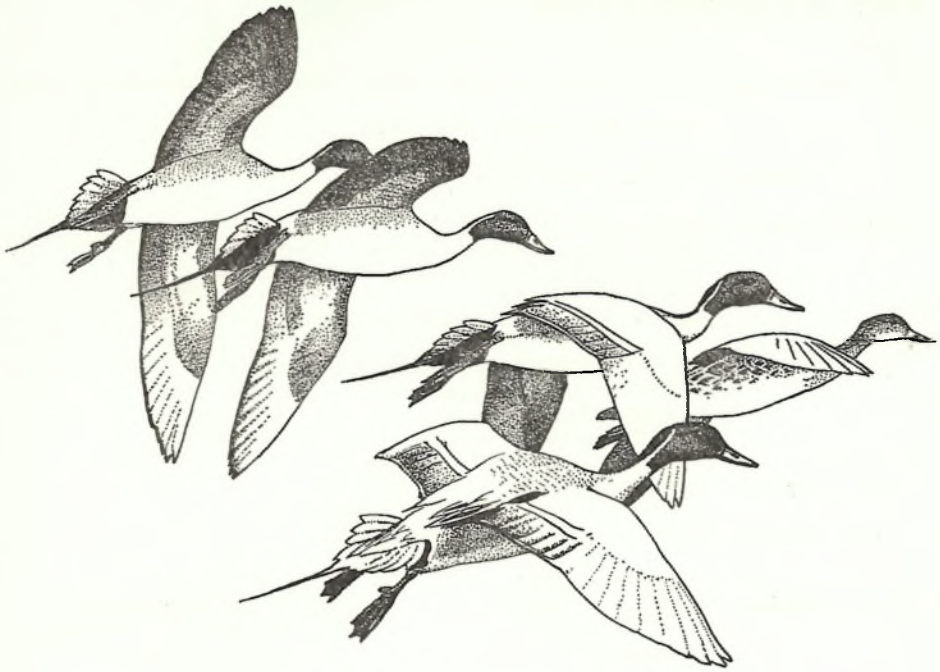

The eighteenth Annual Report of

# The Wildfowl Trust

**Edited by Hugh Boyd, assisted by M. A. Ogilvie**
**Illustrated by Peter Scott and Robert Gillmor**

Price 17/6d. ($3.10 postage paid)

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# The Wildfowl Trust

*Patron* HER MAJESTY THE QUEEN

*President*
His Grace the Duke of Norfolk, K.G., P.C., G.C.V.O.

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Captain R. G. W. Berkeley
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J. O. Death, Esq.
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G. A. J. Jamieson, Esq.
K. Miller Jones, Esq.
R. E. M. Pilcher, Esq., F.R.C.S.
Dr. G. W. Storey
Miss P. Talbot-Ponsonby
Sir Landsborough Thomson, C.B., O.B.E., D.SC., LL.D.
Major General C. B. Wainwright, C.B.
The Hon. Vincent Weir

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Captain J. A. Fergusson-Cunninghame
G. M. Jolliffe, Esq., F.L.A.S.
Christopher Marler, Esq.
J. P. Williams, Esq.

*Invited to attend meetings ex-officio*
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Miss Emilie Davies, H.M.I. (*Ministry of Education Assessor*)

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Guy Benson (*Chairman*)
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G. A. J. Jamieson, Esq.
K. Miller Jones, Esq.
Miss P. Talbot-Ponsonby

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Dr. B. Campbell
R. K. Cornwallis, Esq.
Dr. H. D. Crofton
Dr. J. H. Crook
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Dr. D. Lack, F.R.S.
Professor C. W. Ottaway
R. E. M. Pilcher, Esq., F.R.C.S.
Dr. G. W. Storey
Professor W. H. Thorpe, F.R.S.
Major General C. B. Wainwright, C.B.
Professor E. W. Yemm

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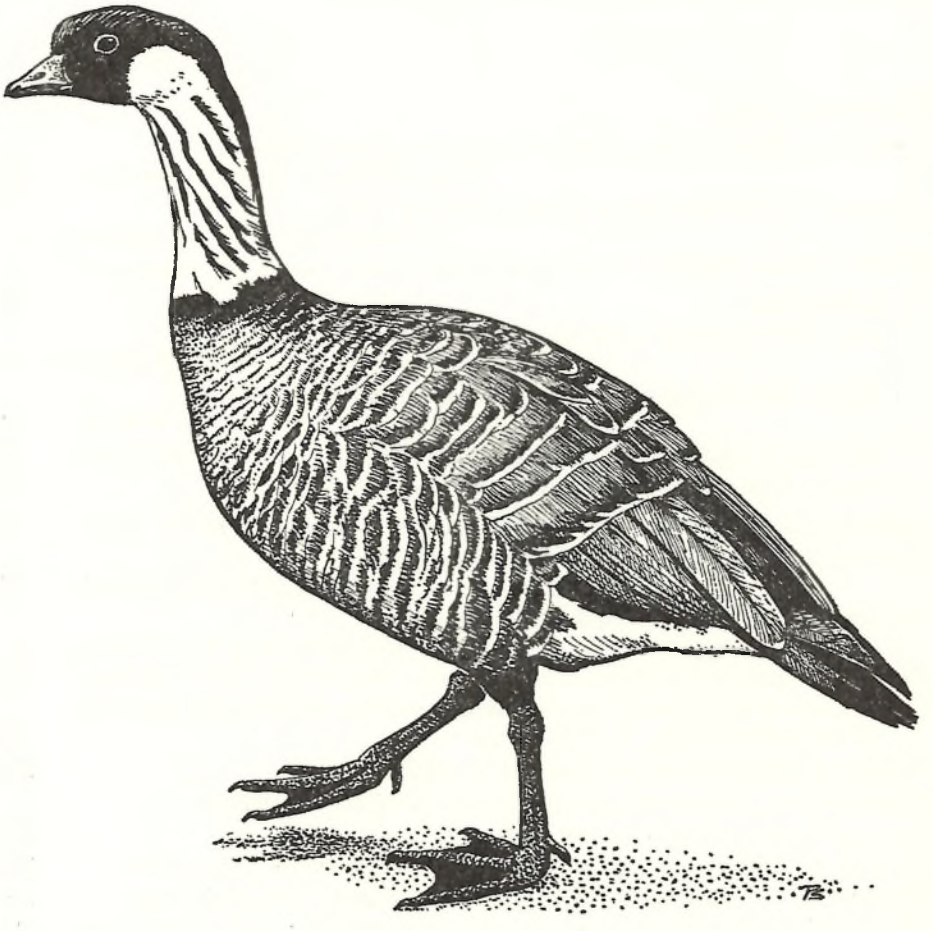

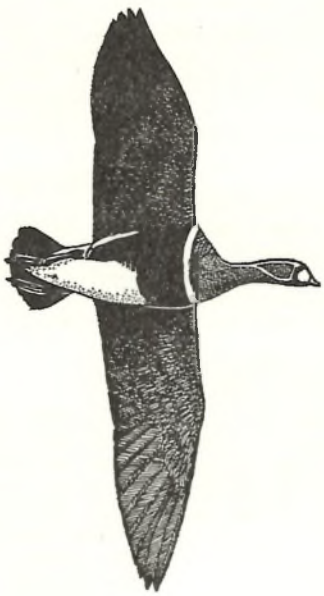

# Annual Report 1965-66

## Report

C. E. H. SPARROW

### Royal Visit

On 23rd April, 1966, the Trust was honoured by a visit by its Patron, Her Majesty the Queen, who came to inaugurate the Research Centre. She was accompanied by His Royal Highness Prince Philip, Duke of Edinburgh, and Their Royal Highnesses the Duke and Duchess of Kent. Her Majesty was welcomed by the Hon. Director and after unveiling a plaque commemorating the occasion was thanked by the President. She then made a tour of the building and of the grounds, and was entertained to sherry in the Hon. Director's house before leaving. (See Photograph Section pp. I and II.)

### Council and Committees

The Officers, Council and Committees of the Trust, as at 31st December, 1966, are shown on page 2. Meetings of the Council were held in London on 22nd February, 9th August and 13th December and of the Finance Committee on 16th February, 26th July and 23rd November. The annual meeting of the Scientific Advisory Committee was held in London on 24th March.

### Annual General Meeting and Dinner

The Eighteenth Annual General Meeting was held at the Royal Society of Arts on 12th May and the Annual Dinner took place at the Hyde Park Hotel the same evening. The President was in the chair at the A.G.M., and presided and spoke at the Dinner. Other speakers at the Dinner were Mr. A. Dickson Wright, M.S., M.B., F.R.C.S., Mr. Peter Scott, C.B.E., D.S.C., LL.D., and Lord Netherthorpe, LL.D., B.SC. The minutes of the Annual General Meeting will be found on page 8.

### Development

In the autumn of 1966 work started on the construction of a Tropical Aviary at Slimbridge with funds given by an anonymous donor. Another development made possible by a generous gift (from Mr. Duncan Holden in memory of his father)

was a new observation tower, close to the sea wall with splendid views over the Dumbles and connected to the Rushy Pen by a screened corridor. (See Photograph Section page X lower.)

**Exhibitions**

A permanent exhibition demonstrating the vital importance of conservation and of the constructive use of leisure in the world today and showing how the work of the Trust is related to these problems was opened in the Research Centre on the day of its inauguration.

In National Nature Week the Trust had a stand in the *Observer* Wildlife Exhibition at Alexandra Palace from 21st April to 1st May, and an educational display was mounted at the *Daily Mail* Schoolboys' and Girls' Exhibition at Olympia from 27th December, 1966, to 10th January, 1967.

**Identification Competition**

The Trust's Fifth Wildfowl Identification Competition for Schools was held at Slimbridge on 19th March, 1966. Leighton Park again had a large and very successful entry: their teams took the first and second places in both Group A and Group B, with Bristol Grammar School third in Group A and Clifton College third in Group B. In Group C teams from Beaudesert Park came first and third and New College Choir School took second place.

**Borough Fen Decoy**

The decoy at Borough Fen was opened to the public on 21st and 22nd May, 1966, and Mr. and Mrs. Pilcher again kindly devoted a weekend to explaining its history and its *modus operandi* to visitors.

**Members' Collections**

The Trust is again indebted to over 20 members who opened their private collections to fellow members during 1966: C. J. and A. J. Bird, A. Cadman, T. Curtis, J. O. Death, A. W. E. Fletcher, R. Law, Miss E. Manasseh, E. A. Maxwell, A. McLean, Mrs. B. Michell, R. B. Moseley, G. Newman, F. W. Perowne, R. E. M. Pilcher, G. R. Pryor, P. Short, Shrewsbury School, E. O. Squire, Mrs. P. V. Upton, J. Williams, D. Wintle.

**Gosling Party**

The annual Gosling Party was held at Slimbridge on 23rd December, 1966. The Hon. Director showed the Trust film, *Wild Wings*, to an appreciative audience of about 80.

**Staff**

It is with regret that the death on 20th December, 1966, of Mr. E. A. Scholes, who was Secretary of the Trust for over 17 years, is recorded. His place has been taken by Lt.-Col. P. G. W. Coke.

The educational potential of the Trust was greatly increased during the year by the addition of an Educational Officer to the establishment. The post was filled in September by Mr. E. E. Jackson.

**Finance**

A record number of visitors to both Slimbridge and Peakirk (see table below) and several generous donations gave the Trust its highest ever income in 1966.

The income shown in the accounts on page 160 is however somewhat misleading because of a change to payment in arrears of the quarterly grant from the Nature Conservancy. Although there were four quarterly grants in the year (on 1st January, 1st April and 1st July in advance and on 31st December in arrears), the receipt of the last payment on 31st December instead of on 1st October resulted in a serious depletion of the Trust's bank balance; the balance was further depleted by the payment of Selective Employment Tax, which is not recovered until the end of the quarter. As a result some £5,000 of the income for the year was absorbed by the need to replenish the working balance. In spite of this the Trust was able to allocate £5,700 to loan repayment and was still left with a small margin for development in 1967.

**Visitors**

| | *1962* | *1963* | *1964* | *1965* | *1966* |
|---|---|---|---|---|---|
| Slimbridge | 162,030 | 130,143 | 151,180 | 141,841 | 200,231 |
| Peakirk | 30,982 | 29,434 | 43,678 | 42,735 | 46,514 |
| | 193,012 | 159,577 | 194,858 | 184,576 | 246,745 |

**Membership**

In spite of an increase of 285 in the number of Full Members during the year, the overall membership fell. This again must be attributed to the increase in the subscription for Associates, which did not affect many members until 1966.

| *Class of Membership* | *31 Dec 63* | *31 Dec 64* | *31 Dec 65* | *31 Dec 66* |
|---|---|---|---|---|
| Life | 304 | 316 | 316 | 326 |
| Full | 3584 | 3644 | 3953 | 4238 |
| Associate and Parish | 2039 | 2422 | 2254 | 1638 \| 217 } 1855 |
| Junior Compounded | 10 | 12 | 15 | 15 |
| Gosling | 759 | 644 | 685 | 626 |
| Corporate | 101 | 94 | 95 | 92 |
| Contributors | 42 | 38 | 40 | 31 |
| | 6839 | 7170 | 7358 | 7183 |

**Terms of Membership**

LIFE MEMBERS: A single payment of 50 guineas. Entitled to all privileges of Full Membership (see below), and exempt from payment of any subscription, excepting any sum 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 Meeting.

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 20/-. Entitled to free access to pens and observation huts, and to free copies of all Bulletins.

GOSLING MEMBERS: Annual subscription 12/6d. Limited to persons under 18. Entitled to free access to pens at the New Grounds and at Peakirk, and to all Bulletins. (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 tests. Full particulars of this scheme are given in the separate leaflet available at the Gate Hut at Slimbridge or Peakirk.)

CORPORATE MEMBERS: Annual subscription 10/-. Limited to Educational Establishments, Youth Clubs, and bodies which are members of the Council for Nature. Parties from member bodies may visit the New Grounds and Peakirk in numbers not less than ten, and not exceeding one coach load at any one time, on payment at the Gate of the entrance fee, except that one adult in charge of a party of ten or more is admitted free. Times must be arranged beforehand with the Curator, and parties are not admitted before 2 p.m. on Sundays. One free Annual Report, one copy of all Bulletins during Membership.

CONTRIBUTORS: Organisations which do not qualify for Corporate Membership may become Contributors by subscribing not less than one guinea a year. Contributors receive all Trust publications.

ARRANGEMENTS FOR VISITORS: The Grounds are open to the public daily (except Christmas Day) from 9.30 a.m. on weekdays and from 12 noon on Sundays. Sunday mornings are reserved for Members.

# Minutes of the Nineteenth Annual General Meeting

1. The Nineteenth Annual General Meeting of the Wildfowl Trust was held at the Royal Society of Arts, John Adam Street, London, W.C.2, on Thursday, 13th May, 1966, at 5.00 p.m.

2. The following Officers and Members of Council and 29 Members were present:
His Grace the Duke of Norfolk, K.G., P.C., G.C.V.O., *President.*
Guy Benson, Esq., *Hon. Treasurer.*
Michael Crichton, Esq., O.B.E.
J. O. Death, Esq.
Captain J. A. Fergusson-Cuninghame.
G. M. Jolliffe, Esq., F.L.A.S.
Peter Scott, Esq., C.B.E., D.S.C., LL.D., *Hon. Director.*
Dr. G. W. Storey.
Miss P. Talbot-Ponsonby.
Major General C. B. Wainwright, C.B.
The Hon. Vincent Weir.
J. P. Williams, Esq.

3. Apologies for absence were received from the following Officers and Members of Council, and thirty-nine Members:
His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O.
The Rt. Hon. the Earl of Mansfield, J.P.
General Sir Gerald Lathbury, G.C.B., D.S.O., M.B.E.
Dr. Bruce Campbell.
Professor J. E. Harris, C.B.E., F.R.S.
Sir Percy Lister, Kt.
Christopher Marler, Esq.
K. Miller Jones, Esq.
Sir Landsborough Thomson, C.B., O.B.E.

4. The Minutes of the Eighteenth Annual General Meeting, circularised with the Agenda, were accepted and signed by the Chairman.

5. The Hon. Director gave an account of the year's activities at Slimbridge and Peakirk, after which he moved the adoption of the Report of Council which was seconded by Dr. S. K. Eltringham and carried unanimously.

6. The Hon. Treasurer moved the adoption of the accounts for the year ending 31st December, 1965. The motion was seconded by Mr. F. W. Perowne and carried unanimously.

7. The Hon. Director proposed the following amendments to the Rules of the Wildfowl Trust:
Rule 6 (1): Delete from "The Annual" in line 10 to the end, and substitute: "The annual subscription payable by or on behalf of Gosling Members shall be for those joining on or before 12th May, 1966, seven shillings and sixpence per annum and for those joining after 12th May, 1966, twelve shillings and sixpence per annum."

Mr. Crichton seconded this amendment which was carried unanimously.
Rule 5 (4) (vi): Delete from "The Council" in lines 18 and 19 to "this privilege" in line 22, and substitute: "(vii) The Council shall have the power to elect as Parish Members such persons as it may from time to time approve for this privilege who are resident in the parishes of Slimbridge or Peakirk or in such other parishes as it may determine."

Mr. G. M. Jolliffe seconded this amendment which was carried unanimously.

8. The following elected Councillors retired under Rule 13 (1), and were not elegible for re-election:
Michael Crichton, Esq., O.B.E.
Christopher Marler, Esq.
E. A. Maxwell, Esq.
J. P. Williams, Esq.

In accordance with Rule 7 (6) the following Council nominees were elected without vote:
G. R. Askew, Esq.
Dr. Bruce Campbell.
J. O. Death, Esq.
Professor J. E. Harris, C.B.E., F.R.S.
the proposal being made by Dr. S. K. Eltringham and seconded by Mr. Christopher Sellick with unanimous approval of the meeting.

9. The election of officers proposed *en bloc* by Major General C. B. Wainwright, C.B., and seconded by Mr. J. O. Death, received unanimous approval of the meeting:
*President:* His Grace the Duke of Norfolk, K.G., P.C., G.C.V.O.
*Vice-Presidents:* Sir Percy Lister, Kt.
Captain R. G. W. Berkeley
The Rt. Hon. the Lord Howick of Glendale, G.C.M.G., K.C.V.O.
General Sir Gerald Lathbury, G.C.B., D.S.O., M.B.E.
Sir Isaac Wolfson, Bt., F.R.S., F.R.C.P., D.C.L.
*Trustees:* His Grace The Duke of Beaufort, K.G., P.C., G.C.V.O.
The Earl of Mansfield, J.P.
John Berkeley, Esq., J.P.
H. H. Davis, Esq.
*Hon. Director:* Peter Scott, Esq., C.B.E., D.S.C., LL.D.
*Hon. Treasurer:* Guy Benson, Esq.

10. The Hon. Treasurer proposed that Messrs. S. J. Dudbridge and Sons of Stroud, Gloucestershire, should be re-appointed Auditors to the Wildfowl Trust for the ensuing year pursuant to Rule 19 (1). Captain J. A. Fergusson-Cuninghame seconded the proposition which was carried unanimously.

11. Mr. Christopher Sellick asked whether the Council would consider distributing Hawaiian Geese to private collectors in Britain, now that the re-establishment of a flock in the wild in Maui seemed assured of success.

The Hon. Director replied that the suggestion would certainly be given consideration, although the Maui project required further stock, and the depleted population at Slimbridge needed replenishing. Mr. Scott drew attention to the fact that the progeny of the Hawaiian Geese at Slimbridge were subject to an agreement, and were not available for sale. However, it might be possible to lend pairs on an agreement similar to the one drawn up with European zoos.

12. Mr. F. W. Perowne suggested that the date of future Annual General Meetings and Dinners should coincide with the Chelsea Flower Show; he suggested that the attendance at the A.G.M. would thus benefit. Council undertook to consider the proposal.

13. Business being concluded, the meeting was closed by the Chairman. Mr. Scott gave a short talk about his recent visit to the Antarctic illustrated with slides.

## Obituary

The Council has learned with regret of the deaths of the following Members and Associates, notified since March, 1966:—

Mrs. J. M. Aas
Mrs. J. W. Awdry
Sir Philip Manson Bahr
Mrs. A. D. Hiatt Baker
Air Chief Marshall Sir Arthur Barratt
Crawford Bassingham
A. D. Bates
S. Boddy
Mrs. E. Brabazon
Mrs. E. Brassey
C. Castle
Miss M. A. V. Cochran
S. H. Combe
Sir John Conybeare
Sir Arthur Curtis
A. W. S. Dean
Dr. Mary G. H. Dickson
Mrs. Maureen Ferguson
Mrs. H. W. Fitzwilliams
Miss Eva Mary Godman
Brigadier C. E. Gray
Mrs. E. F. Hall
J. E. Harris
F. T. Hearle
Keith Heughan
Major A. E. Hopkins
R. C. Hopwood
C. W. Janson
Mrs. H. S. Jones
Sir Norman Kendal
Miss A. Kenrick
Major A. P. Lambert
R. J. B. Leney
The Earl of Lisburne
D. H. Lloyd
G. P. Lloyd
H. W. McComas
A. S. MacPherson
Dr. Margaret Mitchell
A. F. Moody
Miss E. Morray
Brigadier C. E. Morrison
J. B. Mulligan
Colonel G. R. Newton
W. H. Nicholls
Mrs. E. M. Pilcher
Mr. B. V. Ramanjulu
Lt.-Col. Niall Rankin
Baroness Ravensdale
Sir George Reid
Mrs. F. St. George
Captain R. A. Sparrow
Mrs. M. W. Steward
Canon Thomas
Miss D. M. Verini
Miss Dorothy E. Viney
F. H. Wallace
Miss G. Welbourn
His Grace the Duke of Westminster
Mrs. G. C. Wilkins
E. Williams
J. J. Hedley Willis
C. A. Wingfield
Major J. A. R. Wise
Dr. W. R. Wooldridge

# The Collections in 1966

S. T. JOHNSTONE

The collections now comprise 175 kinds of waterfowl, six of Flamingo and two of the Screamers. We have added one new stiff-tail to the collection in the form of a male Peruvian Ruddy Duck *Oxyura ferruginea* sent as a gift from Charles Cordier. It is hoped to add further specimens during the coming year. Geoffrey Lewis collected and presented us with three Coscoroba cygnets, two of which are males, a welcome addition of new blood. Harlequins are once more represented, an expedition to Iceland in August being successful in catching, with the permission of the Icelandic Government, both these and Long-tailed Ducks. From previous experience it had been decided to time the project so that adolescent birds could be caught, the chances of their survival being greater than in the case of adult birds. All the birds arrived at Slimbridge in good condition and although the Long-tails appeared less worried and were considerably tamer, the stress factor in their case must have been severe for unfortunately they all succumbed. On the other hand the Harlequins, apart from two or three initial losses, have thrived and the drakes have moulted into a relatively bright plumage. The difficulty with adult birds had always been to induce their feeding. The juveniles readily feed on a mixture of shrimp and turkey starter. We have, through the good offices of Charles Cordier, been able to add wild caught birds to our Andean Crested Ducks and Puna Teal, the first time for a number of years that new blood has been added to these species. The two male Spectacled Eiders *Somateria fischeri* have improved and one is now in full plumage.

The Flamingo collection has been increased in numbers, and there are now 13 Greater, 26 Caribbean or Rosy, 58 Chilean, 20 Andean, 7 James's and 9 Lesser. (See Photograph Section pp. XIV, XV, and XVI.) With the exception of the African forms, all species are segregated, and a great deal of effort has gone into the provision of conditions not only agreeable to the birds but also suitable for displaying them to the public. Unlike most captive flamingos, they have free range over relatively large natural ponds. Special islands are provided in the form of concrete atolls filled with mud and sea sand, a channel runs through the centre at water level and this again is filled with mud and sand. Concrete nests have been added to these islands. Apart from the expensive food, there is the additional cost of providing winter quarters. Opinion differs as to the ability of the birds to stand severe weather. Certainly at Slimbridge they would run the risk of being frozen into the ponds and would undoubtedly suffer injury when being extricated. Even if the water were kept open one wonders how many degrees of frost could be tolerated without causing distress to at least some of the species. Colour retention in captive birds is difficult; even the Rosy Flamingos usually fade to a pale pink. We have been able to improve the colour greatly by the addition of the pigment canthaxanthin to their diet.

The breeding season produced a large number of birds even though many of the commoner species were restricted by allowing birds to incubate their first clutches. Many birds were hatched in the incubators as will be seen from the accompanying tables. Hottentot Teal laid for the first time in the collection, but unfortunately the eggs failed to hatch. Hooded and Red-breasted Mergansers laid after a lapse of some years. Six kinds of Whistling Duck nested and over 100 young birds were reared. Two Trumpeter and six Whooper Swans were raised. The Bewick's Swan laid two clutches but in spite of the devotion of her mate both sittings were infertile. Other breeding successes included Bronze-wing Duck, Australian Grey Teal and King Eiders. The new indoor rearing unit proved a great success in the case of the more delicate species, and in particular with the large numbers of ducklings hatched in the incubators. Based on the American method of indoor rearing, it comprises a series of small concrete pens each with their own water and heating supply. Each pen has removable sides so that the whole unit can be thrown into one enclosure should the need arise.

# Breeding results 1966: Slimbridge

| | *Date of first egg* | *Reared artificially* | | | *Incubated, reared by parents* | *Total reared* |
|---|---|---|---|---|---|---|
| | | *eggs* | *hatched* | *reared* | | |
| Magpie Goose | | 4 | 0 | | | |
| Javan Whistling Duck | 20.5 | 6 | 0 | | | |
| Fulvous Whistling Duck | 25.5 | 27 | 11 | 8 | | 8 |
| Cuban Whistling Duck | 2.5 | 10 | 8 | 7 | | 7 |
| White-faced Whistling Duck | 15.4 | 26 | 25 | 24 | 10 | 34 |
| N. Red-billed Whistling Duck | 28.3 | 12 | 8 | 8 | 12 | 20 |
| S. Red-billed Whistling Duck | 15.5 | 25 | 24 | 24 | 12 | 36 |
| Coscoroba Swan | 24.2 | 1 | 0 | | | |
| Black Swan | 8.2 | | | | 3 | 3 |
| Black-necked Swan | 7.2 | 6 | 4 | 4 | 3 | 7 |
| Bewick's Swan | 10.5 | 9 | 0 | | | |
| Whooper Swan | 7.4 | 4 | 4 | 4 | 2 | 6 |
| Trumpeter Swan | 24.4 | 4 | 2 | 2 | | 2 |
| Swan Goose | 28.3 | 22 | 4 | 4 | 1 | 5 |
| Western Bean Goose | 27.4 | 4 | 0 | | | |
| Russian Bean Goose | 27.4 | 6 | 0 | | | |
| Pink-footed Goose | 26.4 | 11 | 7 | 6 | | 6 |
| European White-fronted Goose | 17.4 | 4 | 0 | | | |
| Greenland White-fronted Goose | 22.4 | 21 | 3 | 2 | | 2 |
| Lesser White-fronted Goose | 21.4 | 27 | 15 | 12 | 2 | 14 |
| Western Greylag Goose | 15.4 | | | | 20 | 20 |
| Eastern Greylag Goose | 10.3 | 3 | 0 | | | |
| Bar-headed Goose | 23.4 | 32 | 13 | 10 | 1 | 11 |
| Emperor Goose | 29.4 | 43 | 15 | 12 | 2 | 14 |
| Lesser and Blue Snow Goose | 24.4 | | | | 16 | 16 |
| Greater Snow Goose | 24.4 | | | | 13 | 13 |
| Atlantic Canada Goose | 16.3 | | | | 8 | 8 |
| Moffit's Canada Goose | 4.3 | 5 | 1 | 0 | | |
| Giant Canada Goose | 25.3 | | | | 1 | 1 |
| Taverner's Canada Goose | 12.4 | 5 | 1 | 1 | 1 | 2 |
| Dusky Canada Goose | 26.3 | | | | | |
| Hawaiian Goose or Ne-Ne | 9.2 | 63 | 13 | 8 | | 8 |
| Barnacle Goose | 28.4 | | | | 20 | 20 |
| Black Brant | | 12 | 9 | 7 | | 7 |
| Red-breasted Goose | | 5 | 1 | 0 | | |
| Ruddy Shelduck | | 9 | 0 | | | |
| Cape Shelduck | 16.3 | 8 | 7 | 7 | | 7 |
| Egyptian Goose | 25.2 | 19 | 13 | 11 | 9 | 20 |
| Abyssinian Blue-winged Goose | 28.4 | 12 | 5 | 4 | | 4 |
| Andean Goose | 2.4 | | | | 4 | 4 |
| Ashy-headed Goose | 16.4 | 14 | 9 | 7 | 4 | 11 |
| Ruddy-headed Goose | 27.3 | 6 | 4 | 1 | 4 | 5 |
| Lesser Magellan Goose | 29.3 | 8 | 5 | 5 | 4 | 9 |
| Greater Magellan Goose | 7.5 | | | | 2 | 2 |
| Cereopsis Goose | | | | | 1 | 1 |
| Patagonian Crested Duck | 7.2 | 13 | 6 | 6 | 21 | 27 |
| Bronze-winged Duck | 17.2 | 15 | 6 | 6 | | 6 |
| Marbled Teal | 13.4 | | | | 40 | 40 |
| Cape Teal | 26.2 | 11 | 5 | 5 | 19 | 24 |
| Hottentot Teal | | 4 | 0 | | | |
| Versicolor Teal | 1.4 | 23 | 11 | 8 | | 8 |
| Puna Teal | 21.4 | 9 | 0 | | | |
| Red-billed Pintail | | 5 | 3 | 3 | | 3 |
| Bahama Pintail | | 21 | 8 | 8 | 12 | 20 |
| S. Georgian Teal x Chilean Pintail | 17.3 | 8 | 6 | 6 | | 6 |
| Chilean Pintail | | | | | 20 | 20 |
| Northern Pintail | 24.3 | 25 | 21 | 15 | | 15 |
| Kerguelen Pintail | | 4 | 0 | | | |
| Chilean Teal | 31.3 | 33 | 28 | 25 | | 25 |
| Sharp-winged Teal | 17.3 | 8 | 2 | 2 | | 2 |
| Falcated Teal | | 28 | 3 | 3 | | 3 |
| Australian Grey Teal | 26.2 | 32 | 25 | 25 | | 25 |
| Chestnut-breasted Teal | 17.3 | 5 | 3 | 3 | 22 | 25 |

| | *Date of first egg* | *Reared artificially* | | | *Incubated, reared by parents* | *Total reared* |
|---|---|---|---|---|---|---|
| | | *eggs* | *hatched* | *reared* | | |
| New Zealand Brown Teal | 22.2 | 11 | 7 | 7 | 16 | 23 |
| Laysan Teal | 7.4 | 31 | 19 | 19 | 16 | 35 |
| N. American Black Duck | 28.3 | 8 | 7 | 4 | | 4 |
| Indian Spotbill | | 2 | 1 | 1 | | 1 |
| Chinese Spotbill | 19.4 | 10 | 8 | 6 | 6 | 12 |
| New Zealand Grey Duck | 1.3 | | | | 11 | 11 |
| Philippine Duck | 8.5 | 8 | 7 | 7 | 13 | 20 |
| African Yellowbill | 1.4 | 10 | 6 | 6 | | 6 |
| Abyssinian Yellowbill | 17.3 | 31 | 23 | 23 | 7 | 30 |
| Gadwall | 1.4 | | | | 40 | 40 |
| European Wigeon | | | | | 12 | 12 |
| American Wigeon | | | | | 20 | 20 |
| Chiloe Wigeon | 12.4 | 28 | 13 | 7 | 3 | 10 |
| N. Cinnamon Teal | | 7 | 4 | 3 | | 3 |
| Garganey | | 12 | 2 | 2 | | 2 |
| Argentine Red Shoveler | 28.4 | 15 | 4 | 3 | | 3 |
| Cape Shoveler | 13.5 | 16 | 5 | 5 | | 5 |
| New Zealand Shoveler | | 5 | 4 | 4 | 3 | 7 |
| Common Shoveler | 3.5 | | | | 12 | 12 |
| Ringed Teal | 16.4 | 44 | 11 | 5 | 15 | 20 |
| European Eider | 15.5 | 12 | 9 | 7 | | 7 |
| King Eider | | 5 | 4 | 4 | | 4 |
| Red-crested Pochard | 24.7 | 24 | 15 | 12 | 18 | 30 |
| Rosy-bill | 3.5 | 26 | 4 | 4 | 8 | 12 |
| African Pochard | 9.2 | 10 | 1 | 1 | | 1 |
| Canvasback | 29.3 | 6 | 6 | 5 | | 5 |
| European Pochard | 29.4 | 7 | 7 | 6 | | 6 |
| Redhead | 30.4 | 22 | 8 | 6 | 6 | 12 |
| Common White-eye | 15.5 | | | | 12 | 12 |
| Baer's Pochard | | 10 | 8 | 3 | | 3 |
| Australian White-eye | | 24 | 22 | 16 | 4 | 20 |
| New Zealand Scaup | | | | | 20 | 20 |
| Tufted Duck | | 12 | 12 | 12 | 8 | 20 |
| Lesser Scaup | | 11 | 7 | 7 | 2 | 9 |
| European Greater Scaup | | 15 | 7 | 4 | | 4 |
| Brazilian Teal | 5.5 | 20 | 14 | 9 | | 9 |
| Mandarin Duck | 24.3 | | | | 65 | 65 |
| Carolina | 17.3 | | | | 110 | 110 |
| S. American Comb Duck | | 16 | 14 | 4 | | 4 |
| Hartlaub's Duck | 4.3 | 10 | 9 | 4 | 5 | 9 |
| Muscovy Duck | | | | | 15 | 15 |
| Spur-winged Goose | | 6 | 0 | | | |
| European Goldeneye | 8.5 | 4 | 1 | 1 | | 1 |
| American Goldeneye | | 4 | 0 | | | |
| N. American Ruddy Duck | | | | | 15 | 15 |
| African White-backed Duck | | 17 | 6 | 0 | | |
| Hooded Merganser | 28.4 | 7 | 0 | | | |
| Red-breasted Merganser | | 6 | 0 | | | |
| Crested Screamer | | 2 | 1 | | 1 | 1 |

## Breeding results 1966: Peakirk

| | *Date of first egg* | *Eggs incubated* | *Eggs hatched* | *Young reared* |
|---|---|---|---|---|
| Fulvous Whistling Duck | 14.4 | 19 | 0 | |
| Black Swan | 21.2 | 11 | 8 | 5 |
| Black-necked Swan | 12.2 | 5 | 4 | 2 |
| Swan Goose | 9.4 | 19 | 9 | 8 |
| Pink-footed Goose | 6.5 | 5 | 2 | 1 |
| European White-fronted Goose | 23.5 | 3 | 0 | |
| Greenland White-fronted Goose | 3.5 | 9 | 0 | |
| Lesser White-fronted Goose | 5.5 | 5 | 0 | |
| Western Greylag Goose | 27.3 | 21 | 12 | 9 |
| Emperor Goose | 27.5 | 13 | 0 | |
| Lesser Snow Goose | 3.5 | 8 | 0 | |
| Hawaiian Goose or Ne-Ne | 4.3 | 5 | 0 | |
| Barnacle Goose | 25.4 | 26 | 0 | |
| Red-breasted Goose | 8.6 | 5 | 4 | 3 |
| Ashy-headed Goose | 14.4 | 10 | 0 | |
| Greater Magellan Goose | 24.4 | 19 | 14 | 7 |
| Cape Shelduck | 4.3 | 9 | 3 | 3 |
| Common Shelduck | 30.4 | 21 | 7 | 7 |
| Patagonian Crested Duck | 26.7 | 6 | 6 | 4 |
| Marbled Teal | 10.5 | 40 | 25 | 14 |
| Cape Teal | 10.5 | 27 | 15 | 9 |
| Versicolor Teal | 21.3 | 13 | 5 | 1 |
| Red-billed Pintail | 4.7 | 5 | 1 | 1 |
| Bahama Pintail | 4.5 | 44 | 26 | 17 |
| Chilean Pintail | 17.3 | 15 | 14 | 12 |
| Northern Pintail | 22.4 | 8 | 2 | 2 |
| Chilean Teal | 18.3 | 14 | 9 | 8 |
| Falcated Teal | 16.6 | 8 | 2 | 1 |
| Chestnut-breasted Teal | 9.2 | 20 | 0 | |
| North American Black Duck | 9.5 | 13 | 4 | 4 |
| Laysan Teal | 17.4 | 25 | 12 | 9 |
| Chinese Spotbill | 22.4 | 20 | 10 | 6 |
| African Yellowbill | 2.5 | 4 | 3 | 2 |
| African Black Duck | 18.2 | 25 | 8 | 4 |
| Gadwall | 12.5 | 44 | 26 | 15 |
| European Wigeon | 1.5 | 45 | 24 | 20 |
| American Wigeon | 30.5 | 22 | 3 | 3 |
| Blue-winged Teal | 13.6 | 7 | 2 | |
| Cinnamon Teal | 30.4 | 24 | 8 | 7 |
| Cape Shoveler | 26.4 | 9 | 7 | 7 |
| Common Shoveler | 29.4 | 48 | 33 | 30 |
| Ringed Teal | 27.6 | 8 | 6 | 2 |
| Red-crested Pochard | 26.5 | 2 | 0 | |
| European Eider | 28.3 | 71 | 20 | 11 |
| Rosybill | 11.5 | 19 | 7 | |
| European Pochard | 30.5 | 6 | 1 | 1 |
| Common White-eye | 8.5 | 24 | 14 | 12 |
| Baer's Pochard | 3.6 | 9 | 7 | 5 |
| Australian White-eye | 3.5 | 41 | 4 | |
| New Zealand Scaup | 25.5 | 6 | 0 | |
| Tufted Duck | 30.5 | 51 | 22 | 11 |
| European Greater Scaup | 9.6 | 19 | 7 | 3 |
| Brazilian Teal | 22.4 | 18 | 7 | 4 |
| Carolina | 21.3 | 67 | 9 | 3 |
| Comb Duck | 25.7 | 3 | 3 | |
| Barrow's Goldeneye | 13.5 | 4 | 0 | |
| North American Ruddy Duck | 28.5 | | 13 | 4 |

# Conservation, Education and Research, 1966

G. V. T. MATTHEWS

The Research and Educational Centre was graciously inaugurated by H.M. The Queen on St. George's Day, 23rd April. Her Majesty was accompanied by the Duke of Edinburgh and the Duke and Duchess of Kent. The Royal party was welcomed by short speeches from our President, the Duke of Norfolk, and Mr. Scott, and then conducted on a tour of the new building and the grounds. (See Photograph Section pp. I and II.)

The international co-ordination of wildfowl conservation, and of the related research activities, was pressed forward through a series of conferences, at which the Trust was actively represented. In May the Second European Meeting on Wildfowl Conservation was convened at Noordwijk, Holland, to discuss progress on the conservation of internationally important wetlands. The meeting was particularly memorable as the first at which the U.S.S.R. threw its massive weight behind the European movement and indicated that further close co-operation was possible. In July the Executive Board of the International Wildfowl Research Bureau met at Slimbridge. The Bureau is the permanent body charged with the stimulation and co-ordination of wildfowl research, particularly in Europe but also in Africa and Asia. Two very full days of discussions by 21 delegates and observers from Belgium, Denmark, France, W. Germany, Ireland, Israel, the Netherlands, Sweden, Switzerland, S. Africa and the U.K. were presided over by the Bureau's Honorary Director, Dr. L. Hoffmann. (See Photograph Section p. III lower.) A complementary meeting under the auspices of the Bureau was held at Jablonna, Warsaw, in September. Here there were 28 participants from Czechoslovakia, Estonia, France, East and West Germany, Hungary, Latvia, Pakistan, Poland, Roumania, the U.K. and the U.S.S.R. One particular outcome was a detailed plan for a mid-January international wildfowl count to include many countries besides those which have regular counts as in Britain. The Co-ordinator of the Duck Working Group responsible is Mr. Atkinson-Willes. Two other world meetings took place in England in July, the International Council for Bird Preservation in Cambridge, followed by the International Ornithological Congress in Oxford. From the latter 400 delegates descended on Slimbridge in one hectic day which fortunately was fine. Many other overseas ornithologists visited us before and after these meetings. (See Photograph Section p. X upper.)

As in the previous year, the Trust did all it could to help the improving conservation situation in Ireland. The Minister of Lands and three of his senior advisers spent an instructive week-end at Slimbridge and also visited the joint W.A.G.B.I./W.T. experimental reserve at Sevenoaks. Mr. F. O'Gorman, newly appointed Wildlife Officer to the Ministry, also spent some time studying at Slimbridge and with our workers in the field. The first public meeting of the Irish Wildfowl Committee in Dublin was the occasion of a showing of our film *Wild Wings* and a liaison tour. The North Slob, Wexford, winter home of more than half the world's population of Greenland Whitefronts, was threatened by land improvement schemes. We supported the efforts of Irish conservationists to save a nucleus of wet grassland, by arousing international interest and providing data on the ecological requirements of the geese to all parties concerned. There is real hope of a satisfactory outcome. Assistance was also given in connection with the Northern Ireland National Trust's Strangford Lough Wildlife Conservation Scheme.

Research in Iceland was again supported. A substantial grant enabled Mr. S-A. Bengtson, Lund University, to make two more visits to Myvatn to study the populations (which have seriously declined) and the breeding biology of the ducks of this famous lake. A scheme of research was drawn up for a student expedition from Radley College to Central Iceland (p. 134). Mr. C. Savage's untiring efforts in S.W. Asia (p. 150) were assisted, though all the credit for the remarkable achievements there is due to him. A number of workers from overseas came to Slimbridge to study the Collection or to work with our reference material. They included Miss D. Kaltenhauser from Konrad Lorenz's institute at Seewiesen, near Munich; A. Tamisier from the Station Biologique Tour du Valat in the Camargue; L. Nilsson of Lund University, Sweden; R. Marriot of Monash University, Australia; and we were pleased to welcome back Professor Paul Johnsgard, of Lincoln University, Nebraska.

On the home front the Trust staff was involved in conservation activities through the Wildfowl Conservation Committee of the Nature Conservancy, by co-operation with the Royal Society for the Protection of Birds (to which a substantial grant was given to assist in an important purchase of a farm on the shores of Loch Leven) and by service in the Gloucestershire Naturalists' Trust. Plans were drawn up for the conservation of wetland areas, the multiple-use of reservoir facilities and for standardised observation hides. Detailed botanical surveys were carried out and management advice given by Dr. Pollard at a number of sites, notably the Sevenoaks reserve (p. 55), Abberton Reservoir, Tregaron Bog in Carmarthenshire, Fairburn Ings in Yorkshire and Loch Leven, Kinross. He also examined the problems of increased salinity and of erosion of the Dumbles.

To the conservation and research exhibition in the Wolfson Hall was added, in the entrance corridor, an introductory exhibition of nine wall panels—" This Man and This Earth ". Conceived by Mr. Scott, this was executed by Mr. Kim Allen and seeks to offer a challenging, provocative statement of the vital importance of conservation and the constructive use of leisure in the world of to-day. The Trust had exhibition stands at the National Nature Week Observer Exhibition in Alexandra Palace, the Game Fair at Chatsworth, the Peterborough Show and (with a fine new set of exhibition panels) at the *Daily Mail's* Schoolboys' Exhibition, Olympia. The educational activities of the Trust were greatly increased following the appointment in September of a full-time Educational Officer, Mr. E. E. Jackson. It is now possible to offer improved facilities to visiting schools and other educational establishments and to step up the number of outside lectures.

Sir Landsborough Thomson, who has been Chairman of the Scientific Advisory Committee since its inception in 1954, retired in April. The Trust owes a great deal to his wise guidance through a tricky period of growth. He is succeeded by Professor G. M. Hughes of the Department of Zoology, Bristol, thereby strengthening further our ties with our neighbouring University. The opening of the Severn Bridge in September has brought Cardiff within easy reach and the Department of Zoology there has appointed Dr. Matthews an Honorary Lecturer. Other Universities with which we have less formal ties through the provision of facilities and research material are Bath, Cambridge, Leicester, Liverpool, London and Oxford.

Mr. Boyd, based in Edinburgh, was joined in March by Mr. C. R. G. Campbell at Loch Leven, Kinross. In close collaboration with the Nature Conservancy, Scotland, they launched a long-desired investigation into the breeding biology of ducks (p. 36). Regular counts were made on the Loch throughout the year, feeding behaviour patterns investigated, a start made on ringing and the shooting bag analysed. An aerial survey was made in April in Ireland and West Scotland to cover the populations of Barnacle and Brent Geese. The Pinkfeet and Greylag Geese were subjected to the usual co-operative censuses in March and November. It was found that their numbers had increased yet again, to 76,000 and 60,000 respectively.

Besides the detailed preparations for the international mid-winter count, the regular British monthly counts were continued under the guidance of Mr. Atkinson-Willes and Mr. Beale. Long-term analyses of the accumulated data were brought nearer to completion. The country-wide check on the breeding distribution of ducks was also continued.

The ringing activities at our various outstations, the rocket netting of geese and the capture of flightless Canada Geese and Greylag Geese and of Mute Swans are reported separately (p. 17). Mr. Ogilvie has been engaged in an analysis of the results of the latter (p. 64) and Dr. C. D. T. Minton will be publishing a first paper on the detailed study he has been making in Staffordshire, grant-aided by the Trust, in the next Annual Report. Meanwhile, results obtained in a third study on Mute Swans carried out by Dr. C. M. Perrins in the Oxford area are printed (p. 74).

Several more Bewicks' Swans were ringed at Slimbridge and Mr. Scott's studies (based on the recognition of individuals by their face patterns) on the inter-relationships and behaviour of the greatly increased visiting flock, forged ahead. In this he was assisted by Mrs. Scott and Dafila Scott and by our visiting American worker, Miss Maya Scull.

Other behaviour studies included those on the orientation of Mallard (p. 88) in which the number of birds released in field tests now exceeds 10,000. Dr. Kear continued her work on behaviour in relation to feeding habits, largely through

the study of newly-hatched young birds. Ancillary investigations included those into depth perception (p. 122) and into vocalisation and its development in the individual. The breeding history of the Nenes was investigated with the aim of reducing the infertility problem.

Facilities for research into pathology were greatly improved by the reconstruction of the laboratory to give a separate post-mortem room. Dr. Beer continued the work of safeguarding the health of the Collection and was successful in curing a number of ailments. Our Council Member, Dr. G. W. Storey, again helped in the processing of histological preparations. The reference collections of skins, skulls, trachea, wings, etc. were further augmented and re-catalogued. They now contain over 1,300 items. Mrs. M. Bower became the laboratory assistant in October, while Miss E. Wright and Mr. P. Stanley gave most welcome assistance, as did a number of other student workers.

The grant from the Natural Environment Research Council, of which the Nature Conservancy is now part, provided essential support to the work of the Research Unit. In the year beginning April, 1966, it was raised to £16,500. For this we are extremely grateful.

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# Wild Geese at the New Grounds, 1965-66

M. A. OGILVIE

European White - fronted Goose *Anser albifrons albifrons*

The first to arrive were three on 28th September, 1965. There was a slow increase to 100 by the end of October. The cold spells in November brought more birds and 800 were counted in mid-December, the highest for that time since 1959. There were further arrivals in the next few weeks with counts of 2,250 on 3rd January, 1966, and 3,150 on 15th. There was a short-lived but large influx in early February with 4,700 counted on 6th and 5,500 on 9th. This latter figure is the highest recorded at the New Grounds since the Trust was founded. Although some of the birds departed almost at once there were over 4,000 present for the remainder of February. The general departure in March was both early and rapid, with 3,500 counted on 7th, but only 350 the next day. The last few were seen on 10th.

The breeding success in 1965 was similar to that of the two previous years. In November and December the proportion of young birds was 31% and the average brood-size was 2.7. Unusually it was a little higher in January at 35%, average brood-size 2.7. It fell again to 31% in late February, and the average brood-size was also lower at 2.4.

Lesser White-fronted Goose *Anser erythropus*

After only one sighting in the last three winters, 1965-66 produced a bumper crop. Two adults were present during the second week of February, 1966, and a third was seen on 27th February. On that date also two first-winter birds were seen.

Bean Goose *Anser fabalis*

A first-winter bird of the Western race *fabalis* was seen on 6th February, 1966, and on a number of occasions later the same month.

Pink-footed Goose *Anser brachyrhynchus*

The only autumn record was of a flock of 19 flying over the river on 26th September, 1965. This is the third season running in which a few birds have appeared in the autumn but failed to stop. A single bird was seen on 7th January, 1966, and this stayed for several weeks, being joined by a second for a time in February.

Barnacle Goose *Branta leucopsis*

A first-winter bird was present from 2nd February, 1966, until 6th March.

Dark-bellied Brent Goose *Branta bernicla bernicla*

Seven adults were seen together on the Dumbles on 26th January, 1966. This is the largest number recorded at the New Grounds in one winter. A single bird was seen on 2nd February.

# Ringing, 1965-66

M. A. OGILVIE

**Ducks.** The total of 4,697 ducks caught and ringed by the Trust and its helpers is just over 1,000 down on last season. This is principally due to a much reduced catch of Mallard by Mr. W. A. Cook at Borough Fen Decoy. Major General C. B. Wainwright's catch of Teal was his lowest for five years but a larger number of Mallard more than compensated for this. The catch of Mallard at Slimbridge was again kept down to 500.

Useful numbers of ducks were caught at the Trust's other stations. Mr. J. E. A. Lambert caught over 100 ducks at Dersingham Decoy. An account of the history and re-building of the Decoy will be found on p. 22. At Loch Leven, Kinross, Mr. H. Boyd and Mr. C. Campbell of the Trust's research staff caught 80 ducks, including 13 Gadwall and 25 Tufted Ducks, mostly females on the nest. Details of their study of the breeding ducks at Loch

Leven are given on p. 36. Catching has restarted at Deeping Lake, Lincolnshire, by arrangement with Messrs. Dandridge, and 27 Pochard and 42 Tufted Ducks were among a useful catch. At Valley, Anglesey, Mr. R. Palethorpe's traps caught 62 Mallard, and at Abbotsbury, Dorset, the Decoyman, Mr. F. Lexster, had 22 Pintail in his catch.

We were sad to learn of the departure from How Hill, Ludham, Norfolk, of Messrs C. A. and M. R. Boardman. Their ringing station started in 1936, and they have been ringing ducks for the Trust since 1954. In the last twelve years they have caught over 1,000 Mallard and 100 Teal. These have produced a most interesting series of recoveries which have included a very high proportion of foreign recoveries of Mallard, probably as a result of the predominance of late winter catches. It is hoped that Mr. R. Smithson will be able to continue to operate the traps.

**Ducks ringed 1965-66.**

| *Species* | *Abberton Essex* | *Borough Fen Decoy* | *Slimbridge Glos.* | *Other Stations* | *Total 1965-66* | *Total 1964-65* |
|---|---|---|---|---|---|---|
| Shelduck | 38 | | | 1 | 39 | *51* |
| Pintail | 5 | 2 | 2 | 27 | 36 | *18* |
| Teal | 879 | 222 | 3 | 86 | 1190 | *1643* |
| Mallard | 1000 | 1140 | 500 | 508 | 3148 | *3831* |
| Gadwall | 1 | | 1 | 16 | 18 | *1* |
| Wigeon | 11 | | | 23 | 34 | *33* |
| Garganey | 8 | | | | 8 | *19* |
| Shoveler | 25 | 6 | 20 | 7 | 58 | *71* |
| Eider | | | | 1 | 1 | |
| Pochard | 20 | | 3 | 27 | 50 | *15* |
| Tufted Duck | 44 | | 2 | 67 | 113 | *33* |
| Goldeneye | 1 | | | | 1 | |
| Goosander | 1 | | | | 1 | |
| | 2033 | 1370 | 531 | 763 | 4697 | *5715* |

**Geese.** A rocket-netting team spent a fortnight in Scotland in February, 1966, and caught 92 Greylags on Bute and 22 Barnacle Geese on the Solway. These disappointingly small catches were mostly due to the very bad weather conditions encountered. Trust staff took part in a number of round-ups of flightless geese. In Wigtownshire a team organised by Mr. J. G. Young caught and ringed 39 Greylags, and Canada Geese were ringed in Yorkshire, where Mr. A. F. G. Walker and his helpers caught 80 birds, in Staffordshire (61 birds) and at Frampton Gravel Pits, Gloucestershire (21 birds).

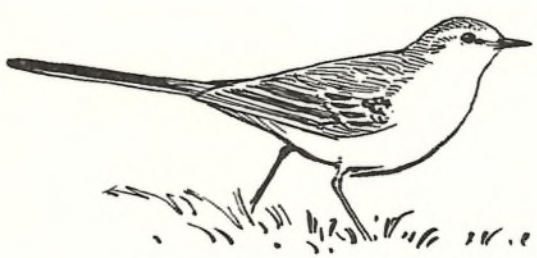
**Swans.** Trust support for the ringing of Mute Swans was restricted to a few ringers undertaking special projects. Fourteen Bewick's Swans were caught and ringed at Slimbridge.

## Numbers of birds, other than ducks and swans, ringed at Abberton Reservoir and Borough Fen Decoy

Although the trapping of ducks is the prime object of the Wildfowl Trust's ringing stations at Abberton Reservoir and Borough Fen Decoy, large numbers of other species of birds are caught and ringed at both places. At Abberton, Major General C. B. Wainwright traps many birds in his cage traps, and also uses mist nets. Mr. W. A. Cook mist nets birds in the Decoy wood at Borough Fen and rings numbers of nestlings. He also rings the birds, mainly gulls, caught in the duck trap at nearby Deeping Lake. The waders on his list come from catching trips to the Wash.

**Numbers of birds, other than ducks and swans, ringed at Abberton Reservoir and Borough Fen Decoy, 1966.**

| *Species* | *Abberton* | *Borough Fen* | *Species* | *Abberton* | *Borough Fen* |
|---|---|---|---|---|---|
| Great Crested Grebe | 2 | 8 | Wren | 13 | |
| Little Grebe | 7 | | Mistle Thrush | | 1 |
| Heron | | 3 | Fieldfare | 3 | 5 |
| Bittern | 1 | | Song Thrush | 72 | 66 |
| Water Rail | 14 | 1 | Redwing | 3 | 8 |
| Spotted Crake | 1 | | Blackbird | 75 | 175 |
| Moorhen | 64 | 125 | Wheatear | 17 | |
| Coot | 68 | 56 | Greenland Wheatear | 1 | |
| Oystercatcher | | 5 | Redstart | 3 | |
| Lapwing | 8 | 3 | Nightingale | 2 | |
| Ringed Plover | | 3 | Robin | 23 | 27 |
| Grey Plover | | 5 | Reed Warbler | 46 | 1 |
| Turnstone | | 5 | Sedge Warbler | 174 | 1 |
| Snipe | 81 | | Blackcap | 11 | 23 |
| Jack Snipe | 2 | | Garden Warbler | 1 | 5 |
| Curlew | | 18 | Whitethroat | 53 | 11 |
| Bar-tailed Godwit | | 1 | Lesser Whitethroat | 171 | 7 |
| Common Sandpiper | 80 | | Willow Warbler | 39 | 7 |
| Redshank | 1 | 4 | Chiffchaff | 6 | 2 |
| Knot | | 33 | Goldcrest | 1 | 1 |
| Dunlin | | 82 | Spotted Flycatcher | | 6 |
| Great Black-backed Gull | | 1 | Dunnock | 102 | 49 |
| Lesser Black-backed Gull | | 3 | Meadow Pipit | 36 | |
| Herring Gull | | 13 | Rock Pipit | 12 | |
| Common Gull | | 27 | Pied Wagtail | 89 | |
| Black-headed Gull | 2 | 196 | White Wagtail | 5 | |
| Common Tern | | 1 | Grey Wagtail | 2 | |
| Woodpigeon | | 33 | Yellow Wagtail | 423 | |
| Turtle Dove | 8 | 5 | Great Grey Shrike | 1 | |
| Collared Dove | | 72 | Starling | 278 | 97 |
| Cuckoo | | 1 | Greenfinch | 60 | 41 |
| Little Owl | | 1 | Goldfinch | 2 | 18 |
| Skylark | 11 | | Linnet | 13 | 17 |
| Swallow | 2 | 3 | Twite | | 2 |
| House Martin | 1 | | Redpoll | | 2 |
| Sand Martin | 104 | | Bullfinch | 22 | 24 |
| Jackdaw | | 2 | Chaffinch | 29 | 23 |
| Great Tit | 14 | 14 | Yellowhammer | 1 | 1 |
| Blue Tit | 25 | 17 | Reed Bunting | 72 | |
| Long-tailed Tit | 2 | 8 | House Sparrow | | 4 |
| | | | Tree Sparrow | 1 | 124 |
| | | | | 2360 | 1497 |



# Borough Fen Decoy, 1966

W. A. COOK

The winter of 1965-66 was generally wet and open, and catches of duck during January were all small. Teal used the Decoy pool in quite substantial numbers at this time but only a few were caught. The pond was frozen from 11th to 24th January and despite early morning ice-breaking nothing was trapped in this period. The pond was completely clear of ice by 1st February but no duck could be tempted into a pipe by feed or dog until 8th, when two drakes were flushed whilst feeding. The next day 19 were trapped. Two female Gadwall were present until the end of the month but showed no inclination to enter any of the pipes. March is not usually a good catching month at Borough Fen and 1966 was no exception. Numbers present gradually decreased from 40 Teal and 30 Mallard to four of each by the end of the month. So ended a rather mediocre season. The full ringing totals will be found in the table on page 18.

The non-duck highlight of the winter months was a circuit of inspection by five Whooper Swans on 25th January. Finch numbers were fairly constant, and Bramblings totalled 15 on 31st January. Fieldfares and Redwings were winter residents, both species being seen well into April. The spring return of migrants started on 4th April when 15 Sand Martins were feeding over the pond and two Chiffchaffs were calling in the wood.

Nest record cards were completed for 188 nests, nearly all of passerine species. There was a heavy predation of eggs and young partly from a pair of Magpies which nested in the wood, the first record for eight years. Rats, and possibly a Grey Squirrel, were also thought to be taking their toll. Table I shows the numbers of nests recorded and their fate for the six commonest species.

Seventy nests were examined for parasites, fly larvae and microlepidoptera. As there was a significant difference between 1965 and 1966 in the numbers of fleas, both species and individuals, it was decided to continue this study for a further season before analysing the data.

A total of 650 non-Anatidae were ringed in 1966, including 138 pulli. The species totals will be found in the table on page 19. Nineteen birds were reported as recovered in 1966, and a number of birds were retrapped from previous years. These included two Blackbirds and a Great Spotted Woodpecker, all of which

**Table I. Nests at Borough Fen Decoy, 1966.**

| *Species* | *Total* | *Deserted* | *Eggs lost* | *Young predated* | *Young reared* | *Incomplete data* |
|---|---|---|---|---|---|---|
| Moorhen | 11 | | 4 | | 5 | 2 |
| Woodpigeon | 17 | 1 | 5 | 2 | 4 | 5 |
| Song Thrush | 28 | 5 | 19 | 1 | 2 | 1 |
| Blackbird | 18 | 1 | 15 | | 2 | |
| Linnet | 26 | 2 | 17 | 4 | 1 | 2 |
| Tree Sparrow | 43 | | 16 | 2 | 15 | 10 |

**Table II. Interesting recoveries of birds, other than Anatidae, notified in 1966.**

| | | | | | |
|---|---|---|---|---|---|
| Song Thrush | Pull | 6.7.64 | nr Tadcaster, Yorks. | 12.5.66 | 95m NNW |
| Blackbird | 1st yr ♂ | 9.12.60 | Pleuven, Finisterre, France | April 1964 | 47.54N 4.02W |
| Blackbird | 1st yr ♂ | 12.2.65 | Goudriaan, Zuid Holland, Netherlands | 15.3.66 | 51.54N 4.54E |
| Starling | 1st yr ♂ | 3.1.63 | nr Moscow, U.S.S.R. (killed by cat) | 22.5.66 | 55.45N 37.40E |
| Linnet | Pull | 4.6.65 | Taussat-les-Bains, Gironde, France | 15.10.65 | 44.43N 1.04W |
| Chaffinch | 1st yr ♂ | 10.11.65 | Anlo, Drenthe, Netherlands | 11.5.66 | 53.02N 6.42E |

had been ringed in 1960. Ringed migrant birds which returned were Spotted Flycatcher, Whitethroat and Sedge Warbler.

Close season maintenance of the Decoy included the building of several new screens and a new backwall to the SW pipe. A new net was fitted to the SE and W pipes. (See Photograph Section p. XI upper.) A fine new headquarters hut, measuring 24 feet by 9 feet, was erected in May and June. This was divided into two sections, one to serve as a store and ringing area. The remaining space is lined and floored and is being utilised as an office and primitive laboratory. It could also be used as temporary sleeping accommodation for visiting research workers.

The Decoy was opened to the public on 21st and 22nd May. One hundred and forty-five people visited including about 40 Members and their guests. Other close season activities included the preparation and manning of an exhibition showing the aims of the Wildfowl Trust at Peterborough Museum in conjunction with National Nature Week.

The 1966-67 duck catching season began on 6th June when two Mallard were dogged into the West pipe, but no more were trapped that month and July produced only 28 ducks from seven catches. August was a frustrating month with a great deal of outside disturbance in the form of pea harvesters on the south-east side. The modern canning process requires the crop to be gathered and into the can within a few hours which means that the machines are often working before first light and the duck have little opportunity to settle in. Good catches were made on 15th (87) and 24th (81) and these helped the August total to 474.

A long series of orientation relay experiments were assisted in early September (p. 88), but despite the time taken by this, there were catches of 109, 90 and 80 ducks on 5th, 6th and 7th respectively, from a total of no more than 1,000 present at one time. Combine harvesters and balers raised the pond at 11.00 a.m. on 13th after 58 had been trapped. These disturbances continued until 19th when the pond was given an opportunity to settle down. The counts to the end of the month varied from 600 to 950. The total of ducks trapped in September was 1,054, rather above the average.

October was a very wet month and five acres of potatoes to the south of the Decoy defied all attempts to lift them. Machinery was constantly getting bogged down and was finally abandoned in favour of manual picking by a female labour force. They conversed at great length and on a variety of subjects at distances up to 25 yards apart. This, with a SW wind, had a decidedly detrimental effect on the equanimity of the ducks on the pond. All things considered, the October catch of 382 was above expectations.

Foggy mornings in early November reduced the number of ducks using the pond as a daytime roost to double figures. With improved weather after 10th, and fewer disruptions, catching got better with three of over 30 in a day, and four over 20, giving a total for the month of 415. The short days of December give only six hours in which one can decoy ducks. Even so the 200 Mallard and 500 Teal flatly refused to play until after 9th when catches of 11, 15, 15 and 15 on consecutive days improved the situation. This was further strengthened with takes of 21, 26 and 26 after Christmas, giving a very satisfactory December total of 230. The year ended with 2,550 ducks caught, comprising 2,089 Mallard, 450 Teal and 11 Shoveler.

Apart from the relay experiments mentioned above, test releases were made in every month except May and June to investigate further the seasonal changes in the orientation of Mallard caught in the Decoy. Twenty-eight releases and 839 birds were involved.

The season 1966-67 is the tenth in which I have been in charge of the Decoy, so a detailed analysis of the catches, weighings, measurings and recoveries has been put in train. The 375 recoveries notified in 1966 will not be set out here, therefore, but an exception is made in one noteworthy case.

A juvenile male Mallard, ring number AJ 49884, caught in the Decoy and released nearby on 21st September 1962 was shot on 4th December 1965 at Raymond, Alberta (49.30 N, 112.41 W) well over to the west side of Canada. The very minimum distance from Borough Fen is 4,300 miles. This is the first recovery from North America of a British-ringed Mallard and right outside the normal migration pattern. It is a matter for conjecture whether the bird went westwards from Britain on its long journey, or by a series of abmigrations from flyway to flyway eastwards across the U.S.S.R. Although the bird was released on an orientation test, this was in heavy overcast conditions with an overall random scatter. The final bearing on which the bird was lost (213°) was therefore of little consequence.

# Dersingham Decoy

J. E. A. LAMBERT and W. A. COOK

Sir Ralph Payne-Gallwey records in *The Book of Duck Decoys* (1886) 26 Duck Decoys in the County of Norfolk, of which five were still operating in that year. Of Dersingham Decoy he writes:

"About 1818 a Decoy was constructed at this place by George Skelton the younger, who died here. The pool was about an acre and a quarter in extent and had five pipes. No Decoy book was kept but Skelton's brother-in-law who worked the Decoy with him, stated that the average number of fowl captured each winter was from 130 to 200 dozen Wild Duck, Teal, Wigeon, Gadwall, and Pintail. Skelton was succeeded by a man named Sharp from Hilgay, and a new cottage was built for him but it is said he was not successful. Owing to alterations in drainage and drying up of the creek on which it stood, the Decoy ceased to answer, and about 1870 it was dismantled."

The suggested reason for the discontinuance of the Dersingham Decoy is probably only partly true, and had it still been a commercial proposition to maintain the Decoy, ways and means would have been found to keep water there. (No water was pumped into the pond in 1965 or 1966 when the water table was considerably lower than in the mid-nineteenth century.) Figures from Borough Fen Decoy show that the price of duck fell greatly during the nineteenth century (Cook 1960, *Wildfowl Trust 17th Ann. Rep.* : 118-22). If 165 dozens is taken as the average annual catch, about £330 would have been realised in 1818 when the price was 39/10 per dozen. By 1830 the price had fallen to 17/7 per dozen, yielding only £144 11s. 3d. from a catch of the same size. Ten years later the same quantity would have made £138 17s. 6d. The price remained low until the war in 1914 and by then all but a handful of Decoys had gone out of business.

Reference to the deeds of the property reveal that the Rev. J. W. Bellamy was the owner in 1867 and, on his death in 1874, it passed to his son who, when he died in 1909, left a Life Interest in his lands to his sister Mrs. Tylden. She died, aged 103, in 1928 and the estate—a considerable one—was then sold. The purchaser subsequently auctioned it in lots and the Decoy and 134 acres of marshes then came into the possession of the present owner, Mr. J. E. A. Lambert.

The Decoy pond was then much overgrown and there was practically no water in it. The pond was mudded out by hand in the early thirties, when the island—a non-traditional feature — was formed with the spoil. By 1937-38 it was in good order with about the right amount of reed cover. Without feeding, large numbers of Mallard and Teal, up to 1,000 at times, congregated there during the day. There were probably more ducks in the district then than now, and certainly less fresh water available to them.

The Decoy was reasonably maintained, but during the second world war the surrounding land was ploughed up, and has remained so. The drainage was also considerably improved, lowering the water table still further and necessitating the installation of a dam and flap to retain water. In some seasons it was also necessary to pump water into the pond to maintain a working level.

The East Coast flood of 1953 washed away the dam and filled the pond with silt and rubbish, and it again had to be dredged. In the Netherlands the same floods destroyed Schouwen decoy, which was entirely rebuilt at government expense (Matthews 1958, *Wildfowl Trust 9th Ann. Rep.* : 142-53). No serious attempt was made to conserve wildfowl whilst the surrounding fields were let to a tenant but in 1960 the adjoining land came " in hand " and it was then that the possibility of reinstatement became a practical proposition.

At a meeting between the writers the pro's and con's of building a pipe were discussed. In 1963 a cage trap was built in order to discover the trapping potential of the Decoy. This was a permanent construction six feet wide and fifteen feet long and took 139 duck in the first season. In the autumn of 1964 a second trap was constructed and the total catches for three seasons are detailed below.

**Table. Catches of ducks at Dersingham Decoy.**

| | *1963/4* | *1964/5* | *1965/6* | *Totals* |
|---|---|---|---|---|
| Mallard | 131 | 55 | 78 | 264 |
| Teal | | 50 | 30 | 80 |
| Wigeon | 8 | | | 8 |
| Shoveler | | 1 | | 1 |
| Gadwall | | | 3 | 3 |
| Shelduck | | | 1 | 1 |
| Totals | 139 | 106 | 112 | 357 |

From these ringed birds 71 recoveries have been reported: 52 Mallard, 15 Teal and four Wigeon. The recovery percentages of 20, 19 and 50 are higher than those for other English ringing stations probably because of high "shooting pressure" locally. Two of the more interesting recoveries were a Mallard in the Eure region of France 22 days after being ringed, and another in a Dutch Decoy on 14th January 1964 having been ringed 20th December 1963.

In 1965 the restoration of the South pipe was begun. The channel which showed where the original pipe had been situated was almost completely overgrown with vegetation. Some of the Elders were fair trees, and a tractor was required to remove the heavier ones. A mechanical digger cleared out the debris and silt, shelving the bank on the screen side at the same time. The backwall bank was graded by hand later.

The little end was lined up and railway sleepers used to provide a revetment and a base for the conduit hoops, obtained from a local scrap yard. When working on this little end Skelton's original timbers were unearthed. Having built the little end of the pipe the more exacting task of bending one and a half inch water pipe to form the hoops had to be considered. This was achieved by trial and error, and no preconceived mathematical formula was used. The first hoop needed 39 feet of metal pipe and this was bent between two trees until a reasonable symmetry was obtained. Then all that was required was to bend subsequent hoops, each two feet shorter than the previous one. Each hoop was held vertical with string until lined up and then concreted in position. The stringers were fabricated by windlassing 12 gauge single strand fencing wire between each hoop. Five separate wires were used from the big end to the sixth hoop and thereafter three to the little end.

Net was fitted in July 1966 and screens, endwall and backwall completed the pipe. The screens were constructed in the traditional way with common reed *Phragmites communis* packed between six cross members and held vertically by three or four uprights. The same technique was used for the backwall but willow trimmings were used instead of reed.

On 3rd September 1966 an informal opening of this refurbished pipe was held, attended by some twenty people including the Hon. Director of the Wildfowl Trust, Mr. Peter Scott, and Mrs. Scott, Dr. G. V. T. Matthews, Mr. R. E. M. Pilcher and representatives from the Nature Conservancy and the Norfolk Naturalists' Trust. Although there were several duck on the pond the disturbance was too great to enable a catch to be made.

By the end of the 1966-67 season 343 ducks had been taken, either by feed or resting on the banks, as no dog is used. The Borough Fen Decoy "Piper" was tried in late October. Although 30 Teal came to the mouth of the pipe they could not be enticed into a catchable position. It is intended to reinstate the north-west pipe this year.

The Decoy wood and its adjacent reed beds have proved a popular habitat for other birds, 78 species having been identified there in 1966. These include Short-eared Owl, Kingfisher, Lesser Spotted Woodpecker and Bearded Tit. Over 100 nests of 20 species were recorded.

**Acknowledgements**

Thanks are extended to Mr. and Mrs. M. Ellison and Mr. R. Berry for their assistance in digging, levelling, erecting screens, etc.

# The Bewick's Swans at Slimbridge, 1966-67

DAFILA SCOTT

(See Photograph Section pp. IV and V.)

