rate of increase of the salmonellas. It is the same whether the bird has a long or short incubation period. If the egg is not incubated the salmonellas do not reach the interior of the eggs until after three or four weeks. It is rare for duck eggs to cause food poisoning as they are usually eaten before the salmonellas pass through the shell. In this respect, a few days incubation is more dangerous than prolonged storage at 68°F.

In Central Europe fluctuations in the frequency of several types of salmonella have been noted equally in man, in polluted waters, in rodents, and elsewhere. In 1945 *Salmonella paratyphi B* was common everywhere. Gulls, and Shelducks also, sickened from it or were proved to be carriers. In 1949 and 1950 *S. panama* appeared as a relatively new form on the North Sea coasts, where it was equally frequent in gulls and ducks, the latter's eggs causing human food-poisoning. In 1952 *S. paratyphi A* became relatively common in sea bird colonies. A subsequent increase in *S. bareilly* caused an epidemic of over 10,000 cases amongst people in Western Germany. This form had seldom appeared in Central Europe before but became very common in seabirds and was clearly spread by their migrations. Thus *S. bareilly* has been detected in migratory gulls, terns, ducks and mergansers from the Spanish Mediterranean coast to the German North Sea and Baltic coasts. In 1956 it was found on Röst Archipelago, the westernmost of the Lofoten Islands, North Norway, and in various kinds of terns on the Upland Archipelago in Sweden. In 1957 it was detected in breeding places on Lake Manyas

near Bandirma in Anatolia, Turkey; in 1958 in ducks wintering in the city of Stockholm and in Sandwich Terns passing down the west coast of Schleswig-Holstein and of Belgium. In 1959 it was found in Sandwich Terns on the west coast of Ireland.

From 1955 to 1957, *S. perisacola* appeared in birds in Western Germany, without any parallel outbreak of human disease. From 1957 to 1959 *S. typhosa*, a form often found on and in gulls' eggs, became increasingly common. In 1958 *S. blockley* turned up rather frequently and in 1959 it was *S. manchester* which caused, for instance, mortality among gulls in the estuary of the Weser and food-poisoning in Bremen.

All these variations in the incidence of the various types of *Salmonella* could be traced not only in the water samples but also in the addled eggs and dead chicks in gull and tern breeding colonies. Certain of the tern colonies on the island of Scharhörn off the mouth of the Elbe and on the North Fresian island of Amrum have produced no offspring since 1956 because of salmonella infections, detectable in the faeces of the adults and on the egg shells. At hatching time the terns abruptly deserted the colony (usually after periods of bad weather between the 18th and 24th of June), so that all the embryos as well as the newly hatched chicks died. The desertion was sometimes extraordinarily sudden, occurring in a few hours. The terns, especially *Sterna hirundo,* founded a new colony about a mile away and laid some eggs. These were however stolen by gulls against which the terns put up little defence.

The month of February, 1956 threw much light on the relation between wildfowl and salmonella infections in severe frosty weather. Numerous Tufted Duck, Scaup, Goosanders and Coots gathered on the coast of Schleswig-Holstein from the open Baltic up to the sea-ports. They stayed wherever warm waste-water flowing into the harbours or bays prevented ice from forming. Here many perished though bird-lovers fed them with stale bread. On post-mortem dry pieces of bread were regularly found stuck fast in the throat above the clavicula. These could have choked the birds, but on the other hand gut-inflammation through salmonella infection was sufficient to have caused death. While the two events may have been only coincidental, it is more probable that ducks already weakened by the enteritis were unable to swallow large pieces of food. The sewage effluent was always found to contain many salmonellas and the food given by bird-lovers was not only unsuitably hard but contaminated by the disease organisms. Great Black-backed Gulls which killed the exhausted and eviscerated the dead themselves succumbed to salmonella infection.

In Britain and Ireland it is clear that losses from salmonella infections in water birds and waders are radically lower than in the Mediterranean, Central European and Scandinavian areas. This may be a consequence of the extremely hygienic methods of sewage disposal in Britain. Certainly it is always striking, from the Central European point of view, how little interest there is in Britain concerning the importance of salmonellas in the conservation of water birds. Salmonellas likewise seldom occur in human food in Britain. This is in strong contrast to the situation in Central Europe as well as in the United States, where by 1954, no food products that included fish-meal, carcass-meal, bone-meal, etc. were free of salmonellas. The wide spread of salmonellas in the raw materials of fodder began some years earlier in the United States than in Central Europe, corresponding to the greater importation

of these materials. It has been found that fish-meal prepared from fish caught off the coast of Angola contains nearly the same salmonella types as those which were responsible for the failure of breeding by terns on the German islands of Scharhörn and Amrum. As many of these terns winter on the West African coast it is a moot point whether they carry the infection to Angola or acquire it there in the first instance.

In 1959 the author made an excursion across England and Ireland to gather material for comparison with that from the other areas described above. Samples of birds' faeces were collected in widely varying sites, frozen and subsequently examined bacteriologically. The methods used, growth on Selenit broth, followed by plating out on Wilson-Blairs' agar, have proved satisfactory over the past fifteen years. It was expected that in the enclosures of the Wildfowl Trust rare salmonellas would be found, since the birds there come from all over the world. The actual results were surprising. Although the Trust's records showed that salmonellas had, on occasion, appeared in the past, not one of the 2240 faecal samples collected over the course of three days contained a single strain of salmonella! Neither could salmonella be cultured from mud-samples taken from the Severn. The results are the more remarkable in that numbers of gulls frequent the enclosures and also that some of the artificial food contains fish-meal. If you attempted to keep such a concourse of wildfowl in Germany, on the estuary of the Elbe, for example, whether in the open or in aviaries, you would be certain to have heavy losses through salmonella infections. The favourable bacteriological condition of the New Grounds is thus a big factor in the successful keeping and rearing of wildfowl that must not be underrated.

