the same; but it is noted that on the Baltic Brent are much more numerous in autumn than in spring (Ptushenko, 1952). In the extreme north, as a rule, the birds fly at night in autumn and do not make long stops (Tugarinov and Tolmachev, 1934; communication of E.P. Spangenberg; our observations).

The wintering area of *B.b. bernicla* embraces the coasts of Denmark, Holland, Belgium, England, Ireland†, south-west Sweden, north-west Germany, north and west France (Delacour, 1954).

The number of Eurasian Brent has decreased during the past half century by at least 90%. Even at the end of the last century Brent Geese were so numerous on the Atlantic shores of central Europe that, according to the model description of Naumann, " the voices of the countless flocks drowned the noise of the sea and their swarms in the distance darkened the sky like smoke." (According to Alpheraky, 1904, p.145). The assemblies on the nesting and moulting grounds were also immense. For example, Birulia (1907, p.120) wrote that in 1901 it was " difficult to state, even approximately, how many thousands of geese assembled to moult " at the mouth of one river (River Kolomiitseva, Gulf of Taimyr, Western Taimyr).

Increased hunting on their wintering grounds and during passage and improvements carried out on a considerable part of the coastal territories of Western Europe long ago began to cause a gradual decline in the numbers of Brent Geese. The decline in numbers became particularly sharp from the 1930's and this, like the decline in numbers of *B.b. hrota,* was linked with the disappearance in the North Atlantic of the basic food of Brent Geese—*Zostera marina**. According to Salomonsen (1955), in Holland, for example, not less than 10,000 Brent Geese wintered annually up to 1931; in 1953 only 1,000 were counted there. According to this same author the number of Brent Geese obtained in Denmark declined from 7,000 in 1941 to 2.500 in 1951. A sharp decline in the number of Brent Geese is also established on their breeding and moulting grounds. For example, in the Gulf of Taimyr, where Birulia observed huge assemblies in 1907, only a few broods were encountered in 1949 while flocks of moulting males and un-paired birds were not met with at all (communication of P. M. Sdobnikov).

The hunting of *B.b. bernicla* on its moulting and nesting grounds does not in general play a perceptible role in affecting the numbers of the birds in view of the extremely small human population in these regions, particularly in Western Taimyr. However, since the numerical strength of the Brent Goose has been very seriously undermined, even a relatively small increase in hunting in the regions of the Far North at once exercises an unfavourable influence. Thus, according to numerous observations made by those wintering in polar stations, there was an especially noticeable decline in the numbers of birds arriving in 1950 and 1951. Precisely during this period (1949-1951) there took place on Taimyr a geological survey and aerial photography which brought into the area a large number of people and thus caused increased hunting of Brent among other species. With the ending of these activities and the decrease in the number of hunters on Taimyr the numbers of Brent became to some extent stabilized.

†Ireland does *not* lie in the normal wintering area (Eds.).

*The destruction of *Zostera* on the Atlantic coasts of Europe was first recorded in 1932 (Zenkevich, 1951).

At present Brent Geese are protected in most regions where they winter. In Holland all hunting of Brents has been forbidden since 1950; in England they have been protected since 1954; in Sweden they have been protected everywhere since this same date except in four provinces. In Ireland hunting Brent Geese was forbidden for a period of three years in 1955 (Salomonsen, 1955).

The Eastern Siberian Brent Goose (*Branta bernicla orientalis* Tugarinow). Apparently the main nesting region of *B.b. orientalis,* like that of *B.b. bernicla,* is very small. As Birulia (1907) pointed out, the main nesting territory of the birds is confined to the maritime plains of the tundra between the rivers Yana and Khroma. According to this same author, the Brents encountered there are almost exclusively breeding birds, unpaired birds and males which have left the broods being very rarely observed.* If one refers the birds of Chukotsk, Anadyr and Wrangel to the following subspecies (*B.b. nigricans*), one can suppose that the eastern limit of the breeding range of *B.b. orientalis* is situated in the area between the Rivers Kolyma and Chauna. In any case it nests at Cape Bolshoi Baranov (Tugarinov, 1941), which perhaps is the most extreme easterly point of the breeding range of *B.b. orientalis.*

The existing fragmentary data make it possible to refer to this race the Brent Geese which occupy Eastern Taimyr and the central areas of this Peninsula and consequently to give as the western limit of distribution of *B.b. orientalis* not the River Khatanga, as has hitherto been accepted (Tugarinov, 1941; Ptushenko, 1952), but Lake Taimyr. The area of *B.b. orientalis* also embraces the Liakhovski Islands and the Anzhu (New Siberian) Islands, but the statements of Tugarinov and Ptushenko as to Brents nesting and moulting on De Long's Islands are incorrect (our observations).

The main route of the spring flight of these birds begins in China and, apparently passes along the eastern slopes of the Khingan range there. More to the west, even in the most easterly regions of Mongolia, odd birds are only occasionally encountered, according to A. G. Bannikov.

The geese enter the Soviet Union by crossing the Amur but only between the railway stations of Magdachi and Shimanovskaya (Shulpin 1936), or a little to the west of the mouth of the River Kumara (Tugarinov, 1941). After this one may assume that the flight follows the valley of the Zeia and its main tributaries. The birds reach the basin of the Lena through the upper courses of the Rivers Gonoma, Timpton, Aldan and probably, Uchur. They are never seen further to the west, in the valley of the Oleksa, nor further east, in the valley of the Maia (Skalon, 1946, 1956).

The Brents reach the Aldan along the River Uchur and the Lena along the River Batoma. On the latter the birds are never encountered north of the mouth of the River Siniaia, about 250 km above Yakutsk (Ivanov, 1929). Brent fly over the Amur mainly between May 20th and 30th and at the end of this month they reach the Yakutsk region (the beginning of passage

*The author appears to suggest that 'males which have left the broods' are seen in other areas, but male Brents, like other geese, do not leave their broods (Eds.).

here takes place May 24th-25th; Skalon, 1956). It is observed that until they reach the Aldan and the Lena the birds fly at a great height and no stopping places on the route are known.

Further north the birds fly low over the water, following all the bends of the rivers. The main route follows the valley of the middle and lower Lena. Smaller numbers fly over the Aldan and the Yana. Brent appear in the lower reaches of the Lena and Yana at the end of May. From there most fly east, to the area between the Yana and the Khroma, to the New Siberian Islands, to the lower reaches of the Indirirka, the Alazeia, and to the Zakolym tundras. In all these areas passage begins in the first days of June (Tugarinov, 1941; data of the polar stations). Apparently, besides this main flight, there is a poorly developed spring passage to the north along the shores of the Sea of Okhotsk (Shulpin, 1936; Tugarinov, 1941). In Yakutia the regular spring passage of Brent Geese has been observed nowhere outside the valleys of the Lena and Yana.

From the lower course of the Lena some birds fly west but in fewer numbers than to the east; the workers at the polar stations see them regularly at the mouth of the Olenko and sometimes on the lower reaches of this river, at Taimylyr and Tiumiateia. Very interesting observations on the westerly passage of Brents have been communicated by the polar stations at Volochanka (middle course of the Kheta, Southern Taimyr), Lake Taimyr and Pronchishchev Bay and also by a number of people spending the spring months in the central parts of the Byrrang range. All these data indicate a regular passage to Eastern Taimyr and also to the eastern regions of Western Taimyr from the south-east.

At Volochanka and Lake Taimyr the birds regularly fly to the north-west at the end of May. North of Lake Taimyr, to the Byrrang range, the birds arrive only from the south according to the data obtained by inquiries. The workers of the polar station at Pronchishchev Bay observe that in this region Brent fly from the south in spring and, having reached Kuldim Bay, turn to the north-west, following the northern slopes of the Byrrang range. These observations give reason to suppose that *B.b. orientalis*, not *B.b. bernicla*, nests and moults in Eastern and Central Taimyr. Not only the direction of flight but also the dates of arrival give evidence of this. Birds (which by the time of arrival can only be *B.b. orientalis*) arrive here as early as the end of May and the very beginning of June, while *B.b. bernicla* at this time is still in the region of the White Sea and the coast of Murman and reaches Taimyr only in the middle of June (not earlier than 10th). Apparently one of the passage routes of birds going to Eastern Taimyr and Pronchishchev Bay passes the mouth of the Olenko and the mouths of the Gulfs of Anabar and Khatanga (Brents are not encountered on the Preobrazhenie Islands). The passage routes of *B.b. orientalis* to the Kheta and the southern shores of Lake Taimyr are not known.

It is of interest to note here that a number of species of birds other than Brent Geese also fly from Western (and even more from Central) Taimyr east to southern Asiatic winter quarters and that in consequence not Eastern but at least Central Taimyr must be regarded as the area where their western and eastern populations meet. In particular one may mention here the fact that Bean Geese, ringed in the Ust-Yeneisk region, have been met

with on spring passage in the Irkutsk district (in Western Taimyr; Shevareva, 1958).

Data are lacking on the total numbers of *B.b. orientalis*. It can only be said that, according to information received as the results of inquiries, in the Yakutsk region (on the main path of spring passage) the number of birds passing amounts to thousands. In the region of the polar station Lake Taimyr some hundreds (more than five hundred) fly through from the south-east and about 1,000 birds nest in a radius of 50 km. The number of birds passing Volochanka is counted in tens. On north-eastern Taimyr, in the region of Andrei Island only single nests are encountered and no gatherings of moulting birds are observed. In the region of Pronchishchev Bay nesting Brent are not numerous but inside the bay some hundreds of moulting birds are encountered annually. Occasionally single, apparently nesting birds, are encountered on the shores of the Khatanga and Anabar Gulfs. On the lower reaches of the Olenko and the Lena, Brent nest in small numbers; assemblies of unmated birds are unknown there.

Along the Yana, the Syalakh, the Muksunovka, on the lower reaches of the Khroma, the birds are apparently still numerous, despite the fact that mass taking of eggs and hunting have been carried on there for a long time (Birulia, 1907; information from inquiries). Thus, in the maritime tundras between Sviaty Nos and Makrushina Strelka, according to information from inquiries, at least 10,000 Brent Geese nest. But here also there are no assemblies of moulting birds. It can be supposed that in the continental tundras, further east, the numbers of Brent Geese are everywhere relatively small.

Brent Geese frequent the Liakhov Islands, as Birulia (1907) noted, mainly for nesting purposes. On Bolshoi Liakhov Island, mainly its eastern part, according to a communication from V. D. Lebedev, the total number of birds nesting in 1956 amounted to only a few pairs. Brents are no more numerous on Maly Liakhov Island. They are not met with at all, according to our observations, on Belkovski Island and on Zemlia Bunga. On Kotelny Island they are rare. Faddeevski Island and, in particular, Novaya Sibir Island are the main sites where *B.b. orientalis* forms moulting assemblies (the number of breeding Brents is very small there). On Novaya Sibir in particular the number of moulting birds is counted in thousands (about 1,000 are obtained here every year (Shevareva, 1958)).

We have already suggested (Uspenski, 1956) that some immature *B.b. orientalis* fly still further to moult—to the north-west of North America—utilising the shortest route and crossing the outskirts of the Central Arctic. This suggestion was based mainly on various observations of flight from south to north and from north to south made on the De Long Islands and in the north of the Eastern Siberian sea. Here are some of these observations: from the vessel "Mod" situated at 75°N on about the meridian of the mouth of the Kolyma on May 21st, 1923, a large flock of Brent Geese was seen flying north. (It is true that the observers were not fully certain of the species of these birds as they were flying at a great height) (Sverdrup, 1930). The workers of the polar station on Henrietta Island have recently observed flocks of geese (almost certainly Brents) flying north from the end of May to the middle of June and flying south in the second half of August. Toll saw several flocks of geese at the end of August and at the beginning of

September, 1902; there can be no doubt that these were also Brent Geese, flying from north to south (Report of the Russian Polar Expedition, 1904). On this same Bennet Island on June 24th, 1956, we saw a small flock of Brent Geese (of 12-14 birds), flying north and keeping to this course until they were lost to sight on the horizon.

Judging from the dates of flight all these Brents have been unpaired birds, flying to moult (the main mass of unpaired birds arrives on Novaya Sibir from the end of June to the beginning of July, Birulia, 1907); the flights from north to south could consist of unpaired birds moving from their moulting sites to their wintering grounds.

For a long time the passage of birds, including Brent Geese, north from the New Siberian Islands served as one of the most important pieces of evidence for the existence of as yet undiscovered land somewhere near the junction of the Laptev and Eastern Siberian Seas—Sannikov's Land. The investigations of recent years have finally proved that Sannikov's Land does not actually exist. Thus only one answer can be given to the question of the destination of birds leaving the New Siberian Islands or flying north or south over the Eastern Siberian Sea; the birds are flying over the ice of the Central Arctic to moult in North America or are returning from doing this.

In recent years this supposition has begun to be confirmed by the results of bird ringing. The Ringing Bureau has already received reports of Brent Geese, ringed in North America*, having been obtained in various regions of the north-east of the U.S.S.R. (Shevareva, 1958). Some of these birds (most probably *B.b. orientalis*) which were mostly ringed as immature during moult in the area between the Yukon and the Kuskokwim, were obtained on Kotelny Island, on Novaya Sibir, at the delta of the Kolyma.

The departure of *B.b. orientalis* from its nesting and moulting grounds begins everywhere in the second half of August and finishes early in September. The autumn passage routes of these Brents do not coincide with those used in spring and so far remain an unsolved riddle. Maak (1886) long ago observed that Brent Geese do not appear in autumn in Yakutia. According to a statement of this same author (Maak, 1859), a noticeable passage of these birds is observed on the lower course of the Amur, in the Maly Khingan region. Here they appear at the end of September. Baxton (according to Shulpin, 1936) reports an intensive passage of these birds along the northern shores of the Sea of Okhotsk—at Ola, Okhotsk, along the River Ulia.

The investigations of subsequent years have added nothing of importance to these observations. It can only be said that the autumn passage routes which have been traced, along the shores of the Sea of Okhotsk (at least from the Piagin Peninsula to the Ulia) and over the Amur at Maly Khingan are sections of the main passage route of these birds. In autumn (and in spring also) they are very rare on the Kuriles, on Sakhalin, in Primorie and in northern Japan (Shulpin, 1936; Gizenko, 1955; Vorobiev, 1954).

It is possible that the birds fly from their breeding and moulting grounds to the shores of the Sea of Okhotsk quickly, at a great height and

*Ringing of *B.b. orientalis* has not been carried out in the Soviet Union.

at night (like *B.b. bernicla*), as a result of which they remain everywhere unnoticed on the Continent. South of the Amur it seems most likely that they follow the same routes as in spring, along the eastern slopes of the Khingan range.

The main wintering area of *B.b. orientalis* consists of the shores of the Gulf of Bokhaivan (Chzhili Bay) and of the Yellow Sea (Tugarinov, 1941).

The wintering conditions of *B.b. orientalis* and the extent to which they are hunted during the winter months are unknown. On their spring passage routes, especially on the Lena, hunting is intensive (Skalon, 1956). A large number is also obtained on the moulting grounds (on Novaya Sibir, about 1,000 a year) and at the nesting sites; until recent years the taking of eggs was widely practised. The information received from polar stations and that obtained by enquiry gives evidence in the overwhelming majority of cases of a rapid decrease in the numbers of *B.b. orientalis*.

The American Brent Goose (*Branta bernicla nigricans* Lawr). In the Soviet Union this is to be found only in the extreme north-east; on Chukotka, Wrangel Island, in the region of the Gulf of Anadyr.

According to the observations of the workers of the polar stations Brent Geese are not encountered at Valkarai in north-west Chukotka. It is very possible that there is here a gap in the distribution of *B. bernicla,* to the west of which is *B.b. orientalis* while *B.b. nigricans* is to the east. A well defined spring passage from the east has been traced as far as Cape Schmidt (i.e. most probably from American wintering grounds). The birds arrive on Wrangel Island exclusively from the south-east (Bannikov, 1941). An examination of a series of Brent Geese in the Zoological Museum of Moscow State University has also convinced us that the birds of Wrangel Island are most likely to belong to the race *B.b. nigricans.**

The birds arrive at their nesting (and moulting) grounds at the end of May. At Cape Schmidt on the northern coast of Chukotka, Brent arrive as early as the last ten days of May, according to the observations of the workers of the polar station. On Wrangel Island they arrive from the middle of May (Bannikov, 1941). In Cross Bay they arrive from the end of May (Belopolski, 1934); in Anadyr, in the last ten days of May (Portenko, 1939) and even in mid-May (communication of the meteorological station). The early dates for arrival in the north-east of the Soviet Union can be considered as additional proof that *B.b. nigricans* nests there and not *B.b. orientalis* which arrives on its nesting grounds usually not earlier than the end of May or the beginning of June.

So far as can be judged from the fragmentary data, an especially active spring passage route passes along the northern coast of Chukotka. It seems most likely that before reaching Chukotka the birds using this route cross over the base of the Seward Peninsula with the main northbound stream (Bailey, 1948).

In spring the birds also regularly pass along the southern coast of Chukotka (this route perhaps going across St. Lawrence Island) and along

*Tugarinov (1941) and Ptushenko (1952) only suggest the possibility of *B.b. nigricans* nesting on Chukotka and Wrangel Island.

the south coast of the Anadyr estuary (possibly across the islands of Nunivak and St. Matthew).

It is obvious that within the Soviet Union *B.b. nigricans* is most numerous on Wrangel Island where the number of nesting birds is reckoned in thousands. On Chukotka far fewer are encountered: from information obtained by enquiries and from the data of polar stations Brent only nest in numbers along the River Amguema and in the neighbourhood of Neshkan. They are usual but not numerous in the area of the Gulf of Anadyr (including Cross Bay). At Anadyr only a few hundreds pass in spring.

As in the case of *B.b. orientalis*, the autumn migration routes of *B.b. nigricans* do not coincide with those used in spring. In autumn passage is not observed on the north coast of Chukotka; from Wrangel Island the birds fly in a different direction from that taken in spring, to the south-west.

Apparently the Brents fly in autumn only along the south shores of Chukotka and the Gulf of Anadyr. They arrive in these localities by cutting across the Chukotsk Peninsula along river valleys. According to information received from enquiries a similar southerly passage is observed in autumn on the River Amguema. The departure of *B.b. nigricans* from its nesting sites finishes everywhere at the beginning of September. The birds winter on the Pacific coast of North America, south to California.

According to counts made on their wintering grounds in 1953 the numbers of *B.b. nigricans* amount to about 175,000 (Salomonsen, 1955). But in the past numbers were larger. An annual and noticeable decline in numbers is reported from the north-east of the U.S.S.R. by the majority of correspondents answering the questionnaire sent out by the Commission for the Protection of Nature.

It can be concluded that Brent Geese (speaking of the species *B. bernicla* as a whole) are very unevenly distributed in the far north of the Soviet Union. It is possible to name a few limited territories which form the summering areas of the main mass of the birds. As has already been described, these are North-West Taimyr, the maritime tundras of the area between the rivers Yana and Khroma, the island of Novaya Sibir (New Siberia), and, apparently, Wrangel Island. The migration routes of Brent Geese which have been traced, though not completely, in the Soviet Union, are, as a rule, extremely narrow and confined to sea coasts and the valleys of certain rivers.

These peculiarities of distribution greatly simplify the organisation of the necessary protection of the birds in our country, the extreme urgency of which is quite obvious. In particular, it appears to us that immediate steps should be taken to provide sanctuaries in the localities where the main assemblies of nesting and moulting birds occur and also to prohibit hunting, in the first place on the Lena, the Aldan, in the Karelian A.S.S.R., in the Leningrad district and on the Kanin Peninsula. The passage of the birds on a narrow front likewise makes it possible to carry out regular counts of their numbers, especially those of *B.b. orientalis* on the Lena and those of *B.b. bernicla* on the Kanin Peninsula.

Finally one cannot omit to mention the desirability of organising mass ringing of Brent Geese in the U.S.S.R., without which many questions of their biology and distribution cannot be solved.

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BRENT GOOSE POPULATION STUDIES, 1958-59

P. J. K. Burton

DURING the past five winters, a study of the proportion of first-winter birds in flocks of Brent Geese in Essex has been made and the results up to 1957-58 have been given in the *9th* and *10th Trust Annual Reports*. The present account deals with observations during the winter of 1958-59 in Essex and other areas.

Collection of Data

An attempt was made to widen coverage by the collection of observations from other parts of the country and from other countries. A circular explaining the purpose of the counts and the methods employed was sent to persons and bodies in the regions concerned. The response was small, but provided valuable information, and a further extension of the scheme is hoped for in the coming winter.

The observations discussed in this paper are from Essex, Norfolk, Lincolnshire, Holland and Denmark, and concern only the Dark-bellied race (*Branta b. bernicla*).

Results

Essex. The sampling method for the determination of first-winter percentages (Burton, 1958) was abandoned during the winter of 1958-59, as it was found that the flocks of Brent Geese contained hardly any young birds at all. Six visits were made to the coast—four to Foulness, one to Dengie and one to Goldhanger in the Blackwater estuary. Thorough searches revealed only seven first-winter birds in the whole season. One was found among some 600 at Foulness on 29th November, and six were discovered there out of about 1200 on 13th December.

Norfolk. The proportion of young birds in the flock wintering at Scolt was about 25%, according to R. Chestney, Warden of the Reserve.

Lincolnshire. Observations submitted to A. E. Vine by a Boston wildfowler suggest a situation among the Brent Geese on the Wash more nearly similar to that at Scolt than in Essex. From a flock of 300 watched at Butterwick on 18th December, 1958, a count of 181 first winters (60%) and 119 adults was made, with a possible error estimated at ± 12.

Holland. Detailed observations were made throughout the winter by T. Lebret in the Ooster Schelde, near Kattendijke.

21st Nov. 103 (± 6) of which 2 were first-winters.

23rd Nov. 139 of which 2 were first-winters.

21st Dec. Two flocks totalling 77, containing 3 first-winters.

4th Jan. 126, no first-winters.

4th Feb. 95 seen in the morning and 121 in the afternoon further east. Neither flock contained any first-winter birds.

Total 661, including 7 first-winters (1%).

Denmark. Observations were made at the reserve of Tipperne on Ringkøbing Fjord, West Jutland, where large flocks are present in spring.

The writer was at Tipperne from 26th to 30th April, and observations were continued by Heine Klausen, of Regensen, Copenhagen, until 25th May, after which no more were seen.

Although a maximum of about 1100 were recorded, neither observer found any first-winter birds during this period.

Discussion

A summary of results for the last five winters is given in Table I.

TABLE I. Proportions of first-winter Brent in sample counts in Essex, 1954-55 to 1958-59.

Season	Number of geese in sample	Number of first-winter geese	Percentage of first-winter geese
1954-55 ..	776	314	40
1955-56 ..	2020	522	26
1956-57 ..	1484	97	7
1957-58 ..	1810	995	53
1958-59 ..	*c.* 1800	7	0.4

The agreement of the Dutch and Danish records with the Essex observations in 1958-59 is good evidence that these were indeed typical of a large proportion of the population. They clearly show that the summer of 1958 was one of almost complete breeding failure for these birds. It must be supposed that the birds from the Wash and Norfolk originated from colonies which were not affected in the same way. The alternative hypothesis of a differential migration of age-groups provides no explanation of this discrepancy, as one would expect it to be at least reasonably constant from year to year. Previous winters' results in Essex show that this cannot be so.

Periodic breeding failures are characteristic of the Brent Goose, and have generally been attributed to storms on the breeding grounds. It is thus of some value to examine conditions in the Soviet Arctic during the five year period over which counts have been made. It must be borne in mind, however, that superimposed on any variations caused by weather there are fluctuations of biological origin. These arise from the fact that geese do not breed in their first summer (nor usually their second), though in adult plumage. Thus a good breeding summer one year will give rise to a population the next year containing a high percentage of sexually immature birds in adult plumage. The proportion of young produced in the second summer will then be less. Another difficulty is that local conditions may vary greatly within the same part of the Arctic, and may affect parts of the population without being sufficiently widespread to be detected from the meteorological data available. Hence, only drastic changes are likely to be relatable to weather effects.

Uspenski (1959, see pp. 80-93 of this Report) gives the main breeding range of the Dark-bellied Brent as the North-eastern part of West Taimyr.

It is found also in smaller numbers on Kolguev Island, Yamal north of 70°, North-east Gyda, the southern part of Severnaya Zemlya and on some small islands in the Kara Sea. In Novaya Zemlya, and on the Kanin and Kola peninsulas, only moulting birds are found.

The summer climate of these areas is severe. Kolguev is in the mildest part of the range, while on the mainland temperatures decrease from south to north. The amount of ice in the Kara Sea, especially off the Taimyr coast, varies greatly from year to year and is of considerable importance in relation to the general climate.

Yearly data from these regions have been obtained from two sources. The Daily Weather Report of the Meteorological Office includes data from Taimyr on its weather maps. The principal stations are at Cape Chelyuskin in the North, and Dikson Island at the South-west end of the coast. Another useful source is the report on the Northern Sea Route now given yearly in the *Polar Record.*

Uspenski (*loc. cit.*) gives arrival dates on Taimyr as 10th to 15th June, and on Severnaya Zemlya as 18th to 22nd June. The first nest on Taimyr was found on 22nd June; the earliest hatched young would thus be expected in late July. Madame Kozlova (in Bannerman, 1957) and Dresser (1908) both state that Brent in the Soviet Arctic are often found breeding on elevated tundra. Hence a smaller proportion should be affected in the event of tide-storm flooding than for instance, the Black Brant on the Yukon delta which nest mainly in low-lying areas (Hansen & Nelson, 1957).