The winter of 1966-67 was the fourth in which wild Bewick's Swans have visited Swan Lake—the pond in front of the buildings in the Rushy Pen at Slimbridge. (For an account of the build-up of the flock and details of 1965-66 winter see P. Scott 1966, *Wildfowl Trust 17th Ann. Rep.* : 20-26.) The first swans to arrive were five days later than the year before; they were Kon and Tiki with four cygnets on 26th October, 1966. Three days later Pink and Rebecca came with four cygnets. These two families had been the most faithful of the winter before, the Kontikis having missed only two days between arrival and final departure, and the Pinks having been away for a period of ten days. The next families to arrive were also old friends of the previous winter—Shieldy and Freckles with five cygnets, Caesar and Calpurnia with four, Ambrose and Mrs. Lee with three, and Pepper and Amber with three. One pair (Porgy and Bess) which had stayed for 60 days in the winter of 1965-66, paid one visit to Swan Lake on November 20th, 1966, and evidently decided it was too crowded, for they went away next day, returning only after 42 days. (Thereafter they remained for 70 days.) Because of the limited feeding area early in the winter there were several new families who came for one day and, not finding the food because established swans drove them away from it, never returned. An example of this was Father and Christmas, who arrived on Christmas Day with four cygnets and did not find the food. They never came again.

It has been found that the amount of food available controls the number of swans and it seems possible that if the feeding space is enlarged, the pond will hold many more swans—perhaps up to 500. The tradition inherent in the swans to winter in the same place every year, although strong, presumably breaks down under certain circumstances—perhaps if they find a better place on the way. Only a certain percentage of the swans of one year returns the next year, as shown in Table I. The figures are restricted to adult and two-year-old birds because of uncertainties in identifying cygnets of a previous winter.

**Table I. Number and percentage of adult and two-year-old Bewick's Swans returning to Slimbridge in subsequent winters.**

| *Winter* | *Number of adults and two-year-olds newly identified in each winter* | *Cumulative total* | *Number and percentage of adults and two year olds returning in subsequent winters* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *1964-65* | | *1965-66* | | *1966-67* | |
| | | | *No.* | *%* | *No.* | *%* | *No.* | *%* |
| 1963-64 | 19 | 19 | 12 | *63* | 11 | *58* | 10 | *53* |
| 1964-65 | 50 | 69 | — | | 19 | *38* | 24 | *48* |
| 1965-66 | 74 | 145 | — | | — | | 31 | *42* |
| 1966-67 | 170 | 315 | — | | — | | — | |
| total number of swans returning | | | 12 | | 30 | | 65 | |
| *% returning of total identified* | | | *63* | | *43* | | *45* | |

On 18th December, 1966, a pair (Wayland and Liz) arrived which had been in the winter of 1964-65 but not in 1965-66 —the first recorded case of swans missing a season. As the bill pattern is subject to minor changes it might not always be easy

The first entirely new family did not come until 14th November, 1966, when Redspot and Scruffy arrived with three cygnets. It is apparent that in most cases the new families are brought in by the old ones, but whether they become "regulars" or not depends on whether they find the wheat which is put down for them. They can find it difficult to get to the food as they are often driven off by the more aggressive "established" swans. The feeding area was extended along the shore in front of the house later in the winter and further modifications to the underwater contours are contemplated.

to recognise birds which skip a season.

About 440 swans have been recorded since 1963-64 on Swan Lake, named and given serial numbers. Three hundred and thirty-six different birds were noted in 1966-67, compared with 147 in 1965-66, 75 in 1964-65 and only 24 in 1963-64. The swans are referred to by names (rather than numbers) as these often help the observer to identify the bird. P. Scott (1966) gives an identification formula for Bewick's Swans based on their individual differences in bill-markings and other features which are incorporated in many of the names. A few additional points of difference have been noted this winter.

There are two main types of head shape, " cat-faced " and " weasel-faced," and also several main bill shapes, "bulgy," when the culmen bulges slightly (a " bulgy " swan usually has yellow across the culmen—a yellow-neb as opposed to a darkie), turned up, straight, and turned down. The body shape varies to a lesser extent and is therefore only noticed when it is a particular characteristic of a certain swan. Some have longer or more turned up tails. It has been found that individual swans have very different dispositions, some being very nervous and others, even if they are new, being very tolerant of human proximity.

Each day each swan is ticked off on a board which shows the general picture of the arrival and departure of the swans. Portrait photographs of them are taken (by Philippa Scott) and filed with the other particulars of each swan. These photographs prove extremely useful as they eliminate any human error involved in drawing the swans.

**Table II. Number and percentage of Bewick's Swan cygnets and the mean brood size at Slimbridge, 1963 - 64 to 1966 - 67.**

| *Winter* | *Number of cygnets* | *Percentage of flock* | *Mean brood-size* |
|---|---|---|---|
| 1963-64 | 5 | 21 | 2.5 |
| 1964-65 | 13 | 17 | 3.3 |
| 1965-66 | 43 | 29 | 1.6 |
| 1966-67 | 101 | 30 | 2.5 |

The number and percentage of cygnets each year are set out in Table II, together with the mean brood size. The samples are rather small for making valid comparisons but the larger brood size in 1966-67 over the previous year is noticeable. The grey cygnets of the year are not named, as it is difficult to recognise them when they return as yearlings unless they are ringed. The pinky-grey indefinite patterns on the bills of cygnets change a great deal as the adult yellow and black patterns develop. Cygnets become whiter in plumage as the winter progresses and we have noticed a curious correlation; that cygnets which retain dark feathering have a more distinct pattern of black on the bill, which does not subsequently change so much when the yellow comes through.

The cygnets often inherit the characteristics of their parents. An example of this is the Kontiki family; both Kon and Tiki are " darkies," that is to say the black extends continuously from the tip of the bill to the feathering of the forehead, and their cygnets have always been " darkies " too. As well as inheriting the facial patterns, the cygnets often seem to share their parents' disposition and status in the peck order. Cygnets of a family which is high in the peck order may chase off adults which are lower than their parents. Bewick's Swans can have a circular peck order. For instance, Smoky and Misty beat Pink and Rebecca in a fight, the Pinks beat the Kontikis, but the Kontikis beat the Smoky/Misties. Their aggressive and courtship encounters are being studied in detail. In some cases, as in geese, the larger families dominate the smaller, but this is not always so. It appears that a new pair will always try to establish themselves among the birds already there when they first arrive, though they do not always succeed.

Some yearlings consort with their parents even though the new cygnets may be with them. This may persist into the third year, though not so strongly. In three years Pink and Rebecca have produced two, three and then four cygnets, and, with the mates of the first two, have all sometimes consorted together as a flock of 13 swans. All the young of Pink and Rebecca of three years are known to be alive except for one of the 1966 brood which died of aspergillosis. In many cases the yearlings do not come with their parents but join up with them after arrival. The percentage of yearlings in both 1965-66 and in 1966-67 was 20%.

Some of the widows and widowers of 1965-66 brought new mates in 1966-67. Maria, who came in February, 1964, with Aristotle and returned as a widow for the two following years, brought Harvey in on 31st October, 1966. Peasant, widowed during January, 1966, brought Gipsy in November, 1966. In 1965-66 there was one other widow—Mrs. X with one cygnet. In 1966-67 there were three widows

—Leda with two cygnets, Beulah with two cygnets, Dusky Girl with three cygnets, and from 30th November, 1966, one widower, Ambrose Lee with three cygnets, whose mate flew into a wall and was killed. There have been no recorded examples of divorce and remarriage in adult swans, although there have been mated swans which have departed in the spring with their mate and returned the next year with a different one, suggesting bereavement. An example of this was the Major who came in February, 1964, with Ethel and one cygnet. For the two following years they came (with cygnets) but on 30th October, 1966, the Major arrived with a big aggressive swan which apparently was mated to him and seemed to be the male. They brought two cygnets with them. In the early part of the season Flicker, as the new swan was named, did not seem very strongly attached to the Major and the cygnets but, as the season progressed, he became more strongly attached, suggesting that the cygnets did not belong to him, but to the late Ethel. In the previous years the Major had been taken for the male. " He " was a bigger more aggressive swan as shown in photographs of " him " with Ethel. Their sexes remain a mystery and can only be resolved by catching one of them.

Other mistakes in the sexing of swans have been made. Rose Lee who came in February, 1964, was taken for a female even when " she " came back the following year with a smaller swan (which was quite aggressive). When this bird flew into a tree and was caught, " he " was found to be a female, making his mate Rose Lee a male. Ambrose Lee as Rose Lee was then called, became a widower soon after when Mrs. Lee, apparently accident prone, flew into a wall and broke her neck. The swans can only be sexed by behaviour and size, or by catching them, and there are exceptions to the rule that males are bigger. Tentative pairings in the second winter seem unlikely to last. Altogether seven pairs were formed in the winter of 1965-66 and the only one to return still paired in 1966-67 was Smoky and Misty with two cygnets. All the others came back with different mates, not even having the same type of facial pattern. Adults which have lost their mates have returned with mates with the same kind of facial pattern as the previous one. For example, Lefty, who lost Mrs. Right a " darky," came back with another mate who was also a " darky."

The continuity of the swans' stay varied considerably in the two seasons 1965-66 and 1966-67. In 1965-66 few swans went away for long periods, though during the floods in December many were temporarily absent. All except two returned before leaving for Arctic Russia. In 1966-67 many swans went away for periods of several weeks, indicating that they were probably not in the Slimbridge area. The longest stays in 1965-66 were by the Pinks, who stayed for 154 days and the Kontikis for 147 days; the mean for 147 swans was 79 days. In 1966-67 the longest stay was made by Pinocchio (135 days) and the mean for 336 swans was 60 days. Ninety-five swans stayed for over 100 days. Seventy-eight swans stayed for only one to five days. The most recorded in one day on Swan Lake was 222 and the most at one time was approximately 220. The total usage of the pond at 20,229 swan-days was nearly double that of the previous winter. Most of the birds departed at the end of February and in the first two weeks of March. The last birds were seen on 16th March.

The pattern of the flights out to the river and back varies as the season progresses. In 1966-67, when the swans first arrived, they spent most of the time on Swan Lake, feeding, preening and sleeping, and only occasionally going out to the river. They mostly spent the nights on the pond under the floodlights. By December most of them were spending the nights on the river and only a few stayed on the pond. They came in early in the morning and stayed until around noon when they flew out and then returned for the evening feed. In the mild weather of early February, the swans came in later and left later. In the latter part of the winter, many of the swans were coming only in the morning or only in the evening. As the season progressed, and with the longer days, the swans flew out in the evening before it was dark. If they fly out after dark, coming out of the floodlights, the risk of flying into trees or buildings is great. Four have been killed in this manner and many have fallen into a confined space and been unable to take off, being subsequently caught and ringed.

Apart from night collisions, other deaths during 1966-67 were Adolpha, a yearling, who died on 28th November of massive brain haemorrhage; a cygnet belonging to Shieldy and Freckles which died on 14th November of pericarditis; and the Pink/Rebecca cygnet already mentioned which died of aspergillosis.

The total number of Bewick's ringed is now 57, 32 of them in 1966-67, 16 in 1965-66 and nine before that. There have

been two recoveries away from Slimbridge (P. Scott 1966). New tall rings made of titanium are being used with larger numerals, which can be read with binoculars. It is hoped to develop plastic rings, which are both coloured and numbered, in the future, for even quicker confirmation of a swan's identity.

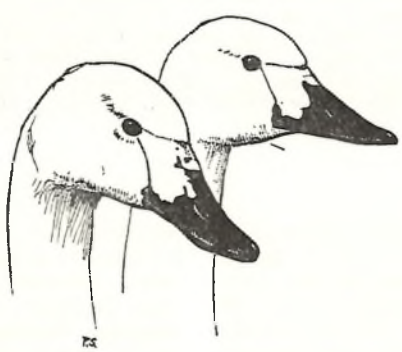
Some of the swans which came to Swan Lake spent part of their time on a flooded grass field about one and a half miles away in an area called the "Moors." A number of birds which only visited Swan Lake once were seen regularly on the Moors and it is probable that they had failed to find the wheat in Swan Lake but had stayed in the vicinity partly attracted by the other birds and partly by the good natural feeding conditions on the Moors. The highest combined count for Swan Lake and the Moors was 271 on 13th January, 1967.

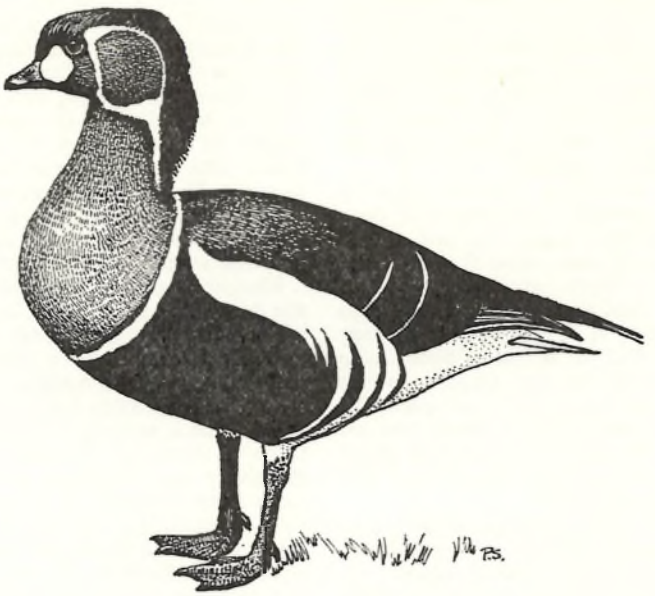
Two swans (Bill and Catherine), who had been regular visitors in 1964-65 and 1965-66, were first seen on the Moors on 9th January and did not arrive on Swan Lake until the following day. Another swan (Groucho), who had been to Swan Lake in 1965-66, was seen on the Moors on 11th January, 1967, during the afternoon and did not arrive on Swan Lake until the evening feed of that day. Although watching the swans on the Moors, which it is hoped will be done in more detail in the future, adds a link in the history of the individuals, there is much to learn of where they go when they leave Slimbridge, and why.

It is hoped that the swans at other haunts in Britain may be studied in as much details as the ones at Slimbridge, to try to fill the great gaps in their winter history. Perhaps one day it will be possible to follow them to their breeding grounds in the Soviet Arctic.

Having already learnt something about the social behaviour of an increasing herd of Bewick's Swans during four winters, we believe that there is still much more to be learnt. The numbers of Bewick's Swans visiting Swan Lake have more than doubled each winter. If the numbers continue to increase, it must become progressively more difficult to identify each swan from memory, as is now done. But by concentrating on swans which have been present in previous seasons, and on swans with families, it seems likely that the most interesting parts of the investigation can be maintained in spite of larger numbers, which without doubt increase the impressive beauty of the spectacle.

This study is essentially a co-operative one, most of the observations, apart from the writer's, being made by Peter Scott, Philippa Scott and Maya Scull.





# Year-book for 1966

## Results of wildfowl ringing at Abberton Reservoir, Essex 1949 to 1966

MAJOR GENERAL C. B. WAINWRIGHT, C.B.

**Summary**

Between 1949 and 31st July 1966, 37,924 ducks and 376 swans were ringed at Abberton Reservoir, yielding 8,162 recoveries so far. Teal made up 70% of the catch and Mallard 21%. Fourteen other duck species have also been marked. The seasonal variations in the catch are examined and an association is found between the catch of Teal and the mean of the monthly winter counts on the reservoir. Tabular summaries of the recoveries show marked differences between species in the proportions recovered locally and overseas. Teal have been reported from 35 countries. Mallard recoveries from within 30 miles of Abberton show that there has not been a falling off in the recovery rate due to "reporter boredom." Average adult mortality rates include Mallard 43%, Teal 45%, Garganey 47% and Gadwall 52%.

### Introduction

Abberton Reservoir lies about four miles north of the Blackwater estuary, one of the major wildfowl areas on the Essex coast. The reservoir, completed in 1940, has a water surface of 1,240 acres and a perimeter of about twelve miles, of which three-quarters is faced with a one in three concrete slope, unsuitable for traps. The remainder, separated from the rest by two causeways, has natural banks. The depth varies from a few feet at the upper end to more than 50 feet behind the dam, and when the water level is low there are large expanses of mud, and sometimes a small island becomes exposed. It is now the most important duck roost in south-east England, frequently holding over 7,000 ducks. (See map, Figure 1.)

I began trapping ducks for ringing in 1949. It started off as a hobby for a quiet retirement but I had little idea then how it would snowball. There was the excitement of catching my first Teal on 8th September, 1949, little thinking that the

one would become nearly 27,000 in 17 years. I had to learn how to make the traps, first five and now 18. They are all to my own design, being large, 12 foot square, but they can be moved up or down the banks as the water level varies (Wainwright 1955, 1957). I started with one boat, but now have a motor boat and a dinghy. By 1952 it had become more than one man could cope with, so I got an assistant. He was not an easy chap to find, but I have been unbelievably lucky in the two that I have had. A secretary as well soon became necessary to help with all the paper work. It isn't just a matter of ringing the ducks, records have to be kept, and pretty complete ones at that, otherwise the rest of this report could not have been written.

Apart from all the scientific information that has been produced I can't resist saying something about the excitement. Some notable days stand out in my mind. That wonderful day I remember particularly, 21st January, 1958, when we caught 205 ducks, 53 of them in one trap. The 135 Teal we ringed that day have produced 31 recoveries so far. Ducks return year after year to Abberton. Often I catch them in the same trap in which they were originally taken and ringed. Two I recall were ringed on the island in 1956 and recaught in the same place within two days of each other in October, 1964. Traps on the island have always been safe from disturbance, but one day a mink killed three Teal in a trap there, having swum the 400 yards from the mainland. Luckily he was foolish enough to stay in the trap and so made a good skin for the Colchester Museum. Mink should not be allowed to escape, they can run like hares, swim like otters and climb like squirrels.

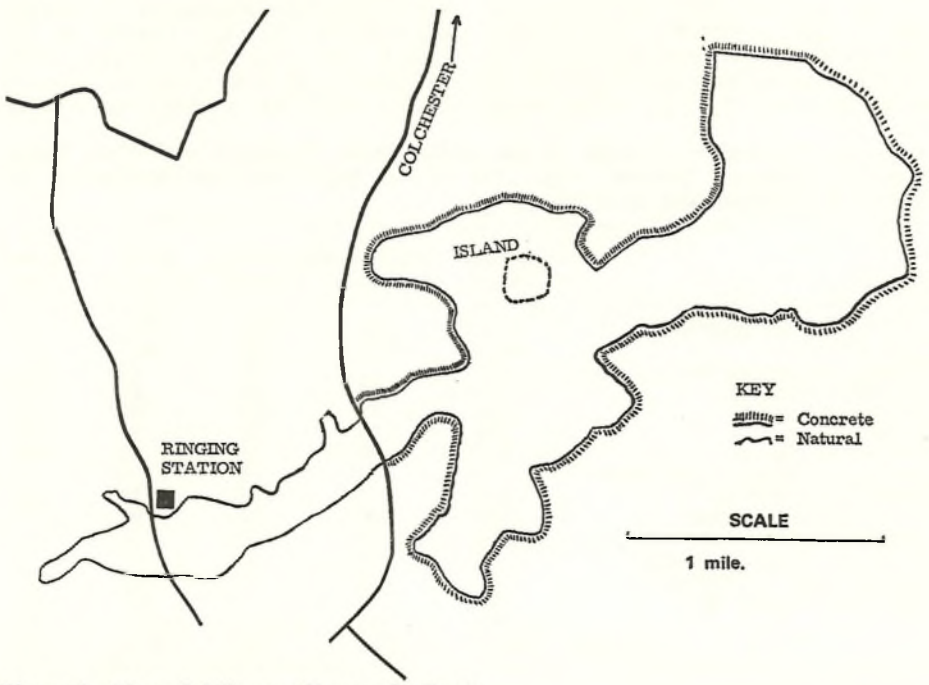



**Figure 1. Map of Abberton Reservoir, Essex.**

Rings are discovered in the most unexpected places. Two of mine were found by diners in London restaurants. One, found in a pork pie, had been put on a Mallard ten weeks before. The second occasion was when a Teal was served up on a plate with the ring, 28 days old, still on its leg!

The progress of the ringing at Abberton has been recorded each year since 1955 in the Annual Reports of the Wildfowl Trust, while recoveries have been listed in the Bird Ringing Reports of the British Trust for Ornithology and used in several analytical papers. However, it seems useful to assemble here a summary of the achievements so far. Because of the great mass of data it is necessary to compress the information into tables and to select only a few points for discussion.

**Ringing**

The total numbers of each species ringed are shown in the first column of Table I. Though Teal and Mallard make up over 90% of the catch, a substantial number of Wigeon, and enough Garganey, Gadwall, Shoveler, Pochard and Tufted Duck have been ringed to add importantly to our knowledge of the movements of English-visiting ducks.

There have been great variations in the seasonal catches (Table II) from the lows of 574 in 1949-50 (when only five traps were in use) and 750 in 1951-52, to the peak of 4,802 in 1959-60. These fluctuations are partly, though not solely, due to differences in the numbers of ducks living on the reservoir. For long periods many birds may be present yet disdain to visit the traps, then suddenly they become interested. The level of the water is important, particularly if it is low enough to expose the island in the main reservoir, which then becomes much the best place for trapping. Table II shows that the numbers caught of all species of ducks, excluding Teal, show remarkably little variation from season to season, whilst the seasonal catches of Teal have fluctuated very widely. A detailed examination reveals that there is no close relationship between the numbers of Teal caught and those of the other species: in five seasons both were above average, in six both below, and in the other six, one above and one below the seventeen-season mean.

**Table I. Numbers of dabbling ducks, diving ducks, Shelducks and Mute Swans ringed at Abberton Reservoir from 1949 to 31st July, 1966, and numbers so far recovered in Britain and overseas.**

| *Species* | *Number ringed* | *Number of recoveries In Britain* | *Overseas* | *Total recoveries* | *% recovered so far* |
|---|---|---|---|---|---|
| Mallard *Anas platyrhynchos* | 8029 | 1493 | 444 | 1937 | 24 |
| Teal *A. crecca* | 26829 | 2755 | 2740 | 5495 | 21 |
| Garganey *A. querquedula* | 249 | 2 | 35 | 37 | 15 |
| Gadwall *A. strepera* | 73 | 14 | 14 | 28 | 38 |
| Wigeon *A. penelope* | 1426 | 97 | 209 | 306 | 22 |
| Pintail *A. acuta* | 114 | 18 | 13 | 31 | 27 |
| Shoveler *A. clypeata* | 265 | 24 | 36 | 60 | 23 |
| Red-crested Pochard *Netta rufina* | 4 | 2 | 0 | 2 | |
| Pochard *Aythya ferina* | 140 | 6 | 13 | 19 | 14 |
| Tufted Duck *A. fuligula* | 476 | 40 | 52 | 92 | 19 |
| Scaup *A. marila* | 16 | 4 | 2 | 6 | |
| Goosander *Mergus merganser* | 2 | 0 | 1 | 1 | |
| Shelduck *Tadorna tadorna* | 278 | 13 | 0 | 13 | 5 |
| Mute Swan *Cygnus olor* | 375 | 130 | 1 | 131 | 35 |
| Totals | 38276 | 4598 | 3560 | 8158 | 23 |

In addition, 3 Goldeneye *(Bucephala clangula)*, 1 Common Scoter *(Melanitta nigra)*, 2 Smew *(Mergus albellus)* and 1 Bewick's Swan *(Cygnus columbianus bewickii)* have been ringed without yet yielding a recovery. Fifteen other wildfowl (hybrids or escapes) have also been ringed, of which 3 have been recovered locally and 1 in Holland.

**Table II. Numbers of Teal and of other ducks, but excluding swans, ringed at Abberton each season from 1949-50 to 1965-66. The season runs from 1st August to 31st July.**

| *Season* | *Teal* | *Others* | *Total* | *Season* | *Teal* | *Others* | *Total* |
|---|---|---|---|---|---|---|---|
| 1949-50 | 375 | 199 | 574 | 1958-59 | 751 | 561 | 1112 |
| 1950-51 | 1575 | 410 | 1985 | 1959-60 | 4112 | 690 | 4802 |
| 1951-52 | 350 | 400 | 750 | 1960-61 | 795 | 592 | 1387 |
| 1952-53 | 1197 | 1287 | 2484 | 1961-62 | 2559 | 719 | 3278 |
| 1953-54 | 1348 | 586 | 1934 | 1962-63 | 1987 | 509 | 2496 |
| 1954-55 | 409 | 572 | 981 | 1963-64 | 1628 | 909 | 2537 |
| 1955-56 | 3126 | 562 | 3688 | 1964-65 | 1333 | 635 | 1968 |
| 1956-57 | 2265 | 706 | 2971 | 1965-66 | 879 | 1162 | 2041 |
| 1957-58 | 2140 | 794 | 2934 | Total | 26829 | 11093 | 37922 |
| | | | | Mean | 1580 | 652 | 2232 |

However, an interesting comparison can be made between the size of the Teal catch and the counts of these birds made on the reservoir. The counts are organized under the National Wildfowl Count Scheme and take place once a month from September to March. The records from Abberton exist without a break from 1948-49. If the mean of each season's seven counts is taken, there is a fairly close relationship between this figure and the catch of Teal made in the same season (Fig. 2). There is also quite a close fit between the trends shown by the counts on Abberton and the trends in Britain as a whole. This suggests that the catch size of Teal at Abberton might be used as an indicator to the situation of the British population of the species. The latter has been discussed by Atkinson-Willes and Frith (1965) who pointed out that after the sharp peak of 1959-60 which was due to a massive influx of birds following the drying-out of an Isselmeer

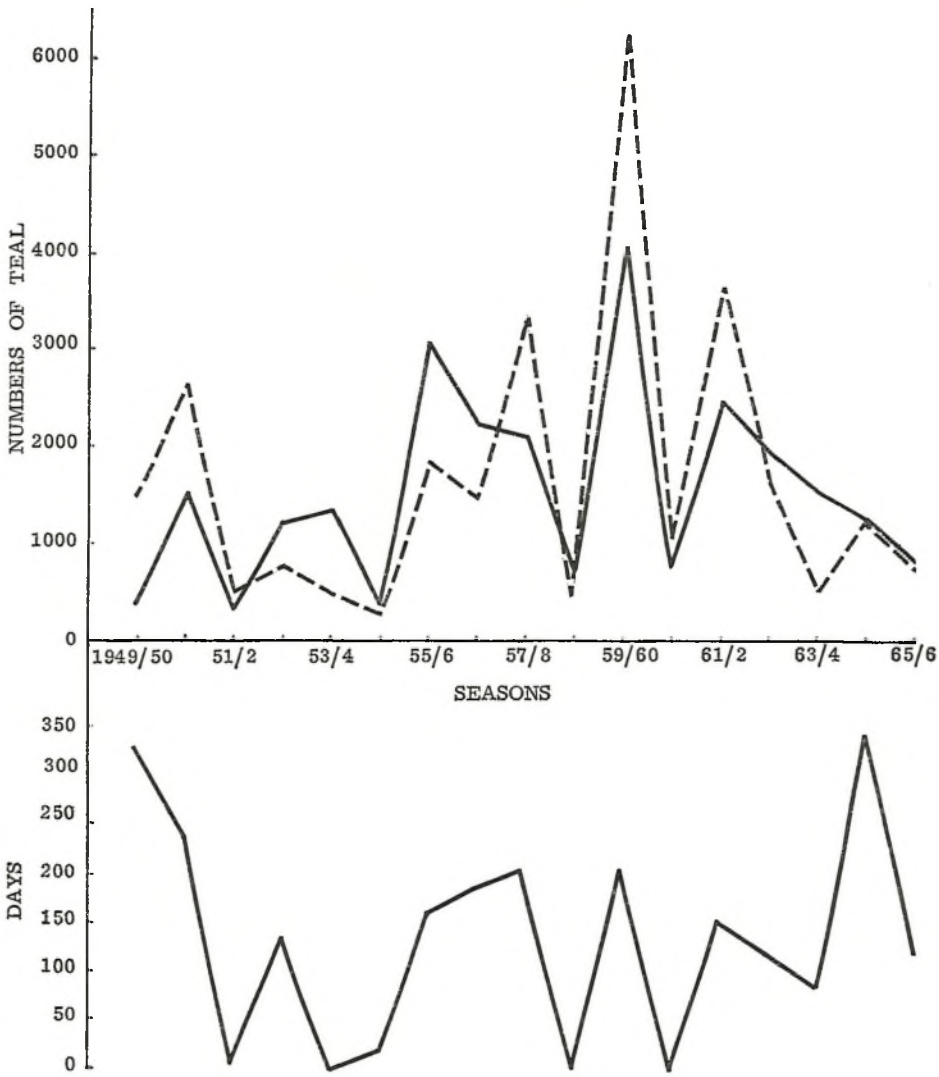



**Figure 2. (Upper) Seasonal catch (——) and mean of monthly winter counts (— — —) of Teal at Abberton Reservoir, 1949-50 to 1965-66. (Lower) Number of days per season when trapping was possible on island.**

polder, the level of population 1960-64 was not below the level of the years prior to the peak. There has been a decline since then (G. L. Atkinson-Willes, pers. com.) and the situation is more disturbing than it appeared two years ago.

### Recoveries

The recoveries of Teal are displayed in Table III which comprises an impressive list of countries to which birds passing through Abberton have dispersed. In Europe, only Luxembourg, which has, however, produced a recovery of a Mallard, Switzerland and Albania are missing. Teal are one of the most widely travelled of ducks with a strong onward passage through Britain which is absent in most other species. Table I sets out the numbers of recoveries in Britain and overseas for all wildfowl species. To compare the dispersal of the different species it is easier to use Table IV in which the recoveries overseas are shown as a percentage of all recoveries.

The Garganey stands out because nearly all its recoveries are from abroad. This

**Table III. The distribution of recoveries so far reported of Teal (*Anas crecca*) ringed at Abberton Reservoir from 1949 to 31st July, 1966.**

| *Country of recovery* | *Number of recoveries* | *Country of recovery* | *Number of recoveries* |
|---|---|---|---|
| England, under 30 miles | 1500 | Roumania | 2 |
| England, over 30 miles | 1129 | Bulgaria | 4 |
| Wales | 82 | Greece | 1 |
| Scotland | 42 | Turkey | 2 |
| Isle of Man | 2 | Belgium | 39 |
| Total in Britain | 2755 | Holland | 181 |
| | | Germany | 133 |
| Northern Ireland | 58 | Denmark | 239 |
| Eire | 351 | Norway | 20 |
| Channel Islands | 4 | Sweden | 116 |
| France | 785 | Finland | 216 |
| Spain | 97 | Estonia | 30 |
| Portugal | 13 | Latvia | 24 |
| Azores | 1 | Lithuania | 3 |
| Morocco | 1 | Poland | 18 |
| Sardinia | 1 | Russia | 359 |
| Sicily | 1 | Siberia | 8 |
| Italy | 26 | Faroe Islands | 1 |
| Austria | 1 | Iceland | 1 |
| Czechoslovakia | 1 | Total overseas | 2740 |
| Hungary | 2 | | |
| Yugoslavia | 1 | | |

**Table IV. Proportion of recoveries of ducks ringed at Abberton, found locally, elsewhere in Britain or overseas, and total recovery-rates.**

All figures are percentages, rounded to the nearest whole number. Species with fewer than 10 recoveries have been omitted.

| | % of Recoveries | | | % |
|---|---|---|---|---|
| *Species* | *Under 30 miles* | *Elsewhere in Britain* | *Overseas* | *Recovered Ringed* |
| Mallard | 67 | 10 | 23 | 24 |
| Teal | 27 | 23 | 50 | 21 |
| Garganey | 3 | 3 | 95 | 15 |
| Gadwall | 32 | 18 | 50 | 38 |
| Wigeon | 23 | 9 | 68 | 22 |
| Pintail | 39 | 19 | 42 | 27 |
| Shoveler | 27 | 13 | 60 | 23 |
| Tufted Duck | 35 | 9 | 56 | 19 |
| Pochard | 32 | 0 | 68 | 14 |
| Shelduck | 77 | 23 | 0 | 5 |
| All ducks | 37 | 19 | 44 | 21 |

is because as a summer visitor to England it arrives after the end of our shooting season and leaves before or very soon after the opening of the season on 1st September. On passage through France and Italy it is often shot, particularly in the valley of the Po. The recovery rate is low, probably because the wintering areas (not yet precisely known) are in Africa, where the reporting of rings is less likely than in Europe. By contrast the low recovery rate of the Shelduck is because the species is fully protected in Britain.

Two-thirds of the Wigeon and Pochard have been found abroad compared with less than a quarter of the Mallard. Two-thirds of the recoveries of this last species have been within 30 miles of Abberton compared with 23-39% of other ducks.

**Table V. First season recovery rates of Mallard ringed at Abberton and recovered within 30 miles.**

| *Season of ringing* | *Number ringed* | *Recoveries %* | *Season of ringing* | *Number ringed* | *Recoveries %* |
|---|---|---|---|---|---|
| 1949-50 | 130 | 9.2 | 1958-59 | 276 | 7.2 |
| 1950-51 | 348 | 11.5 | 1959-60 | 532 | 5.3 |
| 1951-52 | 316 | 15.7 | 1960-61 | 444 | 6.1 |
| 1952-53 | 1025 | 16.2 | 1961-62 | 556 | 6.8 |
| 1953-54 | 207 | 15.4 | 1962-63 | 386 | 8.3 |
| 1954-55 | 334 | 9.3 | 1963-64 | 548 | 7.1 |
| 1955-56 | 371 | 15.4 | 1964-65 | 467 | 8.4 |
| 1956-57 | 468 | 17.3 | 1965-66 | 1006 | 8.7 |
| 1957-58 | 615 | 9.7 | | | |

There have been indications from other studies in Europe and North America that where massive numbers of a species are ringed the recovery rate falls over the years due to a growing disinclination to continue reporting rings by the shooters (Martinson 1966). Where large-scale ringing is taking place at a single ringing station there is likely to be a further fall (Paludan 1953). This would be understandable in the case of Abberton as the local wildfowlers began to realise that nearly every duck they shot with a "British Museum" ring on its leg came from there. It is, after all, quite a chore to write a letter, find a stamp and go to the postbox. Not everyone realises that each recovery is valuable even if it apparently duplicates the previous one.

Table IV showed that 67% of Mallard recoveries are from within 30 miles of Abberton. The data on this species should therefore show whether there is any decrease in reporting by shooters over the last seventeen seasons. I have therefore set out in Table V the recovery rates for the first season of ringing.

These show a much higher level for the first nine seasons than subsequently, but after the drop there has been no further decline. Although some of the fall off in recovery rate may be due to "reporter boredom" a number of other local factors have affected the picture. In 1958 a duck decoy only ten miles away was closed and there has been a decrease in shooting at two localities within two miles of the reservoir. The other fluctuations probably reflect the variability in shooting conditions, the dates at which birds were ringed, the proportion of adults in the catch and so on. As I know many local wildfowlers I have learnt of many local recoveries direct from them.

In general, ducks ringed in their first year of life give fewer recoveries overseas than do older birds, probably because rather more are lost during the season in England and so do not survive to emigrate. The Gadwall appears to be exceptional, 52% of recoveries of juveniles coming from abroad compared with only 19% of adults, but the numbers are still too small to show conclusively what causes the difference.

## Survival

Table VI shows the seasons of all recoveries. The season of recovery is taken as the same as that of ringing, running from 1st August to 31st July. The series diminish rapidly as the birds die off, although a few have survived more than ten years after ringing. For a few species recoveries in the first season are less than those in the second. This draws attention to a bias due to the date of ringing. Species which arrive and are ringed early in the season are more likely to be recovered that season than those ringed near the end. A second bias is caused by the fact that towards the end of the series, ducks have been at risk for fewer and fewer seasons. However, this complication can be allowed for by expressing the number of recoveries as a

**Table VI. Seasons of recovery of ducks and Mute Swans ringed at Abberton Reservoir, 1949-66.**

| | *Season of Recovery* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Species* | *1st* | *2nd* | *3rd* | *4th* | *5th* | *6th* | *7th* | *8th* | *9th* | *10th* | *later* | *Total* |
| Mallard | 980 | 526 | 228 | 102 | 54 | 18 | 10 | 11 | 4 | 2 | 2 | 1937 |
| Teal | 2224 | 1697 | 745 | 422 | 188 | 122 | 61 | 24 | 7 | 3 | 2 | 5495 |
| Garganey | 13 | 8 | 10 | 4 | 1 | 1 | | | | | | 37 |
| Gadwall | 17 | 7 | 3 | | | | 1 | | | | | 28 |
| Wigeon | 63 | 119 | 50 | 31 | 20 | 10 | 2 | 5 | 2 | 2 | 2 | 306 |
| Pintail | 14 | 9 | 3 | 1 | 1 | 1 | 1 | 1 | | | | 31 |
| Shoveler | 37 | 15 | 5 | 1 | | 1 | | 1 | | | | 60 |
| R-c. Pochard | 1 | | | | | | | | 1 | | | 2 |
| Pochard | 10 | 4 | 3 | 1 | | 1 | | | | | | 19 |
| Tufted Duck | 24 | 34 | 16 | 7 | 4 | 1 | 3 | 1 | 2 | | | 92 |
| Scaup | 3 | 1 | 1 | | | | | 1 | | | | 6 |
| Shelduck | 8 | 2 | | 1 | 2 | | | | | | | 13 |
| other ducks | 3 | 1 | | | | 1 | | | | | | 5 |
| Mute Swan | 75 | 19 | 13 | 9 | 4 | 2 | 4 | 2 | 3 | | | 131 |
| Total | 3472 | 2442 | 1077 | 579 | 274 | 158 | 82 | 46 | 19 | 7 | 6 | 8162 |

Of the ducks recovered more than 10 seasons after ringing, one Mallard was in 11th and a second in 12th season; one Teal in 11th and one in 15th; one Wigeon in 11th and one in 12th.

**Table VII. Average annual mortality rates of ducks ringed at Abberton.**
The estimates in italics are less reliable than the others, because of the small numbers of recoveries on which they are based. Figures in brackets are from Boyd (1962) — see text.

| | | | | | |
|---|---|---|---|---|---|
| Mallard | 43% | (48%) | Wigeon | 43% | (47%) |
| Teal | 45% | (51%) | Pintail | *36%* | (48%) |
| Garganey | *47%* | | Shoveler | 37% | (44%) |
| Gadwall | *52%* | | Tufted Duck | 35% | (46%) |

Note: This is encouraging. If one assumes that every pair alive at the beginning of the breeding season averages only two ducklings, a mortality rate of 50% would be tolerable.

**Table VIII. Recaptures at Abberton of ducks and Mute Swans ringed there 1949-1965.**

| | *Season of Recapture* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Species* | *2nd* | *3rd* | *4th* | *5th* | *6th* | *7th* | *8th* | *9th* | *10th* | *Total* |
| Mallard | 214 | 104 | 29 | 14 | 9 | 2 | 2 | 1 | | 375 |
| Teal | 878 | 373 | 216 | 97 | 35 | 17 | 13 | 4 | 2 | 1635 |
| Garganey | 6 | | 2 | | | | | | | 8 |
| Gadwall | 2 | 1 | 1 | 1 | 1 | | | | | 6 |
| Wigeon | 22 | 6 | 3 | 3 | 1 | | | | | 35 |
| Pintail | 1 | 1 | | | | | | | | 2 |
| Shoveler | 3 | 1 | 1 | 1 | | | | | | 6 |
| R-c. Pochard | 1 | | | | | | | | | 1 |
| Pochard | 2 | | 1 | 1 | | 1 | | | | 5 |
| Tufted Duck | 10 | 8 | | 1 | | 1 | | | | 20 |
| Shelduck | 11 | 2 | 2 | 4 | 1 | 1 | | | | 12 |
| Mute Swan | 10 | 1 | 2 | 3 | 3 | | 1 | | | 20 |
| Total | 1160 | 497 | 257 | 125 | 50 | 22 | 16 | 5 | 2 | 2134 |

percentage of the number of ducks eligible. After correction in this way, and excluding the first season, it is possible to calculate the average annual mortality rate, using the method of Bellrose and Chase (1950). Table VII gives estimates of mortality rates for those species with sufficient available data. Comparisons are given where possible with the mortality rates calculated by Boyd (1962) from earlier British and European ringing. Boyd's figures are higher than mine, but he included in his samples recoveries of birds from 1st January, which were in their first season on my definition. No mortality rates for Garganey and Gadwall ringed in Europe have been published before.

Table VIII records the numbers of survivors recaptured at Abberton in later seasons. The series are much like those of the recoveries and likewise can be used to estimate mortality. However, it is unlikely that all surviving ducks return to Abberton, or that ducks that have once been trapped are equally likely to be caught again. Crude calculations for Mallard and Teal put the apparent mortality rates for recaptured ducks at 57% and 54% respectively compared with the estimates of 43% and 45% from recoveries. These figures for retrapped birds may be higher because of increasing trap-shyness with experience.

**Acknowledgements**

I should like to express my sincere thanks to the following:

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# A survey of the ducks breeding at Loch Leven in 1966

H. BOYD and C. R. G. CAMPBELL

**Summary**

Seven species of ducks nested on Loch Leven in 1966. Seven hundred and five nests were found, nearly all on one island, of 105 acres: Tufted Duck 323, Mallard 285, Gadwall 41, Wigeon 41, Teal 9, Shoveler 6, and 5 broods of Shelducks. About two-thirds of the nests of dabbling ducks and a third of the Tufted Ducks' nests were known to have been successful. Predation by Jackdaws caused most egg losses, which were heaviest in June. Rough estimates from changes in brood-size suggest that not more than 1,900 young ducks reached the flying stage, about three-fifths of those hatched.

## Introduction

Loch Leven has long been famous as one of the few places in Britain where a large number of ducks breed. When the Loch was declared a Nature Reserve in the spring of 1964 it became possible to consider intensive research on the breeding wildfowl. Some preliminary work was done in the summer of 1965. In 1966 the authors, members of the Wildfowl Trust research unit, were able to devote most of their time from April to August to finding out how many ducks tried to breed in the Reserve and how many ducklings were reared. Since much of the work was concerned with the practical difficulties of operating on the Reserve and how far they might limit the possibilities for long-term studies and since any population study gains greatly in value by being continued for several years, it would be inappropriate to present the results obtained in 1966 in a definitive form. This brief account may, however, be of use in suggesting what kinds of questions might be answered by sustained investigations at Loch Leven.

Loch Leven is at Kinross, in central Scotland. It lies at 350 ft. above sea level, with the Lomond Hills to the north and Benarty Hill to the south. The Firth of Forth is some nine miles distant to the south and the Firth of Tay eleven miles to the north-east. There are many other natural lochs and reservoirs within 20 miles, but none comparable in size with Loch Leven itself, which has a water area of about 3,350 acres and a perimeter of some eleven miles. The loch is comparatively shallow, with a mean depth of just under 15 ft., and half of it is less than 10 ft. deep. Since 1830 the water level has been controlled by sluices at the outflow of the River Leven, which permit a maximum draw-down of $4\frac{1}{2}$ ft. The day-to-day level is determined by the needs of the industrial users of the water a few miles east along the river, not by the condition of the loch itself. Work has recently begun to determine the feasibility of increasing the use of the loch as a reservoir by intermittent additions of water from the River Devon (six miles west of the loch) to offset greater withdrawals. Biologists must be concerned about the consequences of even more "unnatural" changes in the water level.

The loch has been chosen as the site of a major investigation of eutrophication and freshwater productivity as part of the British contribution to the International Biological Programme. This is primarily the responsibility of a team from the Nature Conservancy and the Freshwater Fisheries Laboratory at Pitlochry. The wildfowl studies are being incorporated into this effort, with special emphasis being put on

the productivity of the Tufted Duck, since this species, unlike the dabbling ducks, feeds almost entirely on the loch itself.

The principal economic value of the loch lies in the trout fishing which lasts from April to September and which is carried out entirely by anglers fishing from boats. Though they are free to choose where to fish on the loch, the points where they may land around its shores or on its islands are greatly restricted. The general public have access to the shore only near Kinross town, on part of Castle Island, and along two short stretches at the north and south-east.

There are six permanent islands in the loch of which St. Serf's Island, of 105 acres, is much the largest and most important to ducks. There is a shelter for fishermen at the south-east corner and they are also permitted to land at one other point but no one is allowed to move about on the island without permission. Rather more than half the island is covered in rough pasture, grazed by sheep in summer. The vegetation of the northern half comprises tracts dominated by tufted hair grass *Deschampsia caespitosa;* by low trees, mostly willows *Salix* spp.; by reed grass *Phalaris arundinacea*; and another seven acres where these dominant plants are mixed and where tracts of nettles *Urtica* spp. also occur. The pasture and the tree-covered areas are relatively little used by ducks but the remaining 33 acres are extremely attractive to them.

### Duck numbers in April-June, 1966

The numbers of ducks on and near the loch in the spring were determined by a series of counts made early in the morning (when the ducks tend to be most visible and before the fishermen's boats are out). The whole loch and some of the adjacent fields, particularly in the south-east, were searched, and the numbers of males and females of each species seen in different sectors were recorded separately. The pooled figures for the entire area are shown in Table I. Detailed mapping of the distribution on different sectors on successive days was attempted early in April. This proved unsatisfactory and was abandoned in favour of quick complete circuits, but as a result no full counts are available before late April. This was certainly too late to detect many nesting Mallard and early-nesting individuals of the other dabbling ducks. After the first week in June these counts were discontinued, as the male dabbling ducks were going into eclipse and disappearing or becoming unrecognisable.

A second source of information was a search for ducks' nests. This was largely concentrated on St. Serf's Island, where most of the nests were, though the other islands were visited at intervals of about ten days and the suitable areas around the perimeter of the loch were also looked at, with diminishing frequency as the season progressed and so few nests were found there. The nests found are recorded in Table II.

**Table I. Numbers of ducks seen on Loch Leven N.N.R. from late April to early June, 1966.**

n.s. = not sexed; — = no successful count; 0 = none seen.

| | | Teal *Anas crecca* | | Mallard *A. platyrhynchos* | | Gadwall *A. strepera* | | Wigeon *A. penelope* | | Shoveler *A. clypeata* | | Tufted Duck *Aythya fuligula* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Date* | | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | ♂ | ♀ | n.s. |
| Apr. | 20 | | — | | — | | — | 47 | 31 | | — | | | 953 |
| | 28 | | — | | — | 12 | 11 | 19 | 14a) | | — | | — | |
| May | 6 | 3 | 1 | 168 | 70 | 25 | 22 | 21 | 12 | 2 | 1 | 533 | 386 | 16 |
| | 17 | 2 | 0 | 123 | 47 | 15 | 11 | 19 | 7 | 13 | 1 | 442 | 281 | 7 |
| | 24 | 5 | 2 | 218 | 70 | 8 | 4 | 17 | 7 | 10 | 2 | 511 | 323 | |
| June | 1 | 1 | 1 | 311 | 74 | 22 | 9 | 13 | 3 | 9 | 0 | 832 | 556 | |
| | 6 | 4 | 2 | 256 | 66 | 26 | 9 | 19 | 5 | 13 | 2 | 565 | 334 | 52 |
| | 7 | 2 | 2 | 117 | 30 | 16 | 11 | 12 | 2 | 6 | 1 | 628 | 403 | 36 |

a) + 29 n.s.

A search for ducks' nests. This was largely concentrated on St. Serf's Island, where most of the nests were, though the other islands were visited at intervals of about ten days and the suitable areas around the perimeter of the loch were also looked at, with diminishing frequency as the season progressed and so few nests were found there. The nests found are recorded in Table II.

**Table II. Number of ducks' nests found on Loch Leven, N.N.R., April—July, 1966.**

| *Species* | *St. Serf's Island* | *elsewhere* | *most in use at one time* |
|---|---|---|---|
| Teal | 9 | — | 6 |
| Mallard | 268 | 15 | 156 |
| Gadwall | 41 | (2?) | 25 |
| Wigeon | 41 | — | 28 |
| Shoveler | 6 | — | 5 |
| Tufted Duck | 320 | 3 | 200 |
| Total | 685 | 20 | 420 |

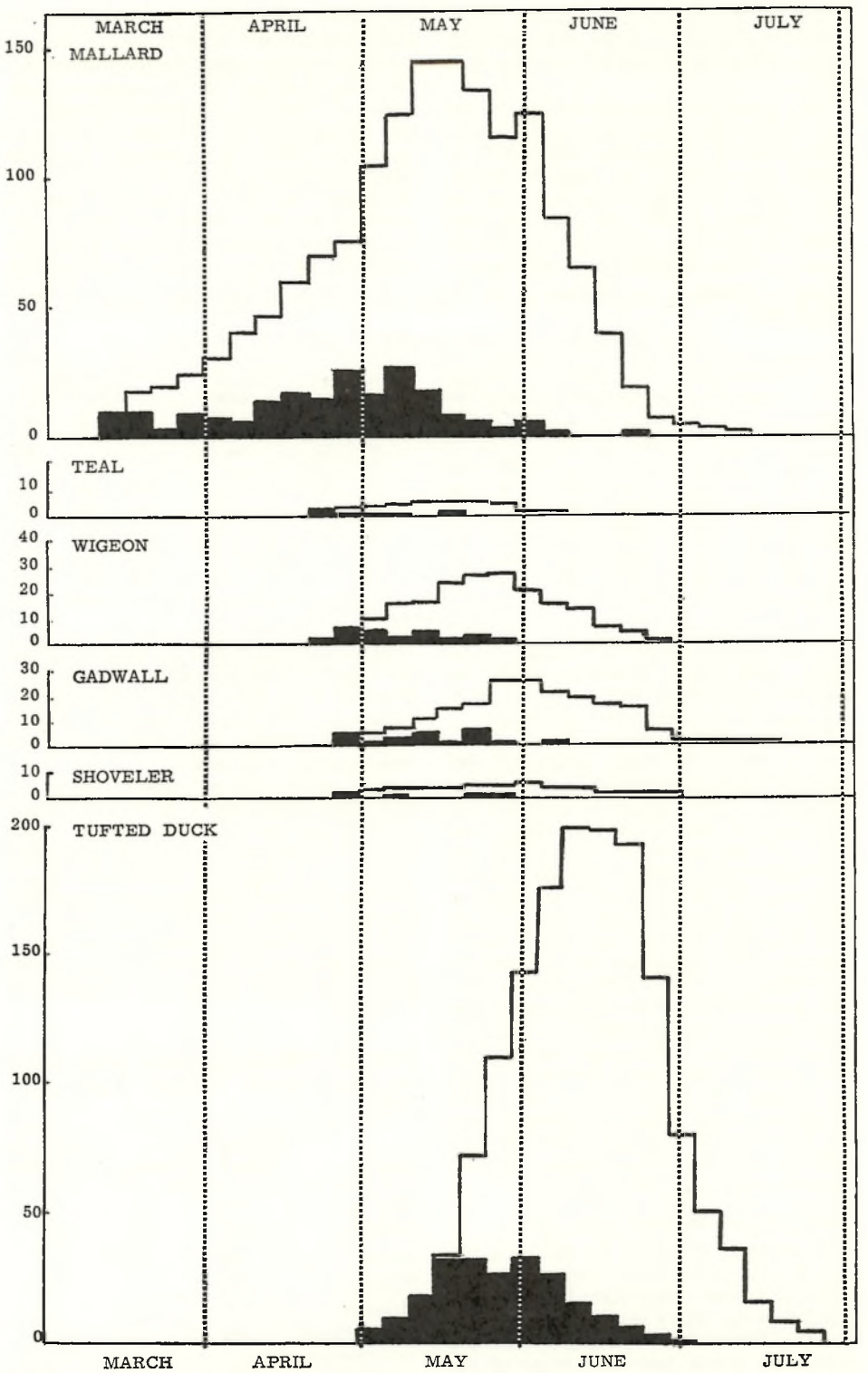


**Figure 1.** Progress of nesting on St. Serf's Island, 1966. Solid histograms show the number of nests in which laying began during each five-day period. Open histograms show the number of nests known to be in use during each period.

The column in Table II headed "Nests —most in use at one time" provides absolute minima for the numbers of ducks that nested, with the exception of the Shelduck. No serious attempt was made to find the Shelducks' nests, in old rabbit burrows on St. Serf's Island.

Further experimental work is planned for 1967 to determine the likely accuracy of counts and the proportion of nests found. It is certain that not all the nests in which eggs were laid were found. Yet it is obvious that the numbers of female dabbling ducks laying were greater than the numbers of either females or males seen in the area in late April and early May. This confirms what has repeatedly been demonstrated in studies elsewhere that counts of ducks seen in the nesting season tend to under- rather than over-estimate the size of the breeding population. This is a point of considerable importance in interpreting the results of the National Summer Wildfowl Survey and contrary to the conservative attitude generally adopted by the editors of local bird reports.

Enough female Tufted Ducks were seen to account for the nests found, but the picture is obscured by the fact that most *Aythya* females do not breed at one year old. Discovering what proportion of Tufted Ducks are non-breeders, and how many of these are sexually mature, will be one of the more difficult tasks for the future.

Pochard *Aythya ferina* and Pintail *Anas acuta* used to nest at Loch Leven. A few Pochard were present in May and a nest found on Alice's Bower, one of the small islands, may have been a Pochard's but was destroyed before this could be confirmed. No Pintail were seen in the nesting season.

**Nesting chronology and success**

Each nest found was marked and its history followed by repeated visits at intervals of five to ten days. Though various technical improvements need to be made in recording and in procedures for determining when the first egg was laid and when the eggs hatched or were lost or deserted, it was possible to date events at most of the nests sufficiently accurately to provide an outline of the progress of the nesting season.

The timing of nesting is depicted by the histograms in Figure 1. These are incomplete for the Mallard as nest-recording did not begin early enough, but the general picture is clear, and unremarkable.

The success of the nests of different species is recorded in Table III. The dabbling ducks did well, though the Gadwall markedly less so than the others. The Tufted Ducks did much less well. It is apparent from Figure 2 that the difference was associated with the later start of nesting by the Tufted Duck. The nest losses increased very rapidly during June. Most of the dabbling ducks had hatched before the most dangerous period was reached. Most of the losses for which some cause was evident was due to predators, of which the Jackdaw *Corvus monedula* was much the most important. Several hundred Jackdaws nest in burrows on the higher parts of St. Serf's Island. The increase in nest predation in June coincided with the appearance of many newly-fledged Jackdaws which spent much of their time sitting in the trees overlooking the principal duck-nesting areas. Both adult and juvenile Jackdaws were seen to visit ducks' nests, usually in the absence of the owner. It was surprising that little activity by Jackdaws was apparent in April when the

**Table III. Success of ducks' nests found on St. Serf's Island, 1966.**

| *Species* | *nests found* | *fate known* | | *fate unknown* | *% successful of* | |
|---|---|---|---|---|---|---|
| | | *hatched* | *failed* | | *fate known* | *all found* |
| Teal | 9 | 6 | 2 | 1 | 75 | *67* |
| Mallard | 268 | 180 | 51 | 37 | 78 | *67* |
| Gadwall | 41 | 21 | 13 | 7 | 62 | *50* |
| Wigeon | 41 | 30 | 6 | 5 | 83 | *73* |
| Shoveler | 6 | 5 | 1 | 0 | 83 | *83* |
| All dabbling ducks | 365 | 242 | 73 | 50 | 77 | *66* |
| Tufted Duck | 320 | 98 | 148 | 74 | 77 | *31* |

**Table IV. Distribution of nests in different types of cover on St. Serf's Island, 1966.**

| Cover | Area (acres) | Mallard nests | Mallard per acre | Gadwall nests | Gadwall per acre | Wigeon nests | Wigeon per acre | Tufted Duck nests | Tufted Duck per acre | All species nests | All species per acre |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Deschampsia* | 18 | 159 | *8.8* | 21 | *1.2* | 24 | *1.3* | 130 | *7.2* | 343 | *19.0* |
| *Phalaris* | 8 | 70 | *8.8* | 8 | *1.0* | 5 | *0.6* | 113 | *14.1* | 198 | *25.4* |
| Low mixed | 7 | 11 | *1.6* | 5 | *0.7* | 7 | *1.0* | 48 | *6.9* | 73. | *10.0* |
| With trees | 17 | 9 | *0.5* | 4 | *0.2* | 2 | *0.1* | 6 | *0.4* | 21 | *1.3* |
| Pasture | 55 | 0 | *0* | 0 | *0* | 0 | *0* | 13 | *0.2* | 14 | *0.3* |
| Total | 105 | 268 | *2.5* | 41 | *0.4* | 41 | *0.4* | 320 | | 685 | *6.5* |

Thirty-six nests are omitted from the cover type classification but are included in the "total" row.

Teal: 7 in *Deschampsia*, 1 *Phalaris*, 1 not classed. Shoveler: 2 each in *Deschampsia* and low mixed, 1 each in *Phalaris* and pasture.

**Table V. Success of nests in different types of cover on St. Serf's Island, 1966.**

Success expressed as (hatched)/(hatched + failed) %.

| | *Mallard* | *Gadwall* | *Wigeon* | *Tufted Duck* | *All species* |
|---|---|---|---|---|---|
| *Deschampsia* | 80 | 68 | 90 | 41 | 66 |
| *Phalaris* | 78 | 40 | 100 | 41 | 58 |
| Low mixed | 82 | 40 | 43 | 46 | 53 |
| With trees | 38 | 75 | 100 | 0 | 40 |
| Pasture | — | — | — | 38 | 44 |

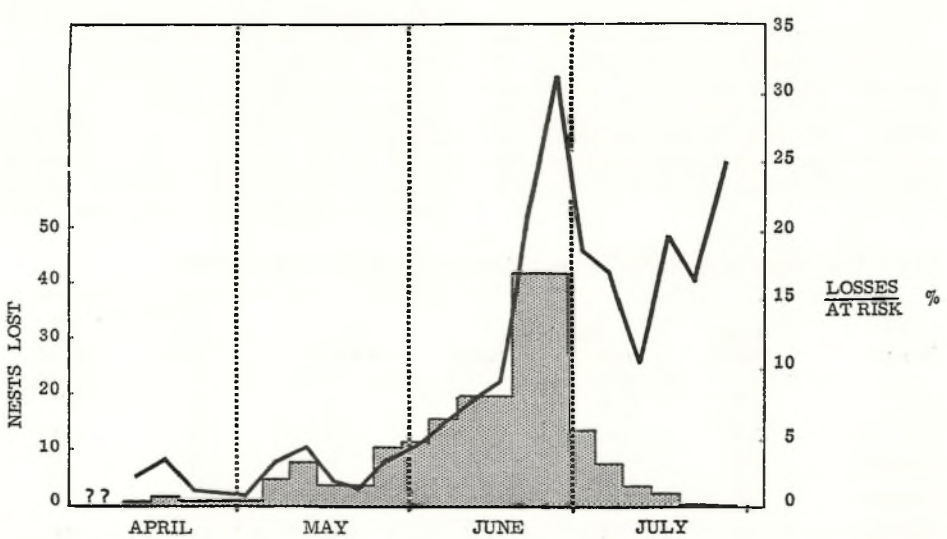


**Figure 2.** Losses of ducks' nests on St. Serf's Island, 1966. Data for all species are taken together. Open histograms show the numbers of nests that were destroyed or abandond during each five-day period. The line records these losses as a percentage of the number of nests known to be in use at the start of each period. Note that the scale for the percentage loss is twice that for the actual numbers lost.

cover for ducks' nests was relatively sparse and when many of the nests contained incomplete clutches and were left unoccupied for much of the time. One long-dead Brown Rat found early in July was the only evidence of the presence of any of the common mammalian nest-predators but a number of clutches of eggs were eaten by sheep. This unexpected activity needs more careful investigation: from observations on the distribution of the sheep in the different types of vegetation on St. Serf's Island it seemed likely that only a very few of the ewes and lambs on the island were interested in finding ducks' nests.

Table IV demonstrates that the use made of the five cover-types by the various species differed appreciably. A more remarkable, if negative, result (Table V) was that nesting success of Mallard and Tufted Duck was much the same in each of the two preferred cover types (*Deschampsia* and *Phalaris*).

The size of each clutch of eggs was determined for those nests found in use on more than one occasion but the investigation of this material and of many other aspects of nesting biology is best postponed until results from several years are available.

**Rearing of young**

Much less attention was paid to the success of ducks in rearing their young than to the study of nests because with the man-power available it was impracticable to deal thoroughly with both. Observations on broods are hard to make on Loch Leven. Most of the shores of St. Serf's Island and of the loch itself are very inhospitable to ducklings. The shores are sandy, lack emergent vegetation and are frequently subject to quite heavy wave action. Most broods are therefore taken by their mothers into thick cover at the south-east corner of the loch, or on to the River Leven below the outfall, or to two rather inaccessible sites on the south-west and north-west shores. Generally, duck broods are least invisible very early in the morning or late in the evening, when they are often led on to open water. In the middle of the day most broods are usually kept in cover. Unfortunately, at Loch Leven disturbance by fishing boats is at its worst in the evening, right up until dark, so that the opportunities for looking at broods are greatly reduced.

It is possible to obtain a rough guide to the numbers of ducklings likely to have been reared to the flying stage from knowledge of the number of clutches hatched and the observed diminution in the mean brood size from those recently-hatched to those approaching full growth (class Ia and class III in the terminology commonly used in North America). These calculations (Table VI) tend to exaggerate production because they do not take into account the losses of entire broods.

Little was learned in 1966 about the causes of duckling death. The periods of greatest loss were during spells of wet cold weather in June and July and it seems likely that bad weather killed more ducklings than did predators. Some ducklings were killed by gulls — though very few Herring, Lesser or Great Black-backed gulls (*Larus argentatus, fuscus* and *marinus*) were present and Black-headed Gulls *Larus ridibundus*, though very numerous, paid little attention to young ducks. No raptors in the area are likely to have attacked ducklings. Dogs roaming the shore in some places probably caught a few. In the course of routine sampling of fish in the loch, Miss D. M. Witcomb found a duckling in the stomach of a pike, but the magnitude of predation by fish remains to be established.

**Table VI. Estimated survival of young to flying stage, from changes in mean clutch- and brood-size, Loch Leven, summer, 1966.**

| | *Production of eggs* | | | | *Survival of ducklings* | | |
|---|---|---|---|---|---|---|---|
| | *Mean clutch size* | *Average number per successful nest* | *nest (incl. failed)* | *Ducklings leaving nests* | *mean brood size class Ia* | *class III* | *Ducklings reared to flying* |
| Teal | 8.7 | 7.8 | 5.9 | 53 | — | — | v. few |
| Mallard | 8.2 | 7.5 | 5.8 | 1640 | 6.5 | 4.4 | 1100 |
| Gadwall | 8.4 | 8.1 | 4.9 | 211 | 8.1 | 3.7 | 96 |
| Wigeon | 7.4 | 6.4 | 5.4 | 221 | 6.9 | 1.3 | 42 |
| Shoveler | 10.5 | 9.8 | 7.8 | 47 | — | — | (9)a |
| Tufted Duck | 9.1 | 7.9 | 3.1 | 1000 | 6.8 | 4.3 | 630 |
| Approx. total | | | | 3200 | | | 1900 |

(a) most seen

**Marking**

Some preliminary attempts were made to catch ducks on nests for ringing. These were very promising in that they showed that trapping at a late stage in incubation did not cause the females to desert their eggs or affect hatching and that a simple hand-net proved more effective than traps set up over the nests. But the numbers of females caught were small and much remains to be done before it can be claimed that a high proportion of the nesting ducks of any species are known as individuals.

One hundred and sixty-four ducklings were also marked with monel wing tags and some trials made of a method of ringing young birds that has been developed in Latvia. It seems likely that in future it will be more rewarding to catch young birds in baited cage-traps when they are old enough to carry conventional rings than to mark very young ducklings.

A female Gadwall caught on a nest on 8th June, 1966, was shot on Lough Corrib, Co. Galway, on 3rd November, 1966, and a female Wigeon, also nesting, marked on 30th May, 1966, was shot 8th January, 1967, near Ballycotton, Co. Cork.

**Possibilities for future work**

There are so many ducks nesting at Loch Leven that it should be a valuable site for research. The survey in 1966 made clear, however, that there are formidable practical difficulties to be overcome in achieving results of sufficient precision to make possible comparisons from year to year of the numbers of females attempting to breed, of the eggs they lay and the young they rear and to find out why these change. To do this for all the breeding species seems likely to be beyond the resources available and it will probably be necessary to concentrate on more intensive studies of particular importance or promise. Because of the needs of the I.B.P. research, special attention must be given to the Tufted Duck, which has one considerable advantage in that it is comparatively easy to study at the pre-fledging stage. And because the Gadwall colony is the biggest in Scotland and that of the Wigeon is the largest available for study in Britain they too should receive particular attention.

**Acknowledgements**

This work was made possible by a grant to the Wildfowl Trust by the Natural Environment Research Council and by permission from the owner of Loch Leven, Sir David Montgomery, Bt., and from the Nature Conservancy, to move about within the National Nature Reserve. We are further indebted to members of the staffs of the Conservancy and of the Kinross Estate Company for help on many occasions and for making equipment available. We are especially grateful to Mr. J. Taylor of Levenmouth Farm, Scotlandwell, for his friendly and practical help.

# The W.A.G.B.I.—Wildfowl Trust Experimental Reserve — the first eleven years

**Introduction**

This reserve was originally established in 1956, when the Kent Sand and Ballast Company gave permission to the Wildfowlers' Association of Great Britain and Ireland (W.A.G.B.I.) to manage their flooded gravel workings in west Kent, as a wildfowl reserve; close co-operation was quickly established with the Wildfowl Trust, and in 1961 the reserve was nominated as a joint experimental unit of the two organisations.

Two preliminary outlines of the management plan and progress have appeared in 1962 and 1965, whilst shorter reports have appeared each year in the *W.A.G.B.I. Annual Reports*. The two lakes within the reserve have undergone dramatic changes during the past eleven years as a result of the close co-operation which exists between the Company's managing director, Mr. George Wallis, and the local wildfowl enthusiasts, in arranging gravel extractions and the planning of modifications calculated to promote the interests of the area as a reserve. The success of these efforts will be apparent to all who study this report.

In 1967 a whole new pit will be flooded. Unlike the other lakes, the new water will be shallow and is likely to have far reaching effects on the waterfowl population of the reserve as a whole. It is desirable, therefore, to assess in detail the achievements of the reserve to date, covering the first eleven years and involving one of the longest series of daily observations on wildfowl made in this country. The first part of this report deals with the analysis of these observations; the second part presents the results of an intensive study of wildfowl feeding biology within the vicinity of the reserve, and is based upon an analysis of the food taken by local duck, which in its turn enabled the planting programme to be devised. Planting has been carried out almost continuously since 1958.

During the summer and autumn of 1966, the productivity of the introduced plants was investigated with special reference to the production of wildfowl food. The results of this investigation are presented in the third part of this report, and it must again be stressed that these results could not have met with the success they have done without the invaluable co-operation of Mr. Wallis. It therefore seems most appropriate that the analysis of achievements should include some indication, in part four, of the cost involved in the course of effecting the improvements which have been made to the habitat.

The whole combined effort represents a most important contribution to conservation in all its many aspects. The vital role of the ecologists concerned with this project is obvious for it was their sphere to identify the plants and other forms of life which the various wildfowl species depend upon for their very existence, and to direct the planting programme accordingly. The advice of such scientists is in fact essential to the proper conduct of any such reserve. Peter Olney's original concept of an analysis of the food preferences of local wildfowl has now extended into a long term study and has demonstrated differing feeding habits according to varying weather conditions and land management.

# Part I. Development of the wildfowl population

J. M. HARRISON, J. G. HARRISON and A. MEIKLE

**Summary**

Data are presented for a continuous series of daily or weekly counts from 1956 to 1967. Mallard constituted the bulk of the wildfowl population, and steady increases have been recorded since the reserve was established. Results suggest that the encouragement of natural breeding by Mallard plays a more important part in establishing a local population, especially during the summer, than does the release of hand-reared birds. However, the first breeding records for Tufted Duck were obtained following the release of hand-reared birds, although the latter could not be definitely established as a prime factor of this development. The numbers of diving duck species in general increased rapidly following the cessation of gravel extraction from one of the two pits.

The number of species recorded annually has increased markedly since 1956. A maximum of seventeen was recorded in the severe winter of 1962-63; a total of twenty-one species of wildfowl has been recorded within the reserve, not including introductions or escapes.

In order to present population data in a reasonably concise form it is necessary to adopt the American " duck-day " system. This provides a means for the comparison of usage by, for example, a large number of wildfowl for a short duration, and a small number over perhaps the whole season. Unfortunately, this is bound to obscure certain factors, such as peak population times. Nevertheless, it is suitable for the investigation of wildfowl usage in relation to controlling factors, food and cover.

Although the reserve has been visited daily during the past eleven years, full data are not available for Mallard: the yearly totals from 1956-1962 have been interpolated from weekly counts in this species. Matthews (1959) has found that such procedures do, in fact, provide a reasonable approximation of the actual value. Daily counts have been made since 1963.

Data for the period summer 1956 to winter 1967 are summarised in Table I. In addition to the 21 listed, four other species have been recorded. These include a Lesser Snow Goose, present from 3rd December, 1963, to 3rd November, 1965, and a Barnacle Goose seen on 6th June, 1966. It is probable that both were escapes from collections. Canada and Greylag Geese have been introduced to the reserve, and their numbers, which have in recent years been supplemented by " wild " birds, are presented in Table II.

The data in Table I are self-evident, but certain features deserve special attention. Mallard have invariably constituted the bulk of the wildfowl population, and have increased continuously from 1956. The annual totals may be differentiated into summer and winter populations. The increase in the summer population seen since 1962 is due to a large extent to an increase in breeding within the reserve. The number of broods observed each year (Figure 1) has increased markedly, to attain a total of 44 in 1966. Whether or not the perceptible increase in the growth rate of the winter population, seen since 1962-63, can be attributed to the increase in breeding stock is difficult to assess. What is apparent, however, is that the release of hand-reared Mallard has had little impact within the reserve. There was some development of a summer population following the release of birds in 1958, but there has been no obvious effect on the population since 1962, following a decline in hand-rearing. From a conservation point of view, however, it may be assumed that the reserve has functioned successfully as a point of release of hand-reared Mallard, before their subsequent absorption into the general population in that part of the country.