In fact salmonella were not detected in bird faeces in any of the places visited in England. In Wales a solitary exception was among the Herring Gulls in contact with the sewage effluent of the port of Little Haven. On the west coast of Ireland infections were detected at only two points. One was from a flock of gulls near a sewer mouth in south Galway, the other from the droppings of Sandwich Terns nesting on an estuary near Lahinch, Co. Clare. Undoubtedly this happy state of affairs stems from the great care exercised in the hygienic disposal of sewage. The strict control on fish-meal imports may also play a part since food poisoning is seldom traced to duck eggs.

Besides salmonellas, the organism *Clostridium botulinum*, causing botulism, plays a certain role among wildfowl on the North Sea coast area. In the United States botulism is much more widespread in wildfowl. Here sick duck are sometimes saved by treatment with an antitoxic serum. A more general remedy is to raise and lower the water level at the source of an outbreak. This floats away matted vegetation and brings it into contact with oxygen. The infective organism is an anaerobe and develops fastest when its substrate is covered by sand, etc. There were large-scale die-offs of Shelduck in 1947 to 1949 around the island of Scharhörn off the mouth of the Elbe. They coincided with stormy periods which by stirring up buried vegetation could have brought the infective organisms into contact with the ducks' food.

In November 1951 there was heavy mortality among Shelduck along the North Sea coast from Hamburger Hallig to the island of Nordstrand off Schleswig-Holstein's western coast. At least 1,500 Shelduck died there after a period of very stormy weather. The dead birds were driven ashore, their necks bent down in front. This is a typical posture of botulism resulting from

convulsions in the muscular system. The heads and beaks were thus forced deep in the water and death was caused by drowning, the lungs and air sacs being full of water. Although the condition of the birds was good, their viscera were almost empty. *Clostridium botulinum* could be detected therein though this is not absolute proof that the organism caused death for it is widely distributed and may be found in healthy birds.

In August and September, 1954 there was much mortality on the Knechsand area, five miles south of Scharhörn, and Goethe (1961) has estimated that 12,384 Shelduck died. In this case the deaths were attributed to the bombing by RAF planes on the practice range established there by agreement with the German authorities. However, the mortality again followed a period of stormy weather and observers reported that dead, drowned birds showed no signs of injury. The author was unable to carry out examinations in the Knechtsand area so no definite statement as to the true cause of death can be made. However there are obvious parallels between this catastrophe and the earlier mortalities in this general area in which botulism was probably concerned. It remains possible that the bomb explosions could cause indirect mortality by disturbing and exposing contaminated material.

Reference

GOETHE, F. 1961. A survey of moulting Shelduck on Knechtsand. *Brit. Birds* 54 : 106-15.

TRAVELLER'S TALES

The wanderings of a sailor

Admiral Sir William Tennant

ALTHOUGH it may sound rather contradictory to be a keen shot and a bird lover at the same time, I must plead guilty on both counts. A naval officer abroad can have tremendous fun with a pair of bird glasses and a gun and a fishing rod.

Some years ago in the Gibson's estancia in the Argentine South of Buenos Aires three of us with fishing waders on went into some marshy country with lagoons and got about fifty duck in an hour. There was a great variety, including many of those to be seen in the South American Pen at the Wildfowl Trust, such as Cinnamon Teal, Rosy-bill, Brown Pintail, Red Shoveler, and Chiloe Wigeon. I am talking of 1924 when we took the Prince of Wales to the Argentine—the whole country abounded with game and wheat straw was often 8 foot high.

A few years later I was Commander of H.M.S. "Sussex" in the Mediterranean and when the ship was at Phalerum Bay our Consul-General, a Mr. Bailey, took us up country to the Thebes district and we shot snipe in the valley of Chaeronea where Alexander the Great won his spurs in 338 B.C.! I took Harry Ross-Skinner of the H.L.I. then stationed at Malta and we had two very good days snipe shooting at Lake Copais and got well over 100 snipe. People seldom tell you what rig to bring with the result that we appeared in shooting shoes while we found the locals in fishing waders. There was a terrific lot of water about which was just not frozen. We had a lot of fun, but my feet got so cold that I began to wonder how much longer my legs would support me.

Another snipe shoot was in Ceylon—literally at the opposite end of the thermometer to the shoot in Greece. Here the problem was to wear sufficient clothes to prevent the recoil of the gun biting into one's shoulder. We shot in paddyfields at high noon in the neighbourhood of the great Tanks—they are enromous reservoirs built about 460 A.D. and one of the biggest contains seven square miles of water built to supply the ancient capital Anuradhapura fifteen hundred years ago. But to return to the snipe, we found a lot and our trouble that day was not frozen feet but a gun so hot than one could barely hold it.

We ate them on board the next night and just in time. Dead birds and dead humans have to be dealt with pretty quickly in that climate.

Now to take you to the other end of the world I would like to tell you of fascinating visits to the Falkland Islands and South Georgia.

The Falkland Islands teem with bird life and the first afternoon I got Bert Fleuret, the Government Ranger, to take me to see the nearest Penguin Rookery. We went on foot from Port Stanley, an easy walk, to see some hundreds of the Gentoo Penguin congregated during their moult on a bit of moor not far from the sea. A wonderful sight and well worth crossing the Equator for. The birds were comparatively tame, and let one get within a few yards of them, but when they did shuffe away I am sure they used most shocking language at being disturbed! During our walk we visited a sandy cove and had the greatest luck in coming on a leopard seal asleep. He is a great killer and feared by small boat fishermen. He is about twelve foot long and has a lovely leopard-like fur. He was very cross when we woke him up and lost no time about getting back to the sea. In the evening I was at a dance at Government House dancing with a local girl of Port Stanley, the Capital, and really the only town in Falkland. I mentioned, by way of conversation to the maiden, what attractive surroundings she lived in and how I had enjoyed seeing my first penguins only a mile or two away from Port Stanley. She looked at me pretty blankly and said "Oh! I've never seen a penguin." I was relieved when the band started again and I said goodbye to the lady for ever, but then she probably thought that anyone coming to the Falkland Islands and then going to look at penguins needed their head looking at!

On other occasions I went mounted with Bert Fleuret and with sandwiches in our pockets across the islands to less frequented parts. His ponies were broadbacked like Iceland ponies and utterly sure footed, if you left their heads alone. Their principal use was to take a nurse or a doctor across the

moor and bog to outlying farms if a baby was on the way, or someone was very ill. Fleuret told me that on the darkest night they would take you right across the islands and never put a foot wrong.