Comparison of breeding success with meteorological records, however, suggests that a crucial factor may be the date at which the ground becomes snow free. The importance of this to Barnacle Geese arriving on the breeding grounds has been shown by Goodhart and Wright (1958): and Handley (1950) found that many Brant on Prince Patrick Island in 1949 failed to breed following a later thaw.

Breeding failures in Brents were noted in 1958 and 1956; counts by Lebret (1956) point to one also in 1948. No direct information on snow cover is available, but the mean temperature at Cape Chelyuskin for these three years in the first three weeks of June is 27°F., 3° lower than the mean for the good years (1954, 1955 & 1957). At the same time, pressures were lower and snow showers more frequent. Berg (1950) gives a map indicating snow cover north of 70° to have a mean duration of 260 days. It lasts from the beginning of October, which puts the date of thaw at about 17th June. This agrees with the statement of Dementiev and Gladkov (*per* Harber, 1955) that the Brent arrives on the breeding grounds when everything is still frozen. Hence temperatures during this period would be critical in influencing the time at which the snow disappears.

Conditions in 1958 were generally the poorest of the five summers. Both at Cape Chelyuskin and at Dikson, temperatures throughout the season were well below average. At Chelyuskin, the mean for the whole summer was only 32.1°F. (compared with 35.6°F. for 1957). Shipping on the Northern Sea Route in 1958 was much delayed and hindered by very difficult ice between Dikson and Chelyuskin (*Polar Record,* May 1959).

In the early winter of 1948, Lebret (*loc. cit.*) found less than 1% young in two counts totalling 528 in Holland. The summer of this year had also started with very low June temperatures, both at Cape Chelyuskin and Dikson Island. Gales occurred on several occasions. 1956 was a year of less complete breeding failure, with 7% young in the Essex flocks during 1956-57. It is likely that a smaller area of the breeding grounds was affected than in 1958 and 1948: the records from Dikson Island in 1956 were good, but those from Chelyuskin were extremely low, with a mean (31.9°F.) below freezing point for the whole summer. Possibly the birds wintering in Essex originate from the northern part of the Taimyr peninsula. This is supported by the occurrence in two successive winters in Essex of a Black Brant (*B.b. orientalis*) (*Essex Bird Report,* 1957 & 1958). The range of this form borders that of *B.b. bernicla* in the Taimyr peninsula according to Uspenski (*loc. cit.*).

It is interesting to note that during the winter of 1958-59, other species from the same breeding areas also showed markedly reduced breeding success. White-fronted Geese had a proportion of first-winter birds of about 14% (see p. 19 of this Report), and Bewick's Swans of about 7-9% (A. E. Vine, personal communication). Such agreement was not noted in 1956-57 when first-winter birds made up 38% of the first flocks of White-fronted Geese arriving at the New Grounds. This is a further indication that the breeding failure of Brent that year was not so widespread as in 1958.

In 1956, the breeding failure coincided with low numbers wintering in Essex, and a direct connection is not unlikely. In 1958, however, despite the breeding failure, numbers in Essex reached spectacular heights. This would seem to indicate that a considerable increase occurred as a result of the good year of 1957, although for some reason its effects were not so apparent during 1957-58.

The recent increase in the numbers visiting Britain is almost certainly a direct consequence of protection, but it is unlikely that the maximum possible population has yet been attained. At the time of writing the decision as to the continuance of protection in Great Britain has yet to be taken, but if an extension is granted and if in addition complete protection for the species in Denmark can be secured, this should greatly hasten recovery. An increase in the numbers nesting on Kolguev and other areas outside Taimyr would be especially valuable. The present distribution renders this race unduly vulnerable to mishaps in the harsh and uncertain climate of that area.

ACKNOWLEDGEMENTS

I offer my sincere thanks to all those who sent in observations or tried to collect them; and to the Air Ministry Meteorological Office for permission to search for data in the Library. Finally, I am deeply grateful to the Wildfowl Trust for a grant making possible my visit to Tipperne.

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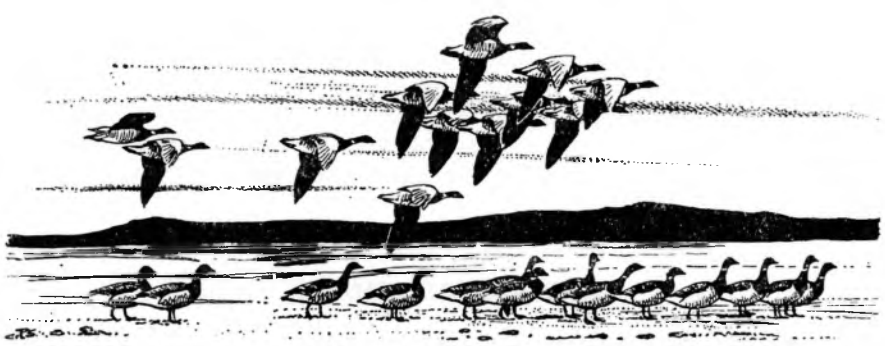


Brent Geese

A SPRING VISIT TO DENMARK

P. J. K. Burton

DURING the spring of 1959, I spent a short time at the reserve of the Danish Naturfredningsrådet at Tipperne in West Jutland. My main purpose was to make observations on the flocks of Brent Geese which collect there in April and May. However, there is plenty to entertain an ornithologist at Tipperne in spring besides the Brent, and perhaps a general account may be of interest.

Dr. Matthews described Tipperne in an account of wildfowl conservation in Denmark in the *Tenth Annual Report*. It is situated on a peninsula jutting out from the south shore of Ringkøbing Fjord, and with the island of Klægbanken covers an area of some two thousand acres. Most of this area is a swampy grassland dotted with small pools, providing feeding for geese and nesting places for wildfowl and waders. Offshore, on the mudflats of the Fjord, grow *Zostera nana* and *Ruppia,* the principal food source for the Brent. The water level is controlled by a sluice gate, so that there are in effect no tides.

I arrived at Tipperne on 26th April, having made my way from the nearest village, 10 miles distant, on a hired bicycle. This was a hazardous undertaking, as the machine lacked brakes, and was made highly unstable by the bulky rucsack which I strapped on the back. However, I completed the journey without injury, and was greeted by a Danish student, Heine Klausen, who was staying at Tipperne until the end of May. After some coffee he showed me around the Observatory. The living quarters can only be described as luxurious, considering the situation of the buildings; I know of no similar British establishment of comparable remoteness which has electric light, water and full sanitation. In addition, there is a well equipped laboratory and even a photographic darkroom.

Beside the main building stands an observation tower equipped with a very large telescope mounted on a mobile tripod. Since the Observatory is situated on the tip of the peninsula, it commands a view over the marsh to the south and the Fjord to the north. Using the telescope for the first time, I was at once struck by the amount that could be seen without stirring from the tower. Scanning the fjord, I soon found the Brent I was seeking, far off to the north-east, and accompanied by a large number of Wigeon. Closer at hand, a large company of some 1500 Godwits was feeding on the mud, the majority of them Bar-tailed. Scattered along the coast were more Wigeon, with Mallard, Pintail, Shoveler and Red-breasted Mergansers, and here and there were groups of Mute Swans with a few Whoopers. Turning my attention inland, I found 3,000 Pinkfeet grazing over the south-east corner of the reserve, with little parties of ducks by the sides of the numerous pools, the majority of them Teal, with a few Garganey.

Even the Observatory telescope with a maximum power of over 100x and an enormous field of view had its limitations, however. In order to be able to determine whether or not Brent Geese were in first-winter plumage, I was obliged to pursue them on foot, armed with my more modest telescope of 60 diameters and a fraction of the field. This raised practical difficulties. In Essex I had been used to watching Brent from the cover of a convenient sea wall, as they floated close in on the high tide. At Tipperne, there was

no sea wall, and the birds fed a long way out on the fjord. I developed a technique of plodding across the mud, bent nearly double, and carrying a wooden box to sit on when I wished to use my telescope. Though several such attempts were frustrated by the flock going up, I managed to get the information I needed. Towards the end of my stay, they became more co-operative, and I was able to watch them from the cover of tall reeds at the shore as they fed nearer to land. After I left, they moved their feeding grounds to the West, and Heine was able to make further observations from the comfort of the tower. Even so, they never came on land this year as is frequently observed at Tipperne in spring.

'Mud crawling' had its aesthetic compensations however. Due to the lack of tides, hard mud and a very gently shelving shore, it is possible to go out a long way into the Fjord. Sometimes an onshore wind spread a few inches of water across the mud, giving the eerie impression that I was walking across the sea in defiance of the laws of nature. On one of these forays I was pleased to find a party of 6 Barnacle Geese feeding near the Brent. When the Brent went up, they moved with them, though always feeding a little way apart. The Brent, which numbered some 1,100 during my stay, were always accompanied by about twice as many Wigeon, congregated around the sides and the back of the flock. The Godwits on the mud were a particularly spectacular feature. The majority were in their russet summer plumage, and when a flock on the wing banked and caught the light, the whole great cloud of birds would suddenly turn copper-coloured. Looking at them through the telescope I noticed that the few that were still in winter plumage were nearly all Black-tailed, although the birds of this species nesting on the marsh were of course in full breeding dress.

The positions of all nests found at Tipperne are plotted each year on a large map of the reserve which hangs on the wall of the Observatory. On two days I accompanied Heine on a search for nests, taking us over a large part of the reserve. The most characteristic features of the reserve in spring are auditory rather than visual. Two sounds which are heard constantly are the squeaky song and tittering alarm note of the Black-tailed Godwits, with a continual grating accompaniment from a chorus of Marsh Frogs, giving an oddly tropical atmosphere. We found one Godwit's nest, as well as several Lapwings' and a Redshank's, but most interesting was a small colony of Avocets. Heine had discovered the position of this colony with the Observatory telescope. The nests were situated on two small muddy islands on one of the larger pools, and as we approached the occupants flew up calling, their pied plumage harmonizing perfectly with a blue sky and the golden-brown reeds flanking the pool. On the first island, about 8 feet in diameter, were five nests, three with 4 eggs, one with 5 eggs and one with 2 eggs. Besides these, one egg lay in a battered and apparently abandoned nest, while four others were scattered and half buried in the mud. Possibly this nest had been the victim of flooding due to a sudden rain storm. The second island held eight nests—four with 4 eggs each and four others with respectively 2, 5, 6 and 7 eggs. This wide variation in numbers seems to be unusual, and possibly the large clutches were the joint efforts of two females.

Another wader plentiful on the marsh but not yet nesting was the Ruff. We came across several motley parties of males bobbing and scuttling about on their display grounds, and were able to approach quite close. In another

part of the marsh I found a dead Ruff which had probably been killed by a tern; it had a neat hole in the back of its head consistent with a peck wound, and several Common Terns were nearby, mobbing me uncertainly as I passed. Once, looking through the big telescope, I found a Gull-billed Tern resting by a pool. This species nests in a nearby part of the Fjord, but is not often seen on the marsh. The only bird of prey I encountered was a Marsh Harrier beating over the reeds by the shore of the Fjord. Foxes are said to be plentiful, though I did not see one, and probably account for many of the Pinkfoot remains I found in the grassy feeding grounds of the geese. Possibly these dated from the previous autumn, when the shooting season was still open, and crippled geese found their way into the reserve. My only encounter with man as a predator while I was at Tipperne was when Heine went out onto the mud with a net and returned with two excellent Flounders, which we ate the same evening. Heine was given to experimentation, and after I had skinned the Ruff I found, he rolled the remains in bread crumbs and fried them. I was amazed to find it highly palatable![1]

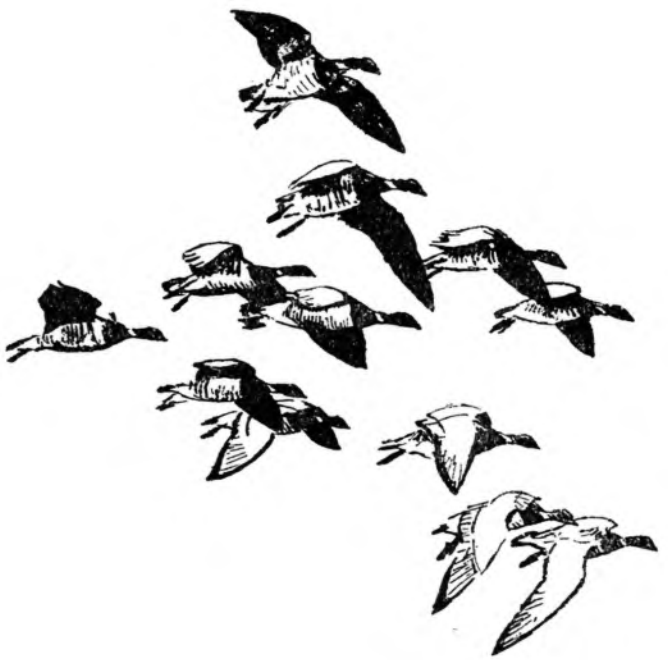
Near the watch-tower stood a small fir plantation, which held a crop of night migrants early each morning. The majority were Chiffchaffs, Willow Warblers and Whitethroats, but on one day they were augmented by a Tree Pipit, a Robin and two Song Thrushes, and on another by two cock Redstarts, a Ring Ouzel and a Red-breasted Flycatcher. One of the Redstarts wandered into an outbuilding, and was rescued and released with the inevitable ring.

The atmosphere of winter was preserved on the marsh by flocks of Golden Plovers and Pinkfeet. In contrast to the autumn, when the shooting season is open, the geese showed little regard for the boundaries of the reserve, and moved about quite a lot. The evening flights were spectacular, for on three of the four evenings I was there, they stayed on the marsh for the night, after spending about half an hour at dusk flying round and round over the sanctuary. My best views of them were had on the last full day of my stay, when from the watch-tower I was able to find among them 11 Greylags, 2 Whitefronts and 2 Lesser Whitefronts. I believe the latter were only the second record of the species for Tipperne. With Brent and the Barnacles seen the day before, this totalled 6 species of geese seen in two days, and 15 species of wildfowl in all.

I concluded my visit by going to Copenhagen to meet Dr. Finn Salomonsen, who recently published an extensive survey of the status of Brent. I left Tipperne on the morning of 30th April, on the primitive bicycle which brought me, and continued from the village of Nymindegab by bus and train to the Danish capital. I arrived about midnight to find that as the next day, 1st May, was a national holiday, all the hotels were full. I soon found myself one of a band of harassed individuals touring Copenhagen in search of a night's lodgings. Eventually I was lucky, and the next day I enjoyed the hospitality of Dr. Salomonsen and his wife at an excellent tea, and had a long and most interesting discussion.

[1]When the Ruff was a common breeding species in eastern England, young birds were caught and fattened for the table (Eds).

I travelled overnight to Esbjerg, and spent the time that remained before I sailed by visiting nearby Ribe. This is a lovely old-world town, famous for its White Storks. This species is dwindling unfortunately, apparently unable to adapt itself to life in noisy modern towns. In quieter places such as Ribe, some may still be seen at their nests on buildings, or on platforms erected for the purpose. Two pairs were in Ribe during my visit, and I watched a magnificent display of soaring by one of the birds, looking strangely vulture-like, with its widespread, upward-curling black primaries. It was with this pleasing picture still in my mind that I returned at length to Esbjerg and boarded the boat for Harwich.



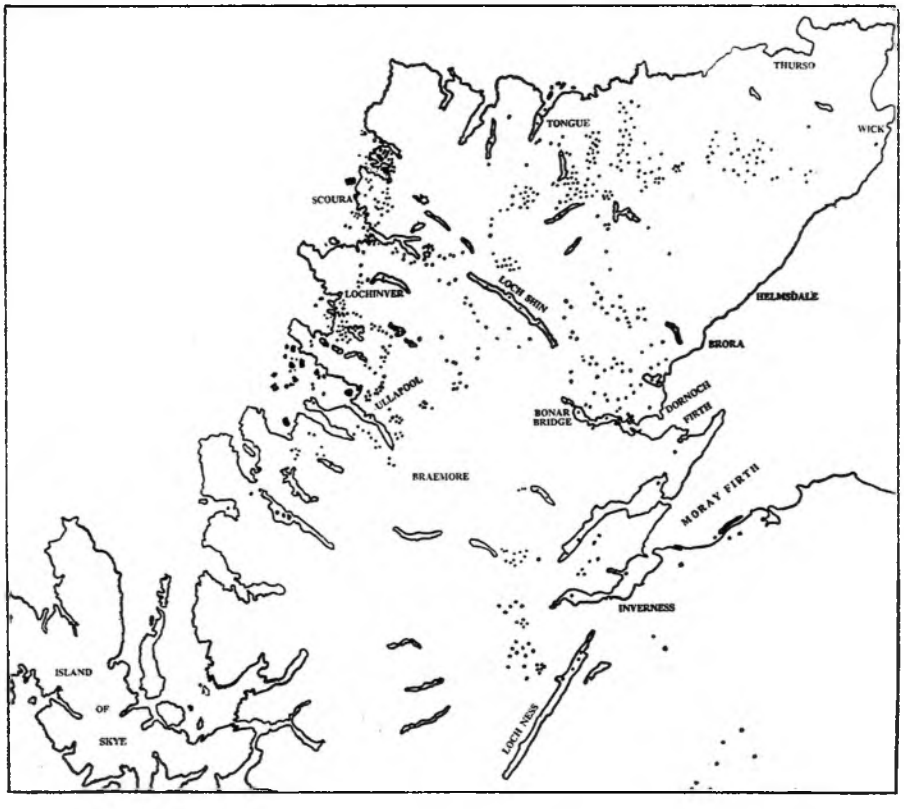
AERIAL SURVEY OF WILDFOWL IN THE HIGHLANDS OF NORTHERN SCOTLAND IN THE SPRING OF 1959

S. K. Eltringham and H. Boyd

Introduction

THE north of Scotland is the home of the remnants of the indigenous British population of Greylag Geese and of a variety of breeding ducks about which there is little reliable or recent information. Since the country has a comparatively small human population and includes large tracts which are difficult of access, it seemed likely that observations from an aircraft would provide an economical means of studying the distribution of wildfowl in the north. The area to be explored comprised the mainland and inshore islands north of a line from Loch Carron in the west to Inverness in the east.

The objects of the survey were two. First, to make a census of Greylags by visiting all the lochs and lochans known to have been used as breeding places within recent years, and as many other likely-seeming places as possible. Second, to obtain a detailed record of the distribution of all species of ducks breeding within the region, paying particular attention to the remoter areas. The more accessible localities, about which information is more readily available, were not visited because of the limited funds available for the survey. This led to the omission of lowland Caithness, which is known to be rather rich in breeding ducks. A map of the areas searched from the air is given at Figure 1.



The survey occupied 28 flying hours between 27th May and 4th June. The aircraft used was an Auster Aiglet which was hired from Airwork Ltd. and flown from their base at Scone (Perth) to Inverness (Dalcross) aerodrome from which operations were conducted. During the survey, the aircraft was flown at a speed of 90 m.p.h. and a height of about 300 feet. The weekend of 30th-31st May, during which no flying was possible, was spent in an extensive ground survey by car of the west coast and the northern inland lochs. We are greatly indebted to Mr. E. A. Maxwell for providing the vehicle and for assistance with the survey.

Results

a. Distribution and numbers of Greylags

From published records and other information it seemed possible that Greylags might be found in some nine regions in west, central and south-east Sutherland and on some lochs and offshore islands in Wester Ross. It was also possible that some remained in south west Caithness. In most places the geese were believed to be truly wild although those in the regions of Loch Carron and Loch Brora were known to have been introduced as, or reinforced by, feral flocks.

All but two lochs known to have harboured geese in the past were visited from the air, together with a great number of other lochs, several of which appeared at least as suitable as the known sites. One of the omitted lochs was visited by car.

The number of geese seen was disconcertingly small and the most favourable total that could be amassed from this survey was 65, of which 16 were probably remnants of feral flocks. Although some geese may have been missed it is unlikely that very many were, for some likely areas were searched very thoroughly and on a number of occasions without results. The extensive ground search covering several hundred miles found geese in only two localities and fully confirmed the conclusion from the aerial search that geese were very scarce. The largest number found was a group of 30 which was seen from the ground in a field near a complex of lochs in central Sutherland. These geese were also seen from the air, flying over the nearby lochs in two flocks totalling 17. A second group of 10 was found on 24th May, about 9 miles north east of the first birds, on a small lochan several miles from the nearest road. On 3rd June they were seen again on the same lochan although only 9 were present. On the first occasion the geese were on the shore when seen and had risen to settle on the water after a brief flight. On 3rd June they declined to fly, however, although a low level run was made over them and it was concluded that they were probably in flightless moult. Some photographs taken of them from about 50 ft. were not sufficiently detailed to show whether this was the case (see p. 184).

Very few geese were seen in the Loch Brora area although the region was very thoroughly searched on two occasions and it seems that the large feral flock there (over 200 strong ten years ago) has been greatly diminished. Another group of feral geese containing two broods was seen near Loch Carron but the number of young could not be counted.

The Summer Isles, known to have been the haunts of a number of resident Greylags in the past, were searched thoroughly on 1st June but four geese spotted in flight off one of the smaller islets were the only ones seen. No geese were found on any of the other islands off the Ross or Sutherland coasts.

This survey was commenced in the last week of May on the assumption that successful breeders would have hatched their eggs a short time earlier, so that an estimate could be obtained of the breeding success by counting family parties. The presence of broods in the feral flock near Loch Carron suggests that this timing was correct but no other broods were seen and none of the adults behaved like breeding birds. It has been pointed out by Dr. J. Berry (*in litt.*) that broods are normally to be seen on open water only in the early morning and late evening, times when, for administrative reasons, it is not possible to fly, and some broods may have been missed as a result. Even so, this survey suggests that the strength of the truly wild Greylag population in the north and north west of Scotland, excluding the Outer Isles, is very meagre and they give no support to the hypothesis that some of the more inaccessible island-studded lochs might still harbour breeding groups unknown to ornithologists.

b. **Distribution and number of ducks**

A study of the Bartholomew " half-inch " maps shows that the inland waters inspected during the survey, about 540 in all, amount to 42% of the total mapped in the whole of Scotland north of the line Loch Carron—Inverness. Of those visited, 242 waters were at an altitude of less than 500 ft. (38% of the total waters below that height), 219 waters were between 500 and 1000 ft. (51% of the total waters between these heights), and 77 waters were over 1000 ft. (35% of the total waters over that height). Only on 56 (10.4%) of the visited waters were ducks of any species seen. 44 of these occupied waters were below 500 ft., 11 between 500 and 1000 ft. and only one over 1000 ft. The occupied waters comprise 18%, 5% and 1.7% respectively of the total waters visited in the three altitudinal samples.

The distribution of each species of duck seen during the survey is summarised in Table 1.

TABLE 1. Summary of distribution of ducks seen in the North West Highlands, May—June, 1959

Species	Numbers of waters occupied		Number of ducks seen	
	Inland	Coastal	Inland	Coastal
Shelduck	5	6	87	223
Mallard	21	5	193	30
Teal	6	0	14	0
Wigeon	8	1	41	10
Tufted	5	0	25	0
Scoter	2	2	3	35
Eider	0	7	0	106
R-b. Merganser ..	10	10	31	28
Goosander ..	10	0	30	0

There was a preponderance of males in all species, except the sawbills. This disparity was expected, being due largely to the timing of the search when most females were likely to be on their nests and so escape detection. Thus the number of birds seen is a measure of the distribution of males and hence, by inference, of breeding pairs rather than a total count.

These results show that not only were very few of the visited waters occupied, but that the number of ducks seen on those in use was small. It is therefore difficult to draw any more definite conclusions from these figures concerning the distribution of ducks than the following brief notes.

Shelduck. Table 1 shows an unexpectedly high proportion of inland records, but all the lochs used are within three miles of the sea. From their distribution and behaviour, few of the birds seen were breeding.

Mallard. The scarcity of this species in the north west, noted in published records, is borne out by the present observations. Only four females with broods were seen (two from the air and two from the ground).

Teal. This is the hardest species to see from the air but, even so, remarkably few were found. Teal seem to have been decreasing in the Highlands in recent years and these results suggest that the species is now only sparsely distributed.

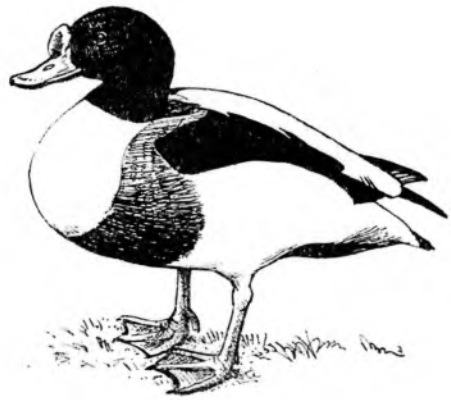
Wigeon. The number seen was fewer than expected, especially as most of the observed birds were probably excess males or non-breeding birds. However, inexperience of the habitat preferences of breeding pairs may have reduced the effectiveness of the search for this species.