There has been a fairly steady increase among diving duck species. In 1961-62, there was a marked increase in Pochard and Tufted Duck populations, which has been maintained at or increased from these levels since then. It is of interest to note that, in the previous summer (1961) excavation ceased in the West Lake and submerged plants and animals rapidly became established. Clearly, Tufted Duck have benefited to a greater degree than Pochard. It is thought that this is partly a reflection of the nature of the submerged vegetation. The only species to become widely distributed within the West Lake is hornwort *Ceratophyllum demersum*. Whilst Olney (1963a, 1963b, 1964) has shown this species may have some value as a food plant, it is not exceptionally productive of seed at the reserve. It is believed that this species has suppressed the growth of more useful species

**Table I. Annual wildfowl usage (in wildfowl days) of the W.A.G.B.I.—Wildfowl Trust Experimental Reserve, Sevenoaks, 1956-67.**

Year includes summer and following winter, e.g., 1956/57 refers to summer 1956 and winter 1956/57. Figures in parenthesis refer to birds seen flying over the reserve, and are not included in totals.

| | 56/57 | 57/58 | 58/59 | 59/60 | 60/61 | 61/62 | 62/63 | 63/64 | 64/65 | 65/66 | 66/67 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dabbling/grazing ducks* | | | | | | | | | | | |
| Mallard | 6150 | 7900 | 9500 | 14700 | 17100 | 19900 | 22370 | 27945 | 33104 | 38201 | 41314 |
| Teal | 12 | 2 | 7 | 8 | 10 | 31 | 84 | 69 | 53 | 69 | 324 |
| Garganey | | | | 1 | | | | | 1 | | 3 |
| Gadwall | | | 1 | | | | | | | 497 | 491 |
| Wigeon | | 3 | | 20 | 2 | 25 | 77 | 6 | 101 | 41 | 11 |
| Pintail | | | | | | | 6 | 5 | 4 | 1 | |
| Shoveler | | 1 | 2 | | | 11 | 17 | 8 | 33 | 27 | 10 |
| Shelduck | | 1 | | | 2 | | 3 | 2 | 2 | 7 | 7 |
| *Total* | 6162 | 7907 | 9510 | 14729 | 17114 | 19967 | 22557 | 28035 | 33298 | 38843 | 42160 |
| *Diving ducks* | | | | | | | | | | | |
| Pochard | 1 | 9 | 2 | 13 | 12 | 337 | 324 | 166 | 324 | 213 | 443 |
| Tufted Duck | | 24 | 73 | 22 | 13 | 159 | 431 | 457 | 1722 | 1663 | 3134 |
| Goldeneye | | | | | | 7 | 11 | | 20 | 1 | 3 |
| Eider | | | | | | | 6 | | | | |
| Common Scoter | | 1 | | | | | | 6 | | | |
| Red-breasted Merganser | | | | | | | 10 | 1 | | | |
| Goosander | | | | | 28 | 109 | 178 | 4 | | 1 | |
| Smew | | | | | | 14 | 248 | 5 | 8 | | 1 |
| *Total* | 1 | 34 | 75 | 35 | 53 | 626 | 1208 | 589 | 2074 | 1878 | 3581 |
| *Geese and swans* | | | | | | | | | | | |
| Whitefront | | | | | | | (295) | 78 | | (100) | (45) |
| Russian Brent | | | | | | | | | | 1 | |
| Mute | 90 | 114 | | | 2 | 14 | 243 | 439 | 248 | 196 | 523 |
| Whooper | | | | | | | 73 | | | | |
| Bewick's | | | | | | | (7) | | | | |
| *Total* | 90 | 114 | | | 2 | 14 | 316 | 517 | 248 | 197 | 523 |
| *Grand Total* | 6253 | 8055 | 9585 | 14764 | 17169 | 20607 | 24081 | 29191 | 35620 | 40918 | 46264 |

**Table II. Canada and Greylag population of the W.A.G.B.I.—Wildfowl Trust Experimental Reserve, Sevenoaks, 1956-67.**

| | *Canada* | | | *Greylag* | | |
|---|---|---|---|---|---|---|
| *Season* | *Resident* | *Autumn Peak* | *Round-up* | *Resident* | *Autumn Peak* | *Round-up* |
| 1956-57 | 27 | 27 | — | — | — | — |
| 1957-58 | 21 | 21 | — | — | — | — |
| 1958-59 | 45 | 45 | — | — | — | — |
| 1959-60 | 48 | 48 | — | — | — | — |
| 1960-61 | 48 | 48 | — | — | — | — |
| 1961-62 | 45 | 80 | — | 5 | 5 | — |
| 1962-63 | 70 | 60 | 50 | 9 | 12 | — |
| 1963-64 | 33 | 63 | — | 12 | 12 | — |
| 1964-65 | 66 | 160 | 24 | 26 | 26 | — |
| 1965-66 | 41 | 123 | 13 | 17 | 17 | — |
| 1966-67 | 51 | 155 | — | 19 | 27 | — |

occurring here, notably *Potamogeton* spp. (Olney, pers. com.). At present, therefore, the amount of suitable food available to Pochard is still rather limited. The situation is rather different with regard to the Tufted Duck, which has increased rapidly since 1961. This could be attributed to a rapidly increasing invertebrate population which, whilst no doubt affected to a greater or lesser degree by the nature of submerged vegetation, will have almost certainly increased since the cessation of extraction activity in 1961. It must be remembered, however, that disturbance has also been considerably reduced by this change.

Table II gives the seasonal numbers of Canada and Greylag Geese present. It will be noted that with three round-ups during the flightless period, in 1962, 1964 and 1965, Canada Geese have been kept well controlled. In the case of Canada Geese peak numbers have been recorded quite regularly for six weeks in autumn from early September. This is the only time when the residents are joined by others from elsewhere. The reserve is used almost solely as a roost throughout the year, except from the breeding season to the end of the flightless period in the second half of July. It is at this time that the geese graze on the submerged water plants by upending. The plant species most seriously affected appears to be *Potamogeton crispus*, which grows abundantly in part of the East Lake. Seeds are rarely formed and indeed very few flowers may be observed. It is thought that the latter are grazed off by geese and perhaps Mute Swans also, resulting in a serious depletion of food suitable for Pochard and other ducks. It seems probable also that the depth of water is often too great for heavy seed yields by this species; better results with this otherwise productive plant are expected in the new shallow pit to be completed in 1967.

There is some evidence to suggest that the smaller Greylags are unsuccessful competitors with Canada Geese, particularly in the choice of nesting sites. Fighting has been observed and for the past three years nesting Greylags have flown to a lake about six miles south, returning

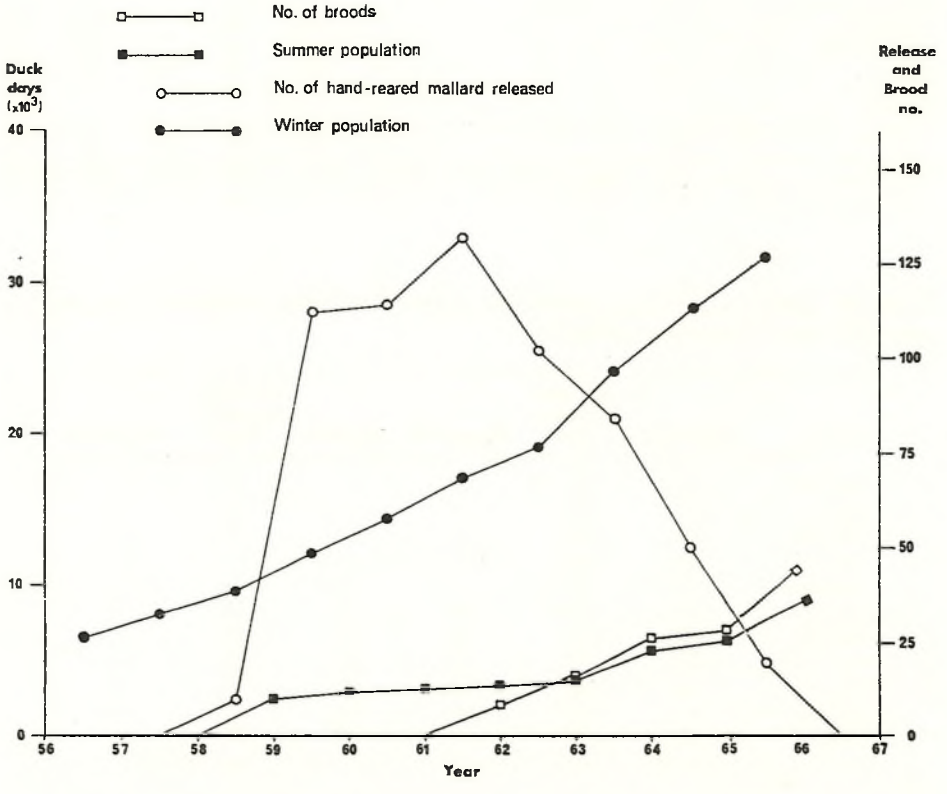


**Figure 1. Mallard population at the W.A.G.B.I.—Wildfowl Trust experimental reserve.**

to the reserve with their families in late autumn.

One of the benefits to be derived from a well-established Mallard population has been the attraction of other species of wildfowl to the reserve. Twenty-one different species have now been recorded, not including feral geese, introductions or escapes, and there has been a general increase in the number of different species seen each year. Data for the severe winter of 1962-63 shows how important such local reserves can be under extreme conditions; no less than seventeen species were recorded during this period.

As might be expected, the number of species visiting the reserve is considerably lower during the summer, but even here a definite increase has been observed since the reserve was established. The summer of 1966 was particularly successful, with a record number of seven summer visiting species; these included Tufted Duck which amounted to a total of 720 duck-days, affected in no small way by the notable presence of five breeding pairs. (It should be noted that young birds were not included in the calculation of "wildfowl-days" until fully grown.) It is interesting to note that this first breeding record occurred in the year following the initial release of seven hand-reared Tufted Duck. Five of the latter were colour-ringed, but no such rings were observed among breeding birds.

In 1965, fifteen Gadwall were released, followed by a further nineteen in 1966, with two Pochard in the same year. It remains to be seen what effect these introductions have on the status of the reserve as a natural breeding ground for these species.

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## Part II. The feeding ecology of local Mallard and other wildfowl

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### Summary

The feeding habits of Mallard *Anas p. platyrhynchos* in an area near Sevenoaks, Kent, were investigated by 226 stomach analyses and by observations between 1957 and 1965. The main feeding areas included the river and its banks, the wet meadows by the river, the gravel pits and their margins and beneath oak trees *Quercus robur* in the valley. The dominant plants in these areas are described. The food taken varied each year, depending on the production and availability of food items, which were correlated with changes in the habitat (e.g. river clearance, grazing) and with the effects of differing weather conditions (e.g. flooding, dry summers).

The most frequently taken foods were: in the river, the leaf and stem of water crowfoot *Ranunculus aquatilis,* together with the mollusc *Hydrobia jenkinsi* and the caddis fly *Hydropsyche angustipennis,* and to a lesser extent the seeds of flote-grass *Glyceria fluitans;* from the river banks, the seeds of bur-reed *Sparganium erectum* and water-pepper *Polygonum hydropiper;* from the wet meadows, the seeds of creeping buttercup *Ranunculus repens,* persicaria *Polygonum persicaria,* hammer sedge *Carex hirta* and sharp dock *Rumex conglomeratus;* in and around the gravel pits a wide variety, mainly the seeds of alder *Alnus glutinosa,* various *Polygonum* species, *S. erectum* and parts of horsetail *Equisetum,* as well as Chironomidae and *Hydropsyche* larvae.

Acorns were eaten in the years when oaks produced seed.

Forty other wildfowl were collected and their stomach contents were analysed. They included Teal *Anas c. crecca,* Wigeon *A. penelope,* Tufted Duck *Aythya fuligula,* Pochard *A. ferina,* Smew *Mergus albellus,* White-fronted Geese *Anser a. albifrons* and Canada Geese *Branta canadensis.*

**Introduction**

The food and feeding habits of Mallard *Anas p. platyrhynchos*, and other species of ducks and geese, were studied over an eight year period in an area along the River Darent between Sevenoaks and Otford, Kent. This area includes two gravel pits, the details of which have already been described (Harrison et al. 1962, Olney 1964) and in which extensive management has already taken place. It was quite obvious from observations that birds feeding in the area between Otford and the gravel pits were flighting to and from the pits where some feeding was also taking place, but whose prime value, at least in the beginning of the survey, was as a roosting area. It follows that any food study would have to consider the area as a whole, though most birds were collected away from the pits.

**Methods and materials**

From 1957 to 1965, mainly during the allowed shooting season of 1st September to 31st January, 266 birds of ten species were collected. Of these only eleven were found to be empty of food. Eight birds were collected within the protected season under a licence issued by the Nature Conservancy. The methods of analysis were the same as those described in detail elsewhere (Olney 1961, 1963a). The nomenclature of all seeding plants follows that of Clapham, Tutin and Warburg (1962).

The main feeding areas include: (1) the river and its banks, (2) the meadows by the river—especially when they are partially flooded, (3) the gravel pits and their margins, and in the case of Mallard (4) beneath the oak trees *Quercus robur* which are scattered along the river valley. It is not possible in this paper to go into much detail when considering the vegetation. Within the river the dominant plants are water crowfoot *Ranunculus aquatilis*, horn-wort *Ceratophyllum demersum*, flote-grass *Glyceria fluitans*, canadian pondweed *Elodea canadensis*, starwort *Callitriche* sp., and duckweed *Lemna* spp. The river is fringed mainly with common bur-reed *Sparganium erectum* and reed-grass *Glyceria maxima*, and in some years with extensive patches of water-pepper *Polygonum hydropiper*. Alder *Alnus glutinosa* and willows *Salix* spp. are found along the river and throughout the valley. The meadows adjacent to the river are typically alluvial grassland habitats often containing semi-aquatic communities where the drainage is impeded. The most frequently occurring species here are various grasses, creeping buttercup *Ranunculus repens*, persicaria *Polygonum persicaria*, hammer sedge *Carex hirta*, sharp dock *Rumex conglomeratus* and soft rush *Juncus effusus*.

Most of this report is concerned with the Mallard. Relatively little material was obtained from the seven other species (five ducks and two geese) studied. This is described and discussed at the end of the paper. Two general locality names are used: the *Otford area*, which includes the grazing meadows adjacent to the river between Otford and the gravel-pits and the river and its banks, and the *gravel pit area*, which includes the pits and their margins.

**MALLARD**

a. *Otford area.* Two hundred and ten Mallard were collected from this area between 1957 and 1965. The main food items found in the stomach contents of these birds are shown in Table I. Plant material, mainly seeds, occurred in 204 (97.1%) of the birds, and occupied 85.7% of the total volume. Animal material was found in 85 (40.5%) birds and occupied 14.3% of the total volume.

The seeds of creeping buttercup *Ranunculus repens* were found more frequently than any other species, occurring in 35.2% of all birds examined. This is a common species in the meadows alongside the River Darent, particularly in those areas which are liable to flood. It was not always possible to distinguish between the seeds of *R. repens* and meadow buttercup *R. acris*, and in such cases they have been included *R. repens*. In four years of survey this was the most frequently occurring plant (Table II).

Common bur-reed seeds were found in 28.1% of the birds, occurring in each year, though rarely were they found in large numbers. In three years of the survey they were the most frequently occurring species. *S. erectum* is the dominant species of the river edges, and with planting it is now common in parts of the gravel pits.

The seeds of persicaria were found in 50 birds and occurred in all years apart from the first year. This species is found in a wide range of habitats in this area and can be particularly common in the wetter parts of the grazing meadows and in the disturbed communities around the pits. The closely related species, pale persicaria *P. lapathifolium* and knotted persicaria *P. nodosum* ecologically resemble (at least in this area) *P. persicaria*. Distinguishable seeds occurred in seven and six birds respectively.

Water-pepper seeds were found in 27 birds in all years apart from the 1958-59 shooting season. This species is characteristically found in damp places, and on river banks and can produce large numbers of seeds. Occasionally birds are shot which are crammed full of these seeds, and for example in November 1964, two birds were collected which contained c.3,500 and 1,500 seeds respectively.

The hammer or hairy sedge is a common plant of the damp, grazing meadows alongside the river, and its seeds were an important part of the diet of those birds feeding in this area. The seeds occurred in 37 birds and were found in each year of the survey, though not in great quantity.

The seeds of clustered or sharp dock were found in 33 birds and occurred in each season, apart from 1960-61. This variable species is a characteristic species of the damp grasslands by the river, and is also found, though less frequently, around the gravel pits.

The most commonly eaten grass species was flote-grass, whose seeds were found in 26 birds. This was a particularly important species during the 1964-65 season, when it was found in nine of the 34 birds examined, and in three birds shot in December and January large numbers were found—one bird had eaten over 9,000 seeds. Other grass species which occurred included reed-grass, glaucous sweet grass *G. declinata*, marsh foxtail *Alopecurus geniculatus* and Italian rye-grass *Lolium multiflorum*. However, none of these occurred often or in quantity.

Alder seeds were found in 25 birds in seven of the eight seasons. It is a common tree of the wetter parts of the valley and has been extensively planted around the gravel pits. The amount and availability of seed produced appears to vary considerably from year to year.

The seeds of *Rosa* spp., and hawthorn *Crataegus monogyna* occurred in 20 and 17 birds. These plants have a limited distribution in the valley and around the pits.

Acorns, the seeds of *Quercus robur*, though they occurred in only 16 birds, formed a substantial part of the total volume (45.3%). They were found in four of the eight years. The production of acorns varies from year to year and from tree to tree, and very large numbers were produced in some years by the relatively few (17) trees in the valley and around the pits. Mallard could often be seen feeding under these trees.

Blackberry *Rubus fruiticosus* agg. is widespread and common around the pits and throughout the valley. The seeds

**Table I. Main food items from the stomach contents of 210 Mallard from the Otford area, 1957-65.**

| *Plant material* | *volume in ml.* | *Frequency* | *% of total frequency* |
|---|---|---|---|
| Seeds: | | | |
| *Ranunculus repens* | 15.3 | 74 | 35.2 |
| *Sparganium erectum* | 5.0 | 59 | 28.1 |
| *Polygonum persicaria* | 7.7 | 50 | 23.8 |
| *Carex hirta* | 6.95 | 37 | 17.6 |
| *Rumex conglomeratus* | 2.9 | 33 | 15.7 |
| *Polygonum hydropiper* | 16.15 | 27 | 12.9 |
| *Glyceria fluitans* | 20.8 | 26 | 12.4 |
| *Alnus glutinosa* | 4.8 | 25 | 11.9 |
| *Rosa* spp. | 2.4 | 20 | 9.5 |
| *Quercus robur* | 264.3 | 17 | 8.1 |
| *Crataegus monogyna* | 4.15 | 17 | 8.1 |
| *Rubus fruticosus* agg. | 0.8 | 16 | 7.6 |
| Leaf and shoot: | | | |
| *Ranunculus aquatilis* | 19.0 | 19 | 9.0 |
| *Equisetum spp.* | 8.9 | 13 | 6.2 |
| *Animal material* | | | |
| Hydropsychidae | 27.95 | 33 | 15.7 |
| *Hydrobia jenkinsi* | 11.8 | 30 | 14.3 |
| Chironomidae | 2.2 | 14 | 6.7 |

Total volume = 583.9 ml.
Plant material = 500.3 ml. = 85.7% of total volume
97.1% of total frequency
Animal material = 83.6 ml. = 14.3% of total volume
40.5% of total frequency

**Table II. Numbers of occurrences of principal food plants and animals in Mallard viscera obtained in eight seasons near Sevenoaks, Kent, 1957-8 to 1964-5.**

| *Food* | *Site* | 1957/58 | 1958/59 | 1959/60 | 1960/61 | 1961/62 | 1962/63 | 1963/64 | 1964/65 | total |
|---|---|---|---|---|---|---|---|---|---|---|
| *Ranunculus repens* | wet meadows | — | 27 | 7 | 7 | 14 | 3 | 6 | 10 | 74 |
| *Carex hirta* | „ „ | 2 | 14 | 4 | 3 | 6 | 1 | 2 | 5 | 37 |
| *Rumex conglomeratus* | „ „ | 2 | 13 | 5 | — | 7 | 1 | 3 | 2 | 33 |
| *Polygonum persicaria* | wet meadows and gravel pits | — | 14 | 6 | 11 | 5 | 6 | 4 | 4 | 50 |
| *Ranunculus aquatilis* | river | — | — | 9 | 3 | 1 | 2 | 2 | 2 | 19 |
| *Glyceria fluitans* | „ | — | 6 | — | 2 | 4 | — | 5 | 9 | 26 |
| *Hydrobia jenkinsi* | „ | 3 | 6 | 8 | 2 | 2 | 8 | 1 | — | 30 |
| *Hydropsyche* sp. | river and gravel pits | — | 3 | 8 | 1 | 11 | 5 | 2 | 3 | 33 |
| *Polygonum hydropiper* | river banks | 1 | — | 1 | 7 | 4 | 5 | 2 | 7 | 27 |
| *Sparganium erectum* | river banks and gravel pits | 5 | 13 | 10 | 12 | 9 | 3 | 3 | 4 | 59 |
| *Alnus glutinosa* | gravel pits | — | 5 | 2 | 4 | 1 | 1 | 2 | 10 | 25 |
| *Equisetum* sp. | „ „ | — | 2 | — | 4 | 4 | — | 1 | 2 | 13 |
| Chironomidae | „ „ | — | 2 | 2 | 1 | 2 | — | 5 | 2 | 14 |
| | total | 13 | 105 | 62 | 57 | 70 | 35 | 38 | 60 | 440 |

were found in 16 birds and in each year of the survey, though never in large quantities.

Cereal grains were not found frequently though the amounts eaten were large. Wheat *Triticum aetivum* grains were eaten by nine birds and formed 7.6% of the total volume, and barley *Hordeum distichon* grains were eaten by six birds and formed 9.5% of the total volume.

Seeds of other species taken did not occur in any appreciable quantity or frequency. All of them are species which occur in the area, and are typical members of wet situations, grassland and disturbed communities.

Plant material other than seeds occupied 6.4% of the total volume. The leaf and shoot of various submerged aquatics occurred the most frequently with those of water crowfoot being found most often (9.0%). Other species found included a number of filamentous algae, canadian pondweed, horned pondweed *Zannichellia palustris*, and starwort. Duckweed was found in only one bird. All these species are common within the river or in the gravel pits. The stem and particularly the tips of horsetail *Equisetum* spp. which can be very common in parts of the wetter areas of the gravel pits, were found in 13 birds. In November 1961, two Mallard were shot which had been feeding on turnips.

Animal material was found in 89 (40.5%) birds and comprised 14.3% of the total volume. The larvae, and to a lesser extent the pupae, of the caddis fly *Hydropsyche angustipennis* occurred the most often, being found in 33 birds. They were taken in all but one of the eight years, usually in association with water crowfoot. They have been a particularly common member of the river fauna in this area. Jenkin's spire shell *Hydrobia jenkinsi*, also a common inhabitant of the river, was found in 30 birds. Other molluscs taken included the freshwater mussels *Sphaerium*, *Pisidium*, and *Anodonta*, and the gastropod *Bithynia tentaculata*. Only *Sphaerium corneum* occurred at all frequently (eight birds) and in any quantity, and though *Anodonta* is common in parts of the gravel pits, it was only found in one bird.

A considerable number of insect larvae and adults were taken, the most common of which were the non-biting midge (Chironomidae) larvae which occurred in 14 birds. At least eight Diptera families were identified (Stratiomyidae, Psychodidae, Dolichopodidae, Empididae, Chironomidae, Rhagionidae, Ephydridae and Simuliidae), though only Chironomids and the larvae and pupae of the blackflies *Simulium ornatum* and *S. erythrocephalum* occurred in any quantity. The larvae and adults of a number of water beetles were also taken including *Helophorus aquaticus*, *H. flavipes*, *Ilybius fuliginosus*, *Haliplus* sp., *Elmis* sp., and surprisingly considering its comparatively large size (about 29 mm.), one adult *Dytiscus marginalis*.

Crustaceans taken included the waterlice *Asellus aquaticus* and *A. meridianus*, the shrimp *Gammarus pulex* and in two birds small crayfish *Astacus pallipes*. There is some evidence that the numbers of *G. pulex* increased in the river after 1961 but after two years decreased because of the sterilization of female *G. pulex* by the parasite *Polymorphus minutus* (Crompton and Harrison 1965). This parasite was found in 50% of 104 Mallard between 1961 and 1964, though the number of possible intermediate hosts, including *G. pulex*, found in the diet of Mallard was not high.

**Table III. Stomach contents of 16 Mallard from Sevenoaks gravel pit area, 1959-65.**

| *Plant material* | *Frequency* | *Animal material* | *Frequency* |
|---|---|---|---|
| *Equisetum* spp. tips | 4 | Larvae: | |
| Algae | 2 | *Hydropsyche* sp. | 4 |
| Seeds: | | Chironomidae | 3 |
| *Sparganium* | 3 | Psychodidae | 3 |
| *Alnus glutinosa* | 3 | | |
| *Polygonium persicaria* | 3 | | |
| *Polygonum amphibium* | 2 | | |
| *Rumex conglomeratus* | 2 | | |
| *Rubus fruticosus* agg. | 2 | | |

Seeds occurring only once: Wheat, Barley, *Polygonum hydropiper*, *P. lapathifolium*, *P. nodosum*, *Lolium multiflorum*, *L. perenne*, *Bromus sterilis*, *Holcus lanatus*, *Juncus inflexus*, *Phleum pratense*, *Poa trivialis*, *Plantago lanceolata*, *Crateaegus monogyna*, *Chenopodium album*, *Atriplex patula*.
Animal material occurring only once: *Gammarus pulex*, *Asellus* sp., *Limnaea pereger*, *Anodonta* sp., Rhagionidae larvae, Dolichopodidae larvae.

Earthworms were taken by seven birds and in three formed the major part of the stomach contents. Only two species could be definitely identified: *Allolobophora caliginosa* and *Eiseniella tetraedra.*

The leech *Helobdella stagnalis* which is common in the shallower parts of the gravel pits was found in a Mallard shot in November 1961.

The only time fish were found was in January 1963, when two birds were found to contain small trout *Salmo fario* remains.

b. *Gravel pit area.* Sixteen Mallard were collected from this area between 1959 and 1965, including eight collected outside the shooting season. The list of species found is shown in Table III.

Few conclusions can be drawn from such a small sample. It does indicate that relatively more animal material is taken in the summer month (in July and August when six birds were collected, five contained animal material and occupied 60% of the total volume) and that the majority of plant species taken are those associated with disturbed habitats such as would occur around the edges of the pits.

**Discussion**

Each shooting season the diet and feeding habits changed to some extent (Figure 1 and Table IV) and these changes can be correlated with changes in the habitat (e.g. river clearance, cattle grazing, etc.) and with the effects of differing weather conditions (e.g. flooding, dry summers, etc.). Field observations on feeding were often confirmed by subsequent stomach analyses, and could be linked to changes in environmental conditions.

In 1957 much of the feeding occurred in the river and along the banks of the river. Though only seven birds were collected during the 1957-58 season the food they contained, which was mainly *S. erectum*, confirmed the field observations.

The wet summer and September floods of 1958 caused the meadows adjacent to the river to be inundated throughout most of the shooting season, though not to any great depth. Most feeding appeared to take place in the meadows—this is confirmed by the stomach contents—and to a lesser extent by the river banks. Statistical analysis showed significantly higher frequencies of wet meadow species taken in 1958-59. In this year also

**Table IV. Main feeding areas and foods of Mallard near Sevenoaks, Kent.**

| *Main areas* | *Main foods* |
|---|---|
| Wet meadows | *Ranunculus repens, Carex hirta, Polygonum persicaria, Rumex conglomeratus.* |
| River | *Ranunculus aquatilis, Hydropsyche* sp., *Hydrobia jenkinsi, Glyceria fluitans.* |
| River banks | *Sparganium erectum, Polygonum hydropiper.* |
| Gravel pits | *Alnus glutinosa, P. persicaria, Equisetum* spp., *S. erectum, Hydropsyche* sp., Chironomidae. |
| River valley and pits | *Quercus robur.* |

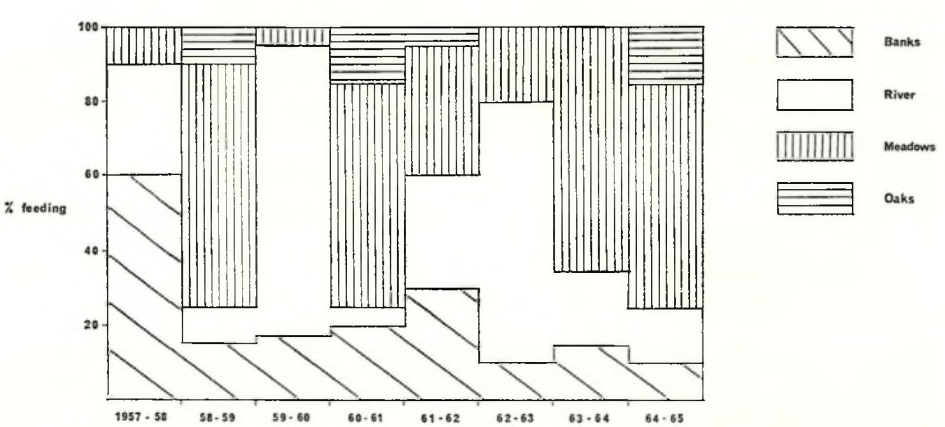


**Figure 1. Feeding habits of Mallard in the Kent study area, 1957-58 to 1964-65.**

most of the oak trees in the valley produced large quantities of acorns and many birds from November onwards were seen feeding under them.

The 1959 summer was very dry and hot and with extensive cattle grazing most meadow vegetation was eaten down and comparatively little seed was produced. In consequence the meadows were not favoured feeding grounds during the 1959-60 shooting season, and most of the food taken was obtained from the river with relatively frequent and large amounts of animal material being eaten, especially caddis-fly and black-fly.

The late summer, autumn and winter of 1960 were distinguished by prolonged and at times heavy rain. This resulted in widespread flooding of the water-meadows, where most of the feeding took place. Comparatively little feeding occurred in the river itself, though the seeds of bur-reed occurred in 46.2% of the birds examined from the 1960-61 season and appeared to be obtained mainly from the river banks. It was in this year, following the floods, that Mallard were first seen to be feeding on horsetail tips, particularly *Equisetum arvense*. The acorn crop was again large, after a year when virtually none were produced.

In 1961 a hot dry summer was followed by rain, and in the beginning of 1962 extensive flooding of the water-meadows occurred. Feeding during this season was spread over a large area, and food was taken from the meadows, from the river and from the river banks in about equal proportions. Again it was a year when some of the oaks produced large acorn crops.

During the 1962-63 shooting season, following a rather cool and wet summer, rain and snow occurred with a prolonged very cold spell into the spring of 1963. In the summer and autumn of 1962 the river was widened and a large proportion of the river bank flora was destroyed, particularly the beds of bur-reed. It was noted that most birds fed mainly in the river, or on the meadows before they were covered with snow and ice. Much of the food taken consisted of animal material (79.3% of the total volume; the most in any of the eight years under consideration) and most of this was obtained from the river, or later on when this was frozen over, from the open parts of the gravel pits. Again, statistical tests showed significantly higher frequencies of river species as compared with wet meadow and gravel pit species.

In 1963 the summer was cold and rather dull with a comparatively mild but wet autumn and winter, with the resultant widespread flooding of the low-lying meadows. There was also some weed clearance in the river during the summer and autumn. Most feeding occurred in the shallow flooded meadows and to a lesser extent in the river and on the banks, where the flora had re-established itself after the drastic clearance of the year before.

The summer of 1964 was dry followed by some rain and shallow flooding, and the conditions for meadow feeding were ideal with a good seed crop being produced and wet conditions prevailing. A large proportion of the food during the 1964-65 season was obtained from the wet meadows with comparatively little being taken from the river and its banks. This was again a year when acorns were produced in considerable quantities and Mallard were often seen feeding under the oak trees in the river valley. Plants characteristic of gravel pits featured significantly in the analysis of stomach contents.

It is obvious then that the general diet changes from year to year and this can be related to factors which effect the production and availability of food items. This does emphasise the need for food studies in one area to extend over a number of consecutive years.

The most striking change in the area in the last ten years has been the development of the gravel pits. More and more wildfowl feeding occurs within and immediately around the pits and this is likely to increase as the planting programme (Harrison, Harrison and Olney 1962, Olney 1964, Harrison and Harrison 1964) takes effect and more seed is produced, and more invertebrates become established, particularly amongst the submerged plants. The overall population of wildfowl is likely to increase, with extra feeding areas around and within the pits, and with the continued undisturbed river valley between Sevenoaks and Otford. This pattern of change (more feeding areas and more birds) is already becoming obvious.

## OTHER SPECIES

### Teal *Anas c.crecca*

*Otford area.* Sixteen Teal were collected from this area during the shooting season between 1959 and 1964. Seeds occurred in 15 of these birds and animal material in six. Then contents of the food tracts are shown in Table V.

The seeds of *Ranunculus repens*, *Rubus fruticosus* agg. and *Polygonum persicaria*, and Chironomidae larvae occurred the

most frequently and in the greatest quantity. This closely follows the rating of foods found in 96 Teal collected from inland waters around the country (Olney 1963a), and appears therefore to be a true indication of what the normal diet in this area is.

forming the largest proportion, is similar to that found in the larger samples described by Olney (1963b).

*Otford area.* Few Tufted Ducks fed in this area and only three were collected from off the river during 1962-63. Animal material predominated with the caddis-fly

**Table V. Food in stomach contents of 16 Teal from Otford area, 1959-64.**

| *Plant material* | *Frequency* | *Animal material* | *Frequency* |
|---|---|---|---|
| Seeds: | | Chironomidae larvae | 6 |
| *Ranunculus repens* | 7 | *Pisidium* sp. | 2 |
| *Rubus fruticosus* agg. | 4 | | |
| *Polygonum persicaria* | 4 | | |
| *Rumex conglomeratus* | 3 | | |

Seeds only occurring once: *Polygonum nodosum, P. amphibium, P. aviculare, Glyceria sp., Scirpus lacustris, Galium aparine, Rorippa officinale, Alnus glutinosa, Sambucus nigra, Juncus* sp., *Trifolium repens.*
Animal material occurring only once: *Asellus* sp., *Planorbis* sp., *Hydrobia jenkinsi,* Limnophilidae larvae, Polycentropidae larvae, Lumbricidae.

Wigeon *Anas penelope*

Two Wigeon feeding in the meadows of the river valley were collected in January 1963, and both contained grasses, including rough meadow-grass *Poa trivialis,* annual meadow-grass *P. annua,* and creeping fescue *Festuca rubra.*

Tufted Duck *Aythya fuligula*

*Gravel pits.* The number of Tufted Duck visiting the gravel pits has increased dramatically since 1960 (Harrison, Harrison and Meikle 1967), presumably mainly due to the increase in the invertebrate aquatic fauna. Five birds were collected in 1962 and one in 1964. The list of food items found is shown in Table VI. The type of food found, with molluscs

**Table VI. Stomach contents of six Tufted Ducks from Sevenoaks gravel pits, 1962 and 1964.**

| *Animal material* | *Frequency* |
|---|---|
| *Hydrobia jenkinsi* | 3 |
| *Pisidium* sp. | 3 |
| *Anodonta* sp. | 2 |
| *Limnaea pereger* | 2 |
| Chironomidae | 3 |
| *Helobdella stagnalis* | 2 |

Animal material occurring only once: *Planorbis complanatus, Gammarus pulex, Asellus aquaticus, Plantambus maculatus.*

Plant material occurring only once: *Ceratophyllum* sp., *Elodea canadensis,* and *Ranunculus aquatilis* leaf.

*Hydropsyche angustipennis* being found in each bird and forming the major part of the contents. Parts of a small crayfish *Astacus pallipes* were found in one bird and in another Tufted Duck picked up dead by the Bradbourne Lakes in January 1963, less than a mile away from the river, most of its last meal consisted of crayfish.

Pochard *Aythya ferina*

A Pochard collected on the gravel pits was found to contain food consisting mainly of a filamentous algae and a few Chironomidae larvae.

Smew *Mergus albellus*

Two female Smew were collected in January 1963 from off the river and were found to contain a number of small trout *Salmo fario,* the longest of which was 14 cm.

Canada Goose *Branta canadensis*

Eight Canada Geese were collected in the Otford area between 1960 and 1963, four of which were found to be empty of food. Three of the others had fed mainly on the leaf, stem and roots of white clover *Trifolium repens* and to a lesser extent on grasses. One bird had fed exclusively on barley grains.

White-fronted Goose *Anser a. albifrons*

A bird shot in January 1964 in the Otford area contained a number of grasses, including the creeping bent *Argostis stolonifera* var. *palustris,* and creeping fescue *Festuca rubra.*

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# Part III. An appraisal of the planting programme, 1959-66

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**Summary**

The production of food (seed) and cover by plants, introduced in the course of management of the W.A.G.B.I.—Wildfowl Trust Experimental Reserve, was estimated in 1966. There were considerable differences between the yields of the sixteen species investigated, when food was assessed in terms of dry weight. In general, much higher yields could be obtained from agricultural crop species.

The amount of food produced was inadequate to support the winter population of wildfowl observed; the prime function of the reserve was to act as a roost in the vicinity of alternative feeding areas.

Considerable cover had been developed through planting, and appeared to be reflected in an increase in the breeding population. The moderate amount of food available may have been an important additional factor of the success of the reserve as a breeding station for wildfowl.

On the basis of results obtained, recommendations are made for short- and long-term planting programmes for similar areas.

**Introduction**

The establishment of wildfowl food and cover plants within the Kent Sand and Ballast Reserve was commenced in 1959. At that time, the reserve consisted of two gravel pits, both in active operation, with little or no marginal and submerged vegetation. The selection of plant species was based on results from the analysis of viscera of wildfowl shot in the immediate vicinity (Olney 1967). Planting has been carried out continuously since 1959, and has always reflected the results obtained from viscera analysis. In recent years, new species have been added which, although not necessarily of previous local importance to wildfowl, have been shown by Olney (1962, 1963a, 1963b, 1964) to be of general value to overwintering wildfowl in Great Britain. Wherever possible, planting to provide resting and loafing cover has incorporated species that are known to provide food also.

Perhaps the most difficult problem in

the development of gravel pits as wildfowl refuges lies in the steep banks and deep water which are generally encountered. Due largely to the co-operation of the owner, however, it has been possible to investigate various techniques for overcoming this problem. Since these techniques are often rather expensive to apply (Meikle 1967), it is important that they should be evaluated, so that the most efficient management programme can be immediately adopted following the instigation of new reserves of this nature. There can be little doubt that gravel pits will play an increasingly important role in the conservation of wildfowl, both in this country and abroad.

The effectiveness of many of the improvements has already been discussed by Harrison, Harrison and Olney (1962) and Harrison, Harrison and Meikle (1965). Some of the more recent modifications, such as the provision of small bays and low-lying areas for planting, have yet to become properly established. Since the area is a joint experimental reserve of the Wildfowl Trust and W.A.G.B.I., however, its progress will continue to be documented in the annual reports of these two organizations.

With vegetation now well established in and around the West Lake, and much of the East Lake also, it was considered that the summer of 1966 would be an opportune time for a critical analysis of the planting completed to date. Furthermore, during the second half of 1966, a new pit (the future North Lake) was excavated. This third sheet of water will be very different from the two existing lakes, mainly on account of its very shallow nature. It was important, therefore, that an assessment be completed in 1966, to permit a detailed analysis of the effectiveness of this additional feature in the future.

The vegetation within the reserve was investigated in two ways. First, the amount of wildfowl food produced by introduced plants (and by the naturally regenerated vegetation resulting from them) was estimated. Secondly, the banks and margins of each lake were examined with a view to evaluating the cover produced by different types of vegetation. The results of these studies have been presented in such a way as to provide some guidance to further planting elsewhere.

## Methods

### *Food production by introduced plants*

This investigation was simplified by the fact that successfully introduced plants only included those species whose prime food value has been shown by Olney (1962, 1963a, 1964b, 1965) to lie in their seed production. Production has been considered in terms of oven-dry (o.d.) weight, since this eliminates the highly variable water content of seeds, and may be readily reproduced for the purposes of comparative studies.

Seed production by species forming definite stands, such as reed-grass *Glyceria maxima* and amphibious bistort *Polygonum amphibium*, was calculated on the basis of stand area. Often, the various stages of seed formation overlapped, rendering direct measurement of total production impracticable. In such cases, the total number of inflorescences was estimated using quadrats, and by measurement of stand dimensions. The yield from ripe inflorescences was determined at a later date, to obtain an estimate of overall production. Allowances were made, where necessary, for losses during the intervening period. For example, several, or sometimes all, capitula within a single inflorescence of bur-reed *Sparganium erectum* died off before the seed had ripened.

Species not forming distinct beds or stands were dealt with as individual plants. The total number of flowering plants was counted, and a sample taken at the time of seed-ripening. Variation in ripening times of seeds within plants necessitated counting unripe seeds or capsules, with corrections made for subsequent changes in weight during ripening. In general, only large herbs and trees were measured in this manner, although the distribution of figwort *Scrophularia aquatica* was such that plants had to be considered individually. In the case of rush (*Juncus* spp.) clumps were counted according to diameter, and yields determined from samples of each size group.

The method of yield measurement may be inferred for each species from Table I. Owing to the very small quantities of material within the reserve, yields for bulrush *Schoenoplectus lacustris*, sea club-rush *Scirpus maritimus* and amphibious bistort were determined from stands in gravel and clay pits in the Slimbridge district. Birch (*Betula*) was not included in this investigation, although over a hundred seeding specimens were present; this was due to practical difficulties encountered in measuring seed production.

A number of seed collecting-boxes, similar to those described by Davidson *et al.* (1955), were placed beneath the canopy of a group of large alders, to provide an estimate of yield from trees older than those planted during the course of management.

*Cover*

The assessment of cover is, of necessity, somewhat subjective since its value cannot be readily determined. Existing vegetation, including that which had resulted from natural colonisation, was considered in terms of potential for nesting sites, and of value as feeding and resting areas for young birds. The former was taken as cover above water level, the latter as cover at water level, including that provided by overhanging branches.

The periphery of each lake was mapped in large scale (1:1,000); the amount of bank and water-margin cover was determined from this map with the aid of a mileage recorder.

**Results**

*Food production*

The mean plant or stand yields are listed for each species in Table I, together with overall yields for the reserve and an indication of seed size. The yields of a number of species not found or not seeding within the reserve, including certain agricultural crops, have been added to the table for comparative purposes.

The gross yield, 71 kgm., was perhaps lower than expected, but it should be remembered that only very narrow strips of land and water margin were suitable for planting. The yield is equivalent to rather less than two hundredweight of fresh cereal grain, which could be grown in about one twentieth of an acre, or recovered from about one acre of stubble.

The highest individual plant yields were obtained from rushes and great water dock *Rumex hydrolapathum*. Since these species occur towards opposite ends of a broad range of seed sizes, it is clear that size of seed itself is not necessarily an indicator of yield.

Among the species in which seed production was measured in relation to ground area occupied, persicaria or redleg *Polygonum persicaria* showed an outstandingly high yield, comparable with that of the related species, buckwheat *Polygonum fagopyrum*. The latter is commonly cultivated in North America as a wildfowl food plant. All other species listed have yields less than 50 gm./m². (about 4 cwt./acre).

It is interesting that rather low yields

**Table I. Seed yields.**

| *Species* | *Mean wt. of single seed (gm)* | *Mean seed yield (gm) /plant* | */m²* | *Wt. of seed produced (gm) West Lake* | *East Lake* | *Total* |
|---|---|---|---|---|---|---|
| Plants within the reserve | | | | | | |
| *Alnus glutinosa* Ht: <4m. | 0.00076 | 8.7 | — | 130 | 0 | 130 |
| Ht: 4-8m. | 0.00076 | c.250 | — | c.5,250 | 0 | 5,250 |
| (Ht: >8m.) | 0.00076 | (730+) | — | 0 | (c.20,000) | (c.20,000) |
| *Carex riparia* | 0.00145* | — | 10.2 | 0 | 0 | 0 |
| *Glyceria maxima* | 0.00050 | — | 20.9 | 310 | 300 | 610 |
| *Juncus effusus*** | 0.000017 | 29.2 | — | 1,450 | 15,780 | 17,230 |
| *Juncus inflexus*** | 0.000016 | 39.0 | — | 2,040 | 11,630 | 13,670 |
| *Luzula sylvatica*** | 0.00124 | 31.0 | — | 0 | 160 | 160 |
| *Polygonum amphibium* | 0.0033 | — | 6.0 | 6 | 15 | 21 |
| *Polygonum persicaria* | 0.0021 | — | 113.0 | 0 | 8,140 | 8,140 |
| *Potamogeton crispus* | 0.0035* | — | 40.2* | 0 | 0 | 0 |
| *Rubus fruticosus* agg. | 0.0022 | — | 38.7 | 4,060 | 2,400 | 6,460 |
| *Rumex hydrolapathum* | 0.0044 | 183.0 | — | 4,560 | 0 | 4,560 |
| *Rumex* spp. (others)** | 0.00081 | 8.7 | — | 3,270 | 3,380 | 6,650 |
| *Scirpus maritimus* | 0.0030* | — | 11.0* | 1 | 0 | 1 |
| *Schoenoplectus lacustris* | 0.00102* | — | 16.7* | 8 | 4 | 12 |
| *Scrophularia aquatica*** | 0.000083 | 4.3 | — | 280 | 6,970 | 7,250 |
| *Sparganium erectum* | 0.0091 | 3.0 | — | 950 | 150 | 1,100 |
| *Total* | | | | 22,315 | 48,929 | 71,244 |
| Other species | | | | | | |
| *Alisma plantago-aquatica* | 0.00039 | 28.8 | — | | | |
| *Eleocharis palustris* | 0.00091 | — | 38.4 | | | |
| *Potamogeton natans* | 0.0028 | — | 24.5 | | | |
| Agricultural crops | | | | | | |
| Cereals (normal harvest) | 0.042 | — | c.500 | | | |
| „ (stubble waste) | 0.042 | — | c.25 | | | |
| Buckwheat | not known | — | c.150 | | | |

* Data obtained outside reserve. ** Self-introduced. ( ) Not included in totals.

were observed in alder *Alnus glutinosa* and bur-reed, species which featured prominently in the viscera analyses of locally-shot birds, described in Part II. It should be noted, however, that the 1966 seed crop in both of these species was exceptionally poor, compared with those observed in previous years. Alder is known to be somewhat periodic in mast yields, although actual periods of high production may not be the same in all plants. Analysis of the contents of seed collecting boxes, placed under three alder trees each about 10 m. in height, indicated a ground yield of 3.6 gm./$m^2$ over an area of approximately 450 $m^2$, i.e., a total yield of 1.62 kgm. or an average of 0.54 kgm. per tree. The boxes used in this investigation were recovered on 12th January, 1967; samples of "cones" collected on this date showed that about 26 per cent of the total yield had yet to be dispersed. Thus, the average tree yield was at least 0.73 kgm. (not including an unknown quantity of seed dispersed beyond the range covered by collecting boxes). This is almost treble the estimated yield of the oldest trees planted during the course of management.

It should be noted that no rushes had been deliberately planted in the reserve. The yields given in Table I resulted entirely from self-introduced and regenerated plants.

Some idea of the relative ease with which different species may be established in this type of habitat may be obtained from Table II, in which the numbers planted since 1959, and the numbers or area of stand established by 1966 are given. Through reference to Tables I and II together, it is possible to determine which species are most likely to be of immediate benefit to a new reserve; long term effects are less predictable, since even quite poor initial results could lead to extensive areas of established vegetation. It should be noted that, in certain cases, there is a discrepancy between the total yield quoted in Table I, and the product of plant yield (Table I) and number established (Table II). This is due to the inclusion of non-seeding plants in Table II.

**Table II. Results of planting.**

| *Species* | *Number planted* | *Establishment* *Number* | *Area ($m^2$)* |
|---|---|---|---|
| *Alnus glutinosa* (Ht: >1m.) | 2066 | 979 | — |
| *Atriplex patula* | 55 | — | 3.5 |
| *Betula* spp. (Ht: >1m.) | 1036 | 470 | — |
| *Carex riparia* | 30 | — | 116 |
| *Ceratophyllum demersum* | 16 | — | >10,000 |
| *Chara* sp. | 23 | Not found | |
| *Eleocharis palustris* | 12 | — | 0 |
| *Glyceria maxima* | 526 | — | 29 |
| *Hippuris vulgaris* | 55 | 0 | — |
| *Juncus effusus* | 0 | 589 | — |
| *Juncus inflexus* | 0 | 351 | — |
| *Luzula sylvatica* | 0 | — | 5.2 |
| *Phragmites communis* | 55 | — | 0 |
| *Polygonum amphibium* | 41 | — | 3.5 |
| *Polygonum hydropiper* | 57 | — | 0 |
| *Polygonum persicaria* | 22 | — | 72 |
| *Potamogeton crispus* | 0 | — | >1000 |
| *Potamogeton obtusifolius* | 0 | — | >50 |
| *Rorippa nasturtium-aquatica* | 100 | 0 | — |
| *Rubus fruticosus* agg. | 192 | — | 167 |
| *Rumex hydrolapathum* | 54 | 25 | — |
| *Rumex* spp. (others) | 0 | 820 | — |
| *Scirpus maritimus* | 200 | — | 0.1 |
| *Schoenoplectus lacustris* | 46 | — | 0.7 |
| *Scrophularia aquatica* | 0 | 1680 | — |
| *Sparganium erectum* | 1425 | 3080 | — |
| *Zannichellia palustris* | 4 | — | 100 |

Numbers of other species planted: *Acer platanoides* (4), *A. pseudoplatanus* (10), *Crataegus monogyna* (101), *Fraxinus excelsior* (2), *Iris pseudacorus* (28), *Larix leptolepis* (184), *Lupinus arboreus* (6), *Pinus sylvestris* (406), *Populus* spp. (35), *Prunus avium* (6), *Pseudotsuga Douglasii* (19), *Quercus robur* (4), *Q. rubra* (4), *Salix atrocinerea* (6), *Salix* spp. (259), *Sorbus aucuparia* (5), *Thelycrania sanguinea* (23), *Ulex europaeus* (37).

*Cover*

The shoreline of the more mature West Lake was 1,395 m. long, of which 987 m. (71 per cent) were backed by bank cover suitable for nesting or affording a screen, and 735 m. (53 per cent) carried margin cover. The most extensive and dense bank cover usually comprised blackberry *Rubus fructicosis* agg., often with raspberry *R. idaeus* and elder *Sambucus nigra*, although stands of willow herb *Epilobium hirsutum* also provided excellent cover during summer. Alders and willows (*Salix* spp.) situated near the water's edge provided both bank and marginal cover. Other marginal cover consisted mainly of bur-reed, which had spread rapidly from planting centres, with some reed-grass, pond-sedge *Carex riparia* and occasional rushes.

The shoreline of the East Lake was 2,900 m. long, with 1,146 m. (39 per cent) bank cover and 800 m. (28 per cent) marginal cover. These low proportions of cover reflect the more juvenile nature of this pit, which is still being excavated. Blackberry and alder provided much of the bank cover. In contrast to the West Lake, rushes were the most abundant plants affording marginal cover, while bur-reed, reed-grass and pond-sedge assumed only local importance.

*Discussion*

The primary object of this investigation was to determine the extent to which planting had contributed to the establishment and maintenance of the wildfowl population in the reserve, described by Harrison, Harrison and Meikle (1967). It is, however, very difficult to obtain an accurate assessment of the value of vegetative components in establishing the population. Certainly, the development of cover was followed by an increase in the breeding population, as indicated by the steady rise in the number of Mallard broods over recent years.

The establishment of a large number of trees and shrubs, including species other than food plants, led to a reduction in general disturbance at the water's edge, and was possibly an important factor in the steady build-up of the winter population.

In order to determine the value of planting food species, it is first necessary to reassess calculated yields in terms of wildfowl maintenance potential. There is, as yet, no precise information relating to the daily food requirements of free-living wild-fowl. Jordan (1953) observed an average daily intake of 82 gm. (0.18 lb.), fresh weight, of small grains during winter in captive drake Mallard. Intake by females was rather less. It is difficult to extrapolate this figure for the requirement of a wild Mallard, which must be highly dependent on environmental factors such as temperature, disturbance and flight distances, and on season. For the purposes of assessing carrying capacity, insofar as it is affected by food, Jordan's figure (above) has been accepted as the minimum likely requirement of each duck. It seems almost certain that the natural requirement of Mallard is higher than this. However, any underestimation is offset by the fact that the Mallard, the heaviest duck under consideration, is not the only species present. Smaller species presumably have lower requirements (Jordan found that Blue-winged Teal consumed only 40% of the weight of small grain taken by Mallard). It is impossible to calculate precisely the oven dry weight equivalent for the mixed grains fed in Jordan's experiments. To compensate further for the higher requirements of wild birds, therefore, the same figure (82 gm.) has been adopted for expression as oven dry weight.

The calculated seed production by introduced plants for the two lakes in 1966 was 71 kgm. (157 lb.). From the above assumption, this may be regarded as equivalent to about 870 duck days. In addition to the calculated yield, however, a considerable amount of seed was produced by birch, several large oaks and many long established alders. Also, an unknown quantity of seed was brought into the West Lake by the River Darent. Yields from submerged plants were not measured; the extensive beds of curled pondweed *Potamogeton crispus* and hornwort *Ceratophyllum demersum* did not, in fact, contribute significant quantities of seed. The reasons for this appeared to be (i) excessive water depth, in the case of the former, and (ii) grazing of emergent flowers and seed heads of both species by resident geese during their flightless period.

All species of wildfowl frequenting the reserve exploit, to a greater or lesser extent, food sources not considered in this paper. Tufted Duck, for example, rely mainly on aquatic animal life (Olney 1963b, 1967), whilst Pochard often feed extensively on the seeds of submerged plants (Olney, pers. com.). No consideration has been made of the feeding habits of the relatively large population of Greylag and Canada Geese, which, besides grazing in surrounding fields, graze extensively on submerged plants during the summer.

It is important to consider the habitat and siting of plants when assessing their importance as a wildfowl food source. Blackberry scrub, for example, occupied considerable areas, yielding a relatively large quantity of seed. Much of this food probably remained unexploited by wildfowl, after falling into dry litter in sometimes impenetrable areas. In contrast, amphibious bistort, with only one seventh the yield of blackberry, is capable of extending into quite deep water (at least 2 m.). All seed falls into water or mud, where it may be utilised by wildfowl. It was not always possible to determine what proportion of food produced was actually available to wildfowl, since this depended on water level, the action of rainfall on banks, and the extent to which wildfowl feed on dry ground. It may be assumed that most of the seed of marginal species was available; however, the fate of seed produced by plants growing on the banks is open to question. Much of the alder seed ultimately fell into water, and accumulated with marginal debris. A sample of such debris, taken from a small pool near the East Lake in January, 1967, was found to include 15 per cent by weight (o.d.) alder seed.

Another characteristic that requires consideration is the buoyancy of seeds. Those of dock *Rumex* spp. sink immediately, whilst seed of birch and wych elm *Ulmus glabra* require several days of soaking before they sink (Pollard, unpublished). Praeger (1913) observed that seeds of bur-reed remain buoyant for at least a year. Clearly, the duration of buoyancy has an important bearing on the distribution of seed as food, and indeed, on the distribution of the plant species itself.

The availability of seed also depends on the period of dormancy before germination. Seeds of marsh yellowcress *Rorippa islandica*, submerged in August, were found to germinate almost immediately; seeds of sea club-rush, on the other hand, showed very low rates of germination even after a year (Pollard, unpublished).

Some seed species may be available or palatable to only a limited number of wildfowl species. Thus, the seed of curled pondweed may be dispersed into any depth of water up to about 2 m., but only in depths up to about 40 cm. would they be generally available to dabbling duck. Diving duck such as Pochard may take seed at any depth within the tolerance range of this plant. Size of seed may also be a critical factor in its utilisation. Seeds of bur-reed are sufficiently large to be selected and ingested as individual items. Seeds of soft rush *Juncus effusus*, weighing about 1/60,000 gm. each, are obviously too small to be considered individually by any duck. Nevertheless, two Teal, shot by the author in December, 1965, from a pack of about 150 birds on an estuary in Wales, contained about 4 gm. (o.d.) each of seeds of this species, i.e. about one quarter of a million items. Similarly, Olney (1963a) found an estimated 73,000 seeds of sharp-flowered rush *Juncus acutiflorus* in the gullet of a single Teal shot in Westmorland. It seems likely that these birds had been dibbling almost indiscriminately around the margins of a flash or ditch, where seeds had accumulated through wind and wave action. In view of the comparative rarity of rush seeds in wildfowl viscera, however, it is thought that these plants are only of importance in the absence of other species, i.e. in rather oligotrophic habitats.

Assessment of seed production in terms of dry weight alone does not take into account the nutritional values of the different foodstuffs. Even under controlled experimental conditions, these values are difficult to establish. With highly mobile subjects such as wildfowl, nutritional values may be almost impossible to determine under field conditions. It is believed, however, that the variability in dry weight yield, as observed among the species considered in this investigation, is likely to be a more important factor of their value as food sources than the variability in nutritional values of standard quantities.

It must be emphasised that the yields for each species given in this account are, in general, as determined within the reserve during 1966. Considerable deviation from these values may occur within the same species in different localities or in different seasons; environmental and climatic factors are known to affect yield. For example, Hunt and Lutz (1959) showed that water depth had a profound effect on the seed yield of curled pondweed. It is important, therefore, that the data presented in Table I are not extrapolated too rigidly to other localities.

The evaluation of the importance of food production within a small artificial reserve such as that studied is complicated by the movement of birds to other feeding grounds. There was a large discrepancy between calculated and observed carrying capacity (if, indeed, actual capacity had been attained). It was shown by Olney (1967) that a great deal of food was available to and was taken by wildfowl in the near vicinity of the reserve. Furthermore, there was considerable

variation in winter feeding patterns from year to year, depending to a large extent on the climatic conditions during the previous summer. It would appear that the amount of food within the reserve, and particularly that derived from introduced plants, could not maintain the winter populations described by Harrison, Harrison and Meikle (1967). This is not to say, however, that planting wildfowl food species had been of no practical value. An abundant supply of vegetable food during the second half of summer is likely to be of considerable importance to a breeding population. Furthermore, it is possible that the availability of food in autumn, albeit limited, encouraged overwintering birds to establish themselves in the reserve, which in turn provided a safe roost in the vicinity of alternative feeding grounds. In this respect, increases in the winter duck population may not reflect proportional increases in food production, although certain species, notably Tufted Duck and Pochard, do tend to act as indicators of the productivity of inland freshwater habitats.

The original planting programme was, as stated above, based principally on the findings of viscera analysis. At that time, little was known of the value of each species; this investigation has shown that food plants vary enormously in their gross food production. Certain species, notably alder, cannot be expected to contribute significantly until they have been established for some time, approximately eight years in this case. However, there are species which offer considerable scope for increasing the productivity of wetlands, with respect to wildfowl, within a much shorter period. It is recommended that special efforts should be made to established the following: persicaria (an annual species which rapidly colonises open ground), great water dock, blackberry, amphibious bistort (which, despite low yields, will spread rapidly into quite deep water), reed-grass, and curled and broad-leaved pondweed. The latter two species are most suitable for shallow waters, and could be augmented by other pondweeds, such as fennel-leaved *Potamogeton pectinatus*. These, together with alder, are considered to be among the most useful vegetative components of smaller wildfowl reserves, producing not only considerable quantities of food, but also providing a variety of cover.

In conclusion, it is suggested that the high winter wildfowl population of the Kent Sand and Ballast Reserve has been due mainly to the protection afforded to birds, in the vicinity of feeding grounds. Food production, on the limited scale that has thus far occurred within the reserve, is more likely to have affected the summer population, especially breeding birds. In view of the large number of food plants yet to attain maturity (particularly alder) this situation may be modified in the future.

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# Part IV. Expenditure for habitat improvement

A. MEIKLE

**Summary**

Minimum expenditure involved in the improvement and management of the reserve is itemised for the period 1956-1966. Of a total outlay of £3,945, £3,230 has been assumed by the owners of the Kent Sand and Ballast Company, and £715 was spent by wildfowlers whilst collecting data and establishing plants and wildfowl in the reserve.

An estimate of the basic cost of converting the original gravel pits into a functional experimental wildfowl reserve is given here as it shows just how great our debt of gratitude is to the Kent Sand and Ballast Company in bearing so large a share of the financial burden of this project.

Among the first improvements to be made was the excavation of shallow pools along the margins of each lake. Six pools have been made, each taking approximately three hours to prepare, at a minimum cost of £1 10s. per hour for labour and equipment. Total cost £27.

After excavations in the East lake, it was found necessary to construct spits in some regions, otherwise a great deal of potential loafing and territorial areas would have been lost. Cost of construction varied according to size and location of spits and weather. Seven smaller spits, each taking about ten hours at £3 per hour were made with *in situ* material. Two large spits involved transportation of material each taking 40 hours to complete at a cost of £5 10s. per hour. Total cost of the nine spits: £503, after making allowance for routine work, which would have been done in any case.

An island, carrying several trees, was left in the East lake at a total cost, including 1,800 cu. yds. of saleable material and extra expenditure involved in adjacent excavation, estimated at £800.

Artificial raft islands have been constructed using steel tanks worth at least £10 each. The four rafts, which have proved to be of immense value as nesting sites for geese and great-crested grebes, cost a total of £200, whilst a further £50 has been spent on maintenance.

Of the 4,000 trees now established within the reserve 1,500 have been planted by the company, at an estimated cost of 8d. each. Total cost £50.

Since 1960, a full-time groundsman has been employed for general maintenance within the grounds. Total wages, etc., have amounted to £4,800, one third of which may be attributed to the reserve itself (the company and fishing interests assume the remainder). Total cost £1,600.

This gives a total cost to the reserve which has been borne by the company over the seven years ending December 31st, 1966, of £3,230. What has this very considerable sum achieved? The wildfowl count results, given by Harrison, Harrison and Miekle (1967), speak for themselves. But far more has been achieved than can be analysed in a paper such as this. The reserve has served as a proving ground for many new techniques of management, and will continue to do so, we hope, for many years to come. Valuable information of wide application has been obtained through being able to study wildfowl in relation to their environment at close quarters. And by no means last nor least, the Kent Sand and Ballast Company have shown that gravel extraction need not lead to dangerous and useless tracts of waste land. They have provided a shining example of how those responsible for industrial development and for wildfowl

conservation can combine together with spendid results; indeed, it is widely acknowledged as such by naturalists, scientists, and sportsmen, both in this country and abroad.

In view of the fact that naturalists are beginning to realise that they are going to have to contribute to the cost of conservation and for the privilege of being able to enjoy such facilities as bird watching, it is perhaps not irrelevant to conclude this section with the cost, which has been borne privately in the management of this reserve up to the end of 1966.

Over the 11 years, the average mileage covered has been estimated at 2,000 a year, at a cost of £220. Some 2,500 trees and 2,800 other plants have been put in. Basing the cost of these at 8d. each, this gives a total of £176. The cost of obtaining and rearing a duck to the time of release has been estimated at 10s. In all, 614 Mallard and 24 Gadwall have been reared at a cost of £319, to give a total cost of £715.

**Reference**

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# Population changes and mortality of the Mute Swan in Britain

M. A. OGILVIE

**Summary**

An index based on winter counts shows that the population of the Mute Swan in Britain underwent a 25% decline between the years 1960-61 and 1964-65, following a peak in 1959-60. In the last three years the numbers have remained constant in the country as a whole, though an increase has taken place in the north and a decrease in the midlands and west. There is no migration and little movement of swans other than following watercourses. The average annual mortality for swans ringed when under one year old, excluding recoveries in year of ringing, is 40.5%, and for birds ringed when over one year 38.5%. The cold weather in the winters of 1962 and 1963 increased both mortality and recovery rates, but mortality was lower than average in 1963-64. There is possibly greater survival in the third and fourth years of life than in the first two. Overhead wires are responsible for over 44% of Mute Swan recoveries where the cause of death is known: young birds are no more vulnerable to this hazard than older ones. Other causes of death include oiling, disease, cold weather, shooting and fighting.

## Introduction

It is only in the last ten years that the Mute Swan *Cygnus olor* has been subjected to extensive scientific study in Britain. With its history obscured by centuries of semi-domesticity and with the belief that all swans belonged to the Crown or to the Livery Companies still widespread, most ornithologists tended, like the general public, to regard the Mute Swan as a tame bird of park lakes and urban rivers whose only claims to fame were fidelity and long life.

The first complete census of the Mute Swan in Britain, organised by the British Trust for Ornithology, was made in the summer of 1955, with a partial repeat the following year. Campbell (1960) gave the results of this census and estimated the total population of England, Wales and Scotland to be between 18,000 and 19,000 birds, with evidence that it was increasing. Further reports of increases led to a second census in 1961. The Wildfowl Trust, co-operating with the British Trust for Ornithology, conducted a ground and aerial survey in eighteen counties that the earlier study had shown to be the most populous. This partial census revealed (Eltringham 1963) that the population had reached a peak in 1959 and had begun to decline. As well as the summer counts, Eltringham used the winter counts of swans, available in the files of the National Wildfowl Count Scheme, to produce a winter index of population which could readily be continued in succeeding years. The first section of the present paper brings that winter index up-to-date and examines the recent trends.

In 1960, as part of the renewed investigation, ringing was begun on a large scale. The ringing of Mute Swans had previously been handicapped by the lack of a really suitable ring. A new, stronger and longer-lasting ring was introduced that year but its price discouraged many ringers. The Wildfowl Trust, therefore, undertook to supply rings free and provided a massive boost. Up to the end of 1959 less than 1,000 Mute Swans had been marked, by the end of 1965 over 14,000. In 1963 it was estimated that in the south of England about one in four birds were ringed and in some areas the proportion has approached 100% The recovery data from this mass of ringing is of a very recent character, but thanks to a recovery rate higher than expected there is a very considerable volume of recoveries already available. These provide the material for the other three sections of this paper, on movements, mortality and causes of death.

## Population changes as shown by winter counts

Eltringham (1963) used indices to compare the winter counts of Mute Swans from year to year. Under the National Wildfowl Count scheme, bird-watchers make a count on their local water in the middle of each month from September to March. By pairing the monthly counts in one winter with the monthly counts on the same water in any other winter, it is possible to calculate a ratio between the two years. Eltringham designated a "Master" season with which all other seasons were compared. The level of population in the Master season was equated to an arbitrary 100. The annual indices were then built up from counts on about 300 waters throughout Britain.

One modification of the above method has been introduced which enables a rather larger sample to be incorporated.

Although the Master season was selected so that it included the maximum number of places counted, inevitably there are a number which were for some reason missed out. Although counts may be available for these places in other years, they could not be compared with the Master season and therefore were excluded from the indices. To overcome this restriction a single Master season has not been used in the present analysis, but each winter is compared directly with the one preceding it. The resultant ratios are then adjusted to a suitable base line. Similarly, counts which have only started in the last few years can be included. Using this process the sample size available for the indices has been increased to over 600 waters carrying up to 10,000 birds. It also avoids the fall-off in the number of pairings, and thus the total number of swans available, the further the season is away from a fixed Master season. The indices arrived at by the two methods differ only slightly, but the new method has the advantage of representing a larger proportion of the total population.

The indices probably reflect changes in the non-breeding section of the population more accurately than in the breeding part. Almost all the large wintering flocks in the country are covered by the National Wildfowl Count Scheme, together with a great many regular small flocks. Although many resident pairs are counted, large parts of the normal Mute Swan breeding habitat, namely stretches of river and canal, are not included because they do not hold the ducks at which the count scheme is aimed. However, breeding success in the previous summer is probably reflected in each winter's index because most cygnets leave their parents during the winter and join a non-breeding flock.

The annual indices for Britain from 1954-55 to 1965-66 are shown in Table I and Figure 1. The population increase and subsequent levelling out noted by Eltringham has been followed by a sharp decrease of about 25% and then a second levelling out for the past three seasons. The decrease is largely attributable to the cold winters of 1962 and 1963. The effects were very marked and further evidence will be given in the section on mortality. Another probable cause is the high proportion of birds dying from hitting overhead wires and other obstructions, both of which have been increasing in number and extent in recent years. This too will be dealt with in a later section.

Figure 2 shows the regional variations within the national picture over the last six seasons. Variations before this were only slight and no trends were apparent. Scotland and northern England south to Yorkshire and Lancashire comprise the

**Table I. Annual indices for Mute Swans in winter in Britain, based on the National Wildfowl Counts.**

| *Winter* | *No. of comparisons made* | *No. of swans counted* *Slave (= Col. 1)* | *Master (= Col. 1 less one year)* | *Ratio* | *Index related to 1957-58 = 100* |
|---|---|---|---|---|---|
| 1954-55 | — | — | — | — | 76 |
| 1955-56 | 1450 | 19,386 | 15,358 | 126 | 96 |
| 1956-57 | 1810 | 24,096 | 22,314 | 108 | 103 |
| 1957-58 | 1853 | 23,565 | 24,347 | 97 | 100 |
| 1958-59 | 1912 | 26,392 | 25,562 | 103 | 103 |
| 1959-60 | 1797 | 23,642 | 23,182 | 102 | 105 |
| 1960-61 | 1871 | 23,892 | 25,813 | 93 | 98 |
| 1961-62 | 1846 | 22,409 | 22,635 | 99 | 96 |
| 1962-63 | 1811 | 19,239 | 22,451 | 86 | 83 |
| 1963-64 | 1761 | 18,984 | 20,296 | 94 | 77 |
| 1964-65 | 1600 | 20,159 | 19,753 | 102 | 79 |
| 1965-66 | 1556 | 20,743 | 21,089 | 98 | 78 |

Note: The reduced sample for 1955-56 is because the previous season, here being used as the "Master", was the first one in which Mute Swans were included in the National Wildfowl Count Scheme and the recording of them was not made universal until the next year. The gradual reduction apparent over the last four seasons of the run is partly a reflection of the reduced population because waters from which swans have entirely disappeared are not included after two blank seasons, and partly due to the dropping from the count scheme, which is primarily for recording the numbers of ducks, of those waters which carry only a very few of the latter plus small numbers of swans.