On one of the expeditions he took me we went to a Rockhopper Penguin Rookery and sat down on the edge of it to have our lunches. They are the most fascinating little chaps and the tamest. If you can think of a two months' old middle white pig, with a white tummy, and walking on his hind legs, you've got something awfully like the Rockhopper. It really seemed when we sat down to lunch that they made bets with each other as to who would get nearest to us. The winner, if such was the case, certainly came within two feet.

South Georgia, although it is in the same latitude as Hull, is in the mouth of the Weddell Sea where the cold reaches a long way north. The mountains in their midsummer, when we were there, were mostly covered with snow and the glacier at the head of Cumberland Sound remained as a vast wall of ice. Wild life here was fascinating. Reindeer imported fifty years ago still flourish. Giant Petrel and Wandering Albatross and strangely enough near these giants the little Antarctic Tern were nesting there, and around the whale factory the Cape Pigeon were in thousands, scavenging the refuse, fighting for every mouthful with various gulls and petrels. Alas, I had no time to get to the other side of the Islands and see the rookeries where King and Emperor penguins are to be found and Neil Rankin made his great bird expedition and more recently the Duke of Edinburgh in " Britannia."

On the way home let us stop in Egypt for that country is still a mecca for the ornithologist and the keen wildfowler. King Farouk and Lord Killearn, the Ambassador, each had shoots where over 1,000 duck would be collected by 6 or 7 guns in a few hours. I personally preferred the smaller bags, such as the Peels used to lay on in the Delta behind Alexandria. We used to leave home about 2 a.m. and drive to the edge of the Delta and then be rowed by our boatmen to a barrel sunk or moored and get there by about 4.30. Shortly after that the first sign of dawn would appear and someone far away—perhaps some miles—would fire a shot and the duck would begin to move. Such great flocks appeared in the distance that they blackened the sky. It was great shooting — generally difficult shots — Teal, Pintail, Shoveler and of course lots of Mallard and Wigeon and some Pochard were the principal kinds we collected.

Bags between three of us were generally between 50 and 80 duck—Quite enough! But we mustn't leave Egypt without a word or two about bird-watching. I used to ride every morning early on Smouha race course and there found quite a flock of Pratincole which fed every day there for weeks. By some of the canals and lagoons my wife and I found herons, bitterns and the Great Reed Warbler, Blue-headed Wagtails, Stilts, Flamingoes and Spoonbills and a great variety of waders.

In our Admiralty House garden a tremendous variety of birds we know so well at home and many others all passed through. A nightingale would sing its lovely song from the middle of a thick bush of Euyonomus, while most of the European warblers and Stonechat and other chats came through. One day my wife spotted a Wryneck resting in the garden. But it is high time that the reader was taken back home to hear his own Thrush and his own Garden Warbler or Blackcap, which take a lot of beating.

In search of ducks in South America

Christopher Sellick

Patagonia

WE began losing height and there below us lay a large lake whose waters were being whipped up into great waves by a wind which had given us all a rough ride from Rio Gallegos to Punta Arenas. But on the west shore of Lago Cisne where the water was sheltered and calm, we saw for the first time the Black-necked Swans after whom the lake is named. There was a vast raft of a thousand to fifteen hundred birds, some with their young broods around them.

Thirty-six hours earlier, we had been enduring the heat and humidity of Buenos Aires in late January where Kit Savage and myself had met Colin Schwerdt, the third member of our expedition. He had travelled from England by ship bringing all the equipment necessary for a three month expedition to Argentina and Chile. Now as we began our final run into Punta Arenas over Porvenir and the Magellan Straits we had all seen one of the most majestic of all waterfowl in their natural surroundings and in numbers only to be found on the Lake of Swans.

Soon after our arrival in Punta Arenas we met the Huntleys without whose help and encouragement our stay in Patagonia would have been far less enjoyable. After a day or two satisfying all the various officials of our good intentions, we soon found ourselves driving out to Estancia Pecket which is one of the many estancias owned by the vast farming company of Sociedad Explotodora de Tierra del Fuego at present managed by Bobby Huntley. Amongst it's many varied activities it has flocks of sheep amounting to the enormous figure of nearly one million. The history of this company is a story in itself, which will perhaps be told one day.

On our way north by car we passed through a semi-arid type of country which was in the process of being improved by ploughing and re-seeding. We were surprised to find so little bird life except in places where there was a little pool or river. Here a few Magellan Geese were grazing and one usually flushed a pair or two of Crested Ducks or Southern Silver Teal. As we entered Estancia Pecket suddenly in front of us lay a string of lakes. The track ran along the southern boundary of these lakes, which were nowhere wider than about six hundred yards, and in this secluded setting there was a mass of bird life. The commonest ducks here were the Brown Pintail and Chiloe Wigeon, then the Chile Teal and Crested Duck. As we drove along great flocks of Pintail rose from the grass around us and alighted out in the lake. On the far side were Black-necked Swans, Coscoroba Swans—a much rarer bird than the Black-necked—Flamingoes and the odd flying Steamer Duck. All around these lakes there were flocks of Upland Geese, with a thin sprinkling of Ashy-headed Geese. We did not see Ruddy-headed until we moved over to the Pacific side of Patagonia. At last we could say that the long months of preparation and the many hurdles which had to be cleared before we found ourselves in South America had been worth while, for we were all amongst the birds which we loved in a part of the world which still holds so many secrets and is unspoiled by modern civilization. As we drove up to the farm house in the evening light, across our path cantered a family group of Darwins Rheas with the youngsters looking all legs and their spidery fluffy

feathers flying in the wind, and within twenty yards of the windows of the house there were Antarctic Skuas and the Diving and Antarctic Petrels.

We were soon to meet Garcia, who was the Manager of Estancia Pecket and who was to be our host. As with all whom we met, nothing seemed to be too much trouble for him and after dinner we discussed our plans for to-morrow. It soon became obvious that we should devote most of our time here to catching the Crested Duck and if such ducks as the Red Shoveler or Versicolor Teal came our way so much the better.