Common Scoter. This species is usually readily visible from the air and the very few seen on inland waters suggests that the Scoter has suffered a decline as a breeding bird in recent years.

Eider. Very few pairs were found but the female is not easily seen on the water, and even less so when in vegetation on land.

The paucity of these results is disappointing and suggests that a representative sample of ducks was not obtained. No doubt, the time of day was unsuitable for optimum observational conditions, although surveys flown over the North Somerset reservoirs at midday seem to have detected 50-100% of the ducks recorded on comparable ground counts. This suggests that, at most, the number of ducks in the areas surveyed in Scotland was not more than twice the number recorded, for the risks of overlooking ducks in the Highlands ought to be less than that in the more overgrown English reservoirs. This is still a very meagre total and it is fair to conclude that it is unlikely that a significant proportion of the British population of ducks breeds in the North Western Highlands of Scotland.

This survey was part of a programme designed to test the feasibility and utility of aerial survey in Great Britain, undertaken on behalf of the Nature Conservancy and financed by that body.



Sheldrake *Tadorna tadorna*

THE SHELDUCK POPULATION IN THE BRIDGWATER BAY MOULTING AREA

S. K. Eltringham and H. Boyd

Summary

MOST British Shelduck undertake a moult migration in July to areas on the German North Sea coasts, but in 1951 the existence of a moulting population was discovered in Bridgwater Bay, Somerset. The present paper describes the results of a number of aerial counts of the moulting population during 1959. The first migrants appeared in July but many of these appeared to leave before the end of the month without moulting. There is evidence of a second peak in early August followed by a steady build up in numbers to the seasonal maximum of nearly 3,300 recorded at the beginning of September. The largest number of moulting birds (roughly estimated at 2.700) was found at this time also with a smaller concentration later on in October. It is believed that there were at least two and possibly three waves of immigrants in July, (August) and September. Moulting birds were found during August, September and October with maxima in September and October. It seems probable that the first Shelduck were largely passage birds followed by the moult migrants with the non-breeders preceding the breeding birds. Most of the moulting Shelduck were found between Hinckley Point and Steart.

The Shelduck population elsewhere in the Bristol Channel and Severn Estuary did not appear to use Bridgwater Bay as a moulting area.

The largest number of young birds was seen in early July, suggesting a rather late breeding season in 1959.

Introduction

The moult migration of the north European Shelduck *Tadorna tadorna* (L.) is a peculiar phenomenon which has come to light comparatively recently. Hoogerheide and Kraak (1942) suggested, from an analysis of ringing data, that Shelduck in Northern Europe migrated in July to the south-east corner of the North Sea in order to moult. These theories were confirmed by Coombes (1949, 1950) who showed from a study of Shelduck in Morecambe Bay that the moult migration of British Shelduck is intense, taking place in July, and that their destination is a comparatively small area of the Heligoland Bight around the island of Mellum near the Weser and on the Grosser Knechtsand off the mouth of the Elbe. The return of the Shelduck from these moulting areas is more gradual than the outward migration and may take up to six months to complete. It appears from observations made by Lind (1957) in south-west Denmark that the moult

migration proceeds in two waves, caused by the non-breeding and one-year-old birds migrating before the breeding Shelduck. Allen and Rutter (1957) have studied the moult migration from the River Mersey, Cheshire, since 1950 and have confirmed that most birds leave in July although adverse winds will hold up the migration, which is made overland in a direct line.

Doubts that all British Shelduck migrated to Germany arose in 1950 when it was noticed that large numbers of Shelduck were present in Bridgwater Bay throughout the summer (Perrett 1951). Further observations, particularly by Messrs. D. H. Perrett, B. King and D. E. Slocombe, proved conclusively that the Shelduck remained to moult (Perrett 1953). These observers suggest that a large body of adults arrive in July and are followed in late August by an influx of juveniles. No other moulting area in Britain has since been discovered. It is not known for how long Bridgwater Bay has been used as a moulting area but an observation in June 1906 of several hundred to the south of Brean Down suggests that the Shelduck have been coming here for many years.

Apart from a few incomplete counts, little study of the moulting Shelduck seems to have been carried out since the discovery of Bridgwater Bay as a moulting area and it was decided to make a survey in 1959 to investigate some of the more immediate problems. The preliminary information required was the size of the population, the proportion actually in moult and the chronology of the major movements that occurred. In order to examine possible interrelationships with other local Shelduck it was considered necessary to include the northern coasts of the Bristol Channel in the survey. An adequate cover of these coasts is not easy because of the lack of approach roads, etc. while the time factor precludes regular simultaneous counts being made on the two shores of this large estuary. In Bridgwater Bay itself the Shelduck are difficult to count, even at high tide, because of the large area involved and the tendency for the moulting birds to keep well out to sea; sometimes as much as two miles from the shore. At low tide they are almost impossible to approach because of the large areas of exposed mud. It is therefore a formidable task to undertake regular counts of Shelduck in the Bristol Channel, but most of the difficulties are resolved if the observations are made from the air. Consequently this investigation was made one of the major projects in the expanding aerial survey programme of the Wildfowl Trust.

Methods

Twenty aerial counts were made of the Shelduck in the Bristol Channel/Severn Estuary area north-east of a line between Bridgwater Bay and Cardiff. These counts have been most frequent during the moulting season when they averaged about one flight per week. A map of the area covered is given in Figure 1. The average time taken to fly these surveys was 2½ hours, of which about 30 minutes were spent over Bridgwater Bay (defined as the area between Hinckley Point and Brean Down). The surveys were timed to coincide with high tide in Bridgwater Bay as Shelduck are more easily seen from the air under these conditions than they are when scattered over the mud at low tide. Most of the flights were made from Staverton Aerodrome near Gloucester, using an Auster 5D of the Cotswold

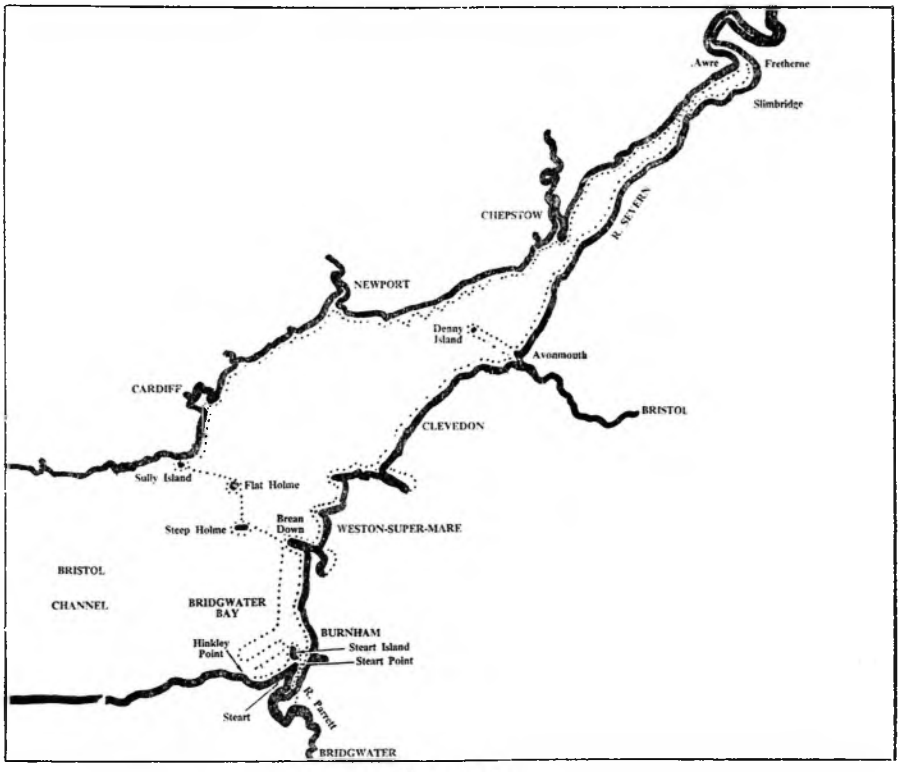


FIGURE 1

Aero Club. This aircraft was not available during August and during this month surveys were made with an Auster Alpha of the Bristol & Wessex Aeroplane Club, operated from Bristol (Lulsgate) Airport. This aircraft was of limited endurance and consequently the complete route could not be flown during August. The survey team consisted of two observers, one of whom was the pilot, sitting side by side and looking out of either side of the aircraft. The surveys of the coasts were flown about 100 yds. offshore at an altitude of about 100 ft. and at an airspeed of 90 m.p.h. Shelduck could be recognised and counted up to half a mile from the aeroplane on the seaward side and diversions were made to inspect unidentified birds further out than this if they were suspected of being Shelduck. A modified technique was required to count the more concentrated population in Bridgwater Bay. The height was increased to 3-400 ft. and the airspeed reduced to about 70 m.p.h. while a series of transects was flown across the sea at varying distances from shore. These optimum conditions enabled large flocks to be seen as units and allowed more time in which to count them. Counts were made with a hand tally in units of 10 or 50 according to the size of the flock. Some photographs were taken in Bridgwater Bay with a K20 aerial camera using Kodak super XX aerofilm but, because of the wide dispersion of the Shelduck, a complete photographic cover was almost impossible to achieve with a hand held camera and visual counts were always made. A rough idea of the proportion of moulting birds was obtained by flying low

over the flocks. Those remaining on the water were assumed to be flightless and therefore in moult. It is a curious fact that Shelduck will not dive to an aircraft although they invariably do so when approached by a boat.

The following results deal with surveys flown during 1959. A few flights were made in 1958 and during the succeeding winter but the regular series was commenced towards the end of April and continued until the beginning of October, except for a few weeks in May and June when the team was away on aerial survey work in Scotland. A few flights have been made since October to assess the level of the winter population.

Flying weather during the summer of 1959 was generally good and only on three occasions was it necessary to postpone flights because of bad weather. The frequency of the surveys was to some extent dictated by the times of high tide as flights from Staverton could be made only between the hours of 8.30 a.m. and 5.30 p.m.

Results

The total number of Shelduck seen in Bridgwater Bay on each survey is shown in Figure 2, which also includes the number of birds estimated to be in moult. The most striking feature of this histogram is the considerable fluctuation which it shows in the number of Shelduck present during July and August even over periods of only a few days. The seasonal increase was first detected in May and numbers reached their first peak in early July, followed at roughly monthly intervals by two further peaks in August and

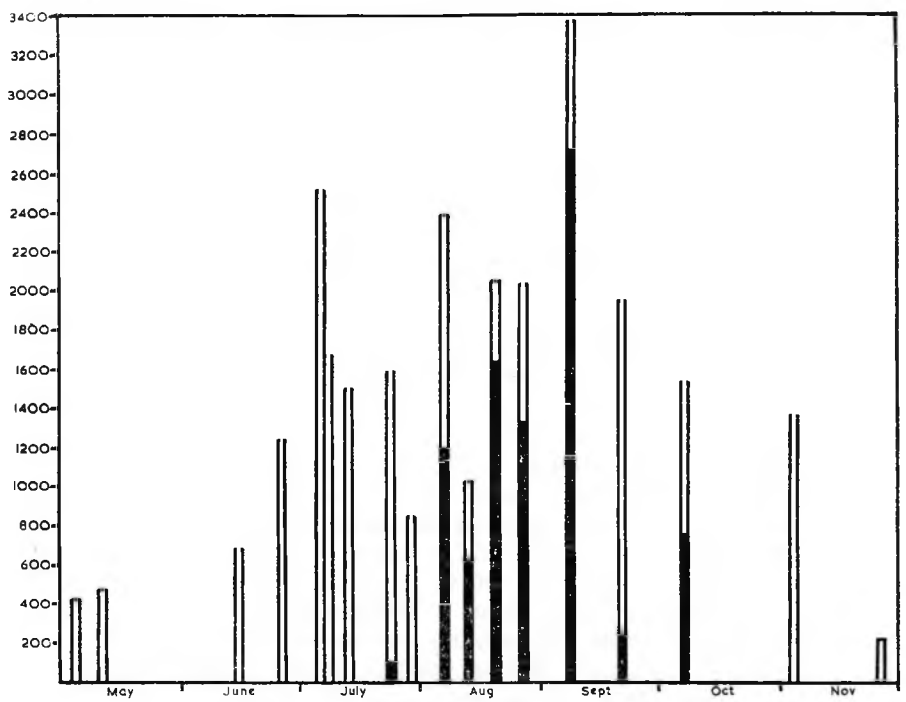


FIGURE 2

September. In between these peaks numbers fell to relatively very low values, only about 30% of the maxima. A fairly large population was maintained well into the autumn but there was a great decrease during November to the winter level.

The proportions of birds which were in moult show some interesting features. Very few flightless Shelduck were seen in the first concentration during July and it was not until the beginning of August that moulting birds became apparent. The largest number in moult was seen in the first week of September. There appear to be considerable fluctuations in the numbers of flightless birds during August but it must be emphasised that these estimations can only be very rough approximations and it is suggested that these figures show a general rise to the September maximum. The drop between the first and second August count is, however, relatively large and may indicate an early August peak of moulting birds. More significance is attached to the large increase in flightless birds between September and October and it is believed that these October moulting birds form a group distinct from the large August—September population.

The regions of Bridgwater Bay most favoured by moulting Shelduck have been determined by noting the frequency of observations in various areas throughout the summer. The areas considered are the coast and sea between 1) Hinckley Point and Steart Village, 2) Steart Village and Steart Point, 3) Steart Island, 4) estuary of the River Parrett and 5) between Burnham and Brean Down. Table 1 shows the total number of Shelduck seen in each of these areas on all flights made between July and October.

TABLE 1. Observed frequency of Shelduck in Bridgwater Bay

Region	Grand Total of Shelduck seen on 12 flights between 6th July and 7th October	%
1. Hinckley Point—Steart Village	10590	48
2. Steart Village—Steart Point ..	5820	26
3. Steart Island	4610	20
4. Estuary of R. Parrett ..	360	2
5. Burnham—Brean Down ..	830	4

It is apparent from this analysis that the great majority of Shelduck in Bridgwater Bay keep west of the mouth of the River Parrett. The area between Hinckley Point and Steart Village is the most frequented of all and most of the flightless birds were seen in this sector. The region between the River Parrett estuary and Brean Down does not appear to attract moulting Shelduck although large concentrations may often be seen there at other times of the year.

The numbers of Shelduck seen elsewhere in the Bristol Channel and Severn Estuary are shown in Figure 3. The coast searched is from Awre to Cardiff on the north and Brean Down to Fretherne on the south, with four islands in the Channel: Sully Island, Flat Holme, Steep Holme and Denny Island. There were no records during August as the complete cover could not be flown. The results suggest that the Shelduck began to leave their breeding grounds, presumably to migrate, in the middle

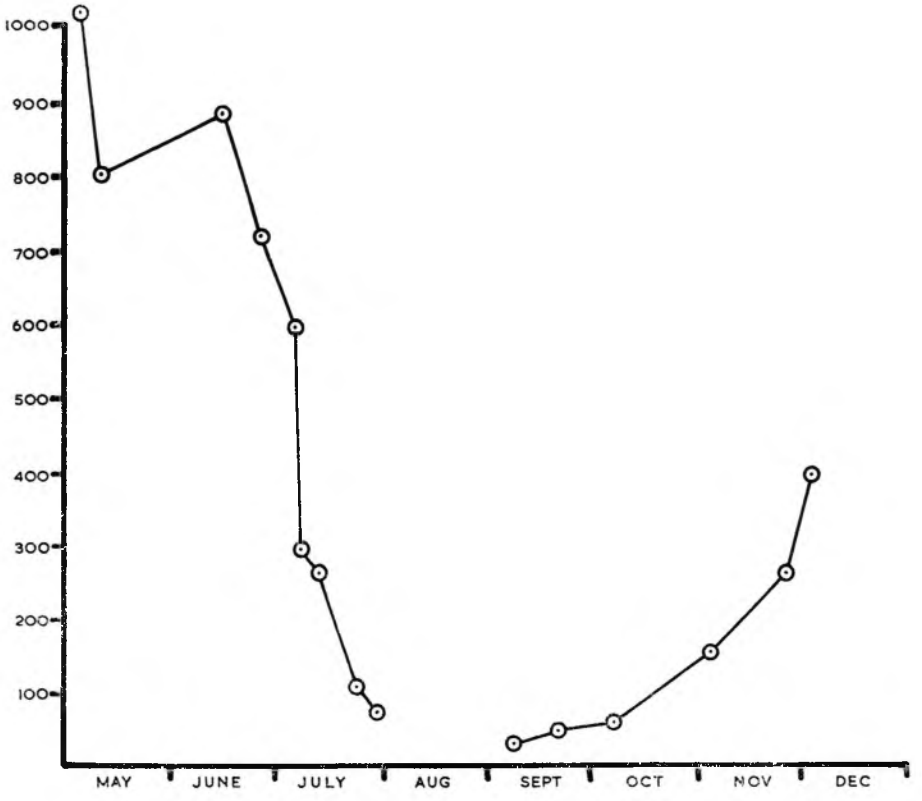


FIGURE 3

of June and that most of the birds had left by the end of July. The return of the migrants was not indicated until early November and, although there was a substantial number present by December, the population was still less than half of its size in the previous spring.

Figure 4 shows the number of young Shelducks seen in the whole of the area surveyed. These figures include all groups from downy young to the fledgling stage. The first young were seen on 15th June and peak numbers were rapidly reached, but after 8th July there was a slight decline. Observations could not be carried on into August as the whole region was not covered but very few young were noticed when the complete census was resumed in September (it was not always possible to distinguish between flying juveniles and adults in the short time available).

Discussion

a. Movements of the Shelduck population in Bridgwater Bay

It is clear from the present results that some modifications are required in our ideas of the status of Bridgwater Bay as a moulting area. The simple picture of a concentrated migration to the Bay followed by the moult is no

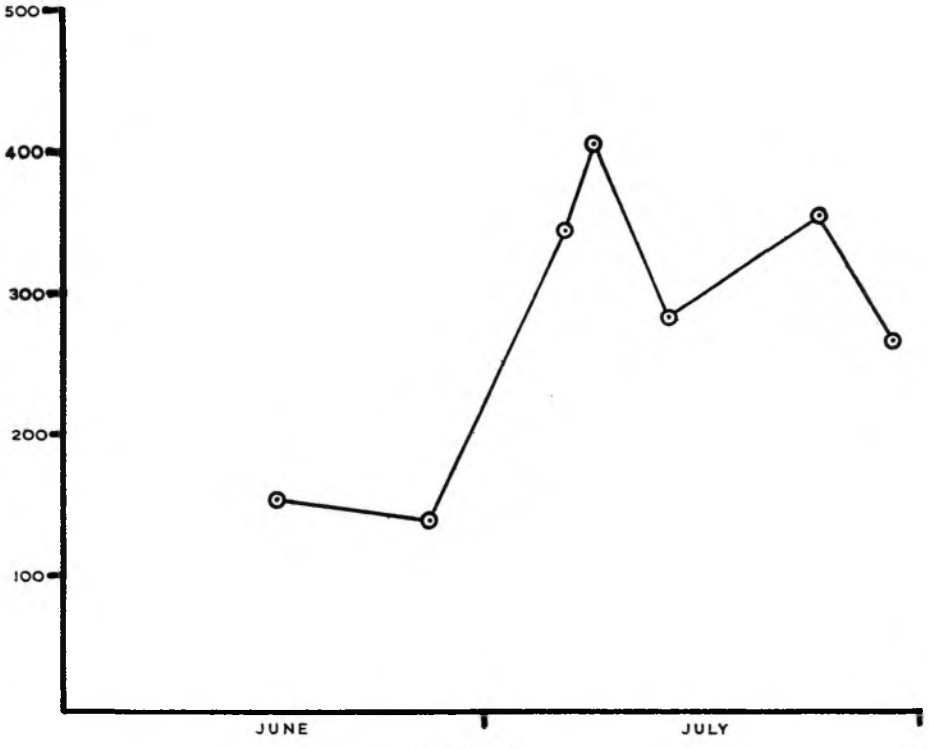


FIGURE 4

longer tenable. The first large influx occurred in July, the month in which other workers have found that Shelduck migrate to the German moulting grounds. However, none of these birds were in moult and it seems likely that many of them were birds of passage, for two-thirds had left by the end of July. The obvious inference is that these birds were using Bridgwater Bay as a staging point on their way to Germany. The absence of flightless birds in July had previously been noted on an aerial survey flown in 1958. By the beginning of August, however, numbers had risen again and the first moulting birds had appeared. It is not clear whether this concentration represents a genuine early August peak for its demarcation is largely dependent upon the small number seen in the next (second) August survey. There is no evidence that this latter survey was less thorough than the others although it was flown in bad weather with high winds, rough sea and low cloud which added to the difficulties of observation. However, there is no doubt of a further peak in numbers in early September when most moulting birds were seen. The evidence for an earlier peak of moulting Shelduck in August is as inconclusive as that for a peak in total numbers. After the September maximum there was a sharp decline in numbers although the population was maintained at a fairly high level (*c.* 1500) during the whole of October. A study of the Wildfowl Count data for October has shown that large concentrations of Shelduck have often been seen off Steart late in the month (e.g. 1800, 28th October, 1951; 1287, 14th October, 1952; 1000, 16th October, 1956; 1600, 21st October, 1958). The final evacuation from the

Bay seems to take place about the beginning of November. This is apparent from the observations made in 1959 and is also suggested by a few aerial surveys flown in 1958. There is no evidence of a late autumn peak in total numbers but there is a significant rise in the number of moulting birds in October compared with late September. These are obviously birds which have arrived late (September) in Bridgwater Bay.

These somewhat complicated fluctuations seem susceptible to explanation although any interpretation must at this stage be highly tentative. It is believed that there were at least two and possibly three peaks in numbers occurring in July (August) and September, followed a month later by peaks in the number of moulting birds. It is probable that the Shelduck arrived in the Bay a few weeks before moulting and that the August—September moulting birds arrived during July and August. The first birds arrived in June but it seems likely that these and many of those arriving early in July did not remain in the Bay to moult.

The suspected double peak occurring in August and September may be explained on the basis of Lind's observation (1957) mentioned above that the non-breeding and one year old birds migrated before the breeding birds. It is likely that such a phenomenon obtained in Bridgwater Bay and that the early moulting birds were the non-breeders while the later moulters were birds which had bred that year. The build-up in numbers during August would therefore be caused by the continuous arrival of breeding birds which had recently left their young. The later peak of moulting birds in October may be due to late breeding or re-nesting birds but a further possibility is that these Shelducks were those that remained behind as 'nurses' to look after the creches of young after the parents had left for the moulting grounds. It does not seem improbable that the Bridgwater Bay area would be a more appropriate moulting ground for such birds than the more distant Heligoland Bight. Perrett's observations (1953) suggest that 'juveniles' (presumably birds of the year) arrive late in August and these may have contributed to the September population.

b. **The origin of the moulting Shelduck**

No information is available on the extremely interesting question concerning the origin of the Bridgwater Shelduck. It is unlikely that they are local birds because their numbers are too high and in any case there is some evidence that the local birds undertake a normal migration to the German moulting areas. This is based largely on the pattern of movements, which show a slow return of birds to the breeding grounds long after Bridgwater Bay itself is clear of moulting duck, and also on observations of birds migrating eastwards from Slimbridge. More direct evidence was obtained when a dead Shelduck was recovered in a decayed state on the Wash in August 1959 very close to the direct line between Slimbridge and the German moulting grounds. This bird, a female, had been ringed at Slimbridge Decoy in May 1955 and recaptured there in April 1956 as a breeding bird. It is also unlikely that the Bridgwater Shelduck come from the south or east coasts of this country for no westward migrations have ever been observed. Shelduck from north-west England seem to migrate to Germany (Coombes 1950). It is possible that the Bridgwater Bay Shelduck come from regions to the west such as Ireland.

Goethe (1957) and Leach (1958) have recently published details of 22 recoveries in Britain of German-ringed Shelducks. These include two in Ireland and four in Wales. Migrants from the south of Ireland and South Wales would seem likely to pass over Bridgwater Bay.