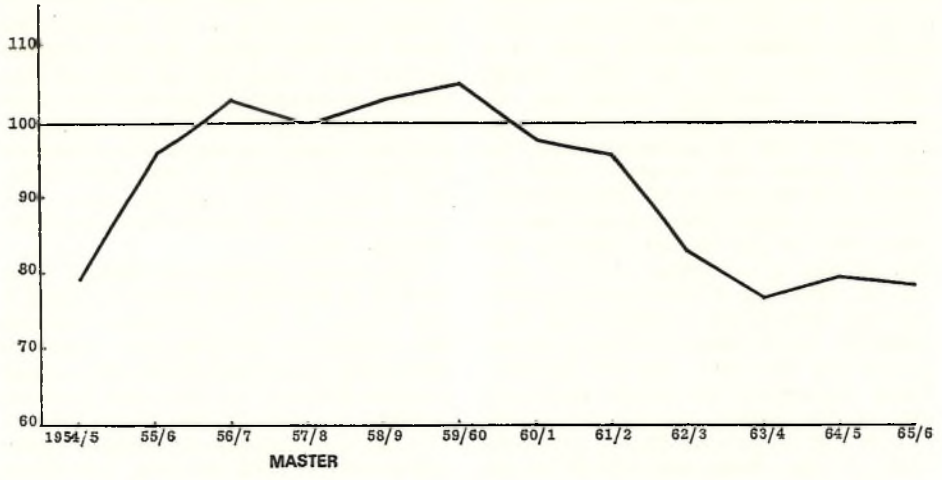


**Figure 1. National indices for the Mute Swan in Britain, 1954-55 to 1965-66.**

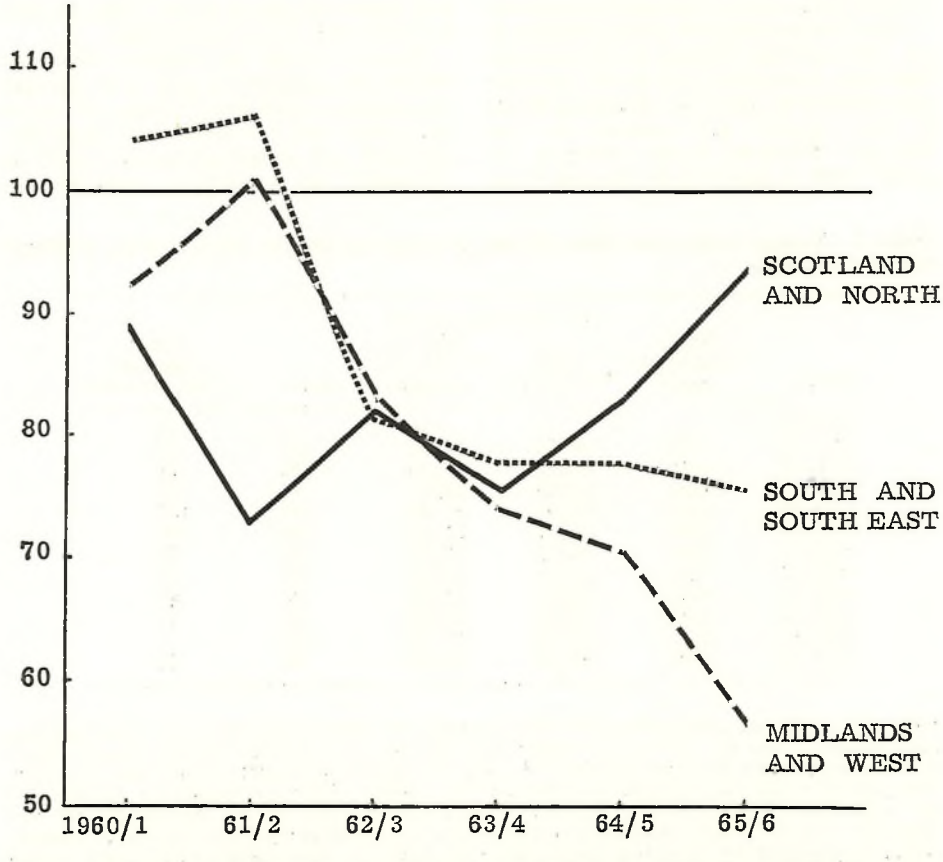


**Figure 2. Regional indices for the Mute Swan in Britain, 1960-61 to 1961-62.**

first region, which contains about 35% of the birds covered by the winter counts; the Midlands, Wales and the south-west counties form the second, holding about 20%; the south coastal counties from Dorset eastwards, the Home counties and East Anglia north to Lincolnshire are the third with 45%. The ringing evidence considered later indicates that less than 2.5% of birds had crossed a boundary between any two of these regions during the six years.

The regional variations shown in Figure 2 are most marked in 1961-62 and in 1964-65 and 1965-66. The index for Scotland and the north of England shows a sharp drop in 1961-62 but a slight rise in 1962-63 when the other regions had great reductions. In 1961-62 Scotland suffered from severe weather for most of January and February while the rest of Britain had just a short, though very cold, spell at the beginning of January. In 1962-63, while the south suffered its worst winter of the century, Scotland, at any rate, had no worse weather than the previous year, and with much less snow in some areas. Although this is less true of Yorkshire and Lancashire, these counties only contributed about 10% to the regional index. Thus for the two winters the regional indices appear to reflect the relative severity of the weather.

The recent increase in the index for the north and the sharp drop in that for the Midlands and west are rather baffling. Just as the reasons for the country-wide trends between 1955 and 1961 remain obscure, so do these differences in regional levels, with the national index stationary. Scotland and the north may have recouped the losses sustained in the hard winters. The birds in the south and east have not managed such a recovery, perhaps because of poor breeding success, but are maintaining a steady lower level. The drop in the Midlands and west, which is nearly comparable to that sustained in the hard winters may be partly explained by a series of poor breeding years.

**Movements of ringed Mute Swans**

Ringing of Mute Swans in the last six years had produced 2,156 recoveries by 1966. Of these 1,513 (70.2%) had travelled less than ten miles from the place of ringing. The other 643 birds had moved as follows:

| | | |
|---|---|---|
| 10 - 20 miles | 385 | (17.9%) |
| 21 - 30 miles | 125 | (5.8%) |
| 31 - 50 miles | 87 | (4.0%) |
| over 50 miles | 46 | (2.1%) |

In 423 of the 643 recoveries the place of ringing and that of recovery were situated on the same river or canal. A further 101 birds moved between two places on the coast, and only 119 (18.5%) had crossed a watershed between two river systems. The suggestion is that nearly all journeys made by Mute Swans in Britain are confined to routes following watercourses.

The recaptures of ringed birds give a very similar pattern of rapidly decreasing numbers with increasing distance. However, because the reporting of local recaptures by ringers is known to be far from complete, it has not been possible to treat them in a systematic way in this investigation.

Since so little movement within the country is shown it is not surprising that there are no regular migrations overseas of British birds. Small influxes of foreign birds into south-east England have occurred during periods of very severe weather (Harrison and Ogilvie 1967).

**Mortality of Mute Swans estimated from ringing results**

Ringing of Mute Swans reached worthwhile annual totals during a period of population decline and much of the data is of such a recent nature that its use for mortality calculations is subject to severe limitations. There is the added complication that two spells of hard weather, in early 1962 and 1963 undoubtedly resulted in markedly different mortality in those years. However, it is worth applying Haldane's (1955) formula to discover the average mortality that has occurred over the six year period both for the birds ringed as juveniles and for those ringed at one year old or older. It is unfortunate that ageing Mute Swans after the second autumn of their life is an uncertain business. For the purposes of the analysis the juvenile class has been restricted to those ringed as juveniles or as first year birds before the 30th June in the summer following their rearing. This naturally means that the "adult" class must include a proportion of birds in their second and third years which may have differing mortalities from older birds.

Tables II and III set out the recovery data for birds ringed, respectively, under and over one year of age. The ringing periods run from 1st July to 30th June. The surprising result is obtained that the mortality of the first year birds is only slightly higher than that for older birds, and the difference is not significant. In other ringing studies birds in their first year have invariably been shown to be

more vulnerable than older ones. Indeed on all counts this is to be expected. In the present study a bias is introduced in that swans cannot be ringed (because the leg is too small) until about three months old. The known high mortality of young cygnets (Reynolds 1965, Eltringham 1966) is therefore not reflected in the present results. Furthermore it is probable that the proportion of non-breeders in the present sample is high, since they form the large flocks on which ringers concentrate to get the best return for their expenditure of effort. The more detailed study of Perrins and Reynolds (1967) has shown that mortality for breeding birds was about 20% whereas for non-breeding immatures the figure was about 40%, similar to the present results.

As pointed out at the beginning of this section, there are a number of reasons which prohibit a detailed statistical treatment of the recovery data at present. However, although this will not be possible for another five or ten years, there are already some points of interest concerning differences of time-specific and age-specific mortality which can be extracted from the recovery series given in Tables II and III.

Are there any significant variations between the mortality in different seasons? Any recovery series may be considered as the resultant of three factors—a constant mortality-rate, a reporting factor and an "annual factor" which may modify one or both of the others. In most calculations of mortality based on recoveries it has been usual to make the assumption that the likelihood of a ring being reported when found does not vary importantly from year to year or from place to place. The validity of this assumption in the case of the Mute Swan has yet to be verified. Supposing it to be justified, a model for the recovery series can be constructed in which successive terms in the series for birds ringed just prior to year 0 are proportional to $k_0d$, $k_1ds$, $k_2ds^2$, $k_3ds^3$ . . . , where $k$ represents an annual factor, $d$ the (constant) death rate and $s$ ($= 1-d$) the constant survival rate. Proceeding in this way for the six year-class samples a table of the expected numbers of recoveries in the years $n = 0, 1, 2, \ldots$ can be compiled, and compared with the numbers actually obtained.

**Table II. Mortality of Mute Swans ringed when under one year old.** The ringing and recovery periods run from 1st July to 30th June, and recoveries in the same period as that of ringing are omitted.

| *Ringing periods* | *Survival after first 1st July after ringing, in periods* | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | total |
| 7/1959 - 6/1960 | 7 | 4 | 7 | 1 | 1 | 2 | 22 |
| 7/1960 - 6/1961 | 55 | 34 | 17 | 11 | 11 | | 128 |
| 7/1961 - 6/1962 | 65 | 27 | 18 | 11 | | | 121 |
| 7/1962 - 6/1963 | 57 | 40 | 13 | | | | 110 |
| 7/1963 - 6/1964 | 44 | 30 | | | | | 74 |
| 7/1964 - 6/1965 | 59 | | | | | | 59 |
| *totals* | 287 | 135 | 55 | 23 | 12 | 2 | 514 |

*Average annual mortality = 40.5± 2.86%*

**Table III. Mortality of Mute Swans ringed when over one year old.**

| *Ringing periods* | *Survival after first 1st July after ringing, in periods* | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | total |
| 7/1959 - 6/1960 | 39 | 23 | 32 | 4 | 0 | 6 | 104 |
| 7/1960 - 6/1961 | 122 | 92 | 32 | 30 | 20 | | 296 |
| 7/1961 - 6/1962 | 152 | 69 | 42 | 42 | | | 305 |
| 7/1962 - 6/1963 | 103 | 60 | 45 | | | | 208 |
| 7/1962 - 6/1964 | 45 | 34 | | | | | 79 |
| 7/1964 - 6/1965 | 41 | | | | | | 41 |
| *totals* | 502 | 278 | 151 | 76 | 20 | 6 | 1033 |

*Average annual mortality = 38.5± 1.84%*

Since the calculations of $\hat{s}$ for the data of Tables II and III separately lead to very similar values, it seems best to increase the sample size by combining the two tables yielding $\hat{s} = 61.8 \pm 2.2\%$. Table IV sets out the expected seasonal recovery totals using the procedure outlined above. Only two of the calculated seasonal survival rates depart importantly from the mean value for all years. In 1962-63 survival was lower (54.4%) and in 1963-64 it was higher (66.8%).

Variations in survival with age can be investigated by an analogous procedure. They used the number of recoveries in the hard winter period of birds ringed the previous year, as a proportion of the total number ringed that year. Extending this method the recovery rates have been calculated for three-monthly periods for swans ringed in each year from 1960-61 to 1964-65. These rates range from 5.0% in periods immediately after ringing down to 0.2% in the periods four or more years after ringing. Table VI sets out the sums of the first and second year recovery rates in each quarter for all age-classes.

When considering the effect of the 1962-63 hard winter on the Mute Swans of England, Boyd and Ogilvie (1964) showed that some differential mortalities could be demonstrated, when the data are limited, by the use of recovery rates.

**Table IV. Seasonal survival of Mute Swans, 1960-61 to 1965-66.**

| *seasons* | 1960-61 | 1961-62 | 1962-63 | 1963-64 | 1964-65 | 1965-66 | *total* |
|---|---|---|---|---|---|---|---|
| *recoveries reported* | 46 | 204 | 382 | 310 | 291 | 314 | 1547 |
| *recoveries expected* | 50.9 | 209.5 | 320.3 | 357.1 | 314.5 | 294.5 | 1547 |
| *reported/expected (= annual factor)* | 0.91 | 0.97 | 1.19 | 0.87 | 0.92 | 1.07 | |
| *seasonal survival* % | 65.4 | 62.8 | 54.4 | 66.8 | 64.7 | 58.3 | $\hat{s} = 61.8\%$ |

**Table V. Age-specific survival of Mute Swans ringed when under one year old.**

| | *age (years after first 1st July)* 1 | 2 | 3 | 4 | 5 | 6 | *total* |
|---|---|---|---|---|---|---|---|
| *recoveries reported* | 287 | 135 | 55 | 23 | 12 | 2 | 514 |
| *recoveries expected* | 273.4 | 137.9 | 65.0 | 26.7 | 9.9 | 0.8 | 514 |
| *age-factor* | 1.05 | 0.98 | 0.85 | 0.86 | 1.21 | (2.5) | |
| *age-specific survival* % | 59.9 | 62.5 | 67.5 | 67.2 | 53.8 | 47 | |

The recoveries of birds of known age (given in Table II) can be compared with those expected from a model incorporating the seasonal survival rates and age-specific survival rates $a_n$ ($n = 1, 2, 3, \ldots$). This gives the results shown in Table V.

The most striking result is the apparent falling-off in survival in the fifth and sixth years. This is probably nonsense due to the relatively small numbers of marked birds that have so far been at risk for more than five years or, perhaps, to ring loss, and a correct assessment cannot be obtained for several years yet. Of much greater importance at present is the indication, from the estimated rates in the first four years, that survival in the third and fourth years of life may be somewhat greater than in the first and second, though the differences are small enough to be negligible for many purposes.

**Table VI. Sums of first and second year recovery rates in three-monthly periods for Mute Swans ringed in Britain between 1960 and 1965.**

| | *Recovery periods* | | | |
|---|---|---|---|---|
| *Recovery year* | *Jul - Sep* | *Oct - Dec* | *Jan - Mar* | *Apr - Jun* |
| 1960-61 | 1.1 | 2.1 | 2.4 | 1.4 |
| 1961-62 | 1.6 | 3.2 | 6.1 | 3.6 |
| 1962-63 | 2.3 | 4.0 | 7.6 | 3.0 |
| 1963-64 | 1.4 | 2.7 | 4.5 | 3.2 |
| 1964-65 | 1.7 | 2.0 | 4.7 | 2.8 |
| *means* | 1.6 | 2.8 | 5.1 | 2.8 |

The effect of the severe weather at the beginning of 1963 is clear. The previous winter's cold spell is also reflected, though less markedly, in higher than average rates both in the last quarter of 1961 and the first of 1962. Boyd and Ogilvie *(loc. cit.)* found that losses in England in the first quarter of 1961 were two-thirds and one-half those in the same periods of 1962 and 1963 respectively. The proportionately higher losses in 1962 shown in the table are probably because of the inclusion of Scottish-ringed birds. It is considered that the rates in the winters of 1963-64 and 1964-65 are more normal than those for 1960-61, which may be depressed because a number of birds ringed in 1960 carried the old-style ring which had a slightly shorter life than the later model.

The table also gives some indication of the incidence of mortality through the year, with the concentration in the winter quarter.

Four age-groups are investigated: birds ringed and recovered in their first year of life; birds recovered in their second year; birds in their third year; and all others. This last grouping includes birds dying when aged over three years, and all those whose age at ringing was not known.

*Overhead wires*

This is the predominant reported cause of death. The mileage of overhead wires and cables increases every year and the growing tendency, welcome in other ways, to run major power lines along valley bottoms rather than on the hills brings them more into the habitat and flight-lines of swans. Harrison (1963) reported 21 swans killed in two months by a quarter-mile stretch of power line in Kent, an estimated 30% of the local flocks.

Table VII shows, perhaps surprisingly, that the proportion of birds in their first year dying by hitting overhead wires (44.1%) is not appreciably higher than

**Table VII. Causes of death in the Mute Swan, and age-distribution at death.**

| | | *Age at death* | | | *Full-grown and* |
|---|---|---|---|---|---|
| *Cause* | *Total* | *1st year* | *2nd year* | *3rd year* | *over 3 years* |
| Wires | 464 | 74 | 66 | 22 | 302 |
| Obstacles | 28 | 10 | 3 | 1 | 14 |
| Railway | 44 | 8 | 3 | 2 | 30 |
| Road | 37 | 8 | 4 | 2 | 26 |
| Injury | 102 | 16 | 7 | 7 | 72 |
| Oil | 100 | 26 | 7 | 6 | 61 |
| Disease | 92 | 5 | 8 | 6 | 73 |
| Cold weather | 36 | 6 | 6 | 4 | 20 |
| Shot | 85 | 7 | 10 | 3 | 65 |
| Fighting | 28 | 5 | 2 | 1 | 20 |
| Fishing | 8 | | | 2 | 6 |
| Miscellaneous | 27 | 3 | 3 | 3 | 18 |
| *totals* | 1051 | 168 | 117 | 59 | 707 |

**Causes of death in the Mute Swan**

A cause of death was specified for 1,051 (48.8%) of the 2,156 recoveries of the Mute Swans ringed in Britain reported between 1960 and 1965. Apart from quarry species this is probably a higher proportion than for any other bird. Table VII sets out the reported causes of death in 12 different categories, and according to the age of the bird when killed. Since post-mortem examinations by skilled persons are rarely made, the reported causes are presumably heavily biassed in favour of those producing superficial injuries or marks. Table VIII sets out all the recoveries received by month of recovery and the distribution for the recoveries of birds reported as flying into overhead wires.

it is for older birds (42.2%), but that there is an appreciably higher level (56.4%) in the birds' second year. In the third year of life the proportion is close to that for all older birds. Table VIII shows the monthly distribution of recoveries for first and second year birds hitting wires. In the first year over 40% are in the months of October and November, which are effectively the first months in which a young bird is flying. In the second year there is a distinct peak in March, corresponding to the time of most movements, when young birds are leaving their adolescent quarters and seeking territories, even though they may not actually be going to breed at two years old. The spring peak is also present, though less marked,

**Table VIII. Monthly distribution of recoveries of the Mute Swan.**

| *Month* | *Total* | *Juveniles in 1st year* | *All others* | *Death caused by wires* | | *Over 2 years* |
|---|---|---|---|---|---|---|
| | | | | *1st year* | *2nd year* | |
| July | 64 | 1 | 63 | 0 | 0 | 5 |
| August | 89 | 1 | 88 | 0 | 2 | 3 |
| September | 155 | 5 | 150 | 0 | 7 | 20 |
| October | 195 | 33 | 162 | 15 | 7 | 35 |
| November | 183 | 31 | 152 | 16 | 7 | 31 |
| December | 180 | 29 | 151 | 8 | 6 | 23 |
| January | 223 | 39 | 184 | 8 | 6 | 29 |
| February | 271 | 39 | 232 | 7 | 4 | 36 |
| March | 314 | 43 | 271 | 8 | 15 | 48 |
| April | 238 | 27 | 211 | 3 | 7 | 52 |
| May | 134 | 18 | 116 | 5 | 3 | 35 |
| June | 110 | 17 | 83 | 4 | 2 | 7 |
| *totals* | 2156 | 283 | 1873 | 74 | 66 | 324 |

in the distribution of recoveries of older birds hitting wires. This is again a reflection of movement by the birds, taking up and defending territories. The number of breeding adults in the older age-sample is not known, but is certainly much less than half.

The evidence suggests that there is no learning by Mute Swans to avoid wires as they get older, and that possibly there is no selecting out taking place. The deaths from hitting overhead wires, and also other obstacles, show no decline with increasing age. There are a very few records of swans hitting wires and not being killed but if this were a regular happening one would expect the figures to offer some evidence of learning.

*Obstacles*

The numbers of swans dying from hitting miscellaneous objects, anything from cliffs to statuary, are fairly small, but presumably the birds have been seen hitting such objects in order that this cause of death is certain enough to have been mentioned.

*Railway*

Although a few birds have actually been seen to be killed by trains, most of the casualties found on the railway have probably flown into the wires which are a concomitant of every line.

*Road*

Incidents of swans being killed on the road are fortunately few in number, though there is one recorded death of a motor-cyclist who was in collision with a swan. Occasionally birds stray on to roads or fly into vehicles and from personal observation a swan that does find itself beside a busy road is bemused by the sight and noise of the traffic. However, road traffic cannot be rated as a major hazard to Mute Swans, nor *vice versa.*

*Injury*

This category is the second largest and probably includes a considerable number of birds that have had flying accidents. The finder has noted that the bird has been injured but it may be that it has survived long enough to move away from the object it hit.

*Oil*

Deaths from oiling tend to involve large numbers when they occur. Most recent examples involved the spillage of oil into a river or harbour. Disturbingly, such accidents show no signs of decreasing. That the number of birds killed is as low as it is must be attributed to the valiant efforts of local inspectors of the R.S.P.C.A. and their voluntary helpers, who, though having to put many birds out of their misery, manage to save and clean a considerable number after every disaster. The River Thames through London and out into the estuary has a bad record, and even upstream at Oxford 22 ringed birds were among many that perished after an oil spillage in June 1965. Flocks on the south coast have suffered in recent years, at Worthing, Southampton Water and Weymouth. The Midlands have recurring trouble, with oil deaths at Leicester in January 1964, and other cases in Derbyshire, Staffordshire and Warwickshire. What was probably the worst case of all as far as numbers of birds killed was concerned took place at Burton-on-Trent in June 1966, when 75 out of a flock of 90 birds succumbed after an oil leakage into the river.

Oiling tends to affect non-breeding flocks of swans rather than pairs and their

families. This is reflected in Table VII which shows a high proportion of deaths for birds in their first year of life. These are all after 1st January when most cygnets will have left their birth-place and joined flocks for the first time.

*Illness and disease*

Apart from one or two well-documented epidemics among flocks of swans, very little is known about the incidence of disease. Understandably very few birds noted to be in poor condition or emaciated when found dead have been post-mortemed. It requires more than average interest on the part of the finder to carry out or arrange for a detailed examination. A number of birds have been brought to the Wildfowl Trust at Slimbridge for post-mortem and Dr. J. V. Beer provided the following information. Eleven birds were examined which had apparently succumbed to disease or poisoning. Avian tuberculosis, nephritis, enteritis and pericarditis were each held responsible for one or more deaths. Two birds were believed to have died from metal-poisoning after fragments of copper and zinc were found in their alimentary tracts. MacDonald (1962) recorded the death of a Mute Swan from an infestation of cestodes.

Epidemics among flocks of swans have been noted occasionally in this country, the best studied being at Abberton Reservoir, Essex, in late 1958 (Jennings, Soulsby and Wainwright 1961), where 50 birds died, heavily infested with parasites. This was coupled with a serious shortage of their normal aquatic food plants. Further deaths, though fewer in number, have taken place in most years since, notably 1963. The birds affected moult their flight feathers in late summer and having done so are unable to leave the reservoir if the food becomes inadequate.

*Cold weather*

Deaths directly due to cold weather conditions are not often reported though the number of birds dying during these periods is much increased (Boyd and Ogilvie, 1964). From Table VII it will be seen that younger birds are probably more susceptible to death in hard weather.

*Shot*

For a protected bird the number reported as shot must be rated as substantial. Vandals take a considerable toll in some parts of the country, both of grown birds and of eggs. Vandalism is becoming more frequent, mostly in urban areas. A number of reports of shot birds come from trout farms or noted fishing rivers and these birds were undoubtedly thought to have come into conflict with the interests of fishermen.

*Fighting*

Small numbers of birds are killed or severely injured in fighting other swans, usually during territorial disputes. An aggressive male Mute Swan is capable, physically, of killing another swan, but it is unlikely that this would normally occur except when the attacked bird is unable to escape.

*Fishing*

Fishing tackle is responsible for a few unpleasant deaths of swans, but records of people removing hooks and lines and releasing live birds are more common.

*Miscellaneous*

Apart from the many causes listed above, a few others occur and make a macabre catalogue. They include death caused by horses, cattle and dogs, death from impalement on barbed wire, death in locks and from boats, and, not least, the bird that got in the flight-path of a landing aircraft at London Airport.

**Conclusions**

Life for a Mute Swan in Britain is an increasingly hazardous business, for man continues to adorn the countryside with obstructions for flying birds. If the first five categories in Table VII are summed, it will be seen that nearly 65% of all reported causes of death are probably due to accidents in flight. There is no sign that these deaths will be reduced in future because of learning by the birds and every sign that they will increase as the obstructions increase. The British population of the Mute Swan remains in a state of flux. Although the national numbers have been stationary for the last three years, there are marked regional variations that may prevent this stability continuing for much longer. The winter index will perform a useful service in depicting the general trends in future years. The mortality figures will gain in validity and reliability as the years pass, and will require review in the future. The really large scale ringing of the period 1961 to 1965 has been reduced by ending the supply of free rings to all ringers. Only those engaged on special projects will continue to be supported in this way. However, the reduction should not be so

great as to render further analysis of recoveries more difficult. With a cumulative recovery rate of about 20% and a recapture rate as high again, the data will continue to flow in. This paper is in the nature of an interim report which serves as a background to the more detailed study presented elsewhere in this Annual Report.

**Acknowledgements**

I wish to thank the Ringing Officer of the British Trust for Ornithology, and his staff, for providing, as part of the investigation, copies of every Mute Swan recovery, and for allowing me to copy all the ringing schedules. I would also like to thank all the many ringers in the country, who, encouraged by free rings, ignored the widely-held belief that Mute Swans could cause them serious injury. It has become just another myth.

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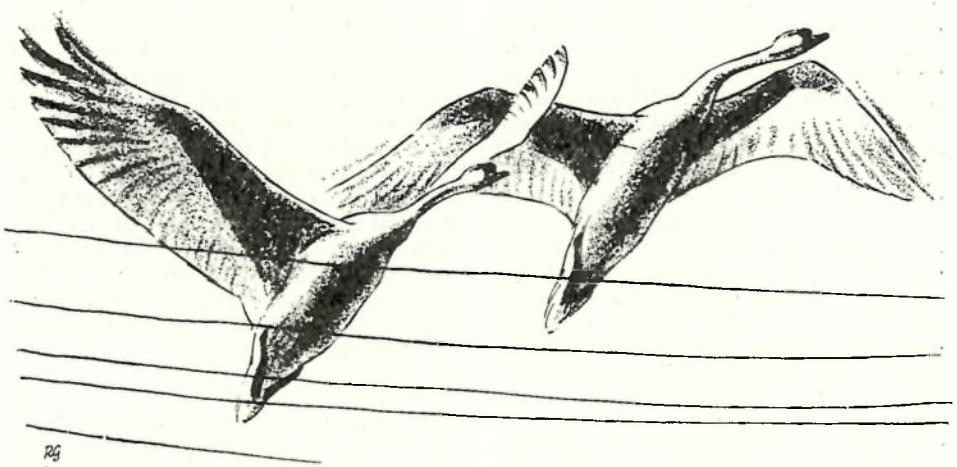

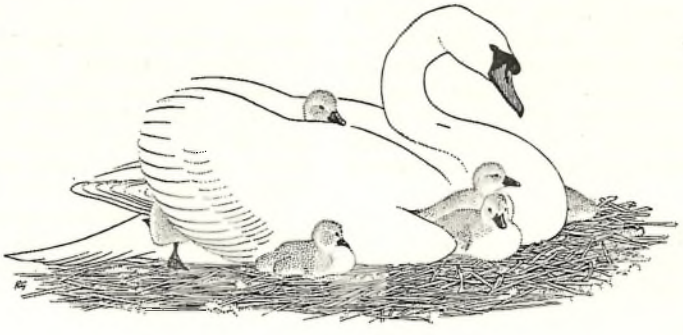

# A preliminary study of the Mute Swan, *Cygnus olor*

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**Summary**

Results of a preliminary study of the Mute Swan in the Oxford area 1960-66. Distribution and movements are discussed: relatively few birds seem to travel any distance during their life and those that do are mostly immature. Mean clutch-size is about six, close to the national average; mortality is about 50% between hatching and fledging in September, and brood-size in September is about three for those pairs with young or two if the unsuccessful breeders are included. About one-third of the remaining young die within nine months October-June. Thereafter mortality is about 33 — 25% per annum for the next two-three years, dropping to 18% for breeding adults (birds most commonly start breeding at three or four). Highest losses appear to occur in late winter and early spring. Life-table data suggest that the Mute Swan is maintaining its numbers within the study area, but there is evidence that there are more suitable nesting sites than there are pairs to occupy them.

## Introduction

This paper is an interim report of a spare-time study of the Mute Swans *Cygnus olor* of the Oxford area. This species has been surprisingly little studied in Britain, especially when one considers that it possesses several advantages over most species for population studies. Amongst these, the most important are its conspicuousness and ease of capture. It is possible to get more accurate counts of this species than almost any other bird and, perhaps uniquely, it is possible to measure the non-breeding population. In addition, in central and southern Britain a higher proportion of the swans than of any other species are caught and ringed. The advantage of this is that many of the swans that have left our study area have been recaptured by other ringers. In addition, some 20% of the birds which we have ringed have been recovered by members of the public who have found them dead or injured; this is an exceptionally high recovery rate.

## The study area

The area which we have covered is centred on Oxford; roughly, it is central and west Oxfordshire and the Thames valley of north Berkshire (see Figure 1). Within this area there are some 60 miles of the river Thames, plus the tributaries Windrush, Evenlode, Cherwell-Ray and Thame. All these and the Oxford Union Canal (which runs parallel to the Cherwell for much of its length) pass through Oxfordshire. North Berkshire is comparatively poor in waters, containing only a few small brooks, gravel pits and lakes which harbour swans; in these also, Oxfordshire is better supplied.

## Methods and background

The study started in early 1960. Since then the coverage of the non-breeding flocks and the breeding pairs in and around Oxford and Abingdon has been fairly consistent. The coverage of the rest of the area has been more limited, consisting in the main of summer visits to

look for breeding pairs and to find birds ringed in the towns that had moved out into the country to breed. We have not even covered the whole area during each summer and have relied on other records to augment our own. In recent summers, however, more of the area has been covered and nearly all of the known breeding sites have been visited. Most of the sites were visited only once a year, the commonest time being when the birds were incubating, since this is the time when most swans are easiest to catch. We have, therefore, little information on the breeding season and our clutch-size records are minimal. From 1964 we have some information on breeding success for broods which we were able to follow after hatching (see also Reynolds 1965).

Unringed swans have been caught and ringed whenever possible; each bird has been given a numbered metal ring and, with very few exceptions, two coloured rings, the combination of the three rings being unique to any particular bird. Thereafter, the birds have not normally been recaptured unless the coloured rings were becoming difficult to read or the birds were nesting; identification can readily be made by the colour combination.

The young were mostly ringed when


**Figure 1. An outline map of Oxfordshire and Berkshire showing the main waterways and the three towns where large non-breeding herds of Mute Swans occur.** The dotted line shows the approximate demarcation of the study area.

they came into the non-breeding flocks during winter and hence were not of known parentage, though since 1964 an increasing proportion of the cygnets have been ringed before the family parties split up. The main age groups used were cygnet (or first year), immature and adult. A cygnet's year of birth can be told for the whole of its first year and sometimes for part of its second; from being a downy cygnet it moults to a dark brown bird and then gradually replaces the brown feathers with white throughout the winter and spring. In some cases there are still some brown feathers, especially on the rump, during the next autumn and winter. White birds with lead-coloured beaks are normally birds in their second year of life, though they may occasionally be older; it is these that form the majority of our age class "immature"; birds which have acquired the red bill are normally in the third or later year and we cannot determine their age. Over the years progressively more and more of the birds have been ringed in their first year so that errors in ageing immatures are not likely to be serious.

Young birds were not usually sexed, but the sexes of the breeding birds were recorded. This was usually easy to do when both birds were present at the nest since the male tends to be the larger of the two and to have the larger knob on the bill. However, we also used behavioural differences which, we believe, are reliable.

**The Annual Cycle**

Mute Swans nest in early spring, laying occasionally beginning in late March, and many of the young are full-grown by late August, by which time their parents have usually moulted. Some young can fly by late September (Heinroth 1924-8 gives 4½ months for the fledging period), after which they may come into the non-breeding flocks (mainly in Oxford and Abingdon); sometimes they are accompanied by their parents. Many of the young, however, appear to be forced to leave their birth-place by the increasing territorial aggressiveness of their parents, and the largest influxes into the non-breeding flocks may occur in January or early February, but there is considerable variation from year to year.

These cygnets may move from one area to another, but commonly they remain in the flocks during the summer, moult and spend the next winter there also. They may then leave in the spring of their second year, possibly to search for a breeding area, though they do not normally breed at the age of two. Some may settle as non-breeding birds in territories, but the majority seem to return to the flocks for at least some of the time and many two-year-olds moult there in the summer. While the majority of birds in the flocks are one and two years old, there are older birds among them and there was one bird present in the Oxford flock up to the age of seven years without apparently ever attempting to breed. The numbers of older birds in the flocks may be augmented during mid-summer by failed breeders which come into the flocks to moult.

The breeding territories are situated along the Thames, the smaller rivers and the still waters (mostly gravel pits) of the area, usually where there is sufficient shallow water for the young to be able to get food (though the parents may bring the food to the surface for them). The territories are usually well-spaced, and though in Oxford there have been nests within about 100 yards of one another, the average distance between nests on the rivers is about 1½ — 2 miles. The breeding pairs often remain in or around the breeding territory throughout the year, though some may visit the flocks. The most common time for them to move is during a cold spell when the still waters freeze over.

**Movements**

Figure 2 shows the recoveries by month of those swans killed by flying into overhead wires. A few of these birds are known to have collided with the wires during darkness. We believe that the peaks in autumn and in early spring are genuine reflections of greater amounts of movement at these times.

Figure 2 also shows the times at which all other swans have been reported as being found dead, except those which died as a result of oiling. Causes of death for only some 40% of these birds were given by the finder and so some of these birds also may have been killed in collisions with overhead wires. However, since it is usually obvious if a bird has flown into wires, we think it unlikely that many of these swans will have died in this way. There is some tendency for both groups of birds to have died in the same months. The reason for this correlation is not clear, but we suggest that the birds have died as a result of having had to move. Shortage of food, territorial

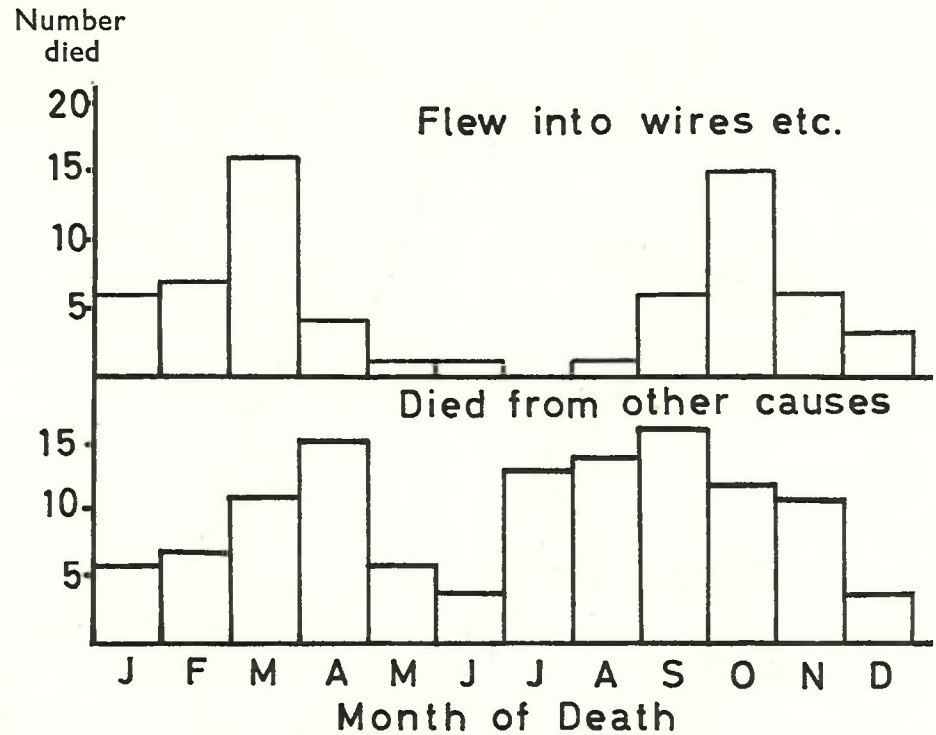


**Figure 2. Monthly distribution of recorded deaths of Mute Swans in the Oxford study area.** Deaths are divided into those birds which are known to have collided with an object in flight and all other causes (which were often not recorded by the finder of the bird). In both categories there is a tendency for there to be more deaths in spring and autumn than in summer and mid-winter. Deaths from oiling are not included.

aggressiveness of the parents, or the need to find a suitable nesting site may all make a bird leave the water it is on. It seems clear that moving is dangerous and therefore presumably birds move only when it becomes necessary to do so; presumably, on balance, those birds are more likely to survive if they move than if they do not. Ogilvie (1967) deals in detail with causes of death of ringed Mute Swans in Britain.

A number of birds are known to have left the study area and the places of recovery of these are shown in the map (Figure 3). A few of these have been recovered in more than one place. Four of the five recoveries at Barrow-in-Furness probably moved there as a party, since they were found there together. One of these had previously been trapped near Birmingham. It was taken from a group of locally colour-ringed birds which may well have included the others from Oxford. The catcher, however, was not at the time familiar with the colour code in use in the north Midlands and did not realise that any of the birds might be alien. At any rate the birds apparently arrived together and none were observed in Oxford after the one was recovered in Birmingham.

There is a large non-breeding flock at Reading, just outside our area. We have visited it from time to time since some of our birds, especially those from Abingdon, have gone there; this is a distance of about 18 miles in a straight line or 30 following the river. There is clearly some interchange with the Reading flock, but there seems to be relatively little movement between birds ringed in our area and the Henley flock, about 6—8 miles below Reading. Apart from six birds that have moved from Oxford to Reading, only 38 swans ringed in our area are known to have left. Ten of these were ringed during the hard weather in the first two months of 1963 and were probably wanderers then, since there was much movement due to most waters being frozen over at that time.


**Figure 3. Long-distance movements of Mute Swans ringed in the Oxford study area.** All recoveries of birds leaving the study area are shown, except some that have moved to Reading. It seems likely that the birds have avoided crossing the higher ground and have followed waterways. The Oxford Canal and River Cherwell head north to Banbury, the canal going on, or running near to, the river and canal systems of Birmingham and Coventry, and further north; the headwaters of the Cherwell run very close to those of the River Ouse which runs through Bedford and near to Cambridge.

Of the 38 birds 28 were only seen on the day of ringing and clearly must have left soon after. Including the six birds that went from Oxford to Reading, 41 out of 44 birds were ringed in their first year (21) or their second year (20). Of these 41 only two did not leave the area in or before their second spring. The remaining three of the 44 birds were older birds, two of which left immediately and the third within a month. No adult breeding bird of ours is known to have left the area. Hence we think that it is unusual for birds to leave our area entirely; this is supported by Ogilvie (1967) who has shown that the large majority of swans remain in the watershed within which they were ringed. Of those birds that do leave, it seems that it is exceptional for them to do so after they are two years old and we doubt that breeding birds ever normally do so. There is the further point that the places of recovery strongly suggest that the birds have left our area by following the river valleys rather than crossing the higher ground, the birds having followed the Thames or the Cherwell—Ouse complex.

**Age of first breeding**

We have relatively few certain records of birds breeding for the first time. For most of these there is little doubt that the age given in Table Ia is that at which breeding was first attempted. Even those that first bred at six years are unlikely to have attempted to breed before since they remained in the non-breeding flocks for most of the previous period. One of the birds that first bred at two laid a clutch of six eggs and raised four young; the other reared three.

It seems clear that 3 — 4 is the most common age at which breeding starts but, as mentioned earlier, some two-year-olds may establish a territory, though breeding is exceptional at this age. The figures in Table Ia will be slightly biassed in favour of birds breeding at an early age since not only have we more data on younger birds, but also it is harder to be certain that older birds have not attempted to breed in some of the earlier years. However, one 1959 cygnet had not attempted to breed by 1966, i.e., at 7 years. Table Ib gives the percentage of each age class that was known to be breeding or not breeding. This shows that, while 3—4 years is a common age to start breeding, a significant proportion of the birds do not start until later than this.

**Eggs and young**

As mentioned earlier, we have little information on the timing of the breeding season, beyond the fact that there is considerable variation in the time at which the clutches are started. Our few records tend to confirm that eggs are not normally laid daily, but at about 48-hour intervals. Repeat, small clutches are sometimes laid after the first clutch has been lost. Flooding is the most common cause of wide-spread losses and probably affects the earliest breeders most frequently.

**Table I. Age of Oxford Mute Swans at first breeding.**
**(a) Numbers of birds which started to breed at known age.**

| | *age in years* | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 |
| ♀ *certainly breeding for first time* | 2 | 13 | 7 | 1 | 1 | |
| ♂ „ | | 9 | 5 | 2 | 2 | |
| ♀ *probably breeding for first time* | | 5 | 4 | 5 | 1 | |
| ♂ „ | | 2 | 2 | | | 1 |

**(b) Proportions of birds known to have been breeding in relation to age.**
Note: Table Ib based on cygnets hatched in 1960-62 only.

| *Year* | *% Breeding* | *% Not breeding* | *Uncertain, but probably did not breed* | *Total* |
|---|---|---|---|---|
| *Third* | 10.5 | 54 | 35.5 | 76 |
| *Fourth* | 37 | 35 | 28 | 60 |
| *Fifth* | 53 | 35 | 12 | 34 |
| *Sixth* | 71 | 29 | 0 | 14 |

Clutch-size (which is a minimum figure since eggs may be lost or stolen, or, in a few cases, the clutches may not be complete at the time of our visit) is around 6.0 (Table II), agreeing with Eltringham 1963) and Campbell (1960) who gave figures of 6.0 and 5.9 respectively. There do not seem to be marked differences in clutch-size in relation to the age of the female.

Reynolds (1965) followed the survival of the cygnets in 18 broods of swans around Oxford in 1964, and calculated the death-rate in each week of life. This was much the highest (22%) in the second week of life. Dr. J. Kear (pers. com.) informs us that a brood of swans which she observed, and which, for some reason, could not be induced to feed, survived until they were 10—11 days old. Heinroth (1928) states that over 25% of the young Mute Swan's weight at hatching is made up from yolk sac; this is retained within the body cavity and Heinroth records that the young swans can live off this for several days without other food. Similar observations have been made by Marcstrom (1966) on Mallard *Anas platyrhynchos* ducklings. At hatching, some 13.5% of the young Mallard's weight is made up from the yolk sac and the ducklings can live off this for about a week without other food. It therefore looks as if newly hatched young of some species of waterfowl (including the swans) are able to survive for a considerable time in adverse conditions. Reynold's findings therefore make it seem likely that the high mortality he observed in the second week of life was due to starvation when the cygnets' internal food reserves ran out.

Reynolds (loc. cit.) further showed that approximately 50% of the hatched young survived until September (after which it became harder to follow the broods since they tended to split up). In 1964 the mean brood-size in September (of all pairs which hatched at least one young) was 3.1. The range of variation is shown in Table III alongside the data for 1965 and 1966; there is relatively little difference between years. It is more difficult to provide a figure for the number of young produced per pair including those that lost all their eggs, since we were not able to visit the areas frequently enough to distinguish all failed breeders from non-breeders. However, we estimate (assuming that most old pairs without young attempted to nest—which seems to be true) that about one third of the pairs lose all their eggs and do not replace them; if this is true then approximately 2.0 young are raised per pair to September.

**Table II. Clutch-size of Mute Swans in the Oxford study area.**

| *Clutch-size* | *Number of clutches* | | |
|---|---|---|---|
| | 1964 | 1965 | 1966 |
| 1 | | | 1 |
| 2 | 1 | | 2 |
| 3 | 3 | 2 | 7 |
| 4 | 1 | 4 | 5 |
| 5 | 3 | 2 | 7 |
| 6 | 5 | 3 | 11 |
| 7 | 7 | 3 | 9 |
| 8 | 3 | 1 | 10 |
| 9 | 2 | 1* | 4 |
| 10 | 1* | | 1 |
| 11 | | | 1* |
| *Number* | 26 | 16 | 60 |
| *Mean* | 6.2 | 5.5 | 6.0 |

Notes: 1. Excluding 3 clutches known to be repeats, one of 5 in 1964 and two of 4 in 1966, average 4.3.
2. There was a strong tendency for the clutches which were kept under observation throughout the laying period to be larger than those which we visited only once. Hence we suspect that many of the smaller clutches may have been robbed. The mean for clutches which were observed several times was 6.8.
3. The largest clutch in each year (marked *) were all laid by the same female. This bird was a breeding adult in 1960 and is of unknown age, She retained the same mate for the years 1963-66 inclusive, and is known to have raised to September: 6 young in 1963 (clutch-size unknown), 5 in 1964, 8 in 1965 and 8 again in 1966.

**Table III. Brood-size of Mute Swans in the Oxford study area in September.**

| *Brood-size* | *No. broods 1964* | *No. broods 1965* | *No. broods 1966* |
|---|---|---|---|
| 0 | 3 | 3 | 2 |
| 1 | 3 | 7 | 7 |
| 2 | 4 | 2 | 7 |
| 3 | 4 | 5 | 5 |
| 4 | 1 | 3 | 5 |
| 5 | 2 | 3 | 0 |
| 6 | 3 | 2 | 4 |
| 7 | 2 | 1 | 2 |
| 8 | 0 | 1 | 2 |
| *Mean* | 3.1 | 3.0 | 3.2 |

**Survival in later life**

We have estimated the survival of young birds after September by observing the birds which we ringed in the non-breeding flocks and noting the time at which they disappeared. An estimate based on such observations is open to several sources of error. When a bird disappears it may not have died, but may merely have moved outside the limits of our area. We have shown that we do not believe that such movement is on a very large scale but it is worth noting that there seem to be seasonal periods of movement (Figure 2). Also a bird might not have died for some time after a last sighting of it, but because of a gap in our observations we did not see it during the remaining portion of its life. However, biasses due to uneven observations on our part should average out over a long period and produce an estimate of only a slightly shorter expectancy of life.

A further difficulty arises in the estimation of mortality of ringed young swans. A young bird is identifiable as such throughout the whole of its first year of life (sometimes even longer) and may be ringed at any time during this period. It is not therefore valid to lump all the data for birds of one year when analysing their survival since, for example, a bird ringed in September is less like to survive to the following June than is a bird ringed only in March. In an attempt to overcome this difficulty we have made our analyses in quarter-year periods and scored the number of birds known to have been alive in each period against those which were not seen again after that period. For example, if 10 birds were ringed in the quarter October-December and five of these were seen during the quarter January to March, when another ten birds were ringed, the survival for January to March would be based on how many of the 15 birds known to be alive then were seen again; if five more were not seen after March then the survival would have been $10/15 = 67\%$. Four such survival figures were obtained for each year and the annual survival was calculated as the product of these.

The calculated survival figures for birds ringed in their first year are shown in Table IV. Since few cygnets were ringed in the quarter July-September the figure of 50% (obtained from observations on the broods—see above) has been used for this period. Also shown in Table IV are estimates, calculated similarly, for birds ringed as "Immature" (nearly all of which are probably in their second year of life). Several points may be noted. First the survival figures are higher for these birds than for those ringed as cygnets, even when the same year classes are compared. The reasons for this are not clear. Even if a few older birds were included in each year class there is no evidence (from this table) that this would result in a higher survival-rate.

Survival of the Immature birds is markedly lower in their second spring—the time when it has been suggested that the birds start to look for breeding sites. However, no such marked decrease in survival is noted for the cygnets when they are two years old. We think that this is probably because some birds ringed as immature have been wanderers when caught. This may have been particularly true of the large numbers of birds caught in the cold periods of 1962 and 1963, especially the latter. Although we have no reason to believe that our breeding birds suffered unusually high mortality during these periods (see below) we lost

**TABLE IV. Estimates of mortality of young Mute Swans in the Oxford study area.**
(m = mortality; s = survival; $\hat{s}$ = calculated survival)

| *Quarter-year periods* | *Ringed in first year* | | | | | *Ringed as immature* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Known alive in quarter* | *Last seen in quarter* | % *m* | % *s* | $\hat{s}$(%) | *Known alive in quarter* | *Last seen in quarter* | % *m* | % *s* | $\hat{s}$(%) |
| *1st year* | | | | | | | | | | |
| Jul-Sep | | | 50* | 50* | | | | | | |
| Oct-Dec | 129 | 17 | 13.2 | 86.8 | | | | | | |
| Jan-Mar | 255 | 28 | 11.0 | 89.0 | | | | | | |
| Apr-Jun | 355 | 43 | 12.1 | 87.9 | | | | | | |
| | | | | | 33.7* | | | | | |
| *2nd year* | | | | | | | | | | |
| Jul-Sep | 348 | 29 | 8.3 | 91.7 | | 81 | 9 | 11.1 | 88.9 | |
| Oct-Dec | 327 | 29 | 8.9 | 91.1 | | 149 | 18 | 12.1 | 87.9 | |
| Jan-Mar | 317 | 46 | 14.5 | 85.5 | | 255 | 57 | 22.4 | 77.6 | |
| Apr-Jun | 271 | 26 | 9.6 | 90.4 | | 251 | 33 | 13.1 | 86.9 | |
| | | | | | 64.6 | | | | | 52.7 |
| *3rd year* | | | | | | | | | | |
| Jul-Sep | 189 | 20 | 10.6 | 89.4 | | 218 | 15 | 6.9 | 93.1 | |
| Oct-Dec | 169 | 6 | 3.6 | 96.4 | | 203 | 12 | 5.9 | 94.1 | |
| Jan-Mar | 163 | 19 | 11.7 | 88.3 | | 191 | 18 | 9.4 | 90.6 | |
| Apr-Jun | 144 | 15 | 10.4 | 89.6 | | 166 | 10 | 6.0 | 94.0 | |
| | | | | | 68.3 | | | | | 74.6 |
| *4th year* | | | | | | | | | | |
| Jul-Sep | 86 | 7 | 8.1 | 91.9 | | 159 | 7 | 4.5 | 95.5 | |
| Oct-Dec | 79 | 4 | 5.1 | 94.9 | | 149 | 6 | 4.0 | 96.0 | |
| Jan-Mar | 75 | 9 | 12.0 | 88.0 | | 143 | 16 | 11.2 | 88.8 | |
| Apr-Jun | 66 | 8 | 12.1 | 87.9 | | 116 | 15 | 12.9 | 87.1 | |
| | | | | | 67.4 | | | | | 70.5 |
| *5th year* | | | | | | | | | | |
| Jul-Sep | | | | | | 101 | 5 | 4.9 | 95.1 | |
| Oct-Dec | | | | | | 94 | 5 | 5.3 | 94.7 | |
| Jan-Mar | | | | | | 89 | 9 | 10.1 | 89.9 | |
| Apr-Jun | | | | | | 60 | 3 | 5.0 | 95.0 | |
| | | | | | | | | | | 76.8 |
| *6th year* | | | | | | | | | | |
| Jul-Sep | | | | | | 57 | 4 | 7.0 | 93.0 | |
| Oct-Dec | | | | | | 53 | 4 | 7.5 | 94.4 | |
| Jan-Mar | | | | | | 49 | 3 | 6.1 | 93.9 | |
| Apr-Jun | | | | | | 35 | 3 | 8.6 | 91.4 | |
| | | | | | | | | | | 75.3 |

* The 50% survival for cygnets in late summer is not based on observations of ringed birds, but on survival of cygnets within broods (see p. 80). The calculated annual survival for the last three quarters only of the first year = 67.9%.

Notes. 1. The January-March mortality of 22.4% for Immatures in their second year is probably biassed by high mortality during the hard winter of 1963. Because most waters froze over during this period abnormally large numbers were ringed in Oxford during this time and Ogilvie (1967) has shown that there were heavy losses during that winter.

2. The small number of birds that were seen alive outside our area have been included in this table and have been scored as having died in the quarter in which they were last reported.

large numbers of immature birds during this time—whether due to movement or death we cannot say but it will be remembered that a quarter of all the birds that moved out of our area were ringed during the cold spell in 1963. Boyd and Ogilvie (1964) showed a high mortality during these winters. A reason for suspecting that not all the disappearance in spring is due to birds moving out of our area is that there is a tendency for the quarterly losses (Table IV) to be greatest during the January-March (and sometimes April-June) periods of the year, even for birds older than two (see also Ogilvie 1967). Since it is unlikely that the losses of the older birds are due to movements out of the area, it seems probable that there are higher death-rates during these times. Not only is this the time of year when natural food is likely to be scarcest, it is also the time of year when many swans are reported dead.

There is some very slight evidence that survival of swans after their sixth year of life is lower than that at earlier ages. However, the evidence is not sufficient to prove this.

It was stressed earlier that the survival figures we have calculated must be regarded as minimal. It is also possible to calculate survival-rates from the ringing recoveries, but apart from practical difficulties the data are at present too few to provide us with accurate answers. However, it is possible to obtain one other estimate of survival, that from the birds that are known to have bred. These are birds that had established themselves on breeding sites and are very unlikely to have moved far in later years. Hence it is highly probable that when such birds have disappeared they have in fact died. Table V gives our data for the survival of these birds. Once again we have not the precise data that we should like in that not every site was visited every year. In the few cases where a site has not been visited for two years and a breeding bird has disappeared it has been assumed that it died in the first of the two years. Hence there will be a slight bias reducing the true survival figure. For this reason little emphasis can be placed on the differences between survival rates in different years. In particular, this error is, in part, likely to have caused the large difference between 1962 and 1963 since coverage was poorest in 1963. However, these errors are unlikely to seriously affect the average survival figures. There do not seem to be marked differences between the survival rates of birds breeding in urban and rural areas (though Reynolds found some variation in chick survival with habitat) nor do there seem to be differences between the sexes; the survival rate for males has been 17.8% and that for females 18.6%.

**Table V. Survival of breeding Mute Swans in the Oxford study area.**

| *Year breeding* | *No. not known to have survived to next season* | *No. known to have survived to next season* | *% Mortality* |
|---|---|---|---|
| 1960 | 1 | 6 | 21.4 |
| 1961 | 5 | 16 | |
| 1962 | 8 | 25 | 24.2 |
| 1963 | 4 | 48 | 7.7 |
| 1964 | 19 | 81 | 19.0 |
| 1965 | 21 | 86 | 19.6 |
| total | 58 | 262 | 18.1 |

### Life-table and population changes

Clearly the data presented above are not as accurate as we would like, nor based on as many years as would be desirable. However, it is of interest to see whether our figures can be used to provide a life-table for the Mute Swan in which production balances the loss of breeding adults. If we assume that breeding first occurs at four (on average) then we can calculate the number of young per pair which survive to age four (from Table IV above). We estimate that about two young were raised per pair to September and so:—

Each pair hatches 4.0 young.

Each pair raises 2.0 young to September: survival 50% from hatching.

Each pair raises 1.3 young to 1 year old: survival 67% for rest of year.

Each pair raises 0.89 young to 2 years old: survival 67% during second year.

Each pair raises 0.67 young to 3 years old: survival 75% during third year.

Each pair raises 0.43 young to 4 years old: survival 75% during fourth year.

From this it seems as if some 0.4 young per pair per year survive to breed. The figures for adult mortality suggest that about 0.36 birds die per pair per year (Mortality is (1.00—0.82) × 2 for each pair), which is roughly the same as the production to four years.

The data are not nearly sufficient to say whether the production is too many or too few to maintain a stable population. However, data collected by the Wildfowl Trust (Ogilvie 1967) show that there is some fluctuation in numbers of Mute Swans and that they may have been declining in the early 1960s. We have not, however, found much variation in the numbers of breeding pairs in our area, but, if one can assume that a site which is occupied in one year by a pair of swans is a suitable nesting site, then we have more suitable nesting sites than we have pairs of swans. For example in 1966, 148 sites where swans are known to have bred in our area (and which were still considered suitable) were visited, but only 112 of them were occupied by territorial pairs (including non-breeders). We would stress that 1966 was not abnormal in this respect; there have been a number of empty sites in all years since the mid-1950s when censuses started. It would therefore seem that the local population of swans is not at present limited by the number of nesting sites.

**Acknowledgements**

We are grateful to many people who have helped us with this study. The Wildfowl Trust has supplied us with the numbered rings used in the study. The R.S.P.C.A. officers for this area, Chief Inspectors Ambrose and Hallam have provided us with many reports of marked swans. Many members of the Oxford Ornithological Society have provided us with records of marked birds and nests. In particular, Messrs. R. S. Bailey, M. J. H. Cook and P. J. Wilkinson have helped in the ringing and recording.

Dr. D. Lack kindly read and criticised the manuscript.

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# Immigrant Mute Swans in south-east England

J. G. HARRISON and M. A. OGILVIE

The wild Mute Swan *Cygnus olor* at present breeds in Holland, Denmark, central and south Sweden, northern Germany and Poland, extending eastwards through Russia to Mongolia. It is stated to be a migrant to south-eastern Europe and south-western Asia. Scott and Boyd (1957) mention that Russian birds move south in winter, and also that some coastal flocks in Britain in winter may contain birds from overseas. Atkinson-Willes (1963) says that it is unlikely that immigration on a substantial scale occurs at present. Authors of county bird books covering south-east England, Ticehurst (1909), Harrison, J. M. (1953) and Walpole-Bond (1938), all thought it likely that occasional migrants reached our shores, particularly in times of severe weather when Whooper Swans *Cygnus cygnus* were prevalent.

Ringing of Mute Swans, both in Britain and on the Continent, which might provide concrete evidence of immigration, has only got under way in the last ten years. Some exciting recoveries following the hard winter of 1962-63 led J. G. H. to review his diary notes concerning the probable occurrence of genuine wild Mute Swans in his home county of Kent. The first mention is for 7th April 1947, when he visited the Wicks, near Dungeness, in company with Norman Moore. There they saw "a single Mute Swan which behaved just like a wild one. It kept its neck like a Whooper's and flew when we were 200 yards off. Undoubtedly, we thought, it must be a wild one. Norman has seen others before, but they are rare." Earlier in 1947 it will be remembered that there had been a prolonged spell of exceptionally severe north-easterly weather.

The next reference was on 17th January 1953, when a solitary adult Mute Swan was seen on flooded pastures on the Isle of Sheppey, near Harty. This was "an obviously wild bird, that kept its neck straight and took flight when a man walked within about 200 yards of it." These two entries are over five years apart and it is interesting to note that both of these birds took flight at approximately the same range. For a few days prior to this occurrence, north-east winds had been blowing, bringing snow storms. A considerable influx of White-fronted Geese *Anser albifrons* was noted in Kent at this time.

It was not until 1963 that the next wild Mute Swans were noted in Kent. On 7th January 1963, when the Arctic spell of weather was at its worst, with persistent east and north-east gales and blizzards, a herd of 15 adult and two sub-adult Mute Swans was found on the Riverhead gravel pit near Sevenoaks. Once again, their behaviour was quite distinct from that of the other resident birds. They were "swimming around quite suspiciously with their necks raised, always on the alert." They were, in fact, quite difficult to photograph. Next morning "while I was there, 12 of them, all adults, rose and circled while taking up a V-formation and then left, flying due west, calling." There was absolutely no doubt that these were hard weather migrants.

On 20th January 1963, J. G. H. visited the same water with his father, Dr. J. M. Harrison, and "there we found one young Whooper Swan walking about on the ice with five adult Mute Swans and one juvenile. All the Mutes had the posture and behaviour of wild birds." All were present at dawn next day, but had gone by 10.15, together with the young Whooper and three other newly-arrived adult Whoopers.

These diary notes clearly demonstrate a relationship between severe weather in north-west Europe and the occurrence of wild Mute Swans in Kent. Two other observations by the same writer suggest that Mute Swans migrate southwards into north-west Europe in autumn. On 15th October 1949, he saw a lone adult Mute Swan among a large gaggle of Greylag Geese *Anser anser* on Bishorst Island, in the Elbe Estuary. Later it parted from the geese and was extremely shy and alert. It flighted inland at dusk and returned to the estuary at dawn.

On 26th October 1949, a large-scale south-westerly migration was watched at the mouth of the River Krückau, on the north shore of the Elbe Estuary. Large numbers of Carrion and Hooded Crows *Corvus corone* and *C. cornix*, Redwings *Turdus musicus*, Chaffinches *Fringilla coelebs* and Starlings *Sturnus vulgaris* were on the move, accompanied by a few Peregrines *Falco peregrinus*, Merlin *Falco columbarius*, Sparrow Hawks *Accipiter nisus* and a Marsh Harrier *Circus aeruginosus*. Included in the migration were two skeins of ten and eight Mute Swans and a

further pair. All were adults and all continued to fly south-westwards directly across the Elbe Estuary (Harrison, J. G. 1954).

As explained above, the evidence from ringing is all of a recent character for although over 15,000 Mute Swans have been ringed in Britain, all but a thousand of these have been marked in the last six years. Out of the 2,700 recoveries received so far only ten show movement overseas. All were ringed in the south-east of England and five were caught during the hard winter of 1962-63. These five were recovered as follows: Holland (March 1963), Schleswig-Holstein, West Germany (August 1965), south-west Sweden (January 1966), Orleans, France (May 1966) and Mecklenberg, East Germany (October 1966). Of the other five overseas recoveries, two were of birds caught on the south coast in the summer following the hard winter and may well have been immigrants that had stayed on. One was subsequently recaptured in Holland in December the same year, the other was found dead in Schleswig-Holstein, West Germany, in May 1964. Two other birds were caught on the Sussex coast, one in January 1961, the other in May 1961, and both were found dead on the north coast of France three months and two months later respectively. The fifth bird was caught whilst moulting on a reservoir in Essex in August 1959 and recaptured five years later moulting this time in Holland.

During the hard winter of 1962-63 there were a number of concentrations of Mute Swans on the south coast where normally only small numbers occur, and two of the foreign recoveries mentioned above came from birds ringed out of these flocks. It was also in one of these flocks that there was only the second record of a foreign-ringed Mute Swan to occur in Britain. A bird caught on 6th February 1963 at Pagham Harbour had been ringed in Holland in May 1961. The third record followed soon after when a bird found oiled at Wells-next-the-Sea, Norfolk, on 21st February 1963 carried a ring put on near Stockholm, Sweden, in July 1962. The only other foreign-ringed Mute Swan to reach Britain was ringed as a juvenile in Lithuania in August 1955, and found dead near Annan, Dumfriesshire, on 12th January 1959. The reasons for this movement must remain a mystery.

There is thus considerable supporting evidence from ringing that during the severe weather in 1963 there was an immigration into south-east England of birds that subsequently returned to France, Holland, the West and East German Baltic coasts and south Sweden, and which, in all probability, originated in those parts. It is therefore worth looking for further evidence from those countries for movements by their Mute Swans.

Berglund *et al* (1963) show that the Mute Swans in central and southern Sweden do not leave their summer breeding and moulting areas until forced to do so by the onset of ice conditions. From ringing results they demonstrate that there is a regular movement at this time to the south coast of Sweden, but that if the conditions become more severe and the sea begins to freeze, these birds will move on further to the German Baltic coast and to the east Danish islands. There has been a considerable volume of recoveries of Swedish-ringed Mute Swans since the above paper was written including those in the 1963 hard winter. Ninety-six of the 107 overseas recoveries are from the Baltic coasts of Germany and Denmark with two-thirds of them in early 1963, and small numbers in each of the succeeding winters, which clearly bear out the statements above. However, the 1962-63 winter also produced recoveries in West Germany (two), the west side of Denmark (two) and single ones in Holland and west France, as well as the Norfolk recovery mentioned earlier. Finally, as evidence of an even more easterly origin for some birds, a swan ringed in Sweden in February 1963 was recovered in the Brest region of Russia (55°N, 23°E) in June 1965.

If we look at the records of ringing in Denmark we find more evidence to relate the movements of Swedish birds to that country to severe weather conditions. Recoveries in Sweden of birds ringed in Denmark can be listed by month and year of ringing as follows: March 1947—1; December 1953—1; February 1954—9; February/March 1956—2; January 1959—1; May 1960—1; October 1961—1; March/April 1963—6. Thus no less than 18 out of 22 recoveries can be directly associated with hard winters. In February 1963 there was also the first recovery of a Danish-ringed Mute Swan from France, near Rouen.

French localities also appear in the Dutch recovery lists for the 1963 cold winter, together with the bird in Sussex already mentioned. Four birds were reported from the west coast of France and two from the Saône valley north of Lyons. In January 1962, another time of severe weather, there was also a recovery of a

Dutch-ringed bird from the west coast of France. There have been two overseas recoveries notified of birds ringed in Holland during early 1963. One bird was recovered in south-west Sweden in November 1964, and the other in Mecklenberg, East Germany, in August 1965.

In conclusion, it now seems certain that in spells of severe weather immigrant Mute Swans reach the south-east of England, and that this is the tail end of a general hard weather movement which has its origins in Sweden and the Baltic. At the eastern end the movement is probably of regular occurrence and the observations of J. G. H. on the Elbe in October 1949 suggests that it extends further south and west than recent ringing recoveries would indicate. Also this part of it does not require the stimulus of hard weather which is undoubtedly responsible for the large-scale movements. None of the published literature dealing with the effects of the 1947 and 1962-63 cold spells on birds in this country makes any reference to the possible arrival of wild Mute Swans, other than a reference in a general article in the Shooting Times (Harrison, J. G. 1963). In view of the recent ringing recoveries it seemed desirable to place the observations forming the first part of this short paper on record.

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Published lists of ringing recoveries for birds ringed in Sweden, Denmark, Holland and Britain were found in *Vår Fågelvärld, Dansk Ornithologisk Forenings Tidsskrift, Limosa* and *British Birds* respectively. We are greatly indebted to the officers of the Swedish and Dutch Bird Ringing Schemes for providing us with all their Mute Swan recoveries up to date and giving us permission to make use of this material.

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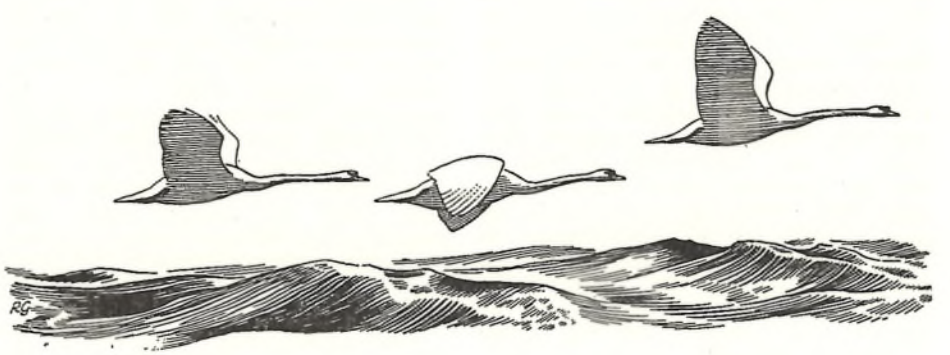

# Some parameters of 'nonsense' orientation in Mallard

G. V. T. MATTHEWS

**Summary**

Relay observers, connected by radio, were established on a north-west line to discover how long Mallard continued to fly in that direction after release. The observers provided positive data on 493 birds. Cross-fixes established the distances to which Mallard can be followed visually, and their straight line flying speeds.

After being lost to sight by the liberator the birds' flight became increasingly undirected and within four miles their general orientation had ceased to have any relation to that which they had initially. The great majority would have landed within twenty minutes. "Nonsense" orientation is thus a short-lived affair.

## Introduction

Several populations of Mallard *Anas. p. platyrhynchos* have, on release away from the point of capture, been shown to fly off predominantly in one general direction (Matthews 1961, 1963a). This is north-westerly for Mallard bred in the areas around the Wildfowl Trust's duck Decoys at Slimbridge, Gloucestershire, and at Borough Fen, Peakirk, Northamptonshire. Progress has been made (Matthews 1963b and in preparation) in ascertaining the physical clues on which the orientation is based but its function remains obscure (hence the use, temporary it is to be hoped, of the adjective "nonsense"). It would clearly be most useful to know how long the orientation was maintained after the birds have passed out of sight of the liberator. This was the main objective of the present exercise.

From the beginning it had been clear that "nonsense" orientation was not continued indefinitely. Subsequent recoveries of Slimbridge birds were not all in Ireland. The one Peakirk Mallard used on orientation experiments and recovered in Alberta, Canada, can be described as exceptional. In our technological age the obvious answer would be to strap small radio transmitters on to the ducks and follow them by "cross-fixing" their position from receivers on the ground. If a range of more than about 20 miles is required the latter have to be in an aircraft. Such techniques are in fact in use in (naturally) the U.S.A. However, as transmitters would cost up to £30 apiece and be non-recoverable, receivers cost several hundred pounds, and running an aircraft is not cheap, it did not appear a practical proposition to use the technique here. Apart from financial considerations, there are severe governmental restrictions on the use of radio transmitters in Britain, because of interference with wireless programmes and other vital services. A rather more old-worldly technique was therefore employed.

## Method

As the birds depart in a fairly tight fan out from the release point, it appeared worthwhile attempting a visual relay system by placing a series of observers along the axis of the scatter, i.e. to the north-west. The fenland of Lincolnshire offered prime locations where observers could be within unimpeded sight of each other. The site chosen was a point (National Grid reference TF 211174) near Deeping St. Nicholas. This had been used previously as a release point in orientation tests so a good deal of relevant data were already available. Including the present series, 1,495 Mallard have been released there in sunny conditions in July through October from 1960-66. These have given rise to 209 recoveries (mostly shot) and 42 returns to the point of capture (Borough Fen Decoy lies only six miles away, bearing 187°). We may use the 86 recoveries of birds which were both lost to sight still flying and recovered the same season (generally before the end of the following January) to illustrate the question we were seeking to answer, namely at what point does the generally north-west orientation (Fig. 1a) from the release point break down and lead to the random or (in this case) slighter south-easterly tendency (Fig. 1b) of the recoveries? There was absolutely no relation between the observed final bearings and the recovery bearings of the individual birds, the mean deviation of the latter from the former being ±96°. From Fig. 1a it will also be seen that birds eventually recaptured back at the Decoy had shown the usual predominantly north-west departures.

The countryside surrounding the Release Point is almost completely flat and divided into large rectangular arable fields by a complicated system of drainage ditches. Hedges are absent and there are relatively few trees. The main features are sketched in Fig. 2 and are, duckwise, the embanked Rivers Welland and Glen, about 40 feet wide, and the various major

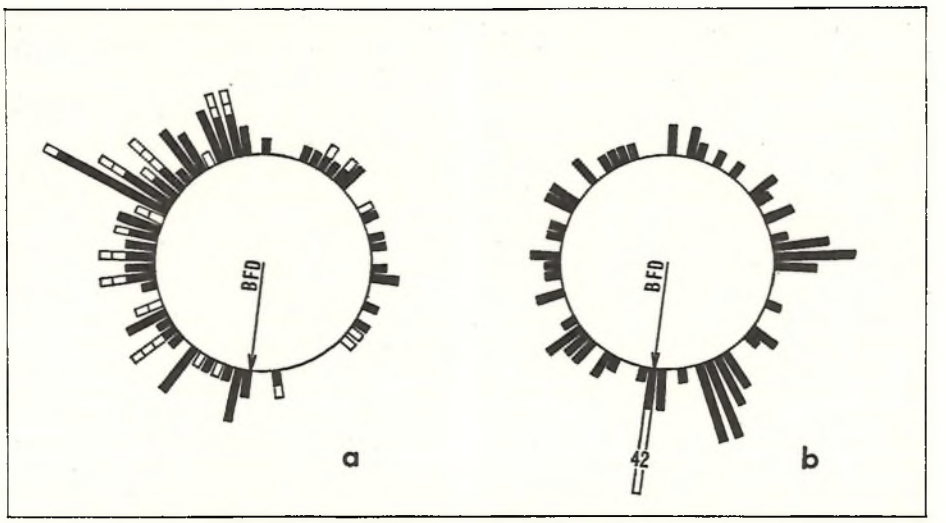


**Figure 1. Initial orientation of Mallard versus their subsequent recovery.** In (a) are shown the bearings on which 86 Mallard were lost to sight from the release point. The same birds were subsequently recaptured (□) at Borough Fen Decoy (B.F.D.) or recovered (■) elsewhere, in directions shown in (b). Length of spoke is proportional to number of bearings. North at top.