During the following days, after much frustration and only an average amount of luck, we managed to catch as many Crested Ducks as we required and one pair of Red Shoveler. We had been warned that the continual wind which occurred in this part of the world would tend to keep the nets blown out and tight, and that any birds hitting the nets would bounce out rather as a tennis ball from a racquet. This we found to be only too true, so we had to adopt a Persian method of catching ducks, which we had seen practised in that country during our visit there a few years ago. This involved setting the net in such a way that as the birds flew low over the water, the net could be lifted quickly in their path. After we had perfected this method we soon found that in calm weather it was very nearly impossible to catch any birds, mainly because they all flew too high, and it was only in rough boisterous condition that we had any success.

During our long vigils at the net, which was manned the whole time that it was set, we came in intimate contact with the bird life of Patagonia. Apart from all the waterfowl which I have described, there was a thrush-like bird with a black head and tail and yellow bill and breast, the Military Starling, and a small chestnut and grey sparrow. The Military Starling is very common and is an impressive little bird as it struts about searching for food. There were three or four species of Plover, including the Spur-winged and Slender-billed, and the very beautiful Fuegian Oystercatcher. But Patagonia is of course particularly rich in the birds of prey. There are many different species of hawk and eagle, the most common being the Carancho. The Chilean Eagle is a magnificent and noble bird but not until we moved to the Island of Riesco did we see this in it's more characteristic environment of trees and forest. The Ashy Harrier is uncommon, but is occasionally seen. Owls, though common in certain areas, are of course not to be seen so much during the day. When we moved west we came across two—the Short-eared and Horned Owls and of course the parrots, but more of these later.

Before we left Pecket, we asked Garcia whether it was possible to get a closer look at Darwins Rhea. To our surprise he told us that he would bring one for us to see the next day. These birds are extremely wary and travel very fast when disturbed and we wondered how he was going to accomplish this. While we were having breakfast on the following morning Garcia drew his truck up in front of the homestead and jumped out holding a Rhea. We were very intrigued to discover how he had caught it and eventually persuaded him to take us out the following day.

Patagonia being sheep country there were of course a great number of dogs kept to help the shepherds with their work. Very rarely did one find a pure bred Collie or other well known breed but rather they were of very mixed inheritance and usually all the better for it. Garcia was the proud owner

of a remarkable dog of no known pedigree without whom he would have been lost. It was with the aid of this dog that he was able to catch Rheas.

The next day was again fine and quite warm—we had been very lucky with the weather so far—and after lunch we all drove out in one of the estancia trucks into a paddock of perhaps 600-700 acres. After a short while a herd of Rheas was spotted and as quickly as possible we pursued them in the truck until about two hundred yards away. The dog then took up the chase until he had herded two or three together as if they were sheep. By continually circling them he got the Rheas to sit down and there they were when, out of breath, we caught up with them a short while later.

The adults are about five feet from head to foot. During February and March the families tend to gather together, three or four pairs with all their progeny making perhaps a flock of twenty five to thirty birds. Their plumage is a dirty brown grey in colour and extremely untidy. When facing into the wind they could possibly be called presentable but when the wind gets underneath their feathers they look very comical.

During our frequent trips into Punta Arenas we had met Kenneth Maclean, the manager of a delightful estancia owned by Colonel De Bruynne on the west side of Patagonia. Rio Verde is about 24,000 hectares (nearly 60,000 acres) and is situated on the Fitzroy Channel, which leads into the Pacific. There are four in the Maclean family—two boys and two girls, the boys Roderick and Robin being very keen ornithologists. Roderick had seen the Bronze-winged duck on their small farm on the island of Riesco. The possibility that this bird could be seen within 60 kilometres of where we were proved irresistible, and so on the next day we left the Atlantic and an hour later were on the shores of the Pacific.

The island of Riesco is partly wooded and as a consequence the bird life was different from what we had already seen. Practically all the raptors to be found in this area were present: the Carancho, Chimango, Chilean Eagle, a Buzzard I believe to be *Buteo polyosoma polyosoma,* the Magellanic Peregrine and a small Kestrel. The Black Ibis was also very common, with it's strident call which can be heard from a long way away. Parrots were everywhere and a most attractive woodpecker which was black except for a flame red head. These birds seemed to be found in colonies, for one could go for days without spotting one and then all of a sudden twenty or thirty would appear as if from nowhere, clinging to the sides of the trees and uttering their squawking cry. Here too we found Magellan Geese breeding amidst the rich verdant valleys which surround the little streams that feed the lakes on the island.

The year before, Roderick had seen the Bronze-winged duck on a stream which drained one of the many lakes of this island and so on the next day we set out with high hopes of seeing this remarkable bird. After a while, when we were all wondering whether perhaps it was too much to hope that these birds would be in the same place a year later, there was a cry of ' Pato Perro ' from the shepherd, and there weaving between the trees was the unmistakable Bronze-winged Duck. The bronze flash of the wing speculum and the characteristic dog-like bark immediately proved beyond all doubt that our ' wild goose ' chase had not been in vain. On rounding the next bend in the river, there was a pair sitting on the water and we could examine in detail these rare birds. The most outstanding feature is of course the white patch on the cheek and also one on the neck and throat. Both the male and female are

similarly marked and apart from these white patches are generally blackish brown with the scapulars black and the tail purplish-black. Not until they fly does one notice the very beautiful large bronze speculum which flashes in the sun as it seems to mirror it's rays.

Having established camp, we began to get down to the serious business of catching and filming these birds. On the next day we rigged a net across the stream where we had seen the duck and with high hopes took it in turns to keep watch. Our daily rations were brought up to us on horseback from the Macleans farm and it seemed that half a sheep was always included. Roderick stayed with us the whole time and his intimate knowledge of the country and of the Spanish language proved to be very valuable.

