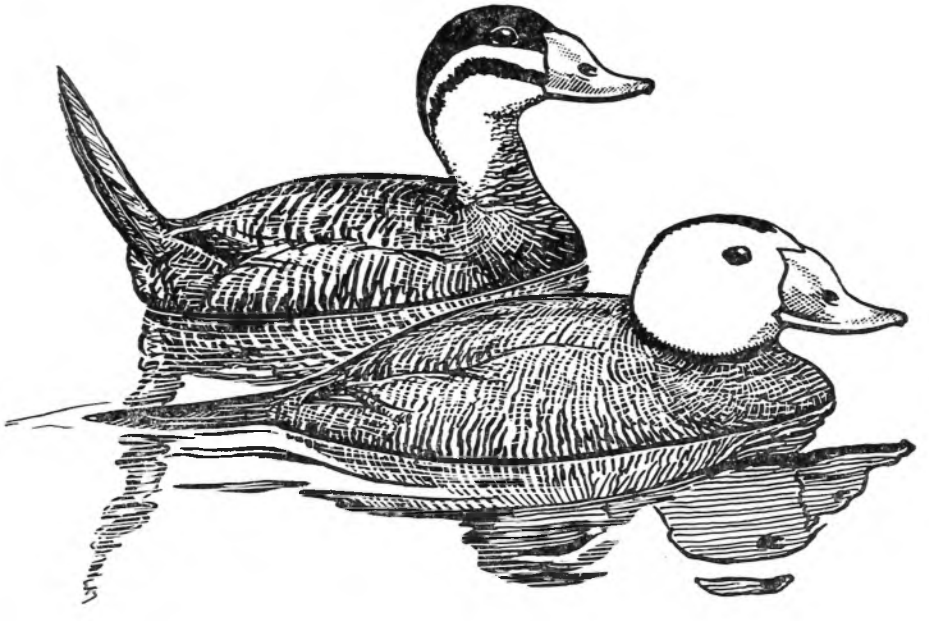

The sixteenth Annual Report of

The Wildfowl Trust

Edited by Hugh Boyd

Illustrated by Peter Scott

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The Wildfowl Trust

Patron HER MAJESTY THE QUEEN

President H.R.H. Prince Philip, Duke of Edinburgh, K.G., K.T.

Vice-Presidents
Captain R. G. W. Berkeley
The Rt. Hon. The Lord Howick of Glendale, G.C.M.G., K.C.V.O.
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H. C. Drayton

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Michael Crichton
J. O. Death
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K. Miller Jones
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Dr. G. W. Storey
Miss P. Talbot Ponsonby
Sir Landsborough Thomson, C.B., C.B.E., D.SC., LL.D.
Major General C.B. Wainwright, C.B.
J. P. Williams

Invited to attend Council Meetings ex-officio
A. G. Hurrell (Ministry of Education Assessor)

Finance Committee
Guy Benson (*Chairman*)
Michael Crichton
J. O. Death
H. C. Drayton
James Fisher
R. C. P. Hollond
J. J. Jamieson
K. Miller Jones
Miss P. Talbot Ponsonby

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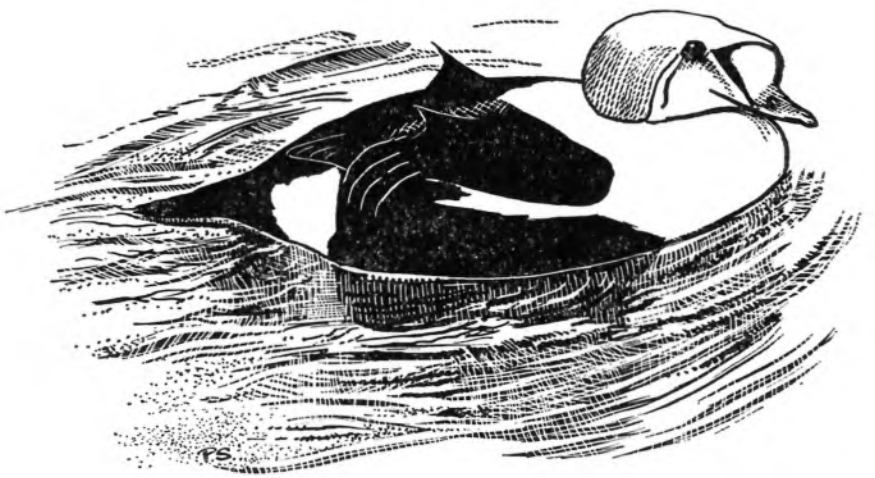
R. E. Moreau
R. E. M. Pilcher
Dr. G. W. Storey
Dr. W. H. Thorpe, F.R.S.
Major General C. B. Wainwright



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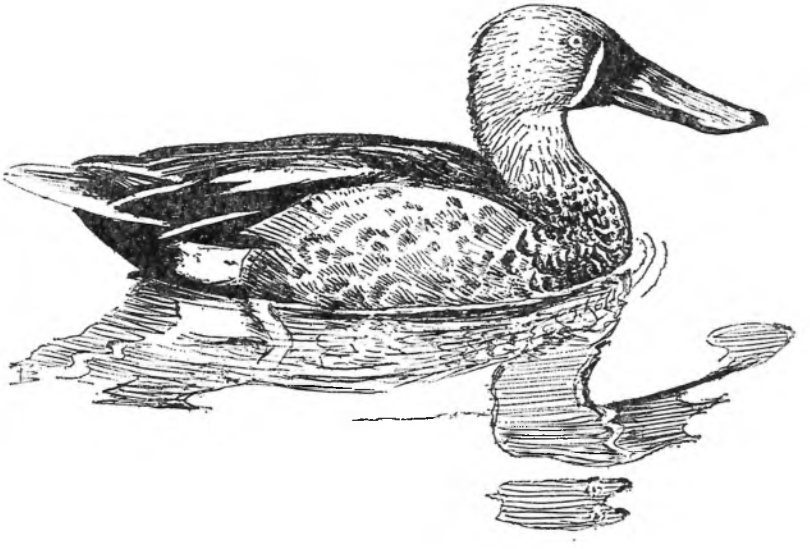
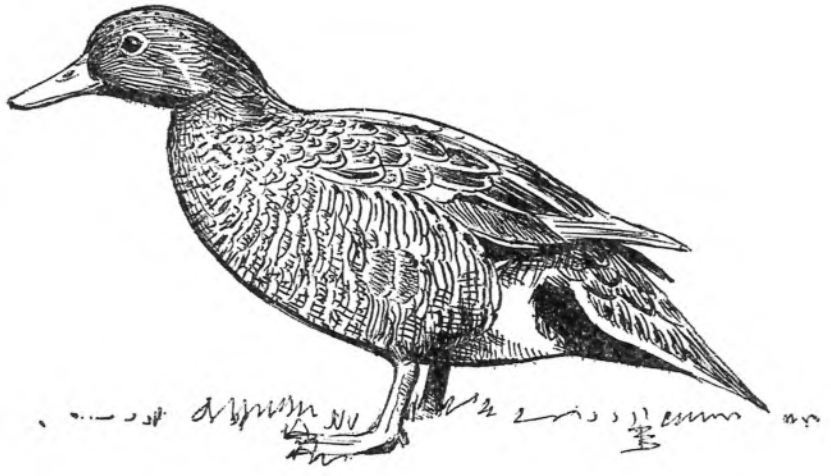
RESEARCH AND CONSERVATION OVERSEAS





Section 1

Annual Report 1963-64

Council and Committees

The Officers, Council and Committees of the Trust, as at 31st December, 1964 are shown on page 2. Council meetings were held in 1963 on 15th January, 19th March, 14th May and 6th October. The Finance Committee met on 25th February, 29th September and 8th December. The annual meeting of the Scientific Advisory Committee was held on 19th March.

Annual General Meeting and Dinner

The Seventeenth Annual General Meeting was held at the Royal Society of Arts on 14th May, and the Annual Dinner took place at the Hyde Park Hotel the same evening. At the dinner The Lord Howick of Glendale, G.C.M.G., K.C.V.O., presided and the speakers were Henry Williamson, Peter Scott, C.B.E., D.S.C., LL.D., Norman Collins and Kenneth Harris. The minutes of the Annual General Meeting will be found on page 7.

Development

In the course of 1964 the Trust was able to lease three additional small areas at Slimbridge totalling about 2·8 acres. One of these provided a site for the Research Centre and another made it possible to move the Acrow Tower to a new vantage point, affording a greatly improved view of the estuary. The third area is being developed as a corridor to give visitors access to observation hides without the necessity of an escort. Early in the year the Curator's staff constructed a water garden on the slopes of the Tump and in the summer the new heated aviaries and the new rearing area at the far end of the Rushy Pen were completed with a new observation post giving views of the surrounding fields. The House Pond in the Rushy Pen was enlarged by the creation of an artificial delta. A new pond was excavated in front of the Research Centre and with this pond in the foreground a splendid vista from the windows of the Centre towards the Acrow Tower was opened up by some tree felling in the Big Pen. At Peakirk the Trust acquired an additional 2·15 acres which will be developed in 1965 as an extension to the grounds.

The Research Centre

A notable milestone in 1964 was the construction of Phase I of a Research Centre, which was begun in April and nearly completed by the end of the year. The upper storey of this first phase of the

building provides work rooms for the Trust's Research Unit and a library: the ground floor comprises exhibition space and a lecture room. Although the laboratory and museum will have to stay where they are until we have funds for Phase II, we shall immediately have greatly improved working conditions for our scientists; in addition we shall be able to show an exhibition illustrating the Trust's work on research and conservation and shall be in a position to expand our educational activities.

For this we are indebted primarily to The Wolfson Foundation and to The Nature Conservancy for grants of £15,000 and £9,500 and to contributors to a special appeal launched by Mr. H. C. Drayton for this and other development projects, who subscribed altogether £9,710.

Identification Competition

The Trust's third Wildfowl Identification Competition for Schools was held at the New Grounds on 7th March in bitterly cold weather. Sixty-four boys and girls from 16 schools took part. Leighton Park again entered several strong teams and had three teams in the first five places in the Senior Competition: their A team won the first prize from Monmouth, thus reversing last year's result. In the middle age group a team from Acklam Hall, who had travelled 250 miles from Middlesbrough, came first with Winchester second. The junior prize was won by Gloucester Girls High School by one point from a Beaudesert Park pair.

Borough Fen Decoy

We are again indebted to Mr. and Mrs. R. E. M. Pilcher for opening the duck decoy at Borough Fen to visitors on two days in May.

Gosling Party

The annual party for Gosling members was held on 19th December, 1964. Johnny Morris talked and showed films to an appreciative audience of about 200.

Members' Collections

During the year the following members kindly showed their collections of waterfowl to fellow members of the Trust: Arthur Cadman, T. Curtis, J. O. Death, A. W. E. Fletcher, R. Law, Miss E. Manasseh, E. A. Maxwell, Mrs. B. Michell, Mrs. C. Mumford, F. W. Perowne, R. E. M. Pilcher, G. R. Pryor, G. L. Reid, Shrewsbury School, E. O. Squire, R. J. Stainsby, Noel Stevens, Mrs. T. V. Upton, J. P. Williams, D. Wintle.

Visitors

The fine weather in the summer of 1964 brought a record total of visitors to the Trust's collections. A comparison with recent years is shown below.

	1960	*1961*	*1962*	*1963*	*1964*
Slimbridge	102,555	151,533	162,030	130,143	151,180
Peakirk	26,531	33,203	30,982	29,434	43,678
	129,086	184,736	193,012	159,577	194,858

Finance

In 1964 the Trust's income provided enough revenue for the developments mentioned above, with a margin for further repayment in 1965 of outstanding loans. On 31st December, 1964, these amounted to £12,961 and until they are cleared, loan repayment must have first claim on any surplus revenue. Fortunately after completing the Research Centre there will be a margin of some £7,000 in the Drayton Fund (see under Research Centre above), which can be applied to other development projects and in 1964 the Trust received a generous gift of £5,000 from an anonymous donor for a tropical aviary, which it is planned to construct in 1965.

MEMBERSHIP

There was a further increase in Membership which passed the 7,000 mark during the year. The figures on 1st January, 1965, were:

Class of Membership	*1 Jan 62*	*1 Jan 63*	*1 Jan 64*	*1 Jan 65*
Life	298	299	304	316
Full	3360	3423	3584	3644
Associate & Parish	1704	1764	2039	2422
Junior Compounded	6	9	10	12
Gosling	296	285	759	644
Corporate	88	107	101	94
Contributors	34	32	42	38
	5786	5919	6839	7170

Obituary

The Council learned with sorrow of the death of H.R.H. The Princess Royal on 28th March, 1965. Her Royal Highness had been a Member for many years and visited Slimbridge several times.

We record with regret the deaths of the following Members and Associates, notified since the last issue of the Report:

D. W. H. Adams
Lady Addis
Miss R. E. Andrews
P. Backhouse
Mrs. M. C. Barnes
Mrs. V. C. Batchelor
Brigadier W. Bisset, M.C.
R. Brice-Smith
Lieutenant-General Sir Frederick Browning, K.B.E., C.B., D.S.O.
Miss R. H. Bruce
Mrs. H. J. Butt
C. Clutsom
Hon. Mrs. A. Crichton
Miss B. Y. H. Duncombe
Lt.-Col. R. T. Foster, D.S.O.
Major J. E. French
J. C. Frith
E. Giles
M. E. Goodfellow
Capt. L. Gregory, O.B.E., R.N.
Rev. Canon L. W. Grensted
D. B. Grubb
F. M. Gurteen
Miss M. Hambly-Parker
Mrs. M. E. Hamilton
Lt.-Col. R. N. Hardcastle, D.S.O.
Mrs. L. Haslam
Col. H. F. Hilton-Green
S. T. Holland
Capt. P. V. James, R.N.
J. A. King
Major-General J. M. Kirkman, C.B., C.B.E.
E. N. Kitcat
Miss J. B. Kitson
The Marchioness of Lansdowne
Hon. Mrs. C. B. Leaf
K. C. Lee
F. H. Lyon
Sir Wilfrid Martineau
Lady Constance Milnes Gaskell
A. Mitchell
Major-General H. de R. Morgan, D.S.O., D.L.
C. C. Nesling
Mrs. J. M. Norris
H. H. Norsworthy
Miss C. I. Nott
J. N. Oliver
R. Perkins
G. H. Pickford
F. A. H. Pitman
Miss F. Pitt
R. E. Pochin
J. G. Pugh
P. R. Quayle
Mrs. H. M. Rait Kerr
H. J. Randall, LL.B., F.S.A.
N. Rathbone
Mrs. B. M. Richardson
G. Robertson
G. W. R. Scudamore
E. O. Shebbeare
Miss M. G. Skipworth
S. H. W. Smith
H. A. Soderberg
Mrs. E. F. Sturt
R. G. Swanton
W. G. Tinsley
Miss H. C. Todd
Sir Stanley White, Bart.
Miss J. M. Wilkins
H. V. Young

Minutes of the Seventeenth Annual General Meeting

1. The Seventeenth Annual General Meeting of the Wildfowl Trust was held at the Royal Society of Arts, John Adam Street, London, W.C.2, on Thursday, 14th May, 1964, at 5.00 p.m.

2. The following Officers and Members of Council, and 36 Members of The Wildfowl Trust were present:

Sir Percy Lister, *Vice-President*
Guy Benson, Esq., *Hon. Treasurer*
Peter Scott, Esq., C.B.E., D.S.C., LL.D., *Hon. Director*
Sir Landsborough Thomson, C.B., O.B.E., *Chairman, Scientific Advisory Committee*
H. H. Davis, Esq.
J. O. Death, Esq.
G. M. Jolliffe, Esq., F.L.A.S.
Christopher Marler, Esq.
E. A. Maxwell, Esq.
K. Miller Jones, Esq.
R. E. M. Pilcher, Esq., F.R.C.S.
Dr. G. W. Storey
Miss P. Talbot-Ponsonby
J. P. Williams, Esq.

3. Apologies for absence were received from the following Officers and Members of Council, and 19 Members:

H.R.H. The Duke of Edinburgh, K.G., K.T., *President*
His Grace the Duke of Beaufort, K.G., P.C., G.C.V.O., *Trustee*

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTERSHIRE

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1963

	EXPENDITURE	£ s. d.	£ s. d.
	To General Expenses:-		
5335	Salaries and Superannuation, Administrative Staff	5828 9 0	
234	Travelling, Administrative Staff	258 9 2	
895	Rent, Rates, Water Rates and Insurance	1210 12 5	
2564	Postages, Telephone and Miscellaneous Expenses	2629 3 7	
1788	Printing and Stationery	1603 9 4	
754	Hostel Upkeep	680 18 5	
564	Loan Interest	563 10 0	
282	Bank Charges, less Interest earned	308 4 4	
2596	Printing Annual Report	2481 10 0	
315	Expenses of Annual Dinner	427 14 10	
1665	Advertising	2789 13 7	
16992			18781 14 8
	New Grounds and Peakirk:-		
10730	Salaries, Wages and Superannuation	11736 2 11	
760	Travelling	493 5 3	
2562	Purchases and Transport of Wildfowl and Eggs	1535 11 10	
7243	Food for Wildfowl	5934 1 6	
2582	Materials, Repairs and Replacements	2666 8 5	
903	Transport and Mechanical Equipment and Maintenance	744 17 1	
1491	Fuel and Power	1360 1 2	
855	Miscellaneous	901 17 8	
27126			25372 5 10
	Gate Houses:-		
17279	Purchases for re-Sale	15824 2 10	
4148	Printing 2nd Edition of Coloured Key	— — —	
698	Royalties Coloured Key Publications	383 18 3	
2957	Salaries, Wages and Superannuation	3000 17 7	
25082			19208 18 8

	INCOME	£ s. d.	£ s. d.
	By General Income:-		
8522	Subscriptions, Ordinary	8906 18 4	
420	Subscriptions, Life Members	420 0 0	
1887	Donations (including Copper Coin Campaign)	7130 13 4	
1922	Income Tax repaid on Covenants	1692 15 1	
316	Receipts from Sale of Annual Reports	455 7 2	
350	Receipts from Annual Dinner	453 12 6	
—	Restaurant	589 16 9	
13417			19649 3 2
	New Grounds and Peakirk:-		
27272	Gate Takings	33159 16 6	
3866	Sales of Surplus Wildfowl	3133 15 3	
31138			36293 11 9
	Gate Houses:-		
21997	Sales, General	22596 9 2	
2726	Sales, Coloured Key Publications	1758 17 2	
24723			24355 6 4

	Scientific and Educational:-								**Scientific and Educational:-**					
9992	Salaries and Superannuation			11598	4	9			*12121*	The Nature Conservancy Grant		12000	0	0		
3366	Travel and Miscellaneous Research Expenditure			3923	11	9			*315*	Donation from Abberton Ringing Station		310	0	0		
1068	Abberton Ringing Station			1152	4	0			*464*	Duck Adoption		528	6	9		
928	Borough Fen Decoy			1074	3	2			*100*	Donations for Research		100	0	0		
15354							17748	3 8	*13000*						12938	6 9
	Capital Expenditure:-													
	New Grounds and Peakirk													
198	Restaurant			131	0	7				**NOTE.**—The figures in the margin are				
362	Development			252	4	0				those for the year ended 31st				
303	Gate House Extension			—	—	—				December 1962 and are given				
426	Equipment			325	16	2				for the purpose of comparison				
1806	Lavatories			39	6	11								
1060	New Water Supply			68	0	0								
4155							816	7 8						
88709	To **TOTAL EXPENDITURE FOR THE YEAR**						81927	10 6	*82278*	By **TOTAL INCOME FOR THE YEAR**					93236	8 0
19750	Valuation, 31st December, 1962						24565	0 0	*24565*	Valuation, 31st December, 1963					23299	0 0
598	Written off Buildings						597	16 3								
—	Balance, carried down						9445	1 3	*2214*	Balance, carried down					—	— —
109057							£116535	8 0	*109057*						£116535	8 0
—	To Balance, 31st December, 1962						2175	5 4	*39*	By Balance, 31st December, 1962					—	— —
2214	Balance for year to 31st December, 1963 brought down						—	— —	—	Balance for year to 31st December 1963, brought down					9445	1 3
—	Transfer to Accumulated Fund						7000	0 0								
—	Balance, 31st December, 1963						269	15 11	*2175*	Balance, 31st December, 1963					—	— —
2214							£9445	1 3	*2214*						£9445	1 3

THE WILDFOWL TRUST, SLIMBRIDGE, GLOUCESTERSHIRE
BALANCE SHEET, 31st DECEMBER, 1963

1962	LIABILITIES	£	s.	d.	£	s.	d.
12502	**Sundry Creditors**				7924	1	11
	Peterborough Provincial Benefit Building Society:-						
	Balance, 31st December, 1962	1534	2	0			
	Less Repaid during year	34	5	3			
1534					1499	16	9
14513	**Loans**				14512	13	10
	Research Centre Fund:-						
	Balance, 31st December, 1962	5072	19	2			
	Add Donations during year	5255	0	0			
	Interest (Net) received on Deposit per Contra	193	8	0			
5073					10521	7	2
	Accumulated Fund:-						
	Balance, 31st December, 1962	15700	0	0			
	Add Transfer from Income and Expenditure Account	7000	0	0			
15700					22700	0	0
	Income and Expenditure Account:-						
Dr.2175	Balance per Account				269	15	11
47147					£57427	15	7

1962	ASSETS	£	s.	d.	£	s.	d.
294	**Cash at Bankers and in Hand**				7738	3	2
5015	**Cash on Deposit re Research Centre Fund**				10211	3	5
1000	**Investment at Cost** (Market Value £1660)				999	15	0
3110	**Sundry Debtors and Payments in Advance**				2613	17	4
	Valuation (as valued by the Honorary Director):-						
450	**Office Equipment**				400	0	0
	New Grounds and Peakirk:-						
8900	Wildfowl	8950	0	0			
1060	Transport	800	0	0			
4010	Miscellaneous Equipment	3465	0	0			
735	Hostel and Restaurant Equipment	650	0	0			
					13865	0	0
	Gate Houses:-						
5110	Stock for re-Sale	5590	0	0			
2300	Coloured Keys	1444	0	0			
					7034	0	0
	Scientific and Educational:-						
2000	Equipment				2000	0	0
24565							23299 0 0
	Freehold Properties:-						
7185	Amount, 31st December, 1962, at Cost or Valuation						7185 10 5
	NOTE.—The Freehold Properties are vested in The Wildfowl Trust (Holdings) Ltd.						
	New Buildings, New Grounds, Slimbridge, Gloucestershire:-						
	Amount, 31st December, 1962				11362	13	10
	Less Written off to 31st December, 1962	5384	11	4			
	Written off in year ended 31st December, 1963	597	16	3			
					5982	7	7
5978							5380 6 3
	NOTE.—The New Buildings, etc. to be written off over a period not exceeding that of the Lease.						
47147							£57427 15 7

We have examined the above Balance Sheet of the Wildfowl Trust dated 31st December, 1963, together with the accompany Income and Expenditure Account and find them to be in accordance with the Books and Vouchers produced to us and the information and explanations given to us.