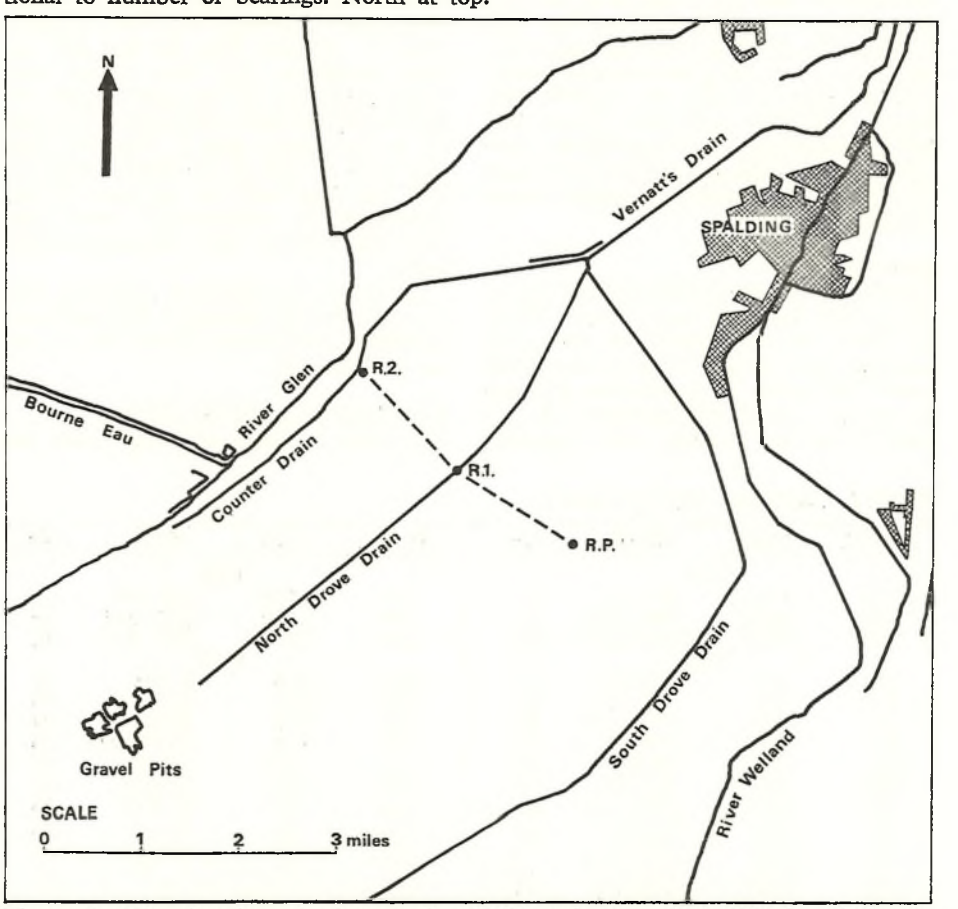


**Figure 2. The situation of release point (R.P.) and relays (R.1, R.2) in relation to nearby watercourses.**

Drains of half that size. Fig. 2 also shows that the Release Point is situated rather centrally to the nearest Rivers and Drains and that they do not in themselves provide the explanation for the north-westerly direction tendency of the released birds.

The two relay points were on the Drains to the north-west of the Release Point, taking advantage of the slight elevation afforded by their embankments. Relay 1 (TF 192186) was 1.4 miles, 304° from the Release Point. Relay 2 (TF 177202) was 1.4 miles, 315° from Relay 1 (exactly the same line of sight could not be used because of farm buildings). A system of simple flag semaphoring and a stereotyped release procedure ensured that the observer at Relay 1 (R.1) was usually able, through binoculars (16 × 40), to sight and follow the bird from the moment of release. The observer at Relay 2 (R.2) had a much more difficult task in that he could not see the release directly and when the bird came into his ken it was generally well up in the sky. To monitor him on to the bird, recourse was had to a walkie-talkie radio link between R.1 and R.2. This worked tolerably well. Each bird was released singly and the next bird was not released until signals indicated that both Relays had lost its predecessor. In a successful follow through this might be a quarter hour later, the whole release taking up to eight hours to complete.

**Material**

Twenty-six releases were carried out in 1964, 1965 and 1966 as set out in Table I. They were confined to the early autumn since it had been shown (Matthews 1963a) that the north-west tendency is obscured in Peakirk-trapped Mallard from November onwards, due, probably, to the arrival of Continental immigrants with contrary "nonsense" tendencies. All the Mallard in the present series were Peakirk-trapped save for 100 introduced from Slimbridge and released in M.281 and, alternating with Peakirk birds, in M.282-4. These reinforcements were brought in since the decline in the north-west tendency among the Peakirk birds had set in unusually early. Slimbridge Mallard are consistent, season-through, in their orientation, but there are obvious logistic difficulties in bringing large numbers across England to the eastern flatlands. The majority of the Peakirk birds were fresh-caught, early autumn being the main catching season at Borough Fen Decoy, which catches 2-3,000 duck a year. A substantial minority were kept in a spacious aviary for a few days to make up lean catches to a worthwhile release.

All releases were with the sun visible and with visibility in excess of three miles, generally five to ten miles. As these were away-from-base experiments they were sometimes carried out in stronger winds than desirable, i.e. over Beaufort Force 3. Mallard then fly low and are more prone to drop into ditches over which they pass. If the wind is from the north-west the birds become more spread out as they battle into it. The unseasonably wide scatter of the birds caught in 1965 has been referred to above. Other tiresomenesses encountered were heat haze and smoke from burning stubble fields.

All in all it is perhaps surprising that as many as 493 individual birds afforded substantial additional information as set out in Table II.

**The visual radius of the observer**

The cases in which the flying bird was

**Table I. The series of relay releases.**

| *M. Ref.* | *Date* | *Wind* | *No.* | *M. Ref.* | *Date* | *Wind* | *No.* |
|---|---|---|---|---|---|---|---|
| | 1964 | | | | 1965 | | |
| 250 | 10.10 | W 2/0 | 35 | 283 | 17.10 | SW 0/1 | 48 |
| 251 | 12.10 | NW 2/0 | 38 | 284 | 19.10 | ESE 2/3 | 39 |
| 252 | 13.10 | NW 2/3 | 34 | 285 | 20.10 | ESE 3/2 | 12 |
| | 1965 | | | | 1966 | | |
| 271 | 2.9 | NNE 4 | 31 | 310 | 26.8 | E 2/4 | 37 |
| 272 | 4.9 | SW 4/3 | 30 | 311 | 28.8 | ESE 2/4 | 40 |
| 273 | 5.9 | SSW 0/2 | 38 | 312 | 29.8 | SE 3/4 | 22 |
| 274 | 6.9 | NW 1 | 38 | 313 | 31.8 | NNW 2/4 | 40 |
| 275 | 7.9 | W 0/2 | 40 | 315 | 2.9 | S 2/3 | 27 |
| 276 | 9.9 | W 4/5 | 6 | 316 | 3.9 | W 4/2 | 45 |
| 277 | 11.9 | NW 1/2 | 38 | 317 | 5.9 | W 3/2 | 40 |
| 278 | 12.9 | W 0/2 | 46 | 318 | 6.9 | W 4/3 | 60 |
| 280 | 22.9 | SSW 2/3 | 21 | 319 | 7.9 | W 2/1 | 46 |
| 281 | 15.10 | W 3/1 | 17 | | | | |
| 282 | 16.10 | NNW 1 | 52 | Total for 26 releases | | | 920 |

lost near-simultaneously by both the R.P. and R.1 provide some necessary data on the distance at which Mallard are normally lost to sight. This was obviously over one and a half miles but previous information was scanty and based on scattered observations of birds passing behind known, distant landmarks.

The bearings from R.P. and R.1, taken at vanishing, intersect to give a cross-fix line. The observer at R.1 could only be expected to relay birds which the liberator lost 70° to right or left of the line between them; R.2 was limited to ± 40°. Using the two mile radius, when a bird vanishes from the sight of one observer its position relative to the next observer can be plotted, and also the bearing on which it will vanish from *his* sight if it continues in a straight line.

**Table II. The additional information provided by the Relays.**

Note. A positive relay was one in which the Relay observer had the bird in view for at least half a minute longer than the Release Point.

| | *No. of birds* | *Average time in sight* |
|---|---|---|
| *Near simultaneous cross fixes R.P./R.1* | | *min:sec* |
| a) on birds seen to land | 87 | 2:41 |
| b) on birds lost flying | 50 | 3:26 |
| *Positive relay by R.1 only* | | |
| a) bird seen to land | 72 | 5:04 |
| b) bird lost flying | 233 | 5:37 |
| *Positive relay by R.2* | | |
| a) bird seen to land | 10 | 8:03 |
| b) bird lost flying | 41 | 7:55 |
| Total | 493 | |

on the bird's position. If the intersection is very oblique the position is doubtful. In some cases the bird had clearly been lost prematurely, having gone low, passed through stubble smoke, etc. Omitting such unsatisfactory cases, we are left with 70 measured distances, ranging from 1.5 to 2.9 miles and with a mean (and median) of 2.1 miles from the observer. Obviously the value varied with the clarity of the atmosphere, the attitude of the bird relative to the observer and so on. But is is clearly justifiable to use a circle of two miles radius to describe the visual field of the observers.

The observational situation can then be represented by three overlapping circles as in Fig. 3. The Relay observers thus had additional crescentic fields of view not available to their predecessors down the

**The directness of the flight paths**

*(a) In sight of liberator*

The cross-fixes on flying birds (which naturally occur around the overlap of the visual circles) and also on birds seen to land by two observers, provide definite measures of the distance they had flown in a known time and hence their (straight-line) ground speed. This in turn gives a measure of the directness or otherwise of their flight.

Scattered references in the literature and personal observations indicate that Mallard flying straight will average around 45-50 m.p.h. From Table III we see that only those birds, still flying, which were lost to sight in less than two and a half minutes were maintaining an essentially straight track away from the R.P. There-

**Table III. Straight-line ground speeds of cross-fixed Mallard.**

| *Time from release (minutes)* | *Still Flying* | | *Landed* | |
|---|---|---|---|---|
| | *No.* | *Av. m.p.h.* | *No.* | *Av. m.p.h.* |
| 1 — 1½ | — | — | 20 | 34.5 |
| — 2½ | 20 | 40.3 | 29 | 24.6 |
| — 3½ | 16 | 31.9 | 19 | 18.9 |
| — 4½ | 15 | 28.3 | 11 | 14.0 |
| over | 9 | 17.7 | 8 | 19.0 |
| | 50 | | 87 | |

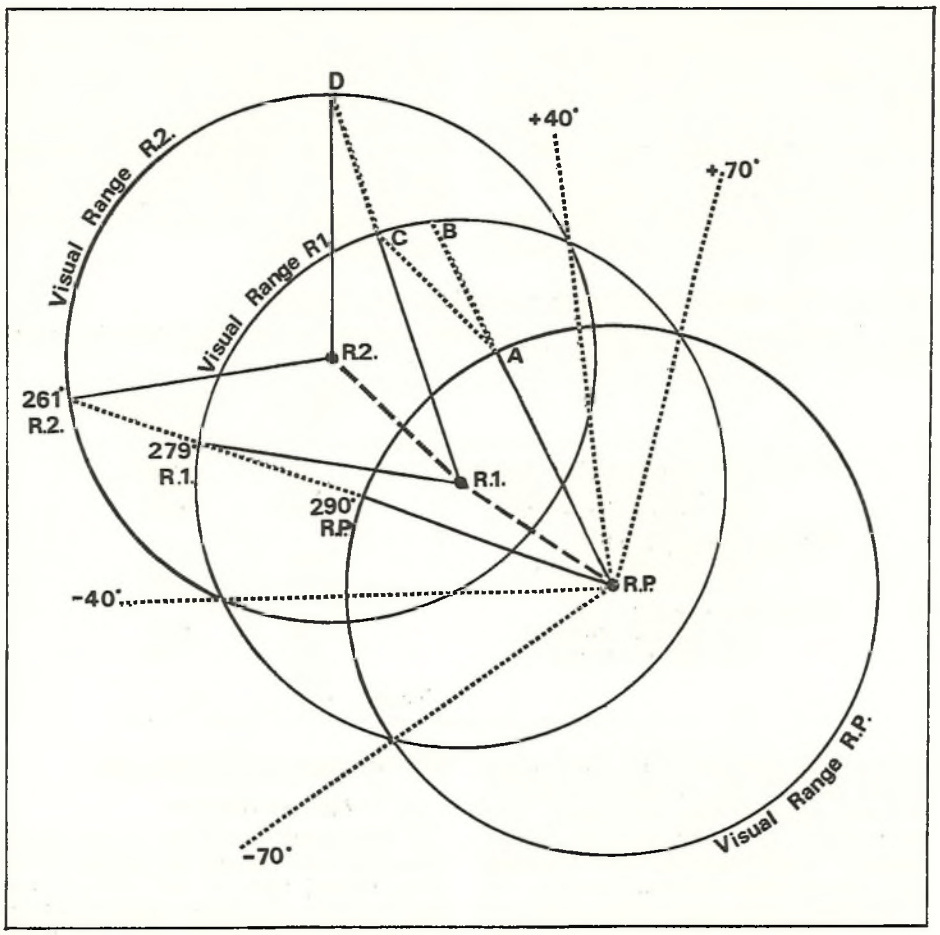


**Figure 3. The visual fields of the observers at the release point (R.P.) and relays (R.1 and R.2).** The circles are of two miles radius. For other explanation see text.

after their speed declined as their deviations from the straight line increased. The same is true of the birds that landed within sight of the liberator. We leave out of account here birds that landed within a minute of release. They were generally flying low and seldom gave a good cross-fix and their intentions were obvious from the start. Those which flew for longer than a minute before landing showed an increased tendency to wander the longer they were in sight. But, in each time interval, their speeds were slower than those of the birds which flew out of sight. This suggests that they had less inclination to fly in the "nonsense" direction and were from early on seeking a suitable ditch in which to land.

We have made it standard practice in all our investigations of free-flying orientation to record the bearing at 30 seconds after release and to use the relation of this to the final bearing as a measure of the directness of the birds' flight. The present observations provided an opportunity to test the validity of this measurement. The speed of cross-fixed birds is set, in Table IV, against the difference between their 30 second and Final Bearings. There is a good correlation, giving confidence in the simpler method of measuring the directness of flight.

### The directness of the flight paths

*(b) After relay*

Birds which remain a long time in the sight of the liberator must, *ipso facto*, be deviating a good deal from the straight line away from him. The decline in "speed" with time in sight shown in Table III does not, in itself, indicate that

there is a progressive increase in meandering. To see if this really is the case we must compare directness of flight shown before and after leaving the liberator's field of view.

Each bird which was subsequently relayed is considered to have been lost to the liberator on his two mile circle. Time in sight thus gives an estimated speed in covering the straight line, R.P. to A in Fig. 3. Using this speed, we calculate how long it would have taken the bird to fly on from the liberator's two mile circle to the point on Relay 1's two mile circle reached by the extrapolation of the liberator's Final Bearing, e.g. the distance AB on Fig. 3. This is the Expected time that Relay 1 should have had the bird in sight if there were no increase in meandering. It is then compared with the actual time he followed it (in both cases additional to the time the liberator had it in sight). Excluding birds vanishing from the liberator in under two minutes (60 m.p.h.) as premature losses, and those which vanished on bearings too near the overlap of the visual circles to give a measurable AB, 206 relays are available, as in Table V.

From this it will be seen that while the bird passed through the additional crescent of view covered by Relay 1 its meandering doubled overall. Those birds which flew the most directly from release showed the greatest proportionate increase in such meandering.

The investigation can be extended to the directness of flight after the birds pass into the crescent of view covered only by R.2. For this, the speed while in R.1's crescent is calculated from the time taken to cover the straight line between the final bearing on the liberator's circle and the actual final bearing on R.1's circle (AC in Fig. 3). This speed is then used to calculate how long the bird should have taken to continue on the latter bearing to reach R.2's two mile circle (CD in Fig. 3). Nearly half the birds received by R.2 gave no measurable value for CD since they did not continue on through, as we shall see below. The 22 birds for which the ratio between expected and actual time in R.2's crescent of view can be calculated, gave a mean of 2.27, i.e. the rate of meandering again doubled. It is obvious that the originally rather direct flight away from the point of release had become very undecided. The next point to be investigated is whether the flight continued in the same general direction or whether there was a change or breakdown in orientation.

**Variation in orientation with distance**

A bird flying straight from the release

**Table IV. Correlation between speed and angular deviation measurements within sight of the Release point.**

| *Calculated speed (m.p.h.)* | *Deviation of Final from 30 seconds Bearing* | | | |
|---|---|---|---|---|
| | *Flying < 1 mile* | | *Flying > 1 mile* | |
| | *No.* | *Average* | *No.* | *Average* |
| 0 — 10 | 13 | ± 50° | — | — |
| 11 — 20 | 13 | ± 37° | 12 | ± 85° |
| 21 — 30 | 9 | ± 20° | 28 | ± 60° |
| 31 — 40 | 5 | ± 16° | 13 | ± 40° |
| 41 — 50 | — | — | 14 | ± 21° |
| 51 — 60 | — | — | 7 | ± 20° |

**Table V. The increased meandering of Mallard which had passed out of sight of the liberator.**

| *Time in sight from release point (minutes)* | *No. of birds* | *Additional time in sight by Relay 1 Actual/Expected ratio* |
|---|---|---|
| 2 — 2½ | 58 | 2.86 |
| — 3 | 34 | 2.00 |
| — 3½ | 44 | 1.76 |
| — 4 | 28 | 1.35 |
| — 4½ | 15 | 1.09 |
| over | 27 | 1.63 |
| | 206 | 1.99 |

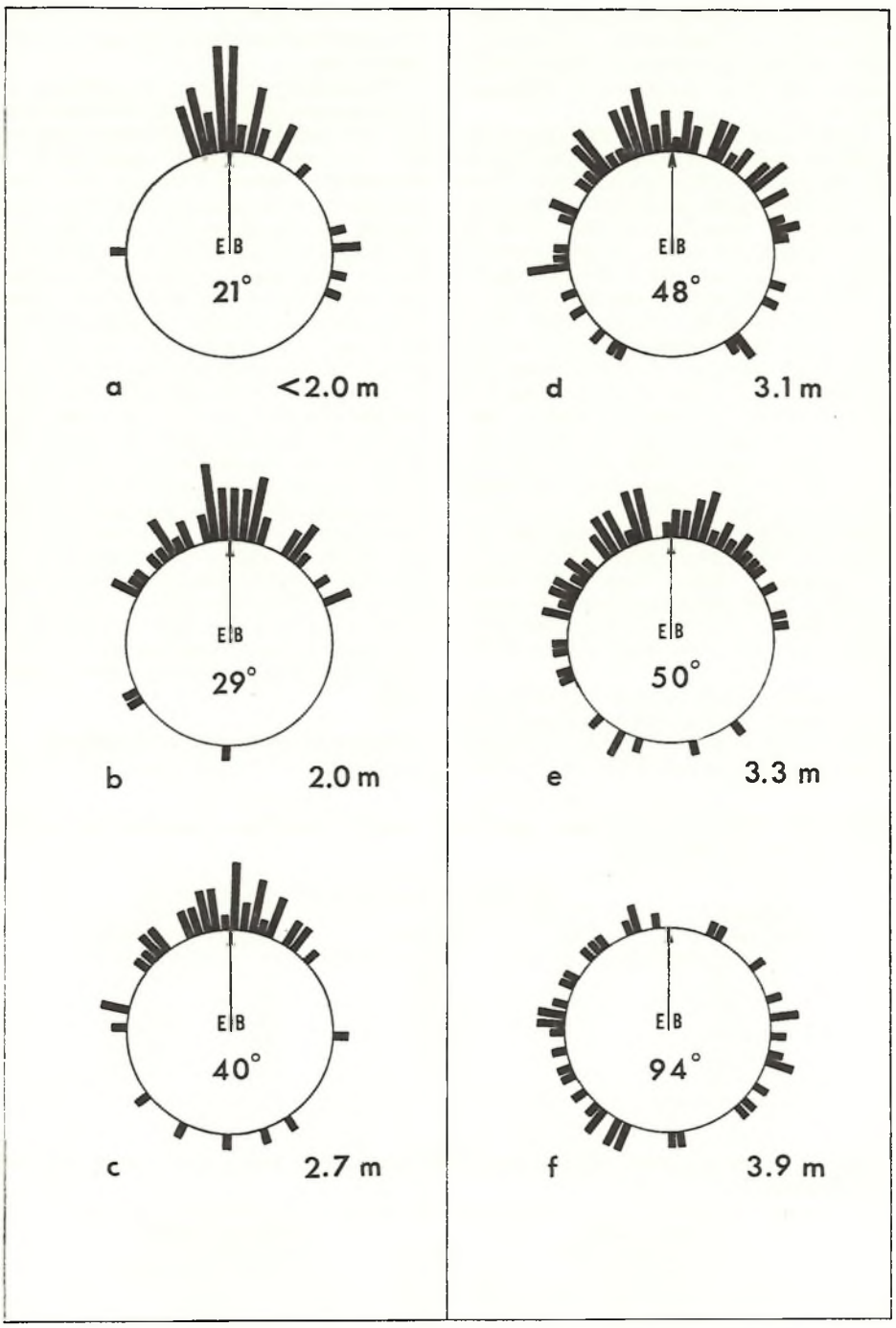


**Figure 4. Increasing deviation from expected bearings with distance from release point.** The vertical arrow (EB) shows the expected bearing on which birds would be lost to R.1 (a—e) and R.2 (f) if they had maintained that on which they were lost to the R.P. The mean deviations of the actual bearings are shown, grouped according to the minimum distance in miles expected to be covered in sight of the relays. See Table VI and text.

point and on over Relay 1 will have the same final bearing for both observers. More usually the bird will pass to one side or the other of the connecting line and the extrapolation of its final bearing with regard to the liberator will give rise to a different final bearing with regard to R.1 and yet another with regard to R.2. These Expected Bearings are found by drawing on a scale plan. Thus in Fig. 3 Final Bearing (R.P.) 290° gives rise to an Expected FB (R.1) of 279° and an Expected FB (R.2) of 261°. Comparison with the Actual Bearings at which the birds were lost from the Relay Points will then give a measure of the deviation from the initial orientation as the bird proceeds away from the release point. Now, a bird lost by the liberator on a bearing close to the relay axis should be under observation by R.1 for a longer stretch than one near to 70° left or right (1.4 miles down to zero). If there were a progressive breakdown in orientation with distance, it should show up more strongly in the former case than in the latter. The deviation of Final Bearings (R.1) from Expected have therefore been grouped in Table VI according to divergencies from the relay line of the FB (R.P.) which gave rise to them. Fig. 4 (a-f) shows the deviations of the individual vanishing points.

**Table VI. Deviation from initial orientation in relation to distance from Release Point.** For explanation see text. Fig. 4 refers.

| | *Relation F.B. (R.P.) to relay line* | *No. of bearings* | *Minimum expected miles* | *Mean deviation F.B. (Relay) from expected* |
|---|---|---|---|---|
| *Relay 1* | | | | |
| | Over ± 70° | 47 | ca. 2.0 | 21° |
| | Under ± 70° | 51 | 2.0 | 29° |
| | Under ± 45° | 46 | 2.7 | 40° |
| | Under ± 30° | 73 | 3.1 | 48° |
| | Under ± 10° | 62 | 3.3 | 50° |
| *Relay 2* | | | | |
| | Over ± 10° | 21 | 3.9 | 94° |
| | Up to ± 10° | 20 | 4.7 | 94° |

As expected, those birds lost near the overlap of the R.P. and R.1's visual circles had made but little change in direction by the time they were lost to the latter. Those leaving the R.P's sight close to the relay axis did, however, show greater deviations, particularly by the time they had travelled at least three miles direct. The Relay 2 results are split into only two categories, partly because of the smaller numbers available, partly because only five were more than ± 30° (the value used to determine mileage in Table VI) from the relay axis. No difference appears in the two categories and we can therefore state that by the time the birds had gone four miles from the Release Point the original directional tendency had disappeared, the distribution of final bearings being quite random with respect to that orientation.

In passing, it should be noted that the proportion of relays achieved by R.2 is not so low as would at first appear. R.2 was not introduced until the releases in 1964 had indicated its desirability. In six other releases it was not possible to operate an R.2. In the rest, 87 birds picked up by R.1 passed within ± 40° of the relay axis. R.2, which picked up 51 birds (including ten seen to land), was thus successful with three-fifths of those which (see Fig. 3) were possibilities. This shows, incidentally, that further relay observers would have been unproductive.

### The rate of landing

In our investigations of the meaning and basis of "nonsense" orientation those birds, usually about 20%, which land within sight of the liberator have been excluded from consideration. In the present series the percentage landing was rather higher, 26%, probably because of the wind effects discussed earlier. As the initial act of orientation can be considered to have terminated when the bird lands, the rate at which this occurs, out of sight of the liberator, is of obvious importance.

Both R.1 and R.2 observed a further 20% of the birds that they relayed from their predecessor landing in *their* sight (respectively 72 out of 357 and 10 out of 51). Each Relay extended the range for which the bird was followed by around a mile. This would indicate that, if this rate of "fall out" continued, 90% of the

birds would have landed within ten miles or so from the Release Point.

Another approach is to consider the data on a time basis, lumping together observations by R.P., R.1 and R.2 and finding the percentage of birds seen to be flying at the start of each minute which had landed by the end of that minute. This is done in Table VII. From this it will be seen that the rate of "fall out" after release was high, about 10%, for the first two minutes, then fell somewhat before increasing towards the end of the observations. If the rate observed in the 14th and 15th minutes was maintained then we would expect 90% of the birds to have landed within about 20 minutes of release. This accords well with the mileage estimates above.

**Table VII. The decline with time of the proportion of birds under observation, and the rate of landing.**

| Minutes from release | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seen flying at start | 920 | 831 | 685 | 530 | 391 | 267 | 172 | 109 | 77 | 55 | 32 | 23 | | 14 | | 2 | | 920 |
| Lost flying | 7 | 63 | 108 | 107 | 95 | 83 | 53 | 30 | 16 | 16 | 6 | 7 | | 8 | | 2 | | 601 |
| Seen landing | 82 | 83 | 47 | 32 | 29 | 12 | 10 | 2 | 6 | 7 | 3 | 2 | | 4 | | — | | 319 |
| % Landing | 9 | 10 | 7 | 6 | 7 | 5 | 6 | 2 | 8 | 13 | 9 | 9 | | 29 | | — | | 35 |

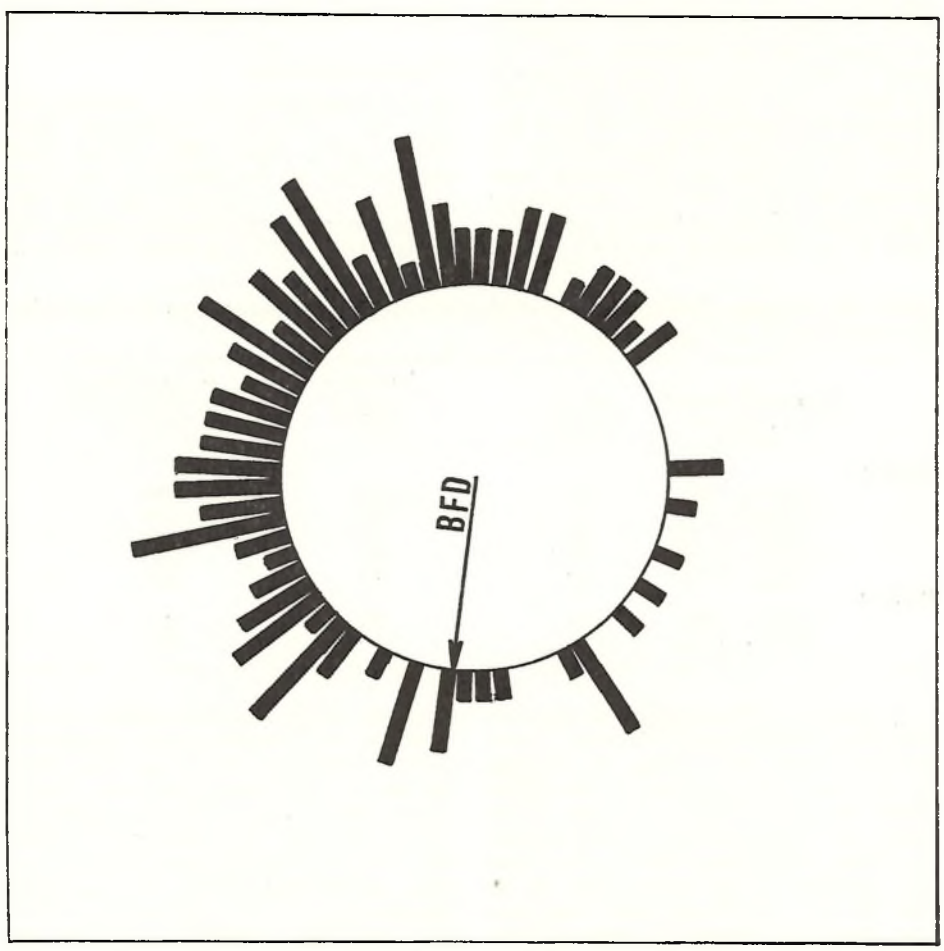


**Figure 5. Final bearings from Relay 1 (Figure 4, d and e) plotted as compass directions.** North to top.

**The effect of local topography**

Although the parameters we have been able to describe probably have general application to the "nonsense" orientation of Mallard, the details must surely have been influenced by local topography. Thus of the 87 relayed birds that R.1 saw land, 28 (39%) came down in the North Drove Drain on which the observer was stationed. Had this watercourse not been there the birds concerned might well have flown farther. On the other hand, at another site other temptations would arise.

It was noticeable that even when the watercourses did not seduce the birds to land they often influenced them to change course. However, the influence of these major landscape features was often only temporary, and minor features such as roads also acted as "leading-lines." We may examine the matter by replotting those R.1 Final Bearings (Fig. 4d and e) which derive from R.P. Final Bearings within ± 30° of the relay axis. These central bearings would not, as viewed from R.1, have a strong bias imported by their origin. In Fig. 5 they are shown as actual compass bearings, i.e. with north at the top of the diagram. It will be seen that there was a generalised spread about the relay axis, not a strong concentration in particular sectors, as there would be if, for instance, many birds had flown SW or NE between the Drains.

Each landscape will have its own effects on the precise way in which "nonsense" orientation breaks down; the important thing is that it *does* break down.

**Conclusions**

After Mallard were lost to sight from the Release Point, their flight became increasingly undirected. Within three or four miles their general orientation had ceased to have any relation to the "nonsense" direction in which they had departed. The great majority would have landed within ten miles or twenty minutes. In other words, "nonsense" orientation is a short lived affair.

This might be thought to strengthen suggestions that it is essentially an escape-reaction. On the other hand, it can plausibly be argued that it would be advantageous for a bird to fly on one general course for a short time while making more subtle measurements whereby it appreciates its position relative to home. The present experiments do not distinguish between these possibilities. They do show, however, that an understanding of "nonsense" orientation will be found by investigations of the behaviour visible to the liberator armed with binoculars. There is no need to launch into expensive technology in this case.

**Acknowledgements**

W. A. Cook operated Borough Fen Decoy and caught the birds used in the tests. He also acted as one of the Relays (generally R.2, with the writer at R.1). The birds were released by the writer and by P. Stanley (M.271-276), R. Collier (M.280), C. J. Beale (M.281-285) and Maya Scull (M.310-319). The Mallard from Slimbridge were caught by M. A. Ogilvie.

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# Observations on the behaviour and relationships of the White-backed Duck and the Stiff-tailed Ducks

PAUL A. JOHNSGARD[1]

**Summary**

1. A number of behavioural and anatomical sources of evidence indicate that the White-backed Duck (*Thalassornis*) should be placed in the tribe Dendrocygnini and be regarded as a whistling duck rather than an aberrant Stiff-tailed Duck.
2. Behavioural evidence supports earlier views that the Black-headed Duck (*Heteronetta*) is the most generalized of the true stiff-tails, and it is suggested that the numerous unusual aspects of sexual behaviour found in this tribe can be traced back to a reduction of pair-forming and pair-maintaining mechanisms which can already be detected in *Heteronetta*.
3. The distinctive aspects of morphology and behaviour found in the Musk Duck (*Biziura*) can be attributed to the predictable effects of intense sexual selection resulting from the breakdown of pair bonds and the establishment of a completely polygamous or promiscuous breeding system in *Biziura*.
4. There is still too little behavioural information concerning the Masked Duck to advocate its generic separation (*Nomonyx*), although it is suggested that this species is probably the most isolated of the typical stiff-tails and presumably represents a less specialised evolutionary line than do the other stiff-tails of the genus *Oxyura*.
5. Recent behavioural evidence tends to support earlier views that the remaining five species of *Oxyura* fall into two broad evolutionary groups; including *leucocephala* and *jamaicensis* on the one hand, and *maccoa, vittata* and *australis* on the other.

The Stiff-tailed Ducks have traditionally been a relatively undisputed and well-defined group of species in the family Anatidae, most members of which may be easily distinguished from all other waterfowl by their elongated and pointed rectrices with stiffened shafts and by their bills having recurved nails. When Eyton (1838) produced the first comprehensive classification of the Anatidae he separated the stiff-tails as a distinct subfamily (Erismaturinae) containing three genera, *Erismatura (Oxyura), Biziura,* and *Thalassornis,* the last genus being erected for the newly discovered White-backed Duck, which Eyton first formally described. He regarded this species as a "connecting link between the genera *Clangula* and *Biziura,* the structure of the tail being nearly like that of the former genus, while the bill is like that of the latter." Later systematists accepted this classification almost without modification, the only change being that the genus *Nomonyx* was erected by Ridgway (1880) to distinguish the Masked Duck from the other typical stiff-tails, primarily on the basis of its less recurved bill nail. This arrangement persisted until the classic revision of the family by Delacour and Mayr (1945), who reduced the stiff-tails to tribal rank (Oxyurini), merged *Nomonyx* with *Oxyura,* and transferred the Black-headed Duck *Heteronetta atricapilla* into the tribe from its former position in the dabbling duck group, largely on the basis of Wetmore's (1926) anatomical observations.

At the species level the classification of the stiff-tails has been hampered by the considerable plumage similarities of most species of *Oxyura,* as well as the meagre information available on their ranges and comparative anatomy. The problem has been especially vexing in southern South America, where the affinities of the forms *vittata* and *ferruginea* to one another have been in doubt, and their possible relationship to the North American Ruddy Duck *O. j. jamaicensis* has also been a problematic matter. Delacour and Mayr (1945) initially regarded these two South American forms and the African Maccoa Duck *O. maccoa* as races of a single southern hemisphere species that also included the Australian Blue-billed Duck *O. australis.* Boetticher (1952) later took the more extreme view that all of the southern hemisphere populations were subspecies of *O. jamaicensis.* However, Helmayr and Conover (1948) pointed out that both South American forms breed together in central Chile, thus two species must be recognised. Lehmann's description, in 1946, of a Colombian race of Ruddy Duck *O. jamaicensis andina* supported the view that the North American Ruddy Duck is thus geographically connected to the South American populations, and that *ferruginea* rather than *vittata* represents the southernmost representative of this geographic series.

In an earlier review of the behaviour patterns of the Anatidae (Johnsgard, 1960), I deplored the lack of behavioural

[1] Contribution (No. *380*) from the Department of Zoology and Physiology, University of Nebraska, Lincoln, Nebraska. Illustrated by the author.

information on the stiff-tails, and suggested that such knowledge might serve to evaluate the validity of including such aberrant genera as *Heteronetta* and *Thalassornis* in the tribe, as well as to help establish species limits and taxonomic groupings within the genus *Oxyura.* Since then it has been my good fortune to observe all of the nine species of Oxyurini (Delacour, 1959) in life, and to observe sexual displays among six of them. Although it is still premature to believe that an adequate knowlege of stiff-tail behaviour is at hand, it is nonetheless possible now to make some comparisons and conclusions that were impossible in 1960. Some such observations have since been published (Johnsgard, 1965a), but others were obtained too late to permit inclusion in my general survey of Anatidae behaviour. Thus, special attention will be paid here to the re-evaluation and probable relationships of the various genera included in the tribe, and to a review of the available behavioural information on the more typical stiff-tails *(Oxyura),* insofar as it may reflect and further clarify their evolutionary relationships.

Without question the White-backed Duck *Thalassornis leuconotus* is one of the most inadequately studied species of waterfowl. The downy young were first correctly described by Delacour and illustrated by Peter Scott in 1959, the tracheal anatomy remained undescribed until 1961, and it also was not until then that the reticulated tarsal surface condition of the species was first noted (Johnsgard, 1961a). The unusual tracheal structure, the associated whistling voices of both sexes, and the reticulated tarsal pattern suggested to me that perhaps the White-backed Duck had been incorrectly placed in the Oxyurini, and that it might actually be an aberrant whistling duck. However, during my two years of study at the Wildfowl Trust between 1959 and 1961, the species, although represented by nine individuals, failed to breed, and very few behavioural observations of taxonomic significance could be obtained (Johnsgard, 1965a). Then, during a return visit to the Trust in July of 1966, I learned that, following a relatively unsuccessful breeding attempt in 1965 (Johnstone, 1966), a second nesting had begun shortly before my arrival.

Accounts in the literature (e.g., Mackworth-Praed and Grant, 1952) indicate that under natural conditions the nests of White-backed Ducks are usually built in rushes or reeds over water and contain no down. However, they are sometimes located at the edges of ponds as well (D'Eath, 1965). The clutch size has been variously reported as ranging between two and 14 eggs, although the latter figure doubtless represents "dump-nests" produced by more than one female. The eggs are surprisingly large (Dr. Janet Kear informed me that the average weight of 21 eggs was 82.5 grams), and are of a distinctive pale rusty brown colouration. This colour and their very smooth surface distinguish them from typical stiff-tailed duck eggs. Each egg represents more than ten per cent of the adult bird's weight, which ranges from 680 to 790 grams (Phillips, 1926). This surprisingly large size is roughly equivalent to the situation in stiff-tails, since unincubated eggs of North American Ruddy Ducks average 74.7 grams (Janet Kear, pers. com.), and adults of this species range from 560 to to 680 grams (Phillips, 1926). It may be hypothesized that in both species this large egg size is a functional adaptation that permits the development of unusually precocial young that are able to forage independently by diving shortly after hatching. Thus, Clark (1964) reports that downy Maccoa Ducks may spend ten to fifteen seconds under water when foraging. Interestingly, Johnson (1965) reports that unusually large eggs are also typical of Torrent Ducks *(Merganetta armata)* which likewise have extremely precocial young that are able to dive and navigate swift currents with ease (Johnsgard, 1966a).

In 1965, the first nesting attempt by the White-backed Ducks at Slimbridge was in a clump of willow herb *Epilobium* and reeds within a foot or two of the water's edge, perhaps because no emergent vegetation is present in their pond. Likewise, in 1966, a nest was built in a similar clump of willow herb and reeds approximately 18 inches from the water, but in this case it was also immediately adjacent to the gravelled public pathway that is used by visitors to the Trust. Indeed, several large pebbles an inch or more in diameter were incorporated into the nest scrape, which was lined with grass but lacked any contour feathers or down. The nest was approximately one foot above the level of the water, but no ramp led to it. Rather, the birds climbed up on shore a foot or two to the side of the nest and entered it indirectly. At the time I arrived on 4th July, six eggs had already been laid at approximately daily

intervals. These eggs had been initially replaced with white wooden dummy eggs until it was found that the adults were ejecting these substitutes, and it was not until domestic fowl eggs that had been dyed brown were tried that they were accepted. This unusual egg discrimination suggests that possibly the unique brown colour of their own eggs enables White-backed Ducks to recognize and eject the white eggs of Maccoa Ducks, which are otherwise identical to their own. It is known that Maccoa Ducks probably perform parasitic egg-laying under wild conditions (Siegfried, 1964).

During my first visit to the nest I noticed that both birds were present in the clump of vegetation that contained the nest. The female, which I learned to recognize on the basis of her smaller head, slightly more mottled cheeks and a more uniformly blackish bill, had been sitting beside the nest but immediately entered the water as I approached. The male initially remained on the nest, hissing and raising his scapulars, then jumped into the water and made several vigorous but abortive attacks. This fierce nest defence by the male was most surprising, since male stiff-tails normally take no interest in the nest. I was further astonished by the male's remarkable threat posture, with ruffled scapulars, wings raised and spread somewhat in the manner of a threatening owl, the head low with neck outstretched and bill gaping (Fig. 1), and with intermittent loud hissing as he paddled his feet so rapidly as to make the water fairly boil. During this display the white back feathers, normally hidden below the wings, were readily visible and greatly ruffled. I have observed somewhat similar but less intense displays in various whistling ducks defending their nests or broods, although none of these has involved wing-spreading. At lower intensities of threat display the male assumed a posture similar to the "Head-back" threat of whistling ducks. These displays contrast with those of *Oxyura* females when protecting their broods, which latter involve stretching the neck forward, gaping, sometimes uttering repeated squeaking notes, and repeatedly raising and lowering the folded wings. Frequently an attack or threat by the White-backed

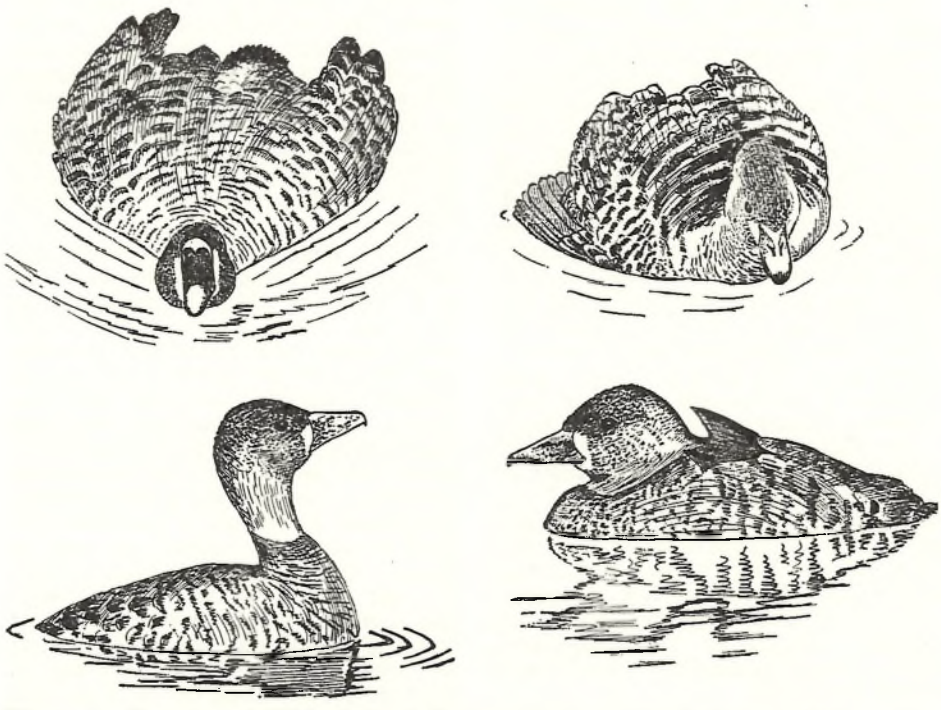

**Figure 1. Postures of White-backed Ducks.** (Upper right) Extreme threat posture assumed during nest defence. (Upper left) Less intense threat posture of male. (Lower left) Chin-lifting threat of female. (Lower right) Resting posture sometimes assumed by male. *Drawings by P. A. Johnsgard.* See also Photograph Section p. VIII upper.

Ducks was followed by a general body shake, which I have also observed in various whistling ducks but not in stiff-tails.

Following a threat or attack the male would quickly return to the vicinity of the nest and female, and occasionally both birds would then utter their whistling notes. I was unable to separate the sexes by their vocalizations, since both seemed to use the same calls. The loudest of these, an apparent alarm note, is a clear double whistle, rather similar to that of a Killdeer *Charadrius vociferus* but not repeated. Another common vocalization is a "conversational" or contact call consisting of from three to five notes uttered as a rising series of soft whistles.

After either member of the pair had been forced to leave the nest, the male was invariably the first to return to it. In instances when the male was foraging during a disturbance that forced the female from the nest he quickly returned to the nest site to defend it. Other than its mate, the male paid little heed to female ducks when they approached the nest, but actively chased other males as well as any individuals of other species that came too near, even including such large birds as male Comb Ducks *Sarkidiornis melanotos*. The female rarely chased any birds, but would vigorously threaten those other than her mate with strong chin-lifting movements associated with a trilled whistle (Fig. 1).

Although incubation had certainly not yet begun by my first visit on 4th July, the nest was never thereafter left unguarded so far as I could determine. On the morning of 5th July I noted that the male was on the nest when I arrived at 9.30 a.m., and later that morning he was replaced by the female. However, the male stayed near, and at 12.20 p.m. a second female approached the nest. The male did not threaten her, but instead the two birds swam about in a tight circle immediately in front of the nest. Suddenly the female went prone, and the male mounted her. The mating attempt was probably unsuccessful since no post-copulatory display by either bird occurred. That afternoon I observed another copulation which involved birds other than the nesting pair. In this case the preliminaries were not seen, but the treading was evidently successfully completed for, on its termination, the male whistled loudly once and both birds performed a "step-dance" parallel to one another in the exact manner of whistling ducks! The male also raised his wing on the side away from the female in the usual manner of whistling ducks, but the female raised hers little if at all. I regard this observation as providing the strongest possible behavioural evidence favouring whistling duck affinities of *Thalassornis*. Only one other copulation attempt was observed. In this case a male swam toward two females foraging near shore, approached one of them closely, and dipped its bill in the water two or three times. The female did not reciprocate, but almost immediately flattened out on the water. The male then mounted but this mating attempt was also apparently unsuccessful. In these three observations, and in another made by S. T. Johnstone (pers. com.), the copulations all occurred within a foot or two of the shore, whereas typical stiff-tails do so in deeper water. Furthermore, the precopulatory bill-dipping observed in the third instance was identically the same as that of various whistling ducks.

On 9th July, I observed a female examining clumps of willow herb on the shore opposite the nest under study and near the place where I had observed a copulation on 7th July. It was therefore no surprise when a second nest with one egg was located on 11th July in that area. Like the others, it was built in willow herbs and rushes only a foot or two from water. This second breeding pair, whose nest was built about 40 yards from the first, may have been responsible for the last two copulations I observed. Strangely, at about this same time five additional eggs were deposited in and near the first nest, so that ultimately eleven eggs were associated with that nest. In the second nest eggs were deposited daily after 11th July, but on several days two eggs rather than one were collected. This indicated that one or more additional females were depositing eggs in both the nests, and thus it is impossible to judge how many were produced by a single female. Altogether, 22 eggs were deposited in the two nests by three or more females. This sudden "explosion" of breeding activity by the White-backed Ducks is difficult to explain since these birds have been in the collection since 1960 and had previously made only a single attempt to breed. Possibly the presence of the initial nesting pair stimulated the remaining birds in some manner; at least the other White-backed Ducks seemed to take unusual interest in the nest and frequently gathered around it.

When not guarding the nest or incubating, the White-backed Ducks sometimes rested near the middle of the pond. Although on a few occasions I observed the birds thus sleeping with their bills buried in the scapular feathers (a posture I had not observed before), they usually adopted a curious resting position in which one or both feet would be lifted out of the water and placed anteriorly on the back so that the webs of the feet looked like miniature sails (Fig. 1). All of the foraging was apparently done by diving, and it is evident that in their abilities to remain submerged the birds are at least the equals of stiff-tails. In Table I some observed periods of submersion and intervening surfacing periods of White-backs can be compared with North American Ruddy Ducks and two representative whistling ducks that regularly forage in this manner. These observations were all made on the relatively shallow ponds of the Wildfowl Trust at Slimbridge.

**Table I. Duration of dives and intervening pauses of White-backed, Ruddy and Whistling Ducks.**

| | *Diving Periods (in seconds)* | | | *Intervening Periods (in seconds)* | | |
|---|---|---|---|---|---|---|
| | *Observations* | *Average* | *Range* | *Observations* | *Average* | *Range* |
| White-backed Duck | 14 | 20.5 | 13-30 | 13 | 14.5 | 9-28 |
| N. American Ruddy Duck | 19 | 14.2 | 8-29 | 17 | 10.1 | 8-15 |
| Fulvous Whistling Duck | 7 | 13.6 | 9-15 | 6 | 11.0 | 10-18 |
| Javan Whistling Duck | 7 | 11.4 | 8-15 | 6 | 9.0 | 5-13 |

Another aspect of general behaviour that has not yet been previously reported is the occurrence of pre-flight movements in White-backed Ducks. Presumably this species flies very little, and an absence of such signals might not be surprising. However, I did once observe a pair that was oriented side by side, facing open water, and appearing very alert. Both performed rapid lateral head-shaking movements with their necks v e r t i c a l l y stretched, and they also occasionally rubbed their cheeks on the scapulars. The male then uttered a few short whistles and the pair attempted to take off. This sequence corresponds closely to the pre-flight behaviour of whistling ducks.

Because of the continuous guarding of the nest by one or both adults, it was difficult to determine when incubation actually began. However, incubation was probably begun at the first nest sometime during the period 13th to 17th July, during which interval no more eggs appeared, and I observed only the male attending the nest. I was not able to visit the Wildfowl Trust again until 27th July, when I noticed that the male was still sitting on the nest. It is well known that in several and possibly all of the species of *Dendrocygna* (Phillips, 1926, lists *viduata, bicolor* and *autumnalis*) the male performs much or all of the incubation. In *Dendrocygna* the incubation period ranges between 27 and 30 days (Delacour, 1954), whereas in the North American Ruddy Duck it is only 20—21 days (Delacour, 1959). Clark (1964) reports an incubation period of 25—27 days for the Maccoa Duck. The majority of the White-backed Duck eggs were incubated under broody hens, and hatched in periods from 29 to 33 days (Janet Kear, pers. com.). However, none survived beyond 15 days. The only success in hatching and rearing this species in captivity was that of Ezra (1934), who noted the unusual precocity of the young in its diving abilities, and that both parents cared for the young. Dr. J. M. Winterbottom and Mr. W. R. Siegfried (pers. com.) have informed me that they have observed both parents attending broods under wild conditions. I was unable to stay long enough to observe the ducklings, but Dr. Kear informed me that, judging from sound spectrographic analysis, the distress calls of d o w n y White-backed Ducks are very similar to those of whistling ducks but are totally different from those of the North American Ruddy Duck (Kear, 1967). Although the plumage of the young is admittedly distinct from that of downy whistling ducks, it is also different from that of stiff-tails. Additionally, although the head pattern is somewhat obscured by a tawny suffusion, it does in some respects resemble that of whistling ducks. It has long been recognized that the whistling ducks are unique in the Anatidae in that their skulls have extensions of the lachrymal bones that project backward to enclose the orbits completely (Phillips, 1923). The White-backed Duck, although lacking this trait, has a skull configuration more closely resembling a whistling duck than a stiff-tailed duck (Janet Kear, pers. com.).

In summary, I believe that there is now sufficient evidence to propose that the genus *Thalassornis* be transferred to the Dendrocygnini and regarded as a whistling duck rather than an aberrant stiff-tail.

**Black-headed Duck and Musk Duck**

I reported earlier (1965a) on certain male displays of the Black-headed Duck, based on limited observations of a single bird at the Wildfowl Trust. I have since seen these same displays performed by males at the Philadelphia and Bronx zoos, and have also observed females at the latter location. Although the female Black-headed Duck's plumage is similar to that of various *Anas* species, its behaviour patterns appear to be *Oxyura*-like. Thus, I heard no Decrescendo Calls nor have I detected any Inciting calls and postures in the three females I observed. Instead, they remained s i l e n t , e v e n w h e n approached by a displaying male. Their most frequent response was a silent gaping threat directed toward the males in a manner reminiscent of female Ruddy Ducks. Thus, the females appeared to lack signals that might facilitate the development of *Anas*-like social courtship groups; indeed, the males appeared to display independently and indiscriminately to any female that came near. The apparent absence of a recognizable Inciting display in this species and in the more typical stiff-tails suggests that distinct pair-bonds may be weak or lacking in most members of this tribe, although Milton Weller (pers. com.) reports the presence of seasonal pair-bonds in Black-headed Ducks. Instead, male stiff-tails may simply defend individual territories and mate with any females that are attracted by the male's display activities. This behaviour is almost certainly true of the genus *Biziura* (Johnsgard, 1965) and there is suggestive evidence for at least one species of *Oxyura* (Clark, 1964). The frequently quoted statement that male North American Ruddy Ducks "assist" (Kortright, 1942) the female in rearing the brood is misleading; little if any attention is paid to the young by the male, which appears to be merely sexually attracted toward the female (Helen Hays, pers. com.). In the North American Ruddy Duck and also the Maccoa Duck the female herself frequently abandons (or is abandoned by) the brood only a few weeks after their hatching. Parental care has been completely lost in the socially parasitic Black-headed Duck (Weller, unpublished MS.), but female Musk Ducks *Biziura lobata* evidently do exhibit prolonged care of their young which usually number only one or two (Lowe, 1966).

Since the publication of my observations (1965b, 1966b) on the Musk Duck, Mr. V. T. Lowe (1966) has produced a similar survey of its behaviour. He is in agreement with most of my observations regarding the display forms and the origins of the various sounds produced by male Musk Ducks. However, he questions the importance of sexual selection in promoting the evolution of the male's remarkable behaviour patterns and the extreme sexual dimorphism of the species, and instead suggests that the male's displays perform a function of recreation and ego-boosting as a substitute for a strong sex interest. Mr. Lowe does support my belief that no pair bond exists at any season in this species. It is significant that Clark's (1964) study of the Maccoa Duck, one of the largest species of *Oxyura*, indicates a situation closely approaching typical Musk Duck behaviour. Thus, during breeding periods individual male Maccoa Ducks patrol small reed-bordered stretches of water where they display and from which they forcibly expel other males, whereas females apparently drift aimlessly from one such territory to another until each chooses "an exceptionally vigorous" male to associate with and in whose territory she may build her nest without interference from other males. In this way more energetic and dominant males might accumulate two or more females simultaneously or consecutively during the prolonged breeding season. It may thus readily be visualized how the similar behaviour of male Musk Ducks, whose overt territorial battles have evidently been largely replaced with visual and auditory displays that serve equally well to delineate territories and attract females, represents a culmination of the trends toward the breakdown of strong pair bonds that can be traced through almost the entire stiff-tail tribe. Therefore, the male Musk Duck's apparently paradoxical subordination of interest in females in favour of a preoccupation with seemingly senseless displays which Mr. Lowe has stressed is no refutation of the influence of sexual selection, for it is only by the complete breakdown of pair bonds and a reduction of the male's attachment to individual females that an effective polygamous or promiscuous mating system can be established.

It would thus appear that the Black-headed Duck might in many ways be regarded, both behaviourally (Johnsgard, 1965; Weller, MS.) and anatomically (Woolfenden, 1961), as the most generalized of the stiff-tailed ducks and as one derived rather directly from the presumed dabbling duck-like ancestor of the tribe, whereas the Musk Duck can be considered the predictable evolutionary end-product of the behavioural trends that may be first detected in the Black-headed Duck and may be clearly observed in the genus *Oxyura.*

### Typical stiff-tails *Oxyura*

For some time it has been my hope to obtain a detailed account of the displays of Masked Ducks *Oxyura dominica,* in several respects apparently the least specialized species of *Oxyura.* This lack of specialization is certainly indicated by its bill structure (" *Nomonyx* " refers to the ordinary appearance of the bill's nail), and by its skeletal anatomy (Woolfenden, 1961). Thus, perhaps the species might be regarded as closest to an ancestral *Oxyura* type (Johnsgard, 1965b) and which in turn may have been derived from a *Heteronetta*-like ancester. Milton Weller (pers. com.) agrees with this view and believes, like Woolfenden, that generic distinction is warranted. Bond's (1961) description of the downy young indicates that Scott's illustration (in Delacour, 1959) is misleading in various details, e.g., the pale areas are actually yellowish buff rather than white, and the light superciliary stripe extends over the lores to the bill. These two mentioned features would seemingly bring the Masked Duck's downy plumage closer in appearance to that of *Heteronetta.* Furthermore, Wetmore (1965) has stated that the male Masked Duck's oesophagus has an elongated and apparently inflatable middle portion, and that the trachea has two air sacs, including a smaller one leading from the anterior ventral surface and a larger one opening from the dorsal surface. So far as is known, the male of no other *Oxyura* species has both an inflatable oesophagus and well developed tracheal air sacs. The male Masked Duck in breeding condition does exhibit black spiny papillae around the base of the intromittant organ (Wetmore, 1965), a feature apparently characteristic of many or all species of *Oxyura* (Helen Hays, pers. com.).

Since my own attempts to locate and study Masked Ducks have thus far been unsuccessful, I am able here to add little information regarding the behaviour of this most interesting of the *Oxyura* species. The only person I have located who has observed Masked Duck display is L. Irby Davis, who informed me (pers. com.) that his observations date from more than 20 years ago and his notes have been lost or mislaid. However, he recalls that the male definitely cocked its tail during display, that the throat or neck was enlarged, and that a sound was produced by the male as it performed movements similar to those made when preening the neck feathers. The occurrence of frequent quick rushes over the water surface by the male was another of the display features which he clearly remembers. These observations would suggest a great deal of similarity between Masked Duck displays and those of the other typical stiff-tails, but it may be hoped that more concrete information on the species' visual and auditory displays will eventually become available for purposes of comparison.

The remaining five species of *Oxyura* also pose considerable problems in understanding their behaviour and relationships. The only male displays which have been reliably reported in all of them involve neck inflation and tail-cocking. In all but the White-headed Duck *O. leucocephala* a display involving repeated bill-dipping followed by lateral head-shaking (" bill-flicking ") or head-rolling on the scapulars has been reported. This sequence serves as a precopulatory display in the North American Ruddy Duck, probably also in the Maccoa Duck (Clark, 1964), and possibly in the Argentine Ruddy Duck, but in the Australian Blue-billed Duck these same movements occur at the end of a display sequence called Sousing (Johnsgard, 1966). This display, first described as such for the Australian species, is clearly identical to one of the displays described by Clark (1964), for the Maccoa Duck, even to the preliminary head-pumping and the following bill-dipping and head-shaking. Furthermore, Dr. Martin Moynihan has recently shown me sketches he made of display in the Argentine Ruddy Duck *O. vittata* and which indicate the occurrence of Sousing in that species too. Considering the complexity and frequency of this display sequence in the Australian Blue-billed Duck it may well be regarded as the species' primary " courtship " display, in the same manner that the Bubbling sequence may be so regarded for the

North American Ruddy Duck (Johnsgard, 1965a). If this is the case, one might conclude that two species of *Oxyura (jamaicensis* and *leucocephala)* probably have as their primary male displays the Bubbling sequence and that the three strictly southern hemisphere species *(maccoa, vittata* and *australis)* presumably utilize Sousing as a characteristic display. This dichotomy would fit in well with the postulated taxonomic relationships which I earlier (1961b) proposed on the basis of the more limited information available. It would further seem probable that each species using Sousing as a display has an inflatable oesophagus whereas those which perform Bubbling may possess tracheal air sacs. Unfortunately, the male tracheal and oesophageal structures of the White-headed Duck and the Maccoa Duck are still undescribed, although Clark (1964) suggests that a tracheal air sac may be present in the Maccoa Duck.

Sound production through splashing movements is evidently a basic part of *Oxyura* displays. Thus, a rapid forward Rush through the water by the male (called Motor-boating in *O. australis*) has been reported for nearly all the *Oxyura* species, and a Ringing Rush (or Display Flight) just over the water surface accompanied by a rattling sound produced by the wings and/or feet striking the water has been noted in all of the species except the poorly studied White-headed Duck, Masked Duck, and Argentine Ruddy Duck. However, an actual display call by males is evidently much more restricted in occurrence. It is apparently best developed in the Maccoa Duck, which produces a "purring" or "vibrating trumpet call" with its tail erect, head forward and beak open, and with the crown feathers raised except for a central groove running from front to back (Clark, 1964). Except for the call, this description exactly fits the posture assumed by the North American Ruddy Duck as it utters its weak belching note at the termination of the Bubbling sequence. A similar posture and presumably an associated call is assumed at the end of the corresponding displays in White-headed Ducks (Mountfort, 1958). Apparently the male Masked Duck also produces one or more vocal sounds, variously rendered as "Kurikirro" or like "a short note from a motor horn," although possibly this latter note is produced by the female. Lord William Percy (in Barber's *Birds of Cuba*) stated that "the male has a curious habit of responding like a cock pheasant to such noises as the banging of a punt pole on the water or an explosion in the distance," suggesting the significance of male vocalizations in territorial establishment and maintenance. It would seem, however, that male vocalizations in most stiff-tails have been subordinated to non-vocally produced noises that may serve these same functions.

As a means of summarizing our still relatively primitive state of knowledge about stiff-tail behaviour, the accompany-

**Table II. Summary of some male displays and display structures in the species of *Oxyura*.**
An "X" indicates presence and a dash indicates apparent absences of the indicated feature.

| | Masked Duck | N. Amer. Ruddy Duck | White-headed Duck | Maccoa Duck | Argentine Ruddy Duck | Blue-billed Duck |
|---|---|---|---|---|---|---|
| Tail cocking | X | X | X | X | X | X |
| Bill-dipping and water-flicking | ? | X | ? | X | X? | X |
| Forward Rush in water | X | X | X | X | ? | X |
| Ringing Rush over water | ? | X | ? | X | ? | X |
| Sousing sequence | ? | - | ? | X | X | X |
| Bubbling sequence | ? | X | X | - | - | - |
| Calling during tail-cocking | X? | X | X | X | ? | - |
| Inflated Neck Display | X | X | X | X | X | X |
| By oesophagus | X | - | ? | ? | X | X |
| By air sacs | X | X | ? | ? | - | - |

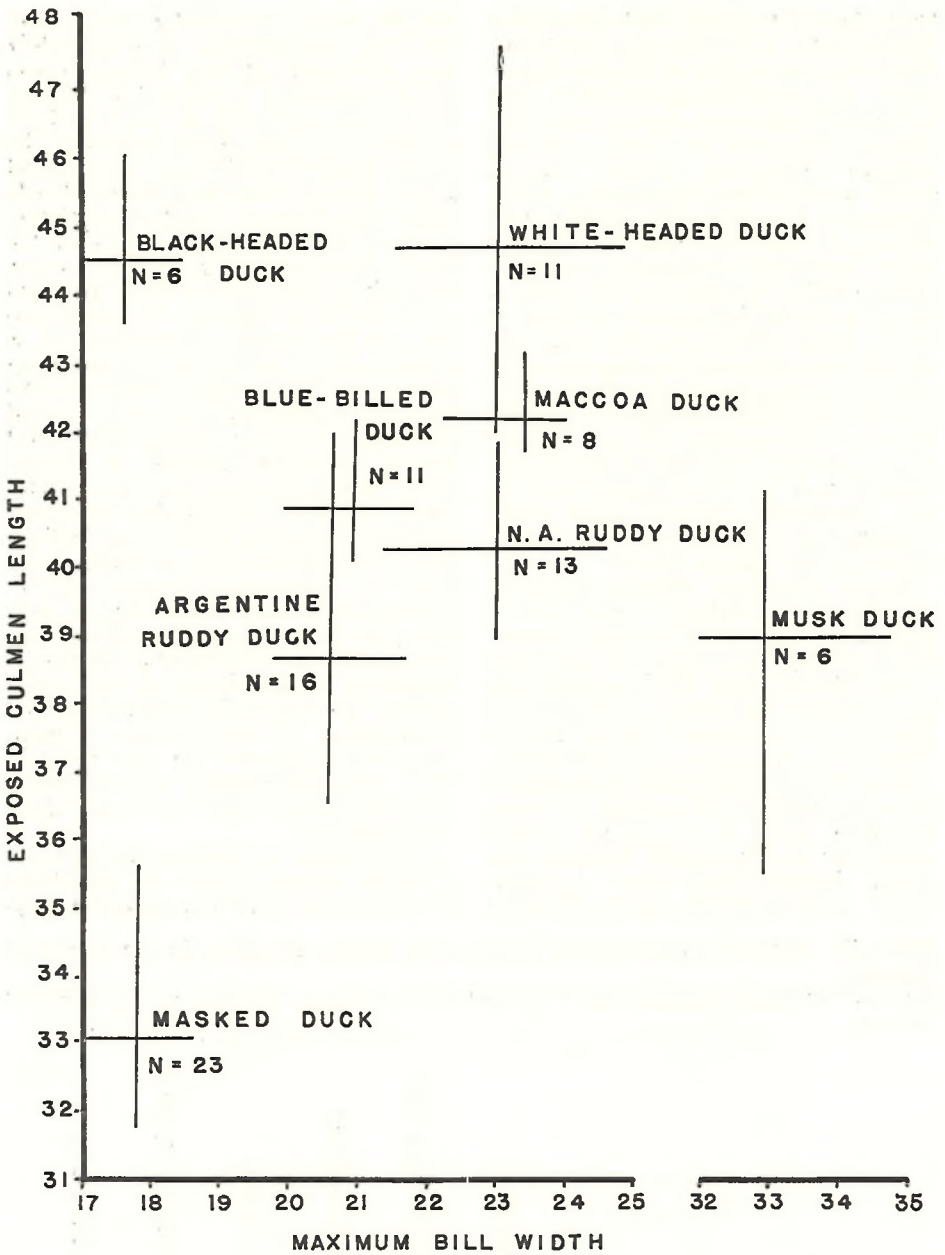


**Figure 2. Measurements (in millimetres) of bills of adult male stiff-tailed ducks.** The lines intersect at the mean of each sample.

ing Table II lists the apparent distribution of these various male behavioural and structural features in the *Oxyura* species. Additionally, a diagram (Fig. 2) showing interspecies variation in exposed culmen lengths and maximum culmen widths of adult male stiff-tail species has been prepared, since these measurements appear to be among the most useful for characterizing the various species. It may be seen that in the genus *Oxyura* a fairly constant ratio between culmen width and length is maintained throughout the genus, with the Masked Duck differing from the others only by virtue of its considerably smaller size. On the other hand,

the Black-headed Duck's bill is relatively long and narrow, much like that of an *Anas* species, whereas the massive bill of the Musk Duck is unusually short and broad, and is evidently adapted to crushing rather than filtering foods.

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# Breeding behaviour of captive Shovelers

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**Summary**

The breeding behaviour of full-winged Shovelers was studied in flight pens measuring 0.15 and 0.19 acre during five seasons. Thirty-one pairs were observed, mostly in groups of four pairs per pen. Only three pairs failed to breed, but hatching success was poor and few ducklings were raised to maturity.

After introduction to the pen, usually in early May, pairs were sociable for a few days but soon established well defined territories. Females began inspecting nesting cover, during the first few hours after dawn, as early as 27 days before laying. Time spent in cover each day increased on the days before laying and continued to increase during laying.

Copulations were frequent in the pre-laying period but decreased during laying and were rare during incubation. Pairs often copulated twice each day before laying began, but no clear preference was shown for certain times of day. Most mountings resulted in apparently successful copulation (120 records); some males slipped off before intromission (10 records); in 15 cases, pairs were interrupted by the approach of other birds. Apparently successful rape of strange females was seen only four times.

Pairs made flights around the pen and some females gave Persistent Quacking during May, but both activities stopped as soon as egg-laying began. Visits to the nest for laying were usually in the morning. Eggs were laid at a rate of one per day, but sometimes a day was skipped. Incubating females left the nest most often in late morning or in the afternoon, but there was much variation.

The number of eggs decreased in many nests during incubation. There was no evidence of predation. Three observations of females flying from the nest carrying an egg in the bill suggested that this behaviour accounts for the disappearing eggs. The eggs seemed to be pierced and carried in the tip of the bill, but whether the eggs removed were addled, and how they became broken is unknown. There is no evidence that Shovelers remove the shells from which ducklings have emerged.

Chasing activities peaked in frequency just after dawn and were followed by a period of sleeping during the middle and late morning. On some days there appeared to be a second peak in the number of birds sleeping in the afternoon. Chasing and sleeping were infrequent in the last hour or so before sunset, probably because feeding activity increased at that time.

Seasonal and daily patterns of activity in the flight pens agreed with what is known of schedules in the wild, but the captive conditions had serious effects on breeding success. Brood behaviour was most strikingly influenced by the crowding and restriction of movement. Females with broods attacked strange ducklings and probably killed some. But the high duckling losses were likely caused mainly by shortage of preferred food in the pens.

A considerable amount of information on the breeding biology of a number of duck species has accumulated during the last 25 years through intensive field studies. For the best-known species, many papers describe nest-sites, clutch- and brood-sizes, and breeding success. Certain kinds of information on breeding behaviour, however, have proved extremely difficult to obtain in the field. In particular, there are many gaps in our knowledge of topics requiring prolonged observations on marked individuals of known age and breeding status. For example, there is little precise information on the chronology of activities in individual pairs during the breeding season, variations in behaviour dependent on time of day, and interactions between breeding pairs. While it is often possible to get the general picture from observations in the wild, it is usually very difficult and time-consuming to gather quantitative data.

Two approaches to the study of breeding behaviour demand such quantitative information. The first involves comparisons between species, with the objective of unravelling the adaptive significance of species-typical behaviour. The second is the experimental manipulation of variables believed to be affecting some aspect of the behaviour—a procedure needed, in many cases, to establish such effects. The fruitfulness of these two approaches has been demonstrated by the comparative and experimental studies on gull behaviour carried out in recent years by Tinbergen and his students (e.g. Tinbergen 1959, Tinbergen *et al.* 1962, Beer 1961-66, Cullen 1957, Kruuk 1964).

Since few ducks nest colonially, as the gulls do, the collection of information on the breeding behaviour of individual pairs is slow and laborious. But most ducks adapt well to confinement in pens and it is possible to gain insight into the behaviour of wild birds through the study of captives. Many species will breed in captivity even after being rendered flightless by clipping the primaries or by removal of the terminal digits of one wing (" pinioning "). But although much of

the behaviour of a pinioned duck seems to be unaffected by such an operation (e.g., the form of many courtship displays), social interactions involving aerial pursuit are impossible, and even energetic chasing of another bird on the surface of the water may be hampered. These difficulties are avoided by studying full-winged birds in large flight-pens.

This paper is the first in a series reporting such studies on the Shoveler *Anas clypeata*. This species is tame and breeds readily in captivity. Males exhibit pronounced territoriality during the pre-nesting and incubation periods but, despite their aggressiveness, birds do not kill one another when crowded. My main aims have been to document the characteristics of social interactions in breeding Shovelers under these conditions, and to investigate variables affecting the frequency and outcome of encounters. The information will provide a base for similar studies of other species and for experiments on effects of radiation on behaviour. This paper gives details of methods and procedure and correlates the frequency of certain behaviour patterns with the stages of the breeding cycle and time of day. Subsequent papers will deal in more detail with displays, pair-formation, and territorial behaviour.