Meanwhile we had rigged a further net across a narrow neck of the lake immediately below the camp site. Here we had seen a great number of Red Shoveler, a plentiful supply of Ruddy Ducks and two pairs of Bronze-winged Duck, and we felt that our luck would indeed be out if we were unable to catch any of them. During the days of waiting and watching I was able to explore and film the surrounding country and some of it's birds. The Bronze-winged Duck proved to be extremely difficult to approach and not until we had moved 1500 miles north, to the High Andes and the territory of the Torrent Duck, did I manage to approach close enough to film them.

We generally chose mid-day to regroup, eat and discuss plans, for it was then that there seemed to be least activity going on in the bird line. Late one morning as Kit and I reached camp in a very pessimistic frame of mind Colin emerged from the tent with the news that he had caught a Bronze-wing. This was too good to be true and I am afraid we didn't believe him. However we bet him a bottle of brandy—it is cheap in South America—that he hadn't. Eventually, after he had extracted another bottle from us, Colin showed us the four Bronze-winged Ducks which he had caught with one throw of the net. We were elated and as far as I was concerned this was one of the great moments of the whole expedition.

Soon after this we left Riesco, for we had been unlucky with our other nets and the weather was turning wet and cold. It was a sorry departure from a wonderful island with the characteristic cry of the parrots, which sounded so very like ' Pato Perro,' and from the haunt of our first Bronze-wings.

We crossed to the mainland and spent the night at Rio Verde where the whole farm was in the throes of preparing sheep for the great show at Punta Arenas. This agricultural show is held every two or three years and is the largest showing of Corriedale sheep in the world. Buyers come from all over South America to purchase sheep here and this year there were even representatives from Australia, where the breed originated. Reluctantly we left the Pacific coast and returned to Punta Arenas prior to the second stage of our expedition, which was to be spent in the central and northern part of Argentina.

Soon after we arrived in Punta Arenas *H.M.S. Protector* docked, back from a trip to the Falkland Islands. Due partly to shortage of time and lack of opportunity we had been unable to visit any of the Penguin rookeries to be found in Patagonia and Tierra del Fuego. This omission was put right when, through the very good offices of the captain, we were given a ride to the island of Santa Magdalena in one of their helicopters. This trip was exceedingly

exciting and nothing we could have done will repay the kindness which was shown to us by the captain, our pilot, crew and all the ships' company.

We took off from the deck of the ship under difficult gusty conditions and after circling the town, made out across the Magellan Straits at about 1500 feet. Twenty minutes later we were having an aerial view of one of the largest rookeries of Magellan Penguins in the world. As we flew over the island, we could see numerous Sea Lions, which trundled in to the sea at our approach. Kelp Geese were quite numerous on the east side of the island and as well as the multitude of penguins which scuttled into their burrows or stood just watching us circling, there were other sea birds in their thousands. On the cliffs and wheeling over the sea were Scoresby Gulls, a beautiful delicate grey little bird with bright orange bill and legs and the Brown-headed Gull, which reminded me of our Lesser Blackback. There were Cormorants by the hundred—I believe at least two different species—and also two different species of Skua—the Antarctic and Arctic. We believe that we might have seen a Black-browed Albatross but it was too far away for absolutely positive identification. All around the cliffs there were dolphins playing—great packs leaping and turning in the water. We had seen some earlier from the house of Senor Richardo Braun-Menendez, on the Atlantic coast of Patagonia, in very clear and shallow water. The water was in fact barely deep enough to cover their backs and it was difficult to see why they had come so close inshore. We were told that in the great masses of weed growing in the shallow water were numerous fish which were a popular dish for the dolphins. This may well have been true, for not only did they burrow into this weed but on occasions leaped out of the water and landed in the middle of it. The rest of the school would be close behind and excitement grew when the weed was disturbed.

The penguins on Santa Magdalena nest in rabbit holes, of which there are a vast number all over the central portion of the island. Most of the young penguins were looking very untidy, with their baby fluff half on and half off and with their adult plumage appearing in places on their bodies. However in spite of their immaturity they were as quick in the water as the adults, and perhaps even a little more agile on land. The rabbits which have kindly supplied the penguins with their nurseries have all now disappeared, having been wiped out by myxomatosis.

After a short time the penguins became quite used to us and we found that they could be approached very easily. On the other hand the sea birds, directly we appeared nearby, took off and with ear splitting cries and shrieks circled around us in their thousands registering protest at our interference with their privacy. But it was the penguins that captivated me—they are so very comical when they waddle about on land looking so business-like and serious. However, directly they have clambered, slipped and fallen over the rocks and stones of the shore and are in the water they lose all their ungainliness and become one of the most agile creatures of the sea.

The time we spent on this fantastic and never to be forgotten island, which because of it's remoteness was undisturbed by man and where so many species of birds lived in such profusion, drew only too quickly to an end and soon we had to return to Punta Arenas where the helicopter was due back on *H.M.S. Protector* as she was steaming up the Magellan Straits.

So ended our trip to Patagonia. As we boarded the plane on the following morning on our way to Buenos Aires where we were to start on our visit to

the central plains of Argentina and the Chaco, we all felt that before long this wonderful part of the world would irresistibly drag us back and that perhaps we would see again the ' Uttermost Part of the Earth.'

Central and northern Argentine

Mid-February in Buenos Aires is still very hot and after two days spent in this city of one way streets we were glad to be on our way west to visit an Estancia belonging to Peter Miles, at Venardo Tuerto. We had hired an Estanciera, a locally manufactured Jeep station-wagon, in Buenos Aires and with our equipment filling all corners of this vehicle, we started our six hour drive to the pampas of Argentina. It takes a long time to leave the built-up area of the capital, but once clear we soon found ourselves in flat country which seemed to stretch endlessly in all directions. Over the whole country there was a thick haze caused by the heat of the sun and so the visibility was severely restricted. As the sun went down and visibility improved, one began to appreciate what is meant by the Argentine pampas. The whole of the central portion of this enormous country is like a billiard table and as far as one can see in all directions the land is level, the only things breaking the skyline being a belt of trees or perhaps a town.