STROUD, Gloucestershire.
21st March, 1964

S. J. DUDBRIDGE & SONS,
Auditors.

The Rt. Hon. the Earl of Mansfield, J.P., *Trustee*
General Sir Gerald Lathbury, G.C.B., D.S.O., M.B.E., A.D.C., *Vice-President*
Capt. J. A. Fergusson-Cuninghame, *Council Member*
James Fisher Esq., *Finance Committee Member*
Major General C. B. Wainwright, C.B., *Council Member*

4. The Director apologised on behalf of the Chairman, The Rt. Hon. the Lord Howick of Glendale, G.C.M.G., K.C.V.O., who had been unavoidably delayed and with the consent of the meeting invited the Hon. Treasurer to take the Chair.

5. The Minutes of the Sixteenth Annual General Meeting circulated with the Agenda were amended in paragraph 10 at which Mr. J. O. Death was shown as having seconded the motion re-appointing the Auditors. The seconder as shown in the original minutes was Mr. R. F. Haigh. The Minutes were then accepted and signed by the Chairman.

6. 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. This was seconded by Mr. R. S. R. Fitter and carried unanimously.

7. The Hon. Treasurer proposed the adoption of the accounts for the year ending 31st December 1963. The motion was seconded by Mr. H. H. Davis and carried unanimously.

8. Dr. James Robertson Justice retired after the Sixteenth Annual General Meeting, and the following elected Councillors retired under Rule 13(1):

John Berkeley, Esq., J.P.
H. C. Drayton, Esq.
Major-General C. B. Wainwright, C.B.

In accordance with Rule 7(6) the following candidates who had been nominated to fill these vacancies were elected without vote:

K. Miller Jones, Esq.
R. E. M. Pilcher, Esq., F.R.C.S.
Dr. G. W. Storey
Sir Landsborough Thomson, C.B., O.B.E.

9. The proposals for the election of Officers were taken *en bloc* having been made by Mr. K. Miller Jones, seconded by Sir Kenneth Swan and carried unanimously:

President: H.R.H. The Duke of Edinburgh, K.G., K.T.
Vice-Presidents: Captain R. G. W. Berkeley, M.F.H.
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 Percy Lister
Trustees: His Grace the Duke of Beaufort, K.G., P.C., K.C.V.O.
The Rt. Hon. The Earl of Mansfield, J.P.
Hon. Director: Peter Scott, Esq., C.B.E., D.S.C., LL.D.
Hon. Treasurer: Guy Benson, Esq.

Council's nominees for election as additional Trustees:

John Berkeley, Esq., J.P.
H. H. Davis, Esq.
H. C. Drayton, Esq.

10. The Hon. Treasurer proposed that Messrs. S. J. Dudbridge and Sons of Stroud, Gloucestershire, be re-appointed, Auditors to the Wildfowl Trust for the ensuing year pursuant to Rule 19(1). Mr. G. M. Jolliffe seconded the motion, which was carried unanimously.

11. The business of the meeting was concluded at 5.20 p.m. and followed by an illustrated talk by Mr. Scott about his recent visit to the Bahamas, and a recent Wildfowl Trust rocket-netting expedition.

The Collections in 1964

S. T. JOHNSTONE

In 1963 at Slimbridge and Peakirk over 1,750 swans, ducks and geese were reared and some difficulty was experienced in disposing of certain species. In consequence it was decided to limit the number of birds reared at Slimbridge in 1964 to 1,000 and at Peakirk to 300. These figures were obtained by non-incubation of eggs of species with which we had been left with a surplus from the previous year, and limiting certain other kinds by allowing the parent birds to hatch and rear their first clutches. 94 kinds were represented in the 1,300 birds raised at the two establishments, and first breeding records were established for Slimbridge with Crested Screamers, Brown-breasted Whistling Duck, Whooper Swan, Trumpeter Swan, Patagonian Crested Duck, Bronze-winged Duck and Baer's Pochard, the Bronze-winged Duck and Patagonian Crested Duck being the first known cases of successful breeding in captivity. Baer's Pochard have been bred previously by Mr. Kooy at Den Helder in Holland. These successes bring the total kinds reared at Slimbridge to 130. Other interesting species reared include Magpie Geese, Andean Crested Duck, New Zealand Brown Duck, Hartlaub's Duck, Old World Comb Duck, King Eider and Common Goldeneye. Puna Teal were again reared successfully at Peakirk.

The year was a poor one at Slimbridge for several species, the Shoveler being particularly unsuccessful – no eggs from the Cape or New Zealand and clear eggs from the Argentines, even the Common produced only a dozen or so youngsters. On the other hand, Peakirk bred Cape and New Zealand Shoveler for the first time. Garganey and Blue-winged Teal failed to produce young. Over 40 Ringed Teal were reared in 1963, but in 1964 only a dozen survived from the 35 hatched, scarcely enough to replace winter losses. The Smew eggs were infertile and no Barrow's Goldeneye hatched. The North American Ruddy Ducks have not yet recovered from the 1962–63 winter, when fifteen breeding pairs were reduced to five. There were few nests and not many broods appeared on the ponds and from these about a dozen juveniles survived.

We are particularly pleased to have been successful with the Trumpeter Swans. The female had laid in each of the previous two years but on each occasion had deserted the eggs after partial incubation. We were, this time, able to put two eggs under a Black-necked Swan (her own were hatched by hens) and two under a Black Swan. Both hatched a cygnet after 33 days, a seemingly short incubation period (W. Banko, 1960, *The Trumpeter Swan*, p. 115, records 33–37 days). The cygnets were enchanting little things with steely white down and pink bills and tarsi. One has felt that Slimbridge was not the most suitable place for breeding swans, but maybe this is not so as Mutes, Bewick's, Whoopers, Trumpeters, Black, Black-necked and Coscorobas have been reared here. Our female Whistling Swan died from an impaction of the oviduct after building a nest.

It is only in the last three years that we have added the Anhimidae to our collection. At present only the Blacknecked and Crested Screamers *Chauna torquata* and *chavaria* are represented. The male of the latter had gone sick in the winter so that the first two clutches of eggs laid were clear. Through the kindness of the London Zoo a male was loaned to us and a third clutch of eggs produced two chicks after the parents had incubated for 41 days, quite delightful little things with a spherical head on an equally spherical body. The down is mustard and pepper colour and the crown a rich orange, the characteristic beak and lores a purplish grey and the prominent feet are quite pink.

The Baer's Pochard laid nine eggs producing nine ducklings after 27 days of incubation by a bantam. The ducklings are midway in size and colour between the Common White-eye and the Australian Hardhead, being a greenish brown above with pale yellow underparts. There are six yellow blotches on the upper parts, two on the rump, two on the thighs and two on the scapulars. The cheeks are yellow and the bill has a pink tip and side, the tarsi are black and the eye brown. The ducklings were reared next to a brood of Common White-eye, and the comparative darkness of the latter was most noticeable.

First breeding of the Patagonian Crested Duck

One of the Patagonian Crested Duck collected for us by the Savvick Expedition laid in October 1963 but the eggs did not hatch. In 1964 two females laid and the nine ducklings hatched were reared, five by bantams and four by the parent birds. Although the adult birds of the two races of Crested Duck are very similar, the

ducklings are quite distinctive. The overall colours of the Andean ducklings are brown and fawn, those of the Patagonian grey and cream. The throat and lower cheeks are white, the underparts cream. The cap, neck and back grey, the brown eye situated in the grey area of the head. There are four cream blotches on the back and the legs and bill are pale grey. The eggs are cream in colour with an average weight of 55 gms and measuring 63 × 46 mm. A Patagonian and an Andean Crested duckling were reared together when one could observe the brownness of the marked eye strip and large bill of the latter.

First breeding of the Bronze-winged Duck

The Bronze-winged Duck, *Anas specularis*, which frequents an area including Southern Chile, Argentina and Tierra del Fuego, is a mallard-sized duck with an overall mottled brown plumage, a white patch on the cheek and a triangular white chin strap. The speculum, a brilliant bronze, is brighter than that of the Crested Ducks. There are very few specimens in captivity, the only birds I know of being at the Wildfowl Trust and at Cologne Zoo.

More than ten years ago the well-known Dutch aviculturist, D. G. Schuyl, acquired two birds which were accepted as a pair. Eggs were obtained and a possible reason for the infertility was suggested to be the extreme tameness of the birds. Mr. Schuyl described how they followed him like dogs, and took great delight in being fondled. Eventually through his kind co-operation, the birds came to Slimbridge in 1955. On cloacal examination it was found that both were females. They were released in our Orchard Pen, an enclosure much frequented by the visiting public. Both birds were delighted to have so many people to follow round and engage their attention. This predilection for humans was however greatly to their detriment, for they got under the visitors' feet and were consequently lamed in a very short time. It was necessary therefore to shut them behind a fence in a small enclosure. Here they both proceeded to lay eggs in a clump of Christmas roses.

All sources were now explored with a view to obtaining a male bird but we could find no one in South America who could acquire a male for us. The Savvick expedition in 1961 were commissioned to catch us some specimens at all costs. This was successfully achieved and four birds were caught and despatched by air. Unfortunately there were delays in transit, a single bird arrived alive and this, a female, only survived a short while. Meanwhile, sad to relate, one of the original birds died. Eventually we learned that Cologne Zoo had obtained two males and in December 1963 Dr. Windecker the Director of the Zoo arranged for one of them to be brought to Slimbridge. After quarantine the male and our surviving female were installed in the Guinness Aviary. We chose an enclosure where there were clumps of pampas grass to help the male feel at home. On 12th February we had the first egg, and five were laid in all. They were removed after five days and placed under a Silky cross bantam.

The eggs were creamish yellow, the average weight being 75 gms and the size 70 × 51 mm.

Over the years it had been customary for members of the staff to pick up the duck at every opportunity, a practice one deprecated for one felt that if ever we acquired a male we would find that this imprinting on humans would have destroyed the bird's interest in its own kind and that if she did lay the eggs would continue to be infertile. It was therefore all the more surprising that in spite of this preference for humans three eggs were fertile. Two embryos died at an early stage but after thirty-one days the remaining egg hatched. This long incubation period suggests that the species may be related to the perching ducks (Cairinini) or the shelducks (Tadornini) rather than to the dabbling ducks (Anatini).

The duckling was large and rather similar in colouring to a Chiloe Wigeon. It was dark brown above, the under parts being cream. The cap was grey-brown and the dark brown eye surrounded with reddish brown down. There was a distinct white area on the cheeks and throat. There were also four white blotches on the back. The large bill and the tarsus were slate grey.

Apart from a few shrimps, the duckling was not seen to take any food for the first three days, and spent most of its time on the back of its foster-mother. On the fourth day, however, it commenced to eat the grated egg and turkey starter crumbs provided. The bird grew apace, and was feathering at three weeks, the white face patch developing at once.

On the day the duckling hatched, the first egg of a second clutch of five was laid. The duck was allowed to incubate for the first three weeks, when it was found that she had cracked one egg. However, the remaining four were fertile. She was given five Mallard to hatch, which she duly did, but was inclined to neglect them after the first few days. Her own eggs, now under a bantam, hatched again after thirty-one

days, but to our dismay all four ducklings had their metatarsi fully flexed. The 'clenched fist' effect of the feet persisted for 48 hours but then gradually disappeared when the ducklings became quite normal. They are now fully grown and in typical adult plumage. Their appearance in juvenile plumage is shown in a photograph on page 5 of illustrations.

Breeding Results 1964: Slimbridge

	Date of first egg	*eggs incu-bated*	*eggs hatched*	*young reared*
Magpie Goose	29.6	24	12	7
Fulvous Whistling Duck	10.3		23	20
Southern Red-billed Whistling Duck	10.4		13	12
Northern Red-billed Whistling Duck			3	3
Black Swan	4.2	10	0	
Black-necked Swan	13.2	14	12	10
Whooper Swan	13.4	4	3	3
Trumpeter Swan	11.5	4	2	2
Swan Goose	5.4	20	9	6
Russian Bean Goose	23.4	12	1	1
Pink-footed Goose	20.4	7	4	4
White-fronted Goose	11.5	7	0	
Greenland White-fronted Goose	20.4	25	4	3
Lesser White-fronted Goose	4.4	22	5	5
Western Greylag Goose	4.4		8	8
Eastern Greylag Goose	10.3		2	2
Bar-headed Goose	15.4	22	7	7
Emperor Goose	23.4	44	21	15
Lesser Snow Goose	17.4		15	15
Greater Snow Goose	20.4		15	13
Ross's Goose	3.4	16	10	8
Giant Canada Goose	27.3		8	8
Atlantic Canada Goose	17.3		7	5
Manitoba Canada Goose	23.4		3	0
Taverner's Canada Goose	6.4		4	2
Dusky Canada Goose	7.4		2	0
Cackling Goose	3.4	8	0	
Hawaiian Goose	27.1	72	16	14
Barnacle Goose	23.4		25	20
Black Brant	22.5	13	5	4
Red-breasted Goose	17.6	21	7	7
Cape Shelduck	4.3	4	0	
European Shelduck	8.5	8	6	6
Egyptian Goose	24.1		15	14
Abyssinian Blue-winged Goose	8.5	26	8	8
Andean Goose	15.5		14	14
Ashy-headed Goose	2.4	12	10	9
Ruddy-headed Goose	2.4		6	0
Lesser Magellan Goose	10.4	9	8	6
Greater Magellan Goose	13.4	3	0	
Cereopsis Goose	1.1		4	2
Andean Crested Duck	2.4	12	4	4
Patagonian Crested Duck	22.2	18	9	9
Bronze-winged Duck	12.2	10	5	5
Marbled Teal	8.5			30
Cape Teal	19.3	26	16	14
Versicolor Teal	6.3	29	2	1
Red-billed Pintail	12.7	3	1	1
Bahama Pintail	15.5	28	11	11
Chilean Pintail	10.4		13	13
Northern Pintail	9.5		14	14
Kerguelen Pintail	12.5		19	17
Chilean Teal	22.4	6	6	6
Sharp-winged Teal	30.6	12	0	
Falcated Teal	18.5	19	6	5

	Date of first egg	*eggs incu-bated*	*eggs hatched*	*young reared*
Australian Grey Teal	1.7	7	6	6
Chestnut Teal	10.3	21	20	19
New Zealand Brown Teal	9.2	26	14	8
Hawaiian Duck	9.3	4	0	
Laysan Teal	11.4	73	28	26
North American Black Duck	30.3		7	5
Indian Spotbill	14.4	5	5	4
Chinese Spotbill	4.4		14	14
New Zealand Grey Duck	10.4		11	10
Australian Black Duck	5.4		3	3
Philippine Duck	20.4		19	17
African Yellowbill	13.3		23	18
Abyssinian Yellowbill	29.3	19	12	11
African Black Duck	19.3		11	6
Gadwall	16.4			30
European Wigeon	31.3		32	32
American Wigeon		10	6	5
Chiloe Wigeon	15.4		15	11
Blue-winged Teal	17.5	5	0	
Cinnamon Teal	8.5	16	13	7
Garganey	7.5	3	1	0
Red Shoveler	14.5	5	0	
Cape Shoveler	10.6	2	0	
European Shoveler	17.4	13	12	11
Ringed Teal	10.5	62	43	16
European Eider	20.5	14	10	8
King Eider	17.4	10	8	4
Red-crested Pochard	23.2	63	42	32
Rosybill	2.6	27	13	10
Southern Pochard (hybrid)	28.2	13	4	4
European Pochard	20.5	7	0	
Redhead	15.7	23	9	8
Common White-eye	18.5		15	15
Baer's Pochard	1.6	9	9	8
Australian White-eye	1.5		16	12
New Zealand Scaup	23.4		20	18
Tufted Duck			2	2
Lesser Scaup	30.5	7	4	3
Greater Scaup	21.6	11	2	2
Brazilian Teal	10.5	6	0	
Mandarin Duck	14.4		49	38
North American Wood Duck	15.3		102	70
Muscovy Duck	18.4		31	31
Old World Comb Duck	12.6	58	41	28
Hartlaub's Duck	5.6	10	9	6
Barrow's Goldeneye	15.5	5	0	
European Goldeneye	2.5	7	3	1
Smew	15.5	7	0	
Red-breasted Merganser				2
North American Ruddy Duck	17.4			12

Assets". This set out the arguments against ill-considered drainage schemes and for the wise use of wetlands. The English language version of 14,000 copies was distributed throughout north-western Europe to selected people and agencies directly concerned with agriculture and drainage. A French version was distributed in southern Europe.

On the home propaganda front, an exhibition was mounted for the Game Fair which took place near Stirling, Scotland. A good deal of thought and preparation went into planning a permanent exhibition illustrating the Trust's work in conservation and research. This will be housed in the new research/educational block, the building of which was nearing completion at the year's end. Fruitful liaison was maintained with the Wildfowlers' Association of Great Britain and Ireland and a joint publication, a pamphlet "Know Your Wildfowl Food Plants", was prepared by Mr. Olney with a view to encouraging and facilitating the improvement of wetland reserves for wildfowl.

Supplementing observations of goose feeding behaviour, Dr. Kear carried through another series of grazing trials with tame birds (p.46). Investigation of the characteristics by which food objects are selected by newly hatched young was continued and a long-term study of the functional anatomy of the feeding apparatus in wildfowl begun. Miss C. Furness joined us on a temporary basis in September to prepare the extensive illustrations needed.

Experiments to investigate the north-west "nonsense" orientation of Mallards were continued with both the Borough Fen and the Slimbridge stocks. Those with the former were aimed at ascertaining the importance of learned landmarks by a lengthy series of releases at short distances from the Decoy. Visual relays of the flying ducks from one observer to another posted to the north-west were successful and gave promise that it will eventually be possible to determine how long the "nonsense" orientation lasts. The Slimbridge birds were subjected to shifts of their physiological "clocks" and then used to investigate the part played by the moon in orientation. This was a lengthy and frustrating business requiring very precise cloud conditions seldom occurring and difficult to forecast.