The breeding conditions imposed on these Shovelers were artificial in four major respects. Firstly, the density of pairs was much higher than would be found in the wild. The pens covered 0.15 and 0.19 acre; the experiments, over five seasons, involved from four to seven pairs in a pen. The main effect of this crowding was to expose the pairs to almost constant sight of other Shovelers. Secondly, the movements of the birds were restricted; in particular, flights were greatly reduced in length and height. Thirdly, food was not evenly distributed in the pens. Although the ponds contained some live food, and the birds spent much time dabbling for it, a number of feeders were also included and these were used by more than one pair. Fourthly, the populations of pairs introduced to the study pens were stable throughout the breeding season; thus all birds quickly learned the identity of their pen-mates, and they were given no chance to react to strange individuals. In other respects, I believe the breeding conditions for these birds were not very different from those to be found in the wild.

**The Flight-pens**

In 1960, 1961 and 1962, observations were carried out in a rectangular pen measuring 127 feet × 51 feet × 16 feet high, located at the Delta Waterfowl Research Station in Manitoba (Figure 1). Three ponds, connected by ditches, were maintained at a constant level, several feet above the adjacent marsh, by an automatic pump. Clumps of grass for nesting sites (10 in 1960-61, 26 in 1962) were introduced. At the beginning of each breeding season the remaining ground was bare or sparsely covered, but a natural growth of grasses rapidly grew during the spring as a result of abundant irrigation from the ponds. When the vegetation grew very tall in June and July, some was removed by careful scything. A certain amount of natural food was available in the water, but pans supplied with grain were also placed in the pen (two in 1960-61, three in 1962). Small numbers of Blue-winged Teal *Anas discors*, Cinnamon Teal *A. cyanoptera* and Green-winged Teal *A. crecca carolinensis* were also kept in this pen. Observations were made from an elevated blind.

Experience with the Delta pen enabled me to design two improved flight-pens for more refined and intensive studies carried out in 1965 and 1966. The new pens are situated on a sandy field on the University of Minnesota's Cedar Creek Natural History Area, 30 miles north of Minneapolis. Each measures 90 feet × 90 feet × 12 feet high. They are adjacent, sharing a common wall, and both are overlooked by one elevated blind.

The Cedar Creek pens were designed to provide "ideal" breeding facilities for eight pairs (four in each pen) (Figure 1). Each contains a large pond, with the water level maintained at one foot by pumping from a well. Seepage is prevented by large sheets of plastic, protected underneath from burrowing rodents by a layer of chicken-wire. Pond edges are thin crusts of cement. The shape is square, with a square peninsula in the middle of each side. This configuration was intended to provide secluded corners in which birds would be out of sight of one another. A two foot wide strip of grass around the periphery of each pen provides the only nesting cover. The remaining land surface in the pens has quickly grown up in natural grasses but these areas are mowed several times each spring to eliminate other possibilities for nest-sites. A feed pan, which can be filled from outside the pen, and a floating

wooden frame to hold duck-weed (*Lemna*), are located in every corner. The plywood base of the wall separating the two pens was originally only two feet high, but this was extended to six feet in 1966, to prevent flying birds interacting through the wire.

**The study birds**

Most of the Shovelers used in the 1960-65 experiments were raised in captivity from eggs collected in the Delta area. A few birds were captured from the wild. In 1966, however, only birds raised in a natural way were used; most were captured from the wild in North Dakota as ducklings, a few were raised with their parents in the Cedar Creek pens.

The selection of strongly attached pairs proved to be a crucial step in the procedure. In order to secure the pairs needed in spring, a flock of 30 to 60 birds

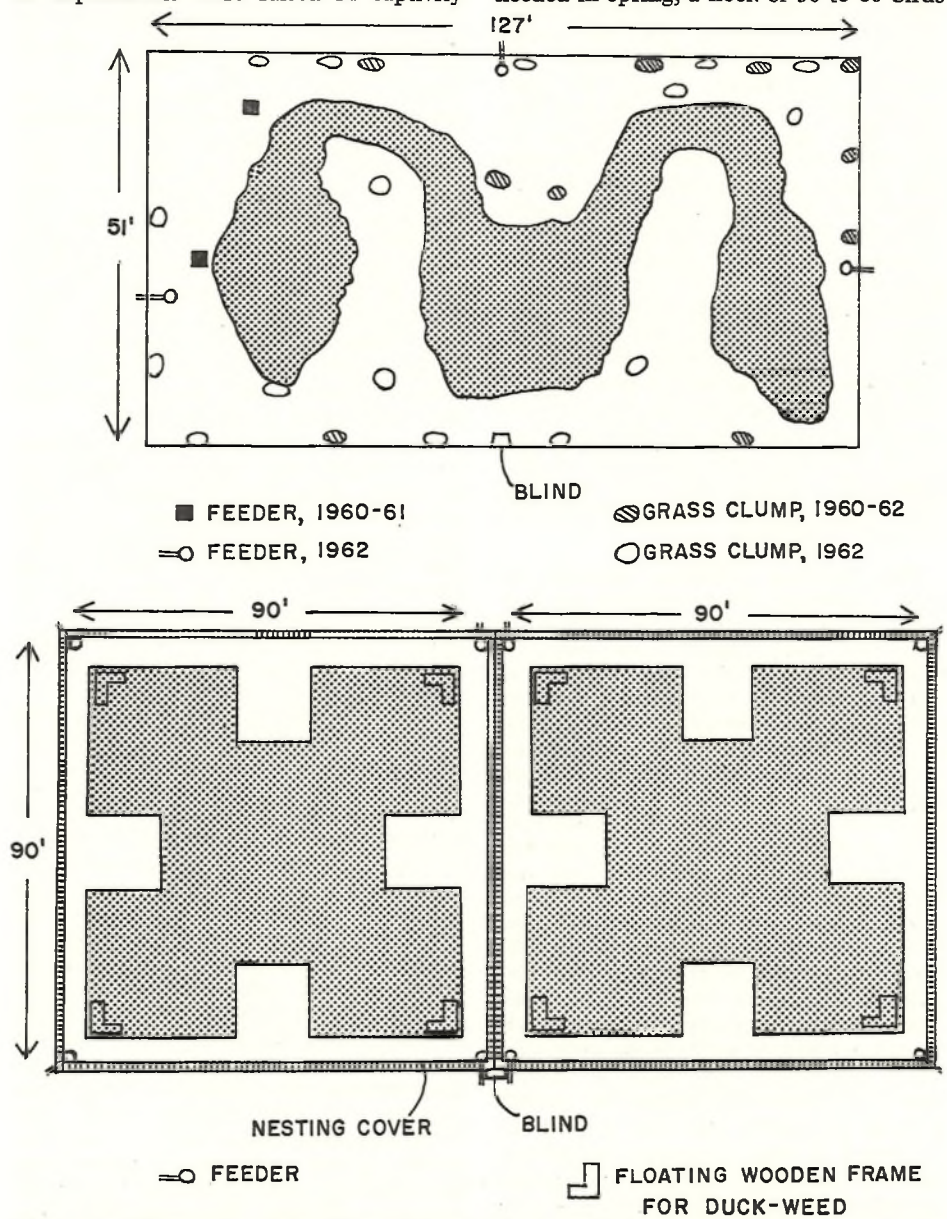


**Figure I. Flight pens at the Delta Waterfowl Research Station (upper) and at Cedar Creek Natural History Area (lower).** See Photograph Section p. IX upper.

was maintained inside a heated building each winter. Pair-bonds were easily detected, especially by watching for the orientation of female Inciting movements, but many bonds were weak and care was taken to select only the strongest. Naturally, birds showing homosexual tendencies were not used.

In 1965 and 1966, the winter flock was divided into four visually isolated groups. Each of the four pairs used in a breeding pen was taken from a different group so that, as "pairs", they met for the first time in the breeding pen. Unfortunately, it was impossible to use individuals which had never seen one another before; the segregation covered only the period from November to May, during which the pair-bonds formed.

The birds were identified by combinations of colour bands and coloured nasal discs in the early years. Numbered nasal discs, similar to those described by Bartonek and Dane (1964), have proved invaluable in the Cedar Creek studies. (See Photograph Section p. IX lower.)

**Procedure during breeding season**

The birds were released into the breeding pens as early as possible in spring, usually during the first week of May. They were allowed to go through the breeding cycle with a minimum of interference until the ducklings were full grown. The inside of the pen was inspected briefly on about every third day. During the laying period, visits were delayed until late in the day when females had laid. Once incubation had started, birds were rarely flushed from their nests, and when small ducklings were present intrusions were avoided. As a result of these precautions I believe the behaviour of the birds was influenced very little by human intrusion, but my records on the fate of eggs and ducklings suffered correspondingly and are incomplete.

Observations at the Delta pen were not intensive and they were made on an irregular schedule. During the territorial phase in May and June my notes cover 15 hours in 1960, 8 hours in 1961, 21 hours in 1962. In 1965, at the Cedar Creek pens, observations were made for several hours on almost every day from 5th May to 30th June (total 175 hours). Whole-day watches from dawn to dusk (about 15 hours) were undertaken on five days. Fortunately the dates chosen were representative of the pre-laying and laying periods and the first, second and third weeks of incubation for most of the pairs. These records provided information on the relationship of activities to time of day, and they showed that the first few hours after sunrise are especially important if hostility, inspection of nesting cover, and egg-laying behaviour are to be studied. Since my main interest was in hostile behaviour, the observations in 1966 were made on the first three or four hours after sunrise (total 103 hours). The 1965 records also showed that daily observation is not essential if a representative sample of the interactions is to be obtained, and every third day was skipped in 1966.

Three experimental manipulations were carried out during the five years of study reported here. In 1962, the eggs were removed from two nests on the fifteenth and nineteenth days of incubation, so that behaviour during the "re-nest interval" could be studied. In 1965, all eight males were caught up on 5th June and held in crates for four hours and then released into the pens again. This treatment appeared to have little effect on the birds; they quickly returned to their territories and behaved in the same way as before their removal. In 1966, all males were removed from the pens for three hours on 24th May; they were transported to Minneapolis where two were irradiated. The results of this treatment will be reported elsewhere. As in the 1965 experiment, the birds quickly resettled when returned to their pens. In this paper, the two treated males are omitted from generalizations relating to behaviour of males after 24th May.

**Breeding results**

Only three of the 31 pairs used in these studies failed to lay eggs (Some pairs, or individuals, were used in more than one season; see Table I). Laying began 10-23 days after the birds were released in the breeding pens. Clutch-size varied between 4 and 11, with one instance of two females laying together to produce 13 eggs. The most frequent clutch-size was 8 (13 of 29 clutches). Incubation periods could not be determined precisely, since nests were not visited near the time of hatching. Estimates based on the first observations of ducklings suggest an average incubation period between 22 and 25 days. Two females remained sitting on dead eggs for at least 29 and 35 days. Hatching success was generally poor, only one female bringing off ducklings from all eggs laid, but there was much individual variation. Very few ducklings survived to reach maturity.

### Sociability of pairs

During the first few days after introduction, pairs showed clear tendencies to be sociable, especially when choosing sleeping places. Thereafter, such tendencies disappeared almost completely until early June (Figure 2), when certain males began to associate while their mates were incubating. This behaviour was not highly developed, however, until the third week in June when hostility waned rapidly.

### Establishment of territories

Hostility between pairs was observed from the day the birds were introduced to the flight pens. Threatening, chasing, and fighting activities increased during the first week and, in general, pairs were frequently involved in hostile encounters throughout May and the first three weeks of June (Figure 3).

Encounters between pairs included all possible combinations: threatening, chasing and fighting occurred between males, between females, and between members of the opposite sex. Most contacts involved chasing or threatening by a male directed at another male or at a female.

Localization of each pair's activities within the pen began to appear within a few days after introduction; rather clearly defined territories could be detected after a week or ten days. Every year, most pairs were successful in establishing a territory while one or two pairs were unable to do so effectively, at least during

**Table I. Breeding records for captive Shovelers.**
* Eggs removed on 14th June. † Two females laying in same nest. (Ad) more than one year old; (y) yearling.

| *Year* | *Pairs* | | *Date pairs introduced to pen* | *Date first egg* | *Clutch size* | *Incubation period in days* | *Eggs hatched* | *Ducklings raised* |
|---|---|---|---|---|---|---|---|---|
| | *Males* | *Females* | | | | | | |
| 1960 | A (Ad) | A (Ad) | April 26 | 5.19 | 8 | ? | 5 | 2 |
| | B (Ad) | B (y) | | 5.22 | 8 | 22-23 | 6 | 0 |
| | C (y) | C (y) | | 5.26 | 8 | 24-25 | 0 | 0 |
| | D (y) | D (y) | | — | — | — | — | — |
| | E (y) | | | | | | | |
| 1961 | A (Ad) | A (Ad) | May 4 | 5.18 | 8 | 29+ | 0 | 0 |
| | D (Ad) | D (Ad) | | 5.27 | 9 | 24-25 | 5 | |
| | F (y) | F (y) | | 5.27 | 8 | 24-25 | 5 | 4 |
| | E (Ad) | E (y) | | 6.9 | 5 | 22-23 | 4 | |
| | G (y) | | | | | | | |
| 1962 | A (Ad) | A (Ad) | May 7 | 5.18 | 8 | —* | — | — |
| | | | | 6.23 | 6 | ? | 5 | 0 |
| | D (Ad) | D (Ad) | | 5.21 | 13† | —* | — | — |
| | I (Ad) | I (?) | | 5.24 | 4 | ? | 0 | 0 |
| | G (Ad) | E (Ad) | | 5.31 | 8 | 24-25 | ? | 0 |
| | J (Ad) | J (y) | | 6.2 | 9 | 20-21 | ? | 0 |
| | E (Ad) | H (Ad) | | 6.7 | 4 | ? | ? | 0 |
| | F (Ad) | F (Ad) | | 6.17 | 6 | 22-23 | 5 | 1 |
| 1965 | 15 (Ad) | 13 (Ad) | May 5 | 5.15 | 8 | 35+ | 0 | 0 |
| Pen 1 | 2 (Ad) | 4 (Ad) | | 5.16 | 7 | 24-25 | 5 | |
| | 14 (Ad) | 8 (Ad) | | 5.18 | 9 | 24-25 | 2 | 4 |
| | 07 (Ad) | 2 (Ad) | | 5.22 | 10 | 22-23 | 8 | |
| 1965 | 0 (Ad) | 5 (Ad) | May 5 | 5.15 | 10 | 22-23 | 5 | |
| Pen 2 | 8 (Ad) | 12 (Ad) | | 5.16 | 8 | 22-23 | 8 | 7 |
| | 12 (Ad) | 10 (Ad) | | 5.16 | 10 | 22-23 | 3 | |
| | 5 (Ad) | 7 (Ad) | | 5.18 | 8 | 25-26 | 4 | |
| 1966 | 0 (y) | 0 (y) | May 3 | 5.17 | 8 | 24-25 | 7 | |
| Pen 1 | 1 (y) | 1 (y) | | 5.24 | 8 | 23-24 | 7 | 5 |
| | 2 (y) | 2 (y) | | — | — | — | — | — |
| | 3 (y) | 3 (y) | | — | — | — | — | — |
| 1966 | 4 (y) | 4 (y) | May 3 | 5.31 | 10 | 19-20 | 6 | |
| Pen 2 | 5 (y) | 5 (y) | | 5.20 | 8 | 23-24 | 2 | 2 |
| | 6 (y) | 6 (y) | | 5.23 | 11 | 22-23 | 5 | |
| | 7 (y) | 7 (y) | | 5.24 | 11 | 22-23 | 6 | |

the early part of the breeding season. Most pairs continued to occupy the first area chosen throughout the season; a few switched to a new area.

Ritualized fighting was frequent between males, especially on the boundaries between territories or when two pairs were in dispute over one area. These fights characteristically involved vigorous circling on one spot, with much thrashing of wings on the water surface.

**Inspection of nesting cover**

Females were seen walking into nesting cover on the first or second day after introduction to the pens, as early as 27 days before laying began. Their males usually accompanied them closely, frequently disappearing into the grass also, and sometimes remaining there after the hen had walked out. Places were found where females had been turning round in the grass, but well developed scrapes, ex-

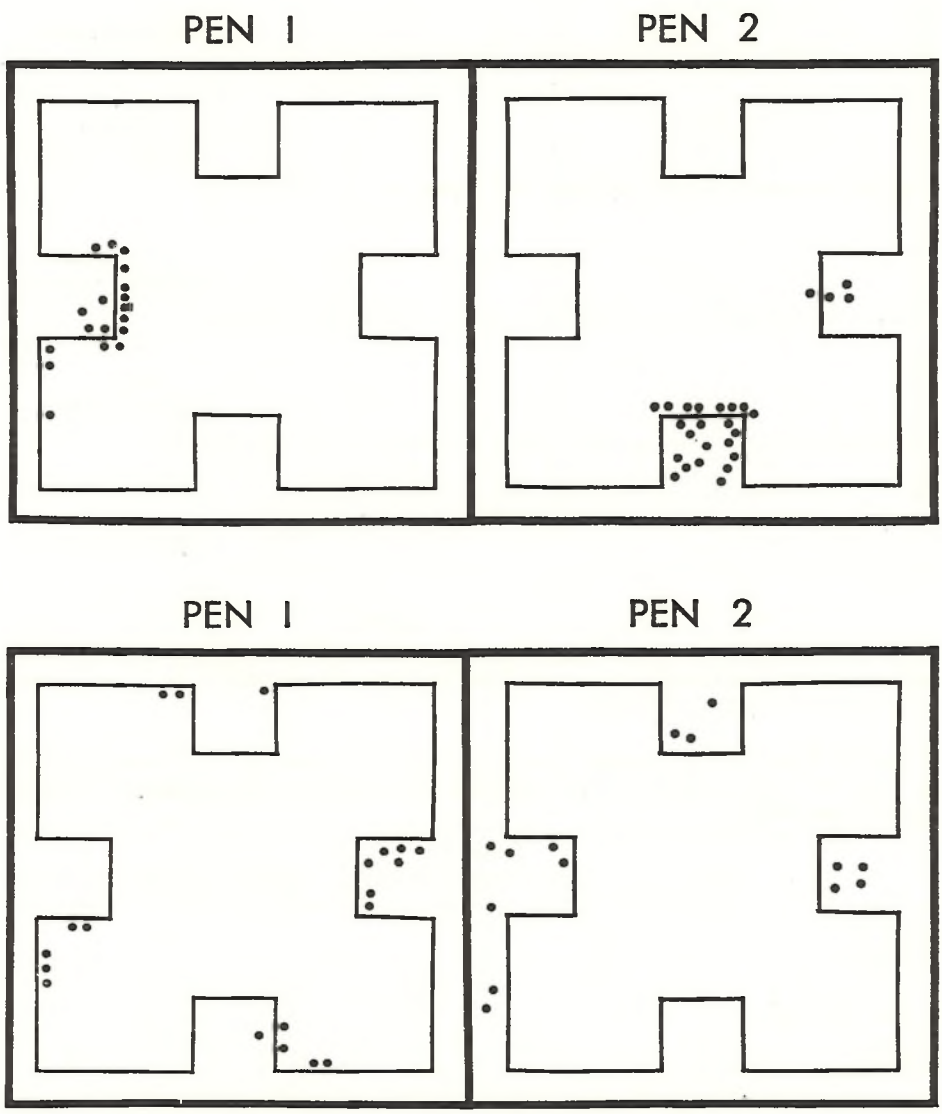


**Figure 2. Decrease in sociability of captive Shoveler pairs illustrated by the distribution of sleeping sites on days 1 and 2 after introduction (upper) and days 13 and 14 (lower).** Based on observations of 8 pairs, 4th, 5th May, 1966 (6 hours), and 16th, 17th May (8 hours).

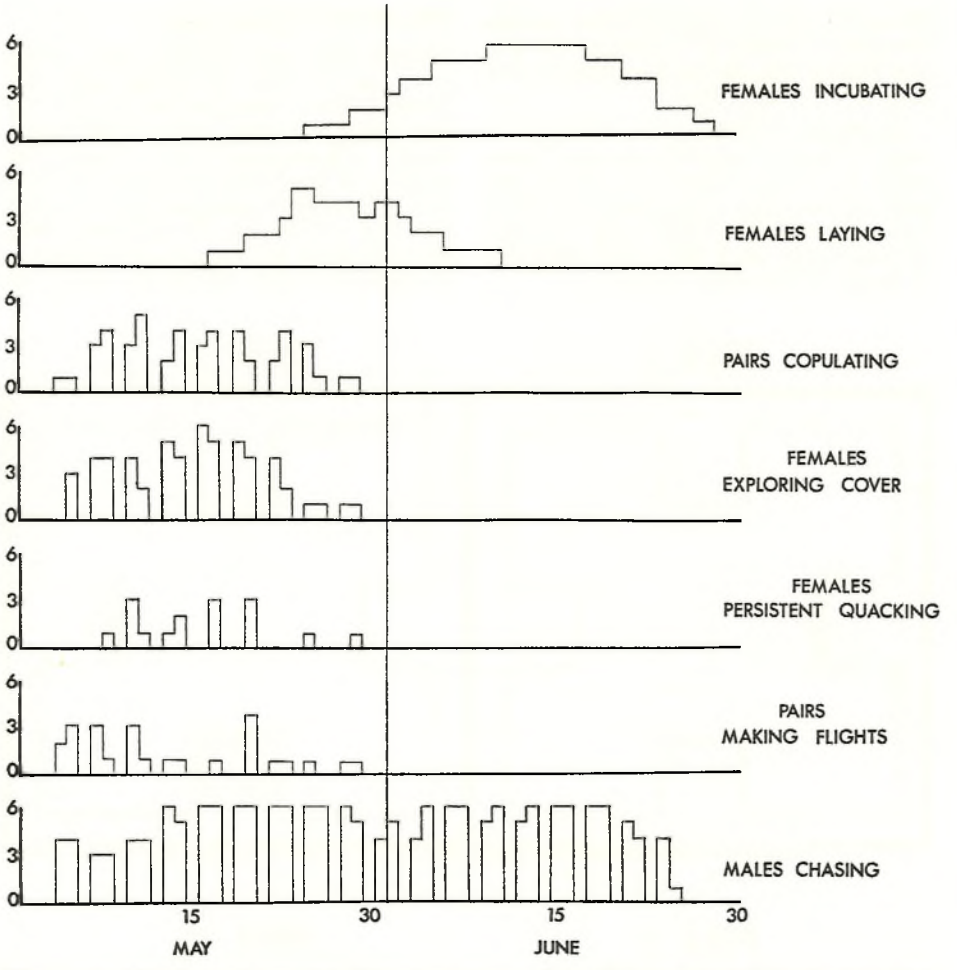


**Figure 3. Number of captive Shovelers engaged in different activities during May and June, 1966 (maximum six pairs).** Based on observation periods of 3 and 4 hours after dawn of every 3 mornings.

**Table II. Frequency of records of percentage of time spent by six Shoveler females in cover or at the nest-site during four-hour observation periods beginning at sunrise (May-June, 1966).**

| | *Percentages* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | <5 | 6-10 | 11-15 | 16-20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 | 81-90 | 91-100 |
| 13-27 days before laying | 9 | | | | | | | | | | | |
| 5-12 days before laying | 25 | 1 | 1 | | | | | | | | | |
| 1-4 days before laying | 6 | 4 | 3 | | | 1 | | 1 | | | | |
| First half of laying period | 1 | | | 1 | 2 | 4 | 2 | 1 | 1 | 1 | 1 | 2 |
| Second half of laying period | | | | | | | 1 | 2 | 1 | 3 | 2 | 12 |

posing bare earth, were not found until around the fifth day. Thereafter, the number of scrapes increased steadily. By 16th May, 1966, the day before the first egg was laid, eight females had made a total of 18 scrapes.

The time spent by females in nesting cover increased during the one to four days preceding the laying of the first egg (Table II). In 1966, three females were recorded sitting on one or more scrapes for periods of 30, 31 and 129 minutes on the day before they laid their first eggs.

Most females were observed inspecting cover in the morning hours, especially during the first few hours after dawn (Figure 4). Many females ranged widely in different parts of their pen but chases often resulted when pairs intruded into territories. As a result, the location of scrapes and nests was influenced greatly by the areas where pairs could move without being chased. Some females showed a clear preference for one scrape several days before the first egg was laid, but others appeared undecided until the day of laying.

The details of the behaviour in cover could not usually be observed, but much time was spent walking slowly through the grass, squatting and turning round in depressions. Some scrapes were lined with grass before laying began while others showed bare ground exposed. On several occasions, females were seen to reach upward to pull grass down (the technique by which a canopy is formed) before eggs were laid. Inspection of cover, sideways-building, and pulling down movements were recorded in one or both of the two females which did not lay in 1966.

Within the week before laying and

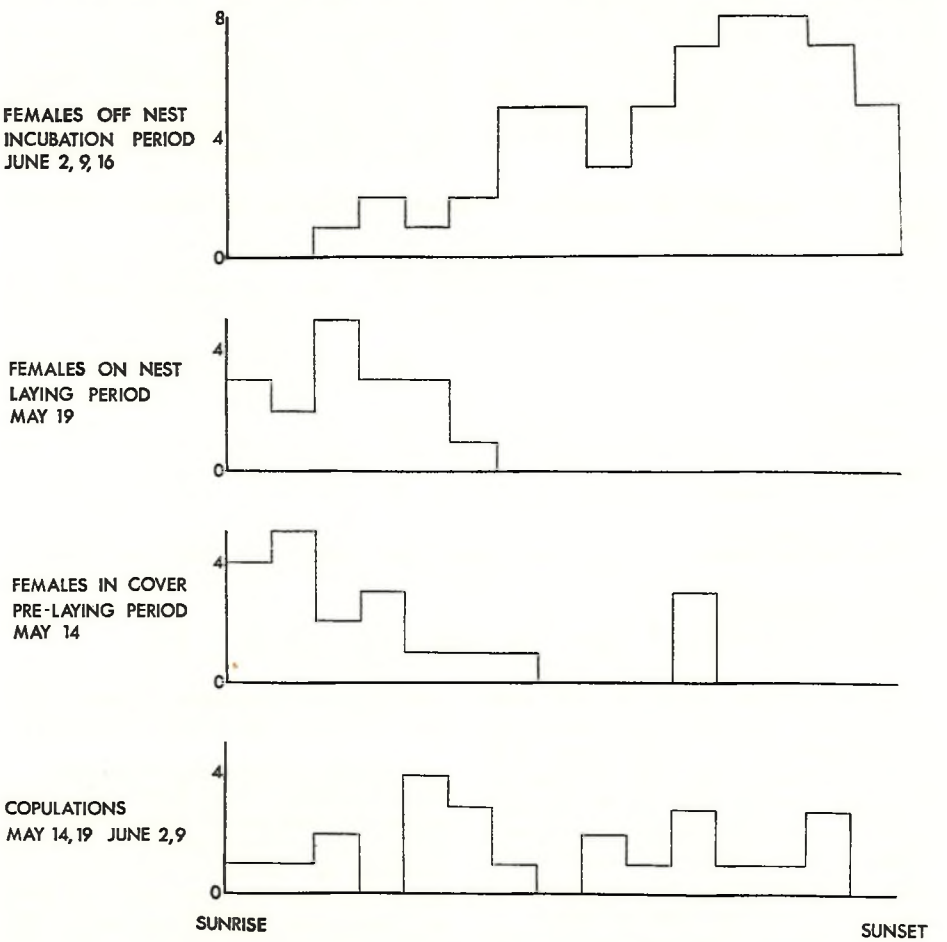


**Figure 4. Nesting activities and copulations of captive Shoveler in relation to time of day during five dawn to dusk watches, 1965.**

during the early days of laying females were observed making sideways building movements while sitting on open ground away from nesting cover or scrapes. On several occasions, these movements were seen just after a female had been at the nest to lay. Males were also observed making sideways building movements while sitting on open grass away from nest sites.

**Copulations**

Copulations were seen regularly from the day after introduction until the end of May. Most were seen during the pre-laying period, as early as 23 days before the first egg was laid, but some were also recorded during the laying period. The records for 1965 and 1966 show a drop in the frequency of copulations during laying. This might be expected since females were spending some time at the nest each day and so were "unavailable" for copulation, but the decrease is still apparent (for the first half of the laying period) when rates are computed on the basis of time when females were available (Table III).

was established that certain pairs may copulate twice in one day, others only once, others not at all. My records suggest that twice per day is usual during the period immediately before egg-laying begins. In four cases, during whole-day watches, pairs copulated at 09.49 and 15.42, 06.43 and 16.23, 09.24 and 17.53, 10.13 and 15.03, giving intervals of 5 h. 53 m., 9 h. 40 m., 8 h. 34 m. and 4 h. 50 m. In the course of morning watches, however, four instances of much shorter intervals were recorded: 06.35 and 09.35 (3 h.), 07.45 and 09.57 (2h. 12m), 04.57 and 07.25 (2 h. 28 m.), 04.58 and 07.32 (2 h. 34 m).

In most instances, mounting of the female by the male resulted in apparently successful copulation (120 records). Certain individual males, however, were unsuccessful in reaching the point of intromission, slipping off the female's back after mounting (10 records involving 6 males). In 15 instances, interruptions of pairs after the male had mounted resulted in incomplete copulation attempts. The close approach of another pair was usually effective in causing such an interruption

**Table III. Frequency of copulations in relation to egg-laying by Shoveler (1965 and 1966).**

| | *Days Before Laying* | | | | | *Laying Period* | |
|---|---|---|---|---|---|---|---|
| | 17-20 | 13-16 | 9-12 | 5-8 | 1-4 | *First half* | *Second half* |
| Number of pairs observed | 3 | 6 | 8 | 13 | 13 | 13 | 11 |
| Pairs observed copulating | 3 | 3 | 7 | 12 | 13 | 7 | 3 |
| Successful copulations observed | 6 | 3 | 9 | 26 | 28 | 8 | 3 |
| Hours of observation when females off nest | 32.5 | 73 | 93.3 | 163 | 228 | 186 | 35 |
| Rate of copulations per female available per 24 hours of observation | 1.48 | 0.16 | 0.29 | 0.29 | 0.23 | 0.08 | 0.19 |

Copulation was observed only three times during the incubation period and undoubtedly this is a rare event. This probably results from lack of adequate responses on the part of the females, since Pre-copulatory Pumping movements continue to be given at times by males, and a non-breeding pair continued to copulate up to 21st June in 1966.

There was no clear tendency for copulations to occur at certain times of day (Figure 4). During whole-day watches, it and typically copulations occurred when pairs were well apart from other birds.

**Pair Flights and Persistent Quacking**

Pairs frequently made flights around or across the pen during May. These were initiated in a characteristic way, being preceded by pre-flight movements, the birds standing in erect postures. With one exception, these flights ceased once egg-laying began (Table IV). Two non-breeding pairs continued to make flights up to 24th June, 1966.

Some females gave series of loud, harsh double quacks during the pre-laying period. This calling corresponds to the Persistent Quacking of the Mallard (= "Continuous Calls", Dzubin, 1957) but it appears to be less frequent in the Shoveler. It was recorded repeatedly in certain individuals but not at all in others. No clear correlation between calling and time of day was noted.

**Rape attempts**

The Shoveler is not one of the dabbling ducks which exhibits highly developed raping activity during the breeding season. Hostile interactions between pairs

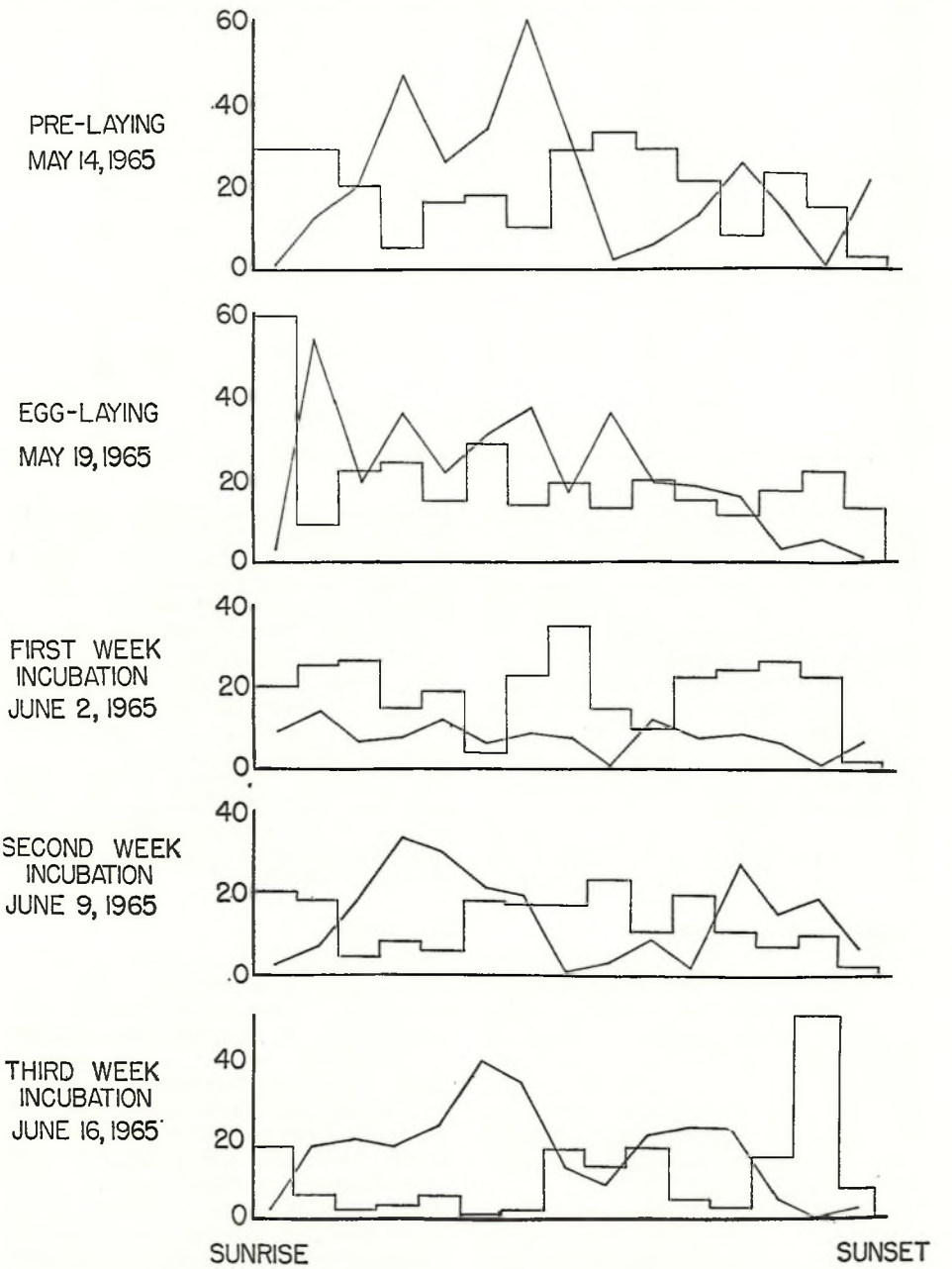


**Figure 5. Number of male chases among Shovelers (histogram) and number of sleeping birds at 10-minute checks (line).**

**Table IV. Occurrence of flights around pen and Persistent Quacking in six Shoveler pairs, 1966.**

| *Days before laying* | *Total number flights* | *Number of pairs making flights* | *Number of females giving Persistent Quacking* | *Number of pairs or females under observation* |
|---|---|---|---|---|
| 27 | 1 | 1 | 0 | 1 |
| 25-26 | 1 | 1 | 0 | 1 |
| 23-24 | 4 | 1 | 1 | 1 |
| 21-22 | 1 | 1 | 1 | 1 |
| 19-20 | 2 | 2 | 0 | 4 |
| 17-18 | 7 | 4 | 1 | 4 |
| 15-16 | 2 | 2 | 1 | 5 |
| 13-14 | 17 | 3 | 2 | 6 |
| 11-12 | 8 | 1 | 1 | 6 |
| 9-10 | 7 | 4 | 1 | 6 |
| 7-8 | 1 | 1 | 2 | 6 |
| 5-6 | 2 | 1 | 2 | 6 |
| 3-4 | 5 | 3 | 3 | 6 |
| 1-2 | 2 | 1 | 1 | 6 |
| *Days of egg-laying* | | | | |
| 1-2 | 0 | 0 | 1 | 6 |
| 3-4 | 3 | 1 | 0 | 5 |
| 5-6 | 0 | 0 | 0 | 4 |
| 7-8 | 0 | 0 | 0 | 5 |
| 9-10 | 0 | 0 | 0 | 3 |
| 11-12 | 0 | 0 | 0 | 1 |

occurred daily throughout the territorial period and males frequently chased strange females, but clear attempts to rape were infrequent, and successful rape was rare. Only four instances of apparently successful rape were recorded during the five seasons. On 6th and 25th May, 1960, the female which did not lay was raped by the most aggressive male in the pen. On 6th May, 1965, and 13th May, 1966, rapes were observed involving females which had not begun to lay. The ability of most paired males to discourage the approach of other males by means of aggressive behaviour undoubtedly plays an important part in protecting females.

### Egg-laying and incubation

Visits to the nest-site by females during the laying period were usually in the morning (Figure 4), but the precise times of laying are not known. Time spent on the nest each day increased during the laying period. During the first few days, most visits lasted one to two hours, but in the later stages of egg-laying many females were on their nests throughout the four-hour morning watches (Table II).

Although the nests were not visited every day it was established that females usually, but not always, laid one egg each day. In several instances, one or more days were missed, e.g. clutches of 7 or 8 eggs would not be complete until the tenth day. Furthermore, on 19th May, 1965, two females, which had already laid 2 and 4 eggs, did not visit their nests at all in the course of a dawn to dusk watch.

Incubating females left the nest at various times during the day, but most often in the late morning and afternoon (Figure 4). Sometimes females had two periods off, sometimes one, and in two instances females did not leave at all in the course of whole-day watches. The period off varied in length between about a half-hour and two hours. While off the nest, females bathed, preened, and fed with their mates.

### Egg removal

Thirteen of 29 clutches were reduced by one or more eggs in the course of incubation and since nests were not visited daily a similar loss of eggs may have occurred in other nests without being detected. There was no evidence that egg predators were responsible, although rats were seen inside the Delta pen during one breeding season. The Cedar Creek pens appear to be effectively predator-proof. Three observations of females carrying an egg or egg shell from the nest suggest that this behaviour accounts for the disappearance of eggs from clutches.

The first observation was made on 8th

June, 1962. The female concerned had 2 eggs on 25th May, 3 on 28th May, 4 on 2nd June, and had 4 left in the nest after the removal was observed. Without more complete information it is impossible to explain the apparently slow laying schedule of this bird and to determine the stage of incubation at which the egg was removed. The eggs later dwindled to 3 and then 2; none hatched. The second observation was made by James March on 8th June, 1965. The female had been incubating a clutch of 10 eggs for two weeks; two days after the removal was witnessed she had 8 eggs. This clutch was subsequently reduced to 7 eggs, and 5 ducklings hatched. In both cases, the bird was seen to fly off the nest carrying an egg in the bill. Apparently the eggs had been pierced since they were carried in the tip of the bill and must have been grasped by a broken edge. After the birds alighted on water, the eggs were dropped and sank.

On 23rd June, 1965, James March saw a female fly off her nest carrying a broken egg shell in her bill, "freshly broken since yolk was still dripping from it." She dropped it in the water. On the next day this bird was found on the nest with newly-hatched ducklings under her.

On 22nd June, 1966, an empty egg shell, neatly cracked across the middle and half-opened, was found floating on the water. An egg was also seen floating on the surface on 27th June, 1965. These eggs must have been removed by females in the same way.

Throughout these studies, the presence of discoloured eggs was frequently noted when nests were checked during incubation. I suspect that some of these eggs are removed by females in the way described, but how they become broken is unknown.

### Distraction Display

Incubating females were flushed from their nests occasionally and in many cases they flew on to the water nearby and made vigorous flapping movements with the open wings on the surface. Sometimes they gave loud quacks, at other times they merely opened the bill. These reactions were most frequent in the later stages of incubation.

### Daily rhythms of sleeping and chasing activities

During the 1965 and 1966 observations, a record was kept every 10 minutes of the birds which were sleeping. A peak of sleeping activity occurred during the morning hours and there are indications of a secondary peak in the afternoon (Figure 5). Few birds were sleeping in the first hour after dawn or in the last hour or so before sunset. Usually the frequency of chasing activity is inversely correlated with the peaks in sleeping. This is especially clear in the case of the early morning burst of hostility. In several instances, however, both sleeping and chasing were infrequent during the last hour before sunset. This is probably correlated with a tendency for birds to feed actively just before sunset, but I cannot document this impression since daily variations in feeding behaviour were not recorded quantitatively.

The conspicuous peak in chasing activity in the late afternoon of 16th June (Figure 5) coincided with the time when a number of females were off their nests. Such an increase in male hostility often resulted when females joined their mates.

### Broods

The behaviour of females with ducklings was not studied intensively. Probably this phase of breeding was more seriously affected by the pen conditions than any other. Ducklings ranged all over the pens, and were the cause of many hostile encounters. Females with broods often attacked ducklings from other broods, sometimes apparently killing them. This in turn lead to chasing and even fighting between females. Broods were also attacked when they passed close beside incubating females. Aggressive males attacked females with broods when they intruded in territories and in some instances the females fought back.

Although such conflicts no doubt accounted for some of the heavy duckling mortality, I suspect that shortage of food also played a part. In the last two years a determined attempt has been made to provide the young birds with an abundant supply of food in the form of duckweed (and the associated invertebrates collected with it) and prepared duckling pellets. But Shoveler ducklings spend a great deal of time dabbling in the water, and perhaps this effort has not been rewarded with a sufficiently rich return in the form of animal food.

### Post-breeding moult

Males began to develop blotchy plumage in mid-June, and many were well advanced into the eclipse plumage by the

end of June. Most males were flightless between mid-July and mid-August, and had grown new primaries by the end of August. The single unpaired male was flightless much earlier than the paired males (by 5th July) in 1960. In 1961 the same individual male succeeded in displacing one of the paired males within a few days of introduction to the pen. This bird again moulted early (being flightless on 11th July), but the displaced male, who remained unpaired, did not lose his primaries early. Further studies are needed to determine whether unpaired males have a tendency to moult at a different time from paired males. Most females were not flightless until the middle or the end of August.

## Discussion

The information on chronology of nesting-cover inspection, Persistent Quacking, pair flights, territorial hostility and copulation agrees well with what is known of these activities in wild Shovelers (e.g. Sowls 1955; personal observations). Variations in certain activities with time of day are also close to what might have been expected on the basis of field observations. The behaviour of females with broods, however, is likely to be highly unusual under such pen conditions, and much larger enclosures with fewer birds would be necessary to obtain natural behaviour.

These captive conditions appear to have influenced fertility and hatchability of eggs, and duckling mortality, in a number of ways. Shortage of ideal food and aggressive behaviour of females were probably involved in the poor survival of ducklings, but my information on the fate of eggs is too incomplete at this stage to yield more than suggestions on the factors involved in egg-loss.

The observations on egg removal, however, raise a number of interesting points. This behaviour is known to occur in wild ducks (e.g. Lindsey 1946, Hochbaum 1944) and Sowls (loc. cit.) has made experiments on egg shell removal by a wild Shoveler. The field observations suggest that females will remove broken eggs from a nest which has been only partly destroyed by a predator, and may return to continue incubation of the remaining eggs. Furthermore, many field workers have noted that eggs disappear from duck nests in the course of incubation for unknown reasons (e.g. Bezzel 1966). Sowls (loc. cit.) tentatively suggested that egg-removal by the hen might explain this phenomenon, and he also made the point that egg shell removal does *not* seem to occur at the time of hatching.

The observations on captive Shovelers support these suggestions. Two of the three cases where females were seen to fly off the nest carrying an egg in the tip of the bill involved nests being incubated. In the third case, hatching was in progress in the nest but the shell had yolk dripping from it, indicating that a duckling had not hatched from the egg concerned. The intriguing question is how the eggs become broken before removal.

I agree with Sowls that egg shell removal does not seem to be a regular occurrence in Shovelers at the time of hatching. Shells are often found in nests after the brood has left, and there are no observations indicating that shells from hatched eggs are removed at this time. Nevertheless, Sowls' experiments clearly demonstrated that females will remove shells during the incubation period. Presumably the situation is quite different from that revealed by Tinbergen *et al.* (1962) in the Black-headed Gull *Larus ridibundus*, where the removal of eggs at hatching is a regular event and has survival value in avoiding betrayal of the nest to aerial predators. The present meagre evidence suggests that incubating female Shovelers will remove addled or broken eggs during the incubation period, but will not remove shells at the time of hatching. An experimental approach to this problem would be rewarding.

### Acknowledgements

My interest in the flight pen technique developed slowly in the course of observations on pinioned birds at the Wildfowl Trust and studies of wild birds at Delta. It is appropriate, as the Trust nears its twenty-first anniversary, that I first acknowledge my debt to Mr. Peter Scott for providing me with the opportunity to learn the advantages and limitations of captive waterfowl for behaviour studies. The Trust's magnificent collection has had a profound influence on many aspects of research, education, and conservation, but its leading role in fostering investigations of waterfowl behaviour has been especially obvious. I take great pleasure in paying tribute to Peter Scott for his tireless efforts on behalf of waterfowl and the study of their biology.

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Mr. Nan Mulder and Mr. Peter Ward for their encouragement and help. The Cedar Creek project was financed by the United States Atomic Energy Commission, Contract AT(11-1)-1332 (Publication C00-1332-33). I am indebted to Dr. John R. Tester, project leader, for assistance and advice of many kinds. For their important parts in facilitating the study I must thank Mr. Floyd H. Davis and the U.S. Fish and Wildlife Service banding crews in North Dakota and South Dakota for supplying birds, Mr. Forrest B. Lee and the Minnesota State Conservation Department for providing wintering quarters for ducks at the Carlos Avery Game Farm, Dr. William H. Marshall and Mr. Alvar Petersen for courtesies at the Cedar Creek Natural History Area, Mr. James R. March for assistance with observations, and Mr. Hugh House for invaluable practical help of all kinds. Mr. David Strohmeyer gave helpful comments on the manuscript.

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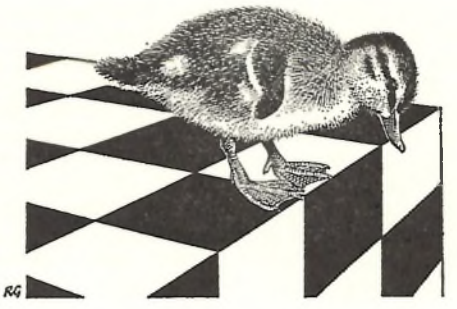

# Experiments with young nidifugous birds on a visual cliff

JANET KEAR

**Summary**

Newly-hatched young of ground-nesting species were found to prefer the shallow side of a visual cliff, while birds normally hatching in holes in trees chose the shallow and deep sides about equally. Species which nest both on the ground and in trees gave intermediate scores. The reaction of the hole-hatching ducklings was definite enough to suggest that their performance was not due to inferior powers of depth discrimination; it possibly represented a compromise between a wide-spread tendency to avoid sharp drops and the necessity for jumping to the ground soon after hatching.

We know that most animals are born with the ability to perceive and react to detailed aspects of the environment, and often their responses seem remarkably adjusted to surroundings of which they have as yet had no experience. Frequently the features they react to are relationships rather than absolutes. Many young wildfowl for instance, respond by pecking at any spots which are small in relation to their visual field and contrast with it. A newly-hatched gosling prefers to peck at a larger object, in absolute terms, than a young duck, and while a Mallard duckling seems particularly attracted to any small spot that moves in relation to the background, a Greylag gosling seems more interested if the object looks green. Thus we may suppose the duckling is drawn to live insects and the gosling to grass, their normal foods.

This preliminary study was designed to test the extent to which young wildfowl and a few other nidifugous birds recognise and prefer another relative feature, depth. Did species that feed on land and those that feed on water react differently to depth, and did both differ from youngsters that dive and obtain their food beneath the surface? The possibilities were investigated by means of a simple experimental apparatus designed and used mainly in America by Gibson and Walk (1960). It is called a Visual Cliff, but the drop is a simulated one so that the reactions of the animals can be observed while they are protected from actually falling.

The apparatus used here consisted of a central board covered with soft cloth laid across a rectangular piece of heavy glass supported about 50 cms. from the ground (see Figure 1). On one side of the board a sheet of chequered material was placed directly against the under side of the glass, thus giving it the appearance of, as well as actual, solidity. On the other side the sheet of material was laid 20 cms. below the glass thereby producing the visual cliff. The piece of glass with the board bisecting it was surrounded by an upright edging some 10 cms. high.

Ten individuals of ten species were used in the tests. Each individual came straight from the incubator or the nest where it had hatched; thus all were less than 24 hours old, and had had a minimum of visual experience. The young bird was placed singly on the board in the centre of the glass, and the direction it took when leaving the board was noted. It was then returned to the centre so that ten responses were recorded in all. After the fifth movement from the board the whole apparatus was turned round to cancel out any irrelevant direction preferences the birds might have.

Results are given in Table I. The first important finding was that there were indeed differences between the species' be-

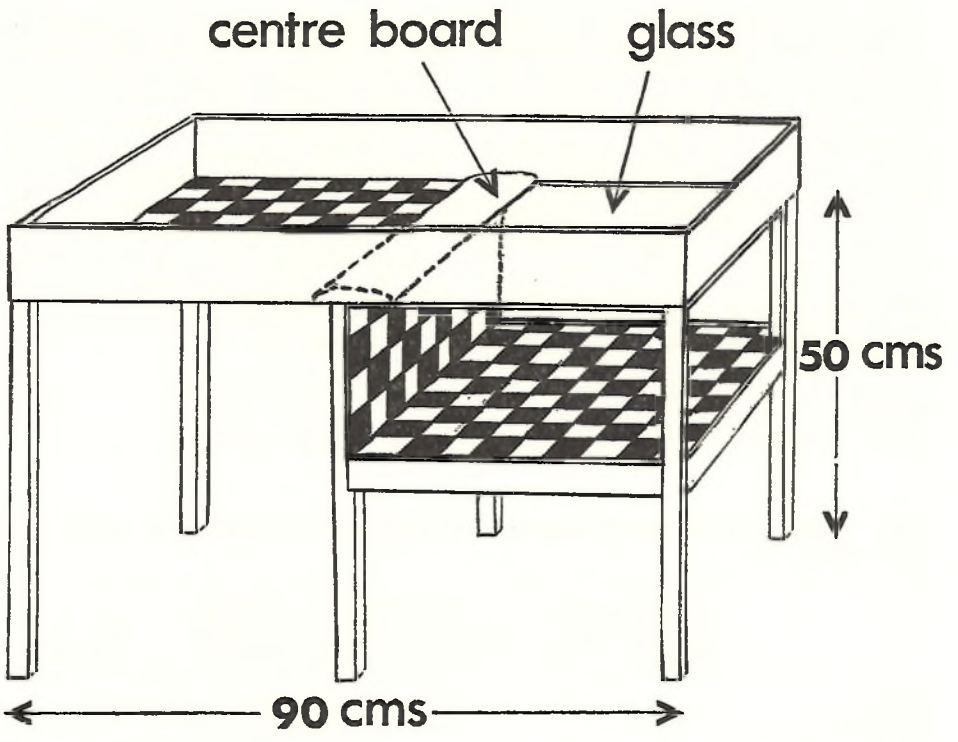


**Figure 1. The visual cliff apparatus.**

haviour on a brink. However, the obvious correlation did not seem to be with the normal feeding environment of the young. The little Australian White-eye duckling, which in nature feeds both on and under the water surface, ventured off on the deep side only 13 per cent of the time, while the Wood duckling, which very seldom dives for food, chose the deep side in 54 per cent of its responses. It seems therefore that the drop side of the visual cliff was not interpreted as water. Instead the results make more sense if they are correlated with the normal position of the nest in which the young bird hatches. Species that hatch on the ground, like the White-eye, the Pheasant and the Partridge, markedly preferred the shallow side of the apparatus, while ones that hatch in holes in trees, such as Mandarin, Comb ducklings and Wood ducklings, appeared to choose either side at random. However, hole-hatching ducklings did not react as if they were unable to detect the difference between deep and shallow; they ran off the shallow side and jumped right out on to the deep one—just as they must when leaving a hole in a tree. Similarly, 23 per cent of the Mallard, which at Slimbridge occasionally hatch in trees, did not "mistake" the deep side for the shallow; they did not jump so vigorously from the edge but bent forward very low and pushed off with both feet. Results in Table I are given both for the first response and for the sum of the responses by the ten individuals of each species. As far as they go, the figures indicate that the direction of the first movement did not influence those that followed and that the birds were not applying learning to the situation.

Gibson and Walk (1960) have shown that a number of young mammals, including human babies, and certain birds such as domestic chicks, can discriminate depth as soon as their locomotory powers are developed, even if locomotion starts at a day old. None of these experimental animals stepped out on to the glass covering the drop. The only creature that showed a poor performance in their tests were aquatic turtles, but even 70 per cent of these crawled off the central board on to the shallow side. The relatively large minority that chose the deep side suggested to Gibson and Walk either that the turtle had inferior depth-discrimination to other animals, or that its aquatic habitat gave it less occasion to "fear" a fall.

With the ducklings there is no reason to believe that powers of depth discrimination in ground-nesters, hole-nesters and intermediate species are very different. In general, the ability to see and avoid a sharp drop must help in survival, but it would clearly be disadvantageous if a Mandarin or Wood duckling hatched with an invariable disinclination to jump into a chasm and thereby failed to join its mother at the bottom of the tree. It is interesting, too, that it does not positively prefer the drop; if it did, it might perhaps hurl itself over every cliff it met.

More research will be undertaken to discover what cues the youngsters respond to in recognising depth and distance and whether there are critical ages at which the behaviour of the various species changes. For instance, it is possible that a few days experience of swimming will modify a young bird's reactions. The advantages need not be stressed of having access to the bird collection of the Wildfowl Trust, in which nearly 100 related species with different habitat requirements breed successfully.

**Reference**

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**Table I. Reactions of recently-hatched individuals of some nidifugous species to a visual cliff.**

| | *First Response (by each bird)* | | *Total Responses (10 by each of 10 birds)* | | *Feeding environment of young* | *Nest site of parent* |
|---|---|---|---|---|---|---|
| | *Shallow* | *Deep* | *Shallow* | *Deep* | | |
| Partridge *Perdix perdix* | 9 | 1 | 94 | 6 | on land | on ground |
| Australian White-eye *Aythya australis* | 9 | 1 | 87 | 13 | on and under water | „ |
| Pheasant *Phasianus colchicus* | 9 | 1 | 86 | 14 | on land | „ |
| White-faced Tree Duck *Dendrocygna viduata* | 7 | 3 | 81 | 19 | on and under water | mainly on ground, sometimes in hollow trees |
| Moorhen *Gallinula chloropus* | 9 | 1 | 81 | 19 | on water and land | mainly on ground, rarely in trees |
| Marbled Teal *Anas angustirostris* | 9 | 1 | 79 | 21 | on and under water | quite often in holes, but not often off the ground |
| Red-billed Tree Duck *Dendrocygna autumnalis* | 8 | 2 | 78 | 22 | „ | more often in hollow trees than *viduata* |
| Mallard *Anas platyrhynchos* | 8 | 2 | 77 | 23 | on water | 8-10% off the ground |
| Muscovy Duck *Cairina moschata* | 7 | 3 | 64 | 36 | on water | always in holes at ground level or above |
| Mandarin Duck *Aix galericulata* | 5 | 5 | 54 | 46 | on water | in holes above ground |
| Comb Duck *Sarkidiornis melanotus* | 5 | 5 | 51 | 49 | „ | „ |
| Wood Duck *Aix sponsa* | 5 | 5 | 46 | 54 | „ | „ |

# The significance of clutch-size in waterfowl

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**Summary**

1. The average clutch-size of the different species of waterfowl varies inversely with the relative size of the egg. This applies to the Anatidae as a whole, to each of the four genera which can be tested separately, and to four subspecies of the Mallard.
2. It is suggested that the average clutch of each species has been evolved in relation to the average availability of food for the female around the time of laying, modified by the relative size of the egg.
3. The specific differences in clutch-size and egg-size are mainly hereditary and variations in the food supply for a particular female perhaps influence mainly the date of laying.
4. The inverse relationship between clutch-size and egg-size is only broad, probably because the average availability of food differs greatly in different species.
5. The advantage of a relatively large egg is that the newly hatched chick has a relatively large reserve of food.

Twenty years ago, I advocated that the clutch-size of birds which feed their nestlings has been evolved in relation to the size of brood from which, on average, most young survive, the limit being set by the amount of food which the parents can bring to the young; and this view, with minor modifications, has been supported by later observations (Lack 1947, 1966). However, it cannot apply to those birds in which the young feed for themselves from hatching, notably the family Anatidae. Yet, if one believes in natural selection, the normal clutch of each species of waterfowl should be that which, on average, results in the parent concerned leaving the greatest number of surviving offspring.

Why, then, should different species of ducks lay clutches of such different size, ranging from two to three in the Musk Duck *Biziura lobata* to about a dozen in some species of *Dendrocygna*, *Tadorna*, *Anas*, *Aythya*, *Aix* and *Bucephala*? H. J. Frith suggested to me some fourteen years ago that the number might be limited by the food reserves of the adult female, but I dismissed this. However, I later found evidence that the food reserves of the female can modify the clutch-size of the Swift *A. apus* and perhaps of gallinaceous birds (Lack 1956, 1966).

The figures for the weight of the fresh egg and the adult female of many species of Anatidae given by Schönwetter (1960-61), and extensively supplemented by J. Kear (pers. com.), show that the weight of the egg in proportion to the weight of the bird differs greatly in different species, ranging from $2\frac{1}{2}$ per cent in the White-winged Wood Duck *Cairina scutulata* to a little over 20 per cent in two stiff-tails *Oxyura maccoa* and *O. dominica*. Part of this variation is due to a general trend, found within every family of birds, and also within each genus and tribe of ducks, for the smaller species to have proportionately heavier eggs (Heinroth 1922), but this is not the only factor concerned. For instance, though the female Pintail *Anus acuta* and White-headed Duck *Oxyura leucocephala* are of similar weight, their eggs weigh 45 and 96 grams respectively. Again, though the Black Swan *Cygnus atratus* is nearly nine times as heavy as the Bahama Pintail *Anas bahamensis*, the eggs of both are about six per cent of their body-weight.

When proportionate egg-weight is plotted against body-weight for all the available species of waterfowl, a mean curve can be fitted by eye to show the average increase in proportionate egg-weight with decreasing body-weight. The points for some species, notably swans *Cygnus* and stiff-tails *Oxyura*, come well above this mean line, while those for certain other species, notably in the genera *Dendrocygna* and *Anas* and the tribe Cairinini, come well below it, and these species can be said to have relatively large and relatively small eggs respectively (Figure 1).

By drawing lines parallel to the mean line, I separated off all the species with relatively large or small eggs, and relatively fairly large or fairly small eggs, respectively, in such a way that there were a nearly equal number of species in each of these four categories. As there is not space to publish here the weights for each species and the egg-size category to which it has been allocated, copies of this information have been deposited at the Wildfowl Trust and the Edward Grey Institute, together with the usual clutch of each species, based on Delacour (1954-64) and modified by J. Kear (pers. com.).

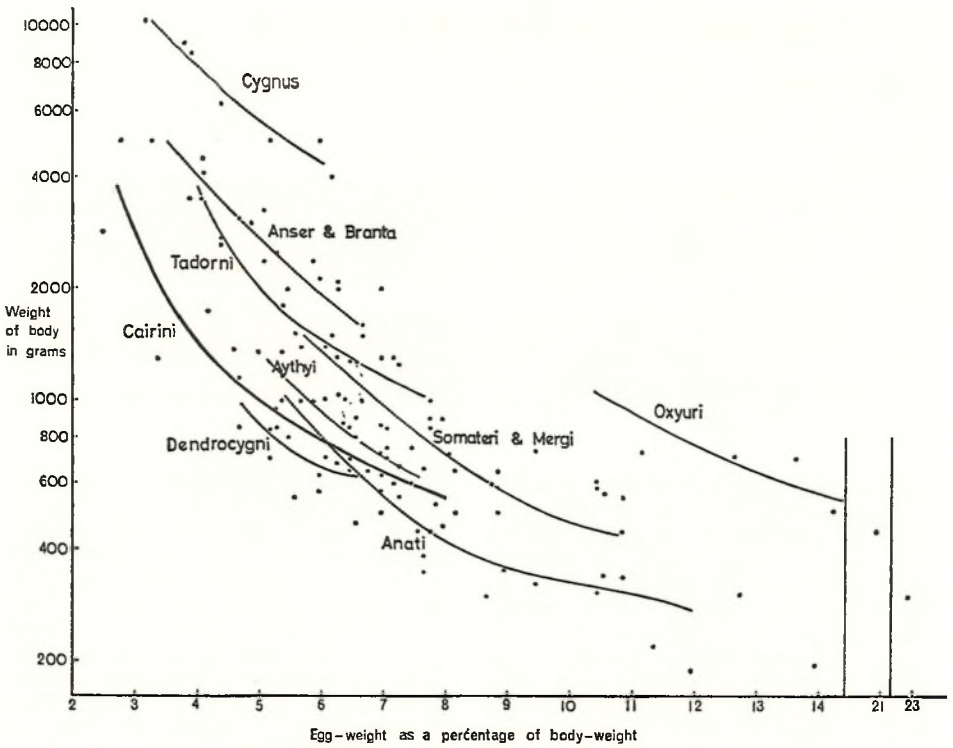


**Figure 1. Proportionate egg-weight in relation to body-weight in Anatidae.**

Table I shows that the average clutch-size is just over five for the species with relatively large eggs, about seven and a half for those with fairly large eggs, eight for those with eggs of medium size, and nearly nine and a half for those with relatively small or fairly small eggs. Hence clutch-size and the relative size of the egg are inversely related. This suggests that the female has limited food reserves which can be used to form either a few large eggs or more smaller ones. Since both clutch-size and the size of the egg are relatively constant in each species, the main differences between species are probably due to hereditary factors, evolved through natural selection. It is reasonable to suggest that they have been evolved in relation to the average availability of food for the female around the time of laying.

The inverse relationship between clutch-size and relative egg-size is only broad, as shown by the wide limits in the average clutch-size of the species in each egg-size category in Table I. But this is to be expected if the relationship depends on the average availability of food for the laying female, as the latter must be expected to differ greatly in different species. A few species lay about their own weight of eggs in a clutch, including the Shelduck *T. tadorna*, the Ruddy Duck *Oxyura jamaicensis* and the three species

**Table I. Clutch-size and relative size of egg in the Anatidae as a whole.**
Separate figures are included for a few well-marked subspecies of the same species.

| *Relative size of egg* | *Number of species (or subspecies)* | *Average clutch* | *Limits of average clutch* |
|---|---|---|---|
| large | 18 | 5.1 | 2-8 |
| fairly large | 20 | 7.6 | 4-12 |
| medium | 55 | 8.0 | 4-13 |
| fairly small | 20 | 9.4 | 6-12 |
| small | 21 | 9.3 | 6-11 |

of goldeneyes *Bucephala*, while at the other extreme, the clutch is only about 16 per cent of the body-weight in the Trumpeter Swan *Cygnus c. buccinator*.

It might be objected that the different tribes of Anatidae are so different that the figures for all species of waterfowl should not be grouped together as in Table I. However, Table II shows that there is a similar inverse relationship between clutch-size and the relative size of the egg in each of the four genera for which there are enough species with eggs of different size for a separate analysis, namely *Anser*, *Branta*, *Anas*, and *Aythya*. Moreover a similar relationship holds among four races of a single species, *Anas platyrhynchos*, as the egg is relatively smallest in the Common Mallard *A. p. platyrhynchos*, with a clutch of about 11, next smallest in the Florida Duck *A. p. fulvigula*, with a clutch of nine, rather larger in the Hawaiian Duck *A. p. wyvilliana*, with a clutch of eight, and relatively largest in the Laysan Duck *A. p. laysanensis*, with a clutch of five. Again the Auckland Island Flightless Teal *Anas a. aucklandica*, with a clutch of three to four, has a relatively larger egg than the New Zealand form *A. a. chlorotis*, with a clutch of six.

**Table II. Clutch-size and relative size of egg in certain genera of waterfowl.**

| *Relative size of egg* | *Number of species (or subspecies)* | *Average clutch* |
|---|---|---|
| *Anser* | | |
| fairly large | 5 | 5.3 |
| medium | 5 | 6.1 |
| *Branta* | | |
| fairly large | 2 | 4.3 |
| medium | 3 | 5.7 |
| *Anas* | | |
| fairly large | 2 | 4.8 |
| medium | 13 | 7.6 |
| fairly small | 13 | 9.6 |
| small | 8 | 9.4 |
| *Aythya* | | |
| fairly large | 2 | 7.3 |
| medium | 7 | 9.2 |
| fairly small | 2 | 9.0 |

Since, in waterfowl, a relatively larger egg has been evolved at the expense of a smaller clutch, it must have some compensating advantage. This is probably in providing the newly hatched duckling with a relatively large fat reserve, which is at first in the yolk sac, but is rapidly transferred to the liver and under the skin just after hatching (Kear 1965). The advantage of this fat reserve is that it enables the young to withstand temporary food shortage. For instance, ducks have proportionately larger eggs than gallinaceous birds, and correspondingly a young Mallard can survive without food for longer than a young Capercaillie *Tetrao urogallus*; further, Swedish Mallard have larger yolk sacs and can survive for longer than English ones (Marcström 1966). Again, swans have relatively large eggs, and their newly hatched chicks can survive unusually long without food (Heinroth 1926, Perrins and Reynolds 1967). The other waterfowl with relatively large eggs are the stiff-tails, and the young of *Oxyura leucocephala* have an unusually thick dorsal layer of fat; further their eggs are unusually resistant to changes in temperature, which may be a subsidiary advantage of a large egg (Phillips 1926).

It is presumably because they have a big fat store that newly hatched ducklings can walk a long way from the nest before their first meal, and this has the special advantage that the duck need not nest beside water, and so may select a safer site than might otherwise be possible. A large fat store confers a special advantage on arctic species such as the Goldeneye *Bucephala clangula*, since it can act as an insulating layer. Further, young Goldeneyes maintain their body temperature by metabolising fat, and so can continue searching for food, whereas young Mallard are not cold-hardy and, if cold, have to be brooded by the parent (Koskimies and Lahti 1964). It is therefore suggestive that nearly all the waterfowl which nest in the arctic belong to genera with relatively large or fairly large eggs, namely *Cygnus*, *Anser*, *Branta*, *Somateria*, *Melanitta*, *Bucephala* and *Mergus*. Again, J. Kear pointed out to me that probably the ducklings which find it hardest to obtain food are those which have to dive for it, notably in the tribes Mergini and Oxyurini, and these have relatively large or fairly large eggs; pochards Aythyini do not have relatively such large eggs, but their young at first feed from the surface, except for the New Zealand Scaup which according to Porter (1940) will go down to six feet to feed even at a day old. This species also has relatively the largest egg among the Aythyini. It may be wondered whether conditions are unusually rigorous for ducklings on islands, since the Laysan and Auckland Island ducks have relatively larger eggs than most other species of *Anas*.

Clearly, the extent to which a larger egg, and hence a fatter duckling, is advantageous depends on the conditions experienced by the young soon after hatching. The size of egg evolved by each species is presumably that at which the improvement in the survival-rate of each chick resulting from a larger egg just balances the resulting decline in the number of eggs laid.

If, as argued here, the hereditary differences in clutch-size and egg-size between different species have been evolved in relation to the average availability of food for the laying female, it might be thought that, if food were unusually sparse, a duck would lay either a smaller clutch or smaller eggs than usual. That it does not usually do so is presumably because, if it did, its chances of leaving offspring would be too small to set against the risks and strains of breeding. Further, in many areas a shortage of food at the start of the breeding season is likely to be very temporary. Hence if food is sparse, it is probably most advantageous for a duck to postpone breeding until it can produce a clutch and eggs of the normal size, though there is no direct evidence on this point. Again, if food is unusually plentiful, a duck does not usually lay more or larger eggs; perhaps it lays earlier, though again there is no direct evidence. Early laying might be advantageous when the potential breeding season is short. While these remarks seem true in general, some annual, local and seasonal variations in clutch-size are known in ducks and need study.

**Acknowledgements**

I must apologise to H. J. Frith for ignoring for so long his suggestion mentioned in the first paragraph. I am extremely grateful to J. Kear for her trouble in helping to assemble the data on weights and clutch-size on which the paper is based.

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# Geese on the Hortobágy, autumn 1966

JULES PHILIPPONA and TOM LEBRET

## Introduction

In 1966 it was thirty years after Peter Scott's visit to the Hortobágy, the famous puszta in the eastern part of Hungary. The story and the pictures in *Wild Chorus* (Scott, 1938) and papers in *Aquila* the well - known Hungarian ornithological magazine gave a legendary fame to an area where a considerable part of all the geese of Europe gathered in autumn and spring. In recent years rumours about a decrease in the numbers of the geese were heard. Both the former fame and the wish to know what actually is going on, made us decide to visit the Hortobágy. And so our group of five ornithologists—F. Haak, R. Visser, P. Zomerdijk and the authors—arrived at the Hortobágyi Csárda (csárda means inn) in the evening of October 29th, 1966. Here we spent six fine days. In the evening we enjoyed the music of the gypsy band of the Burai family. The leader of the band is still the same violinist we found in the stories of *Wild Chorus*.

Our main object was to count the geese as accurately as possible and to get an idea about their behaviour patterns in this part of their range. Our first observations were made on October 30th, the last in the early morning of November 5th.

## The area

The Hortobágy is situated east of the river Tisza and west of the town of Debrecen (47°30'N and 21°E). It measures some 45 km from north to south and some 30 km from east to west. Nagy (1938), referring to the early 1930s, gives the size as some 200,000 ha (772 sq. miles). In the MAR list of wetlands (1965) the area is given as c.450,000 ha (1,736 sq. miles). The "Hortobágy Guide Book," edited by the Foreign Traffic Office Debrecen, mentions 200,000 cadastral Hungarian acres. One Hung. acre = 1,422 Eng. acre = 0.575 ha. This would make a total of only 115,000 ha (443 sq. miles). But this still refers to the area as a whole. We tried to plot on our map the actual size of the grasslands (puszta) still present and from this got the impression that only 40,000 to 50,000 ha (154-193 sq. miles) are still untouched. See map Figure 1.

Originally the Hortobágy consisted mainly of endless flat grazing land, but there has been an increase of arable country, especially at the borders of the area. Moreover many fish-ponds have been created, mostly in the centre of the area. According to the Guide Book the total area of these ponds amounts to 4,600 ha (11,380 acres).

The most typical and finest parts of the original puszta landscape we found to the east and north-east of the oldest and largest fish-pond, the Hortobágy halastó (halastó means fish-pond); between Víztárolo and Elep halastó; and to the east and south-east of Nagyiván. According to Dr. Sóvágó the Bagota puszta in the north of the Hortobágy is also very beautiful. One can best enjoy the grandeur of the landscape when making long walks into the heart of the puszta. Then the horizon is only broken by some lever arms of wells, a line of distant trees and a lonely herd of sheep.