Assuming an Irish origin for at least some of these Shelduck, it is not unlikely that such migrants *en route* for the moulting grounds in Germany would use Bridgwater Bay as an intermediate point where they could rest and feed. Thus the first July peak could be interpreted as being caused by such birds, supplemented perhaps by the local Shelduck which may congregate in Bridgwater Bay before leaving for the German moulting grounds. It is not impossible that all the Shelduck in Bridgwater Bay are potentially passage birds and that the area provides such favourable conditions that they tend to linger until they are overtaken by the moult. The moulting to the flight feathers is a very rapid process in Shelduck and one individual in Bridgwater Bay was observed to lose all its flight feathers at once while attempting to take off on being approached by a boat. That Shelduck migrations may be halted through a sudden loss of the power of flight is suggested by a report from Kent (Jolly *in litt.*) of nine Shelduck in flightless moult on Swanscombe marshes in July 1959.

c. Location of the moulting Shelduck

The factors which govern the suitability of Bridgwater Bay as a Shelduck moulting ground are not clear but presumably they are connected with food and the topography of the area. The analysis of the distribution of the birds shows that the region between Hinckley Point and Steart is the most favourable moulting ground, closely followed by Steart Point and Steart Island. The proportion of flightless birds on these last two sites, however, was usually low. The absence of appreciable numbers of Shelduck in the Parrett estuary and off the Berrow coast between Brean Down and Burnham is most likely to be due to disturbance factors. The traffic to and from Bridgwater Docks would make the river estuary an unsuitable area for flightless birds while the Berrow shore in summer is a popular rendezvous for holidaymakers who in turn would tend to drive away the Shelduck. At other times of the year, Shelduck are often found in these places and there are probably no factors which would make them inherently unsuitable moulting grounds.

d. The Shelduck population elsewhere in the Bristol Channel and Severn estuary

The pattern of the Shelduck movements elsewhere in the area surveyed is similar to that expected if these birds migrated to the German moulting ground. The spring population of about 1000 was maintained until the middle of June when there was a sharp drop in numbers which continued to fall until only a very few birds remained by the end of July. During this period, there was a very noticeable decline in the first week of July suggesting a further mass exodus at about this time. These observations support the belief that the Shelduck leave in two waves with the non-breeding birds preceding those which have bred. The results also agree with those of Coombes (1950) who found that the moult migration took place in July. He

also established that the return from the moulting areas was in the nature of a drift back spread over a period of at least six months. This is in accord with the present findings, for the repopulation by the Shelduck of the Bristol Channel and Severn Estuary after the moulting season of 1959 was very slow.

Very few Shelduck have bred on either Flat Holme or Steep Holme in recent years but considerable numbers were seen on these islands between May and July (in all, 55 on Flat Holme and 62 on Steep Holme). Some of these birds may form part of the Somerset population for evidence of movements between the islands and the shore was obtained on 15th June when two pairs of Shelduck were seen over the sea between Brean Down and Steep Holme. One pair was flying towards the island and the other in the direction of Bridgwater Bay. No Shelduck were seen on these islands after 8th July.

e. **Breeding success**

The study of the brood production was continued until the beginning of August. It is improbable that all the young Shelduck were seen from the air although a comparison with some ground counts made by members of the Bristol Naturalists' Society suggests that a high proportion of the young were recorded from the aircraft. However, the method should suffice to show trends and the results could be used as samples for comparing the breeding success in different years. The first young were seen in the middle of June and had presumably hatched a few days earlier, as the ducklings are led to the water soon after hatching. Maximum numbers were recorded during the first week in July. These results suggest that breeding was a little late this year as the peak period for egg laying is usually given as the second week in May with an incubation period of 28 days. A report on the breeding survey in the Bristol district (Taylor, 1960) gives fuller details of breeding success, and also compares the completeness and accuracy of counts from the ground and from the air.

Conclusion

This survey of the Bridgwater Bay Shelduck seems to have been sufficiently promising to warrant further investigation. There is little doubt that aerial survey is the most efficient and also the cheapest method of obtaining a census of the birds present but any further work ought to be linked with investigations made on the ground. It seems desirable to know what type of birds (*i.e.* breeder or non-breeder, *etc.*) is in moult in order to test the theory of a double wave of immigrants. This would require the collection of a sample of birds from which details of weight, plumage and gonad development could be extracted and used to throw some light on the problem. It is highly desirable that some of the moulting birds should be ringed in order to ascertain their place of origin, but this is a difficult task for which at the moment there is no easy solution.

The factors which make Bridgwater Bay a suitable moulting area are not known and call for further research. The causes are likely to be found in conditions of food and topography and a detailed study of these factors is required. Stomach analyses should detect the nature of the food and field

observations ought to disclose the feeding areas. An ecological investigation of the food organism would follow next and should yield information allowing the limiting factors which prevent the dispersal of the moulting Shelduck to be more clearly understood.

At the same time more aerial counts are necessary to examine further the several peaks detected in 1959. These surveys ought to be carried on throughout October for there appears to be a sizeable moulting population during this month.

ACKNOWLEDGEMENTS

Mr. S. M. Taylor and members of the Bristol Naturalists' Society have co-operated in this work during 1959 by making ground counts of a large sector of the area covered from the air. Other persons who have provided useful information include Miss E. M. Palmer, Wing Commander the Rev. J. H. K. Dagger, Dr. N. W. Moore, Mr. I. Presst and Mr. J. Morley (Warden, Bridgwater Bay Nature Reserve).

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THE NUMBERS OF DUCKS CAUGHT IN BOROUGH FEN DECOY, 1776-1959

W. A. Cook

In the years since Borough Fen has been operated as a Trust ringing station detailed notes have been made on the numbers of ducks caught. These notes are of immediate value in a number of ways, such as showing which pipes and which methods of catching are most successful at different times, but their greatest general interest lies in the picture they give of seasonal fluctuations in the catch. I have recently been able to examine the books kept by members of the Williams family, who worked the Decoy from about 1670 to 1958, and to compile from them graphs showing the numbers of ducks caught annually during most of the last 180 years. It is intended to make a full study of the records in relation to other decoy catches, shooting bags, and factors such as weather and land drainage which are likely to have affected the numbers of ducks caught. This study will take a long time, but there are a number of obvious features about the annual catch graphs which made their preliminary publication worthwhile.

From 1776 to 1840 the Williams' books show the total catches in 53 seasons, there being a break from autumn 1780 to spring 1787 and no records for 1797-98, 1800-01 or 1818-19. No records for 1841 to 1888 can be found. The five seasons 1888-89 to 1893-4 are chronicled and then the seven 1896-97 to 1902-3. A ten year break follows, but the series is complete from 1913-14 until the present time.

Since 1888 the species have been listed separately, but the records for 1776 to 1840 are unfortunately complicated by the fact that the units used consist of 'dozens' and that in making up a 'dozen' for the market species other than Mallard were counted as half-ducks (24 Teal or Wigeon=12 Mallard=1 dozen ducks). There is no means of discovering the proportions of different species caught during the early period and so we do not know exactly how many ducks were taken in the various seasons. Each recorded figure is obviously a minimum (as if only Mallard were caught) with a total twice as big as the listed one representing a possible maximum (all half-ducks, no Mallard). For the purpose of long-term comparison it seems simplest to treat recent catches in the same way and to plot them all in 'dozens' (Figure 1).

The catch of 450 dozen and 8 in 1804-05 is the largest recorded, followed by 422 dozen in 1919-20, 404 dozen and 9 in 1776-77 and 400 dozen and 9 in 1916-17. The lowest catch noted, 25 dozen, was in 1837, with those of 1955-56 and 1956-57 and the years 1838 to 1840 very little better. The best period for sustained high yield seems to have been 1913 to 1920.

It is remarkable that the general level of catches in the earlier years for which records are available is no greater than that in recent times, despite the great changes in land use which have occurred in the Fens, and in many other parts of the range of the ducks visiting Peakirk.

During the last seventy years at least, Mallard and Teal have made up most of the catch. Figure 2 shows the variations in seasonal catch of these two species (in ducks, not dozens). It makes very clear that the harvest of

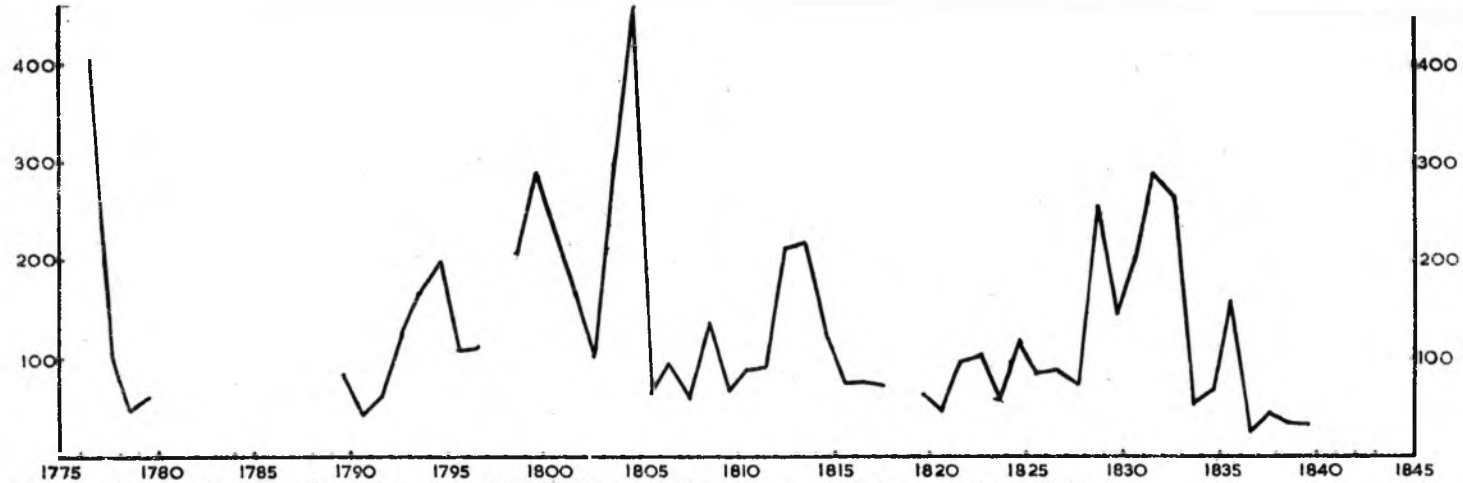


FIGURE 1 (part 1). Number of ducks taken in Borough Fen Decoy, in 'dozens,' 1776-1840.

FIGURE 1 (part 2). Number of ducks taken in Borough Fen Decoy, in 'dozens,' 1888-1959.

the bumper years 1913-20 consisted largely of Mallard and that only in two seasons (1937-38 and 1939-40) were Teal greatly in excess. It is encouraging to note the recent rise in Mallard numbers after a 15-year period of decrease, especially since these birds are being returned to the population after ringing instead of being killed. The Teal graph is less reassuring, though it could be that catches will again increase greatly as they did after the low period around 1915.

The only other ducks that have been taken in significant quantities at Borough Fen are Wigeon, Pintail and Shoveler. The largest catches of Wigeon were 436 in 1939-40, 420 in 1948-49 and 410 in 1900-01. In 1888-93 the average annual catch was 94; in 1896-1903 it rose to 150 (60 in the worst season, 1896-97); from 1913 to 1920 it was about 134 (range 25-280); from 1920 to 1930 the average catch was 45 (the range 2 to 268; from 1930 to 1940 the average was 107, range 0 (1930-31) to 436; from 1940 to 1950 average 112. Since the high of 420 in 1948-49 the catch has fallen right away, only sixteen having been caught in ten seasons. This is probably a reflection of the reduced flooding which now takes place in Cowbit Wash.

Recent catches of Pintail and Shoveler have also been negligibly small but there have been periods in which each was relatively common, though there is no information prior to 1913. The highest known season's catch of Pintail was 286 in 1942-43, followed by 132 in 1943-44. The war period 1939-45 was very much the best. 60 in 1926-27 was the only catch of more than fifty outside that period and in most seasons the number was nearer ten.

The record catch of Shoveler was 267 in 1917-18, with 157 in 1945-46 second and 114 in 1948-49 third. For most of the period from 1918 to 1945 the annual catches were less than 10 birds and since 1949 this has again been the case. It seems unlikely that we can discover why these species are occasionally catchable in numbers until a good season again occurs. (At Slimbridge too hardly any are caught although Pintail winter in hundreds and Shoveler are resident. Pintail ignore the Decoy pool. Shovelers use the pool but cannot be baited or dogged into the pipes).

The Decoy books occasionally give some information on prices realised in the past. In 1793 ducks were sold for 1/8d each; in 1799 2/6d; in 1806 3/2d; in 1810 4/9½d; in 1818 3/4d; in 1826 3/2d; in 1835 1/5d; in 1917-19 8/- (compared with 4/9d to 5/- at the present day). It is of some interest to compare these prices with others for different places and periods during the last 250 years. Figure 3 records graphically some changes in the market price of a Mallard from 1713 to 1959. The prices other than those for Borough Fen ducks have been found by superficial search of published sources. They represent the sum paid to the decoymen, not the retail price.

There are large gaps in the record, particularly in the 19th and early 20th centuries, but the available figures suggest several points. During much of the 18th century the price ranged between 7d and 2/- each. From 1794 to 1810 the apparent value of a Mallard rose by nearly four times. This large change was probably due to inflation at the time of the Napoleonic wars. The subsequent slump in price during the 1830's was not only a result of the changing value of money but because ducks became easier to obtain.

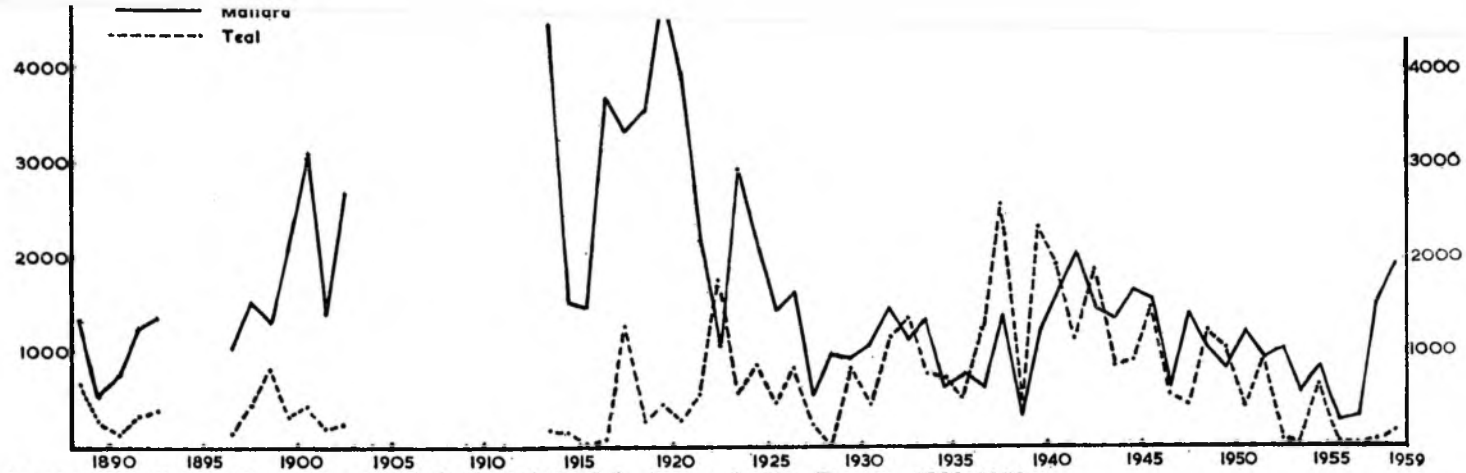


FIGURE 2. Seasonal catches of Mallard and Teal in Borough Fen Decoy, 1888-1959.

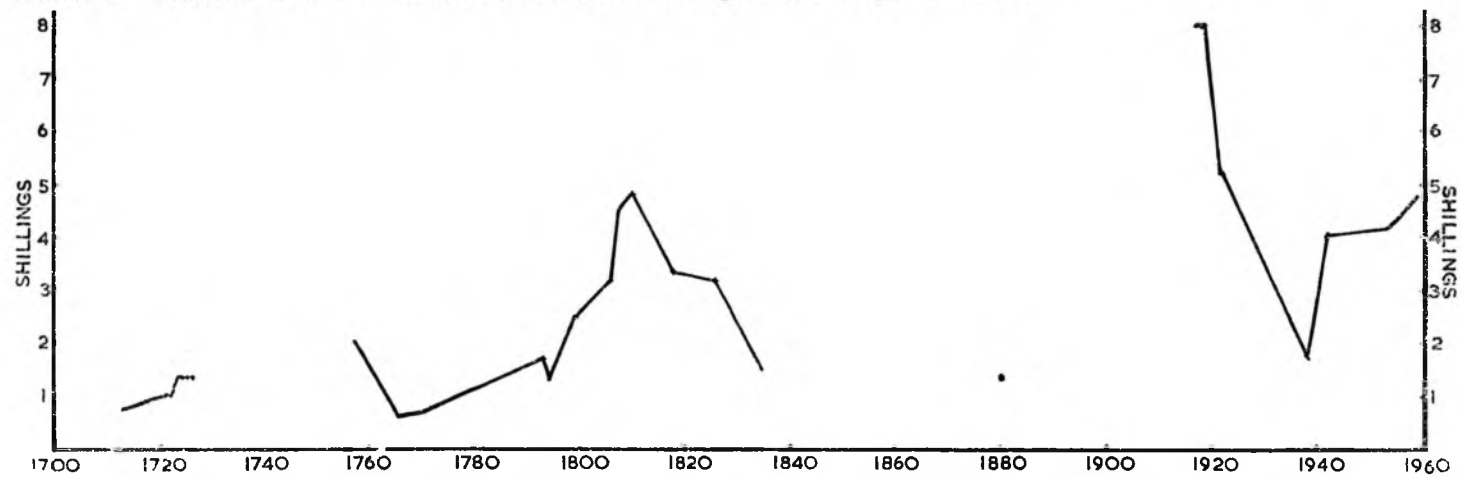
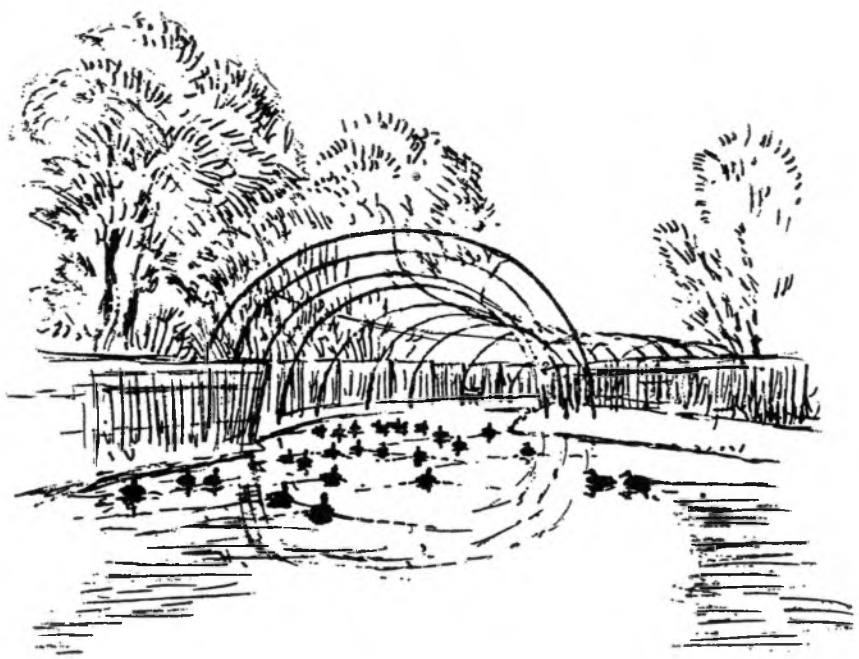


FIGURE 3. Prices obtained by decoymen for Mallard at various times between 1713 and 1959. Figures on the abscissa show price of a single bird, in shillings, though ducks are normally sold in dozens.

It was at this period that reliable guns suitable for wildfowling came into use and also that the importing of ducks from Holland began on a large scale. The British decoys had formerly provided the majority of ducks offered for sale. Now serious competition arose from two directions—the British gunners and the Dutch decoys. Thus it came about that though many decoys were built in the middle of the 19th century few of them, if any, proved profitable and most were soon abandoned.

In the 20th century the two World Wars caused temporary booms, especially remarkable in 1917-19, but the profitable operation of a decoy has become increasingly difficult. Captain H. A. Gilbert, writing in 1938, considered that an average seasonal catch of 3500 was required to begin to make a profit. Very few British decoys have consistently yielded catches of that size (Borough Fen did so only in the years 1913-20). At present, with further substantial increases in the costs of labour and material in the last twenty years, even Gilbert's suggested figure would be too low.

The money value of a Mallard is now nearly four times what it was in 1794. Yet at that time the decoyman's price for a duck was equal to a day's earnings of an agricultural labourer. Even the most frugal of modern decoymen would find it hard to exist on 4/10d a day.



LEAD POISONING IN WILDFOWL[1]

P. J. S. Olney

Summary

THE symptoms and pathology of lead poisoning are fully described, with special reference being made to diagnostic features which could be used in any quantitative assessment.

The amount of lead shot which constitutes a fatal dose is discussed. It is estimated that 60/80% of adult Mallard with one ingested pellet will succumb, if they are feeding on a diet of wild seeds.

The availability of lead shot pellets to wildfowl on a particular body of water is determined by 1) the shooting intensity and number of shot deposited on the bottom, 2) the nature of the bottom material and 3) the size of the shot pellets involved.

The incidence of ingested pellets can be determined by fluoroscopic examination and examination of viscera material, and will vary with the species and its feeding habits.

Tables showing the incidence of ingested lead shot in four species of dabbling ducks in this country and in comparable species in North America are shown and discussed. There is a marked similarity between Mallard in this country and North America carrying *ingested* lead.

The reproductive capacities of poisoned wildfowl do not seem to be seriously affected.

The variations in mortality between different ages and sexes are attributed primarily to differences in the quality and quantity of food consumed.

Means of reducing or eliminating losses are discussed, including the use of non-toxic shot, encouraging the growth of natural foods most likely to alleviate the poisoning effects, and more care in the choice of shot range. As yet no satisfactory non-toxic shot has been produced.

Introduction

Lead poisoning, caused by the actual ingestion of lead pellets, is a significant mortality factor amongst wildfowl in many parts of the United States, and has caused considerable concern to conservationists for many years. Its occurrence in this country has rarely been recorded in wildfowl (Clapham, 1957 and personal comm.) or in any other birds (Keymer, 1958 and personal comm.), and no quantitative assessments have been made. The purpose of this paper is to show the nature of the disease, its implications, and the various methods which can be used in evaluating the losses due to lead poisoning. Basically it is a review of available literature.

That fatal results are caused by birds of many species—ducks, geese, swans, coots, rails, partridge, and pigeons—eating lead pellets, whether as food or grit, has been recognised since the 1870's (Phillips & Lincoln, 1930). Grinnell (1894, 1901) described the symptoms that appeared following the ingestion of shot by swans, geese and ducks at Currituck Sound on the coast of California, and he also noted three places in Texas where lead poisoning had occurred. Bowles (1908) recorded similar symtoms in a number of Mallard (*Anas p. platyrhynchos*) and McAtee (1908) in the same year gave an account of lead poisoning in Canvasbacks (*Aythya vallisneria*). Wetmore (1915, 1919) not only reported lead poisoning in Whistling Swans (*Cygnus c. columbianus*), Mallard and Pintail (*Anas a. acuta*), but also carried out the first experimental work on lead poisoned ducks, from which he described the premonitory and postmortem symptoms. Since Westmore's pioneering work many instances of plumbism have been observed and recorded (Munro, 1925; Van Tyne, 1929; Howard, 1934; Pirnie, 1935; Shillinger & Cottam, 1937; Jones, 1939; Jones, 1940; Roberts, 1940; Adler, 1942; Mohler, 1945;

[1]This paper has also been published in Bull British Orn. Club 80(3) : 35-40 & (4) : 53-59, 1960.

Bellrose, 1947; Ayars, 1947; Yancey, 1953; Wisely & Miers, 1956; Bellrose, 1959).

In some instances the number of deaths directly attributable to lead poisoning reaches spectacular proportions. Bellrose (1959) cites an outbreak in the Claypool Reservoir area near Weiner, Arkansas, where between mid-December, 1953 and mid-February, 1954, an estimated 16,000 ducks, most of them Mallard, succumbed to lead poisoning. This represents a 6.4 per cent mortality among the 250,000 duck present. A further example quoted by Bellrose took place at Dalton Cut-Off in Chariton County, Missouri in 1949, where it was estimated that in a population of 10,200 duck, again mostly Mallard, 1,000 died from the effects of ingesting lead pellets.

Signs and Pathology

The signs of lead poisoning in wildfowl are recognisable before and after death and have been described by a number of people, including Wetmore, 1919; Howard, 1934; Shillinger & Cottam, 1937; Adler, 1944; Jordan & Bellrose, 1951; Coburn, Metzler & Treichler, 1951; Elder, 1954; and Wisley and Miers, 1956. The following account of symptoms and pathological conditions is based mainly on their work with a few observations of my own. The general pathology is similar for wild and captive birds with ingested lead pellets, induced or freely-taken, and for wild-caught birds with an administered lead salt solution. Typically there is a definite pattern with the development of each symptom being followed by an increase in its severity, usually an illness of short duration, ending in death.

One of the first symptoms to appear with experimental birds is a marked lethargy with a lessening resistance to being handled and a quick return to a resting position. This has been interpreted as the beginning of muscle paralysis, though it is probably correlated also with a lowered food intake, where consumption falls to a level below minimum nutritional requirements. At the time of death the body weight may average only 40 per cent of the original weight, with a reduction in, or total absence of any fatty tissues. Bright green droppings (due to excessive bile production) are commonly observed within two days of lead ingestion. Frequent water drinking is usual and a greenish diarrhoea is produced with in some cases a green bile staining of the feathers in the ventral region. By the third and fourth weeks the sternum becomes prominent and there is a characteristic ' roof-shaped ' positioning of the wings as they are held over the back, with an associated dropping of the chest and high carriage of the tail. In some cases the wings of sick birds are extended downwards in a ' wing-drop '—analagous to the characteristic wrist-drop in human lead poisoning.