Dr. Beer continued his routine post-mortem examinations of birds dying in the Collections, establishing the relative importance of the various mortality factors and devising prophylactic measures. A particularly interesting study was that of lead poisoning from ingested lead shot (p.30). Council Member Dr. G. W. Storey again provided invaluable assistance in the preparation and examination of histological specimens. The researches of workers in other institutes, in this country and in Finland, were facilitated by the provision of specimens for physiological and parasitological investigation. As usual, preparations of heads, skulls, trachea, wings and complete skins – the latter by our preparator Mr. Barrow – were made for the ever growing reference collections. These will be housed in a separate museum room when the move to the new block is made. We were therefore able to accept gratefully a fine collection of British wildfowl mounted by Gunn of Norwich and presented by Mr. L. Balfour.

Our links with Bristol University were further strengthened. Mr. R. A. Avery continued to utilise parasitological material from the Collections in his studies for a Ph.D. in the Department of Zoology. The Department of Psychology, laying stress on comparative behaviour studies, was much interested in the facilities available at Slimbridge and Dr. Matthews gave courses and seminars to the advanced students of both Departments.

Personnel

We were greatly saddened by the sudden death of our colleague John Frith at the age of only 27. Our sympathy must especially go to his widow, a bride of six months, and to his unborn heir.

Mr. Olney, who came to the Trust in 1956, left in August to take up the new post of Biologist to the Royal Society for the Protection of Birds. He went with everyone's good wishes and our anticipation of even closer relations between the two organisations. Mr. Phillips, who had left following a serious motor cycle accident three years before, returned as laboratory assistant, when Miss Rebbeck left after nine months with us.

Finance

The Nature Conservancy continued its essential support of the research programme at the rate of £12,000 p.a. In addition the Conservancy, with Treasury approval, awarded a capital grant (payable in the financial year 1965–66) towards the cost of building and equipping one floor of the new research centre. The Trust is deeply grateful not only for the actual money but also for the implicit recognition of the value of our activities in research and conservation.

Ringing, 1963-64

The number of ducks ringed in 1963–64 was 5472. The reduction from the previous season is principally due to a much reduced catch of Mallard at Slimbridge. Although the Trust has no intention of ceasing to operate the duck decoy at Slimbridge, it has been decided to cut down the catching effort, particularly in the early part of the season, a period when very large numbers of Mallard have already been ringed in past years. A striking feature of the catch at Abberton by Major General C. B. Wainwright, C.B., is the high total of Wigeon ringed. This is the second highest catch of this species and comes after a period of several lean years. Borough Fen Decoy, operated by Mr. W. A. Cook, had a slightly more successful season than last year with more Mallard caught, but a drop in the number of Teal.

Other trapping stations operated in co-operation with the Trust included a new one at Dersingham, Norfolk, where Mr. J. E. A. Lambert made a successful beginning with 131 Mallard and 8 Wigeon ringed in collaboration with Mr. W. A. Cook. Messrs. C. A. and M. R. Boardman caught 37 Mallard at Ludham, Norfolk. Mr. D. R. Anderson continues to operate the duck trapping station at Duddingston Loch, Midlothian, where he caught 62 birds. We are pleased that Mr. W. Murray of Culterty Field Station, Newburgh, Aberdeenshire, has restarted duck trapping on the nearby Ythan Estuary where the late Miss E. A. Garden had pioneered in catching, especially diving ducks. We have arranged to receive his results.

Geese

A Trust rocket-netting team spent a fortnight in Perthshire in November 1963 and ringed 630 Greylag Geese. This was undertaken to provide a sample of marked birds in support of the population study being made of this species. Mr. J. G. Young and helpers caught 21 Greylag Geese in Wigtownshire in June 1964.

Following the successful round-up of moulting Canada Geese on the Beauly Firth, Inverness-shire in July 1963, described in the 15th Annual Report, the Hon. Douglas N. Weir organised a further operation in July 1964. 93 birds were caught of which five had been marked the previous year and three bore rings put on in Yorkshire, thus adding valuable information to the results already obtained concerning the moult-migration undertaken by these birds. 41 Canada Geese were rounded-up at Frampton Gravel Pits, Glos., on 16th June 1964.

There was no catch of White-fronted Geese at Slimbridge in 1964.

Swans

The ringing of Mute Swans in Britain, with the Trust paying for the rings, has slowed up slightly as an increasingly high proportion of the population is already marked. 2,303 were ringed in 1963 and the total in 1964 will probably have been smaller.

Two Whooper Swans were ringed in Dunbartonshire during the winter of 1963–64. Three Bewick's Swans were also marked, one at Abberton Reservoir and two at Slimbridge.

Waders

A full report of a visit paid to Holland in September 1964 to catch waders will be found on p. 48, together with a summary of the results of our five years catching on the Wash.

Ducks ringed, 1963–64

Species	*Abberton Essex*	*Borough Fen Northants*	*Slimbridge Glos*	*Other stations*	*Total 1963–64*	*Total 1962–63*
Shelduck	30	–	–	–	30	*4*
Pintail	1	1	5	–	7	*42*
Teal	1628	200	12	20	1860	*2428*
Mallard	547	1603	750	300	3200	*3478*
Gadwall			4		4	*1*
Wigeon	250	1		8	259	*49*
Garganey	25				25	*20*
Shoveler	21	10	21		52	*59*
Pochard	18				18	*15*
Tufted	16			1	17	*174*
	2536	1815	792	329	5472	*6270*

Wild Geese and Swans at the New Grounds, 1963-64

European White-fronted Goose *Anser albifrons albifrons.*

The first seven arrived on 23rd October 1963, the latest date ever recorded. The build up during the autumn was also remarkably delayed and there were still only 32 present on 1st December. Numbers then increased steadily with 2000 at the end of the year and nearly 3000 on 6th January. The peak numbers were in late February with about 4500 on 23rd. Departures began in early March with 2100 remaining on 10th. The last seen were 29 on 24th March.

Counts of young birds showed that the breeding season had been only an average one. The proportion of juveniles in a small sample in early December was 38·2% with an average brood-size of 2.75. These fairly high figures dropped with the big arrivals and at the end of January there were 27·4% young, average brood-size 2·5. In early March a further reduction was recorded to 20·75% young.

Lesser White-fronted Goose *Anser erythropus*

A single adult of this species was seen on 2nd and 4th February 1964.

Bean Goose *Anser fabalis*

Two single birds were seen: an "orange-billed" on 26th January and a "dark-billed" on 8th February 1964.

Pink-footed Goose *Anser brachyrhynchus*

28 arrived on 28th September 1963 and there were 42 on 29th, but they left the same day because of earth-dumping operations on the Dumbles and did not return. Two were present throughout January and February with a third bird reported on 5th and 8th February.

Barnacle Goose *Branta leucopsis*

8 arrived on 18th December 1963 and were joined by a ninth on 11th January. This is the most recorded at one time at the New Grounds. They remained until 17th January after which date five remained. Six were counted on 6th February and these were last seen in mid-March.

Dark-bellied Brent Goose *Branta bernicla bernicla*

Three different individuals of this race were present during January 1964. A single bird on 20th February was the last seen.

Red-breasted Goose *Branta ruficollis*

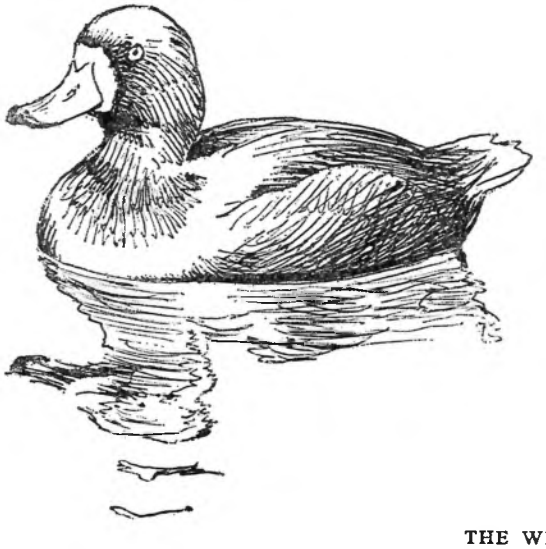
A fine adult male, the fourth record for the New Grounds, appeared on 31st December 1963 and stayed until 8th March.

Bewick's Swan *Cygnus columbianus bewickii*

The first arrivals were 5 on 17th December 1963. More came during the following week and by 30th December there were 26 present. As in previous years the birds were frequently in the pens. During January and February 1964 numbers remained around 20–25 with a peak of 32 on 31st January. Departures took place in the first half of March leaving a single juvenile which stayed in the pens until 22nd April.

Whooper Swan *Cygnus cygnus cygnus*

Three were seen on 28th January 1964 and again on 9th February. A single bird was recorded on 15th March.



Trends in the population of British wintering ducks 1961–64

G. L. ATKINSON-WILLES and J. C. FRITH

Summary

The data available through the National Wildfowl Counts are used to keep a running check on the numbers of wildfowl occurring in Britain during the winter months from September to March. Each month a brief report is sent to all observers engaged in the investigation, and it is these which provide the basis of the present summary. The species reviewed are Mallard, Teal, Wigeon, Pochard and Tufted Duck and the results are derived from a sample selected from the more important concentration areas. Although referring to the trends apparent in the ten years prior to 1959–60, the discussion centres mainly around the train of events since 1960, and on the effect of the hard weather of early 1963. It is also shown that the autumn counts of dabbling ducks give a good indication of the relative abundance of the species over the winter as a whole, enabling a forecast to be made some four months in advance of the seasonal result.

None of the species considered has shown any serious decline as a result of the hard weather of 1963. Mallard continue to increase slowly but steadily. Teal have maintained a more or less constant level since 1949, except for a period of great abundance between 1959 and 1962, which is attributed to events in Holland. The Wigeon population has also remained unchanged, although the numbers are liable to wide fluctuation from year to year. Both Pochard and Tufted Duck have shown substantial increases since 1949, and have also extended the length of their stay in this country. Since 1957 the Tufted Duck population appears to have become more or less stable; the Pochard made its last advance in 1960.

The results of the Wildfowl Count investigation for the period 1948–61, and full descriptions of the current methods of analysis, have already been published by Eltringham and Atkinson-Willes (1961) and by Atkinson-Willes (1963). The present paper is concerned therefore with recent results, and more especially with events since 1961. This period is one of especial interest because it includes the exceptionally cold weather of January and February 1963, which is known to have caused heavy mortality amongst several species of 'wetland' birds, though not apparently amongst the ducks. Of the five species considered here (Mallard, Teal, Wigeon, Pochard and Tufted Duck), none has shown signs of disastrous decrease; indeed the present populations are mostly above the average level for the past fifteen years.

As in previous reports the numbers of ducks counted in each season are presented as percentages of the numbers counted in 1959–60 (i.e. an index of 85 against a certain year indicates that only 85 ducks of that species were present for every 100 in 1959–60). Two sets of indices are given for each species:

The *monthly* indices are obtained by comparing in turn the counts for each month of each season with the data for the corresponding months of the 'master' season, 1959–60. In compiling the samples for these monthly comparisons use has been made of the records from all places which were covered in both the 'master' and the paired month; the individual samples vary therefore in both size and composition, according to the data available. The resulting indices are nonetheless comparable, each being related to the others through the medium of the master season. They provide the means of detecting annual variations in the population at certain stages of the season, notably during autumn and early winter.

The *seasonal* index is compounded from monthly results, and describes in a single figure the relative abundance of a species over the winter as a whole. In compiling the indices only the records from the more important areas in Great Britain have been considered. These total about 170 in all, of which 150 are used by large numbers of Mallard, 70 by Teal and Wigeon, 40 by Tufted Ducks and 35 by Pochard. In practice not more than three-quarters of such places are covered on any one occasion, but despite this the number of birds counted represents a substantial fraction of the estimated British population (about 10% in the case of the dabbling ducks, and as much as a quarter of the diving ducks).

Mallard *Anas platyrhynchos*

Table I. Monthly indices showing the relative abundance of Mallard in the same months of different years. The figures show the number of birds present in various seasons for every hundred recorded in 1959–60. The figures in brackets are the highest indices obtained in the periods for which an average index only is given. **The indices in this table and in Tables II–V should be compared only within the columns, NOT along the rows.**

		Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*
Average Index	1949–54	66(101)	58(64)	78(83)	91(97)	78(100)	85(98)	85(102)
Average Index	1954–59	69(75)	59(74)	88(91)	90(101)	76(82)	94(102)	94(117)
Master Year	1959–60	100	100	100	100	100	100	100
Index	1960–61	85	75	103	82	79	87	77
	1961–62	114	84	96	131	105	96	102
	1962–63	84	68	106	107	74	76	95
	1963–64	92	81	112	101	104	89	91
	1964–65	90	78	122	85	95	83	114

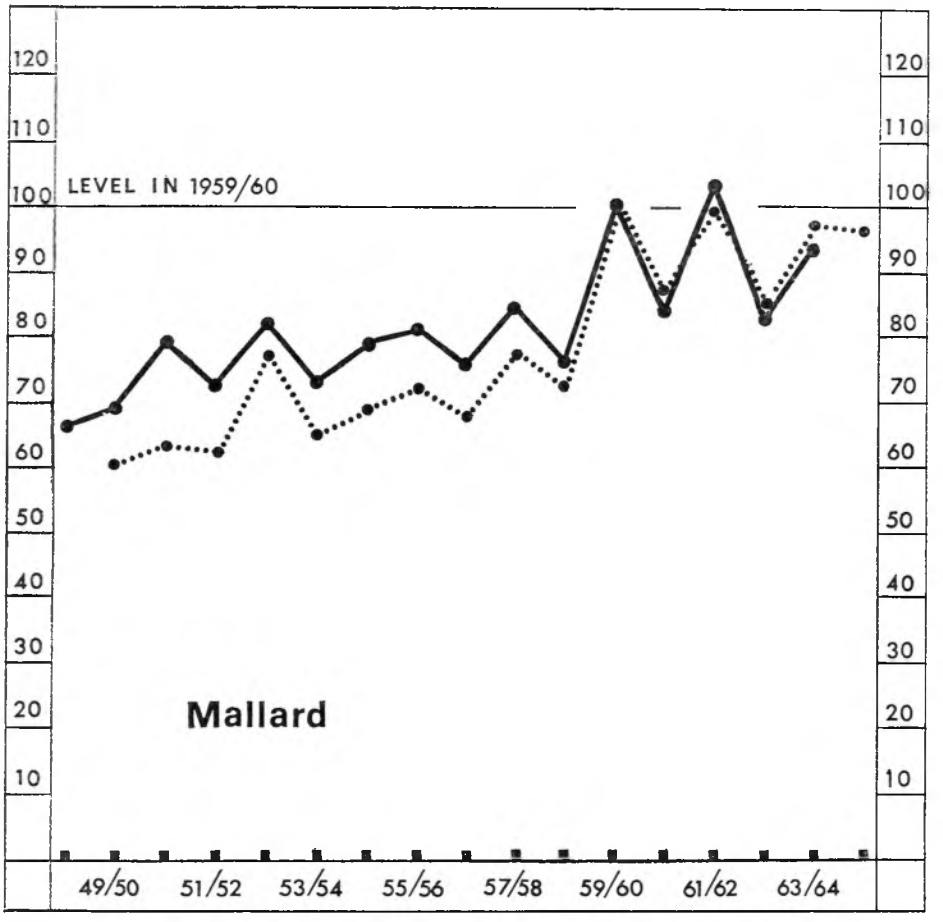


Figure 1. Seasonal indices for Mallard, 1948–1964 (solid line), and the monthly indices for September, October and November combined (broken lines). The similarity between the two readings makes possible a forecast of the seasonal index some four months in advance.

The salient points emerging from Table I are as follows: (*a*) Since 1959 the level of population during the first half of the season has been substantially higher than in either of the two preceding five year periods. In February and March, however, the indices have remained virtually unchanged since 1949. This suggests that the increase in the early part of the season has been due mainly to a larger inflex of immigrants, and that the native stock, which forms a predominant proportion of the late winter population, has remained at a more or less constant level.

(*b*) The results for the autumn of 1963 (immediately following the cold winter) compare favourably with those for 1962; moreover the results for February and March 1964 (which provide a partial measure of the resident stock) show no significant signs of decrease. If anything there were rather more Mallard in Britain in the season *after* the cold winter of 1962–63 than in the season immediately before.

(*c*) In most seasons the largest numbers of Mallard are counted in November (in 1964, 56,000 on the selected sample areas); it is also evident from Table I that the population at this time is less liable to annual fluctuations than in any other month. In earlier Novembers the lack of any marked variation from year to year is indicated by the closeness of the average indices to the corresponding maxima; more recently the upward trend has been remarkably smooth except for one rather low result in 1961. Also of interest is the striking similarity between the fluctuations in the seasonal indices and those in the early part of the season; this making possible a reasonable forecast of the final result while the season is still young (see Figure 1). The practical application of such forecasting has yet to be exploited, but with growing confidence it may be possible to issue "early warnings" as much as 2½ months before the end of the shooting season, should the need arise. For the time being, however, the situation is satisfactory: the 2½% annual increase detected by Eltringham and Atkinson-Willes (1961) appears to be continuing, despite the rather wider fluctuations of recent years; moreover there is no evidence of a contrary trend in any of the months under review, implying that all sections of the population are at least holding their own.

Teal *Anas crecca*

Table II. Monthly indices to show the relative abundance of Teal in the same months of different years; the figures in brackets are the highest indices obtained in the periods for which an average index only is given.

		Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*
Average Index	1949–54	24(32)	36(49)	33(47)	29(40)	83(121)	117(184)	156(245)
Average Index	1954–59	28(40)	42(59)	53(69)	46(65)	102(160)	101(118)	123(168)
Master Year	1959–60	100	100	100	100	100	100	100
Index	1960–61	88	63	46	30	65	75	91
	1961–62	75	85	85	108	110	96	90
	1962–63	75	99	92	45	62	53	62
	1963–64	93	46	50	37	56	63	67
	1964–65	—	56	53	41	77	69	83

As in the other tables, the figures in Table II should be compared only within the vertical columns, the fluctuations within the horizontal rows being very largely a reflection of events which took place in the master season, 1959–60. Due to exceptional circumstances during that autumn the influx of migratory Teal into Britain was very much larger than usual; later on, however, the population returned to a more normal level, and by March was noticeably smaller than in previous years. The indices for 1959–60 being fixed throughout at 100, the corresponding values for the other autumns are reduced to a relatively low level, whilst those for the latter part of the winter are somewhat inflated. This is especially noticeable in the periods prior to 1959, and in no way implies a build-up of birds during the course of the winter.

Comparisons within the columns of Table II reveal some striking changes in the behaviour of the immigrant Teal which comprise the great majority of the British winter population. During the past 15 years there has been a marked increase in the autumn population, the largest influxes being in 1959, 1961 and 1962. Since then the numbers have decreased, the present

levels being much the same as those attained prior to 1959. Reports from the Netherlands (Eygenraam 1964) suggest that these fluctuations can be attributed to various stages in the reclamation of the Oostflevoland polder at the south-east corner of the Ijsselmeer. Drainage here began in 1954 with the closing of the dyke, and by 1958 the water level had been reduced to a depth of a few inches over an area of 125,000 acres. In October of that year more than 300,000 ducks, mostly Mallard and Teal, were counted in the vicinity of the dyke alone, and the total number is believed to have been upwards of a million. By the following autumn much of this shallow water had been removed, and the polder was able to accommodate less than a quarter of the previous population. As a result many of the birds arriving there were forced to move on, and substantial numbers came across to England, raising the size of the autumn counts to four or five times the usual level. Compared with those for 1958, the 1959 counts (taken from a sample of 55 waters) showed an increase of 8,000 Teal in September, 10,000 in October, 16,000 in November and 19,000 in December. Of special interest at this time was the recapture in South-east England of several Teal which had been ringed in previous winters in the Rhone delta in southern France; such recoveries were previously unknown, despite intensive trapping in both areas for several years.