## Observation methods

We had two cars and were able to make observations at two or three different points simultaneously. The morning flight proved to be the best opportunity to count the geese. Every day we observed the morning flight, mostly at one or two places near the Hortobágy halastó, but also at the Virágoskut and Elep ponds. The evening flight was also observed at the Hortobágy and Virágoskut ponds. By car we could reach all different parts of the puszta, and from the roads we made long walks into the puszta landscape. Especially in the puszta to the north and to the north-east of Hortobágy halastó we observed several groups of flying White-fronted Geese *Anser a. albifrons*. The flight lines proved to be related to that pond and sometimes perhaps with the Virágoskut halastó.

## The roosts

The fish-ponds are very important in many ornithological respects. They provide the geese with very good roosts. During our stay we found that two ponds, the Hortobágy halastó and the Virágoskut halastó, were used by large numbers of geese, while the Elep halastó may have harboured some hundreds of geese. The fish-ponds consist of a system of rectangular dykes. Between these dykes the water level of the ponds is some two meters above the surface of the puszta. There are heavy stands of reeds *(Phragmites)* and other aquatic vegetation. Reed-

mace *(Typha)* is considered to be a weed and it is cut out.

The largest and oldest fish-pond is the Hortobágy halastó, which dates from 1916. Its total size is about 1,350 ha (3,330 acres). It is divided into eight or ten sections of 100 to 140 ha each. The main fish is Carp *Cyprinus carpio*. After two to five years each section is emptied and kept dry for one season, but during winter it may be partly flooded by rain water. We waded in such habitat and found a rather open vegetation of Orache *(Atriplex)*, Bulrush *(Scirpus)* and Water Dock *(Rumex)*. The water between the vegetation was covered by a sheet of seeds. No doubt this is extremely attractive habitat for surface feeding ducks and we saw many thousands of Mallard *Anas platyrhynchos* and Teal *Anas crecca* on the ponds.

The Virágoskut halastó is smaller than the Hortobágy pond. Its size is some 600 ha. Its largest section measures about 300 ha (740 acres) and is probably the most extensive in any fish-pond at the Hortobágy. This may have been an important factor in its attractiveness for the geese. Perhaps it was also important that this very section happened to be drained during our stay.

It is unlikely that important numbers of geese roosted at the other ponds in the centre of the Hortobágy. We did not visit

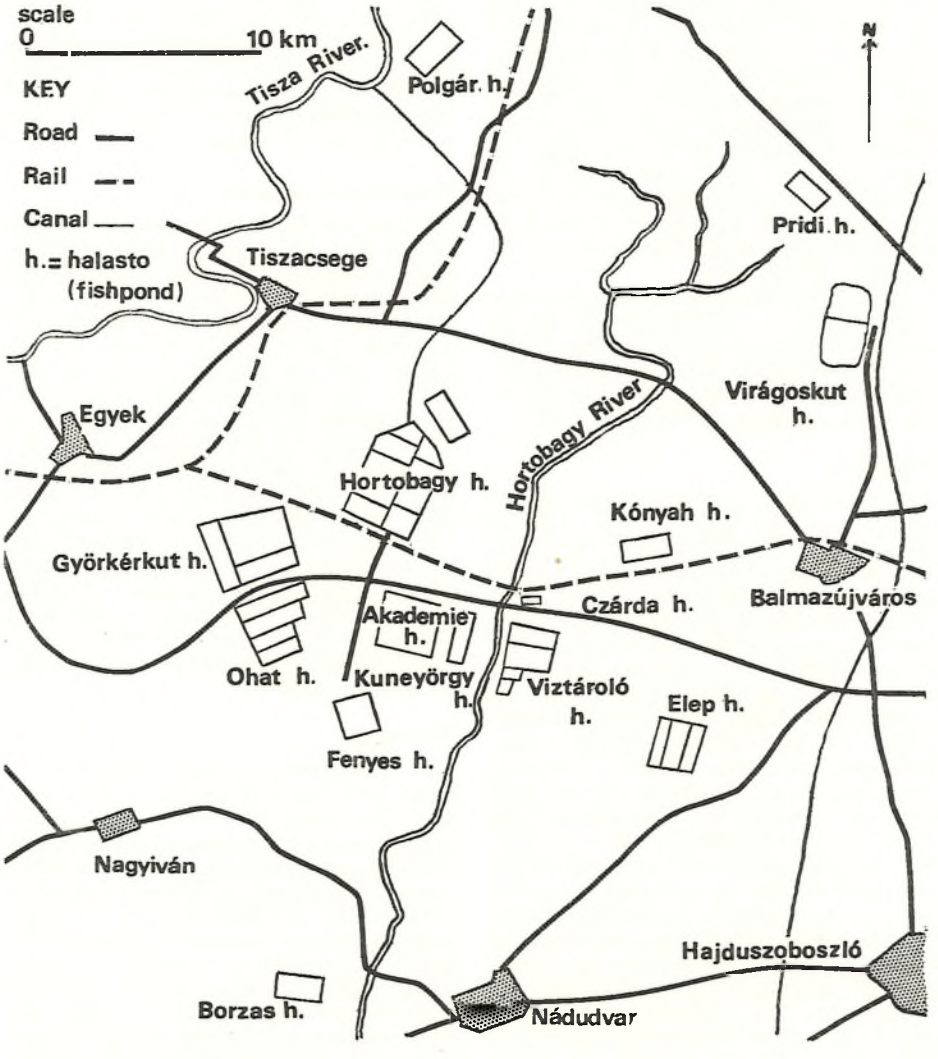


**Figure 1. Map of Hortobágy, eastern Hungary.**

some ponds at the edge of the area, like Polgár, Fenyes and Borzas, but looked at the surroundings of these ponds in the daytime and think it very unlikely that geese occurred there.

When parts of the puszta are flooded, geese also sleep at such places, but during our visit the puszta was still rather dry and flooded places were few in number and very small.

**The feeding grounds**

It proved to be rather difficult to trace the feeding grounds of the geese. Only some smaller groups of a few dozen up to some hundreds of geese were seen on the puszta near the Hortobágy halastó. Although we inspected large tracts of puszta we found practically no other geese on this type of habitat. It is very likely that the arable fields at the edges of the puszta were the main feeding grounds of the White-fronted Geese during our stay. We know from literature, however, that many geese often occur on the grasslands. In some cases the geese were seen flying well into the arable country and those coming back had their feet and sometimes even their bills heavy with clay. On one occasion some hundreds of White-fronted Geese were seen in an area with arable fields 13 km to the south-east of the Hortobágy pond. It is more difficult to inspect the arable fields than the puszta, because the fields are sometimes not quite flat and in many cases unharvested corn, hedges and rows of trees restrict one's view.

We have no proof that the Greylag Geese were also feeding on the arable fields.

**The Geese**

*Anser anser* — Greylag Goose

We were told that some 35 pairs breed at the Hortobágy halastó. We do not know if they are breeding on other ponds, but several ponds appeared to supply suitable breeding habitat.

During our stay we regularly observed Greylags in the near surroundings of the Hortobágy pond. 50 to 100 may have been present. Subspecific identification was impossible.

*Anser albifrons* — White-fronted Goose

A total of at least 10,000 Whitefronts was observed. In the first days of our visit numbers were probably less. Seven thousand Whitefronts roosted at the Hortobágy halastó, 3,000 at the Virágoskut halastó and 200 at the Elep halastó.

*Anser erythropus* — Lesser White-fronted Goose

At the Hortobágy halastó our maximum count amounted to 130 birds, at Virágoskut up to 50 birds. The Lesser Whitefronts mainly occurred in separate flocks, but some were heard and seen in flocks of Whitefronts. It was fascinating to hear whole flocks flying overhead, producing their very high-pitched musical voices, which previously we had known only from gramophone records and from tame birds.

We were shown two specimens shot on November 2nd; the gullets of these birds were stuffed with a dense mash of stems and leaves of the short thin puszta grass.

*Branta ruficollis* — Red-breasted Goose

One bird was seen near the Hortobágy halastó in a small group of Whitefronts.

**Morning and evening flight**

Generally the morning flight started not earlier than 35 minutes before sunrise, when there was already sufficient light to see the geese at distances of many hundreds of meters. In the evening many geese arrived only after it had completely darkened and of course these birds could not be seen.

Our visit coincided with the period from full moon to first quarter. It is quite normal for wild geese to be feeding during the night in this part of the moon cycle, when there is sufficient light. This was not the case in the first nights, as the sky was heavily overcast. But from the afternoon of November 3rd most of the clouds disappeared and the nights were much lighter than those before. The observations during the morning flight however make it probable that the geese did not feed during any of the foregoing nights.

*Morning flight* was observed at the following places:

Hortobágy halastó — on 7 days
(on 3 days at two places simultaneously)
Virágoskut halastó — on 1 day
Elep halastó — on 1 day

*Evening flight* was observed at:

Hortobágy halastó — on 4 days
Virágoskut halastó — on 1 day

At the Hortobágy halastó most of the geese were observed at the south and south-east edges of the fish-pond. Most of them were flying to the east and south-east, many also to north-east and south. In the evening geese came back from the same directions, but at least

400 Whitefronts were seen arriving from the north.

The observations of the geese which roost at the Virágoskut halastó prove that the main feeding grounds must be situated to the north, north-east, east and in lesser degree to the south-east of the pond.

**Changes in the numbers of geese**

Has the time of one or two hundred thousand geese gone forever? It seems so. There has been a large scale decrease in the numbers of wild geese visiting the Hortobágy puszta (Keve and Sterbetz 1964). This decrease had probably more the character of a rather sudden break down than of a gradual one. This happened in the early 1950s.

Our observations cover only the period of October 30th - November 5th. As top numbers may arrive during the latter part of the first half of November, we are well aware that we may have missed the arrival of the bulk of the Whitefronts. For this reason we were eager to know more about the average numbers of Whitefronts in recent years. We understood that since the years of the great decrease, numbers do not exceed 50,000 or 60,000 birds and we got the impression that the numbers do not reach this level in many years.

Dr. Radó (in litt.) reports that maximum numbers in 1966 stayed between 16th and 22nd November. Totals were about 55,000 or 60,000, with the Whitefront by far the most numerous species.

Precise data on the size of the geese populations in the ancient days are difficult to obtain. This is quite understandable, as some observers speak of "hundreds of thousands" or "half a million" or even more geese. Nagy (1938) says there were "hundreds of thousands" of Whitefronts. If we interpret this as 200,000 and *if* we assume 50,000 as representative for the last fifteen years, this would mean a decrease of the order of 75%. But if the former numbers were larger and the present ones are smaller, the decrease is proportionally and absolutely still more important.

We shall never know exactly how many geese passed through the Hortobágy. But we have to handle with care old records which speak of half a million or one million geese. We believe that authors like Scott (1938) and Nagy (1938) who speak of "one hundred thousand" or "hundreds of thousands" (200,000?) give a good idea of the situation in the past. Moreover those numbers are more in accordance with the carrying capacity of the breeding grounds in the tundras of the Soviet Union (Uspenski 1965).

It is not certain that the decrease at the Hortobágy results from a decrease on the breeding grounds, as this might also have affected the numbers of flocks wintering in Western Europe; but these do not show such a decrease.

A westward change of migration routes, so that former Hortobágy geese passed through the area of the Neusiedler Lake in Austria seems possible, as a great increase occurred in the latter area in the years 1950-1962. Peak numbers of 100,000 or more geese have been counted (H. Steiner, *in litt.*). But in recent years the maximum has fallen back sharply to the much lower level of 5,000 to 20,000 geese (Greylags, Whitefronts and Beans). F. Haak and T. Lebret observed morning flight from the main roost there (Lange Lacke) before and after their Hortobágy trip. On October 28th there were some 8,000 Whitefronts and on November 5th, 6th and 7th some 15,000 Whitefronts. The numbers of Bean Geese were 1,000 and 2,000 respectively. The numbers of Greylag Geese in the whole "Seewinkel" were 4,000-5,000.

The White-fronted Geese have possibly again changed their migration patterns. It is not unlikely that we have to look for many of our lost geese in countries more to the east and south-east, like Roumania, Bulgaria, Greece and Turkey.

Sudden changes in the use of migration routes by the White-fronted Goose in Canada and the U.S.A. are known (Linduska 1964).

**Observations of other birds**

Not all the species observed are mentioned here. Exact numbers are only given of such less numerous birds as raptors, the Crane and some others.

*Ardea purpurea*—1 at Hortobágy halastó.
*Botaurus stellarus* — 1, 2 or 3 at Hortobágy halastó on different mornings.
*Buteo buteo* — about 30 birds.
*Buteo lagopus* — at least 4 (3 of them near Virágoskut halastó).
*Accipiter nisus* — 7 at different places.
*Accipiter gentillis* — 1 bird.
*Haliaëtus albicilla* — 3 birds at fish-ponds (a adult and 1 juvenile at Virágoskut halastó).
*Circus aeruginosus* — 7 birds.
*Circus cyaneus* — 17 birds (6 male and 11 females).
*Pandion haliaëtus* — 1 bird.
*Falco columbarius* — 1 female.
*Falco tinnunculus* — about 50 birds.

*Falco* species — 1.
Raptor species — 4 larger birds (3 of them probably buzzards, the fourth probably a middle-sized eagle).
*Megalornis grus* — 4 small groups (11, 35, 6 and 7 birds).
*Vanellus vanellus* — at many places, mostly in smaller groups of 10-50 birds and only few larger groups of some hundreds. Certainly not very numerous.
*Larus argentatus* — about 50.
*Larus ridibundus* — at least 2,000 in one group.
*Athene noctua* — some heard or seen.
*Dendrocopus syriacus* — at least 1 near Csárda.
*Lanius excubitor* — 6 birds.
*Remiz pendulinus* — some at Hortobágy halastó. Some tens at Virágoskut halastó.
*Corvus frugilegus* — very c o m m o n . Totally many thousands.

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# Observations on the Pink-footed Goose in Central Iceland, 1966

D. E. HARDY

**Summary**

Eleven members of a Radley College Expedition spent from 31st July to 5th September 1966 in central Iceland. Until 16th August investigations were confined to the region west of the Hofsjökull, from Guðlaugstungur in the north to Hvítárnes in the south. Scattered areas of meadow in this area are used as moulting grounds for non-breeders. Details of food, behaviour and time of moulting of non-breeding birds are given. The use of separate areas by non-breeders undergoing moult may relieve pressure on available food in the breeding area.

Observations on the main breeding colony in þjórsárver, which was inaccessible until the middle of August, are compared with those made in 1951 and 1953. A late cold spring had delayed the breeding cycle by about twelve days. Mortality due to predation was considerable during both early and late stages of the fledging period. Faeces, and viscera of fresh corpses, revealed a definite change in the pattern of feeding during August to a diet rich in soluble carbohydrate.

Newly-reported localities for breeding Pinkfeet in the area include a large colony on the Jökulfall river which flows south-west from the Hofsjökull and Kerlingarfjöll.

The arrival and flocking of Pinkfeet in the Åsgarð area are compared with observations made in 1954.

## Introduction

During the summer of 1966, a Radley College expedition was based for five weeks in central Iceland, ten days of which were spent in þjórsárver við Hofsjökul. This famous oasis of vegetation holds the largest known breeding colony of Pink-footed Geese *Anser brachyrhynchus*. The expedition had been asked by the Wildfowl Trust to carry out preliminary investigations into the vegetation of the oasis and the food preferences of the geese.

The party of six senior boys, two undergraduates, two masters and a doctor, had intended to move into þjórsárver as soon as possible after 31st July but, owing to the late summer, the glacial rivers were impossible to cross. Initially several areas of meadow at Fossrófulœkur were investigated as moulting grounds or as scattered breeding localities for small colonies of Pinkfeet, and on 9th August the ornithologists spent two days in Guðlaugstungur, a huge area of meadow and marsh to the north of Hveravellir, where they saw several Pinkfeet and found evidence of isolated breeding. The party finally moved in þjórsárver on 16th/17th August, establishing a camp on the eastern side of the hill Nautalda (see map). Between 17th and 25th August, analyses of the vegetation by point sampling were carried out, and collections made for laboratory analysis and herbaria. Details of predated birds were taken, and viscera and droppings collected for analysis. Notes were made on the observed food preferences of geese and goslings, together with details of their behaviour. Enclosures of nylon netting, supported by bamboo corner posts, were set up for a short time to see if they survived the weather conditions and prevented geese from feeding on the enclosed area of vegetation. Soil borings were taken, which, from analysis of the pollen content and dated by ash from volcanic eruptions, may indicate changes in the vegetation over the last 500 years. As no ringing was carried out, it was impossible to estimate the size of the colony, but the whole of the area on the north side of the þjórsá was covered and it is possible to make some comparisons with the observations of the 1951 and 1953 Wildfowl Trust expeditions (Scott, Fisher and Guðmundsson, 1953; Scott, Boyd and Sladen, 1955).

The party spent the remainder of the time at Fossrófulœkur, where observations were made of the arrival and flocking of Pinkfeet in the area. The first snow fell overnight on 2nd/3rd September, covering the hills above 1,800 feet, and the party left on 5th September.

## Distribution of non-breeding Pinkfeet outside þjórsárver, 1966

Pinkfeet probably do not breed until they are three years old. In 1951 yearlings and two-year-olds occurred in such small numbers in þjórsárver as to indicate a separate moulting area for immature birds; in 1953 it was found that, although one-year-old birds were very scarce, two-year-olds comprised about 20% of the full-grown population and that these birds

remained in the colony throughout the breeding season (Scott, Boyd and Sladen, 1955). Since yearlings, which must total over 1,000 individuals, seem to be so scarce in the colony, they must moult elsewhere.

In 1966 no single area where the pre-breeders undergo moult was found but a number of scattered areas of variable size were occupied. Blurton Jones and Gillmor (1955) suggested that the autumn gathering of Pinkfeet in Ásgarð probably retraced the pattern of spring dispersal, and that it was likely that pre-breeders remained in these gathering areas to moult after the breeding birds had moved to the nesting grounds.

### Sites of study (see map)

*Blágnípuver.* Two Pinkfeet were first seen here in flight on 3rd August. The most inaccessible northern part was occupied by a flock of about 70 flightless Pinkfeet. Goose droppings were found scattered throughout Blágnípuver, which may indicate its use as a dispersal ground in spring, but great concentrations of droppings and moulted feathers in this small northern area, together with heavy cropping of the vegetation, indicated that it had been occupied by a flock for at least the whole of the flightless period of about 25 days (Scott, Boyd and Sladen, 1955).

*Hvítárnes.* This marshy area was visited on 6th August and held some 300 non-breeding adults. Scattered breeding colonies of Pinkfeet may occur along the gorges of the river Fróðá but this could not be established as the river Fúlakvisl was uncrossable.

*Neðri Seyðisárdrög.* Thirteen adults were seen in this oasis on 11th August.

*Guðlaugstungur.* Four separate flocks totalling 39 fully flighted adults were seen on 12th and 13th August in this much larger oasis. No goslings were seen, although a single old nest was found on

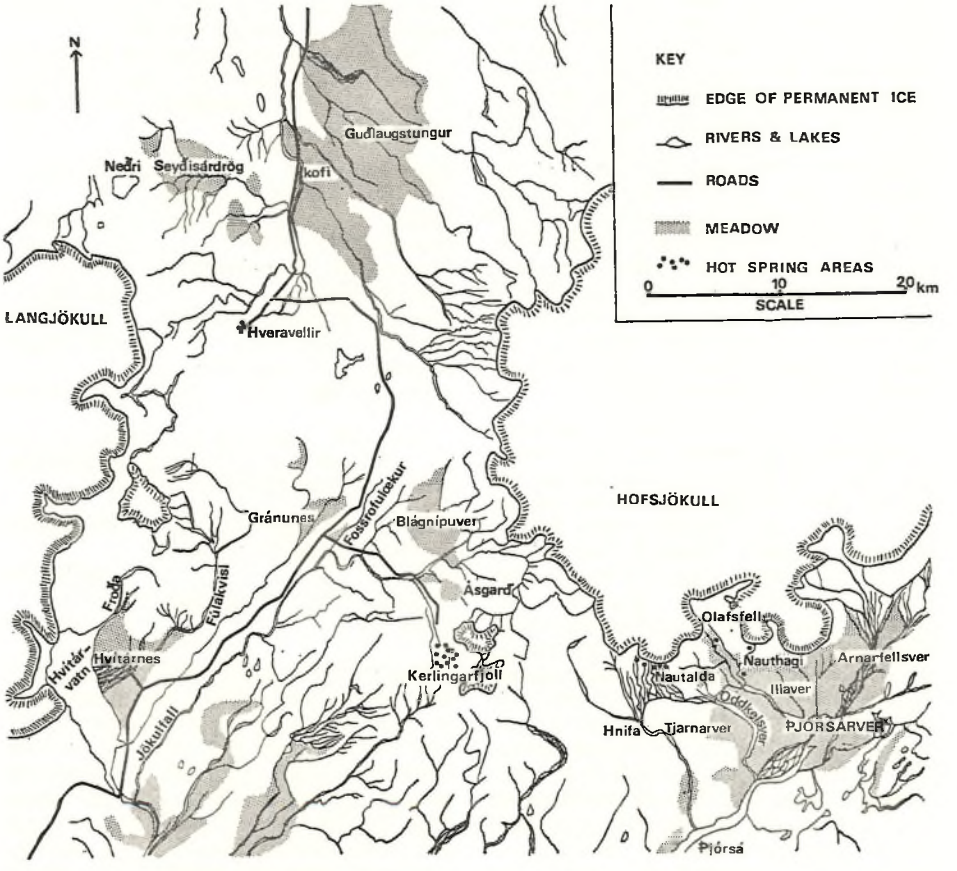


**Figure 1. Map of central Iceland.**

the roof of a hut (kofi) where the party spent the night.

**Behaviour and time of moulting of non-breeding birds**

Flightless non-breeding Pinkfeet are very wary. It was extremely difficult to approach the Blágnípuver flock closer than about 600 m. By contrast, the Hvítárnes non-breeders, visited two days later and mostly capable of flight, were easily approached to within 200 m. At intervals, flocks of about 50 birds would fly out over the lake for up to three minutes and then return to feed. This apparently random flighting may play an important part in exercising the wing muscles after the inactive period of flightlessness.

All but two of the Blágnípuver flock were flightless on 4th August; by 6th, ten birds were fully flighted and 45, or 60%, were able to rise briefly into a strong headwind. On the same day, 70% of the geese at Hvítárnes were fully capable of flight. It seems likely therefore that by 10th August the majority of non-breeding Pinkfeet in central Iceland had regained flight, and certainly no flightless non-breeders were seen after that date. In þjórsárver in 1951 and 1953 most of the *breeding* geese could fly by 4th August and these regained flight about one week later than the non-breeding birds. Thus in 1966 the non-breeders were undergoing their moult 10—12 days later than in 1951 and 1953. This might be explained by the lateness of the 1966 season, a view partly corroborated by the flightless condition of the þjórsárver goslings.

The flocking of non-breeders to moult in scattered areas outside the main breeding colony of þjórsárver may be an important aspect of behaviour which relieves pressure on the available food in the breeding grounds. There is no lack of suitable moulting areas in the central Highlands and it is probable that thorough exploration of the region round Hofsjökull would reveal several groups similar to that found in Blágnípuver. Taylor (1953a and b) has provided evidence that some moult-migration of non-breeding Pinkfeet to Greenland occurs after an exceptionally bad spring. It seems likely that most moulting of non-breeders takes place in the remote mountain oases round Hofsjökull and the evidence of Yeates (1955) appeared to support this view.

**Breeding Pinkfeet in þjórsárver**

The party arrived in þjórsárver on 17th August, by which date both adults and goslings were expected to be fully capable of flight. In fact, although all adult birds had regained flight, no goslings were seen flying until 18th August, and by 23rd August about 30% were still flightless.

Since all birds leave for the wintering grounds in the British Isles at the onset of cold, snowy weather, the breeding cycle, including moulting of adults and fledging of goslings, must be rather closely synchronised with the short sub-Arctic summer. This synchronisation helps to maintain the gregarious habit, the chief advantage of which is probably an increased awareness and defence against predators (Lack, 1954). The Icelandic summer permits some extension of the breeding season in the event of a late start, though Blurton Jones and Gillmor (1959) and Norderhaug, Ogilvie and Taylor (1965) have shown that in Spitsbergen, 12°—15° further north, the Pinkfoot breeding season can only just be accommodated by a normal summer.

The previous expeditions to þjórsárver established the following dates for stages in the Pinkfoot breeding cycle in this colony:—

| | |
|---|---|
| Eggs first laid ... | ... c.12th May |
| Peak date for clutch completion ... | ... ... 25th May |
| Peak hatching date ... | 22nd June |
| Majority of non-breeders regained flight ... | ... 28th July |
| Majority of breeding adults regained flight ... | ... 4th August |
| Majority of goslings achieved flight ... | 6th—10th August |

The 1966 season was unusual in that the melt was late and the dates of major events were recorded as follows:—

| | |
|---|---|
| Non-breeders regained flight | 10th August |
| All breeding adults regained flight by ... | ... ... 17th August |
| Majority (70%) of goslings flying by ... | ... ... 23rd August |

Among the remaining 30% of goslings, there was a remarkably wide discrepancy in size, and many were still very small. One freshly-killed bird collected on 23rd August weighed only 860 g. compared with an average of 2,280 g. for first winter birds reaching Scotland in October (Beer and Boyd, 1962). Assuming that birds of such small size, and probably only about three weeks old, would not be capable of

flight until around 20th September, they might well be unable to migrate before the winter snows, which are often heavy from 10th September.

Thus it seems that, even in Iceland, the success of the Pinkfoot is still dependent on favourable weather and that a delay of even a fortnight at the start of the breeding season may be crucial.

Many groups of between four and seven goslings of various ages were seen, unaccompanied by any adult. So common were these parties that they would hardly have passed unnoticed by the 1951 and 1953 expeditions had they occurred. Their presence might be related to the late season of 1966, but the actual mechanism whereby goslings lost or became separated from their parents is not known. Unaccompanied goslings were very tame and showed marked differences in behaviour from those accompanied by parents, particularly in reaction to danger, and this probably exposed them to a greater risk of predation, since parent birds are able to repel some attacks on their offspring.

**Predation**

Table I compares the numbers of predatory species seen in 1966 with those seen in 1951 and 1953.

The numbers of predators did not seem appreciably greater than in 1951 and 1953, but predation nevertheless appeared high, perhaps owing to the numbers of unattended goslings. Although the party arrived in Þjórsárver later than the two previous expeditions, when most of the goslings were about six weeks old, no decline in either the numbers or activity of predators was noticed. Predatory animals did not seem to move out of the oasis once the goslings were well-grown, and it appeared that healthy flightless goslings could readily be killed by Arctic Foxes *Alopex lagopus*, Great Black-backed Gulls *Larus marinus* and Iceland Falcons *Falco rusticolus*, while their remains provided food for predatory and carrion-feeding species such as Arctic Skuas *Stercorarius parasiticus* and Ravens *Corvus corax*. Snowy Owls *Nyctea scandiaca*, which were seen in 1951 and 1953, were not recorded in 1966.

Numerous corpses damaged by predators were found, 25 of which were sufficiently intact for age to be estimated from body dimensions (bill, skull, tarsus and wing). Six birds were less than five weeks old, whilst 16 were between five and seven weeks. Since this ratio (6:16) resembles the ratio of these two age groups seen in the population, 3:7, it

**Table I. Species predatory on Pink-footed Geese in Þjórsárver.**

| *Species* | *1951 (June 26 - Aug. 2)* | *1953 (July 9 - Aug. 7)* | *1966 (August 17 - 25)* |
|---|---|---|---|
| White-tailed Eagle | One | None. | None. |
| Iceland Falcon | One or two pairs. Individuals seen on at least 12 occasions. | Individuals seen only twice. | One pair. Individuals seen on four other occasions. Sightings confined to Nautalda/Ólafsfell area |
| Arctic Skua | c. 10 pairs. | c. 10 pairs. | c. 10 pairs. Estimate of numbers:<br>8 pale<br>1 intermediate<br>13 dark. |
| Great Black-backed Gull | c.40. | less than 10. | c.20 (including 1 juvenile). |
| Snowy Owl | Probably one seen twice. | Probably one seen five times, but possibly two. | None. |
| Raven | None. | One only, seen once. | One pair. Individuals seen on two other occasions. |
| Arctic Fox | One seen, one heard. No earths occupied. | Vixen and one cub seen at earth 11 July | Nautalda: Two.<br>Arnafellsver: Two (earth occupied).<br>Lower Oddkelsver: Tracks found. |

appears that losses were similar during both stages of the fledging period. This is somewhat contrary to the results obtained by the 1953 expedition when losses were found to be higher among younger birds. The 1966 results must be evaluated with caution, as the sample was small and many unmeasured corpses which had decayed may well have been of younger goslings. Even so, our observations indicated that predation during the second half of the fledging period was appreciable and may well have been increased because of the larger numbers of unattended goslings. The considerable number of dead goslings seen during nine days in Þjórsárver was itself of interest, as previous expeditions had reported so few.

Arctic Skuas were not seen to kill goslings, presumably because most of them were too old and large to tackle, but the Skuas frequently mobbed gulls which were hunting or eating goslings. The Great Black-backed Gull was a serious threat to young geese, but here also there appeared to be an upper limit to the size of gosling that it could kill. An Iceland Falcon was seen attacking a gosling and two other fresh corpses which we collected were almost certainly killed by this bird. Probably the most serious predator on larger goslings was the Arctic Fox. Six goslings, all found within a small area of Nautalda where two foxes were active, were killed in a manner typical of this species. The birds were attacked overnight and showed considerable scarring of the neck; four were headless but others were intact, with the exception of one on which a gull was feeding. These goslings were at least six weeks old and near to fledging, and five other freshly killed goslings of a similar age were thought to result from fox predation.

We found no evidence of the presence of Mink *Mustela vison* in Þjórsárver, although the species was breeding near Fossrófulœkur and in Gránunes.

**Food**

Samples of goose droppings and viscera of fresh corpses were collected whenever possible. Droppings were sealed, without preservative, in polythene bags, while the viscera were preserved in 15% formalin (Harrison, 1960). These specimens were analysed later by Dr. D. F. W. Pollard of the Wildfowl Trust (Table II). In addition, some direct observations of food preferences were made. Goslings unaccompanied by parents were often easily approached and it was possible to see, for example, that one moss species was taken rather than another. In some areas, in particular in the moulting grounds used by non-breeders, the heavily grazed plant species were easily recognised and recorded.

The flock of about 70 geese in Blágnípuver in early August appeared to be feeding exclusively on the sedge *Carex bigelowii* Torr. (*C. rigida* Good) which grew abundantly in the marshes. A strip of vegetation approximately two metres wide round the tundra pools was most heavily grazed, the top 10 cm. of the plants, including young leaves and seeding heads, having been removed. The same sedge was also abundant in Hvítárnes, and analysis of droppings collected there showed that this food-plant featured prominently in the diet of non-breeders. Remains of mosses, grasses, *Juncus* sp. and occasionally *Equisetum variegatum* were also found in the faeces.

A definite change in the pattern of feeding during the month of August emerged. The sedge *Carex bigelowii*, which is abundant in all the marshy oases in central Iceland, featured prominently in the diet of adults, pre-breeders and goslings throughout the month. Mosses were also important for geese of all ages, but *Equisetum*, mentioned by Witherby *et al.* (1940) as an important food plant on the breeding grounds, occurred in only three samples out of 32, despite its frequent and widespread distribution. It may, however, be taken earlier in the breeding season when the shoots are young and tender.

From the middle of August the leaves and fruits of *Empetrum hermaphroditum* and *E. nigrum* became increasingly important in the diet. The fruits of these species ripened rapidly in a period of hot sunny weather between 19th and 22nd August, and this coincided with a movement of the geese from the marshes to the higher and drier areas of the oasis where *Empetrum* flourished.

Similar marked and abrupt changes in diet, even though the staple foodstuff remains abundant, have been noted in other species. Berries become favoured food of the Icelandic Greylag *Anser anser* after the moult (Kear, 1966) and indeed the only arctic or subarctic goose reported *not* to take berries in the autumn is the Lesser Whitefront *A. erythropus*. Many insectivorous birds take berries in the late summer. Recently Evans (1966) noted the importance of Blackberries *Rubus fruti-*

**Table II. Plant remains found in viscera and droppings of Pinkfeet collected in central Iceland in August, 1966;** analyses by Dr. D. F. W. Pollard.

KEY: L = leaves; S = seeds and fruits; D = dropping sample; V = viscera sample; *** = very abundant; ** = present; * = trace.

| Locality | Date August | Sample type | Plant species | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L *Carex bigelowii* | Mosses | *Equisetum variegatum* | L *Juncus* sp. | L&S Graminae spp. | S *Empetrum* spp. | L *Empetrum* spp. | S *Polygonum viviparum* | L&S *Veronica alpina* | L *Oxyria digyna* | S *Festuca vivipara* | L *Ranunculus hyperboreus* | L *Rumex acetosa* | L *Vaccinium uliginosum* |
| Hnífárver | 2 | D | *** | | | | | | | | | | | | | | | |
| Blákvísl | 3 | D | *** | | | | | | | | | | | | | | | |
| Blákvísl near Blágnipuver | 5 | D | *** | ** | | | | | | | | | | | | | | |
| Blágnipa meadows | 5 | D | *** | | | | | | | | | | | | | | | |
| ,, ,, | 5 | D | *** | | | | | | | | | | | | | | | |
| ,, ,, | 5 | D | *** | | | | | | | | | | | | | | | |
| 1 m. N. of Ásgarðsver | 7 | D | *** | ** | | | | | | | | | | | | | | |
| ,, ,, | 7 | D | *** | *** | | | | | | | | | | | | | | |
| Ásgarðsver | 7 | D | *** | | | | | | | | | | | | | | | |
| Neðri Seyðisárdrög | 11 | D | ** | ** | ** | ** | ** | | | | | | | | | | | |
| S. end of Illaver | 19 | D | *** | ** | | | | | | | | | | | | | | |
| S. end of Nautalda | 20 | V | ** | | | | | ** | | | | | | | | | | |
| ,, ,, | 20 | V | ** | ** | | | | | | | | | | | | | | |
| ,, ,, | 20 | V | * | | | | | | | | | | | | | | | |
| ,, ,, | 20 | V | ** | | | | | ** | | | | | | | | | | |
| ,, ,, | 20 | V | ** | | | | | *** | ** | | | | | | | | | |
| Nauthagi | 20 | V | ** | ** | | | | *** | ** | | | | | | | | | |
| | 21 | D | ** | ** | | | | ** | ** | | | | | | | | | |
| N. end of Illaver | 21 | D | ** | | | | | ** | | ** | | | | | | | | |
| ,, ,, | 21 | D | ** | | | | | ** | | | | | | | | | | |
| Nauthagi ,, | 21 | D | ** | ** | | | | ** | | | | | | | | | | |
| N. end of Ólafsfell | 22 | V | ** | | ** | ** | ** | ** | | | ** | ** | ** | ** | | | | |
| ,, ,, | 23 | V | ** | ** | ** | ** | | * | | | | | | | | | | |
| N.W. end Nautalda | 23 | V | ** | ** | | | | * | | | | | | | ** | ** | | |
| N.E. ,, ,, | 23 | V | ** | ** | | | | * | | | | | | | | | | |
| W. side Ólafsfell | 23 | D | ** | ** | | | | | | | | | | | | | | |
| Nautalda | 24 | D | ** | ** | | | ** | | ** | | | | | | | | | |
| ,, ,, | 25 | V | ** | ** | | | | * | | | | | | | | | | ** |
| Gránunes (near Fossrófulækur) | 26 | D | * | *** | | ** | | *** | | | | | | | | | | |

*cosus* and Elder *Sambucus niger* in the diet of the Blackcap *Sylvia atricapilla* and Garden Warbler *S. borin* in north-east England in autumn. He commented that such fruits were excellent sources of soluble carbohydrate, easily assimilated by birds and laid down as energy reserves in the form of fat for migratory flights. He suggested (Evans, pers. com.) that while the change in diet of the Pinkfoot might have arisen simply because it preferred *Empetrum* berries (which were not available earlier in the season) to *Carex* leaves, such a change in diet would certainly be advantageous to the bird in its physiological preparation for migration since *Carex* leaves supply few calories. The change from a diet consisting almost exclusively of *Carex* leaves and mosses to a more varied one which included *Empetrum* berries of a high sugar content, took place about three weeks prior to migration. It is interesting to note that the fruits and leaves of *Vaccinium uliginosum*, although common in the same localities as *Empetrum*, were rarely eaten by the geese, at least during August.

**Breeding outside Þjórsárver**

Some evidence was found of Pinkfeet breeding in small colonies in the central region around Hofsjökull. The largest of these colonies was along both sides of the gorge of the Jökulfall river, where 70 nests were found and some sites may have been missed on the inaccessible south side of the gorge. On the north side, eight nests occurred within a distance of 150 m., and on one almost isolated rock stack there were no less than four nest sites along a 15 m. flat top. At the base of this stack was a fox earth with a few bones and goose feathers littered round the entrance.

Blurton Jones and Gillmor (1955), who spent four weeks in the Åsgarð area during the gathering and departure of Pinkfeet in 1954, cited as evidence of scattered breeding in the area records of three family groups and the remains of a juvenile, killed before it could fly. It is probable that these birds came from the colony on the Jökulfall, but it is also possible that family groups with juveniles originated in Þjórsárver, as in a normal season they would have been flying for some ten days by the middle of August when they were seen. Some family groups left Þjórsárver, flying west, from 23rd August onwards and when the expedition party passed Åsgarð meadows on 25th August 1966, four feeding flocks of adults and goslings totalling 70 birds were seen.

Although the Åsgarð and Blágnípuver area was thoroughly investigated, no other breeding places were found. The huge area of meadow, Guðlaugstungur, to the north of Hveravellir, is similar in character to Þjórsárver and seemed to be suitable as a breeding ground for Pinkfeet. The single nest on the roof of a kofi, apparently occupied during 1966, indicated that this area should be more thoroughly investigated.

**Flocking and movement of Pinkfeet at Fossrófulœkur 26th August — 4th September**

The gathering and pre-migratory movements of Pinkfeet in this area were studied by Blurton Jones and Gillmor in 1954 and observations in 1966 merely provided some comparisons. The actual departure on migration was not seen and much of the flighting observed appeared to be movement from one feeding ground to another or to resting places towards evening. A mixed flock of between 15 and 33 adults and juveniles came every morning to feed on the dry ground round the oasis, arriving at about 08.00 hrs. from the east, and usually departing about noon, possibly disturbed by activities round the camp site. They were sometimes joined by smaller family parties. All flocks of geese seen in the Åsgarð—Fossrófulœkur area were feeding on the raised, drier areas of vegetation, where a more varied plant association including *Empetrum* occurred; none were seen to feed in the marshy parts of the oases, such as Blágnípuver, where the moulting prebreeders had been found earlier. Only on two occasions was movement witnessed which could be described as migratory: during three days of very cold weather around 31st August at Hveravellir, a skein of 26 Pinkfeet passed high overhead at 11.25 hrs flying south; the same night, at 22.00 hrs. a flock was heard, also heading south.

A most noticeable feature at Fossrófulœkur was the many small flocks of geese seen flying in a bewildering variety of directions. Blurton Jones and Gillmor also noticed this, and suggested that such movements were social, in that they enabled small flocks to join up with larger ones prior to migration, and advantageous in that the gathering and movement might be important in stimulating the physiological development of the flight apparatus prior to migration. Similar

flight behaviour was observed in the large non-breeding flock of Pinkfeet at Hvítárnes which had just completed moult.

In conclusion, the Åsgarð area is evidently a major gathering ground where Pinkfeet can associate before leaving Iceland on migration.

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# Food habits of sea ducks from the north-eastern United States

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**Summary**

During the 1964-1965 hunting seasons, 274 gizzards of five sea duck species—American Eider, White-winged Scoter, Surf Scoter, American Black Scoter, and Long-tailed Duck—were collected from hunters at five localities between central Maine and Long Island, New York, in the United States of America. Based on occurrence and volume, the 16 most important foods are listed. Only animal material was consumed as food. Molluscs were by far the most important, particularly the blue mussel. Of the crustaceans, green crabs were the most important. The sand launce was the only fish found. None of the important food items are of economic importance in the United States.

## Introduction

Most of the sea ducks are circumpolar in distribution. Their conservation and management are therefore of concern to a number of countries. There have been only two major publications on the food habits of this group. Cottam (1939) reported on sea ducks from both coasts of North America, based on analysis of birds collected primarily in the first decade of the 20th century. In Europe, the most important work has been by Madsen (1954).

This paper will discuss food habits of 274 ducks collected from hunters on the north-eastern coast of the United States during the winters of 1964 and 1965. The results of this study are compared with those of Madsen and Cottam. The original individual food habits cards used by Cottam are on file at the Patuxent Wildlife Research Centre and were used to extract data for the east coast of the United States.

The birds were collected for the Bureau's Migratory Bird Populations Station to study methods of determining sex and age by wing plumage. To make maximum use of specimens, a food habits analysis was conducted.

## Methods

During the hunting seasons of 1964 and 1965 (October to January), hunters shooting sea ducks off the north-east coast of the United States were requested to supply birds to the U.S. Bureau of Sport Fisheries and Wildlife.

Major harvest areas were:

1. Maine — Penobscot Bay and Frenchman's Bay, between latitude 44° and 44° 30′.
2. Rye-Newburyport — Rye Harbor, New Hampshire; Newburyport, Massachusetts, at the mouth of the Merrimack River, latitude 43°.
3. Plymouth-Duxbury — Plymouth and Duxbury Bays in central coastal Massachusetts, latitude 42°.
4. Monomoy — Monomoy Peninsula at the outer end of Cape Cod, Massachusetts, latitude 41° 30′.
5. Long Island Sound — between Connecticut and central Long Island, New York, latitude 41°.

Of more than 500 birds received, 274 contained sufficient food material for analysis. Included were 124 White-winged Scoters *Melanitta fusca deglandi*, 70 American Eiders *Somateria mollissima dresseri*, 55 Surf Scoters *Melanitta perspicillata*, 17 American Black Scoters *Melanitta nigra americana* and eight Long-tailed Ducks (Old Squaw in North America) *Clangula hyemalis*. The nomenclature is that of Delacour (1959). With the exception of the Surf Scoter, all these species are circumpolar in distribution.

Food items removed from the proventriculus and gizzard were recorded by occurrence and volume. All items found in the proventriculus were also present in the gizzard. Because of this and the relatively few birds with food in the proventriculus, only gizzard content is discussed. These ducks fed on few items and usually one item predominated in each stomach. Food habits by age, sex, and area taken were examined within each species to determine any significant differences.

The scientific and common names of Mollusca used here are from Abbott (1954). Those of other invertebrate animals are from Pratt (1935).

**Results**

*American Eider*

Of the 70 gizzards examined, 14 were from Maine, 12 from Plymouth-Duxbury, and 45 from Monomoy. The sex and age composition was 33 females (14 adult, 2 subadult, and 17 immature) and 37 males (18 adult, 7 subadult, and 12 immature).

Area of collection, sex, and age did not make any discernible difference in the food habits of American Eiders. Blue mussels *Mytilus edulis* were by far the most important food, being found in 87 per cent of the gizzards and constituting 70 per cent of the total volume (Table I). They were found in 68 per cent of the birds examined by Madsen in Denmark and 81 per cent of the birds examined by Cottam (1939). Wintering areas of Common Eiders, both American and European, seem to be strongly influenced by the location of blue mussel beds.

Only two other items were found in over 10 per cent of the gizzards. Green crabs *Carcinides maenas* occurred in 20

**Table I. Gizzards contents of 274 sea ducks from north-eastern U.S.A. listed (a) by percentage of occurrence and (b) by volume of each food.**

Food species listed in descending frequency of occurrence in the total sample.

| | *American Eider* | *White-winged Scoter* | *Surf Scoter* | *American Scoter* | *Long-tailed Duck* | *all species* |
|---|---|---|---|---|---|---|
| (a) % *occurrences* gizzards | 70 | 124 | 55 | 17 | 8 | 274 |
| *Mytilus edulis* | 87.1 | 11.3 | 23.6 | 47.0 | — | 35.0 |
| *Nassarius trivittatus* | 7.1 | 34.7 | 3.6 | 5.8 | 25.0 | 19.3 |
| *Littorina obtusata* | 14.2 | 21.8 | 14.5 | — | — | 16.4 |
| *Nucula proxima* | — | 19.3 | 10.9 | 17.6 | 62.5 | 13.8 |
| *Yoldia thraciaeformis* | — | 21.0 | 10.9 | — | — | 11.6 |
| *Carcinides maenas* | 20.0 | 11.3 | — | — | — | 10.2 |
| *Thais lapillus* | 2.8 | 17.7 | — | — | — | 8.7 |
| *Yoldia limatula* | — | 10.5 | 10.9 | 23.5 | 12.5 | 8.7 |
| *Ammodytes americanus* | — | 18.5 | — | — | 12.5 | 8.7 |
| Talitridae sp. | — | 0.8 | 16.3 | 11.7 | | 4.3 |
| *Littorina littorea* | 8.5 | 4.8 | — | — | | 4.3 |
| Gammaridae sp. | — | 8.1 | — | — | | 3.6 |
| *Yoldia sapotilla* | — | — | 14.5 | — | | 2.9 |
| *Siliqua costata* | — | 1.6 | 9.0 | — | | 2.5 |
| *Nuculana tenuislocata* | — | 4.0 | 3.6 | — | | 2.5 |
| *Panopeus herbstii* | — | 0.8 | — | — | 62.5 | 2.1 |
| other animal species | 7.1 | 6.4 | 1.8 | 5.8 | — | 5.4* |
| algae sp. | 45.7 | — | — | — | — | 11.6 |

* 15 occurrences: *Anachis translirata* (4); *Libinia* sp. (3); *Urosalpinx cinerea, Aequipecten irradians* (2); *Buccinum undatum, Crassostrea virginica, Chiridotea caeca, Ovalipes* sp. (1).

| | *American Eider* | *White-winged Scoter* | *Surf Scoter* | *American Scoter* | *Long-tailed Duck* | *all species* |
|---|---|---|---|---|---|---|
| (b) *volume* c.c. | 1172 | 1529 | 359 | 75 | 65 | 3200 |
| *Mytilus edulis* | 70.1 | 8.1 | 22.6 | 54.1 | — | 34.4 |
| *Nassarius trivittatus* | 0.6 | 9.7 | 0.2 | 4.0 | trace | 5.1 |
| *Littorina obtusata* | 3.9 | 12.2 | 7.2 | — | — | 8.3 |
| *Nucula proxima* | — | 4.8 | 5.0 | 12.7 | 14.6 | 3.5 |
| *Yoldia thraciaeformis* | — | 10.8 | 9.5 | — | — | 6.4 |
| *Carcinides maenas* | 12.8 | 6.6 | — | — | — | 8.0 |
| *Thais lapillus* | 1.2 | 17.3 | — | — | — | 9.0 |
| *Yoldia limatula* | — | 8.8 | 8.0 | 25.6 | 33.8 | 6.5 |
| *Ammodytes americanus* | — | 9.6 | — | — | 2.3 | 4.8 |
| Talitridae sp. | — | 0.2 | 8.0 | 3.6 | — | 1.0 |
| *Littorina littorea* | 0.2 | 1.0 | — | — | — | 0.6 |
| Gammaridae sp. | — | 3.6 | — | — | — | 1.6 |
| *Yoldia sapotilla* | — | — | 24.2 | — | — | 2.8 |
| *Siliqua costata* | — | 0.3 | 12.6 | — | — | 1.5 |
| *Nuculana tenuislocata* | — | 1.6 | 2.5 | — | — | 1.0 |
| *Panopeus herbstii* | — | 0.2 | — | — | 49.2 | 1.1 |
| other animal species | 2.1 | 5.4 | 0.1 | trace | — | 1.0 |
| total animal | 90.9 | 100.2 | 99.9 | 100.0 | 99.9 | 96.6 |
| algae sp. | 9.1 | — | — | — | — | 3.4 |

per cent, and northern yellow periwinkle *Littorina obtusata* was found in 14 per cent of the gizzards (Table I).

Algae occurred in 45 per cent of the stomachs, but this was probably incidental ingestion because it adhered to the blue mussels.

*White-winged Scoter*

Of the 124 White-winged Scoters examined, 25 were from Maine, 26 from Rye-Newburyport, 14 from Plymouth-Duxbury, and 59 from Long Island Sound. Fifty were females (20 adult, 3 subadult, and 27 immature) and 74 were males (46 adult, 7 subadult, and 21 immature). Though there were no differences in food habits due to sex or age, there were very noticeable differences between areas.

Atlantic dogwinkles *Thais lapillus* were found in over one-half of the gizzards and constituted over one-half of the volume of food from Maine birds. In Massachusetts blue mussels and broad yoldia *Yoldia thraciaeformis* made up the bulk of the food. Long Island Sound birds had a much more varied diet with sand launce *Ammodytes americanus*, New England nassa *Nassarius trivittatus*, northern yellow periwinkle and file yoldia *Yoldia limatula* the most prominent in occurrence and volume (Table II).

Because birds from both the Atlantic and Pacific coasts were combined in Cottam's publication and many scoters were deliberately collected over oysterbeds, the original cards used in his study were examined for comparable information. The cards revealed that Massachusetts birds (mostly collected in 1922) primarily contained blue mussel, northern yellow periwinkle, and scallop *Pecten irradians*.

Madsen (1954) found that the European White-winged or Velvet Scoter *Melanitta f. fusca* fed primarily on cockles (*Cardium* sp.), blue mussels, dog whelk *Nassa reticulata* and periwinkles (*Nassarius* sp.) in Denmark.

*Surf Scoter*

Fifty-five Surf Scoters were examined: 14 from Maine, 14 from Rye-Newburyport, 18 from Plymouth-Duxbury, and 9 from Long Island Sound. The 27 females included 3 adults, 5 subadults, and 19 immatures. The 28 males included 8 adults, 3 subadults, and 17 immatures.

The sample is too small to reflect accurately regional differences in food habits, but some differences were evident. Only birds from Massachusetts contained blue mussels and short yoldia *Yoldia sapotilla* and these were the two most important items. Beach fleas (Talitridae) were the most important food in the small Maine sample. Atlantic razor clams *Siliqua costata* made up the bulk of food in Long Island Sound birds.

Most of the New England birds reported by Cottam (1939) were from Massachusetts, and blue mussels were by far the most important food.

*American Black Scoter*

This is a relatively uncommon sea duck on the Atlantic coast and only 17 usable gizzards were available. Six were from Maine, 9 from Plymouth-Duxbury, and 2 from Long Island Sound. Of the 12 females, 2 were adult, 2 subadult, and 8 immature. All five males were immature.

Blue mussels were found in nearly one-half of the gizzards and comprised over one-half the total volume. The file yoldia and Atlantic nut clam *Nucula proxima* were the only other two items of importance (Table I).

Of 57 birds from New England

**Table II. Comparison of White-winged Scoter foods from three areas in north-eastern U.S.A.**

Percentages of occurrence and of volume.

| | *Area* | | | | | |
|---|---|---|---|---|---|---|
| | *Maine* | | *Massachusetts* | | *Long Island Sound* | |
| *Food* | *Occ.* | *Vol.* | *Occ.* | *Vol.* | *Occ.* | *Vol.* |
| *Mytilus edulis* | 3.4 | 1.3 | 33.3 | 33.5 | 1.6 | 0.1 |
| *Nassarius trivittatus* | 6.8 | 1.4 | 22.2 | 11.7 | 55.9 | 14.9 |
| *Littorina obtusata* | 17.2 | 4.9 | 16.6 | 6.1 | 27.1 | 20.8 |
| *Nucula proxima* | 20.6 | 6.9 | 13.8 | 2.7 | 22.0 | 4.3 |
| *Yoldia thraciaeformis* | 6.8 | 2.8 | 44.4 | 30.3 | 13.5 | 6.9 |
| *Carcinides maenas* | 6.8 | 6.8 | 11.1 | 5.8 | 13.5 | 6.9 |
| *Thais lapillus* | 55.1 | 51.8 | 2.7 | 0.5 | 8.4 | 0.5 |
| *Yoldia limatula* | — | — | 2.7 | 1.4 | 20.3 | 19.0 |
| *Ammodytes americanus* | — | — | — | — | 38.9 | 21.6 |

reported by Cottam, 37 contained blue mussels. The sand dollar (*Clypeastroidea* sp.) was the only other significant item.

Madsen (1954) found that the European Black Scoter *Melanitta n. nigra* also fed heavily on blue mussels, which were found in over half of 219 birds examined. Cockles were the only other important items.

*Long-tailed Duck (Old Squaw)*

Only eight gizzards contained enough food to be usable. One bird was from Massachusetts and seven from Long Island Sound. There were six females (five adults and one immature) and two adult males. Mud crabs *Panopeus herbstii* were the most important item, being found in five gizzards and constituting 49 per cent of the total volume (Table I).

Cottam (1939) found that in 190 gizzards crustaceans made up nearly one half the total volume and molluscs only 15.7 per cent. In contrast, 174 Danish birds examined by Madsen (1954) contained 93.8 per cent molluscs, primarily cockles. Although crustaceans were found in 54.9 per cent of the stomachs, they were the sole food in only 3.5 per cent.

*Grit and Lead Shot*

Due to the predominantly molluscan diet of most sea ducks, grit (gravel and sand) appears to be of less importance than it is to other ducks. Among species the frequency of grit ranged from 51.4 per cent in Eiders down to 29.4 per cent in Black Scoters. In most gizzards the amount of grit in relation to the total content was low. The volume ranged from 13.3 per cent in Eiders down to 5.7 per cent in White-winged Scoters.

Lead poisoning, due to waterfowl ingesting spent shot in feeding areas, has become of serious concern in North America. It particularly affects certain dabbling ducks, such as the Mallard *Anas p. platyrhynchos*, Black Duck *Anas rubripes*, and Pintail *Anas a. acuta*, and inland divers of the genus *Aythya*, which appear to be particularly susceptible. Bellrose (1959) estimated that about 4 per cent of the Mallard in the Mississippi Flyway die of lead poisoning annually. Over 10 per cent of 3,400 inland divers were found to contain ingested lead shot. Of 274 birds examined in this study, six contained ingested lead shot. One Eider contained two shot. Three Eiders, one White-winged Scoter, and one Surf Scoter contained one shot each. This indicates that lead poisoning is not a serious problem in sea ducks.

## Conclusions

Sea ducks examined in this study fed entirely on animal material. Molluscs were the most important food and were found in 92.7 per cent of all gizzards. They constituted 79.1 per cent of the total volume of food. Crustaceans were found in 21.5 per cent of the gizzards and made up 11.7 per cent of the volume. The sand launce was the only fish eaten and it occurred only in White-winged Scoters and Long-tailed Ducks from Long Island Sound. It was found in 8.7 per cent of the stomachs and made up 4.8 per cent of the total food volume.

The animals consumed are of no importance to the American fish or shellfish industry.

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# Experience in waterfowl management under the conditions prevailing in the Latvian S.S.R.

H. MIHELSONS, J. VIKSNE and G. LEJINS

**Summary**

Trials and observations in Latvia show that for the preservation of the resources of waterfowl and their nesting populations in densely populated localities a complex of the following preservation and biotechnical measures is needed:

1. Complete cessation of human economic activity and of the sojourn of humans during the spring and summer on areas of reservoirs suitable for nesting of birds, on grassy islands and peninsulas;
2. Adaptation of existing islands and peninsulas for intensive nesting of ducks; (a) by cutting trees and bushes growing on them; (b) by complete destruction of reeds on the inner part of islands; (c) by arranging wide passages to the open water in belts of dense growth around islands;
3. Construction of small artificial grassy islands;
4. Permanent maintenance of intensive nesting grounds, by control of overgrowing by trees, bushes and reeds, and by preventing the formation of compact reed banks and thickets of other plants in the accesses to the water;
5. Reduction to a minimum of the number of raptorial birds and beasts which destroy nests in the vicinity of large nesting grounds of waterfowl;
6. Establishment of zones in which hunting is banned, so as to offer shelter to the birds during the hunting season.

## Introduction

The decline in the numbers of waterfowl of sporting interest in densely populated districts is a well-known fact. One of the measures applied with increasing frequency to protect waterfowl from excessive destruction are hunting restrictions. In the Latvian S.S.R. spring hunting of ducks is completely banned and the autumn season is opened later, shooting time is restricted to definite days and hours, norms of hunters' bags are established by regulations, so is the number of cartridges per hunter to reduce the number of crippled birds, and so on.

Hunting restrictions alone, however, are in our view not sufficient to avert the reduction of game waterfowl stocks. In densely populated districts the diminishing numbers of local (nesting) waterfowl populations are closely correlated with the general increase of population, intensification of economic activity, and the assimilation and transformation of new lands previously little utilized. As a result of general and ever-expanding human activity, birds lose more and more suitable living strongholds with an adequate habitat. Under such conditions the conservation of wild ducks may be practically supported only by a system of individual parcels or ranges assigned specially for this purpose in the form of permanent or seasonal conservancy zones or reserves. The latter should represent the most suitable areas for the indicated purpose, areas where restrictions of economic activity may be of maximum benefit for the preservation of birds, while entailing only a minimum of prejudice to other branches of human activity.

Our team of ornithologists has been occupied during the last ten years with elaborating a system of management and biotechnical measures with a view to preserving and multiplying the nesting waterfowl populations on restricted areas adapted to conditions prevailing in Latvia. Experiments in waterfowl management were performed on a number of lakes, principally on the large (44 sq. km.), strongly overgrown, shallow littoral Lake Engure (situated on the western coast of the Gulf of Riga).

## Major results of trials and observations

Rating surveys and censuses of birds have shown that the favourite nesting places of ducks on overgrown lakes are small open islands covered with grass-sedge vegetation. Ducks' nests are found considerably more frequently on such islands than in coastal meadows. Since some agricultural practices are normally being carried on on the islands, the majority of the nests usually fail. According to our observations the major danger for the birds derives from the grazing of cattle and especially of sheep. On the islands where early hay harvesting is performed in the first half or middle of June many nests are abandoned or, being deprived of their disguise or camouflage, are ravaged by birds of prey. Finally, a large number of ducks simply avoid settling on islands where hay mowing or cattle grazing is practised, because of the usual absence from such islands of sufficiently high old grass left in

the spring for the birds to conceal their nests. On places where the grass has been destroyed in autumn the highest density of duck nests was, according to our observations, only half that on adjacent sites where the grass of the preceding year had been left untouched. A very adverse effect on the numbers of ducks is also exerted by intense human activity (fishing, tourism) in the overgrown areas of natural reservoirs; not only does the loss of clutches of coots and ducks which nest in the reed banks and on sloughs (predominantly Pochard *Aythya ferina*) increase substantially, but many broods also perish. Our experience on Lake Engure (and subsequently also on other reservoirs) confirms that the complete cessation of human economic activity on small areas suitable for the nesting of ducks represents an extremely efficacious measure for the protection and preservation of these birds under the prevailing conditions. Since 1957 economic activity has been banned on several islands in the lake, and a conservancy zone was established covering a large part of its water surface on which any economic or sports activity has to cease and human visits are restricted every year from March to the end of July. At the same time control of birds of prey (predominantly Marsh Harrier *Circus aeroginosus* and Carrion Crow *Corvus corone*) was strengthened. As a result the safety of nests and broods in the conservancy zone was substantially improved. In the reed-fields of the lake the numbers of some ducks increased markedly within a few years. Pochard increased two-and-a-half times in some places, and Coot *Fulica atra* up to three-and-a-half times.

Nevertheless, the most striking effect was produced by the complete cessation of economic activity on the islands. The increase in the number of nesting ducks on three islands, where a regular count of nests was carried out both before and after the introduction of the conservancy regulations, is demonstrated in Table I. At the same time also an increase in the number of nesting waders (island A) gulls and terns (islands B, C) was noted; the presence of these birds, particularly of gulls and terns, is of great importance for attracting ducks to the nesting grounds

**Table I. Increase in numbers of nesting ducks after introduction of preserve conditions on some islands of Lake Engure, Latvia S.S.R.**

The figures are of numbers of clutches found. " -3 " to be read " up to 3 ".

| | *In years when pasturing was being practised (A) or hay mowed (B, C)* | *After cessation of economic activity* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *1948-1956* | *1958* | *1959* | *1960* | *1961* | *1962* | *1963* | *1964* | *1965* |
| *All duck species on the individual islands* | | | | | | | | | |
| *A* Lielrova, 16 ha, devoid of trees, never fully flooded | 10-15 | 85 | 70 | 116 | 163 | a ring of reed formed around the island 161 | 164 | 152 | 134 |
| *B* Akmenrova, 25 ha, with groups of shrubs, in spring, sometimes fully flooded | 4-11 | 6 | overgrown by shrubs 26 | 40 | 31 | 26 | 6 clearance | 31 | 54 |
| *C* Lopsalrova, 6 ha, with groups of shrubs, in spring sometimes fully flooded | 4-5 | 10 | overgrown by shrubs 9 | 32 | 41 | 13 | 19 | 37 | 51 |
| *Individual species of ducks on all three islands.* | | | | | | | | | |
| *Anas platyrhynchos* | -3 | 5 | 13 | 16 | 24 | 11 | 12 | 20 | 18 |
| *Anas clypeata* | -4 | 13 | 36 | 36 | 38 | 26 | 39 | 28 | 30 |
| *Anas acuta* | 0 | 0 | 0 | 3 | 3 | 6 | 8 | 5 | 8 |
| *Anas querquedula* | -9 | 35 | 30 | 62 | 47 | 56 | 49 | 46 | 56 |
| *Aythya fuligula* | -11 | 29 | 19 | 51 | 75 | 71 | 45 | 93 | 90 |
| *Aythya ferina* | -3 | 18 | 7 | 17 | 39 | 26 | 31 | 25 | 27 |
| Other species of ducks | -5 | 1 | 0 | 3 | 9 | 4 | 5 | 3 | 10 |
| Total clutches | 18-31 | 101 | 105 | 188 | 235 | 200 | 189 | 220 | 239 |
| broods | not more than | 82 | 69 | 135 | 136 | 141 | 121 | 159 | 114 |

and for the protection of their nests from birds of prey.

An adverse consequence of the cessation of economic activity (in particular, of hay mowing) consists in the islands becoming overgrown with reed *Phragmites communis* and shrubs (principally *Salix*). As a result of quick over-growing the number of duck nests began to diminish and only after clearance of shrubs did it again show signs of increase (see for example islands B and C in Table I). To avoid over-growing, in recent years, after the end of the nesting period (in July), a partial mow of grasses has been organized. This is done in strips in such a way that in spring not less than half of the area of each island remains covered with old grass, each strip being mowed once in two or three years. By observing this rule no appreciable reduction in the numbers of nests on the islands has been noted.

A special investigation of more than 70 islands on various lakes in Latvia has led to the finding that on woody islands nests of ducks are met rarely (except perhaps for single separate nests of the Mallard *Anas platyrhynchos*. By complete clearance of the woods it is often possible to transform such islands into sites for the mass nesting of ducks provided the surrounding water presents a suitable habitat for the birds. For example, on one small island (0.8 ha, or 2 acres) in Lake Engure, partly overgrown with small trees and shrubs, the number of nests remained as low as previously, after cessation of agricultural practices: in each of two consecutive years only four nests were found. In the first year after deforestation 22 nests were counted and in the following two years 25 and 28 nests.

Trees and tall bushes facilitate the activity of nest predators. Even in cases when on grassy islands there were only separate single trees the latter were often surrounded by a zone of completely ravaged and destroyed nests. It is possible that just for this reason many ducks avoid settling on islands with trees, even if the latter occupy only a small area. Thus, in autumn 1961 on the overgrown Lake Kanieris a small group of tall bushes and low trees occupying about 0.3 ha ($\frac{3}{4}$ acre) in the centre of a comparatively large grassy island (12 ha, or 30 acres) was cut. The number of duck nests on the island increased the next year from 15 to 30-35. Unless there are weighty objections on aesthetic grounds, the clearing of trees and shrubs from overgrown islands suitable for ducks must be considered as a promising measure for encouraging large-scale nesting of ducks.

Ducks also avoid nesting on grassy islands if these are surrounded by a dense closed belt of thick reeds. Such islands which have no access to the open water are populated by ducks only in years when the spring water level is high so that the water floods the edges of the island inside the reed ring. By exterminating the dense reed thicket such islands may be converted into large-scale nesting grounds of ducks.

In recent years the creation of artificial islands was started in our republic with the objective of improving the nesting conditions of waterfowl. In autumn 1964 five such islands with an area of 0.04-0.3 ha were erected in Lake Kanieris. Already in 1965 on the still almost bare, grassless, stony and unlevelled islands ducks began to nest (according to certain sources there were more than 20 nests). The prospects of using artificial islands for ducks are quite evident.

As a result of the measures outlined above, the principal gain in numbers of ducks is in most cases due to dense settlement on islands by Tufted Duck *Aythya fuligula*, Shoveler *Anas clypeata* and Garganey *Anas querquedula*. On preserved islands suitable for ducks, high nesting densities were observed, which increased with decreasing area of the island (Table II). Observations on various inland reservoirs of Latvia have shown that a nearly equal density of nests may be attained on peninsulas subjected to preservation. Under any other conditions the density of nests was very much lower. Therefore small islands and peninsulas under rules of preservation on reservoirs for ducks may, in our view, be considered the most promising sites for massive concentrated nesting of waterfowl in densely populated districts under conditions similar to those prevailing in this country. It is comparatively simple to protect such naturally isolated localities against undesirable intruders (humans, cattle, domestic animals). The principal consideration is, however, that the layout of a broad system of small grassy islands and peninsulas with cessation of agricultural practices on them undoubtedly offers the greatest advantage for the conservation and reproduction of waterfowl with a minimum of prejudice to other branches of the economy.

The most suitable places for contriving high-density nesting grounds are low islands covered with old grass and which do not flood in spring, where the ducks may start nesting at their normal early

**Table II. Density of duck nests on islands and peninsulas of various sizes.**

| Lake Engure 1958-1965 Preserved islands | | | Lake Kanieris .1961 Unpreserved islands | | | Unpreserved peninsulas and islands connected with the shore | | |
|---|---|---|---|---|---|---|---|---|
| *area ha* | *maximum number of nests* | *maximum density per 0.1 ha* | *area ha* | *number of nests* | *density per 0.1 ha* | *area ha* | *number of nests* | *density per 0.1 ha* |
| 16.0 | 164 | 1.0 | 11.7 | 15 | 0.1 | 1.8 | 5 | 0.3 |
| 2.5 | 54 | 2.2 | 1.8 | 8 | 0.4 | 1.6 | 8 | 0.5 |
| 0.8 | 29 | 3.6 | 1.5 | 20 | 1.3 | 1.1 | 3 | 0.3 |
| 0.6 | 51 | 8.5 | 0.8 | 11 | 1.4 | 0.4 | 4 | 0.9 |
| 0.1 | 27 | 27.0 | | | | 0.4 | 3 | 0.8 |

time. Violation of the normal nesting schedules, regular raids by birds of prey and mass destruction of nests are to be tolerated in no circumstances. As is confirmed by the results of ringing (including over 300 cases of repeated capture of adult hens ringed on nests or one-day-old ducklings) all the aforesaid factors entail relatively similar negative consequences. The ducks leave the unfavourable surroundings and move in search of other nesting ranges that are often less suitable or more dangerous. Even old hens frequently move to new quarters despite their having lived for several years in the place now abandoned. In almost all cases the beginning of the nesting period is delayed, and in some species (this applies undoubtedly to *Aythya fuligula*) the survival rate of late broods (delayed or repeated clutches) manifests a sharp decline. Finally, there are indications that nesting grounds abandoned by the ducks are repopulated relatively slowly for some of the young females follow the older hens which have left their previous nesting ranges because of the unfavourable circumstances.

Islands, as distinct from peninsulas, are frequently not accessible to raptorial mammals of which, under the prevailing conditions in Latvia, the Raccoon Dog *Nyctereutes procyonoides* appeared to be one of the most dangerous. Frequently it succeeds in penetrating even on to islands, in particular the islands of Lake Engure, and causes great damage. The Fox *Vulpes vulpes*, less frequently the Polecat *Mustela putorius*, and other mammals are also enemies of the ducks. In coastal meadows they often devastate up to 69% of all duck nests. To birds of prey, unfortunately, all large scale breeding and nesting grounds are attractive and accessible. On the overgrown reservoirs of this country the most dangerous enemies of ducks are the Marsh Harrier and Carrion Crow, and in some cases individual specimens of the Raven *Corvus corax*. Despite intensified control (by shooting and trapping) raids of predatory birds increase in proportion to the growing density of nesting birds. On the experimental islands of Lake Engure birds of prey destroyed on the average 12-14% of the annual total of duck nests, this figure increasing on certain islands in some years (if control measures against the raptors were delayed in spring) to 48%. It requires no special emphasis to point out that control of birds and beasts of prey is an indispensable element in the complex of measures required in the organization of high-density nesting grounds of waterfowl.

In the prevailing circumstances the establishment of closed hunting districts is of prime importance for the preservation of waterfowl. Such districts have been established on several reservoirs of the republic. Within the boundaries of these districts (in contrast to preservation zones in the nesting period) any visits of humans during the shooting season are prohibited. In the period of heavy shooting many alarmed ducks do no more leave the reservoir but gather in the forbidden zone. There are indications that the existence of forbidden hunting districts on the large lakes (i.e. Babite, Engure, Liepaja) not only saves indigenous and migratory birds from excessive destruction but prevents also premature departure of some local and migratory birds.

The size and location of forbidden hunting districts on the reservoirs of the republic are determined in various ways depending on local conditions. The larger the area of the zone the better it fulfils its functions of preservation of waterfowl. If, however, the zone is too extensive or if it is allotted in the principal feeding places the birds do not leave the forbidden zone and become inaccessible to hunters. On the lakes Engure (44 sq. km.) and Babite (25 sq. km.) these zones at present amount to about 20-30% of the area of each lake.

# Wildfowl Survey in south-west Asia : progress in 1966

CHRISTOPHER SAVAGE

**Summary**

In the spring of 1966 the Survey received a grant from the World Wildlife Fund which greatly stimulated its development. International liaison was promoted through visits to Tehran, Baghdad, Cairo, Kabul and Bombay, where preparations were laid for participation in the January 1967 International Wildfowl Census. The I.W.R.B. Warsaw Conference on co-ordination of wildfowl research was attended by the writer; the decision to set up an Asiatic Wildfowl Working Group was one of the results of the conference. Ringing efforts were intensified during the year with a start being made in three new areas, Iran, Iraq and Assam. There was, however, no significant improvement in the return of Russian rings from south-west Asia. Of special interest during the year was the discovery that the White-headed Duck *Oxyura leucocephala* moults its flight feathers in West Pakistan in November, and the discovery that the Snow Goose *Anser caerulescens* and Bean Goose *Anser fabalis* had been wrongly included in the fauna of India and Pakistan. There was also encouraging news of the White-winged Wood Duck *Cairina scutulata* from Assam.