The most striking post-mortem feature is the extreme emaciation with a loss or reduction of fat deposits in the body cavity. Particularly noticeable is the reduction of the main flight muscles. Flaccid muscle tissue is a general finding. There is usually a marked flabbiness of the heart muscles, exaggerated by the small amount of impoverished blood and often an effusion of the pericardium. There is generally a marked reduction in the size of the liver, which histologically was shown by Coburn, Metzler and Treichler (1951), to be due in part to necrosis. More than the normal amount of bile is present

in the gall bladder and duodenum, and characteristically it is bright green. Regurgitation of bile into the gizzard and proventriculus is common, though it is doubtful if this should be taken as a definite sign of lead poisoning as was done by Anderson (1959). The gall bladder may be enlarged to five times its normal weight. Atrophy of the gizzard muscles is a regular observation. The horny pads of the gizzard may be very stiff, abnormally rough and easily peeled off. Commonly the gizzard is ulcerated and the proventriculus impacted (44 per cent of the penned Mallard used by Jordan & Bellrose, 1951). Anaemia is a constant finding with definite changes in the blood. These changes, particularly affecting the erythrocytes, follow a consistent pattern according to Coburn *et al.* (1951). In their experimental Mallard, dosed with an aqueous solution of lead nitrate, anisocytosis (inequality in size of erythrocytes) was observed early on, followed by poikilocytosis (irregular shape of erythrocytes). In the majority of cases there was a decrease in the numbers of erythrocytes. The normal average number for Mallard is 3.06 millions per cubic millimetre according to Magarth & Higgins (1934), though it will vary with the sex and age of the bird. Though reductions in erythrocyte numbers of up to 40 per cent have been noted by Elder (1954), and it has been suggested that the decrease varies with the dosage and could therefore be used as a measure of toxicity, there does also appear to be a considerable variation between individuals of the same species.

The characteristic basophilic stippling of the erythrocytes first noted by Ehrlich (1885) and correlated with lead poisoning by Behrend (1899), which is so apparent in mammalian plumbism, is not a consistent finding in avian species. Coburn *et al.* (1951) state that they had rarely observed stippling in any avian species. However, Johns (1934) in a careful survey of the blood of wild duck poisoned by lead pellet ingestion, found extensive basophilic stippling. In chronic cases numerous stippled cells begin to appear, coincidental with unmistakeable changes in the nucleus. It was suggested that the direct combination of lead with phosphates on the surface of the erythrocytes and the local liberation of a weak acid, as shown by Aub, Reznikoff & Smith (1924), is sufficiently toxic to produce actual cell death. This has since been disputed by Jandl & Simmond (1957). Whatever the toxic mechanism is, the stippling produced by a basophilic stain is considered to be characteristic of a *dying* cell, seen in the sequence of events in the usual maturation of semi-mature cells in the peripheral circulation. The disagreement between the work of Coburn *et al.* and Johns may possibly be due to differing dosage rates and the difference in acute and chronic cases. More detailed work is needed before stippling of the erythrocytes can be used as a diagnostic character in avian lead poisoning.

It was clearly demonstrated by Jordan & Bellrose (1950) that the toxic effects of ingested shot is due to the lead fraction in the pellet alloy. Abrasion of the pellets in the gizzard results in the circulation of complex lead componds in the blood stream throughout the body. It seems probable that soluble lead salts are formed in the presence of gastric juices (Cantarow & Trumper, 1944). These may form albuminates, peptonates and other more soluble compounds which are readily absorbed and distributed throughout the tissues by the blood stream. Lead compounds may be deposited in varying amounts in the liver, kidneys, bones, nerve and muscle tissues.

Chemical analyses of various organs from lead poisoned birds can be used as diagnostic aids, though the rate of deposition is not directly proportional to the dosage level or to the time of poisoning. Coburn *et al.* (1951) found that the most significant increases in lead content were in the liver, where the average value for the poisoned birds was forty times that for the normal controls. Likewise, the lead content of skeletal material from poisoned birds was seven times higher than that found in the controls. Adler (1944), from his work with lead poisoned Canada Geese (*Branta c. canadensis*), has suggested that the liver is the best organ to choose for chemical analysis in aiding diagnosis. By using his approach a more accurate index of lead poisoning may be had. Malysheff (1951), cited by Bellrose (1959), made chemical analyses of the bones and liver of wildfowl taken in the Lower Fraser Valley of British Columbia. He found that 52 per cent of the 79 Mallard he examined had ingested lead at one time or another in their lives, though only about 16 per cent had actually got lead in their gizzards. Recently, Schöberl (1958) has suggested that either a photometric method. using diphenylthiocarbazone, or a polarographic method is most suitable for determining the amount of lead in various tissues.

It seems that the liver is efficient in removing lead from the portal blood but is not so effective in removing it from the systemic circulation. It is possible that lead reaching the liver in the portal system is excreted in the bile and may subsequently undergo reabsorption: this cycle preventing or limiting the amounts of lead that reach the systemic circulation (Cantarow & Trumper, 1944).

The gross pathologic findings are very similar to those produced by starvation, as has been well shown by Jordan (1951, 1953). The suggestion is that death from lead poisoning may be due to, or accelerated by, starvation caused by the paralytic inactivity of the gizzard muscles and a low food intake. Jordan (1951) and Jordan & Bellrose (1951) outlined experiments where they measured the food intake daily of Mallard dosed with one pellet, and fed exactly that amount to a companion control the following day. In nearly all pairs, the weight loss curves, symptoms, gross appearance of viscera and muscles, and mortality were similar, though no impaction of the proventriculus was shown by the deliberately starved birds. Jordan (1953) showed that in intentionally starved Mallard the loss of weight in the liver, kidneys and heart averaged 69.4, 26.8 and 36.7 per cent respectively for males and slightly less for females, with an enlargement of the gall bladder (3 times normal weight) in both sexes.

Fatal Dosage

The amount of lead shot which constitutes a fatal dose varies with the species, the age and sex of the bird, the individual, its general condition, whether it is hand-reared or wild, the feeding habits of the species, and often from author to author. In comparing American work on this subject with available British figures, account must be taken of the differences in shot size. Most of the American work on duck has been done with their No. 6 shot (225 pellets per ounce) or No. 5 (170). Fortunately these shot sizes compare favourably with the sizes usually used in duck shooting in Britain; No. 5 (220) and No. 4 (170). Wetmore (1919) found that six No. 6 shot were

always fatal with hand-reared Mallard. Jordan & Bellrose (1950) found that *one* No. 6 shot was fatal for six out of 10 wild Mallard fed on a diet composed wholly of natural-growing seeds and for seven out of 10 wild Mallards fed on a diet of mixed grains. As a large proportion of the Mallard in England during the shooting season are feeding on a high percentage seed diet (Olney, unpubl. mat.), Jordan & Bellrose's work has obvious importance. They concluded that 60/80 per cent of adult wild Mallard carrying *one* pellet were likely to succumb, if they depended upon diets of wild seeds. It is apparent from their work (1950, 1951) and that of Elder (1954) that the nature of the diet rather than the dose of ingested lead was the more important variable. The effects of lead poisoning are considerably reduced when various leafy, aquatic plants are introduced into a grain or wild seed diet. *Ceratophyllum demersum, Potamogeton pectinatus, Lemna minor* and *Lemna trisulca* were found to be particularly beneficial—probably by acting as buffers and lessening the mutual grinding effect between seed and pellet. In this country, probably only the two duckweed species (*L. minor* and *L. trisulca*) are taken in appreciable quantities by Mallard, Teal (*Anas c. crecca*) or Wigeon (*Anas penelope*) during the winter months.

Availability

The frequency of occurrence of ingested lead pellets will vary not only with the availability of the pellets, but also with the feeding habits of the different species. Most of the shot fired in the pursuit of wildfowl will in fact fall over water, sink and, depending on the nature of the bottom material, be liable to become ingested by feeding birds. The primary limitation on availability will depend on the shooting intensity and the amount of shot which is deposited on the bottom. It is impossible, and it would certainly be tactless, to estimate accurately the number of cartridges fired for every duck or goose killed. Nevertheless, in certain parts of the country, particularly where most of the shooting is done from behind butts (hides) or over flight ponds, the number of pellets which do not hit a bird, and are deposited in the adjacent mud, must be very high. There will obviously be an increase in susceptibility as the shooting season progresses. The pellet numbers actually available to birds will depend to a large extent on the type of bottom material, and on the size of shot used. This has been shown to be true by Bellrose (1959), using lake beds of different firmness and sinking ceramic pipes in each area with three shot sizes in the top soil of each. By sifting the mud contents a year later, he was able to show that movement of the pellets depended on the degree of firmness of the soil and on the size of shot. The smaller the size of shot, the more likely was it to be dislodged and scattered.

The actual depth to which the bird will dabble in the mud will depend on the species involved and on the food available or preferred. Species of duck differ to some extent in preferred feeding depths, so that the depth of water above the bottom may also determine the availability of pellets. Dabbling ducks usually feed in waters of less than 15 inches in depth, whilst diving ducks feed at depths of many feet, though Pochard (*Aythya ferina*) and Tufted Duck (*Aythya fuligula*) may and often do feed in shallower water. Other species of duck will rarely sift through bottom muds for food,

relying more on leafy aquatic plants (Gadwall, *Anas strepera*), or actually grazing on various grasses and seaweeds (Wigeon, Olney 1957). That the incidence of ingested lead varies considerably with the species and its feeding habits is well shown by American figures (Shillinger & Cottam, 1937; Cottam 1939; Bellrose, 1951; Anderson, 1959). It is probable that the pellets are taken by the birds accidentally or deliberately as or with grit, or accidentally with food material.

Frequency

The incidence of lead shot can be determined either by examining the dead bird (usually as a by-product of a food investigation) or by fluoroscoping live-trapped or dead birds. But the absence of lead shot is not a sure indication that the bird is not suffering or has not suffered from the effects of lead poisoning. Jordan (Bellrose 1959) found in controlled experiments with captive Mallard that 21 per cent of 119 birds dosed with a single No. 6 pellet had *no* pellets in their gizzard at the time of death. Of 1153 Mallard picked up either dead or dying from lead poisoning between 1938 and 1955 in six American states, 132 (11.4 per cent) had no lead pellets in their gizzards (Bellrose, 1959).

The actual time which a pellet has been in the gizzard can often be roughly ascertained by the amount of abrasion and erosion that has taken place over the surface. By using an aspirator (Nord, 1941) to recover pellets from a live duck which has been dosed with shot, it is possible to observe the effects of the digestive processes and grit movements. Signs of erosion are evident within 12 hours. The ridges and craters commonly formed on the pellets when discharged, are smoothed, the surface is pitted and in places a silvery grey cast appears.

Bellrose (1959) provides a comprehensive table showing the incidence of lead shot found in gizzards of various Anatidae in America during the autumn and early winter months of 1938-1953. Parts of this are reproduced opposite (Table 1) in order to show species comparable to those found in this country.

Since 1957 the Wildfowl Trust has been examining viscera and their food contents. Table 2 opposite summarises the numbers and species which were found to contain lead pellets.

Though only three species have so far been found to contain pellets, this is probably due to the smallness of the available sample. Mallard, though they may do considerable feeding in grainfields at certain times of the year, spend much time feeding in marshes and open stretches of water, often heavily shot over. Their habit of deep-puddling into the bottom soil in pursuit of seeds probably brings them into contact with deposited lead shot more frequently than any other dabbling species. The proportion of gizzards from Mallard which contain pellets is remarkably similar for British and American birds. It is significant that of 277 Teal viscera examined in this country *none* contained lead shot, although their diet is similar to that of the Mallard. Field observations suggest that Teal only dabble in the top one or two inches of mud in search of food, and they may therefore be missing the critical depths where lead pellets are lodged. All of the sixteen Mallard found to contain pellets had been feeding inland or in

TABLE 1. Incidence of lead shot in N. American species 1938-53. (after Bellrose, 1959, p.260).

Species	No. of gizzards examined	1 pellet No.	1 pellet %	Over 1 pellet No.	Over 1 pellet %	Total No.	Total %
Mallard *Anas p. platyrhynchos*	17,066	757	4.44	402	2.35	1,159	6.79
Gadwall *Anas strepera*	1,141	14	1.23	7	0.61	21	1.84
Baldpate *Anas americana*	1,577	42	2.66	8	0.51	50	3.17
Pintail *Anas a. acuta*	4,530	241	5.32	161	3.55	402	8.87
Green-winged Teal *Anas crecca carolinensis* ..	2,272	23	1.01	8	0.35	31	1.36
Shoveler *Anas clypeata*	1,439	19	1.32	4	0.28	23	1.60
Redhead *Aythya americana*	597	56	9.38	25	4.19	81	13.57
Lesser Scaup *Aythya affinis*	886	67	7.56	49	5.53	116	13.09
Canada Goose *Branta c. canadensis*	511	4	0.78	0	0	4	0.78

TABLE 2. Incidence of lead shot in British species 1957-59.

Species	No. of gizzards examined	1 pellet No.	1 pellet %	over 1 pellet No.	over 1 pellet %	Total No.	Total %
Mallard *Anas p. platyrhynchos* ..	244	14	6	2	1	16	7
Wigeon *Anas penelope*	288	4	1	0	0	4	1
Teal *Anas crecca*	277	0	0	0	0	0	0
Shoveler .. *Anas clypeata*	14	1	7	0	0	1	7

a slightly brackish habitat, and none of the birds shot whilst *feeding* on saltmarsh species contained any pellets.

A large sample of diving ducks is needed before any figures comparable to American species are available. Possibly in certain areas diving ducks are particularly vulnerable to lead ingestion—at least the American figures indicate that is so.

A small number of birds sent in for post-mortem examination have been found to be suffering from lead poisoning. The most startling case was a first-year drake Mallard, hand-reared though not pinioned, which had 41 pellets in the gizzard, and not surprisingly showed the typical lead poisoning syndrome symptoms. In this case, although the pit where the ducks were kept had not been shot over, it is thought that some old cartridges may have been thrown into the water.

Fertility and Fecundity

Apart from direct losses, some concern has been engendered by evidence in other animals that their reproductive capacities are impaired by lead poisoning (Cole & Bachhuber, 1914—rabbit and fowl; Aub *et al.* 1926—man). Shillinger & Cottam (1937), Cheatum & Benson (1945) and Elder (1954) have voiced concern over possible sterility as an after effect of lead poisoning in wildfowl. However, Cheatum & Benson (1945) concluded that no significant loss of fertility resulted from the ingestion of lead shot in male Mallard. In a series of experiments by Elder (1954) to test the effects of lead poisoning on fertility and fecundity in Mallards, he administered 18 No. 6 shot to his experimental birds. Although he managed to show that fecundity was reduced, while fertility, embryonic success and hatchability were not, his results are somewhat nullified by his use of such a large dosage level. Rarely will 18 pellets be ingested by a duck, and seldom will significant numbers recover from the resultant severe poisoning.

Movement and Mortality Rates

Field experiments conducted by Bellrose (1959) in the years 1949-51 showed that birds dosed with lead shot had 1) a greater vulnerability to being shot, 2) a lower ability to migrate and 3) higher over-all mortality rates in the first year after being ringed and released. Wild Mallard that were dosed with one No. 6 shot each and then released were 1.5 times as vulnerable to shooting as were undosed controls; those dosed with two No. 6 pellets were 1.9 times as vulnerable and those dosed with four No. 6 pellets were 2.1 times as vulnerable. In the dosed Mallard the effects of the ingested shot did not appear to affect their behaviour until 5 days, when the proportion of ring returns became higher than for undosed birds. The period of affliction appeared to persist for about 15 days or slightly longer until the ringing returns reverted to more similar figures for both dosed and undosed birds. It is suggested that either the duck is shot or dies of lead poisoning in the second or third week following ingestion, or they begin to recover by the early part of the fourth week. The weakness and fatigue symptoms so apparent as part of the lead poisoning syndrome, are likely to reduce their movements. That it has a pronounced effect on their local movements has been shown experimentally by Jordan & Bellrose (1951) and Bellrose (1951, 1959). The more ingested lead pellets there are per bird, the greater is the reduction in the movements of those birds.

The variations in mortality rates with different sexes and ages were attributed primarily to differences in the quality and quantity of food consumed. It is known that the food intake of juvenile Mallard exceeds that of the adults, and it has been shown experimentally (Jordan & Bellrose, 1951) that the juvenile Mallard mortality rate from lead poisoning is less than the adult rate. The female mortality was higher than comparable male mortality in all months apart from the spring months when the female is known to eat more than the drake. At all other seasons the female is thought to eat less than the male (Jordan & Bellrose, 1951). Lower air temperatures which are known to increase food consumption may well have an effect on the mortality numbers.

Reduction of losses

In an effort to eliminate the losses due to lead poisoning among wildfowl various non-toxic shot alloys have been advocated and tested. Jordan and Bellrose (1950) reviewed previous work and tested a number of possible alloys. Several metals regarded as being non-toxic were considered as substitutes for lead. The availability, physical and chemcial properties, price, and ballistic performance were factors which had to be taken into consideration. Green & Dowdell (1936) suggested that a lead-magnesium alloy shot would not cause lead poisoning. They suggested that the magnesium would be hydrolysed by water which would produce irregular cracks across the surface and the final disintegration of the pellet. Unfortunately their findings were not substantiated by Jordan & Bellrose's careful experiments. Three other lead-alloy shots tested, lead-phosphorus, lead-calcium and a copper-alloy coated lead shot, were not less toxic than the usual lead-alloy shot used. Attempts to coat lead shot with a nylon plastic in order to lessen the abrasion effects were unsuccessful (Bellrose 1959). However an iron-alloy was found to be non-toxic when dosed to penned wild Mallard, but it has the disadvantage of not being so effective a shot as a lead shot when fired at maximum ranges, because of its lower density (Bellrose 1953). Ignoring their availability and price, there are many metals which could probably make good or even better shot pellets than the lead-alloy now used. The physical properties of gold would make it a good example—though its use as a shot would probably be confined to a favoured few.

As the effects of lead poisoning can be greatly minimised by the form of food consumed, one of the means of alleviating losses would be to encourage the growth of suitable leafy, aquatic plants. Though often freely given, corn is the least beneficial in reducing the poisoning effects.

It would probably be impertinent to suggest that less pellets would be available for ingestion if wildfowlers were more careful in their selection of shot ranges. Nevertheless, more careful shooting would undoubtedly reduce the chances of lead pellets being obtainable by feeding birds.

There are no records in this country comparable to the spectacular local outbreaks of lead poisoning recorded in the United States. It is probably more in the dispersed, day to day mortality that our losses occur. Such mortality can occur constantly, and generally will pass unnoticed, particularly if there is cover available for the sick birds to hide until they die or are taken by predators.

Bellrose (1959) has estimated that approximately one-fourth of the wild Mallards in North America in any year ingest lead shot, and that in the Mississippi Flyway approximately 4 per cent. of the Mallards die as the direct result of lead poisoning, with an additional 1 per cent afflicted with lead poisoning being shot. For all wildfowl species in North America the annual loss due to lead poisoning is estimated to be between two and three per cent. of the population. These figures can only suggest what may be the extent of the problem in this country, and until we have more information no accurate assessment can be made. At the present time losses due to lead poisoning are probably small, but their possibility should certainly be taken into account in the dynamics of any wildfowl population.

ACKNOWLEDGEMENTS

It would be churlish of me to finish this paper without fully acknowledging the use of all the references mentioned in the text. I am, as must be so apparent, particularly indebted to the various papers of Bellrose & Jordan.

I am also most grateful to Miss P. Clapham and I. F. Keymer for a number of personal communications, and to all those wild-fowlers who have sent in viscera for food investigation. This paper is a by-product of work which is financed by the Nature Conservancy.

I would also like to thank H. Boyd and J. G. Harrison for reading and criticising the manuscript.

Appendix A

An adult female Pochard (*Aythya ferina*) found dead in a duck trap at Abberton Reservoir, Essex, on 20th February, 1960 proved on examination to contain *84* ingested lead pellets. Not surprisingly the bird exhibited signs of actue lead poisoning.

It is difficult to theorise as to the reason why such a large number were taken. Possibly the total is an accumulation of many ingestions—though the amount of erosion as shown in the photograph on p. 188, suggests that if this was so, it was not over a very long period.

Appendix B

An interesting paper by M. N. Rosen and R. A. Bankowski (A diagnostic technic and treatment for lead poisoning in swans, *Calif. Fish & Game* 46, 3:81-90, 1960) was unfortunately received too late to be included in the above review. Their work at Tule Lake National Refuge in Northern California on Whistling Swans (*Cygnus c. columbianus*) showed a range of 1.0 to 3.3 per cent. mortality due to lead poisoning. Of particular interest is their use of calcium versenate (calcium disodium ethylene diamine tetra-acetate) as a diagnostic aid and possible cure. An intravenous inoculation of this compound will cause a temporary alleviation of the lead poisoning effects by detoxification within the blood and tissues. The detoxification is due to the calcium versenate forming a soluble complex with lead which is rapidly excreted. It is however only a temporary remission, for any lead shot retained in the gizzard is unaffected and as more lead was absorbed the bird would suffer a relapse. Continued administration of calcium versenate effectively cured some swans, though those that had too many lead shot, or had the additional complication of impaction did not survive.

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A TECHNIQUE FOR REMOVING WILDFOWL VISCERA FOR RESEARCH

Jeffery G. Harrison

In July, 1957, Dr. Geoffrey Matthews and I published an article on "Duck Viscera for Scientific Research" in the *Shooting Times* for the benefit of wildfowlers, who were to supply the basic material for the proposed food and parasitic surveys of wildfowl to be undertaken by the Wildfowl Trust. My part in that article was to produce a practical method of extracting the viscera from a duck without spoiling the bird in any way for the table. The method had been worked out experimentally on a small number of duck obtained towards the end of the previous season, but since then the technique has been perfected and as the results are proving of such value, it would seem useful to record the method in some detail for others to follow or modify.

No wildfowler can be expected to co-operate if he is unable to eat his bird after he has finished removing the viscera, or if he finds the process too difficult or if his wife then tells him that the duck is in too disgusting a state to pluck. The technique to be described avoids all these pitfalls and has been performed by wildfowlers in all walks of life. The only instrument required is a sharp-pointed knife. If all goes well, I can now remove a specimen in two minutes. This should be done as soon as possible after death, because the gastric juices continue to digest any food for a considerable time, thus making the analysis far more difficult or impossible.

The following steps should be taken:—

(a) Pluck the belly. This enables the viscera to be removed without soiling the surrounding feathers, which would otherwise be unpleasant to pluck when the rest of the bird is dealt with and avoids complaints from the housewife.

(b) Place a plug of wool into the beak and push it down into the lower end of the oesophagus or gullet with the blunt end of a knitting needle. The plug should be pushed in until it is level with the shoulder joints and inside the chest. The exact length required can be measured first on the outside with the knitting needle.

(c) Leaving the needle in place and the bird lying on its back, with the thumb and forefinger of one hand, feel for the needle at the lower end of the neck, thus locating and holding the gullet, while the needle is withdrawn with the other hand. The soft tissues at the front of the lower end of the neck are then cut across, with the object of severing the gullet. This is ensured by fixing it firmly between the thumb and forefinger, otherwise it may slip away and remain intact.

(d) Open the belly with a cut from the lower end of the breast bone to the vent, care being taken not to pierce the intestines. Photograph One illustrates the position up to this point.[1]

(e) Identify the gizzard or lower part of the stomach. This is a large, hard, rounded structure; silvery with dark red muscle round the edge. It lies in the upper left side of the abdomen. With the thumb and forefinger of one hand feel above it for the proventiculus or upper part of the stomach. This is a soft, muscular structure, lying under the lower end of the breast bone. At its upper end it can be felt to narrow again and become continuous with a firmer tube, which is the lower end of the gullet. These structures should all be freed from the surrounding tissues with the forefinger and

[1]The photographic illustrations for this paper will be found at pp. 186-7.

when this is done, the lower end of the gullet is firmly grasped and pulled downwards. The whole of the gullet from the level where it was divided in the neck, can then be brought out through the abdominal incision. Photograph Two illustrates the position now, with the oesophagus being held.

This is the most difficult part of the whole operation, but the gullet contains the most recent and therefore the least damaged food and it is important to try to get it all. The difficulty is that the gullet sometimes breaks off. This is due to not freeing it properly at the lower end and then pulling on the proventriculus instead, which is not strong enough to bring out the gullet with it.

(f) Before going any further, close the upper end of the gullet by tying on a tag label, numbered in black Indian Ink. We have found that even the hardest pencil can be illegible after long immersion in the preservative solution.

(g) It only remains now to lift out the rest of the intestines to remove the whole viscera specimen intact. This is very easy. The bile duct breaks spontaneously and the lower end of the large intestine is cut across at the vent to complete the task, as shown in Photograph Three.

(h) The specimen is now placed in preserving fluid. I use 15% formalin in normal saline (formo-saline), which is stronger than the 10% originally recommended. The reason for this is that I fill a large pan with fluid, in which I leave the specimens until enough are collected, perhaps twenty, before removing them, wrapping them in rag, placing them in a polythene bag and parcelling them up for sending to the Trust. Such parcels have to be really secure.