We entered Venardo Tuerto as it was getting dark, to find that on the previous day a hurricane had caused tremendous damage to the surrounding country. It had torn telephone poles out of the ground, uprooted vast areas of trees and damaged houses and buildings. The wood surrounding the home of Peter Miles was a ghastly mess with half the trees either destroyed or badly damaged. But in spite of this, we were welcomed by his wife and himself and were soon planning stage two of our expedition. We decided to spend three or four days around Venardo Tuerto and then to drive north to the Chaco to visit an Estancia owned by La Forestal and run by Robin Welch.

I was woken on the next morning by the most impressive dawn chorus that I have ever heard. All around the house there were Oven-Birds singing from the trees. We were to hear them wherever we went in central Argentine. They have a highly distinctive call. It is a cry which one associates with a certain place, just like the call of the Long-tailed Duck of Iceland or the Black Ibis of southern Patagonia. The nests of these birds are to be seen everywhere—spherical and made of mud, very often on top of fence posts or supported on the T's of telegraph posts. Directly it rains the oven birds get down to house building and the speed with which they work is unbelievable for as soon as the puddles dry out, which often only takes a few hours, all work has to stop and cannot begin again until there is a further fall of rain.

As soon as one leaves the immediate area of the towns and main roads the first thing that impresses one is the abundance of bird life. Where in England one might see a dozen birds here, especially in and around the marshes which dot the countryside, one would find hundreds.

Our plan was to spend a few days exploring the marshy area called San José not far from Venardo Tuereto. Here there were three or four shallow lakes varying in size from about thirty acres to two or three hundred. There were vast reed beds around these lakes consisting of reeds eight to ten feet tall, which stood in water about two feet deep, and could be waded with comparative ease. We expected to find many interesting birds in this area and were not disappointed. Having set up camp, we quickly made a preliminary reconnaissance and soon found Rosybills, which were perhaps the commonest

duck, Versicolor Teal, Cinnamon Teal and Black-headed Ducks. On one pond we found thirty or more Black-headed Ducks and so decided to concentrate our efforts during the following days on filming and perhaps catching them. This duck is now generally regarded as being in the tribe Oxyurini and from our observations seemed to behave very similarly to the other stiff-tails. Various authorities have stated that these birds are very loathe to fly, but we were soon to discover that not only did they fly extremely readily and well, but were very shy birds and difficult to approach. They contrasted very much with the Ruddy Ducks, which seemed to consort with the masses of Coots on these lakes. At first we thought that the proportion of female Blackheads to males was large, until we realised that the female Cinnamon Teal and female Black-headed duck are very similar. Generally the Stiff-tails kept themselves slightly apart from the other ducks and we soon learned to look for the very marked black head of the males when searching for these birds. Egrets were quite common here and were usually found probing the mud in the shallow water, or daintily lifting their long legs as they waded through the duck weed which covered the water on the windward side of the lagoons. There were two species, the large White Egret and the Snowy Egret, which is much smaller and has yellow feet and black legs. We tried over the course of a few days to photograph the White Egret but found it impossible to approach even close enough to be able to use our large telephoto lenses. On the other hand the Snowy Egret was less shy, perhaps because there were generally quite a few together, while the White Egret was usually found by itself.

Every morning and evening, one could imagine oneself back in England on the Lincolnshire Fens as the great flocks of Ibises flew to and from their feeding grounds, just as the Pink-footed Goose flies from the Wash to the potato fields or young corn. The Glossy Ibis was the commonest species and it's strident call could be heard a long time before the skeins appeared in great wavering lines and neat V's all over the sky. There was also the larger Common Ibis, as well as two different species of Heron.

We had hoped to see large numbers of Crested Screamers here, but only saw one which flew off and disappeared as soon as we got within three hundred yards. When we had moved 600 kilometres north we saw this very interesting and wary bird at close quarters and were able to film and catch it, but more of this later.

We also saw an Harrier, I believe the Ashy, and several species of owls, very often sitting on the fence posts alongside the dirt tracks which criss-cross the pampas. In places at least a third of all the fence posts supported an owl, a small hawk, Oven Bird or one of the many hundreds of passerines to be found here.

On the next day we erected two nets—one for Black-headed Ducks and the other for Ruddy Ducks. I had noticed that the Blackheads frequently flew from the open water into the small pools in the middle of the huge reed beds surrounding the lagoon, so we set up nets around these pools, camouflaged by the reeds. Later the same day we put up another net for Ruddy Ducks near one of the islands which studded the open water. The heat made us very lackadaisical and as a result we were pessimistic from the start about our chances of catching these birds. In four days, apart from a lot of Rosybills and Coots and a few unexplained holes in our nets, we failed to catch either

of the ducks which we wanted. We were however able to photograph them and many of the other birds in this wonderful place and so when we had to leave to travel northwards, we felt that we hadn't left Venardo Tuerto completely empty handed.

From Venardo Tuerto, we (Peter Miles, Kit Savage, Colin Schwerdt and myself) set off in two station wagons to drive to Las Gamas, a farm owned by La Forestal and managed by Robin Welch who lives there with his wife Jean, and their two children. The main business of this estancia is producing tannia and raising beef, while we were htere they were having the annual census, which revealed that there were 45,000 cattle and 3,250 horses on the farm. The horses are kept for use by the cattlemen and every so often a proportion of the wild horses are rounded up and broken, as replacements for the older animals.

We arrived late at night after driving 600 kilometers under very hot and tiring conditions. Again, we were soon to discover that the generous hospitality of South America is not confined to Patagonia and that in spite of four very often dirty and scruffy men about the farmhouse, the Welch family went out of their way to make our stay in the Chaco a most memorable one.

The main purpose behind our journey north was to find the Crested Screamer. It is believed that this bird is fairly closely related to the Magpie Goose of Austrila and the Wildfowl Trust was anxious to obtain some for detailed comparative studies. We were also hoping to see the Ringed Teal and the Brazilian Teal, which we had been told were to be seen in the marshes of the Chaco. We discussed our plans with Robin Welch and, although it appeared that there were not very many Screamers nearby, he thought that we should with luck find a few.