In 1960, the autumn counts were comparatively small, due possibly to the wetness of the season and the great amount of floodwater, but in 1961, and again in 1962, much larger numbers than usual were present in October and November – the beginning, it seemed, of a new tradition. If this in fact existed, it appears to have been disrupted by the cold weather of early 1963, which is known to have driven

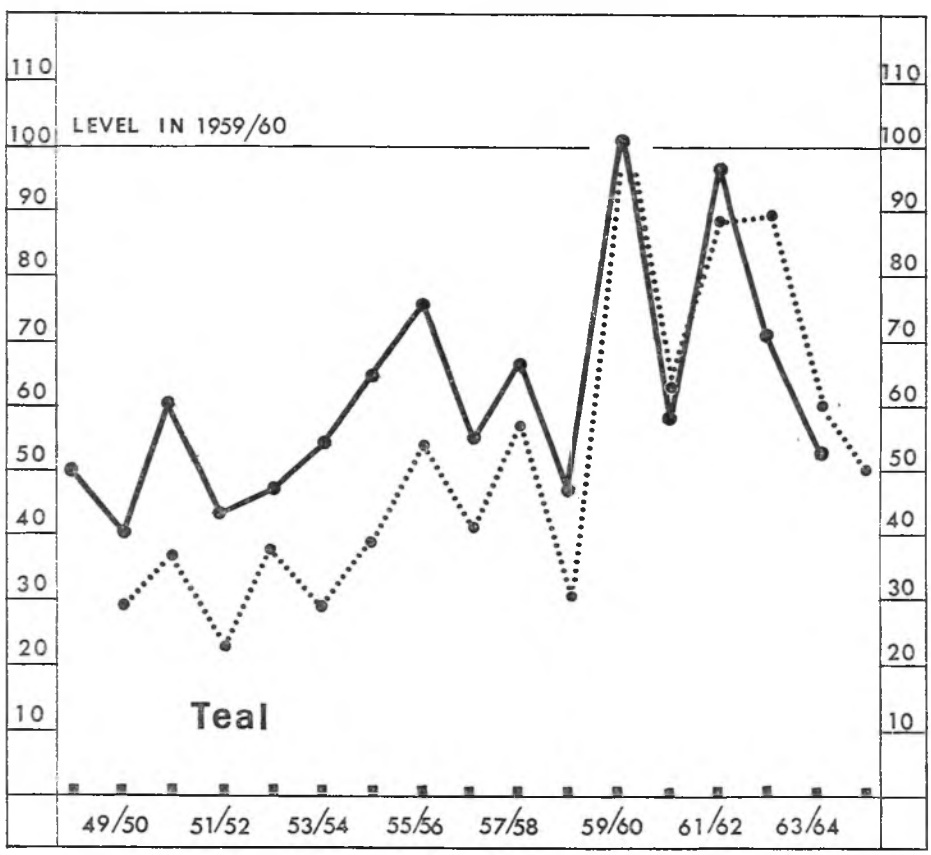


Figure 2. Seasonal indices for Teal, 1948–1964 (solid line), and the monthly indices for September, October and November combined (broken line). The similarity between the two readings makes possible a forecast of the seasonal index some four months in advance.

large numbers of Teal southwards, back into France and Spain. In the following autumn (1963) the September counts were again large for the time of year, but the more important influxes in October and November failed to materialise. In 1964 the September counts failed to produce a realistic index, but the subsequent counts were similar to those in the previous season.

Reviewing the seasons as a whole (Figure 2) it will be seen that the present level of the indices is well within the range of the years prior to 1959, and as such gives no cause for alarm; at the same time the optimistic outlook engendered by the years of plenty can no longer be sustained. In all probability the big influxes between 1959 and 1962 were due to a redistribution of the autumn population and not to a general increase throughout Europe. This is to some extent confirmed by the late winter counts which show no sign of a comparable increase; indeed the trend at this time has been steadily downwards. In 5–10 years time the draining of another polder in the south-west corner of the Ijsselmeer may well result in further large influxes into Britain, but in the meantime any large scale increase seems unlikely.

As with Mallard it is possible to predict with some confidence the level of the final seasonal index from the results of the autumn counts. For the past ten years the pattern described by the two sets of values has been remarkably similar, the only serious divergence being in 1962–63 when the size of the seasonal index was affected by a marked exodus of birds during the cold winter. In the earlier years, the disparity between the two graph lines is due to sudden changes which took place in the master season; with further changes taking place, a similar disparity is likely to emerge, but this will in no way preclude the possibility of forecasting so long as it remains constant.

Wigeon *Anas penelope*

Table III. Monthly indices to show the relative abundance of Wigeon in the same months of different years; the figures in brackets are the highest indices obtained in the periods for which an average index only is given.

		Oct	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*
Average Index	1949–54	103(140)	99(119)	74(92)	90(115)	126(155)	92(123)
Average Index	1954–59	91(115)	114(144)	77(91)	104(130)	129(184)	97(151)
Master Year	1959–60	100	100	100	100	100	100
Index	1960–61	87	111	62	104	126	93
	1961–62	129	124	120	131	110	87
	1962–63	100	101	76	118	103	50
	1963–64	116	65	63	115	72	81
	1964–65	121	102	78	79	110	83

Compared with those for other species, the Wigeon indices show much wider variation from year to year, and yet over the past 15 years it is evident that the level of population has been well maintained, with no significant trend towards increase or decrease. This is particularly apparent in the seasonal indices plotted in Figure 3, but the same may also be deduced from the monthly indices. From the latter it is clear that the population in any given month is liable to quite substantial fluctuation, but at the same time the range of variation has remained more or less constant, and there are few months in which any perceptible change has taken place. Since 1960 the results for January have perhaps been more consistently high than previously, and those for March more consistently low, but any suggestion of a trend would be premature. The results for December show rather less variation than those in other months, and it is often at this time that the largest counts are made.

Although the numbers of Wigeon counted in September, October and November comprise only a quarter of the total numbers recorded in the season (compared with about a third in the case of Mallard and Teal), the autumn results are still sufficiently representative to permit a forecast of the seasonal index. Except in the early years between 1949 and 1953, when there was no correlation between the autumn and seasonal indices, the two sets of values are shown to follow the same pattern with very fair regularity. That this should be so suggests that weather conditions in mid- and late winter have much less influence on the size of the British population than was at one time supposed. In this respect the results for 1962–63 are of special interest; the similarity between the autumn and seasonal indices (in relation to the neighbouring years) implying that the pattern for that season was already determined as early as mid-November. The cold weather that followed in January and February did not apparently bring big influxes from the Continent (see Table III) nor did it cause a massive exodus.

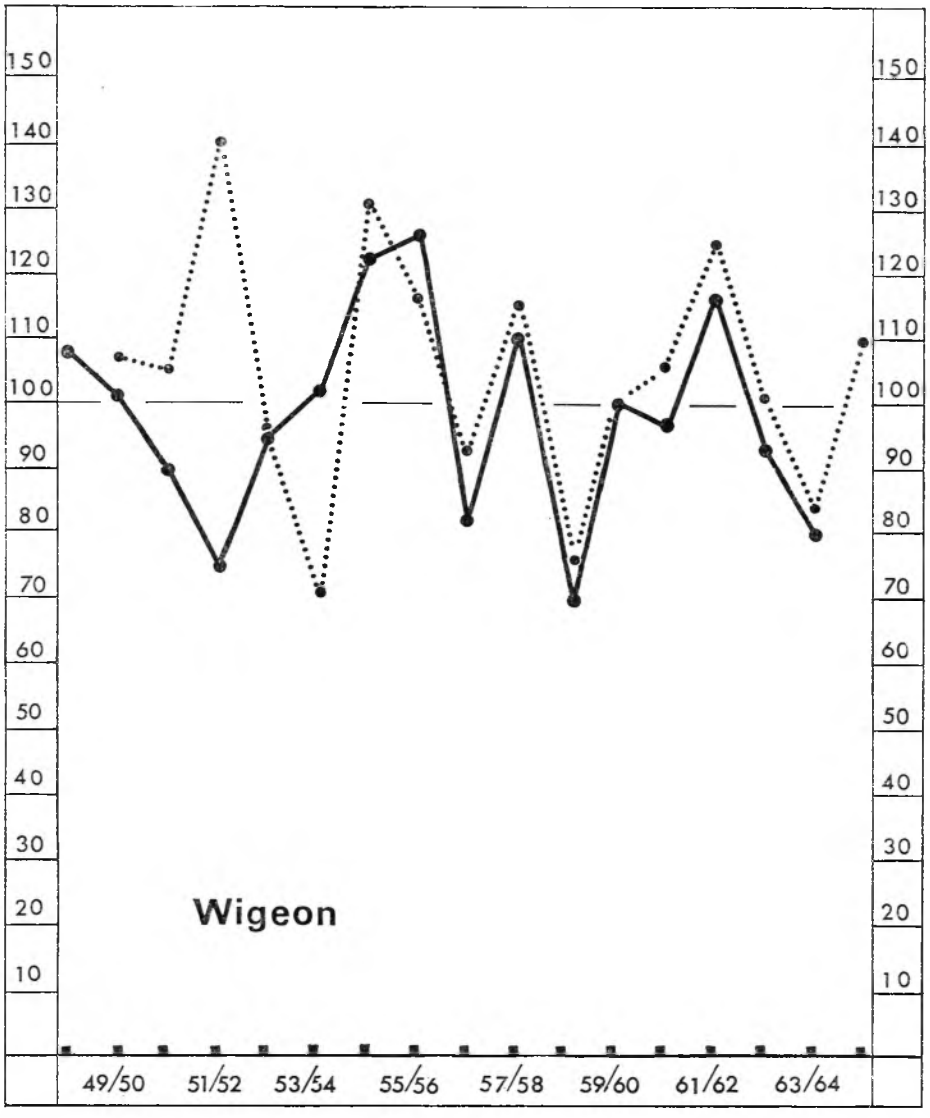


Figure 3. Seasonal indices for Wigeon, 1948–1964 (solid line), and the monthly indices for September, October and November combined (broken line). The similarity between the two readings makes possible a forecast of the seasonal index some four months in advance.

Pochard *Aythya ferina*

The increase in the numbers of Pochard is one of the most striking results so far obtained, the recent level of population being almost double that in the early 1950's. From the seasonal indices in Figure 4 it will be seen that these gains have been achieved not by a gradual progression but in two distinct upward steps. The first of these occurred in the winter of 1952–53 (although the new level was not established until two years later); there was then a period of remarkable stability until the second up-surge in 1960–61. As a measure of the two increases, the average level of the indices was 67 in the period 1949 to 1952; from 1954 to 1959–60 it stood at 95, and from 1960 until 1963 at 130. At each stage the individual indices

Table IV. Monthly indices to show the relative abundance of Pochard in the same months of different years.

		Oct	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*
Average Index	1949–52	65	79	63	73	79	44
Index	1952–53	210	136	129	65	90	37
Index	1953–54	88	63	56	68	72	62
Average Index	1954–59	111	124	93	84	81	69
Master Year	1959–60	100	100	100	100	100	100
Index	1960–61	186	171	115	84	90	76
	1961–62	147	221	111	90	110	70
	1962–63	227	181	124	116	125	105
	1963–64	95	111	112	153	116	150
	1964–65	112	176	100	117	120	197

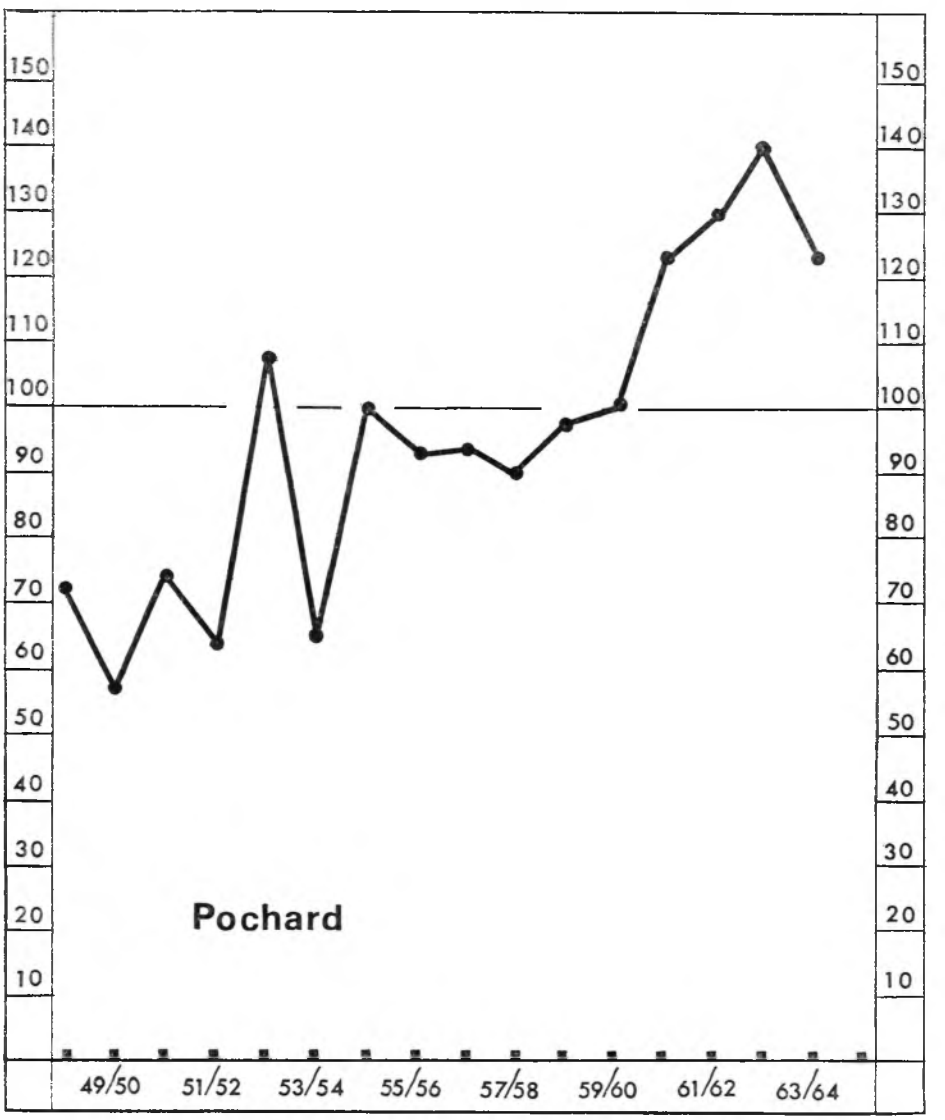


Figure 4. Seasonal indices for Pochard, 1948–1964

varied from the mean levels by less than 15%, and in the middle period by as little as 5%.

As with the Tufted Duck, these increases are attributable in part to a lengthening of the period during which large numbers of birds are present. The effect of this factor upon the size of the seasonal index is clearly shown by the monthly indices in the winters of 1952–53 and 1953–54, which in this case have been excluded from the averages for the early years (see Table IV). In 1952–53 a very large influx of birds occurred in October, and for the next two months the numbers were well above the average for the previous three years. From January onwards the population was about normal for the time of year (implying that no fresh immigrants had arrived to augment the early influx); but because the birds had been in the country that much longer the seasonal index was raised by more than 60%. In the following year the autumn influx failed to materialise and the seasonal index fell back to its former level. From then on, however, the early arrival date became a regular feature, and this, together with a general increase over the winter as a whole, resulted in the plateau between 1954 and 1959. More recently the process has been repeated, the second up-surge in 1960 being due partly to an even larger autumn influx and partly to the upward trend of the mid- and late winter results.

Of special interest are the figures for the season 1963–64, the one immediately after the cold winter. That autumn the numbers were substantially lower than they had been in the previous three seasons, and for a time it seemed as though the species had suffered heavy losses. By December, however, the usual numbers had arrived, and for the rest of the winter the level was considerably higher than normal, especially during January and March. In 1964 the arrival date was again delayed, but in this case only until November.

The reasons for these changes in habit are not yet known, but the answer must presumably lie in northern or eastern Europe. From the ringing data it appears that the British winter population is composed almost entirely of birds from Germany, Poland and Russia; the native stock is small and there is no immigration from Iceland, where the Pochard is a recent and still rare invader.

Tufted Duck *Aythya fuligula*

Table V. Monthly indices to show the relative abundance of Tufted Ducks in the same months of different years; the figures in brackets are the highest indices obtained in the periods for which an average index only is given.

		Sep	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*
Average Index	1949–54	67(120)	27(47)	57(74)	84(107)	68(88)	79(115)	77(87)
Average Index	1954–59	86(116)	55(72)	94(124)	116(144)	77(92)	101(126)	106(114)
Master Year	1959–60	100	100	100	100	100	100	100
Index	1960–61	81	103	137	68	79	118	157
	1961–62	119	112	113	76	77	120	112
	1962–63	60	73	95	92	96	171	113
	1963–64	73	70	97	88	123	94	168
	1964–65	—	60	95	88	73	82	111

In a previous review of the Tufted Duck (Eltringham and Atkinson-Willes, 1961) the annual rate of increase over the period 1948–1959/60 was calculated at 8½%, a result confirmed by independent studies in both England and Scandinavia (Haartman 1957; Homes 1958). With the data for a further four seasons to hand, it appears that this increase has now ceased (see Figure 5), and that the seasonal indices have remained constant at a level which was first attained in the winter of 1957–58. It should be stressed, however, that the level of these indices depends not only on the size of population, but to some extent on the length of time during which large numbers of birds are present. From the monthly results set out in Table V, it appears that both factors are contributory in this instance, though the relative importance of each is not yet clear.

Substantial increases undoubtedly took place during the 1950's, the average level of the indices for each and every month being noticeably higher in the second five year period (1954–55 to 1958–59) than in the first. It is clear, however, that the rate of increase was greater in the autumn than it was in the latter part of the winter. Since 1959 the indices for February and March have shown further gains, and the same is also true of October and November, despite a decrease in the last three seasons. In December, on the other hand, the indices

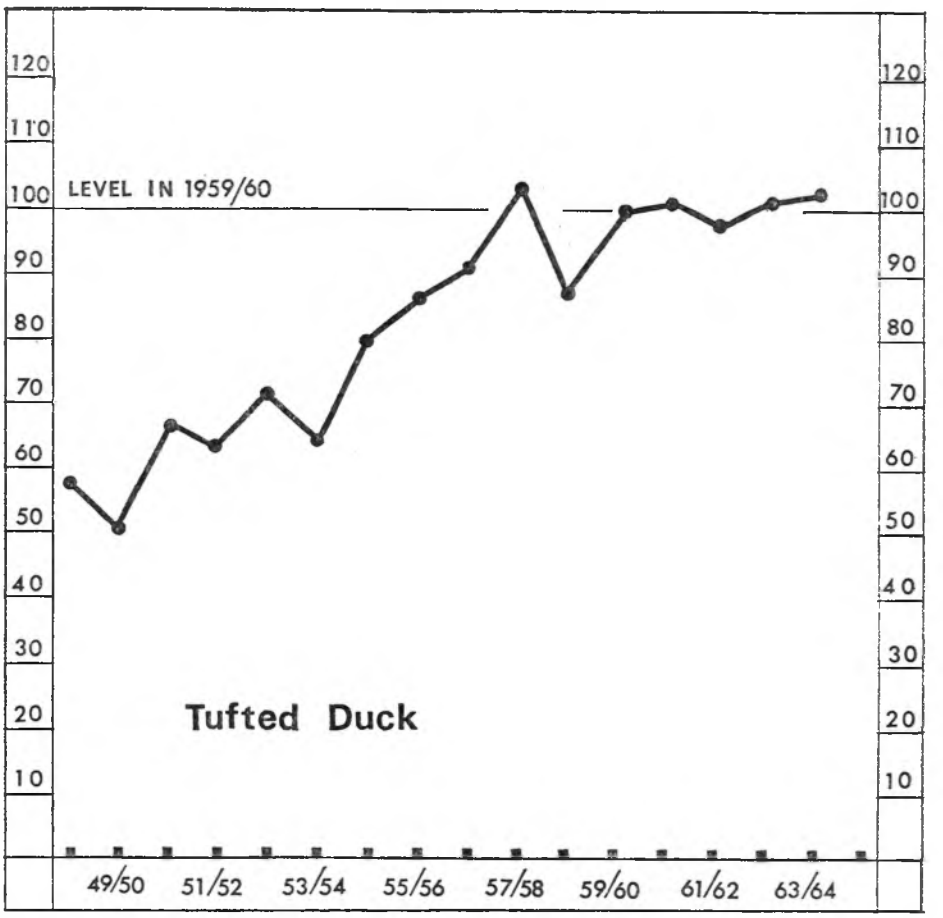


Figure 5. Seasonal indices for Tufted Duck, 1948–1964.

have dropped and for the past five seasons the average level has been virtually the same as it was 10–15 years ago.

These changes in the relative abundance of Tufted Ducks at various stages of the winter are a subject for further investigation. In undertaking it, an attempt must be made to differentiate between the native stocks and the two immigrant populations from Iceland and Russia, and to ascertain whether or not the trends in the populations are the same. Until this can be achieved, any further interpretations would be out of place.

Acknowledgements

I am grateful to the Nature Conservancy for the financial support afforded to the National Wildfowl Count investigation over many years. I should also like to record my debt to John Frith who so cheerfully undertook the task of analysing the data. He died, aged 27, on 28th August 1964.