One modification is occasionally required. This is when the gullet is so full of food that it is impossible to plug it with cotton wool and withdraw it through the abdomen. Thus, a Teal, which contained 10,000 *Salicornia* seeds had its neck, from the beak downwards, distended to more than twice its normal size and a Mallard which had just taken more than eleven acorns was similar. In such cases I divide the gullet and milk out the contents onto a piece of rag, which is then tied and labelled separately, before carrying on in the usual way with extracting the viscera.

The number on the label corresponds to a record of the species and sex of the bird, date, time and place where shot. Any notes of the feeding habits observed may be of value. In early September, 1959, I noted about Mallard in my diary that " Their routine was to come onto the fresh marsh fleets at dawn (from 0515 to 0700), then flight back to the stubbles and out to sea about 0900." This may have seemed rather surprising, but it was confirmed later by Mr. Peter Olney's analysis of a Mallard, which was found to contain seeds of barley, *Potamogeton* and *Scirpus*. Finally it is worthwile just looking at the divided lower end of the intestine to see if any seeds were about to be passed undamaged. If there are any, these should be sent in a separate container unpreserved, so that they may be grown. In this way, much may be learnt about the spread of plants by wildfowl.

Although the viscera specimen shown in the first three photographs was empty, photographs four and five show a specimen extracted from a Mallard by Dr. James Harrison, which was full of food. The oesophagus has been opened to reveal large numbers of seeds and a water beetle, lying separately. I am most grateful to Mr. Gordon Anckorn for taking the photographs to illustrate this article.

A BREEDING POPULATION OF THE MALLARD

Hugh Boyd and Bernard King

Summary

THE Mallard breeding population of four reservoirs in north Somerset consisted of 150 to 160 pairs in each of the three years 1957, 1958 and 1959. The recently constructed Chew Valley Lake, which first held breeding ducks in 1954 and which held 106-110 pairs in 1957-59, has been responsible for a great increase in the population, which averaged 60 pairs (range 30-80) from 1948 to 1953, and 120 pairs from 1954 to 1956.

Early nesting Mallard are almost wholly unsuccessful, apparently because of heavy predation due to lack of nesting cover in March. Newly hatched broods are unusually small, averaging 6-7 ducklings. The apparent size of broods changes little before fledging, as small broods seem unusually liable to coalesce.

It is estimated that over a twelve-year period about one-third of the females attempting to breed were wholly unsuccessful, though in several years (notably 1959) there were few failures.

1950 seems to have been a particularly bad year for the production of young, and this was reflected in a small breeding population in 1951. There is a clear linear relationship between the numbers of Mallard present in late August and the numbers attempting to breed in the following spring, suggesting that the population may be nearly 'closed,' despite substantial immigration into the area in autumn and winter. Provisional estimates indicate annual adult losses of 57% and of birds in their first year after fledging of 76%.

This study will be continued. It is suggested that parallel investigations elsewhere in Britain would be valuable and could be made by teams of local observers.

Studies of breeding populations of ducks have flourished in North America during the last twenty-five years. In Britain very few have been attempted. This neglect has perhaps been due to the facts that breeding ducks are relatively scarce over most of the country and that thorough studies require much time and so seem beyond the scope of most bird-watchers. The main purpose of this preliminary report on an investigation which it is hoped can be continued for many years is to suggest that in some circumstances useful results can be obtained by spare-time observers working together without elaborate planning.

The aim of the study is to obtain data on the breeding population of the Mallard in part of North Somerset, to see how and why the size and success of the population varies from year to year. The inquiry is concentrated on the reservoirs of the Bristol Waterworks Company, and in particular on the large Chew Valley Lake (1,170 acres) and Blagdon Lake (440 acres), lying 1¼ miles apart to the north-east of the hills of Mendip and 12 miles south of Bristol. The numbers of ducks of all species found in North Somerset from August to April have been recorded voluminously by many people in recent years, but the breeding population, consisting almost entirely of Mallard, Tufted Duck, and Shoveler in that order of abundance, was largely neglected until 1957.

Methods. The size of the breeding population based on the reservoirs has been assessed from frequent counts from February to August (though few are practicable in June and early July), the numbers of males and females being recorded separately. Wide variations in the numbers seen on different occasions are found. These are partly attributable to errors of observation (such as failure to flush ducks from cover, or confusion resulting from accidental disturbances causing some birds to be counted more than once, or not at all). But the most important cause of variation is the behaviour

of the ducks, which changes with the advance of the breeding cycle. In the simplest case, pairs segregate from a winter flock, each remaining more or less constantly in a limited area, the 'territory.' When the female begins laying she spends a short time each morning at the nest but rejoins her mate at a 'loafing place' for most of the day. When she begins to incubate she remains on the nest almost continuously, with perhaps two short spells off in the morning and evening for drinking, bathing and feeding. The male stays in the vicinity for some time, but normally abandons the female before the brood is hatched and joins other males in flocks which assemble in places offering security for the flightless period of the moult. The simple picture is more or less obscured by seasonal and individual variation in the onset of egg-laying, by the effects of nest losses and subsequent attempts at re-nesting, by diurnal changes in the activities of the birds, by an excess of males in the population, by late emigration of some winter visitors and by the immigration of males prior to the moult. But by mapping the positions of pairs, individuals and flocks, and by noting their undisturbed behaviour, it is possible to estimate the number of pairs attempting to breed within fairly narrow limits of error.

It is a striking, and helpful, feature of the nesting behaviour of the Mallard in North Somerset that almost all the inland breeding pairs in the district spend part of their time at the large reservoirs. The small ponds, streams and drainage ditches, which in other areas would be used territorially, are rarely occupied by pairs in the pre-incubation stage, even though females may later rear broods on them. Pairs nesting up to eight miles away have been seen to return to Blagdon after an early morning visit to the nest. This aggregating behaviour may result from the low breeding density of the Mallard in North Somerset—a little less than one pair to two square miles over the whole area. With so few ducks present the stimulatory effect of territorialism could only be achieved by congregation at the major waters.

No attempts have been made to find nests. A nest census is in theory the best measure of the breeding population. In practice the wide scatter of part of the population makes the task too time-consuming and for the nests in the vicinity of the reservoirs it is most undesirable, because found nests are far too vulnerable to crows and other predators. Thus the survey provides no information on the number of eggs laid, and no quantitative data on egg losses. This deficiency is not very serious, since studies elsewhere have established the likely range and mean of the clutch-size and the (relatively small) extent of losses due to infertility.

The collection of data on broods is an essential requirement. The needs are to find how many broods are hatched, the mean brood-size on reaching the water and the losses before fledging. Observations distinguishing only between newly-hatched, partly grown and nearly full-grown broods seem sufficient to estimate average production for a successful female. Determining the number of broods brought to the water is very much more difficult. Direct observations normally yield too low a figure, since some females are adept at concealing their broods. Late evening has been found to be the best time for seeing young ducklings which then emerge most freely into open water.

The breeding population from 1957 to 1959. During each of the last three seasons it appears that 150-160 pairs of Mallard have been based on the

Bristol reservoirs—106 to 110 pairs on Chew Valley, 30 to 36 pairs on Blagdon, 11 to 14 on Barrow Gurney and 2 or 3 on Cheddar. At the same time between 50 and 100 pairs have been present elsewhere in North Somerset (though the estimate of 55 pairs in this category in 1959 is the only one in which much confidence could be placed). This apparent stability of the reservoir population is remarkable.

The population from 1948 to 1956. For the years before 1957 the number of potential breeding pairs can only be estimated from sex-ratio counts made incidentally by various people, these counts being less frequent than in recent years and not necessarily made at the most suitable times. There were too few records before 1948 to allow even this rather unreliable method to be used. The estimates for 1948 to 1956 are set out below:

TABLE 1. Numbers of pairs of Mallard estimated to have been based on the Bristol reservoirs from 1948 to 1956.

	Chew Valley	Blagdon	Barrow Gurney	Cheddar	Total (to nearest ten pairs)
1948	—	50	14	15	80
1949	—	35	15	12	60
1950	—	30	17	10	60
1951	—	13	2	12	30
1952	—	34	10	22	70
1953	—	35	18	8	60
1954	25	40	10	6	80
1955	40	45	25	9	120
1956	55	80	20	7	160
mean 1948-53 ..	0	33	13	13	60
mean 1954-56 ..	40	55	18	7	120
mean 1957-59 ..	108	33	13	2	160

The most striking feature of these figures is of course the emergence and growth of the Chew Valley Lake population from 1954 (25 pairs) to 1957 (110 pairs). The construction of this large lake, with a shallow shelving shore around most of its $7\frac{1}{2}$ mile perimeter, has been of immense benefit to wildfowl and has nearly doubled the Mallard breeding population of the district (120-130 pairs in 1950-54, 260 in 1956, 220 in 1959).

The boom at Chew Valley has coincided with the eclipse of Cheddar reservoir, never really suitable for Mallard (as its banks are concrete-lined) and rendered almost untenable by dinghy-sailing. Barrow Gurney and Blagdon seem to have retained populations of a pre-Chew Valley level, after unusually large numbers in 1955 and 1956.

Only in 1951 of the seven years 1948-1954 did the population of the established reservoirs appear to depart widely from the average. The marked drop in 1951, affecting Blagdon and Barrow Gurney, seems to have been due to very poor breeding success in 1950, the numbers present in the late summer of 1950 and throughout the subsequent winter, being unusually low.

Records of broods seen, 1957 to 1959. The first dates on which Mallard ducklings have been seen at Chew Valley Lake in the last three years have been 25th April, 25th May and 21st April. These are very late, that of 1958

quite exceptionally so. The reason seems to be that early nesting attempts in the vicinity of the reservoir are doomed to failure because of the comparative scarcity of good nesting cover in March and the abundance of crows.

The latest newly-hatched broods have been seen on 11th July, 10th August and 3rd July. Thus hatching is spread over eleven weeks, with a peak about 20th May in 1957, in mid June, 1958, and late May, 1959. These dates, like those of the first broods seen, are unexpectedly late. Few broods are seen at Blagdon, chiefly because there is an abundance of cover for them at one end, while nests elsewhere are mostly unsuccessful.

Records of brood-size are assembled in Table 2. The numbers of broods included are small, because attempts have been made to eliminate repeat records of the same brood in any one of the age-classes. The average size of newly-hatched broods is exceptionally low. In Holland Eygenraam (1957) reported day-old broods to average about 10.5, and the mean of broods in their first week to vary from 7.44 to 9.65 in different years. (The Somerset data are too few for useful comparison between years.) The scarcity of broods of more than 10 ducklings seems to be a purely local phenomenon.

TABLE 2. Brood-sizes of Mallard at Chew Valley and Blagdon Lakes, 1957-59.

Mean brood size	No. of broods	No. of ducklings	Brood size												
			1	2	3	4	5	6	7	8	9	10	11	12	over 12
First broods															
recently hatched 6.1	59	414		2	5	2	7	10	11	6	4	7	1	3	1 of 14
partly grown 6.3	57	359	1	3	4	5	11	6	6	6	9	2	2	1	(17, 19)
well grown 6.8	160	1087	1	7	12	11	18	23	16	25	21	16	5	5	(15, 16, 17, 18)
Re-nests															
recently hatched 6.9	38	263	1	1		4	8	5	2	8	4	2		1	13, 15
partly grown 6.6	7	46			1	2	1				1	1	1		
well grown 5.6	22	122	2	1	3	2		6	2	3	3				

At Slimbridge, only 40 miles north-east, where the average clutch-size is 13.3, the mean size of new broods is more than 10. Perhaps the low output in Somerset results from few of the ' first broods ' emerging from ' first clutches'.

The recorded increase in the size of first broods with age is an apparent absurdity often found in American studies, though not in the Dutch one. It is probably due partly to the greater ease of counting well-grown broods and partly to a tendency for broods to coalesce—shown clearly by the emergence of ' monsters ' of 16 to 19. Mixing of broods seems to occur more readily at Chew Valley than is usual. More detailed studies of brood-size in Somerset, and elsewhere in Britain, are badly needed, for these preliminary results differ widely from those obtained in Holland, where the proportions of both large (9 and over) and very small (1 or 2) broods were found to decrease markedly with age.

For the purpose of a population study the most important piece of information about broods is the average number of ducklings reared by a successful female. From the combined ' first broods ' and ' re-nests ' of Table 1 this appears to be about 6.6, a figure within the range of 6.02—6.91 reported in different years by Eygenraam (*loc. cit.*) and justifying the assumption that there is no major difference between Somerset and Dutch Mallard in this respect.

Total production of young. In 1957, the year in which most field-work was done, observations suggested that 25 females brought first broods to the water at Chew Valley and that a further 15 were later successful, indicating that only 40 of the 100-110 females attempting to breed succeeded in hatching young. But this figure must be a minimum, since it is very unlikely that all broods were seen.

Eygenraam (*loc. cit.*) used an indirect method of estimating the proportion of unsuccessful females, based on the sex-ratio of adults in June, which indicated that in each of two years 20-24% of Dutch Mallard females were unproductive. This method cannot be used for the Bristol reservoir population, because of the influx of " foreign " males in late May.

From sex-ratio counts in August it appears that most of these immigrants probably leave again soon after regaining the power of flight. Assuming this to be so, the only method so far devised for estimating the production of young at the Bristol reservoirs is to subtract the number of adults present in the nesting season from the highest total count in late August. If this estimated production is then supposed to correspond to six juveniles for each successful female, a figure for the latter is obtained. The method is very crude, since in late August some females are moulting and probably not counted, while juvenile dispersal is probably under way, perhaps involving immigration as well as emigration. The results of this procedure are set out in Table 3. In 1957 and 1958 about half the resident females appear as successful (compared with one-third to one-half estimated from observations of broods in 1957). 1959 was generally believed to be a very good year for Mallard production in most parts of England, so that the suggestion that nine-tenths of the Bristol reservoir Mallard reared some young is not wholly implausible.

TABLE 3. Estimated breeding success in relation to population size at the Bristol reservoirs 1948-59.

Year	Estimated breeding population (pairs)	Highest August count	Apparent Production	Proportion of females breeding successfully
				%
1948 ..	80	270	110	23
1949 ..	60	360	240	67
1950 ..	60	170	50	13
1951 ..	30	360	300	167
1952 ..	70	650	510	122
1953 ..	60	460	340	95
1954 ..	80	600	440	91
1955 ..	120	780	540	75
1956 ..	160	810	490	50
1957 ..	150	750	450	50
1958 ..	160	800	480	50
1959 ..	160	1180	860	90
Total ..	1190	7190	4810	67

For the earlier year the reliability of the estimates is even lower. The suggestion that in 1951 and 1952 more than 100% of females were successful, while numerically absurd, is not biologically impossible, if the average brood reared in those years was well above six, though in the present case it seems more likely to be attributable either to under-estimates of the breeding population or to early autumn immigration. The estimate that over the whole twelve-year period the average proportion of successful females was two-thirds is rather below that of Eygenraam for Holland, but well above that for some Canadian studies.

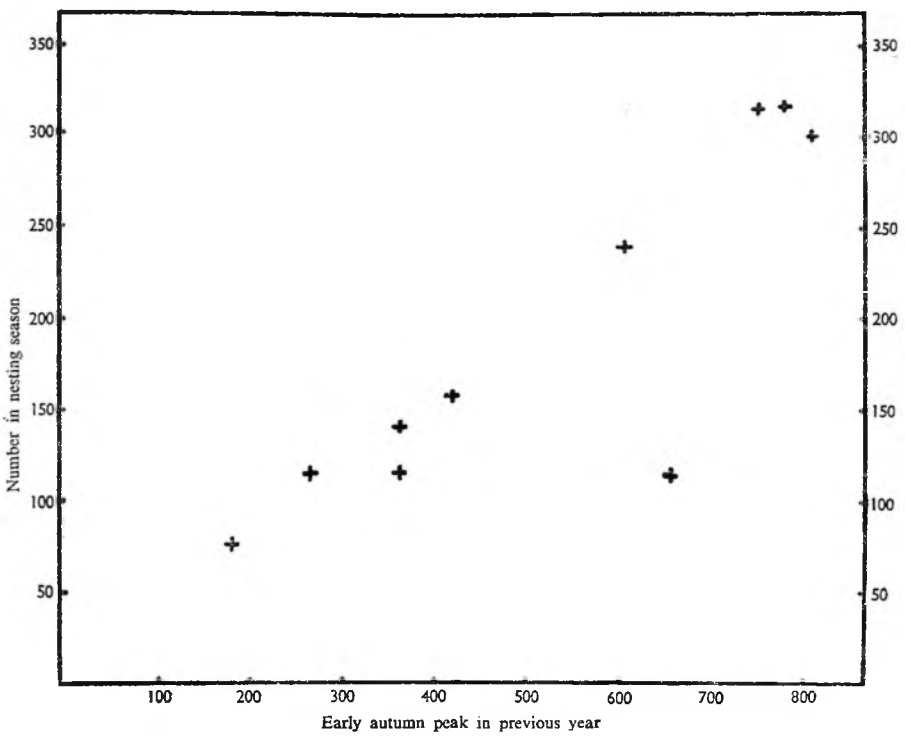


FIGURE 1. Relation between numbers of Mallard on North Somerset reservoirs in the nesting season and numbers in the preceding August, 1949-59.

Self-maintenance by the population. The comparison of the August numbers with those in the following spring is of great interest. Figure 1 shows that for nine of the ten pairs of observations available (data of Table 3 again) there is a close approximation to a linear relationship, so that the size of the nesting population is apparently directly related to the numbers present in the previous August. This suggests that the losses suffered between August and April, whether by death or emigration, constitute a nearly constant fraction of the August numbers. Confirmation of this finding by a long series of more reliable spring and autumn counts would be of great theoretical interest.

The data of Table 3 can also be used to give an estimate of the average losses during the year, if information from Mallard ringed elsewhere in England is utilised. Boyd (unpublished) has found that about nine-tenths of the losses of British-breeding Mallard occur between August and April, and that the mortality of birds in their first year after fledging is greater than that of older birds by a factor of 1.32. Applying these corrections to the apparent losses between August and April, it appears that the annual losses of Somerset adults have averaged about 57% and those of young birds 76%. These losses may include emigrants unreplaced by immigrants. This estimate of adult losses is rather above the mean rate of adult mortality found in a variety of studies in Europe and America. The apparent first year mortality is comparatively low.

It appears that changes in the number of autumn and winter visitors to the Bristol reservoirs may normally be of little significance to the local breeding population, although in 1956 the increase in the breeding birds of Chew Valley lake was very probably enhanced by some of the hard weather immigrants of February remaining with the summer residents.

Discussion. The tentative results of this unfinished study are not startling. Is there any reason for supposing them to be of more than local interest? The writers believe there are at least two good reasons. First, the simple assumption that the late August numbers are an index of the production of young, though theoretically open to criticism on many grounds, seems in practice to be valuable, because it seems unlikely that if the population at that date was really highly heterogeneous it would give rise to a relationship with the estimated breeding population as clear and consistent as that indicated by Figure 1. If similar observations elsewhere produce similar results, it would seem possible to carry out long term studies of local breeding populations with a remarkable economy of effort, the requirements being a series of sex-ratio counts in the spring, and of total counts in August and September.

Second, the brood counts suggest marked differences in early brood-size and in the incidence of duckling losses between the Somerset Mallard and those studied by Eygenraam and his collaborators in Holland. The latter collected better data (ageing broods more precisely than has yet been done as a general practice in Somerset), so that some of the discrepancies in the results may not reflect real differences, but they suggest that widespread sampling in Britain might produce valuable results.

Acknowledgements. We are grateful to the Bristol Waterworks' Company, and especially to Mr. Kennedy Brown, Fisheries Officer, for permission to work on their reservoirs. We are also very grateful to the following for helping us with observations: Mrs. G. P. Boyd, B. K. Brooke, Mr. and Mrs. G. C. Buxton, P. J. Chadwick, S. E. Chapman, G. E. Clothier, S. K. Eltringham, J. A. McGeoch, P. J. S. Olney, R. H. Poulding, G. Sweet, N. R. Webb and M. A. Wright.

DUCK CATCHING IN ICELAND[1]

Christopher Sellick

IT was in 1953 that I had last heard the magical " a- aadelow, a-aadelay " of the Long-tailed Ducks and here we were again in 1958 within a few miles of that most wonderful duck paradise of Myvatn, breeding ground of these and so many other species of ducks.

There were four in our party, Kit and Michael Savage, Gina—Michael's wife, and myself, and we were hoping that we would be able to catch Harlequins, Longtails and Scoters for the Wildfowl Trust, as these birds, though represented in the collection before, were again badly needed.

Kit Savage had sailed from Leith with a Land Rover together with all our equipment and had met us two days earlier at Reykjavik airport.

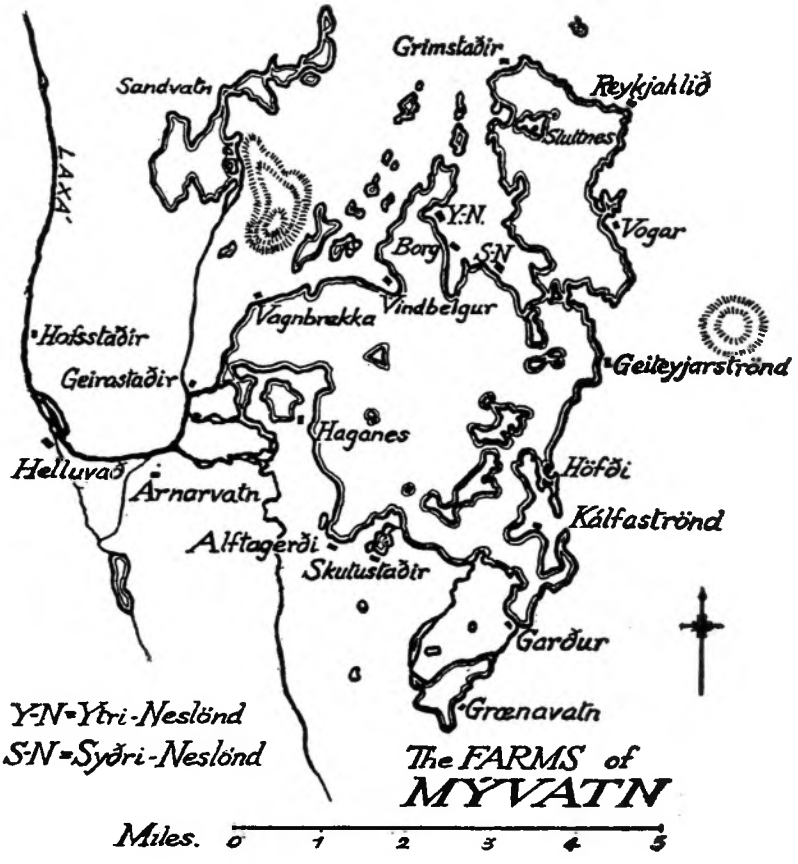
During the drive to Myvatn—carried out in easy stages and avoiding the main road to the north as far as possible, principally so that we didn't at times have to drive amid clouds of dust stirred up by other vehicles, we saw many varieties of birds, amongst which were Ptarmigan still in winter plumage, Ravens, Snow Bunting, White Wagtail, Red-breasted Mergansers, Goosanders, Whooper Swans and, amidst a wonderful setting high up in the hills with snow as a back-cloth, our first glimpse of Harlequins. In 1953 I had unfortunately not seen the male Harlie as when we were at Myvatn the females had already begun to sit and the males had either moulted or left the females. My first glimpse therefore of this duck swimming within a few yards of our car and against a pure white background was quite unbelievable. It was perhaps the most breathtaking sight that I have ever seen. Exclamations of, ' It can't be real ' and ' how beautiful ' came from my companions, and so we sat just admiring these very beautiful birds with their red flanks, dark blue and white patterned head and white stripes on their flanks. There were three males and two females who were light greyish brown, drab and untidy looking compared with the magnificence of the males.

After a time Kit Savage brought us all to our senses, jumped out of the car and exclaimed, ' Well let's catch them,—that's what we're here for,'—but our Harlies had been kind enough to us already, and flew unhurriedly upstream and out of sight, leaving us with a most beautiful memory and the desire to press on to Myvatn where we hoped to see these birds in greater numbers.

However, Peter Scott during his expedition to Myvatn in 1951 had seen Harlies on the Laxá just south of Blonduos and so we planned to visit this area again to see for ourselves. We arrived at this village during early afternoon but found no sign of any Harlies, so decided to explore inland as far as Svinavatn, because we had noticed that these ducks particularly like rivers where they joined two lakes which were fairly close to each other, and here we thought the country was made for Harlies. We were proved to be right, so having established contact again, we pitched our tents and fell asleep on a cold night with thoughts of handling on the next day those beautiful creatures which we had seen that morning.