On the next day we explored the marsh near the house and soon found Screamers in one's and two's, mostly standing in water which was about a foot deep. The marshes were very difficult and tiring to walk over, for the mud had been pock-marked by the cattle and horses and one was continually stumbling into these holes. However during the course of the day we saw quite a number of Roseate Spoonbills, Flamingos and again the Black Ibis and the small Snowy Egrets. But it was the Screamer which interested me. The bird is about the size of a Turkey and very much the same shape but with longer legs and a crest on it's head. It is grey all over but has reddish patches on its cheeks. I was later to discover that although the bird appeared to be large it was very light, perhaps only weighing six to eight pounds, with a thick cushion of air under it's skin. It also possesses two vicious looking spurs on each wing, which we found to be extremely dangerous, although I believe they are rarely used when fighting other birds. The long spur projects from the wing shoulder and is about two inches long and the shorter one is about half as long.

The Screamer is a very graceful and agile flyer and loves soaring under suitable conditions. When moving from one side of the marsh to the other, it gains height with a few quick wing beats and then glides for long distances before again flapping and gaining more height. They are not often seen soaring but when they do they fly to great heights with effortless ease.

On the next day, after visiting the large factory belonging to La Forestal, which extracts tannin from the local Quebracho wood that grows in this area, we boarded a small motor trolley that was used on the private railway, which was the only link to the outlying portions of the estate. We quickly moved into a more remote region and after passing numerous charcoal burning beehives,

suddenly found ourselves passing through a marsh where we at once saw a number of Screamers. Most of the birds were quite close to the railway line and at least thirty were perched on two or three trees. This was the first time that we had seen these birds perching, enhancing their resemblance to the Magpie Goose. It soon became obvious that this was the place where we should try to photograph and catch the Screamer, especially when we saw a few moments later a flock of about sixty Ringed Teal wheel around and settle on the edge of a little pool in the middle of the marsh.

We spent three or four hours here exploring the possibilities of catching the Screamers, but quickly found that during the day it would be very difficult. Their eyesight was extremely good and they could not be relied upon to fly in any one direction at a low enough height for us to be able to set a net. It did in fact take me nearly two days to photograph them, and even then I was unable to persuade the birds to approach any closer than a hundred yards. A few years previously, Kit Savage and I had studied the way of catching ducks in Persia by the gong and flare and had accidentally come across a derivation of that method which was used on the plains surrounding Kara Tappeh for catching the Lesser White-fronted Goose. Instead of using a boat on which is mounted the light, and in which, the gonger, netman and puntsman are seated; the Persians, when catching geese, walk over the marshes in line astern with the front person carrying the light, the second the gong and the third the net. This had appeared to be quite successful and so we decided to try out this method, using two netsmen instead of one, walking on each side of the gonger. We had brought the special gongs as used in Persia with us and that night, soon after ten o'clock, we moved into the marsh.

One of the most important prerequisites of catching birds this way, is a night as dark as possible, and we were lucky that there was no moon. From the time that we moved on to the marsh, began one of the most exciting and at the same time exhausting few days and nights that any of us had experienced. It is difficult to depict the scene except to say that we made our base a cattle drover's hut on the edge of the lagoon and as soon as we left the light of their hurricane lamps and walked around the marsh in darkness, we were incessantly tormented by extremely vicious mosquitoes, which were capable of inflicting serious damage even through our canvas anoraks. Coupled with the extremely difficult walking, it wasn't long before we were all wondering whether it was all worth while.

The first essential was to locate the flock of birds but, though vociferous during the day, they were very quiet at night and it took some time to discover where they were roosting. Instead of the more usual bullrush heads soaked in paraffin which the Persians use, we had a Tilley lamp to supply the light. Earlier we had cut away one side of a biscuit tin into which we had put the Tilley lamp so that all the light was thrown in one direction only. Kit Savage was carrying the light and I was with the gong while Peter Miles and Colin Schwerdt wielded the nets. Behind us were Felix Martinez and a friend, who carried the sacks in which we hoped to put the Sreamers if we should catch any.

Slowly we made our way across the marsh, stumbling and slipping on the uneven ground until the sweat was pouring off us, hoping that we were nearing the Screamers. Every few minutes we stopped ringing the gong and paused to locate more accurately the position of the birds. To those who had never seen this way of catching birds before, it must have seemed a strange spectacle. It

would appear to need a particularly stupid bird to be deceived by a noisy procession in the middle of the night, with it's way being lit by a swinging Tilley lamp.

Suddenly Kit stopped and there thirty yards in front of us stood a Screamer. What were we to do now? Wait or go on—go slow or go fast—with quick whispers we decided to creep forward. The light was kept steady, the gong was beaten more furiously and the nets were poised in readiness. Slowly, step by step we moved forward, until only ten yards separated us. Then we realised that beyond this single bird there were a further fifty. With two nets we might catch two, should we disregard the bird which was almost within our grasp. The tenseness and excitement that was affecting all of us, would I felt sure not allow us to give up what now appeared a near certainty for the possibility of catching two birds at one stalk, so perhaps wrongly we decided to concentrate our efforts on the single bird which if caught would frighten the entire flock.

So again very slowly we moved forward until, when about six yards away, the bird began walking towards us. We stopped and stared in amazement, for we saw that not only the single bird was coming, but also the whole flock behind. Then without warning all the Screamers took off and at shoulder level flew straight for us. Our position changed instantly from hunter to quarry and with fifty or so turkey-size birds hurtling towards us we ducked. Too late I shouted to Peter to catch the birds flying, or was it because, 'discretion is the better part of valour,' but the result of our first stalk at Screamers was the same—we ended up empty-handed, but certainly we had gained valuable experience.

The flock was now split up. Having decided upon the direction of our next stalk, we set off feeling that the Crested Screamer could be caught by the flare and gong. With more confidence we made our way towards the source of a noisy Screamer, which was no doubt troubled by it's recent experience and soon were forty yards from a dozen birds. Again we slowed down and crept forward a foot at a time until about ten yards away. It took what seemed to us about ten minutes to cover another six yards and then with a leap forward Peter and Colin with their long twelve foot nets pinned two birds to the ground and so we caught our first Screamers.

For the next few nights we walked the marshes and eventually caught as many Screamers as we wanted and discovered that we could catch anything from Ibis to Spoonbills by this method.