## Introduction

Receipt of a welcome grant from the World Wildlife Fund permitted intensification of the survey as outlined previously in the 16th and 17th Annual Reports (Savage 1965, 1966) and the development of liaison with the International Wildfowl Research Bureau. The writer also had opportunities of making visits to Tehran, Baghdad and Cairo twice each, and also to Kabul and Bombay. Discussions were held with some of the leading naturalists in the countries concerned and plans were made for a vigorous co-operative effort on the International Wildfowl Census in January 1967.

Plans for 1967 include co-ordination of the mid-winter census, special enquiries into the status of the White-winged Wood Duck, participation in the Pakistan Wildlife Commission and if possible a regional conference on wildfowl in the winter before the 1968 census.

Progress and prospects in the region are best summarised country by country.

## Egypt

There is as yet no official protection of wildfowl in Egypt, but the Egyptian Government appreciate the value of their remaining wetlands as a tourist attraction and for this reason are considering saving a few of the remaining important areas from reclamation. There is, however, still extensive market trapping and a huge demand for wild duck—which sell for more than chicken at 65 PT (10/6d.) each.

A " festival of duck-shooting " was held in November-December, 1966, with prizes offered for rare species shot. This understandably aroused great indignation abroad and it was suggested by the writer that conservation of wildfowl and wetlands as currently practised by W.A.G.B.I. and the Nature Conservancy in Britain might be more beneficial to the tourist trade and would certainly receive favourable publicity. There has so far been no comment.

A promising development has been the commencement of a three year research programme on the migration of birds in the Nile delta by an expedition of the Smithsonian Institution and under the leadership of Dr. G. E. Watson. It is not known yet to what extent the programme will include wildfowl, but such work is bound to stimulate thought in regard to rational conservation of wildlife and habitats in general.

## Iraq

On the retirement of Dr. Bashir Allouse, the directorship of the Iraq Natural History Museum passed to Professor Nuri Mahdi, who has taken a vigorous interest in the Wildfowl Survey and the International Wildfowl Census in particular. The ornithological work of the museum had also been expanded with the recruitment of P. V. George, lately a research associate of the Bombay Natural History Society. The museum is part of the University of Baghdad and is also supported by grants from the Gulbenkian Trust. It is thus well placed to carry out research into the wildfowl and wetlands of the Tigris and Euphrates marshes.

The game laws of Iraq are comprehensive, but enforcement is difficult in so large a country, much of which is difficult of access. At the same time shooting has been almost abolished for internal security reasons and numbers of duck and geese have increased by all accounts during the last eight years. Flocks of geese in one particular area occur today in tens of thousands yet no mention of these is made

in the ornithological records of the country. Species include Greylag *Anser anser* and Whitefront *Anser albifrons* mostly, but also Lesser Whitefront *Anser erythropus* and up to four hundred Red-breasted Geese *Branta ruficollis*. The latter is of great interest as there has been only one other sighting (Vernon Robertson *in litt*) since the cautious remarks of Ticehurst (1922).

A reconnaissance survey of the Tigris and Euphrates marshes in summer by P. V. George showed that the Marbled Teal *Anas angustirostris* bred quite commonly in some areas, but there was no indication of any other breeding ducks or geese in the areas visited.

**Iran**

Wildfowl conservation is being sponsored by the Department of Game and Fisheries. One small reserve has already been purchased near Bandar Pahlavi in the south-west corner of the Caspian Sea and a second of nearly four thousand acres is being provided by H.R.H. Prince Abdur Reza near Sari in Mazanderan, also near the Caspian. These reserves are planned as sanctuaries as well as ringing stations.

It is sad to note that the goose flocks which used to winter near Farahabad in Mazanderan (Savage 1963) no longer do so except in very small parties on account of the disturbance caused by hunters in jeeps.

A survey of Lake Rezaiyeh made during the summer by Colonel Golasorkhi of the Game Department showed that the Common Shelduck *Tadorna tadorna* was still nesting in similar numbers to those found in 1960 (Savage 1964) and in addition huge numbers of Greater Flamingo *Phoenicopterus roseus* appeared to be nesting on the mudflats at the south-east corner of the lake. The latter, however, were unapproachable nearer than about one mile due to the shallow water and soft mud. Breeding has not been confirmed.

In addition to the work of the Game Department useful observations have been made by Lindon Cornwallis, now curator of the Pahlavi University Zoological Museum, Shiraz.

**Afghanistan**

There is as yet no control of shooting except on Lake Kargah, which lies about ten miles west of Kabul. Lake Kargah, however, is a valuable refuge particularly for the large numbers of duck that use the extensive feeding grounds around Kabul. Market trapping and shooting over decoys are still practised on a large scale, mostly during the period of the spring passage.

An interesting bird seen in the Kabul bazaar in March was a Marbled Teal *Anas angustirostris*. Although this is a common breeding bird along the Amu Darya in Uzbekhestan (Salikhbaev and Bogdanov 1961), and formerly in the Hamun-e Helmand in Baluchistan, it has not been previously recorded from central Afghanistan.

**Pakistan**

An expedition from the World Wildlife Fund, led by Guy Mountfort, visited Pakistan in October-November at the suggestion of the writer to investigate and advise on the problems of wildlife conservation. After three weeks in the field they prepared an outline report which was extremely well received by President Ayub Khan. As a result of this, a Wildlife Commission is being set up to review the whole position of wildlife in both East and West Pakistan, and especially the administration of the Game Laws. Several wildfowl refuge projects will be considered and the Wildfowl Survey has been asked to participate in the work of the Wildlife Commission.

An important discovery during the year was that the White-headed Ducks *Oxyura leucocephala* which congregate at Khabbaki Lake do so to moult their flight feathers. As a result of this discovery Khabbaki Lake is being made a permanent wildlife refuge in collaboration with the World Wildlife Fund.

**India**

The private efforts of M. J. S. Mackenzie in Assam have again produced much valuable information. His records of the Chinese race of the Spotbill *Anas poecilorhyncha zonorhyncha* have been confirmed by the Bombay Natural History Society after examination of specimens. It should be noted, however, that there is still a marked difference from the Chinese Spotbills at Slimbridge (believed to be of Japanese origin). The possibility of a "cline" cannot be ruled out and only ringing and specimens from the Chinese side can solve the problem.

A number of sightings of the White-winged Wood Duck *Cairina scutulata* were recorded as the result of enquiries but the fact remains that the species only remains in India in very small numbers in limited localities. It is totally protected and rightly so. Two sightings have come

to light in East Pakistan, both around 1954 and near Pablakhali but the habitat concerned is now submerged under the new Kaptai Lake.

The Bombay Natural History Society has participated wholeheartedly in the Wildfowl Survey and so has the Delhi Birdwatching Society.

### Ringing programme

One thousand four hundred and fifty-two ducks and geese were ringed in West Pakistan and India (Table I). In addition about 50 ducks were ringed in Assam, including two Falcated Ducks, and a small number of Mallard in northern Iran. Efforts in Pakistan, Iran and Iraq are being intensified in 1967. As decided at the I.W.R.B. Warsaw conference, ringing efforts are to be concentrated in mid-winter.

The recovery rates for Asia are still less than five per cent and are almost entirely from the U.S.S.R. This indicates that there is room for a big improvement in the reporting of recoveries in southern Asia.

**Table I. Wildfowl ringed in India and Pakistan in 1966.**

| *Species* | *India (B.N.H.S./W.H.O.)* | *Pakistan (Game Dept.)* | *Total* |
|---|---|---|---|
| Pintail *Anas acuta* | 293 | 19 | 312 |
| Common Teal *A. crecca* | 564 | 109 | 673 |
| Indian Spotbill *A. peocilorhyncha* | 43 | — | 43 |
| Mallard *A. platyrhynchos* | — | 28 | 28 |
| Gadwall *A. strepera* | — | 4 | 4 |
| Wigeon *A. penelope* | 9 | — | 9 |
| Garganey *A. querquedula* | 209 | 7 | 216 |
| Shoveler *A. clypeata* | 67 | 26 | 93 |
| Red-crested Pochard *Netta rufina* | — | 2 | 2 |
| Common Pochard *Aythya ferina* | 1 | 6 | 7 |
| Ferruginous Duck *A. nyroca* | 3 | 7 | 10 |
| Tufted Duck *A. fuligula* | 3 | — | 3 |
| White-headed Duck *Oxyura leucocephala* | — | 10 | 10 |
| Ruddy Shelduck *Tadorna ferruginea* | — | 2 | 2 |
| Greylag Goose *Anser anser* | — | 2 | 2 |
| Bar-headed Goose *A. indicus* | — | 8 | 8 |
| Comb Duck or Nukhta *Sarkidiornis melanotos* | 20 | — | 20 |
| Cotton Teal *Nettapus coromandelianus* | 10 | — | 10 |
| | | Total | 1452 |

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# Melanistic White-fronted and other Grey Geese

JAMES HARRISON, JEFFERY HARRISON and MICHAEL HUDSON

On 28th January, 1966, a shepherd, John Dockwrey, reported to Michael Hudson that there was a black goose grazing among the European White-fronted Geese *Anser albifrons albifrons* on the Thames fresh marshes at High Halstow, Kent. Next day Michael Hudson found it grazing in the same area with Whitefronts and we found it again on 2nd February, when we attempted to stalk it for a closer inspection and for photography, but the geese in whose company it was proved to be extremely shy. The bird was similar in size to the other Whitefronts, and fed with them. It was extremely conspicuous on account of its overall blackness, but when carefully inspected there was no doubt about its identity for the small white forehead marking was definitely visible. The rest of the head, neck, breast, belly, flanks, upper and under tail-feathers and primaries were uniformly black. The feathers of the mantle, wing-coverts and secondaries were slightly paler and those of the mantle showed paler edges giving the upper-parts the normal barred effect, although far less conspicuous than usual. The beak was pinkish-orange and legs a dark orange.

At first we wondered whether the bird could have been oiled, but quickly ruled this out, for it was quite obviously extremely fit. Furthermore, the white forehead would not have been clean, had the bird been oiled.

The bird was last seen on 15th February, 1966, when a flock of 468 White-fronted Geese was present at High Halstow.

In conversation with Count Léon Lippens and M. Thierry Robyns de Schneidauer, we learnt that a melanistic White-fronted Goose had been seen at Zwin, Belgium, between 10th and 15th March, 1965. It was in company with 13 other European White-fronted Geese, This bird was the same size as the other geese and was a beautiful brownish-black, without any trace of black bars on the breast or flanks. The white forehead mark was pale grey rather than white and the bill orange instead of pink. The feet and tarsi were a darker orange than normal.

The fact that the under tail-coverts of the Belgian bird were white would appear to distinguish it from the Kentish bird in which they were black, unless there was a colour change in the intervening moult.

The behaviour of the Belgian bird was normal as was the behaviour of the other geese towards the melanistic one. This was also true of the Kentish bird.

It is of considerable interest that two melanistic European White-fronted Geese were reported in 1967 at Walmsley Sanctuary, Wadebridge, Cornwall, by R. J. Salmon of the Cornwall Bird Watching and Preservation Society. They arrived in mid-January and remained for several weeks in company with other European Whitefronts.

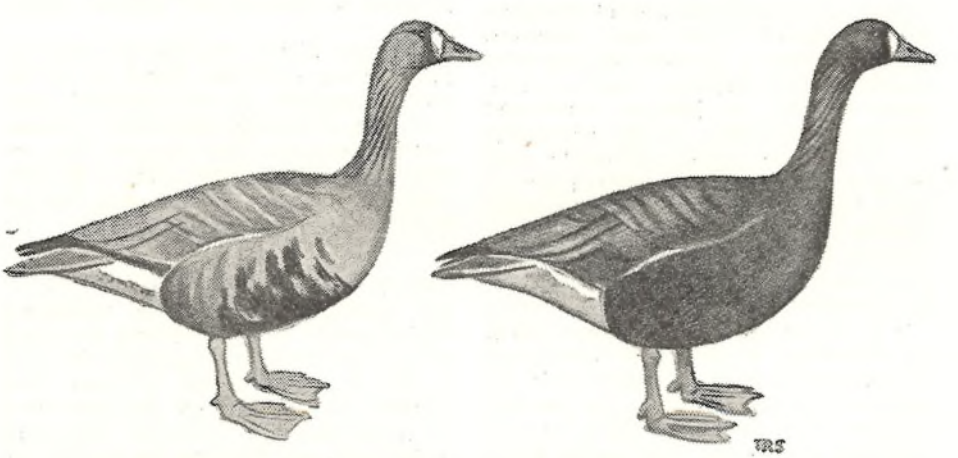

**Figure 1. The Belgian melanistic White-fronted Goose (right) beside a normal adult Russian bird.** *Drawing by Thierry Robyns de Schneidauer.*

They were described as being "far darker than any of the usual variations. They were all dark except for the tip of the tail—a dark grey-brown that in poor light looked black. The under tail-coverts and vent area were as dark as the rest of the body . . . the 'white front' was limited to an area above the bill and was not as bright as it should be . . . the legs and feet were orange."

It is tempting to speculate as to whether these two geese were the Belgian and the Kentish birds in company together, in which case, the former would have developed dark under tail-coverts in the interval, but this is quite possible.

The presence of these melanistic geese led us to collate some of our views on the melanistic patterning which many of the grey geese exhibit. The most characteristic feature is the black barring of the breast and belly, which is most highly developed in adults of the White-fronted and Lesser White-fronted Goose *Anser erythropus*. The extreme is shown by the Greenland White-fronted Goose *Anser albifrons flavirostris*, in which the under-parts may be almost entirely black. Black barring is not confined to these two species, for it is also a common feature in adult Greylag Geese *Anser anser*. In these, the bars are much smaller and narrower, but may be widespread over the breast and belly. Much more rarely, minimal black barring may be seen in geese of the Bean/Pink-foot complex, *Anser fabilis/brachyrhynchus* for an adult Pink-footed Goose, which was shot by James Harrison in Angus in January, 1950, had an unmistakable black bar upon the upper breast.

Although first year geese lack any black barring, some 10-20 per cent of European White - fronted Geese, *Anser albifrons albifrons*, show a general flecking with individual dark feathers, which is much more marked in juvenile Greenland White-fronted Geese, a high percentage of which have almost uniformly dark under-parts. A similar condition, although much less obvious, can be seen in some juvenile Greylags and Pink-footed Geese. Juvenile White-fronted Geese also have a black facial band, which is a characteristic identification feature for this species.

The darkest upper-parts are also seen in the Greenland White-fronted Goose and this includes a marked diminution in the amount of white bordering on the tail-feathers. The Greenland White-fronted Goose may also show dark barring in the mantle-feathers, a character which has not been previously recorded. A particularly good example of this feature was found in a female which was shot at Loch Ken in January, 1966. It is obviously only a short stage from a bird such as this to one exhibiting almost complete melanism, such as the one described from Kent.

Melanism has also been recorded in the Greylag Goose. A bird seen on 6th March, 1964, at Newburgh, Aberdeenshire, by Dr. G. E. Dunnet (*Scottish Birds* 3 : 92) had a black belly and under-parts, while the upper-parts including the head and neck, were dark brown with individual black feathers, appearing to have lighter edges. The outer tail-feathers were the only white plumage on the bird. The legs were very much darker than normal, but the bill appeared normal in colour.

Two other melanistic Greylags are recorded in the same issue of *Scottish Birds*. Both were seen at Maybole, Ayrshire, on 15th March, 1964, by G. A. Richards. One was dark brown on the back, breast and belly, with slightly lighter feather edges giving a normal pattern on the back. There was some white on the under tail-coverts. The grey leading edges of the wings were freckled with brown.

The second bird was black-brown on the head, neck, back, breast and belly, with a nigger-brown back pattern. There was a little white on the upper tail-coverts.

It seems that all the adult grey geese mentioned have a tendency to produce a melanistic pattern, which reaches its normal extreme in the Greenland White-fronted Goose. Exceptionally, the melanism may be so extensive as to be almost total. There is a similar tendency for the juveniles to produce dark mottled under-parts.

It seems highly unlikely that any external factor could be found to explain the development of this melanistic pattern. The controlling mechanism is almost certainly genetic. This suggests that the grey geese of the genus *Anser* were preceded in the evolutionary tree by the black geese of the genus *Branta*.

We are most grateful to Colin Willock for the specimen of the adult Greenland White-fronted Goose, showing the black mantle bar; to Bryan Sage for checking his records of melanism and to Count Léon Lippens and M. Thierry de Schneidaur for telling us of the melanistic Whitefront in Belgium, and the latter for allowing us to reproduce his excellent sketch of this bird.

## A bigamous Greylag gander

JEFFERY HARRISON

Since the summer of 1964 one or two pairs of Greylag Geese *Anser anser* have taken to nesting on islands in Lord Hollenden's lake at Leigh, near Tonbridge, Kent. These birds originate from the W.A.G.B.I./Wildfowl Trust experimental gravel pit reserve near Sevenoaks, to which they return in autumn with their offspring.

In 1966, five geese appeared in spring, two pairs and a lone bird. In view of the fact that we did not wish to build up a large population with a tradition for nesting on this lake, the clutch from pair A was removed and hatched under a broody hen. They subsequently relaid and reared two young on the lake.

Pair B duly hatched off three goslings. When they appeared on the water as a family unit in mid-May, they were promptly joined by the lone bird, which proved to be a female. After only a few days in company, the gander of pair B deserted his family and separated off in company with the lone goose. By June 6th they were found to have a clutch of six eggs, which were also taken and hatched elsewhere. After this both of these adults returned to the reserve to moult. Meanwhile, the deserted goose successfully reared the three goslings by herself and returned to the reserve with them in September after the flightless period.

I can find no references in the literature to such an event occurring in Greylag Geese. In the strictest sense, this is an example of successive polygamy, as defined by Armstrong (1964), in which the male establishes more than one pair bond. This state of affairs is rendered all the more likely if a situation occurs in which more than one mature goose is present in a restricted habitat. This is exactly what happened with these Greylags.

I am most grateful to Mr. Peter Beagley, head gardener to Lord Hollenden, for bringing these happenings to my notice and indeed for establishing the true state of affairs. I am also extremely grateful to Lord Hollenden for allowing me to study his lake and for the use of his boat.

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## Drake Harlequin escorting its family

JEFFERY HARRISON

On 5th August, 1966, at Grund, Skorradalur, West Iceland, a drake Harlequin *Histrionicus histrionicus* was found still in full plumage, closely escorting its duck and four ducklings, which were then about a month old. This family party was found in the river at its outflow from the loch. When first seen the family was resting on the rocky bank in company with about 25 other female Harlequins. These flew off, leaving the family swimming in the river. It was found again in the same place on 11th August, when we returned through the area.

Even at this date, the drake showed no signs of moulting into eclipse plumage, but it was flightless, for the primaries were missing on the right side, although present on the left. We had already noted this, when it was first seen. Possibly this may have been traumatic, for there was a single strand telegraph wire crossing the river close by at ten yards height which must take its toll of Harlequins. Even if this was so, there was still nothing to prevent the bird from swimming down river to the open sea about five miles away to moult.

According to Bengston (1966) the normal behaviour of drake Harlequins in Iceland is to leave the nesting area from mid-June to early July and to return to sea, part of the journey being made by swimming down river. Once at sea the birds quickly moult into eclipse plumage.

Two facts make this event most unusual. First, that the drake should have remained in company with the female and young, and second, that it should have failed to moult into eclipse plumage. The second fact is highly likely to be dependent upon the first.

Such an event has not been recorded before in Harlequins and no such thing has ever been seen by Dr. Finnur Guðmundsson or Mr. Sven-Axel Bengtson in Iceland. Bengtson, however, once observed a solitary pair of Harlequins at the end of June in a river near the mountain Herðubreið in north-east Iceland. The male was still in full nuptial plumage. He queries whether there is a growing tendency for males to remain longer with their mates when the pairs are isolated.

Hochbaum (1959) has recorded this behaviour in the Ruddy Duck *Oxyura jamaicensis* and on rare occasions in the Mallard *Anas platyrhynchos*. He considers that it occurs when the period of reproductive activity in the drake overlays the incubation and brood periods. Harrison and Harrison (1965) have also recorded this behaviour in the Mallard. It is perhaps of interest to note that the Eider drake *Somateria mollissima* in Iceland very frequently stays in close attendance on its incubating duck and may escort its family for a short while after hatching. This does not occur in other Eider populations.

**Acknowledgements**

I am most grateful to Dr. Finnur Guðmundsson and Mr. Sven-Axel Bengtson for their information on Harlequin behaviour.

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# Techniques for rapid extraction of ingested food from wildfowl viscera

D. F. W. POLLARD

**Summary**

Details of equipment and application are given for two methods for sampling wildfowl viscera. The first method, suitable for use on grazing species, relies on dry extraction from the oesophagus and proventriculus by means of a self-opening crook. The second method, employed for extraction from seed and animal feeders, involves a simple water pump, with which food is washed from the gullet.

The main advantages of these methods, which together should permit analysis of most species of wildfowl, are that it is unnecessary to dissect or disfigure the carcass in any way, and that a large number of birds may be treated in a short period.

During the winters 1965-66 and 1966-67, various methods were investigated for the extraction of ingested food from the oesophagus and proventriculus of dead wildfowl. Two techniques are described which permit a rapid examination of the material, and which are applicable to most species of wildfowl.

The first method employs the principle of a toggle-bolt: a self-opening "barb" is fitted to a rod long enough to reach the proventriculus, and sufficiently narrow to permit insertion without pushing food material beyond the reach of the barb itself. The equipment is operated without the use of water.

The second method is basically similar to stomach pumping: water is simply pumped into the gullet and allowed to drain out, usually under pressure, with food items in suspension.

These techniques have been found to be especially useful when a large number of specimens must be rapidly examined, and when it is desirable to leave carcasses intact for table or other purposes.

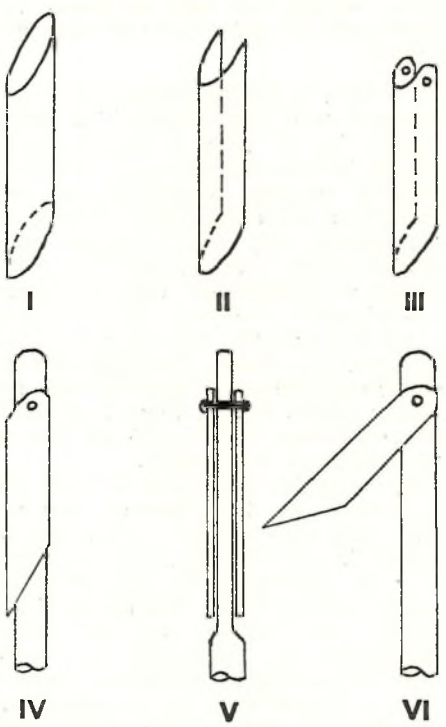
1. *Dry extraction*

Construction of apparatus. Prepare a 3 ft. (1 m.) length of $\frac{1}{8}$ in. (0.3 cm.) diam. brass or galvanised wire, by fitting a short wooden handle at one end and filing two flats along the last inch (2.5 cm.) of the opposite end (Fig. V). Drill a 3/64 in. (c. 0.1 cm.) hole through these flats, $\frac{1}{4}$ in. (0.6 cm.) from the end.

A "barb" is prepared from $\frac{1}{4}$ in. (0.6 cm.) outside diameter soft P.V.C. tubing, by cutting a $\frac{5}{8}$ in. (1.5 cm.) length at an angle of 60° each end (Fig. I). A $\frac{1}{8}$ in. (0.3 cm.) strip is cut away to produce a "U"-shape cross section (Fig. II). Drill

or hot-pierce a 3/64 in. (c. 0.1 cm.) hole close to one end through both sides, and round off upper corners (Fig. III).

Place the completed barb over the wire, aligning drillings on each (Fig. IV). A small pin is inserted and burred to form a hinge (Fig. V). It may be found necessary to slightly modify the dimensions given, to ensure free movement of the barb to the open position (Fig. VI), since materials vary somewhat according to source.




**Figures I—VI. Construction of apparatus.**

Procedure for use. The barbed end of the rod is pushed over the tongue of a dead bird, which is suspended by its legs, until a solid resistance from the gizzard is felt. On withdrawal, the barb will open, pulling out food material within the gullet. This procedure should be repeated several times.

It has been found advantageous to fit a "piston" about 2 in. (5 cm.) below the barb. This may take the form of a tight coil of twine, about $\frac{3}{4}$ in. (1.9 cm.) in diameter and 2 in. (5 cm.) long, having the effect of consolidating food material below the barb and facilitating extraction.

Food items should be washed off into water, and separated later by sieving.

2. *Wet extraction*

Construction of apparatus. A metal or plastic tube, about 2 ft. (62 cm.) long and $\frac{3}{8}$ in (0.9 cm.) outside diameter is connected to a water container of up to 2 gallons (9 l.) capacity, with rubber tubing. Connected separately to the container is a rubber bulb, fitted with a non-return valve at each end to permit continuous pumping of air into the filled container.

Procedure for use. Suspend the bird by its legs. To collect food items, a polythene bag may be held over the head; this is facilitated by cutting a small hole in the side of the bag, and passing the tube through from the outside before inserting it into the gullet. About 1 pint (0.6 l.) of water vigorously pumped from the container is usually sufficient to wash out food. This should be drained by pouring the contents of the polythene bag through a sieve of not less than 120 mesh/in. (47 mesh/cm.).

After both wet and dry extraction, material may be preserved and labelled in the usual manner.

In practice, it has been found that dry extraction is most suitable for investigations involving grazing species, whilst seed and animal feeders should be sampled by washing. It may be necessary to employ both methods, dry first, when specimens are tightly packed with food.

Finally, it should be noted that these methods are qualitatively less sensitive than conventional methods of viscera analysis, as described by Harrison (1960), since the gizzard is not emptied. However, there is reason to believe that quantitative precision may be enhanced, since the effects of differential digestion are considerably reduced (see Pollard 1967).

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# Comparison of techniques for the analysis of wildfowl viscera

D. F. W. POLLARD

**Summary**

Gullet and gizzard contents were analysed after water extraction and conventional extraction techniques had been applied. The results suggested that the four species of seed eaten had been digested differentially within the gizzard, due mainly to differences in their resistance to mechanical digestion. A similar order of relative resistance was observed following artificial grinding of an undigested sample from the gullet. Since the more resistant seed species accumulate within the gizzard, conventional analysis may show an undue bias towards these forms; extraction methods which sample only the gullet should overcome this problem, at the expense of some qualitative precision.

Differential digestion rates have been observed by Koersveld (1950) to exert a considerable effect on the results of viscera analysis of dead jackdaws. Olney (1961) has suggested that the results of analysis of wildfowl might be similarly modified. Since analyses of wildfowl viscera are usually confined to the oesophagus, proventriculus and gizzard, the main source of error would appear to lie in differences in the rates of mechanical digestion within the latter organ, whilst the bird was alive.

While investigating various methods of viscera analysis, an opportunity arose for comparative analyses of a single bird by conventional and water extraction (see Pollard 1967) techniques. A duck Mallard was shot in January, 1966, shortly after feeding among flood debris from the River Severn. The intact bird was first treated by washing out the oesophagus and proventriculus, after which the viscera were removed. It was found that the oesophagus and proventriculus had been completely emptied by washing; the gizzard contents were set aside for analysis. Five sub-samples were taken from each sample of ingested food, and separated into food types. These comprised seeds of four species of flowering plants. The mean frequency of each species in each sample is given in Table I, as a percentage of the total number of seeds in each sample.

Statistical analysis of the sub-sample counts showed that significant differences ($P = 0.05$) in the percentage frequencies occurred in all four species. The results suggest that the order of digestion rates was as follows: *Rumex* sp. (very rapid), *Glyceria maxima, Ranunculus* sp. and *Polygonum persicaria* (slow). Clearly, if the gizzard only had contained food, analysis would have indicated that *Polygonum* and *Ranunculus* together formed a considerable proportion (32.6 per cent) of the food ingested, whilst *Rumex* would be regarded as almost a trace item. In fact, analysis of the gullet revealed that the former species totalled only 8.2 per cent, whereas *Rumex* formed 15.6 per cent of the number of items taken.

In comparing the results of these two analyses, it has been assumed that the food items were distributed at random in the feeding area, and that the bird did not alter its preference for any particular species whilst feeding. The nature of the feeding area suggests that the former assumption was reasonable, but there could be no check on preference changes.

As a further check on the hypothesis that the seed species under consideration varied in their resistance to mechanical digestion, an attempt was made to simulate gizzard action on an undigested sample. The classified contents of the oesophagus and proventriculus were mixed with grit from the gizzard for the same bird, moistened, and lightly ground with a pestle and mortar for about a minute. After resorting, the numbers of remaining intact seeds were calculated as

**Table I. Results of viscera analyses.**

| *Food species* | *Mean frequency (%) in oesophagus and proventriculus* | *Mean frequency (%) in gizzard* |
|---|---|---|
| *Glyceria maxima* | 75.2 | 65.8 |
| *Polygonum persicaria* | 3.8 | 16.4 |
| *Ranunculus sp.* | 4.4 | 16.2 |
| *Rumex sp.* | 15.6 | 1.6 |

percentages of their original frequency. The losses incurred by each species during this treatment were as follows: *Rumex* 87%, *Glyceria* 86%, *Polygonum* 26% and *Ranunculus* 4%. Whilst there is obviously considerable difference between grinding by the gizzard in a live bird and the simulated treatment applied, the orders of resistance observed are rather similar. The comparatively high percentage loss shown for *Glyceria*, after artificial grinding, was due to the fact that most seeds were simply broken into two pieces; as such they were still identifiable. This also applied to some fragments of other species. However, under natural conditions, there would be a certain amount of chemical digestion, rendering identification more difficult, whilst fragments would be quickly passed into the intestine.

Whilst the results presented above cannot be regarded as entirely conclusive, they do indicate that conventional analysis of viscera may bias the apparent food preferences or availabilities towards items more resistant to mechanical digestion. This resistance would be controlled by a variety of factors, including, in the case of seeds, size, shape and wall thickness; the nature of other items ingested is probably important also. In an analysis of contents of crop, gizzard and droppings of force-fed quail, Jensen and Korschgen (1947) observed similar effects of differential digestion on the apparent diet composition. For example, the original diet included 11.8 per cent, by weight, *Pinus* seeds and 24.3 per cent *Robinia* seeds. Slight reductions were observed in the crop composition (10.5 and 19.2 per cent respectively); the gizzard was found to contain 71.2 per cent *Pinus* and 6.5 per cent *Robinia* seeds. Analytical methods involving the gullet only, such as the rapid extraction techniques described by Pollard (1967), would appear to overcome this problem, although they are less sensitive, qualitatively, than full analysis of all three viscera components.

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# THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTERSHIRE

## INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1966

| 1965 | EXPENDITURE | £ | £ |
|---|---|---|---|
| | To **General Expenses:—** | | |
| 6590 | Salaries and Superannuation, Administrative Staff | 6788 | |
| 252 | Travelling, Administrative Staff | 246 | |
| 1431 | Rent, Rates, Water Rates and Insurance | 1607 | |
| 2589 | Postages, Telephone and Miscellaneous Expenses | 2951 | |
| 925 | Maintenance of Buildings | 1711 | |
| 1814 | Printing and Stationery | 1814 | |
| 50 | Hostel Upkeep (Net) | 187 | |
| 437 | Loan Interest | 232 | |
| 204 | Bank charges, less Interest earned | 253 | |
| 2111 | Printing Annual Report | 2779 | |
| 2945 | Advertising | 5942 | |
| 19348 | | | 24510 |
| | **New Grounds and Peakirk:—** | | |
| 13500 | Salaries, Wages and Superannuation | 14279 | |
| 424 | Travelling | 369 | |
| 3135 | Purchases and Transport of Wildfowl | 4897 | |
| 6946 | Food for Wildfowl | 8173 | |
| 2915 | Maintenance of Grounds | 1800 | |
| 1118 | Transport and Mechanical Equipment and Maintenance | 1260 | |
| 1404 | Fuel and Power | 1616 | |
| 831 | Miscellaneous | 1054 | |
| 30273 | | | 33448 |
| | **Gate Houses:—** | | |
| 21540 | Purchases for re-Sale | 23333 | |
| 316 | Royalties, Coloured Key Publications | — | |
| 3865 | Salaries, Wages and Superannuation | 4259 | |
| 1885 | Miscellaneous | 1521 | |
| 27606 | | | 29113 |

| 1965 | INCOME | £ | £ |
|---|---|---|---|
| | By **General Income:—** | | |
| 9572 | Subscriptions, Ordinary | 10445 | |
| 105 | Subscriptions, Life Members | 578 | |
| 1839 | Donations (including Copper Coin Campaign) | 1850 | |
| 1931 | Income Tax repaid on Covenants | 2089 | |
| 564 | Receipts from Sale of Annual Reports | 428 | |
| 9 | Annual Dinner (Net) | — | |
| 1088 | Restaurant (Net) | 1822 | |
| 1272 | Interest on Investment and Deposits | 1333 | |
| — | Film Royalties | 1110 | |
| 16380 | | | 19655 |
| | **New Grounds and Peakirk:—** | | |
| 38237 | Gate Takings | 52409 | |
| 3370 | Sale of Surplus Wildfowl | 3504 | |
| 41607 | | | 55913 |
| | **Gate Houses:—** | | |
| 26503 | Sales, General | 36279 | |
| 1412 | Sales, Coloured Key Publications (2nd Edition) | — | |
| 27915 | | | 36279 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | To **Research and Conservation:—** | | | | By **Research and Conservation:—** | | |
| *13535* | Salaries and Superannuation | 15521 | | *14250* | The Natural Environment Research Council Grant | 16173 | |
| *4929* | Travel and Miscellaneous Research Expenditure | 4028 | | *415* | Donation from Abberton Ringing Station | 473 | |
| *1307* | Abberton Ringing Station | 1256 | | *425* | Duck Adoption | 440 | |
| *1029* | Borough Fen Decoy | 1180 | | *162* | Donations for Research | 188 | |
| — | Grants and Subscriptions | 433 | | | | | |
| — | Donations to R.S.P.B. towards purchase of Vane Farm, Loch Leven | 1000 | | | | | |
| *20800* | | | 23428 | *15252* | | | 17274 |
| | **Educational:—** | | | | **Educational:—** | | |
| — | Salaries and Superannuation | 373 | | — | Grants | | 192 |
| — | Exhibitions | 397 | | | | | |
| — | Miscellaneous | 315 | | | | | |
| — | | | 1085 | | | | |
| | **Capital Expenditure:—** | | | | | | |
| *2129* | Development | 3484 | | | | | |
| *869* | Equipment | 1289 | | | | | |
| *2998* | | | 4773 | | | | |
| *101025* | To **TOTAL EXPENDITURE FOR THE YEAR** | | 116357 | *101154* | By **TOTAL INCOME FOR THE YEAR** | | 129313 |
| *21151* | Valuation, 31st December, 1965 | | 23733 | *23733* | Valuation, 31st December, 1966 | | 24593 |
| *83* | Written off Buildings | | 100 | | | | |
| *2628* | Balance, carried down | | 13716 | | | | |
| *124887* | | | £153906 | *124887* | | | £153906 |
| *2600* | To Transfer to Accumulated Fund | | 14000 | *1278* | By Balance, 31st December, 1965 | | 1306 |
| *1306* | Balance, 31st December, 1966 | | 1022 | *2628* | Balance for the year to 31st December, 1966, brought down | | 13716 |
| *3906* | | | £15022 | *3906* | | | £15022 |

# THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTERSHIRE

## BALANCE SHEET, 31st DECEMBER, 1966

| *1965* | LIABILITIES | £ | £ |
|---|---|---|---|
| *£* | | | |
| *10537* | **Sundry Creditors** | | 9809 |
| | **Peterborough Provincial Building Society:—** | | |
| | Balance, 31st December, 1965 | 1429 | |
| | *Less* Repaid during year | 33 | |
| *1429* | | | 1396 |
| | **Loans:—** | | |
| | Balance, 31st December, 1965 | 7200 | |
| | *Less* Repaid during year | 5700 | |
| *7200* | | | 1500 |
| | **Special Funds (see separate Accounts):—** | | |
| *2712* | Research Centre Fund | 351 | |
| *5461* | Tropical Aviary Fund | 5363 | |
| *6100* | Contingencies Reserve Fund | 8411 | |
| — | Special Reserve Fund | 5000 | |
| *14273* | | | 19125 |
| | **Accumulated Fund:—** | | |
| | Balance, 31st December, 1965 | 30300 | |
| | *Add* Transfer from Income and Expenditure Account | 14000 | |
| *30300* | | | 44300 |
| | **Income and Expenditure Account:—** | | |
| *1306* | Balance per Account | | 1022 |
| *65045* | | | £77152 |

| *1965* | ASSETS | £ | £ |
|---|---|---|---|
| *£* | | | |
| *2448* | **Cash at Bankers and in Hand** | 5264 | |
| *20357* | **Cash on Deposit** (including Special Funds) | 25630 | |
| *22805* | | | 30894 |
| *1000* | **Investment at Cost** | | 1000 |
| *5208* | **Sundry Debtors and Payments in Advance** | | 8466 |
| | **Valuation** (as valued by the Honorary Director):— | | |
| *475* | **Office Equipment** | 680 | |
| | **New Grounds at Peakirk:—** | | |
| *10140* | Wildfowl | 11140 | |
| *860* | Transport | 1360 | |
| *3225* | Miscellaneous Equipment | 2854 | |
| *678* | Hostel and Restaurant Equipment | 583 | |
| | | 15937 | |
| | **Gate Houses:—** | | |
| *6355* | Stock for re-Sale | 5976 | |
| | **Scientific and Educational:—** | | |
| *2000* | Equipment | 2000 | |
| *23733* | | | 24593 |
| | **Freehold Properties:—** | | |
| *7599* | Amount, 31st December, 1965, at Cost or Valuation | | 7599 |
| | **New Buildings, New Grounds, Slimbridge, Glos.:—** | | |
| | Amount, 31st December, 1965 | 11363 | |
| | *Less* Written off to 31 December, 1965 | 6663 | |
| | Written off in year ended 31st December, 1966 | 100 | |
| | | 6763 | |
| *4700* | | | 4600 |
| | **NOTE.**—The New Buildings, etc., to be written off over a period not exceeding that of the Lease. | | |
| *65045* | | | £77152 |

We have examined the above Balance Sheet of The Wildfowl Trust, dated 31st December, 1966, 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 us.

S. J. DUDBRIDGE & SONS,
Chartered Accountants.

STROUD, Gloucestershire. 5th April, 1967.

# THE WILDFOWL TRUST

## SPECIAL FUNDS AS AT 31st DECEMBER, 1966

**Research Centre Fund (including Drayton Appeal)**

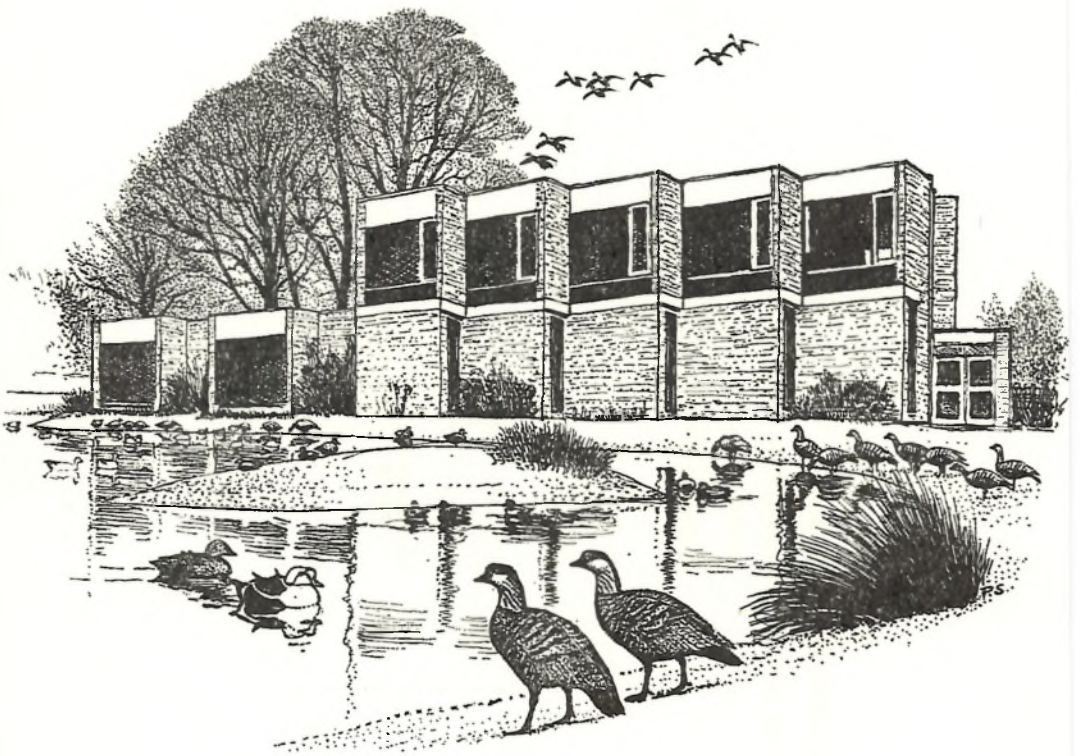
| | £ | £ |
|---|---|---|
| Amount Contributed (including Interest) to 31st December, 1965 | 34766 | |
| *Add* Balance of Grant from Natural Environment Research Council | 1500 | |
| Donations | 210 | |
| Interest Earned | 133 | |
| | | 36609 |
| *Less* Expended on New Research Centre and Gate House to 31st December, 1965 | 32054 | |
| Expended on New Research Centre during year | 4204 | |
| | | 36258 |
| Balance, 31st December, 1966, as per Balance Sheet | | £351 |

**Tropical Aviary Fund**

| | £ | £ |
|---|---|---|
| Balance, 31st December, 1965 | 5461 | |
| *Add* Donations | 200 | |
| Interest Earned | 133 | |
| | | 6040 |
| *Less* Expended on Tropical Aviary during year | | 677 |
| Balance, 31st December, 1966, as per Balance Sheet | | £5363 |

**Contingencies Reserve Fund**

| | £ | £ |
|---|---|---|
| Balance, 31st December, 1965 | 6100 | |
| *Add* Special Donations and Legacy | 8311 | |
| | | 14411 |
| *Less* Retirement Gratuity | 1000 | |
| Transfer to Special Reserve Fund | 5000 | |
| | | 6000 |
| Balance, 31st December, 1966, as per Balance Sheet | | £8411 |



## Photographs

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P. A. Johnsgard
F. McKinney
*Peterborough Citizen and Advertiser*
*The Citizen and Gloucester Journal*
Philippa Scott

# THE WILDFOWL TRUST

## SPECIAL FUNDS AS AT 31st DECEMBER, 1966

**Research Centre Fund (including Drayton Appeal)**

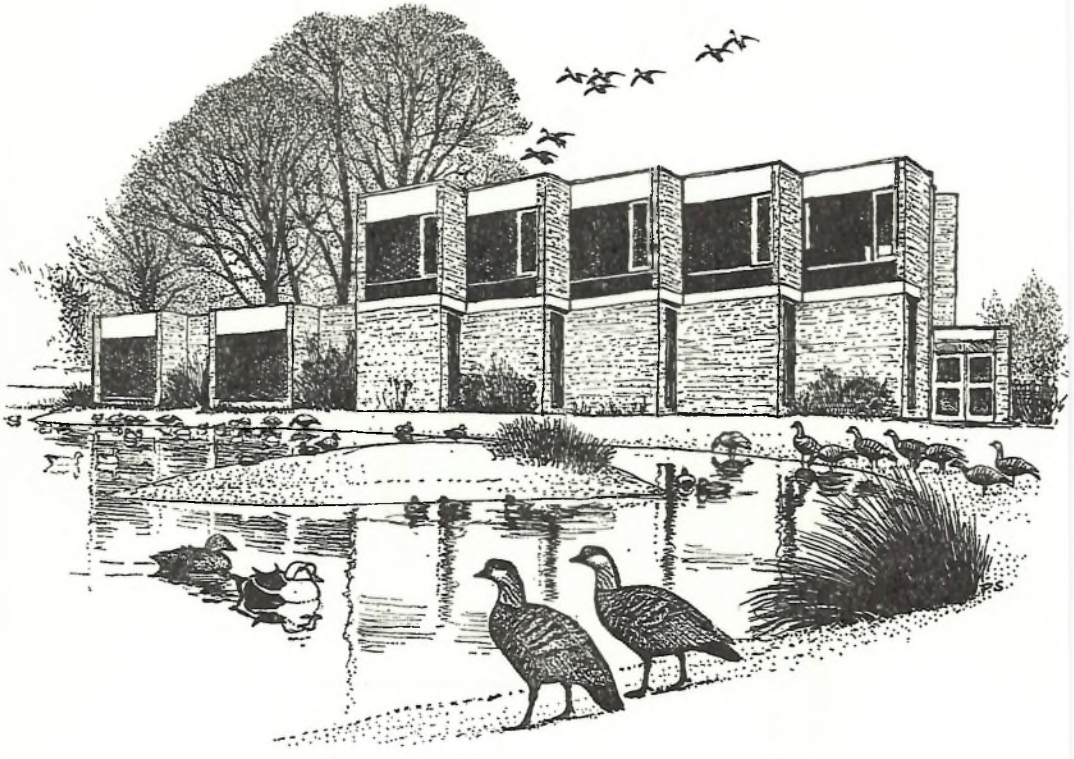
| | £ | £ |
|---|---|---|
| Amount Contributed (including Interest) to 31st December, 1965 | 34766 | |
| *Add* Balance of Grant from Natural Environment Research Council | 1500 | |
| Donations | 210 | |
| Interest Earned | 133 | |
| | | 36609 |
| *Less* Expended on New Research Centre and Gate House to 31st December, 1965 | 32054 | |
| Expended on New Research Centre during year | 4204 | |
| | | 36258 |
| Balance, 31st December, 1966, as per Balance Sheet | | £351 |

**Tropical Aviary Fund**

| | £ | £ |
|---|---|---|
| Balance, 31st December, 1965 | 5461 | |
| *Add* Donations | 200 | |
| Interest Earned | 133 | |
| | | 6040 |
| *Less* Expended on Tropical Aviary during year | | 677 |
| Balance, 31st December, 1966, as per Balance Sheet | | £5363 |

**Contingencies Reserve Fund**

| | £ | £ |
|---|---|---|
| Balance, 31st December, 1965 | 6100 | |
| *Add* Special Donations and Legacy | 8311 | |
| | | 14411 |
| *Less* Retirement Gratuity | 1000 | |
| Transfer to Special Reserve Fund | 5000 | |
| | | 6000 |
| Balance, 31st December, 1966, as per Balance Sheet | | £8411 |



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*Peterborough Citizen and Advertiser*
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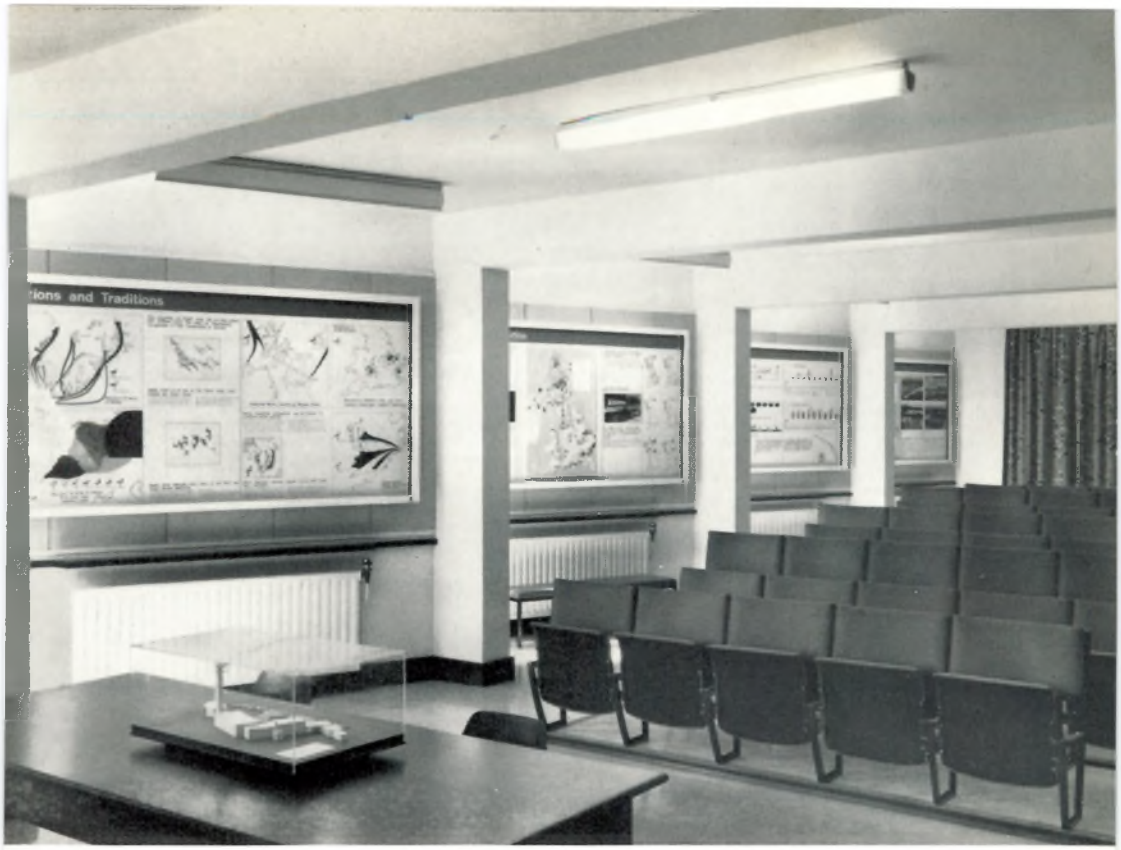
Philippa Scott

Her Majesty the Queen visited the Wildfowl Trust on 23rd April, 1966, to inaugurate the Research Centre.


(Upper) The Queen after unveiling the commemorative plaque by the main entrance.
CHELTENHAM NEWSPAPER CO. LTD.

(Lower) The Queen and the Duke of Edinburgh, with the Duke and Duchess of Kent and the Duke of Norfolk, being shown round the pens by Mr. and Mrs. Scott after the inauguration ceremony.
F. BAILEY & SON LTD.

II



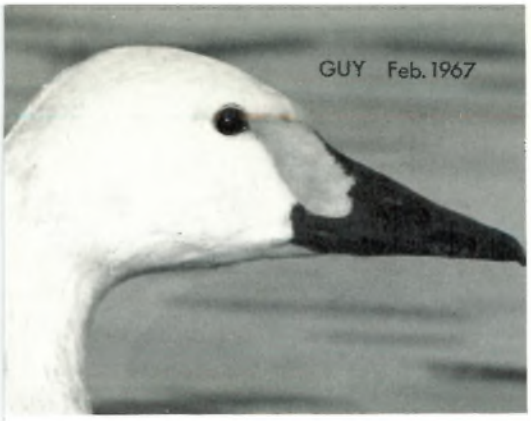

(Upper) The interior of the Wolfson Hall showing part of the permanent exhibition of the Trust's research work. H. J. HARE & SON LTD.

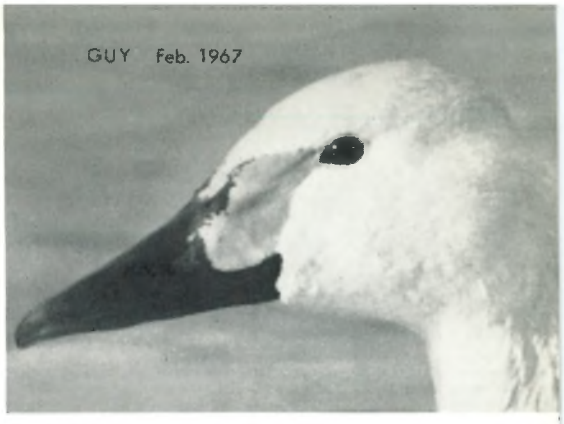
(Lower) A meeting of the International Wildfowl Research Bureau was held in the Wolfson Hall, 7th to 9th July, 1965.
Present at the meeting were (from left to right): J. Berry (Scotland), P. Scott, H. H. Hoekstra (I.W.R.B.), H. M. Thamdrup (Denmark), H. Boyd, F. M. Morzer Bruijns (Netherlands), C. D. T. Minton, A Zahavi (Israel), J. A. Eygenraam (Netherlands), P. J. S. Olney, L. Hoffman (Honorary Director of I.W.R.B.), J. M. Winterbottom (South Africa), U. Glutz von Blotzheim (Switzerland), K. Curry Lindahl (Sweden), G. L. Atkinson-Willes, Ch. David (I.W.R.B.), G. Eber (Germany), Th. Robijns de Schneidauer (Belgium) and G. V. T. Matthews. Also present but not shown were: W. M. Finlay (Ireland) and J. Penot (France).
P. A. JOHNSGARD



The wild Bewick's Swans *Cygnus columbianus bewickii* at Slimbridge. (Above) Peter Scott at his studio window with some of the swans on Swan Lake outside. (Below) The scene on Swan Lake under the floodlights. PHILIPPA SCOTT

IV





(Top and centre left) Guy. (Bottom and centre right) Turkey. These " passport " photographs are taken through the studio window and are used to complement the paintings of each bird's face pattern made by Peter Scott. They show the very small but nonetheless distinct differences between the birds.

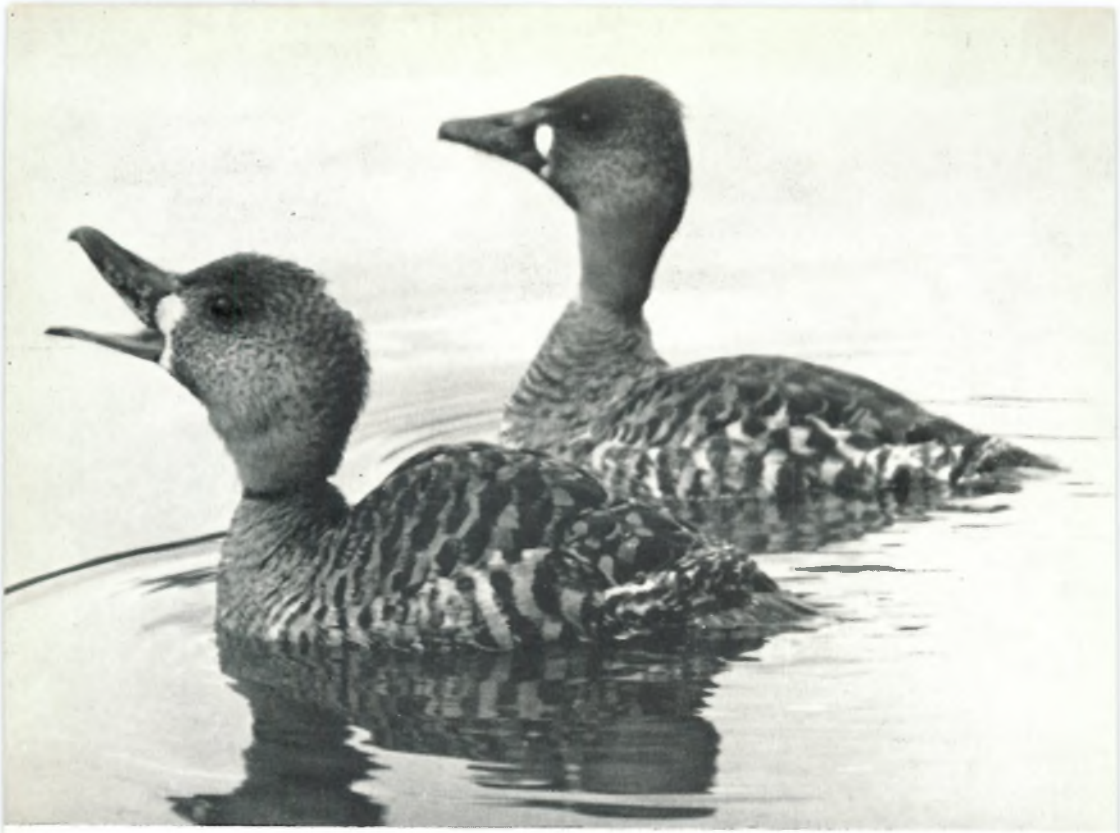
PHILIPPA SCOTT

V



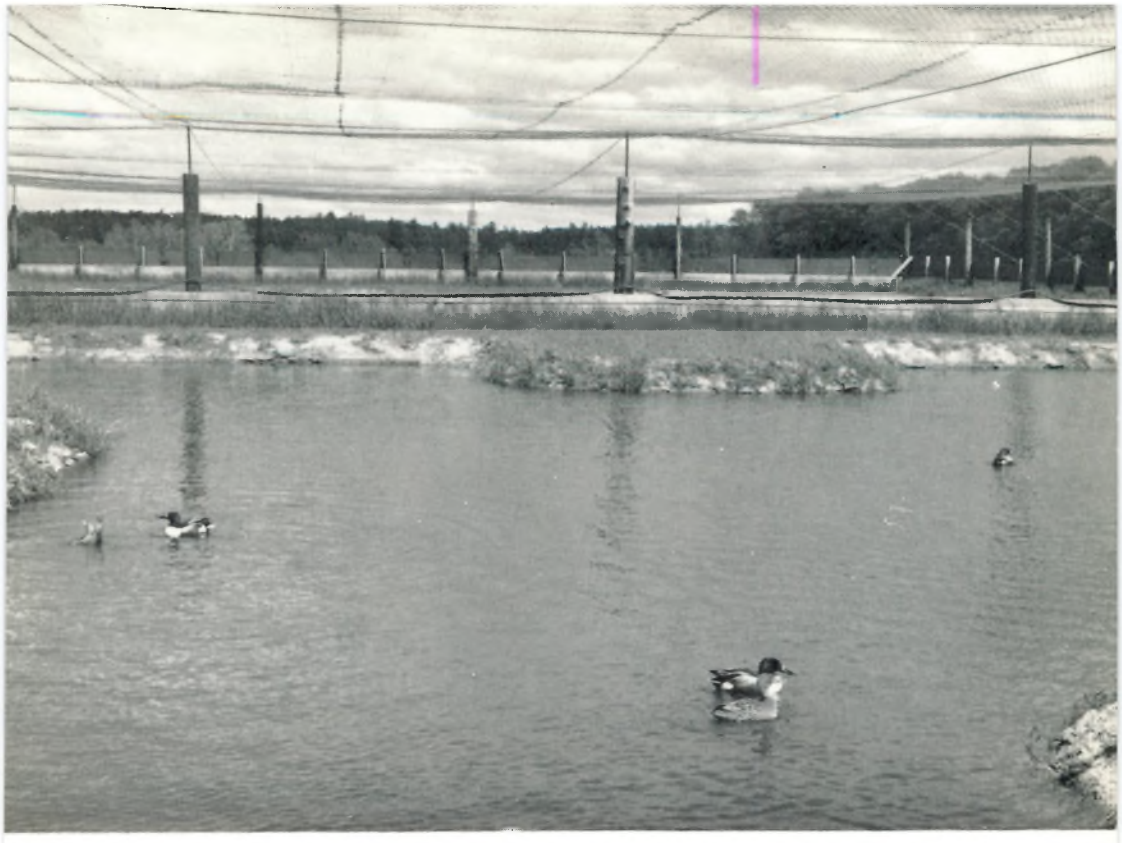
VI Mute Swans *Cynus olor*. (Above) Courtship behaviour. (Below) A male in full threat display. PHILIPPA SCOTT

(Above) A male defending his mate on the nest. (Below) A Mute Swan being ringed. Its mate is taking a great interest. E. E. JACKSON VII



A pair of African White-backed Ducks *Thalassornis leuconotus leuconotus*. The male (left) is in a " head-back " display; the female is " chin-lifting." (See pages 98 to 107.)
P. A. JOHNSGARD

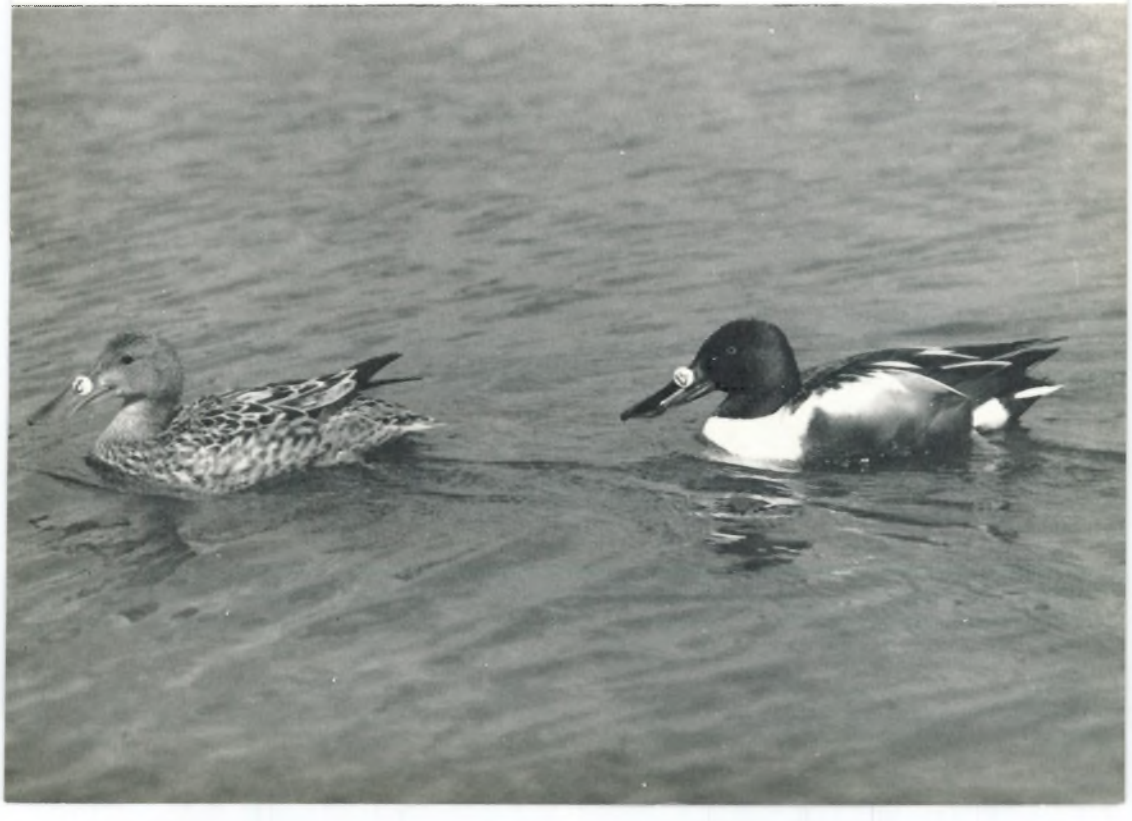
VIII (Lower) African White-backed ducklings hatched at Slimbridge. PHILIPPA SCOTT



(Upper) Shoveler pairs *Anas clypeata* hold well-defined territories in one of the flight pens at Cedar Creek Natural History Area, Minnesota. (See pages 108 to 121.)
F. MCKINNEY

(Lower) A pair of the Shovelers fitted with numbered, plastic, nasal discs. F. MCKINNEY

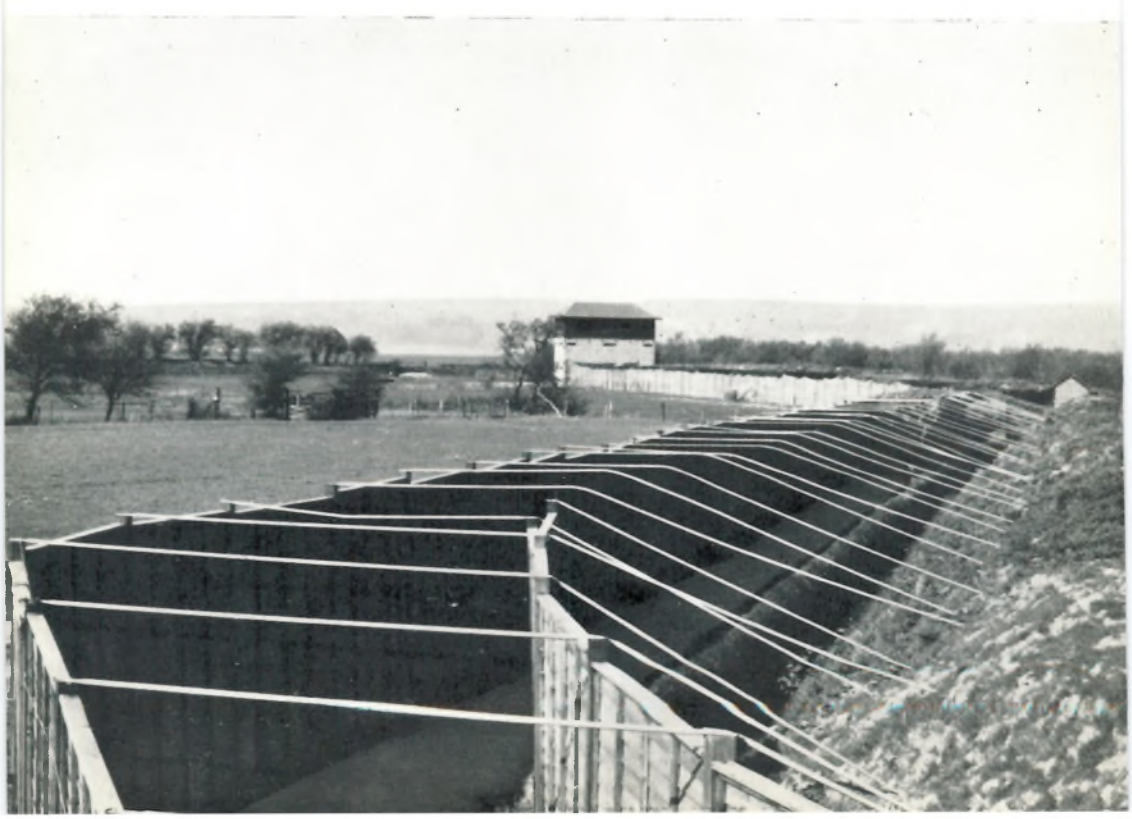




(Upper) On the occasion of the visit of 400 delegates from the International Ornithological Congress to Slimbridge, Mr. Scott presented a Ne-Ne skin to Professor L. Portenko of Leningrad—there being none in Russian museums. Looking on are Professor E. Stresemann, Berlin, doyen of modern ornithology, and Dr. Matthews.
J. V. BEER

(Lower) The Holden Tower, overlooking the Dumbles, was completed in October, 1966. The screened corridor allows visitors to reach the tower unescorted. A roof of camouflage-netting completes the arrangement when the wild geese are present.
PHILIPPA SCOTT





(Upper) Tony Cook, the Borough Fen Decoyman, securing new netting on one of the Decoy pipes. PETERBOROUGH CITIZEN AND ADVERTISER

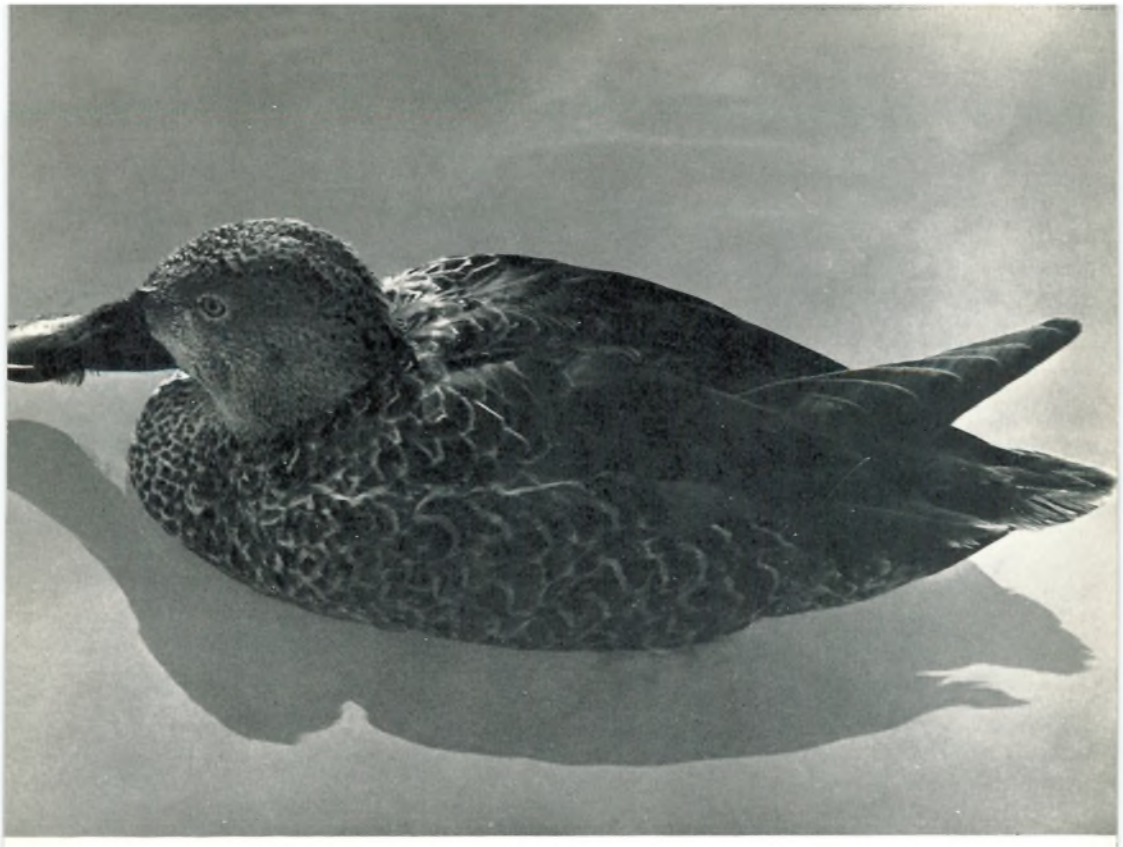
(Lower) A view of the recent 2½-acre extension to the Peakirk Waterfowl Gardens. PHILIPPA SCOTT



(Upper) Adult male Comb Duck *Sarkidiornis melanotus melanotus*. The knob or "comb" of the male becomes enlarged in the breeding season as is well shown in this photograph. D. R. BAYLISS

XII

(Lower) Abyssinian Yellowbill *Anas undulata rupelli*. PHILIPPA SCOTT



(Upper) Cape Shoveler *Anas smithi* showing some of the lamellae which form the filter-feeding mechanism of all Shovelers. PHILIPPA SCOTT

(Lower) Drake Spectacled Eider *Somateria fischeri*. Two of these unusual birds can be seen at Slimbridge. PHILIPPA SCOTT



Caribbean or Rosy Flamingos *Phoenicopterus ruber roseus*.

XIV PHILIPPA SCOTT

The Slimbridge collection of flamingos was completed with the arrival of (left) Andean Flamingo *Phoenicoparrus andinus* and (right) James's Flamingo *Phoenicoparrus jamesi*. The photographs illustrate the different bill patterns of these two species, both of which live in the High Andes. PHILIPPA SCOTT

(Lower) The flock of Chilean Flamingos *Phoenicopterus ruber chilensis* in the South American Pen. PHILIPPA SCOTT



Andean Flamingo.

XVI

PHILIPPA SCOTT