During the early part of June the weather in Iceland was cold with temperatures often falling to well below freezing at night, with clear blue

[1]Illustrated by photographs at pp. 190-4.



skies and sun that by 10 a.m. was quite warm. The snow was still at the sides of the roads and all the high ground was white, the grass had not as yet started to grow and so, with no flowers, the whole country bore an arid look which would at the end of the month be magically transformed into a most luxurious green, through which in July would explode a dazzling array of alpine flowers. So with the sun warming our tents we ate our breakfast, and walked to the bridge which spanned the Laxá. We were told that Harlies take great delight in flying under bridges, so that our best chances of catching them was to hang nets from these bridges and, ' hey presto—Harlies in nets.' We later found that though one could catch them this way, setting up nets on the bends of the rivers was far more efficient, and accounted for most of the birds that we sent back to the Wildfowl Trust. However, we did catch our first two ducks under a bridge within about 50 yards of our tents. We wanted to be able to send a crate of birds back by air when we arrived in Akureyri, so not having had much further success during the day we had to bring the Icelandic twilight to our aid, for there was no doubt that the ducks could see our nets. So with Kit Savage on one bank and myself on the other and a net suspended over a weir, we tied a warning line to our fingers, got into our sleeping bags at 1 a.m. and waited. It wasn't long before we were galvanised into life, when first one and then another and another

Harlie hit our net. We no sooner had these birds out and safely crated and ourselves back in the warmth of our sleeping bags, before we were called out of bed again, and thus we filled our crate and spent a restless night.

As the sun was lifting itself above the dazzling white peaks and we were packing our nets away, there on the lake in front of us was a raft, or perhaps a family is a better term, of Red-necked Phalaropes, turning and bobbing on the rippled surface of the water. They were like a gang of boys advancing across a potato field picking up the potatoes just turned up by the harrows, as they picked the flies off the water. Suddenly a fish jumped and tumbled with a splash back into the water—the Phalaropes were away, a Great Northern Diver swung into our bay and with its characteristic laughing cry was on his way.

Later that day we loaded our first consignment of ducks aboard a Dakota, and 12 hours later they were at London Airport.

Having purchased some provisions in Akureyri, we then made our way to the estuary of the Skjálfandafljot where we hoped to meet an Eider farmer and see for ourselves the islands on which the eiders nest, and the way which the Icelanders look after the birds and collect the down.

High up on the east bank of this great river which was now being swollen by the melting snow and ice from the glaciers and hills inland, lived the family who owned one of the best known eider farms in this region—Hellulandi. The steading looked down on the river which was here divided into many channels by the islands on which the eiders nested. Even from the farm we could see the white of the males on and around these islands. We also saw a strange erection of poles and coloured flags which we had heard a lot about but had not yet been able to understand. We were soon to learn how much importance was attached to the distribution of these poles and their different coloured attachments.

The farmer was out when we arrived but his attractive daughter offered to show us the colonies. We were lucky in this, for the Eider farmers as far as possible like to leave their islands undisturbed, for the ducks could well leave for quieter quarters which would mean a considerable financial loss.

We four climbed into a boat and much against our will we weren't allowed to take the oars, which we later found out was just as well, for by expert handling the boat was navigated over shallows and through fast water with considerable less danger than if we had been propelling her. Soon we were landing on one of the larger islands amid the eiders. All around us were laying and sitting females, whose nests in places were only a few feet apart. Most of the males with their distinctive white back, black belly and crown to their head were together in big rafts off the island. Suddenly with loud protestations a Greylag got up in front of us and revealed two newly hatched goslings with a third almost out of the shell. She alighted with the gander only 50 yards from us, telling us in no uncertain terms that we had no right to be here just at this time. After quickly photographing the nest we left, and it wasn't long before she was back and attending to her last arrival.

Scattered, at what at first sight seemed haphazard, around the islands were poles with coloured material fixed to many of them. On many of the islands there was a veritable forest of poles. We had been told earlier that these erections were an essential part of the business of eider farming and we

were keen therefore to discover what part they played. After a little difficulty due to our poor knowledge of the Icelandic language, we learned that these poles were put in the ground at places above the flood level of the river. It had been discovered that the eiders were particularly partial to setting up house around bright bunting and so by the judicious use of these flags the eiders were encouraged to nest on high ground, so that when the river became swollen later in June, the nests weren't washed away. Most of the eider colonies had their own colour schemes and it was partly the appeal to the female eye that these colours had that determined the financial result of the farm—or so we were told!

When at the end of June and beginning of July the female has hatched her young and left the nest the down, with which she had liberally lined her nest a few weeks earlier, is collected and rough cleaned by the farmer, and then sent to receiving depots where it is washed, cleaned and exported all over the world.

Back at the farm house, we were entertained to tea and, leaving the daughter dealing with a new born calf, we said our farewells and were indeed sad to leave such a delightful and hospitable family.

Later that night after a drive over roads that had only just been opened and over which melting snow water was still pouring—for we were one of the first private cars to get through to Myvatn—I found myself after a five year interval once again on the shores of this wonderful lake. Level camping sites were few near the banks of the Laxá, but after the inevitable difficu.ty of getting four people to agree on the ideal site, we pitched our tents a hundred yards from the farm of Helluvað owned by Jonas Sigurgeisson.

Next morning—another perfect day—we contacted the local farmers who throughout our stay in this area were all most friendly and extremely helpful. Without their help our expedition couldn't have succeeded, because although we had permission from the authorities in Reyjavik to export ducks to England, we had to get the farmer's permission to catch them on their land. This accomplished and our supply of fresh eggs and milk arranged, we got down to the business of duck catching.

There were a great number of Harlies on the river in front of our camp and as we had learned already, they were comparatively easy to catch. During the course of the next few days we managed to catch our quota and they were now all safely back in England.

Having accomplished Phase I of our mission, we considered that the time was ripe for a grand tour of the Lake itself, if possible to repeat what I had done in 1953. We learned from Ragnar Sigfinnsson, one of the farmers of Grimsstaðir, that the numbers of duck on the lake, particularly Long-tails, had greatly diminished over the past few years. This later appeared to be only too true with perhaps no more than 60% of the 1953 population of duck on the lake, which is a very sad state of affairs. There appear to be many causes, with the advent of the wild Mink being one of the major contributing factors. In recent years the numbers of Mink have increased alarmingly and it seems that as their numbers have risen so has the duck population fallen.

I had always wanted to return to the island of Slúttnes where in 1953 I had first seen all the ducks which nested there. So to-day Kit and I borrowed a boat from Ragnar and rowed ourselves across to this island. On the way

we were treated to a marvellous display of flying skill as the Longtails, with their melodious cry ringing out over the lake, weaved and turned all around our boat. Generally there were two or three males chasing a single female as they vied with each other for a mate. It appeared they were quite oblivious of our presence, for at times they came almost within arms length of the boat. We saw Red-necked Phalaropes bobbing on the water, Slavonian Grebes, Scaups, Tufted, Scoters, Barrow's Goldeneyes and a pair of Gadwall. Apart from the quantity of Longtails which had obviously diminished from 1953, there didn't seem to be so many Barrow's Goldeneyes. These beautiful ducks are distinguished from the Common Goldeneye by the rather more squashed head, coloured purple instead of green, and the crescent-shaped patch in front of the eye as opposed to a round blob. They appear to occur more commonly in parts of the lake than others. This probably has something to do with the fact that the females nest in holes, and they tend therefore to seek the area where these are most abundant.

After about half an hour's rowing, we landed on Slúttnes hoping to see the very great concentration of laying and sitting ducks I had seen a few years previously. There were of course a great number of duck but as we half expected far fewer than in 1953. And so it was on the other islands, in the bays, and everywhere on Myvatn—still a lot of duck but a tremendous drop in population since I had last been there.

We only had ten days left to accomplish Phase II of our expedition, namely to catch Longtails and Scoters. So on the next day, 10th June, we downed our fishing rods (Harlequins are not the only life on the Laxá) and drove to some marshes to the west of Grimstaðir, where we had previously seen a few Longtails. Here amidst patches of snow and a rich greenness which by now was becoming the predominant colour of Myvatn, we found a chain of small lakes set amidst marshland. As well as the Longtails and Scoters which were quite common in these secluded lakes, there were Pintails, Scaup, Wigeon and in one corner a party of Mergansers.

Over-confidence, as a result of the success that we had had with the Harlies, made us think that we should have our ducks in the bag in a couple of days and could then return to a less exacting form of recreation.

While Michael and Gina were erecting one net, Kit and I were at the other end of the marsh erecting another, in the hope that the Longtails in their passage up these string of lakes would fly into one or other of our nets.

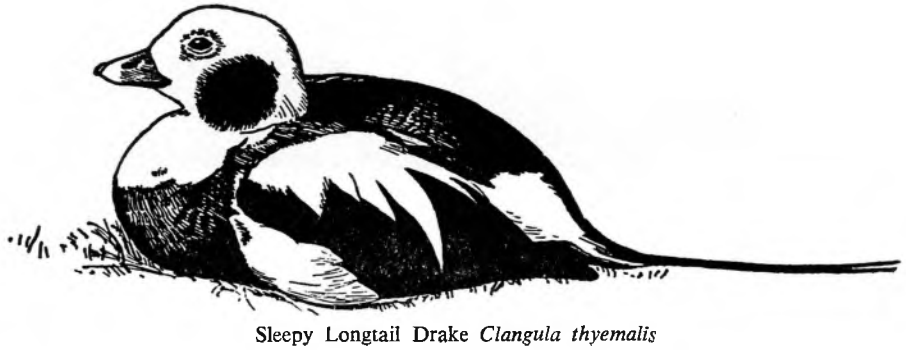
For the next two days, all four of us took it in turns sitting over the nets, at the end of which time, morale was low and tempers short, principally through lack of sleep. The main trouble appeared to be that the birds could see the nets—due in part to the almost 24 hours of light that occurs in Iceland at this time of the year. We tried re-siting the nets with different backgrounds, but eventually hit on the idea that if we could raise the net just as the ducks were approaching, we would stand a chance of catching them.

On the next day, we re-erected our nets incorporating the latest modification and during the ensuing night had more than half our quota of ducks in crates. In order to extricate the ducks from the nets which were suspended over the narrow parts of the lake, we had to use a rubber boat which we had brought from England. Though stable, it was a precarious business standing up removing birds from the net and at the same time

endeavouring not to be drifted down-wind. We had set up two nets but one of them accounted for nearly all the Scoters and Longtails which we finally despatched to England.

Towards the end of June, a reduction in the number of male Harlequins appears to take place on the Laxá as the females are now beginning to lay and some indeed to incubate their eggs. Just before we left Myvatn, I walked down the Laxá for some miles, in order to take some photographs of Harlies amidst their natural environment of tumbling waters and white water rapids. I found quite a few Harlequin nests with their seven or eight olive brown eggs. The farmers, unlike those that actually live on the shores of the lake, do not seem to take the eggs of the birds that nest on the Laxá. So instead of finding nests with the regulation four eggs—the remainder of the clutch being removed—the ducks often were sitting on a full clutch of eight or more eggs. As I climbed amidst the thick undergrowth on the banks of the river, I disturbed many other birds who were sitting, amongst which were Wheatears, Snow Bunting, Whimbrel, Golden Plover, Meadow Pipit and Snipe. A very devoted Golden Plover parent led me up the garden path, with a marvellous display of a 'broken wing' until quite by accident I spotted her nest a few yards to my right. In fact, I owe this bird a great debt for she made me look into a deep ravine of the river where to my surprise I found about 60 or 70 male Harlequins. There wasn't a female in sight which I found extremely interesting. There has been a theory that all the male Harlequins, as soon as the females begin to sit, make their way to the sea. The males soon go into eclipse after the females start incubating, and I believe that they stay on the river in secluded spots, perhaps similar to where I had found all these birds. In late July and August, if one sees Harlequins, one assumes they are females, for then it is almost impossible to tell the sexes apart. I later asked Kiristjan Geirmundsson as to whether he thought that this might be so, and he was quite surprised to hear that we had thought that the males went down to the sea. However we should like one day to catch a sample of Harlequins in August just to see whether there are any males left on the Laxá.

On the next day I had unfortunately to return to England, so with the unforgettable cry of the Longtailed Duck ringing in my ears, and the Harlequins skimming up the river in front of our camp—two of the most wonderful ducks in the world—I said good-bye to all our good friends of Myvatn and left Iceland—the island that possesses such riches in bird life—for the second time, with a lump in my throat.



Sleepy Longtail Drake *Clangula thyemalis*

SHORT NOTES

British literature on European wildfowl — A correction.

Dr. J. M. Harrison has pointed out a misleading mistake in the list of British publications on wildfowl which appeared in the *Tenth Report*, pp. 162-175. The published entry: " J. M. Harrison and C. H. B. Grant (1953) *Turdus musicus* Linnaeus. The scientific names for the Bean and Pink-footed Geese. *Ibis* 95:152 " suggests that *Turdus musicus* is a possible name for a goose. This is not so. Harrison and Grant published consecutive but separate notes dealing with two of the most persistent and vexatious nomenclatorial disputes. It was not our intention to stimulate the fires by combining them. " *Turdus musicus* Linnaeus " should be deleted from the quoted entry.

Hæmorrhage from an œsophageal diverticulum causing death in a wild Mallard*

On 25th August, 1959, a freshly dead immature drake Mallard, *Anas platyrhynchos platyrhynchos* Linnaeus was found on the Kent Sand and Ballast Water wildfowl reserve at Sevenoaks. It was in good condition, but had free blood in its mouth. Post mortem examination showed that there was rather over an ounce of free blood in the oesophagus and on dissection an oesophageal diverticulum was found at the level of the bifurcation of the trachea. The diverticulum was full of food, being about the size of a walnut, and had become firmly adherent to the root of the lung by inflammatory adhesions. There was a marked apex to the diverticulum in the area of attachment and there is no doubt that it was a traction diverticulum being slowly enlarged with each movement of respiration as the adhesions tugged on the apex.

When the food contents of the diverticulum were removed for analysis, an ulcerated area of the lining was immediately apparent, in which a blood vessel had become eroded, resulting in a fatal haemorrhage.

*First published in Bull. B.O.C., 80, 43-5. 1960.

DIVERTICULUM CONTENTS

Species	Number	Volume	% Volume
PLANT MATERIAL			
Lolium multiflorum Lam. (Italian Ryegrass)	seeds 371	1.3 ml.	59.1%
Lolium perenne L. (Perennial Ryegrass)	seeds 57	0.3 ml.	13.6%
Bromus sterilis L. (Barren Brome Grass)	seeds 10	0.2 ml.	9.1%
Holcus lanatus L. (Yorkshire Fog)	seeds 12	0.1 ml.	4.6%
Juncas inflexus L. (Hard Rush)	capsule & seeds 22	trace	
Equisetum arvense L. (Common Horsetail)	stem and sheath	trace	
ANIMAL MATERIAL			
Hydropsychidae larvae (Caddis-fly)	3	0.3 ml.	13.6%

GIZZARD CONTENTS

PLANT MATERIAL			
Polygonum amphibium L. (Amphibious Bistort)	seeds *c.* 90	0.4 ml.	80%
Rumex conglomeratus Murr. (Clustered Dock)	seeds *c.* 43	0.1 ml.	20%

The contents of the diverticulum were completely different from those of the gizzard, indicating that the bird had been feeding in two separate habitats, and that once the diverticulum was full any further food ingested would pass normally into the gizzard. The state of the seeds in the gizzard would suggest this this meal had been taken only a short time before the bird succumbed. It is in the food contents of the diverticulum that the clue to the fatal haemorrhage is found. The spikelets of both the *Lolium* species are hard and sharply pointed, as are the narrower and longer seeds of *Bromus sterilis*. As the diverticulum and its contents are moved with each respiration, the consequent friction could easily result in these seeds causing the ulceration and haemorrhage. In this case the seeds of the *Bromus* and *Lolium* species must have been the direct cause of the bird's death.

Bromus sterilis seed.
Nat. size

Lolium multiflorum
spikelet, x3

It is interesting to note that this is the first time that the spikelets of either *Lolium* species have been found in any bird sent in to the Wildfowl Trust for food examination. Seeds of *Lolium perenne* L. have been found in duck gizzards before but not still as part of the spikelet. This particular Mallard could scarcely have taken a more unfortunate meal.

We are most grateful to Dr. C. E. Hubbard for help in identifying the grass seeds.

Jeffery G. Harrison and P. J. S. Olney.

Tuberculosis in a wild Pochard and remarks on the recognition of disease by predators*

On 19th August, 1959 Major General C. B. Wainwright and Mr. Roy King found an eclipse drake Pochard *Aythya fuligula* (Linnaeus) on Abberton Reservoir, Essex, swimming weakly and with its neck badly lacerated by some predator, which judging by the tooth marks was most likely to have been a fox or an otter. It was also very wasted and the bird was killed and given to us on the same day.

On examination, apart from being very wasted, the belly was extremely distended. On opening the body, this distension was found to be due to a grossly thickened, yellowish-white thoraco-abdominal air-sac, containing about a quarter of a pint of straw-coloured fluid. The pericardium was similarly thickened and there was an advanced plastic pericarditis, the whole heart looking as if it was covered with soft butter. Lying behind the air-sac, the liver was enlarged and studded with many small, hard, whitish nodules, while other nodules were present on the visceral surfaces of the gall-bladder and intestines, which were matted together by adhesions. One nodule had eroded the eighth right rib. Many of these features can be seen in the picture of the specimen after dissection (see p. 189), in photographic section).

A direct film from a liver nodule showed that numerous pleomorphic acid-alcohol fast bacilli were present. Histologically, a section of the liver stained with haematoxylin and eosin presented a picture of miliary tuberculosis with multiple caseous areas largely destroying the central area of each liver lobule, with small round-celled infiltration and giant cell systems surrounding the caseation, as a prominent feature, leaving only a narrow zone of liver cells.

A slide stained by the Zeihl-Neelsen technique showed many acid-alcohol-fast bacilli in the affected parts. From a study of these slides it is apparent that as a blood-borne infection, the disease reaches the central artery of each lobule and that caseation develops from this point peripherally, ultimately destroying the whole lobule. A culture was set up on Finlayson's medium and growth of a typical avian strain appeared in three weeks. Unfortunately owing to a technical error on our part, Dr. A. McDiarmid, of the Agricultural Research Station at Compton, was subsequently unable to type the strain.

This is the first confirmed case in a wild Pochard and only the fourth confirmed case in a wild duck in Britain. These others were a Wigeon, *Anas*

*First published in Bull. B.O.C. 80, 40-2. 1960.

penelope Linnaeus, from Orkney (Randall and Harrison, 1956) a Shelduck, *Tadorna tadorna* (Linnaeus), from Kent (Harrison, 1957) and a Wigeon from Abberton (Wainwright, 1959), while a further Wigeon from the same place was almost certainly tuberculous, but the culture was lost. General Wainwright, in recording the second Wigeon, states that he believes tuberculosis will be found to be not uncommon in wildfowl in the wild state and the occurrence of yet another case from Abberton lends support to his views. In America, Quartrup and Shillinger (1941) have recorded the disease in two Redheads, *Aythya americana* (Vieillot).

The pathological features presented by this Pochard are rather unusual in the marked involvement of the air-sacs and pericardium with great distension by fluid. The route of infection would appear to have been by the alimentary tract, which is the most usual in birds. Skeletal tuberculosis is rare and the involvement of a rib by direct spread was similar to a case recorded in a Sparrow-Hawk, *Accipiter nisus* (Linnaeus) (Harrison, 1949).

We have now examined fifteen cases of tuberculosis in wild birds and of these, three had been found with gross lacerations and tooth marks, undoubtedly caused by some mammal predator. The first of these was a Short-eared Owl, *Asio flammeus* (Pontoppidan), from Cambridgeshire (Harrison, 1943), the second was the Kentish Shelduck and this Pochard is the third. The predator had made no attempt to eat any part of the owl; the Shelduck had had its head torn off and the Pochard had been badly wounded, but left alive. It would seem that these birds in their weakened state fall an easy prey, but that the predator is able in some way to detect that the victim is unpleasant and discards it. We have noticed that there is a faint but distinctive smell from such birds and we think that scent is the most likely way in which the predator is protected from eating something which might prove dangerous to it.

We are most grateful to Mr. J. Heather, Dr. K. Randall and Dr. A. McDiarmid for their help with this case.

James M. & Jeffery G. Harrison.

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Natural weld in a Mallard and a Pink-footed Goose

THE accompanying photograph (p. 188) shows the right and left humeral bones of a female Mallard *Anas p. platyrhynchos* shot in December, 1959.

The right humerus is a remarkable example of a natural weld, where the fractured bone has been re-united by the formation of a callus. The bird was shot as it flew up from a bed of rushes at Whire Moss near Kirkby-in-Furness, nine miles north of Barrow, Lancashire. The original injury had apparently been caused by a BB shot which was later found under the skin close to the bone. The bird at the time of death was in good condition and could obviously fly.

There had undoubtedly been a complete fracture of the humerus and the callus uniting the two bone segments had formed at the end of one piece and on the lower surface of the other. This left one end free and protruding, with a resultant shortening of the bone by 1.6 cm. The formation of a permanent callus anchoring the broken pieces would have taken some time and during this period the bird would have been particularly susceptible to predation. There must have been a time when the bird was flightless and even with the comparatively quick formation of a provisional callus it is highly desirable that the muscles over the fracture site are rested as much as possible. It is in fact amazing that this bird survived at all.

I am most grateful to Mr. Frank Taylor for sending me this bird and for details of his shot.

The lower photograph on p. 188 is of a rather similar healed fracture in the tarso-metatarsus of a Pink-footed Goose *Anser brachyrhynchus* shot in the winter of 1953-54. The leg was later sent to Slimbridge in the condition shown. The successful welding of this fracture is less remarkable than that of the Mallard humerus since geese are comparatively well able to look after themselves with one leg out of action.

P. J. S. Olney.

Mute Swans feeding on fallen Prunus blossom

IT is a custom for very large quantities of gathered *Prunus* blossom at the Parade Gardens, Bath, in spring, to be put into the River Avon at Pulteney Weir. The light material floating on the surface of the water is eagerly swallowed by the twenty to thirty non-breeding Mute Swans (*Cygnus olor*) which live there. With a thrustful and forward sieving movement of their bills the food is consumed with extreme rapidity. Equally large amounts of grass cuttings are more frequently and similarly distributed on the Avon but the swans take this much more at leisure.

Bernard King.

Grey Lag Geese feeding on the stalks of Dandelion

A PARTY of twenty feather-cut Grey Lags (*Anser anser*) which had the complete freedom of Chew Valley Reservoir, Somerset, were observed on 20th May, 1957, from a distance of only thirty yards. During the thirty minutes they were being watched they fed exclusively on the fresh and milky stalks of Dandelion (*Taraxacum officinale* agg.). Their method of feeding was to pluck the Dandelion stalks (the heads of which were or had been in full seed) very near to the base of the plant, and then 'chew' the trailing stalks until only the seed heads were visible. These were usually, though not always, discarded. Each bird acted in the same way a great many times. I am unable to trace similar records of Dandelion as a food for geese.

Bernard King.

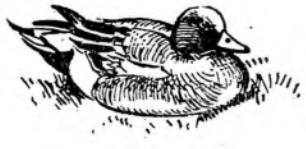
Wigeon feeding on moss

AT Cheddar Reservoir, Somerset, the embankment sometimes becomes heavily encrusted by moss, much of which grows in and around the concrete slabs. In early November, 1952, I watched a party of about twelve Wigeon (*Anas penelope*) eagerly feeding on this—they appeared to take only the surface of the material and seldom pulled up large quantities of the moss. At the time of observation it was just after dawn and very cold with heavy ground frost in the district, but in the area in which they were feeding comparative mildness prevailed, and this may have been the reason for the presence of the Wigeon.

When the birds departed I carefully examined the embankment. The moss showed considerable interference and loss of the surface greenness. No other distinguishable plant life was growing in the moss crevices.

James W. Campbell in his paper 'The food of Wigeon and Brent Goose,' *Brit. Birds* 39:194-200 (1946) mentions moss in small quantities found in the stomachs of four Wigeon taken in Lancashire, South Wales and Benbecula.

Bernard King.



Diving behaviour of Shelducks

In the summers of 1955 to 1958 inclusive, single broods of Shelducks (*Tadorna tadorna*) were discovered at Chew Valley Reservoir, Somerset, twelve miles from the coast. Two of the brood found in 1957 were present until they became full-winged and on the many occasions I had them under observation they were always accompanied by their parents. When the young birds were about three-quarters grown and becoming well feathered they were led frequently into some of the deepest water (15-20 ft.) to feed and I then witnessed some interesting feeding and submerging behaviour.

They began by feeding normally on the surface of the water, quickly moving their heads from side to side, but seeking food at greater depths the juveniles gradually submerged and completely disappeared below the surface for periods timed up to fifteen seconds. On the few occasions I was able to discern them below the surface they were still performing the scythe-like movements of their heads.

The adults were never seen acting in a similar manner. That adult Shelducks will dive readily too was well illustrated when D. H. Perrett, D. E. Slocombe and the writer discovered Bridgwater Bay, Somerset, as a moulting ground for the species in 1950. There large ' rafts ' of moulting and flightless Shelducks in July and August dived readily if approached too rapidly by boat, having endeavoured to get away by swimming quickly.

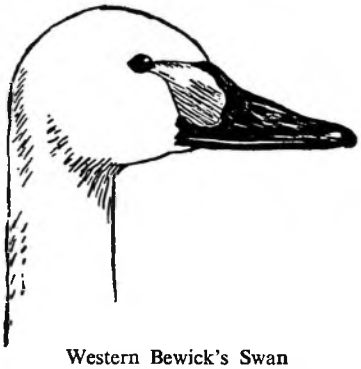
Bernard King.