On our frequent trips through the woods around the marshes we came across the Common Rhea, very similar to the Darwin's Rhea of Patagonia but paler brown and slightly larger, many raptors including the Chimango and several species of harriers and kestrels including the Ashy Harrier which we had previously seen at Venardo Tuerto. Perhaps the commonest owl was the Burrowing Owl, which is about the same size as our Little Owl, but there were many other species that weaved their way through the trees in the dusk. In the early morning on a honeysuckle tree in the garden of the farmhouse there were always hummingbirds which darted at incredible speed from one flower to another.

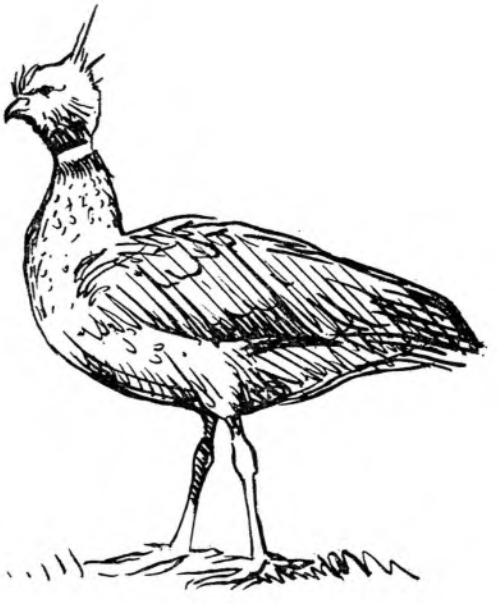
On the next day we were shown how the young wild horses are brought in from the forest land and how they start breaking them for use by the cattlemen. After the initial 'doma,' or buck jumping as it is called, the breaking of these horses is usually fairly easy and quick and it is only a short

time before they can take their place as riding horses. We were also shown the spectacular art of throwing rawhide lassoos, which are of course used extensively by the cattlemen.

Later we drove down to the Parana river where four hundred cattle belonging to La Forestal were being loaded onto a ship. During a most magnificent lunch we discovered from our hosts that on the islands in the middle of this enormous river, there were big colonies of Crested Screamers, and that many of them nested here during the spring. The river was in spate when we were there, because further north they had had torrential rain—in fact about 360 mm. in less than twenty four hours—and coming down the river were vast islands of weed and rubbish, on which we were told, snakes and small crocodiles, with a host of other small animals, journeyed past Buenos Aires to the open sea. These vast weed masses are a continual navigational hazard and the snakes on them a potential source of danger.

Our time at Las Gamas was quickly coming to an end, as on the next day we had to return to Venardo Tuerto and Buenos Aires. We were sorry to leave this very interesting part of Argentina and to say good-bye to the Welch family, who had been so kind to us during our stay on the Estancia.

Two days later, having left Peter Miles, whose help and advice proved invaluable and without whom our trip would have been far less successful, at Venardo Tuerto, we returned to Buenos Aires. Unfortunately Colin Schwerdt had to catch a boat back to England, but Kit Savage and myself later flew to Bariloche, to find the elusive Torrent Duck and to see again the Bronze-winged Duck in numbers enough to make photography a lot easier.



THE NEW WILDFOWLER

Edited by Noel M. Sedgwick, Peter Whitaker and Jeffery Harrison. Published by Herbert Jenkins for the Wildfowler's Association of Great Britain and Ireland. London, 1961. 311 *pp.* 42*s.*

READING the extensive bibliography at the end of this book, one feels that the choice of a title may not have been the least of the authors' problems. The choice made is a fortunate one. This is essentially a book on Wildfowling but with a new approach. Unlike its many predecessors it is not merely a manual of instruction on how to obtain big bags of waterfowl. Big bags are in fact deprecated as being short-sighted, for the thesis of this book is that wildfowl are a legitimate harvest for man to gather, but there can only be a harvest if the husbandry is good. In addition therefore to the chapters on wildfowling, the actual harvesting, many chapters are devoted to conservation, the husbandry, and the book is the product of a team of authors drawn mainly from W.A.G.B.I., the Wildfowl Trust and the Nature Conservancy.

The technique of wildfowling, with the various modifications required on marsh, mere and salting, is described by a group of acknowledged experts. They cover the ground in detail from the acquisition of clothing and equipment to the pursuit and final successful conclusion of the chase when the quarry ends up on a plate—there is a chapter on cooking—or as a skin or mounted specimen, described in a chapter on taxidermy. The authors have achieved with great success the difficult task of giving elementary advice to beginners without appearing to " talk down " to them; at the same time they remain interesting to more experienced readers. The folly of not possessing a compass or a knowledge of the local Tide Table is very rightly stressed. Wildfowling, whatever qualities it may call for, need not be a dangerous sport and many lives have been risked or needlessly lost through failure to take these elementary precautions. There are few of us, as the book remarks, who have not looked at our compass, felt it must be wrong—and found out later it was not! The reviewer agrees than punt-gunning is the most interesting, exciting and probably the most exacting form of wildfowling, but he is not wholly convinced by the arguments as to the smaller number of birds " pricked." Punt-gunning is essentially " browning," which shoulder-gunning should never be, and however strong-minded one is in the matter of suitable shots, there must always be occasions when the near birds are well within shot but the far birds are at the extreme limit of range. All the chapters on shooting are clearly based on first-hand experience and written by men, who by their sound advice and moderation have clearly the welfare of wildfowling at heart.

It is stressed that the main cause of the decrease in the numbers of wildfowl over the past century has not been over-persecution but the increasing loss of habitat and a decreasing freedom from disturbance. Emphasis is therefore laid on the importance of the preservation of habitat, both on a national basis by the formation of wildfowl refuges, and on a local basis by clubs or individuals, who may, either by improving existing sites or by making new ones, provide a safe roosting place or feeding ground for waterfowl. The methods of making these sites attractive, especially by introducing their known food preferences, are described. The rearing of Mallard should present no problems to anyone after reading the chapter on the subject; it is possibly too early to assess the long term effect of artificial rearing on Mallard populations in this country, but the experiment is clearly well worth continuing.