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Lead poisoning in the Slimbridge wildfowl collection

J. V. BEER and P. STANLEY

Summary

Rather surprisingly, lead poisoning, following the ingestion of spent shot gun pellets, has been found to be an important cause of death among captive wildfowl at Slimbridge, Gloucestershire. Thirty-two species have been affected and the post-mortem findings are described. The source of the pellets has been investigated. The differential mortality among the various wildfowl tribes is possibly related to differences in feeding habits, diet and gritting as well as to susceptibility. Methods of prevention are discussed. Lead poisoning casualties have also been found in other collections in England.

Introduction

Lead poisoning, caused by the ingestion of spent shot gun pellets, has long been recognised as an important mortality factor in free-living wildfowl. Olney (1960) has given a comprehensive review of the situation. In 1959 and 1960 a series of deaths occurred in the Magpie Geese *Anseranas semipalmata* at Slimbridge, and some form of poisoning was suspected. Then one case showed all the classic signs of lead poisoning and lead pellets were found in the gizzard. Subsequently a close watch has been kept for signs of lead poisoning in all post-mortems and, in all, 74 primary cases have been detected. These have occurred in the 32 species listed in the Appendix.

Post-mortem findings

The pellets found in the gizzard varied from the large BB pellet down to pellets the size of No. 6 shot and fragments. Some still showed signs of denting, others were spherical, while some were eroded to discs or tiny fragments. The surface of the pellets was a dark grey metallic sheen produced by the chemical and grinding action of the gizzard. 47 (63%) of the cases contained one pellet or fragment of lead while the remainder contained between two and seven. This amount of lead is similar to that found by Jordan and Bellrose (1950) to be sufficient to kill Mallard *Anas platyrhynchos* fed on a diet of mixed grain.

As in the case of birds poisoned in the wild, most of the corpses were emaciated. This was quantified by grading the pectoral muscles from 1 (very atrophied) to 4 (normal) and the subcutaneous and visceral fat each, from 0 (no fat) to 4 (massive

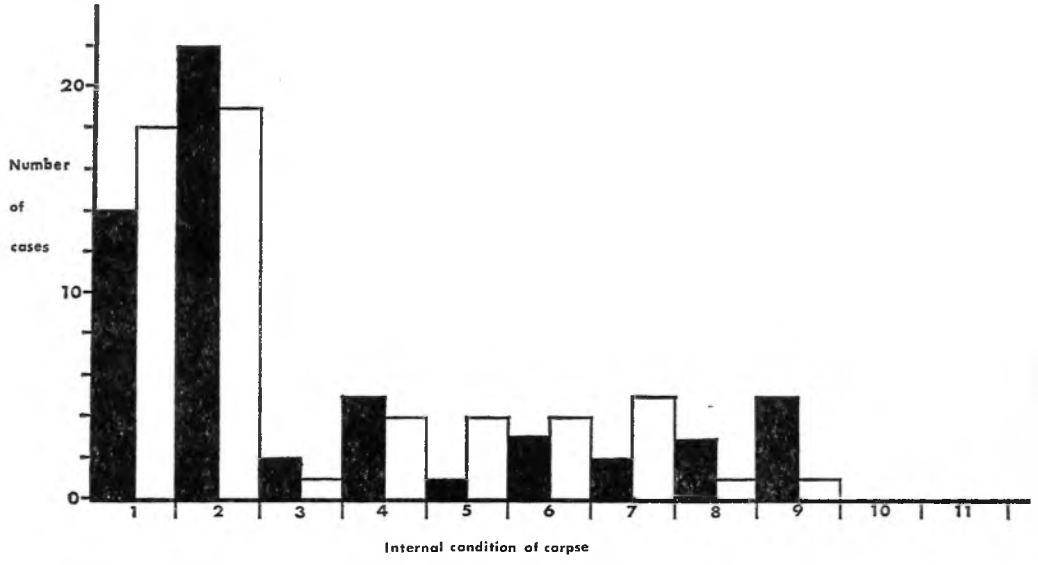

Figure 1. Condition of wildfowl poisoned by lead.

deposits). Adding the three grades gives values ranging from 1 (extremely emaciated) to 9 (healthy) to 12 (obese). Figure 1 shows that two-thirds of the Slimbridge cases were emaciated.

Many of the birds had nevertheless eaten shortly before death. The accumulation of food in their oesophagi was not always a direct result of impaction but was probably caused by a weakening or paralysis of the gizzard muscles. Actual gizzard impaction was noted in 24 (32%) cases. The impaction, sometimes extending to the proventriculus and duodenum, was formed of tough fibrous grass and other vegetable material which could not be broken down by the weakened gizzard. Jordan and Bellrose (1951) found proventricular impaction in 44% of their penned lead-poisoned Mallard. The horny pads of the gizzard were eroded and ulcerated in 9 (12%) of the Slimbridge cases.

Anaemia is a common finding in lead poisoning and was noticeable in 45 (61%) of the post-mortems. One Red-billed Whistling Duck *Dendrocygna autumnalis* was markedly anaemic before death, the bill and legs being almost white. An enlarged gall-bladder was present in 61 (82%) cases and the excess bile usually stained the gizzard, and also the cloacal and tail feathers, bright green. The liver was atrophied in 15 (20%) cases and some deterioration was noted in 24 (32%) cases.

In addition to the above post-mortem findings which, coupled with the presence of lead pellets in the gizzard, are pathognomic of lead poisoning, congestive heart failure was noted in 20 (27%), kidney impairment in 27 (36%) and pneumonia in 8 (11%) cases. The parasites *Echinuria* sp. and *Amidostomum* sp. were only found in 7 and 3 cases respectively, whereas Hansen, McNeil and Priebe (1957) considered that infections of the latter parasite contributed substantially to the death of wild Canada Geese *Branta canadensis* suffering from lead poisoning.

Source of the pellets

There has been little or no shooting in the immediate vicinity of the 35 acres of enclosures at Slimbridge since the Trust was founded in 1946. Controlled goose shoots are still held three or four times a year but well away from the pens. In any case the heavy shot used figures relatively seldom among the pellets found in gizzards. It seems, therefore, that the pellets now finding their way into the captive birds are two or more decades old, deriving from the time when the area was used for more general (but always strictly controlled) shooting.

One hundred soil samples each comprising 100 ml. of the top six inches were taken at random throughout the largest pen (6 acres). Not a single lead pellet was found, showing that the general level of contamination is not high. Similarly no pellets were found in fifty samples of deep, soft mud well out in the ponds. Fifty samples taken from along the marginal shelf of the ponds, however, yielded four pellets. The enclosures are on alluvial soil reclaimed from the river some three centuries ago. The edges of newly dug ponds are therefore unstable and prone to crumble into the water as birds dibble and tread along the margins. It is here that any lead pellets in the soil would most likely to be exposed within reach of the birds.

Erosion of the pond margins has been a major maintenance headache, for the ponds rapidly increase beyond the desired size, and fill with mud, while the circulation channels become choked with silt. To combat these effects it has been the practice to line the banks, two or three feet above and below the water line, with rough cast concrete coloured to simulate earth. This is a slow and expensive business so that a range of ponds with and without 'anti-erosion' linings has been available throughout the enclosures. In ponds with no anti-erosion linings twenty-six samples yielded 10 pellets; 21 cases of lead poisoning had occurred in these ponds. In ponds where the edges were mostly protected by concrete twenty-one samples yielded no pellets and there had been only 3 cases of lead poisoning. There have been clear instances where a species, such as the Magpie Goose, suffered from lead poisoning when kept with access to ponds with natural banks but not when kept in concrete-edged ponds.

The pellets found in the gravel on the marginal shelf were mainly No. 4 and No. 6 shot. No BB shot was found. All the pellets were pale buff or off-white due to a coating of lead hydroxide and salts which had prevented extensive corrosion over the years. Most of the pellets showed the characteristic denting which is produced during firing, but a few were very small and rounded and had possibly already been ingested and defaecated by a bird.

Differential mortality

It is clear that lead poisoning occurs, under captive conditions at least, much more frequently in some groups of wildfowl than in others. The known occurrences and the total number of post-mortems made in the six-year period 1959–64 are compared in Table I, using the taxonomic grouping into tribes proposed by Delacour (1954–64).

Table I. Frequency of occurrence of lead poisoning in post-mortem examinations of Anatidae kept at Slimbridge, 1959–64

Tribe	*Post-mortems undertaken*	*Lead poisoning cases*	
		number	%
Anseranatini	28	6	21
Aythyini	163	22	13
Cairinini	260	17	7
Dendrocygnini	159	7	4
Anatini	530	15	3
Oxyurini	47	1	2
Somateriini	44	1	2
Mergini	99	1	1
Anserini	302	2	<1
Tadornini	149	1	<1
	1781	74	4

It is suggestive that the Anseranatini are root eaters with powerful digging bills; that the Aythyini are diving bottom feeders; and that the Cairinini concerned (most cases were in the genus *Aix*) obtain their food by picking up individual seeds rather in the manner of poultry. All these methods of feeding are likely to bring them into contact with pellets more readily than, say, are the grazing habits of most of the Anserini. But for a number of reasons considerable caution must be exercised in relating differences in incidence of poisoning to the feeding habits. Experimental work in America (see Bellrose, 1964) has stressed the importance of the actual diet taken. After a bird has ingested a certain number of pellets, lead poisoning is much more likely to develop on a diet of whole grain than if the bird is fed grain meal or green stuffs. It is thought that the greater abrasion against the cereal grains leads to quicker erosion and solution of the lead. In the densely populated enclosures at Slimbridge natural foods are rapidly used up and the birds of many species subsist on an artificial diet rich in cereal grains. In these conditions the incidence of lead poisoning may reflect specific susceptibility as well as the likelihood or otherwise of the birds ingesting lead. To test the latter thoroughly it would be necessary to make X-ray investigation of the living birds in the collection. The disturbance this would entail is not justified.

Another reason why feeding habits may not be closely linked with the incidence of lead poisoning is that the pellets may be ingested in mistake for grit rather than for food seeds. The birds may well obtain their grit in places other than those in which they feed. Moreover, where grit is short, as in an alluvial soil, not only are lead pellets more likely to be taken in, but they are retained for longer in the gizzard. Excess grit passes rapidly through the birds, taking any pellets with it.

It is probable also that both the feeding and gritting habits are different in young birds from those of adults; they may also be more susceptible to poisoning. A combination of these factors, together with the necessity for keeping young birds on temporary, unconcreted ponds, probably accounts for the much greater incidence of lead poisoning in birds of less than one year old. These produced 39 cases (14%) in 269 post-mortems; 768 comparable adult post-mortems produced only 23 cases (3%). No case has been found in a downy bird over the six years, but their chances of coming into contact with lead pellets in the rearing pens are small.

Prevention of lead poisoning in collection birds

The situation at Slimbridge is by no means unique as the disease has been found recently in birds from collections in Lancashire, Norfolk, Surrey, Hampshire and Dorset. The general level of incidence (4%) indicated by Table I probably underestimates the seriousness of the position at Slimbridge owing to diagnostic difficulties in the earlier years. In 1963 and 1964, by when the condition was clearly recognised, the general level was 7% (52 cases in 702 post-mortems) making it one of the more important single causes of mortality.

Lead poisoning is difficult to diagnose and cure in the living bird, so that methods of prevention are most important.

When a potential collection site is being

considered, the extent of any shooting in the past should be ascertained and taken into account. Ideally the site should be entirely free of lead but, if not, precautions can be taken to keep the incidence of lead poisoning low. The banks of the ponds should be protected by concrete from erosion, while marginal shelves in shallow water can be covered with a uniform large gravel. However, if there is an appreciable amount of water-weed this should not be disturbed. New pens and ponds are best populated with animal feeders and grazing species. The Anseranatini, Aythyini and the Cairinini should be kept in old pens that have had the pond banks protected against erosion. Any soil or mud that has been removed from a pen or pond should be removed entirely or allowed to grass over before birds are put back in the pen. A plentiful supply of grit should be made available and the diet should contain as much green food as possible.

Acknowledgements

We would like to thank Captain R. G. W. Berkeley and Mr. W. Bowditch for details of the past shooting over the collection area and Mr. W. H. Hoff, Mr. T. Jones, Mr. J. Murray, Mr. D. T. Page and Mr. H. Whitehead for details about certain birds. Also we would like to thank Mr. S. T. Johnstone and his staff for collecting the dead birds for post-mortem examination.

Appendix. Species that have died of lead poisoning in the Slimbridge wildfowl collection.

	Post-mortems undertaken	*Lead poisoning cases*
Magpie Goose *Anseranas semipalmata*	28	6
Fulvous Whistling Duck *Dendrocygna bicolor*	61	4
Red-billed Whistling Duck *D.autumnalis*	33	3
Bewick's Swan *Cygnus columbianus bewickii*	2	1
Greylag Goose *Anser anser*	31	1
Falkland Island Steamer Duck *Tachyeres brachypterus*	6	1
Salvadori's Duck *Anas waigiuensis*	13	1
Versicolor Teal *A.versicolor*	18	1
Northern Pintail *A.acuta*	18	1
Chestnut-breasted Teal *A.castanea*	26	2
Mallard *A.platyrhynchos*	65	3
Laysan Teal *A.laysanensis*	11	1
Chinese Spotbill *A.poecilorhyncha zonorhyncha*	9	1
New Zealand Grey Duck *A.superciliosa*	7	1
Philippine Duck *A.luzonica*	15	1
African Yellowbill *A.undulata*	7	1
Cinnamon Teal *A.cyanoptera*	13	1
New Zealand Shoveler *A.rhynchotis variegata*	6	1
Steller's Eider *Polysticta stelleri*	26	1
Rosy-bill *Netta peposaca*	4	1
South American Pochard *N.erythrophthalma*	12	2
European Pochard *Aythya ferina*	7	1
Redhead *A.americana*	25	9
Common-White-eye *A.nyroca*	3	2
Australian White-eye *A.australis*	13	1
Tufted Duck *A.fuligula*	6	1
Lesser Scaup *A.affinis*	12	1
European Greater Scaup *A.marila*	14	3
Brazilian Teal *Amazonetta brasiliensis*	27	3
Mandarin Duck *Aix galericulata*	30	2
North American Wood Duck *A.sponsa*	106	13 + 1 pull.
European Goldeneye *Bucephala clangula*	11	1
North American Ruddy Duck *Oxyura jamaicensis*	7	1

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Breeding success of White-fronted Geese from the Nenets National Area

HUGH BOYD

Summary

The breeding success of White-fronted Geese has been inferred from the age composition of flocks wintering at Slimbridge, Gloucestershire, since 1947. These Whitefronts breed in the north east of European Russia. Annual variations in brood-size (average 3·24) have been comparatively slight, though there were unusual numbers of small broods in 1950 and 1958 and of large broods in 1951 and 1956. The proportion of first-winter geese has varied widely about a mean of 33·3%. The fluctuations seem to have reflected changes in output rather than in adult mortality. Attempts to relate production to the limited weather data from the breeding areas by means of correlation methods suggest that wet weather in July has markedly reduced production. Snow in late May and early June has been less important, while low temperatures without snow have had no perceptible effect. Marked geese breeding for the first time, at nearly three years old, have had smaller families than parents four to six years old. So have those more than seven years old.

Introduction

The best way of studying the fertility of geese and the factors affecting it is by direct observations on breeding groups continued over many years. For species nesting in the Arctic such investigations are very rarely practicable but much of the pertinent statistical information can be obtained by studying flocks in winter (Lynch and Singleton, 1964). The White fronted Geese *Anser albifrons albifrons* that visit Slimbridge, Gloucestershire, have been studied in this way since 1947 (Lebret 1948, Boyd 1954, 1957). The present paper adds data collected since 1956 and examines three factors likely to affect the output of young. First, attempts are made to use published weather records to investigate the effects of weather conditions on the breeding grounds upon reproductive success. Second, records of the family-sizes of marked geese are used to illustrate variation in output with age. Third, the proportion of young geese is compared with annual variations in the losses of full-grown birds. The results of all three lines of inquiry are tentative. Their thorough exploration would require a great increase in efforts to catch and mark geese, as well as access to detailed weather records not available outside the U.S.S.R.

Recoveries of ringed birds have shown that nearly all the Whitefronts visiting Slimbridge breed at the western end of the range of *A.a.albifrons*, on the south island of Novaya Zemlya and on Vaygach and Kolguev Islands and on the tundra of the Nenets mainland from the Kanin peninsula east to about 55°E (Shevareva 1959, Boyd 1961). The Slimbridge-visiting Whitefronts do not form a simple closed group. They are part of a much larger stock wintering chiefly in east Germany and the Netherlands with a breeding range extending as far as 70°E. (Philippona and Mulder, 1960). The consistent reappearance of

ringed geese suggests that a high proportion of the geese that have once visited Slimbridge continue to do so, but the extent of the gains and losses due to infidelity to tradition, rather than to births and deaths, has yet to be measured. For the purpose of the ensuing analyses it is assumed that the reproductive performance of immigrants is much the same as that of persistent members of the group, although recent work in the Netherlands has shown marked differences between flocks wintering in different parts of that country (W. J. Doude van Troostwijk, personal communication).

Fertility

Two measures of annual production can be got by looking at Whitefront flocks in autumn: the proportion of birds in first-winter plumage and the sizes of family parties. Both measures tend to diminish through the winter, because young geese are more vulnerable than older ones (Boyd 1957), so that records collected in the autumn best reflect the success of the previous breeding season. Whitefronts have been scarce at Slimbridge before December, particularly in recent years, and the earliest arrivals tend to be unrepresentative, so that for adequate samples it is necessary to lump together data from October, November and December. Since most early arrivals remain for long periods, and so may be looked at repeatedly, the subsamples within any year are not independent. Because of differences in the accessibility of the geese and in the amount of time spent in searching, the annual samples summarised in Table I do not reflect the changes in the numbers of geese arriving at Slimbridge in autumn (compare columns (1) and (4) with column (6)).

The means and the frequency distributions of brood-size show considerable superficial differences between years. The standard errors of the means are relatively large, often because the samples have been small but also because the distributions are platykurtic and positively skewed. The coefficient of variation is always very high (from 36·2 to 53·8 even in the largest samples). Thus significant departures from the average are only demonstrable in four of the seventeen years. In 1950 and 1958 there were few large broods: in 1958 there were very few broods at all and an unusually high proportion of ones and twos, while in 1950 there was a marked excess of twos and threes. In 1951 and 1956 there were exceptionally many broods of more than four young.

Column (5) of Table I records the proportion of first-winter birds observed each autumn. Marked departures from the average value for the total sample appear to have occurred in thirteen of the seventeen years, only the values for 1949, 1954, 1956 and 1959 lying close to the mean. This great variability is paralleled in the sub-

Table I. Annual measures of breeding success of White-fronted Geese seen at Slimbridge in October-December, 1947–63. Values in italics show departures from the long-term means significant at the 5% level.

	no. of broods (1)	*mean brood size* (2)	*s.e. of means* (3)	*proportion 1st winter birds sample size* (4)	*1st w. per 1000* (5)	*max. number seen before 31 Dec.* (6)
1947	11	3·55	0·47	606	*206*	3000
1948	49	3·22	0·21	184	*196*	1500
1949	45	3·29	0·18	466	290	650
1950	252	*3·04*	0·08	3511	*391*	3000
1951	176	*3·66*	0·14	3166	*402*	1900
1952	282	3·22	0·09	3647	*372*	3900
1953	105	3·19	0·16	1900	*242*	1500
1954	4	4·75	0·55	900	311	1000
1955	114	3·24	0·16	900	*470*	1270
1956	102	*3·67*	0·19	683	326	1700
1957	133	3·54	0·15	1500	*462*	2200
1958	48	*2·54*	0·15	807	*124*	700
1959	239	3·05	0·10	2893	346	1400
1960	106	3·30	0·16	994	*371*	780
1961	22	3·86	0·36	381	*454*	450
1962	43	2·79	0·20	2039	108	1450
1963	37	2·84	0·23	615	228	1000
total	1756	3·24	0·038	25192	mean 333	mean 1610

samples within a year and is undoubtedly affected by incomplete mixing of young and old birds within flocks due to the persistence of family parties. Boyd (1956) has discussed a similar situation in *Anser brachyrhynchus* from a statistical point of view.

Although by ingenuous statistical criteria the mean brood-sizes show few 'significant' differences while the proportions of young birds show many, the correlation between the annual values for the two measures is much greater than might be expected ($r = + 0{\cdot}62$). Taken in conjunction with the fact that even in 1958 and 1962 the proportion of young geese did not fall below 10% this leads to a general inference of major importance: the variations in production of young seem more likely to be due to differences in rearing success than to alterations in the number of geese laying eggs. Clearly, taking the entire range of this Nenets stock as a whole, no year since 1947 has been a "non-breeding" year in the sense of a year in which breeding was wholly prevented or abandoned (Marshall, 1952). Variations in brood-size in autumn might reflect either differences in the numbers of eggs laid or in hatching or fledging success. Only direct observations in nesting areas could distinguish between these alternatives with certainty but it is possible to make some progress by studying the phenology of nesting and the effects of weather.