Large-Billed Bewick's Swans in Somerset

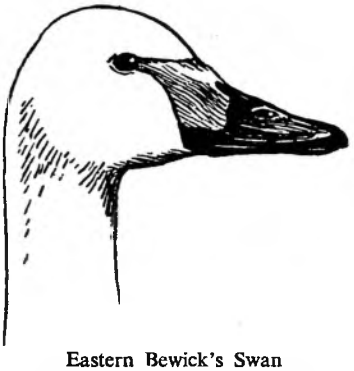
A party of fourteen swans at Durleigh Reservoir, Somerset, on 20th February, 1956 included twelve typical Bewick's Swans *Cygnus columbianus bewickii* and two which, from a distance, appeared to be a little larger and to have decidedly larger bills. I was able to come unseen to within fifty yards of the party, most of them resting on a flat and muddy piece of ground. At this range the two unusual swans still looked larger than the others and their bills seemed not only heavier but had more yellow on them. The yellow areas on the upper mandible were rather truncated in shape and extended up to and just beyond the nostrils. The bills immediately reminded me of the Jankowski's Swan *C.c. jankowskii* in the Wildfowl Trust Collection at Slimbridge. By loudly clapping my hands I was able to induce most of the swans to call, including the two unusual ones. Their voices were similar to those of the remainder, confirming that they were Bewick's rather than Whooper Swans *C.c. cygnus*. Mrs. C. D. Palmer and Miss E. M. Palmer, who were with me, agreed with my field description.

There is still some uncertainty about the validity of the difference between Bewick's Swans breeding in western Siberia (*bewickii*) and those in the far east (*jankowskii*). Delacour (*Waterfowl of the World*, vol. I, 1954) believes that the two are separable, though noting that their ranges overlap in the region of the River Lena. Russian authors on the other hand maintain that some birds taken in the east are indistinguishable from *bewickii*, while some from Novaya Zemlya near the western limit of the range of the species

have bills of the large eastern type. Thus it is not possible to be sure that the two large-billed swans at Durleigh were from an eastern breeding area, but, since such birds are apparently rare in England, it seems desirable to draw attention to their occurrence.



Western Bewick's Swan
Cygnus columbianus bewickii

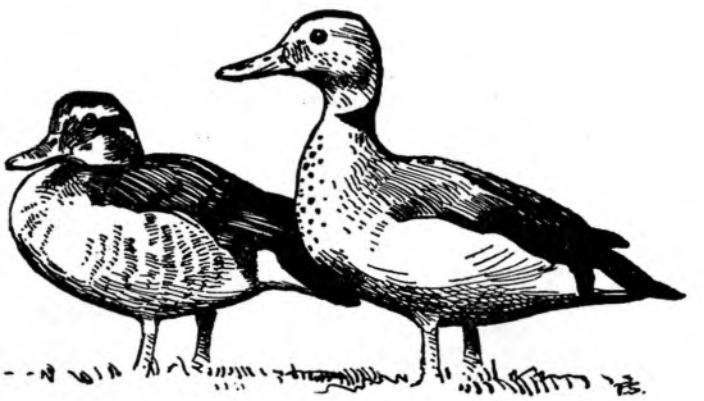


Eastern Bewick's Swan
Cygnus columbianus jankowskii

It is not thought that the distribution of black on the culmen which varies widely in different individuals has any significance in distinguishing the two races.

February, 1956, was a time at which unusually large numbers of Bewick's Swans (some 3000 individuals) were seen in England and Wales (I.C.T. Nisbet, *British Birds,* vol. 52, pp. 393-416). Nisbet considers that 5% to 10% of the Bewick's Swans that reached Great Britain at that time were misidentified as Whoopers. The difficulty of distinguishing large-billed Bewick's from Whoopers when typical *bewickii* or *cygnus* are not present cannot be ignored, but thorough scrutiny of flocks of Bewick's at close range, when this is possible, should establish whether large-billed birds occur regularly, even if only in very small numbers.

Bernard King.



Ringed Teal

THE
TWELFTH ANNUAL GENERAL MEETING

MINUTES

THE Twelfth Annual General Meeting of the Wildfowl Trust was held at The Royal Society of Arts, John Adam Street, London, W.C.2. on Tuesday, 26th May, 1959 at 4.30 p.m.

The following Officers and Council Members were present:

Sir Percy Lister (Vice-President). In the Chair
Guy Benson, Esq (Hon. Treasurer)
Michael Crichton, Esq.
H. H. Davis, Esq.
K. Miller Jones, Esq.
Dr. James Robertson Justice
R. E. M. Pilcher, Esq., F.R.C.S.
Peter Scott, Esq., C.B.E., D.S.C. (Hon. Director)
Miss P. Talbot-Ponsonby
Major General C. B. Wainwright, C.B.

Apologies for absence were received from:

Field Marshal the Rt. Hon. the Viscount Alanbrooke, K.G., G.C.B., O.M., G.C.V.O., D.S.O.
His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O.,
The Rt. Hon. the Lord Kennet of the Dene, G.B.E., D.S.O., D.S.C.

Sir Percy Lister expressed regret that Lord Alanbrooke's recent accident had prevented him from taking the Chair at the Meeting, but Sir Percy was delighted to report that the President hoped to attend the Annual Dinner that evening.

The Minutes of the Eleventh Annual General Meeting which had been circulated with the Report of Council were taken as read and signed by the Chairman.

1. The Hon. Director began by referring to the tragic loss that the Trust and he personally had sustained by the death of Michael Bratby. He was

first Hon. Secretary of the Trust and remained a Council Member and closely connected with the affairs of the Trust until the time of his death. He was happy to say that Mrs. Bratby would be the guest of the Trust at the Annual Dinner.

The Director continued by reminding Members that he was now traditionally allowed to give stop-press news from The Wildfowl Trust and reported details of the breeding season. The first Magpie Goose to lay this season had done so that morning, and the first Brent Goose egg had been laid two days before. Until last year's success at Slimbridge Brent Geese had never previously been reared in captivity. A pair of Trumpeter Swans owned by The Queen had nested for the first time, the young four-year-old female only having been at the Trust for three years. Only two eggs had been laid, these ten days apart, and it was doubtful whether they would hatch. Pink-footed Geese had bred for the first time at the Wildfowl Trust. Two other new species to nest this year were the American Hooded Mergansers, and the Australian White-eyes which are the only ones outside Australia and which only arrived in the Collection twelve months ago.

Mr. Scott made particular reference to the Hawaiian Goose or Nene breeding season in this country, and gave the following details:—

Twenty-three young Nene were now being reared at Slimbridge, one at Peakirk, and eight by Mr. Terry Jones at Leckford. The Hawaiian Breeding Project at Pohakuloa had fifteen young birds, and eleven young had been observed with the wild flock there. The total world population now stood at 212 and from the original three birds sent to Slimbridge in 1950 and 1951, 101 Hawaiian Geese had been raised—almost half the total world population.

Latest arrivals at The New Grounds included one pair of South Georgia Teal, and two male and three female King Eiders, which, with the pair that had been at Slimbridge for three years, made a magnificent little flock. Fifteen Salvadori's Ducks and five Eyton's Tree Ducks had recently been brought back from Australia and New Guinea by the Curator, Mr. S. T. Johnstone. Sir Edward Hallstrom of Sydney, who is Founder-Director of the Taronga Park Zoo, had made it possible by considerable financial help for the Trust to send its Curator out to collect these valuable birds. Although still in quarantine pens, they had already drawn great crowds to Slimbridge, and had formed a valuable attraction of the Trust at Whitsuntide. Mr. Scott expressed the gratitude of the Trust to Sir Edward for his great interest and generosity. A further great advantage of the Curator's trip had been the opportunity to call in at Hawaii and confer with the authorities there who were responsible for the future of the Nene.

The Hon. Director then explained in detail the most significant features of the Accounts and Balance Sheet, referring to the stock of the *Coloured Key to the Wildfowl of the World* which alone accounted for more than three quarters of the increase in the valuation, but which were selling well.

He drew the attention of the meeting to the fact that income from ordinary membership had dropped by £500, which showed that the Trust could not afford to let up in its efforts to maintain membership levels. He felt it was not fair to expect support unless it was worked for, and thought that the Trust urgently needed a membership drive. He then appealed to the meeting to help the situation by persuading all members to endeavour to enrol at least one new member during the year.

The Hon. Director then moved the adoption of the Report of Council and Accounts for the year ending 31st December, 1958. Mr. Guy Benson seconded the motion which was carried unanimously.

2. Sir Percy Lister proposed the election of the Council's nominees for vacancies on the Council which were as follows:—

To fill the vacancy created by the death of Michael Bratby, Esq.,
R. E. M. Pilcher, Esq., F.R.C.S.

Councillors due to retire under Rule 13(1) and nominated for re-election:
James Fisher, Esq.
Sir Landsborough Thomson, C.B., O.B.E.

The proposition was seconded by Mr. Guy Benson and carried unanimously.

3. Mr. Michael Crichton proposed the election of the following Officers:

President: Field Marshal the Rt. Hon. the Lord Alanbrooke, K.G., G.C.B., O.M., G.C.V.O., D.S.O.

Vice Presidents: Sir Percy Lister
Captain R. G. W. Berkeley

Trustees: The Rt. Hon. the Lord Kennet of the Dene, G.B.E., D.S.O., D.S.C.
His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O.

Hon. Director: Peter Scott, Esq., C.B.E., D.S.C.

Hon. Treasurer: Guy Benson, Esq.

The Motion was seconded by Mr. R. E. M. Pilcher and carried unanimously.

4. Mr. Guy Benson proposed that Messrs. S. J. Dudbridge & Sons of Stroud, Gloucestershire, should be appointed Auditors to The Wildfowl Trust for the ensuing year pursuant to Rule 10(1). Mr. K. Miller Jones seconded the proposal which was carried unanimously.

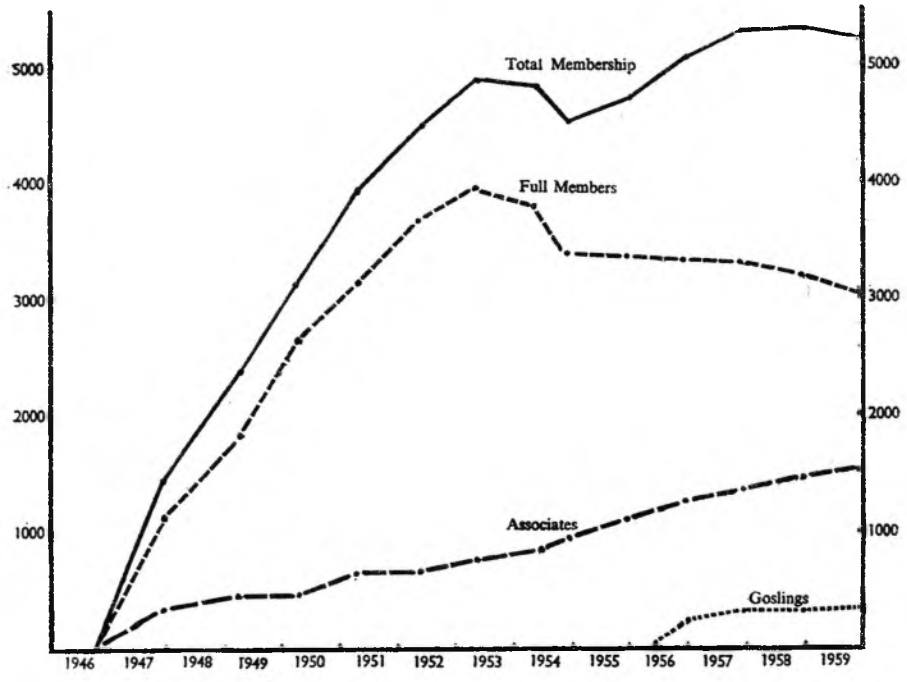
5. In a short discussion Mr. Edwin Cohen referred to the danger that crowds at Slimbridge and Peakirk might discourage individual membership. The Hon. Director recognised this danger especially if Members visited the Trust at weekends and Bank Holidays in the summer. The increased space provided by the new enclosures had greatly ameliorated the situation and on week days the grounds were reasonably empty of people. The same applied in winter when the wild geese drew the keener ornithologists. Mr. Russell Marris raised matters connected with the Trust's scientific publications and the encouragement of young ornithologists working in the wildfowl field. The Hon. Director said that these points were noted with interest and would be considered by the Council.

Business being concluded, the meeting was closed by the Chairman, Sir Percy Lister.

MEMBERSHIP

THE membership of the Trust rose by only thirty-two from 1st January, 1958 to 1st January, 1959, but the total of 5,352 on the latter date was the highest yet reached. The slow rate of increase in 1958 and the decline which followed in 1959 were due chiefly to a reduction in the numbers of Full Members from 3315 to 3206 (and to 3024 on 1st January, 1960, after the period covered by this report). Life, Associate and Gosling Membership increased during both years, but gains of Corporate Members and Contributors in 1958 were lost again in 1959.

Class of Membership	Jan. 1958	**January 1959**	Jan. 1960
Life Members	138	157	184
Full Members	3315	3206	3024
Junior Compounded ...	1	1	3
Associate and Parish Members	1383	1475	1505
Gosling Members ...	300	315	331
Corporate Members ...	154	174	169
Contributors	29	24	28
	5320	5352	5244



Membership of the Trust 1946-1959

The history of the growth of Trust Membership is depicted in the graph above. It is obvious that the increase of the subscriptions in 1954, though it caused far fewer immediate resignations than had been anticipated, has been sufficient to prevent the recruitment of Full Members from replacing the inevitable losses. The continuing gain of Associates shows that Membership of the Trust has not lost its appeal: the problem is to make it worth two guineas to an increasing number of people.

CLASSES OF MEMBERS

No changes in the conditions or costs of Membership were made in 1958-59.

Life Members:

(a) up to 50 years of age:	£52	10	0	}	One
(b) over 50, not over 60:	£26	5	0	}	Final
(c) over 60:	£10	10	0	}	Payment

Entitled to all privileges of Full Membership (see below) during life, and exempt from payment of any subscriptions, excepting any sum being paid yearly under Deed of Covenant.

Full Members: Annual subscription £2 2s. 0d. Entitled to free access to pens and observation-huts at the New Grounds and at Peakirk, with one free guest, one free copy of the Annual Report for each year of Membership and of all Bulletins issued during Membership, and to attend and vote at the Annual General Meetings.

Junior Compounded Members: Only persons under 21. One payment of £10 10s. 0d. Entitled to all privileges of Full Membership (as above) until attaining the age of 21. May then, if they wish, pay another 40 guineas and be elected Life Members.

Associate Members: Annual subscription 10/-. Entitled to free access to pens and observation huts, and to free copies of all Bulletins. (Associate Members may, by subscribing One Guinea, also have one copy of each Annual Report posted to them on publication).

Gosling Members: Annual subscription 7/6d. Limited to persons under 18. Entitled to free access to pens at the New Grounds, and at Peakirk, on Saturdays and Sundays. (With the aim of encouraging interest in Wildfowl among children, a system has been introduced of grades of Goslings, with appropriate distinguishing marks and promotion by recognition-test. Full particulars of this scheme are given in the separate Leaflet available at the Gate Houses at Slimbridge or Peakirk).

Corporate Members: Annual subscription of £2 2s. 0d. Limited to educational Institutions. Entitled to free access to pens and observation-huts at New Grounds in parties of 10 or more by arrangement with the Gate-House. (Sundays before 2 p.m. excepted). One free Annual Report; one copy of all Bulletins during Membership.

OBITUARY

The Council of the Wildfowl Trust sustained two grievous losses in the year 1959 by the lamented deaths of Michael Bratby, in March, and of Sir Archibald Jamieson, K.B.E., a former Member of the Council and benefactor of the Trust, in October.

The Council has learned with regret of the deaths (notified since the last issue of the Annual Report) of the following Members:

C. T. Austin
H. J. Bratby
Mrs. C. S. Buckley
Dr. T. H. Butler, PH.D., J.P.
G. H. Charman
Mrs. E. M. Commeline
Mrs. D. M. Dickinson
Lieut-General Sir Ralph Eastwood, K.C.B., D.S.O., M.C.
Lieut-Col. C. L. Estridge, D.S.O.
G. C. Gadd
Sir Evan Gwynne-Evans, BART.
R. T. Hadfield
Commander C. E. Hamond, D.S.O., D.S.C.
Miss E. M. Harding
Wing-Commander J. H. Heyworth
Sir Thomas Harrison Hughes, BART.
The Earl of Ilchester, O.B.E.
The Rev. Kenneth Ilderton
Mrs. S. E. Isaacs
Mrs. M. Johnstone
H. R. Jones
Captain M. J. Kingscote
Miss P. C. Kinnear
Mrs. F. J. Lister
H. G. Mack
J. A. Marston
B. F. May
Major P. M. Murray, O.B.E., M.C.
Captain D. S. Peploe
S. Porter
H. K. Reeves
R. M. Reid
Mrs. S. P. Richard
H. C. Scrimgeour
S. H. Shoveller, M.C.
W. A. Sibly
R. Stratton
Viscount Templewood of Chelsea, P.C., G.C.S.I., G.B.E., C.M.G.
Lieut-Col. J. R. West

THE WILDFOWL TRUST

BALANCE SHEET, 31st DECEMBER, 1958

LIABILITIES

		£ s. d.	£ s. d.
	Sundry Creditors :—		
8591	On Open Accounts		11943 10 3
	Westminster Bank Limited :—		
	Overdraft		1157 9 6
	Loan Accounts :—		
	Balance, 31st December, 1957 ..	11502 13 10	
	Less Repaid	190 0 0	
11503			11312 13 10
	Reserve Account :—		
2000	Balance, 31st December, 1957 ..		2000 0 0
	Income and Expenditure Account :—		
	Balance, 31st December, 1957 ..	4992 0 7	
	Less Excess of Expenditure over Income for the year	106 7 6	
4992			4885 13 1

ASSETS

		£ s. d.	£ s. d.
	Cash :—		
40	In Hand	133 6 5	
796	At Bank, Westminster Bank Ltd.	— — —	
23	At Bank, Lloyds Bank Ltd. ..	60 15 8	
859			194 2 1
894	**Sundry Debtors and Payments in advance** .. .. .. (The Debtors include £73 6. 8. in respect of the Narrow Boat. See Note 2 below).		988 17 1
	Valuation (as valued by the Honorary Director)		
	Membership and Administration :—		
410	Equipment	300 0 0	
	New Grounds and Peakirk :—		
8577	Wildfowl 8500		
300	Transport 785		
2852	Breeding Equipment, etc... 3252		
460	Hostel Equipment .. 540		
		13077 0 0	
	Gate Houses :—		
1250	Stock for re-sale	4930 0 0	
	Scientific and Educational :—		
575	Equipment	765 0 0	
1467	**Longaston House**	2300 0 0	
15891			21372 0 0

		Narrow Boat :—			
		Valuation, 31st December, 1951 ..		1000 0 0	
		Less Rents to 31st December, 1957	525		
		Rent for year ended 31st December, 1958	100		
				625 0 0	
475					375 0 0
		New Buildings, etc., New Grounds, Slimbridge, Glos.			
		Amount, 31st December, 1957 ..		11362 13 10	
		Less Written off to 31st December, 1957 ..	2395 10 1		
		Written off in year ended 31st December, 1958	597 16 3		
				2993 6 4	
8967					8369 7 6
		Note.—The New Buildings, etc., to be written off over a period not exceeding that of the lease.			
£27086					£31299 6 8

Notes—1. The Narrow Boat is hired from the Trust under a ten-year agreement at £100 per annum, payable by quarterly rents of £25 in advance, as from 21st October, 1952, with the option to purchase for ten shillings after rents amounting to £1000 have been paid.

2. The rents for the two years ended 31st December, 1958 had not been paid in full at that date and the sums of £40 and £33 6. 8. therefor, for 1957 and 1958 respectively are included in the Sundry Debtors.

£27086	£31299 6 8

We have examined the above Balance Sheet of the Wildfowl Trust, dated 31st December, 1958, together with the accompanying Income and Expenditure Account and find them to be in accordance with the Books and Vouchers produced to us and the information and explanations given to us.

STROUD, Gloucestershire
10th April, 1959

S. J. DUDBRIDGE & SONS,
Auditors.

THE WILDFOWL TRUST

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1958

EXPENDITURE

DR.		£ s. d.	£ s. d.
	To Membership and Administration :—		
2054	Salaries and National Insurance ..	2390 1 8	
403	Travelling	211 8 11	
723	Office Expenses, Postages, etc. ..	643 19 7	
1188	Printing and Stationery, General ..	1177 17 10	
400	Telephone	496 14 3	
145	Bank Charges	249 0 11	
2378	Printing Annual Report	2792 6 4	
107	Expenses of Annual Dinner ..	99 19 6	
688	Miscellaneous	335 6 6	
8086			8396 15 6
	New Grounds and Peakirk :—		
6312	Salaries, Wages and National Insurance	7238 16 2	
681	Travelling	648 18 5	
1146	Purchases and Transport of Wildfowl and Eggs	2707 14 8	
4524	Food for Wildfowl	4815 5 0	
591	Rent, Rates and Insurance ..	582 19 2	
1454	Materials, Repairs & Replacements	1472 12 2	
613	Transport & Mechanical Equipment and Maintenance	693 9 8	
846	Fuel and Power	822 8 10	
168	Hatching Expenses	81 15 4	
1283	Hostel Upkeep	926 5 8	
	Miscellaneous	511 15 6	
17618			20502 0 7
	Gate Houses :—		
9203	Purchases for resale	7878 9 4	
	do. Coloured Key Publications	5973 2 8	
1459	Salaries, Wages and National Insurance	1888 7 6	
10662			15739 19 6

INCOME

CR.		£ s. d.	£ s. d.
	By Membership :—		
7768	Subscriptions, Ordinary	7228 2 4	
355	Subscriptions, Life Members ..	216 17 0	
663	Donations	1181 12 0	
261	Receipts from Sale of Annual Reports	264 12 5	
106	Recepits from Annual Dinner ..	112 12 6	
9153			9003 16 3
	New Grounds and Peakirk :—		
16933	Gate Takings	20300 1 0	
2202	Sales of Surplus Wildfowl ..	2926 1 5	
19135			23226 2 5
	Gate Houses :—		
11242	Sales, General	14099 15 7	
	Sales, Coloured Key Publications ..	2083 10 4	
11242			16183 5 11
	Scientific and Educational :—		
4825	The Nature Conservancy Grant ..	5875 0 0	
530	Nuffield Foundation Grant ..	530 0 0	
650	Bristol Zoo Grants	900 0 0	
263	Donations from Abberton Ringing Station	262 10 0	
479	Duck Adoption	410 17 6	
859	Fees and Collections from Lectures	116 1 0	
7606			8094 8 6

	Scientific and Educational :—							
4415	Salaries and National Insurance ..				5964	2	0	
745	Travelling				519	4	4	
626	Rocket Netting				576	15	11	
893	Abberton Ringing Station ..				880	12	11	
79	Orielton Ringing Station				29	0	0	
732	Borough Fen Decoy				672	12	0	
240	Wildfowl Counts				138	10	5	
623	Equipment and Maintenance ..				759	6	2	
743	Aerial Survey				1312	2	5	
72	Duck Adoption				—	—	—	
328	Lectures				—	—	—	
9496								10852 6 2
	Capital Expenditure :—							
2178	Peakirk Development				274	13	9	
	New Grounds :—							
168	Equipment	248	17	2				
136	Hostel Equipment ..	179	15	10				
1787	New Area Development	1746	0	10				
	Gazebo	257	7	8				
	Transport	773	19	6				
	Gate House Extension	715	8	6				
50	Deep Freeze ..	—	—	—				
2141					3921	9	6	
	Scientific and Educational :—							
556	Building Conversion .	200	0	0				
279	Coloured Film ..	327	17	6				
	Tape Recorder ..	120	14	2				
	Equipment ..	136	3	2				
	Wildfowl Counts ..	55	16	6				
	Trapping Equipment..	106	0	4				
131	Boat and Trailer ..	—	—	—				
966					946	11	8	
	Longaston House :—							
1468	Expended thereon				863	7	8	
6753								6006 2 7
52615	**TOTAL EXPENDITURE FOR THE YEAR** ..							61497 4 4
11406	Valuation, 31st December, 1957							15891 0 0
598	Written off Buildings							597 16 3
£64619								£77986 0 7

47156	**TOTAL INCOME FOR THE YEAR**				
15891	Valuation, 31st December, 1958	21372	0	0	
1500	Transferred from Reserve Account	—			
92	Balance, Excess of Expenditure over Income for the year	106	7	6	
£64619		£77986	0	7	

Note.—The figures in the margin are those for the year ended 31st December 1957 and are given for the purpose of comparison only.

PHOTOGRAPHS

The Trust is greatly indebted to the following for permission to reproduce the photographs they have taken: Salim Ali, G. Anckorn, P. J. K. Burton, J. Dunn, P. Glasier, Dr. P. A. Johnsgard, John Myers, R. E. M. Pilcher, Christopher Sellick and P. Talbot-Ponsonby.

Three members of the staff—J. V. Beer, H. Boyd and Dr. S. K. Eltringham —have also provided illustrations.