Breeding phenology and weather data

Irregular observations scattered over many years, summarised by Dementiev and Gladkov (1952) and Shevareva (1959) led to the general phenological picture given in Table II. In addition to the evident differences between one place and another, there are important differences from year to year, though the data are too fragmentary to show this well. Both types of variation are due to climatic differences.

The weather around the shores of the Barents Sea is usually extremely unpleasant. Snow cover persists on Kolguev for over 230 days a year and on Vaygach for 250 days, while the rivers of the Kanin peninsula are frozen over for more than seven months (Zaborski, 1955). In the summer "Kolguev is exceedingly subject to fogs and gales of great duration" (Trevor-Battye, 1895) and Novaya Zemlya is even worse. Though there is a long-established chain of weather stations in the area, full records are not published outside the U.S.S.R. and the only data immediately available are those provided by The Daily Weather Report of the British Meteorological Office. The synoptic map for 1200 h. GMT published in the Report includes data from three mainland stations in or near the breeding range of Slimbridge-visiting Whitefronts (at Cape Kanin, Tabseda and Amderma), from Vaygach Island and from Malye Karmakuly on the west coast of the south island of Novaya Zemlya. There is no report from Kolguev. The data comprise wind direction and speed, present weather, temperature and cloud cover. Such a set of instantaneous observations is far from ideal for assessing the impact of the weather upon nesting geese, especially as until very recently there were many gaps in the plotted records. For 1947–50 it has been possible to supplement the D.W.R. records with the monthly mean temperature and total precipitation at Malye Karmakuly and Voygach published in *World Weather Records 1941–50* (Weather Bureau, U.S. Dept. of Commerce, Washington, 1959). There is an encouraging measure of agreement between the published monthly mean temperatures and those calculated from the D.W.R. data. More surprisingly, there is a satisfactory consistency of trend between the records of total precipitation and an index of "days-with-precipitation recorded at 1200 h. GMT" derived from the D.W.R.

From studies of other geese nesting in various parts of the Arctic (see especially Barry 1962, Cooch 1961, Goodhart and

Table II. Phenology of White-fronted Geese in the Nenets National Okrug, around the south-east shores of the Barents Sea.

	Kanin peninsula	*Kolgnev Island*	*Novaya Zemlya*
first arrivals	May 9–23	May 25–June 5	May 15–25
laying begins	May 29–June 8	June 4–20	
incubation begins	June 5–15	June 11–28	
hatching begins	July 1–12	July 7–25	July 13–28
first young fledged	August 4–26	Zug. 10–Sep. 10	
final departures	after Sep. 19	from Aug. 31	Sep. 4–Oct. 7
length of stay	105–140 days		

Table III. Yearly variations in temperature and rainfall in Whitefront breeding areas, May–July.

	May 16–June 15 mean temperature & rainfall index						*July rainfall index*		
	mainland		*N. Zemlya*		*weighted means*				
	°C	*rain*	°C	*rain*	°C	*rain*	*mainland*	*N. Zemlya*	*mean*
1947	−0·7	*0?*	−0·6	*0?*	−0·6	*0?*	31	250	140
1948	+2·6	*80*	−1·1	*95*	+0·5	*88*	56	0	28
1949	+3·3	*61*	+0·5	*62*	+1·8	*62*	48	133	93
1950	+6·9	*139*	−0·9	*148*	+2·6	*144*	132	107	120
1951	+4·3	*0*	−1·3	*130*	+1·2	*65*	0	160	80
1952	+4·1	*67*	+1·6	*111*	+2·7	*89*	26	71	49
1953	+7·1	*20*	+1·0	*36*	+3·7	*29*	78	69	74
1954	+6·2	*92*	+2·4	*65*	+4·1	*79*	20	32	26
1955	+5·6	*89*	−0.3	*43*	+2·4	*66*	41	0	20
1956	+4·7	*87*	+0·4	*148*	+2·3	*118*	0	0	0
1957	+3·4	*240*	−0.2	*276*	+1·4	*258*	43	129	86
1958	−0·6	*182*	+2·7	*321*	−1·7	*252*	104	345	225
1959	+2·5	*244*	−0·2	*281*	+1·0	*263*	0	348	174
1960	+1·8	*305*	+0·1	*111*	+0·9	*208*	83	200	142
1961	+0·4	*138*	−1·1	*250*	−0·5	*194*	14	77	46
1962	+3·7	*207*	−1·0	*200*	+1·1	*204*	133	172	203
1963	+2·2	*235*	−0·1	*100*	+0·9	*168*	127	103	115

Wright 1958, MacInnes 1962) it seems likely that weather conditions are especially liable to affect breeding success at two periods in the nesting cycle. First, cold weather at the time of arrival of the geese in the spring may make it difficult or impossible for them to lay eggs, by delaying the disappearance of snow cover from nest sites or by fresh falls of snow. Second, cold, and especially wet-and-cold, weather around the time when most clutches are hatching or goslings are less than two weeks old may also lead to relatively high losses. Table II shows that in the Nenets region the first of these critical periods falls somewhere between 16th May and 15th June, while the second may occur during most of July. Table III summarises the relevant weather data for each year from 1947 to 1963. Means for late May and for early June were also calculated separately. Their use affords no additional insight. The two means are positively correlated, especially on the Nenets mainland. Craddock and Ward (1962) have demonstrated an association between temperature anomalies in May and June in this region.

In testing hypotheses about association between weather characteristics and breeding success it is proper to use non-parametric techniques, since the available weather measurements are unlikely to be metrical with respect to the factors that directly influence egg-laying or the survival of goslings. On the assumption that the relationship between the variables is linear, rank correlation coefficients have been calculated to test association between the scales of breeding success provided by mean brood-size, proportion of first-winter birds and their joint rank order and the indices of May-June temperature and precipitation, July precipitation and their combined rank orders (Table IV). From

Table IV. Rank correlation coefficients between measures of breeding success and of weather in the breeding season

	measures of breeding success		
	mean brood-size	*proportion of young*	*combined ranking*
weather 16 May–15 June			
temperature	+0·27	+0·41	+0·10
precipitation	−0·45*	−0·01	−0·05
combined ranking	+0·25	+0·09	+0·23
July rainfall index	−0·61**	−0·57*	−0·62**
good summer weather			+0·43*

* significant at 5% level; ** significant at 1% level

these coefficients, successful breeding appears to be positively correlated with generally fair spring and summer weather. The only correlation between measures of success and the weather in late May and early June that is significant at the 5% level suggests that broods were larger after dry springs.

Since the assumption of linearity in the relationships between weather and breeding success may be unreasonable, contingency tables have also been used to compare the observed frequencies of good, average and bad output with various groupings of weather conditions. No convincing association between spring temperatures and breeding success could be demonstrated in this way either.

Analogy with the reported behaviour of other geese nesting in other parts of the Arctic led to the expectation that the condition of the environment at the times of arrival of the geese would be of primary importance. In particular the extent and persistence of snow cover has been shown to determine how soon *Branta bernicla* and *A. caerulescens* may begin to nest (Barry, 1962, Cooch, 1961). The weather at the time of return is important in such cases because of its effect on the snow cover, rather than on the geese themselves, which arrive ready to lay eggs. Dementiev and Gladkov (1952) state not only that a delay of 10–16 days occurs between the arrival of Whitefronts and the beginning of laying but also that the geese arrive with the gonads in a relatively undeveloped state. If there is indeed little urgency about the beginning of nesting in this Whitefront population the weakness of correlations between early spring weather and breeding success becomes less surprising, especially since no measure of the extent of snow cover in the middle of May has been available. There seems to be a marked difference between the relation of Nenets Whitefronts to the spring weather and that of the Barnacle Geese *Branta leucopsis* and Brent Geese *B.b.bernicla* which nest in the same region. For those species, both in Siberia and elsewhere, a delay in the start of nesting leads to the abandonment of laying for that year. Perhaps the apparent relative invulnerability of the Whitefront population is due to ability to remain on its breeding grounds well into September, which the other species seem not to do. However, too little is known about the timing of departures for this point to be explored thoroughly at present.

All three indices of breeding success are strongly correlated with the rainfall in July, production being high in years of low rainfall and poor in wet years. Perhaps this correlation is well marked because the annual differences in rainfall in July tend to be great.

Effects of age upon fertility

Continued observations upon the small number of ringed geese in the flocks at Slimbridge have confirmed the earlier evidence that one- and two-year-old geese are not accompanied by offspring and that a smaller proportion of three-year-olds have families than do geese four years or more old (Boyd, 1954, 1957). More remarkably, it now appears possible that production of young may fall off with increasing age after no more than four years of maturity. The evidence is meagre, because very few geese of precisely-known age can be found, so that the performance of older birds can only be inferred by comparing the output in successive years after marking of all ringed geese seen, including those whose age at marking was not known. Perhaps Table V shows no more than a

Table V. Variations in production of young with increasing age, from observations of families accompanying ringed White-fronted Geese at Slimbridge

(*a*) *Proportion with broods*

	years after marking						
	1	2	3	4	5	6+	*total*
with broods	36	39	36	24	7	4	146
without broods	25	18	12	7	10	4	76
	61	57	48	31	17	8	222
proportion with broods	0·59	0·68	0·75	0·77	0·41	0·50	

$\chi^2 = 10{\cdot}55$, $0{\cdot}10 > P > 0{\cdot}05$

(*b*) *Size of broods*

		broods of				*proportion of broods*	
		1,2	3,4	5+	*total*	*small*	*large*
years	1,2	38	28	9	75	0·50	0·12
later	3,4	28	16	16	60	0·47	0·27
	5+	3	7	1	11	0·27	0·09
total		69	51	26	146		

$\chi^1 = 9{\cdot}60$, $0{\cdot}05 > P > 0{\cdot}02$

tendency to stability of breeding performance with increasing age. The point needs further exploration, though this cannot be done without a great increase in the number of geese ringed and successfully detected many years later. It seems unlikely that a reduction in the number of young reared after the age of eight or nine years could be related to senescence, for captive White-fronted Geese have often lived for fifteen years or more and wild-caught birds have sometimes not begun to breed in captivity until over ten years old.

The suggestion in Table V that a high proportion of young parents rear only one or two goslings is consistent with observations on geese of several species nesting in captivity, in which there is a general tendency for geese nesting for the first time to do less well than more experienced individuals. This inefficiency of first breeders may account for the existence of a negative serial correlation ($r_s = -0{\cdot}516$) between the proportions of young birds observed in year N and in year N + 3, a year of large output being followed three years later by an increase in the breeding stock but a reduction in breeding success. In contrast, no statistically significant correlation is apparent between the proportion of young birds seen in year N and those found one, two, four or five years later.

Annual mortality and production

It has so far been assumed that variations in the observed proportion of young geese in the autumn are chiefly due to differences in the number of young reared. This assumption needs justification because it is theoretically possible that the changes could be brought about in another way, if the number of young reared were relatively constant but the survival of adults altered appreciably from year to year. A detailed study of adult losses is in preparation. For the immediate purpose attention will be confined to a set of estimates of annual losses in the years 1950–51 to 1963–64. These are derived from recoveries of geese ringed at Slimbridge in February or early March in eight years between 1948 and 1962. Applying the maximum-likelihood modification of Lack's method devised by Haldane (1955) to the entire recovery series, the average annual mortality rate is found to be 27·0 ± 3·6%, assuming that the rate does not vary with the ages of the birds. (This assumption appears to be well justified, especially since no Whitefront has been ringed before it was at least 7½ months old.) Using this constant value of 27% and the number of recoveries from each year of ringing it is possible to construct a table of the number of recoveries expected in each year. The losses in any one year can then be estimated by multiplying the average rate (27%) by the ratio (recoveries reported)/(recoveries expected). The results are summarised in Table VI.

Table VI. Estimates of annual losses of White-fronted Geese (from one 1st October to the next) obtained from recoveries of ringed birds, 1950–64

year	*recoveries reported*	*recoveries expected*	*annual losses (%)*
1950–51	2	5·39	10·0
1951–52	8	7·04	30·7
1952–53	11	10·50	28·3
1953–54	19	13·59	37·7
1954–55	6	9·93	16·3
1955–56	10	7·24	37·3
1956–57	6	5·29	30·6
1957–58	1	3·81	7·1
1958–59	16	15·15	28·5
1959–60	14	20·26	18·7
1960–61	12	14·59	22·2
1961–62	15	10·52	38·5
1962–63	19	12·07	42·5
1963–64	5	8·56	15·8
total	144	143·93	27·0

The hypothesis to be tested is that a relationship exists between the proportion of young geese found in the autumn and the losses of adults in the preceding year. The correlation coefficient between the proportion of young geese in the autumn of year N and the adult losses in the preceding twelve months is − 0·21, a value far too low to provide good evidence for such a relationship ($0{\cdot}5 > P > 0{\cdot}4$). The use of multiple regression coefficients, partialling out the effects of brood-size and of summer weather upon the proportion of young geese in autumn, serves to reduce the value of the coefficient. Thus, on the available data, it appears that annual variations in adult mortality do not lead to important differences in the autumn age ratio.

Discussion

The publication of results as tentative as these can best be justified by considering the feasibility of alternative, more rigorous, methods of studying the factors affecting gosling production. In the case of the Nenets Whitefronts political difficulties preclude direct observations by foreigners. Even in politically-accessible areas it will always be comparatively expensive to put observers into breeding areas in the spring before the return of the geese and to maintain a watch throughout the breeding cycle.

It can be done, as the outstanding efforts of the Canadian Wildlife Service have shown (Barry, 1962, Cooch, 1961, Lemieux, 1959). The present study should also have shown the desirability of looking at the behaviour of geese nesting in the low-arctic to see how it differs from that of the high-arctic species studied in Canada. But, supposing that observations in breeding areas must always be few and short-lived, any methods of maintaining continuous records of fertility and of analysing the effects of possibly relevant factors over many years deserve investigation. In the writer's opinion the work reported here suggests that in carefully-selected cases the combination of observations in winter and of weather data from established meteorological stations may be of value. Some Arctic weather stations keep records of the extent of snow cover. It would be instructive to repeat analyses of the type attempted here for a population nesting around a station providing such full weather data.

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Brent Geese in western Europe during the winters of 1962-63 and 1963-64

P. J. K. BURTON

Summary

Hard weather during January and February 1963 concentrated most of the population of Dark-bellied Brent Geese into England and France, making a good estimate of numbers possible. The population in mid-January 1963 was between 23,000 and 25,000. Less comprehensive counts during the winter of 1963–64 suggest that the numbers were then much the same. Very few young were recorded from any areas during 1962–63, but during 1963–64 counts from all areas lay within the range 30–40% first-winter.

The Pale-Bellied Brent wintering in Ireland have had two successful breeding seasons in succession, with about 39% young in sample counts in 1962–63, and about 33% in 1963–64.

Introduction

Although the winter of 1962–63 was exceptionally severe throughout Europe, the counts made of Brent Geese were more comprehensive than any obtained pre-

viously. In part, the weather helped by concentrating Brent into relatively few areas. Such full coverage was not attempted during 1963–64. During 1962–63, a special appeal was made for observations regarding the effect of the hard weather on Brent Geese and these, together with details of counts in both winters, are given below. Counts of age-ratios and total populations were made in all major wintering areas in both winters.

Dark-bellied Brent Goose *Branta b. bernicla*

ENGLAND

Devon

24 on the Taw estuary, 17th February, 1963 (A. J. Vickery).

Hampshire and Sussex

Details for Langstone and Chichester Harbours in both winters have been received from B. W. Renyard. The maximum combined total for both harbours during 1962–63 was 1,500 on 12th January. No first-winter birds were seen. The main feeding areas of the Brent were not as badly affected by ice as the upper part of the shore, and thawed more quickly. The flocks split up more than usual, and one sickly bird was seen. Otherwise, the weather appeared to have little effect on Brent in these areas. 15 were recorded at Christchurch Harbour on 4th January, 1963 (A. J. Wise).

During the following winter, an unusually large influx occurred during mid-December, and the flocks quickly became scattered, making counting difficult. The highest full count for the two harbours was 1,360 on 14th December, 1963. Counts of numbers of young birds in the flocks during the winter totalled 377 out of 919, 41%.

Kent

In the north, about 370 were present at Shellness and Egypt Bay on 11th November, 1962. During mid-January 1963, the total is not thought to have exceeded 150, most of these birds being on the Medway and Swale (D. F. Musson). At Pett Level, a flock of from 60 to 80 (including one Pale-bellied bird) flighted regularly up to a mile inland during February 1963 (H. F. Greenfield, Dr. J. G. Harrison).

Essex

The maximum count during 1962–63 was 9,495 on 13th January, 1963 (R. V. A. Marshall). No first-winter birds were seen at all throughout the winter. In the Bradwell area, Brent fed regularly on the saltings and to a lesser extent on pasture fields inland during January and February. The snow cover was very thin for most of this time, and did not hinder grazing very much. Inland foraging was also reported from Foulness, Canewdon, Fambridge and Leigh-on-Sea (P. Stockwell, Miss M. Drake). Many instances of extremely tame behaviour occurred; one party of 38 landed on the children's paddling pool at Leigh-on-Sea, while others on the shore in the same area allowed dogs to approach within a few yards before taking flight. A single stray found its way to Hanningfield Reservoir. Despite all this, only 10 dead Brent were reported in Essex, contrasting with high mortality of several other coastal species, particularly Shelduck.

The maximum during 1963–64 was 8,813 on 15th December, 1963. In counts made by the writer, 464 first winter birds were found in a total of 1,420, about 33%.

Herts

2 at Tring Reservoir, 16th March, 1963 (N. E. Gammon).

Norfolk

At Scolt Head, 500 were present from late December 1962 to the beginning of March 1963, but no young at all were found (R. Chestney). There were 2,500 altogether at Blakeney and Wells on 25th January, 1963 (H. Hunt). About 10% first-winter birds were estimated at Blakeney (R. A. Richardson).

In the autumn of 1963 the first arrivals at Scolt Head were 57 on 25th October, earlier than usual. 350 were counted there on 6th January, 1964, and from then until 26th February numbers fluctuated between 350 and 550, the proportion of young remaining constant at 28%. The majority left by early April and the last seen were three on 3rd May, 1964 (R. Chestney).

Wash

(Lincs. and Norfolk). D. Broom estimated the average number present during January 1963 at about 3,500.

Northumberland.

Some 2,000 appeared at Holy Island about New Year 1963 and stayed until the end of the cold weather. There were no signs of increased mortality (F. Stabler). These birds are assumed to represent most of the Spitsbergen section of the Pale-bellied population.

128 Brent arrived on 1st December, 1963, and increased to 3–400 by 13th. These are thought likely to have been Dark-bellied birds. By mid-February 1964 5–600 geese were present, most likely Pale-bellied (F. Stabler).

Cheshire

2 seen flying east at Leasowe Shore, Wirral, on 6th January, 1963 (B. W. Kendrick) were most likely to have been Dark-bellied.

WALES

Glamorgan

25–35 were present on the Burry Estuary, Gower, during January 1963. In January 1964, a maximum of 37 were recorded at Whiteford Point, and on 2nd February, 12 first-winter birds were seen in a flock of 32 (D. Cabot and R. Howells).

Anglesey

2 first-winter birds at Newborough Warren on 27th January, 1963, are virtually certain to have been Pale-bellied (P. Hope Jones).

CHANNEL ISLANDS

Jersey

The maximum total in 1962–63 for St. Aubyn's and Grouville Bays was 410, on 21st January and again on 22nd February. On 13th January, 1963, when counts were made in several countries to coincide with the British wildfowl count, there were 350.

Guernsey

27 on 20th January, 1963, three on 21st and 22nd (W. A. Burridge). None was seen during 1963–64.

Herm

This was not visited during 1962–63, but 90 were seen on 21st December, 1963, 75–80 on 30th March, 1964, and 40 on 13th April (W. A. Burridge).

DENMARK

(Details submitted by Mette and Jørgen Fog.) No young were seen at Jordsand in the autumn of 1962, where the maximum count was 1,300 on 15th October. Most Brent left Denmark when the severe weather started, and a series of aerial counts during January 1963 only revealed 720 on the 13th in East Jutland.

In 1963–64, details were submitted of 167 shot birds in the autumn; 110 of these were young. On 12th January, 1964, an aerial count in Jutland revealed 230 birds.

FRANCE

During 1962–63 a series of counts was organised between 9th–15th January by F. Roux. The counts covered all but a few of the regular wintering areas of Brent on the French coast. The results were:-

Manche	80
Côtes du Nord	130
Finistère	110
Morbihan	5,230
Vendée	150
Charente-Maritime	400
Gironde	300
Total	6,400

The counts from Manche, Côtes du Nord, Vendée and probably Gironde may be underestimates. Counts of first-winter birds were made as follows:-

Morbihan: no young seen out of approximately 1,250 examined (R. Bozec). 7 young out of 149 (F. Roux).
Côtes du Nord: 4 young out of 11 (J. P. l'Hardy).
Vendée: none seen in 760 (Dr. Ricouleau).

In Morbihan, the *Zostera* was frozen, and the Brent left the reserve where they usually enjoy protection. A massacre was averted by the suspension of shooting on a national scale throughout the severe weather. On 19th and 20th January, small parties and individuals were reported feeding on fields near the sea in company with Whitefronts in Manche, Seine Maritime and Pas de Calais. Records north of the Seine are unusual, as is the record of 76 at the entrance to the port of Croix de Vie, Vendée, on 22nd January. Despite this disruption of their normal routine, the mortality of Brent in France is not considered to have been any higher than in a normal winter.

Counts in January and February 1964 recorded between 9,560 and 10,680 individuals in 19 localities. Several suitable areas in Charente-Maritime, Côtes du Nord and Finistère could not be searched and it is likely that the true number of Brent wintering in France lay between 11,000 and 12,000. (F. Roux and F. Spitz: Les recersements d'anatides en France pendant l'hiver 1963–1964. *Oiseaux de France* 14(4): 1–17. 1965.) Counts of age groups in Morbihan by Abbé R. Bozec gave a total of 134 young out of 449, about 30%.

HOLLAND

The number of Brent in Holland during the severe weather of 1962–63 appears to have been negligibly small. Few were seen in the Kattendijke area until 19th March, 1963, when there were 136. Numbers seen on Terschelling during autumn 1962 were considerably smaller than in previous years, and the proportion of young recorded was about 5%.

In 1964 about 300 were counted at Veerse Meer on 10th January, and 160–180 on 2nd February. On the latter date, 12 young were seen in a flock of 40. At Terschelling a maximum of 1,400 was attained on 1st December, 1963, with the percentage of first-winter birds decreasing from 33% in October to 8% in January, 1964.

(Details for South Holland were sent by T. Lebret, and for Terschelling by J. Tanis.)

SPAIN

Although it might have been expected that larger numbers of Brent than usual would visit Spain as a result of the severe weather, there is no evidence that this occurred. Some were seen near Baldayo, province of Coruña, where a few occur in most winters (Don Mauricio Gonzalez Diez).

Discussion

An attempt was made to synchronise all counts in all areas with the British National Wildfowl Count on 13th January, 1963. This was almost completely successful, and the population during mid-January may be put with some confidence at between 23,000 and 25,000. This total is considerably greater than was expected, considering that two poor breeding years had passed since the population was estimated in 1960–61 at 'between 21,000 and 26,000' (13th Annual Report). It is virtually certain that the earlier estimate was too low. The discrepancy underlines the fact that the coverage of Continental wintering areas is still incomplete, notably in Germany. The greater success of counts during 1962–63 must largely be due to the hard weather driving Brent out of areas where they normally escape observation, into regions well covered by counters. Nevertheless, mortality between February 1961 and January 1963 was low, probably reflecting the lower mortality of the adults which formed the bulk of the population over this period.

The counts made in various areas during 1963–64, though less comprehensive, give a general picture of numbers maintained, but not increased. Since the proportion of young was about 35% during this winter, higher total figures might have been expected. The hard weather of the preceding winter may have been partly responsible for the failure to increase. However, reports from all areas make it obvious that Brent fared much better than most wildfowl during the hard weather. For the most part, an alteration of normal feeding behaviour was the principal effect, and even the number of strays reported from unusual areas was no more than in most winters.

The results of age-group counts since 1954–55 are summarised in the table below. Figures from 1954–55 to 1957–58 refer to Essex only while those from 1958–59 onwards are based on results from several areas.

Season	*Proportion of young birds in Dark-bellied population*	*in Irish Pale-bellied population*
1954–55	40%	?
1955–56	26%	?
1956–57	7%	?
1957–58	53%	?
1958–59	hardly any	?
1959–60	20%	?
1960–61	50%	39%
1961–62	7%	none
1962–63	5%	39%
1963–64	35%	33%

Pale-bellied Brent Goose *Branta b. hrota* in Ireland

Details of Brent observations in Ireland have been collated by Major R. F. Ruttledge.

By contrast with Dark-bellied Brent, the Irish Pale-bellied birds evidently had a good summer in 1962. Counts of the proportion of young in the flocks at several different wintering areas made by D. Cabot, T. R. E. Devlin, F. King and Major R. F. Ruttledge, gave a total of 256 first-winter birds out of 659, or approximately 39%. Counts of total numbers were drastically disrupted by weather conditions, but it appeared that numbers were in fact rather higher than in the previous year, especially in Counties Kerry and Wexford.

During 1963–64, counts in the same areas by A. C. Baird, D. Cabot and Major Ruttledge totalled 1,138, of which 371 (33%) were birds of the year.

Acknowledgements

All the observers above, and many others, have helped to make this report on Brent population the most comprehensive achieved. Their labours during two winters, one of Arctic severity, deserve the warmest thanks and congratulations.

Birds at Borough Fen Decoy, 1964

W. A. COOK

This is an account of observations on birds at Borough Fen Decoy from January to December 1964. More of the available time was spent on counts and nest records than on ringing, so that it is rather surprising that the total of 1,480 birds marked (Table I) is the highest since ringing started in 1960. This may be due to the higher number of pulli (439) ringed. Recoveries reported in 1964 are listed in Table II. A Bullfinch trapped on 12th January, 1964, had been ringed at Cleethorpes, Lincs., 62 miles north, on 18th November, 1963.

The weather in January was as open and mild as 1963 had been cold. Only one small flock of 16 Pinkfeet fed near the Decoy, on 16th. Three Bramblings were seen from 22nd to 27th. Fieldfares never reached double figures and Redwings were irregular, with a maximum of 7 on 10th.

February showed little difference in the general pattern except for an influx of 25 Yellowhammers in the last week. Two Garganey appeared on the pond for one day only in March. Fieldfares were more plentiful towards the middle of the month, 75 on 17th dropping to 15 by 31st. Eyes and ears were cocked for the first warbler which did not oblige until 12th April, when three Chiff-chaffs were seen and heard in the wood. These were followed by Willow Warblers on 13th, Blackcap the next day and Whitethroat on 21st. A new species for the Decoy, a Grasshopper Warbler, was seen on 26th and 27th April. Another first for the Decoy was a Buzzard on 15th April. On this same day 30 Redwings settled in the top of an oak and stayed for about an hour. The last recorded Fieldfares were three on 19th. Swallows were late (28th), Cuckoo average (20th), and Turtle Doves early (20th). Swifts on 30th April were followed by Spotted Flycatchers on 12th May.

Most of the summer migrants had left by mid-September, latest dates being Sedge Warbler 3rd, Whitethroat 18th, Willow Warbler/Chiff-chaff 24th. Stragglers into October were three Blackcaps and five Reed Warblers on 5th. A very late Turtle Dove was seen on 9th. Long-tailed Tits made a welcome re-appearance on 18th September, a small flock of five being the first since December 1962. This built

Table I. Birds other than Anatidae ringed at Borough Fen Decoy in 1964

Species	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*total*
Moorhen	1		1				1	1	1	5	1	1	12
Wood Pigeon			2			2	3	4	2	10	4		27
Great Tit		1		2	11	1	9	3	2	4			33
Blue Tit	6		1	1			2	3	3	11	4	1	32
Song Thrush	2	8	8	22	31	10	15	6	4	14	8	1	129
Blackbird	4	18	43	11	53	15	10	16	17	50	27	5	269
Robin		1		1	1	6	3	2	2	3	1		20
Reed Warbler						6	2	1	1				10
Blackcap				4	6	2	12	9	6	1			40
Garden Warbler							3	6	3				12
Whitethroat				4	7	12	5	2	1				31
Spotted Flycatcher					2	7	1	4					14
Dunnock	1	7	4	17	6	8	13	10	5	6	6	1	84
Starling			5		5	3							13
Greenfinch	1		6	6	6	11	15	21	5	22	10		103
Goldfinch		4	3			24	27	21	1	2	6		86
Linnet		1	1	4	32	48	54	7		1	1		149
Bullfinch	1	1		2		3	4	2	5	8	7		33
Chaffinch	12	1	3	1	4		1	9	11	7	8		57
Reed Bunting		1	3	11			1		1	8			25
Tree Sparrow	8	11	8	36	15	38	20	12	8	31	35	1	223
19 others	2	10	8	3	2	11	6	15	7	5	6	1	76
Total	38	64	96	125	181	207	207	154	85	188	124	11	1480

Species of which less than 10 were ringed: Stock Dove 1, Turtle Dove 6, Cuckoo 1, Great Spotted Woodpecker 4, Swallow 9, Jackdaw 1, Willow Tit 5, Long-tailed Tit 4, Tree-creeper 2, Wren 4, Fieldfare 4, Redwing 9, Redstart 1, Sedge Warbler 9, Willow Warbler 8, Goldcrest 1, Brambling 1, Yellowhammer 5, House Sparrow 1.

Table II. Recoveries of birds other than ducks ringed at Borough Fen reported in 1964

	age	*date ringed*	*where found*	*date recovered*	*movement*
Moorhen					
AJ 32047	FG	21.11.61	Throckenholt, Crowland, Linds.	31.3.64	6m.W.
Moorhen					
AJ 32062	Juv	26.5.62	Elsham, Brigg, Lincs.	10.1.64	65m.N.
Wood Pigeon					
3080681	FG	25.1.63	Easton on the Hill, Northants.	23.3.64	10m.W.
3092555	1st W	1.4.63	Ickleton, Saffron Walden, Essex	14.11.64	80m.SSE
Turtle Dove					
2037512	Pull	6.7.61	Bouliac (Gironde) France 44°54′N, 0°30′W	7.9.64	
Swallow					
AK 87522	Juv	15.8.63	Maxey, Peterborough	27.4.64	5m.W
Blue Tit					
AK 87802	Juv	10.10.63	Moulton Marsh, Spalding, Lincs.	20.8.64	12m.NE
AH 25219	FG	4.5.64	Haxey, Epworth, Lincs.	2.12.64	62m.NNW
Redwing					
59128 R	FG	24.10.62	Legazpia, Spain 43°03′N. 2°20′W	13.1.63	
Blackbird					
67542 X	1st W	6.11.60	Dogsthorpe, Peterborough	20.1.64	5m. S
Linnet					
AK 87035	Pull	23.5.63	Malaga, Spain 36°43′N, 4°25′W	3.11.63	
AH 25032	FG	10.12.63	Elm Park, Romford, Essex	11.1.64	77m. SSE
Chaffinch					
AH25141	FG°	19.3.64	Kenilworth, Warwicks.	22.12.64	57m. WSW

Only recoveries more than five miles distant are listed. There were in addition 7 local recoveries, of 5 species, during the year.

Table III. Nests found in use in Borough Fen Decoy, 1964

species	*number of nests found*	*unsuccessful nests*			*successful nests*	
		deserted	*eggs lost*	*young lost or died*	*some reared*	*complete success*
Mallard	1		1			
Moorhen	4	1			1	2
Woodpigeon	15	6	1	2	1	5
Turtle Dove	8	2	1		2	3
Swallow	1					1
Great Tit	1					1
Blue Tit	2				1	1
Wren	3					3
Mistle Thrush	1		1			
Song Thrush	34	6	6	3	6	13
Blackbird	37	2	9	4	11	11
Reed Warbler	3					3
Sedge Warbler	1				1	
Blackcap	3			1	2	
Whitethroat	4			1	1	2
Dunnock	10	1	2	2	2	3
Spotted Flycatcher	2				2	
Starling	1					1
Greenfinch	15	1	2		4	8
Goldfinch	18		3	2	1	12
Linnet	74	5	10	14	20	25
Linnet/Cuckoo	1			1		
Bullfinch	1				1	
Chaffinch	1				1	
Tree Sparrow	35	1	2	7	15	10
Total	276	25	38	37	72	104

up to twelve by the end of 1964 which I hope will survive the winter and breed in 1965.

The first winter migrants were 15 Redwings on 1st October and ten Fieldfares on 18th. Peaks of about 60 and 70 respectively were reached by the end of the month, their numbers shrinking to less than ten through December.

The first of the 276 nests recorded (Table III) was a Moorhen with one egg on 25th March. This nest was in a tussock of *Juncus communis* that has provided the first Moorhen nest of the season for the past four years. Once again it was successful and the young had hatched and left the nest by 21st April. Many of the nest sites in the Decoy appear to be traditional and this may be one of the reasons for the increase of 170 records over 1963. This may also be interpreted as evidence of natural recovery after the winter of that year. A special note was made of nests containing partly hatched clutches, and details have been extracted for a Nature Conservancy inquiry into the possible effects of pesticides upon egg fertility. The Decoy was operated in July, a month earlier than usual, in order to learn about the dispersal of the Mallard present in summer. This resulted in many late warbler nests being missed. All flying warblers ringed were weighed and measured for a British Trust for Ornithology inquiry. Blackcaps topped the list with 52 individual records, 40 newly-ringed and 12 re-traps.

The assessment by grazing trial of goose damage to grass

JANET KEAR

Grazing trials using captive geese form an important part of the study into the interaction of wild geese and agriculture which is being carried out by the Wildfowl Trust. Experiments have involved mainly winter- and spring-sown cereals (Kear, 1965) since it was the possibility of damage to these crops which most interested the farming community. Grassland trials, in which some of the effects of goose grazing were simulated by clipping plots with garden shears (Kear and Rodger, 1963), indicated that close clipping has no effect on silage yield provided that it is not continued beyond the end of March. Thus it seemed that some loss of herbage during the winter was unimportant. However, a number of farmers' complaints concerned the *early* grazing of undersown grass soon after harvest when it was claimed that the geese rather than grazing actually pulled up the grass by the roots. During early October 1963, therefore, a grazing trial using a captive flock of Pinkfeet and Greylag Geese was run on a young ley at Rosemaund Experimental Husbandry Farm in Herefordshire.

The experiment was set up so that the trial contained one grazing treatment and one control and was replicated three times. The procedure was that given in Kear (1965): the randomly arranged plots measured 8·5 feet (13 drill rows) × 30 feet, or 1/171 of an acre. From field observations it appears that 9,000 goose-hours on the same acre is maximal in any season and a goose usage rather greater than this was therefore the aim in the experimental situation. Ten geese were penned for 6½ hours on each plot, giving the equivalent of about 11,000 goose-hours per acre. Grazing started at 8.45 a.m. and after removal from the experimental plots, the geese were kept overnight in a shed with adequate water for washing. Water for drinking only was provided during the grazing period.

Table I. Yield of grass and clover field grazed by geese in October

	Green weight (lbs.)		*Dry Matter (%)*	
	Grazed	*Control*	*Grazed*	*Control*
October 5th	49	30	18·5	17·7
6th	37	40	19·5	18·1
7th	33	38	15·5	17·7
Average	40	36	17·8	17·8

The spring barley was drilled on 4th April, 1964, undersown with a grass and clover mixture* on 15th May and harvested on 6th September. Grazing covered the period 5th–7th October and on the first and last grazing days there was rain. The geese obviously found the grass palatable, but only the slightest 'damage' by trampling could be seen on the wet days. Uprooted plants scattered on the surface, or patches of bare earth from which plants might have been pulled, were entirely absent at the end of each grazing period. Table I gives the yields of the plots on 22nd May, 1964, and shows that no statistical difference could be found between the harvests from the grazed and control areas. Thus it appears that, even with very high grazing

usage, geese need cause no damage to young grass in early autumn.

It is a pleasure to thank the staff of the Rosemaund Experimental Husbandry Farm at Preston Wynne, Hereford, for their assistance in the running of this trial.

* 5 lb. 2 23 Ryegrass (perennial)
5 lb. S 24 „ „
5 lb. S 101 „ „
4 lb. S 48 Timothy
4 lb. S 215 Meadow Fescue
2 lb. S 123 Red Clover
1 lb. S 100 White Clover

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The reaction of captive Mallard to grain treated with a commercial bird repellent

JANET KEAR

Wildfowl predation presents a very minor problem to agriculture as a whole in Britain, and only at certain times and in certain places does it become necessary to limit their activities (Kear, 1963). It is recognised that the application of a substance to a crop which will render it unattractive but not kill would be very advantageous, but the study of chemical protection against birds is still in its early stages. A variety of substances relying on the sense of taste, smell, touch or pain has been tried unsuccessfully with ducks in America (Neff and Meanley, 1956); whole barely soaked in gum turpentine and in kerosene was completely eaten and the commercial American repellent Pestex, dusted on to the grain, did not even slow down the birds' feeding rate. However, Neff and Meanley (1957) and Neff, Meanley and Brunton (1957) claimed consistent success against grackles, cowbirds, redwings and other birds when anthraquinone was used at heavy levels. Later, Duncan (1963) reported the reactions of feral pigeons to seven active ingredients of commercial repellents in solution. All solutions, with the exception of anthraquinone, produced a significant reduction of fluid intake and β-naphthol was markedly rejected. Duncan pointed out that, although insoluble anthraquinone showed no repellent action when tested in this way, this does not mean that it is valueless when used as a powder. Anthraquinone (a harmless, yellow crystalline ketone, $C_6H_4(CO)_2C_6H_4$) is in fact a basic ingredient of a German-made bird repellent marketed in Britain as Morkit. At the Wildfowl Trust, a few preliminary tests have been made in which four caged hand-reared Mallard were offered grain treated with Morkit.

Methods

Wheat grain was selected for testing because it is known to be preferred to other cereals by both tame and wild-caught Mallard over short periods (Kear, unpublished data). The birds were kept in pairs (a male and a female together) in separate cages and fed on a mixed diet of wheat, rusks and commercial poultry crumbs, with water and grit always available. In their daily test regime, the ducks had a dish of mixed food over night and for part of the day, but for six daylight hours they were offered only wheat grain. For a preliminary period, this grain was untreated, and for the following two weeks the birds had a choice of treated and untreated grain from two similar containers, the position of which was altered at random. For the next two weeks they were offered only treated grain in both dishes and during the final fortnight they returned to the choice situation. The treated sample was prepared by mixing 10 kilos of wheat with 1 pint of Morkit 'solution', made up as directed on the packet (about 1·7 gms dry weight of Morkit to 10 kilos of wheat). This amount of liquid effectively wetted the surface of each grain, which was subsequently dried in warm air. The control wheat sample was moistened with one pint of tap water per ten kilos and also dried.

Results

During the first two weeks of the test the ducks consumed on average 15·7 gms per bird per trial period, and of this only 25·2 per cent during the first week and 23·6 per cent during the second week was of the treated wheat grain. During the third and fourth weeks, when only treated grain was available, the birds reduced their intake and consumed on average 5·9 gms and 4·6

gms respectively per bird per trial period. In the last two weeks the Mallard took on average 13·3 gms per bird per test period, and 7·9 per cent during the fifth week and only 3·1 per cent during the sixth week was of the grain treated with Morkit.

Discussion

It appears from these few experiments that Morkit, even at low concentrations, will repel ducks that are not particularly hungry. What it is that the birds dislike about anthraquinone is uncertain. To humans it is tasteless, though producing a rather odd sensation in the mouth as an after effect. It must be pointed out that caged birds normally prefer uncontaminated food with which they are familiar whatever the contaminant (Neff *et al.*, 1957), and a true repellent must satisfy two paramount requirements: it must repel even hungry birds, while not being toxic to plants nor harmful to structures (Duncan, Wright and Ridpath, 1960). With wildfowl, however, the problem is often not to remove the birds altogether but to persuade them to feed in places where the damage they can do is negligible. Subsequent, more important trials will assess the value of anthraquinone when sprayed on to selected areas of grass in an effort to control the grazing of geese and swans.

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Wader ringing by the Wildfowl Trust, 1959-64

M. A. OGILVIE

In August 1959, the Wildfowl Trust's rocket-netting equipment was successfully used to catch waders on the south shore of the Wash. The initiative for this operation came from Dr. C. D. T. Minton and other ringers under the collective name of the Wash Wader Ringing Group. Although the rocket-nets were designed for catching geese and had, apart from occasional sorties after ducks, been used exclusively for this purpose, the equipment required no modification in kind for wader-netting. The greatest single obstacle to catching waders with nets thrown over them, as opposed to flight-netting, is finding suitably hard ground, frequented by the birds and preferably not ever covered by the tide, on which to place the nets. The topography of the Wash with its areas of salting and mud in front of the sea-wall and large fields behind provided the answer. During normal high tides the waders are driven off the mud-flats, over which they feed, on to the saltings. Here they roost until the water has receded. During periods of spring tides, however, the saltings are generally completely covered and the birds then fly over the sea-wall and roost in large, compact flocks on suitable fields, usually choosing ploughed land or fields with very short vegetation. It was this habit that was first observed and then taken advantage of by the Wash Wader Ringing Group using the rocket-nets. The catching was all done in daylight, the tides sometimes giving us two chances in a day, more often just one.

In each of the five years 1959–1963 catching operations were carried out for one or two periods of a week, between July and September. At this time of year relatively few suitable fields were available as roosting sites, making the choice of where to set the nets a little less difficult. The technique improved with experience but a number of important discoveries were made early on. Unlike geese, many waders do not lie quietly when caught by the net and it was necessary to cover every bird with blackout material immediately after firing the nets. This done, the birds were extracted and placed in the hessian keeping cages. Here they sat quietly until ringed and released. It was learnt very soon that two rocket-nets of ¼ acre each cover very little of a field which may be up to 110 acres in area. However if, as not infre-

Table I. Ringing totals and recoveries of waders caught on the Wash 1959–1963

species	Total ringed	Recovered total	Recovered rate %	RECOVERIES abroad	Britain outside Wash	local dead	local recaps
Oyster-catcher	207	7	3·38	1	1	2	3
Grey Plover	417	3	0·72	1		2	
Turnstone	302	3	0·99			1	2
Curlew	235	24	10·20	2	2	19	1
Bar-tailed Godwit	72	2	2·78			2	
Redshank	934	31	3·32	2	13	16	
Knot	3157	29	0·92	7	10	5	7
Dunlin	7560	38	0·50	22	3	3	10
other species*	32	–	–				
Total	12916	137	1·06	35	29	50	23

* Also ringed, no recoveries:— Ringed Plover 2; Golden Plover 1; Whimbrel 1; Black-tailed Godwit 7; Curlew Sandpiper 7; Sanderling 14.

quently happened, the waders landed outside the catching area, it was possible to move the flock either all together or bit by bit in the desired direction by driving them very gently with a slow-moving vehicle or sometimes a single person on foot. Mounted decoys were used, as in goose-netting, to attract the birds to the catching area by the nets. The best possible decoys, again as in goose-catching, were small flocks of birds landing in the catching area before the main flight over the sea-wall began. During the late summer and early autumn the numbers of waders in the Wash are quite high; not infrequently 5–10,000 waders roost in a single close-packed flock on one field, and there may be three such flocks roosting along the 15-mile south shore of the Wash. As in every type of catching operation, failures or part-failures always tend to predominate, so that the totals caught in one throw of the nets range from under 100 (often) to 2,200 (once). Only very occasionally were both nets fired at once, the almost invariable practice with geese, because it was thought possible that between them the two nets might one day catch more birds than could be safely and conveniently managed. A large team of ringers, skilled in handling and ringing birds with care and speed, was always present and with even the largest catch was not overwhelmed by the numbers involved.

As Table I shows, Dunlin were caught in much greater numbers than any other species, because they were most plentiful as well as being the easiest to catch. Other species were not so tolerant of being moved around a field, and, as one of the smallest species, the Dunlin were the first to be affected by the rising tides so there was always a longer period and more days when they came over the sea-wall to roost. At the other extreme, Curlews and Godwits were only driven off the saltings for perhaps the three or four highest tides in a week and for one or two hours each time instead of four or five. Efforts, not always successful, were directed, especially in the last two years, towards catching species other than Dunlin. Ringing large numbers of Dunlin just because it was possible to do so was placed second to deliberate attempts to catch Knot, Bar-tailed Godwit and Curlew, three species which have not been ringed on quite the massive scale that the Scandinavians in particular have marked Dunlin. Only Knot were caught in large numbers, with smaller though useful catches of Oystercatcher, Grey Plover, Turnstone, Curlew and Redshank.

Results from ringing

Set beside the expected reporting of 15–25% of ducks and geese ringed, the recovery percentage of waders is low (1%). Even among the species that may legally be shot in most of the countries they visit, returns are meagre. Table II records all the recoveries so far reported outside the British Isles.

Oystercatcher

The single overseas recovery is the second British-ringed Oystercatcher to reach Morocco. It is known from other ringing (Buxton, 1957) that there is a regular migration from Britain down the west coast of France into northern Spain with a few birds reaching Portugal, south Spain and the north coast of Africa.

Three Oystercatchers marked on the Wash in early August have been recaught breeding there in subsequent years.

Grey Plover

So far the ringing in 1963 of 383 of this species, rather more than three times the

number previously marked in Britain, has provided a single recovery in Morocco, the only one away from the Wash. This bird fits in well with the pattern of recoveries from over 500 Grey Plover ringed in Denmark and Norway. These birds, breeding it is thought in Siberia, migrate through western France to Africa, one bird reaching 6°N by early October (Nørrevang, 1959).

Turnstone

There have been just three local recoveries of Turnstone, two of them a year after marking. Other ringing has shown (Nørrevang, 1959) that the breeding populations from Greenland and Ellesmere Island and from northern Scandinavia and Russia migrate to western Europe and south to west Africa.

Curlew

The two foreign recoveries confirm the continental origin of Curlew wintering in Britain. A single recovery on the Severn estuary is possibly an example of the known onward passage of some birds through England, some going to Ireland, others to western France. Over half the local recoveries were in years subsequent to that of ringing, indicating a strong attachment to winter-quarters.

Bar-tailed Godwit

The two recoveries are both local, one and two years respectively after ringing. From European ringing, the origin of the wintering birds in Britain is northern Eurasia (Nørrevang, 1959).

Redshank

Ogilvie (1963), using recoveries of British-ringed Redshank notified to the end of 1962, concluded that, while the local breeding stock moves south and west in autumn, the wintering population in Britain, comprised largely of birds from Iceland, is fairly sedentary throughout the winter months. The exceptionally severe weather during the early part of 1963 caused many birds to leave Britain and decimated those that remained. Pilcher (1964), writing about the effects of the cold on the north coast of the Wash, lists 144 corpses of Redshank found in one week at the end of February. 14 recoveries were reported during the cold spell including one in France and seven others over 50 miles from the Wash. In the autumn of 1963, Redshank were still very scarce on

Table II. Overseas recoveries of waders caught on the Wash 1959–1963

Ring number	*date ringed*	*age*	*cause of death*	*recovery locality*	*recovery date*
Oystercatcher					
AT 83155	17.8.62	Fg	shot	Near Bouznika, Morocco (33°49′N, 7°10′W)	16.12.62
Grey Plover					
DS 14153	6.9.63	Ad	caught	El Merja region, Kenitra, Morocco (34°25′N 6°30′W)	14.3.64
Curlew					
AT 83036	28.8.61	Ad	shot	Højer, Jutland, Denmark (54°58′N, 8°48′E)	3.8.64
AT 83042	28.8.61	Ad	found dead	Söderveckoski, Borgå, Usuimaa, Finland (60°23′N, 25°25′E)	6.7.64
Redshank					
P 10005	18.8.59	Ad	killed	St. Martin de Brehal, near Coutances, Manche, France (49°03′N, 1°27′W)	13.1.63
P 19404	29.8.61	Juv	killed	St. Marie du Mont, Manche, France (49°22′N, 1°14′W)	21.11.61
Knot					
734282	17.8.62	Juv	shot	Crown Prince Island, Disco Bay, Godshavn, West Greenland (69°00′N, 53°20′W)	8.6.64
734389	3.9.63	Juv	? dead	Igdlerssuit, Umanak, West Greenland, (71°15′N, 53°25′W)	28.6.64
CX 25424	3.9.63	Juv	caught & killed	Bomi Hills, Liberia (6°55′N, 10°55′W)	11.9.63
CX 25719	3.9.63	Juv	killed	Lake Malika, 20 kms from Dakar, Sénégal (14°38′N, 17°27′W)	29.9.63
CX 26635	6.9.63	Juv	killed	M'Boro, near Thies, Sénégal 14°49′N, 16°52′W)	25.9.63
CX 26864	6.9.63	Juv	killed	M'Boro, near Thies, Sénégal (14°49′N, 16°52′W)	25.9.63
CX 27680	6.9.63	Juv	killed	Lake Tamna, near Kayar, Sénégal (14°53′N, 17°24′W)	13.10.63

Table II. Overseas recoveries of waders caught on the Wash 1959-1963-*continued*

Ring number	*date ringed*	*age*	*cause of death*	*recovery locality*	*recovery date*
Dunlin					
624034	18.8.59	Ad	shot	Near Holbaek, Sjaelland, Denmark (55°43′N, 11°44′E)	20.8.61
624167	18.8.59	1stw	killed	Baie de Goulven, near Plouneour, Finistère, France (48°38′N, 4°19′W)	31.7.62
624803	18.8.59	Ad	shot	Rammu Island, Harju, Estonian S.S.R. (59°35′N, 25°13′E)	10.8.61
627010	9.8.60	Ad	? dead	North shore of Ringkobing Fjord, Jutland, Denmark (56°05′N, 8°15′E)	0.8.61
627372	11.8.60	Ad	found dead or killed	Octeville, Seine Maritime, France (49°33′N, 0°07′E)	25/29.3.62
627403	11.8.60	Ad	shot	Vallensbaek, near Taastrup, Sjaelland, Denmark (55°36′N, 12°23′E)	15.8.61
622747	26.8.60	Ad	controlled	Amager, Copenhagen, Sjaelland, Denmark (55°38′N, 12°34′E)	18.8.61
622908	26.8.60	Ad	killed	Póvoa de Santa Iria, near Loures, Estremadura, Portugal (38°50′N, 9°10′W)	c.1.2.62
61309 S	25.8.61	Ad	caught & killed	Santa Iria, near Loures, Estremadura, Portugal (38°51′N, 9°05′W)	c.25.12.62
61556 S	29.8.61	Ad	found dead	Manslagt, near Emden, Niedersachsen, Germany (53°23′N, 7°08′E)	16.6.62
61661 S	29.8.61	Juv	killed	Near Severodvinsk, Arkhangel, U.S.S.R. (64°32′N, 39°55′E)	19.5.63
639521	17.8.62	Ad	controlled	Skanör, Skåne, Sweden (55°25′N, 16°24′E)	23/25.7.64
639488	19.8.62	Juv	killed	Audenge, Gironde, France 44°40′N, 1°01′W)	21.9.62
BA 48030	7.8.63	Ad	killed	Puerto Real, Cadiz, Spain (36°32′N, 6°11′W)	c.23.2.65
BA 48517	7.8.63	Ad	killed	Figueira da Fez, Beira Litoral, Portugal (40°09′N, 8°51′W)	22.9.63
BA 4813–	4/5.9.63	Fg	found dead	Grève de l'Epois, Baie de Bourgneuf, Vendèe, France (47°02′N, 2°00′W)	12.5.64
BA 49788	6.9.63	Ad	killed	Baie de Mont-St.-Michel, Ille et Vilaine, France (48°38′N, 1°30′W)	15.3.64
BA 49822	7.9.63	Ad	controlled	Aflandshage, Amager, Sjaelland, Denmark (55°33′N, 12°36′E)	6.8.64
BA 4989–	7.9.63	Ad	shot	Figuiera da Foz, Beira Litoral, Portugal (40°09′N, 8°51′W)	23.9.63
BA 50034	7.9.63	Ad	controlled	Amager, Sjaelland, Denmark (59°38′N, 12°34′E)	9.8.64
BA 50046	7.9.63	Juv	killed	Baie de l'Aiguillon, Vendée, France (46°18′N, 1°15′W)	11.11.63

the Wash and only 12 were caught compared with the previous four years' total of over 900.

Knot

The breeding distribution of this species described by Kozlova (1962) is both widespread yet discontinuous, with colonies on Victoria Island, Melville Island and Ellesmere Island in Northern Canada; northwest, north and east Greenland; probably some in Spitsbergen; and the Taymyr Peninsula and Novosibirskiye Islands in Asian Russia. Wintering is recorded from the Caribbean, the west and east coasts of South America; western Europe, equatorial West Africa, and Angola; the west and east coasts of Australia, and New Zealand.

From ringing in Scandinavia, where over 3,000 have been marked, Nørrevang (1959) showed that birds from Arctic Canada and Greenland, and from Siberia, come to western Europe, with many passing through on their way to Africa. The capture of 2,000 Knot on the Wash in September 1963 has produced as yet very few, but very spectacular recoveries, especially those from West Africa showing an extremely rapid onward passage. In just eight days, one bird was killed in Liberia, 3,300 miles to the south. Other recoveries were reported from Sénégal, two within three weeks of ringing and two more before five weeks had passed. All these were juveniles that had already travelled considerable distances from wherever they were bred. The only evidence as to the origin of the Knot ringed on the Wash comes from two recoveries in west Greenland. There is a definite movement through Britain to

Ireland, possibly of birds of a different stock. Others winter in the Wash, as shown by nine local recoveries and recaptures in the same season of ringing.

Dunlin

As mentioned above, this was the easiest bird to catch and, although efforts were made to catch other birds instead, more Dunlin were caught each year than any other species. The total of 7,500 ringed is less than half the number marked in Scandinavia since the war. Ogilvie (1963), using recoveries notified to the end of 1962, showed that winter visitors to this country come from Scandinavia and Russia, and also from Iceland with a certain amount of autumn passage through Britain of both stocks to areas further south. The recoveries since then have not altered this picture. From recaptures and recoveries it is known that Dunlin arriving on the Wash as early as mid-July may stay there the whole winter, whilst passage-migrants continue to pass through for a further two months or more. Over 200 Dunlin have been recaught in subsequent seasons and these have shown that there is a marked tendency for birds to return not only to the Wash itself, but to a particular part of the coast. The main catches of Dunlin have been made in two areas either side of the mouth of the River Nene, only seven miles apart, but the number of birds recorded as moving from one roost to the other even after three or four years is less than one-sixth the number recaught at the ringing place. Such strong attachment to discrete areas away from a nesting place had not previously been met with in waders, though well known in wildfowl.

Age-ratios, moult, weights and measurements

Whilst it was always the aim to extricate, ring and release the birds caught as expeditiously as possible, the opportunity was taken to examine as many as was practicable and to collect such information as the age, state of wing-moult, weight and various measurements. With a small catch and plenty of people every bird could be examined in this way, but only a sample could be taken of the larger catches. The age and state of primary-moult was comparatively simple and quick to record at the same time as ringing each bird and consequently more data of this kind were gathered than from the more detailed and time-consuming weighing and measuring. Because the timing of the catching trips each year depended on the spring tide periods, the dates varied widely and direct comparisons from year to year are invalid. However, a much greater advantage is gained by having records over five years covering the whole of the period from mid-July to early September. Thus it has been possible to study the variation of age-ratio with date, and the timing and speed of the wing-moult. Full results of this work are being written up and will be published elsewhere in the near future.

Foreign-ringed birds caught on the Wash

Many Dunlin ringed on passage in Scandinavia have been recaptured each year by the rocket-nets at the Wash. They were marked in Finland (2), Sweden (25), Norway (7), Denmark (5), Heligoland (1). Two others ringed in May in eastern Finland and in June on the Great Ainov Islands in the White Sea were probably breeding birds.

A single Turnstone ringed on passage in south Norway was caught at the Wash in September 1963.

Other wader-ringing undertaken with the Trust's rocket-nets

The Dee, Cheshire

In September 1961 a Trust team joined with Dr. E. White of Liverpool University in an attempt to catch Oystercatchers on the Dee estuary. A single catch of 151 was made on the Welsh side of the Dee, after several frustrations and disappointments on the islands off the north shore. Dr. White subsequently developed his own equipment and is studying the waders of the area. The Oystercatcher has now become the subject of an intensive study by the Ministry of Agriculture, Fisheries and Food who are using their own design of cannon-nets.

Vlieland, Holland

A Wildfowl Trust rocket-netting team visited Vlieland from 3rd to 11th September, 1964, at the invitation of Dr. A. C. Perdeck, Director of the Vogeltrekstation, a division of the Instituut voor Oecologisch Onderzoek, Arnhem, to discover whether the equipment could be used successfully to catch some of the very large numbers of waders frequenting the island in late summer and autumn. Members of the W.W.R.G. also took part, together with members of the staff of the Vogeltrekstation and representatives from Germany and Belgium. Catching operations began on 4th when a net was set by a small freshwater stream crossing mud-flats visited by many Shelducks in order to drink. A catch of 61 was quickly made. A second catch of 31 was made on 7th, when the ducks were noticeably more wary.

Table III. Birds caught on Vlieland, September 1964

Species	*Total*	*Species*	*Total*
Shelduck	95	Greenshank	2
Oystercatcher	2	Knot	2
Ringed Plover	5	Purple Sandpiper	1
Kentish Plover	1	Dunlin	81
Turnstone	349	Curlew Sandpiper	1
Redshank	486	Common Gull	15
Spotted Redshank	1	Black-headed Gull	111
		total catch	1152

The first catch reassured us that the equipment could be used in very wet conditions, the rockets firing well despite immersion in sea-water. Thus, in the absence of any promising assembly of resting waders on dry land, it was decided to set both nets on a sandy shore close to high-water mark for a catch on the morning tide of 5th. In the event, the tide covered the nets as well as the rockets with over 6 inches of water and no large concentration of waders in the catching area was achieved, despite great activity as the tide began to ebb. The nets were not seriously displaced by the tide. A catch of 89 was made in one net, nearly all Dunlin. Attempts on the succeeding days to move the large numbers of Knot, Dunlin and Bar-tailed Godwit in this area confirmed that they were not prepared to sit on dry land at high water, which was essential before they could be caught.

From 5th onwards the evening tides were too late for catches to be made before dark. For the morning of 6th the nets were set on the sand flats of the Vliehors, an area used by several thousand Oystercatchers. The shore there is so gently shelving that accurate prediction is very difficult, if not impossible: the tide rose higher than expected, the nets were carried over the rockets and pieces of driftwood also settled across the nets, so that they could not be fired. Continued attempts to drive Oystercatchers into the catching area failed. For the tide of 7th the nets were moved up the sand flats to a point most unlikely to be inundated. It was necessary to move the Oystercatchers a long distance to bring them into the catching area. This was achieved very successfully by herding them in front of the Land Rover, Oystercatchers being exceptionally willing to walk or run and unwilling to fly during their long high-water resting period. Unfortunately, just as the first birds had entered the catching area, a low-flying aircraft proved too great an additional stimulus. A small catch of gulls was inadequate compensation for what had promised to be a notable haul of waders. The Vliehors could not be used after 7th because of the resumption of target-practice by tanks, which caused the birds to leave.

On 8th one net was set in a small grass field being used as a roost by gulls and a few Oystercatchers and the second net was set in a very small field very close to the village of Oost-Vlieland. The first field proved useless, perhaps because the earliest-arriving birds found setting in progress, but a catch of Turnstones and gulls was made near the village.

The only dry site remaining to be exploited was a large Curlew roost on dunes inland. This posed considerable problems in setting, because it was hard to find space to set both nets and impossible to see the area adequately from a safe distance. On the afternoon of 8th the nets were set in a T-shape, with a firing-point within 40 yards of and almost in line with the end rocket of the nearer net. Much time was spent in covering the nets, which remained uncomfortably conspicuous for such wary birds as Curlew. On the morning of 9th several thousand Curlew and Bar-tailed Godwit settled in the vicinity, but fewer than a hundred sat in the catching area and no build-up could be achieved, despite many efforts at moving the birds. The nets were removed and set in a wet field close to the team's base at Het Posthuis which had come belatedly into favour with waders, especially Redshanks, and gulls. The nets were set in tandem to fire down-wind and disguised. A catch of nearly 800 birds was made in one net.

This international exercise was extremely stimulating to everyone who took part. We are most grateful to Dr. A. C. Perdeck for bringing it about, for securing financial support and for his generous and successful arrangements for the visitors. It is perhaps not invidious to express particular satisfaction at the presence of J. P. van de Weghe, of Vogelringstation Braakman, and F. Gräfe, of Vogelwarte

Helgoland, not merely as representatives of Belgium and Germany but for contributing notably to such success as was achieved.

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Nests and eggs of Greylag Geese in Galloway

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Summary

Sixty eggs in 10 nests of Greylag Geese in Galloway in 1964 were measured. Their dimensions (average length 84·5 mm., breadth 59·2 mm.) were similar to those published for other British eggs which tend to be smaller than eggs from continental Europe. All 10 nests were successful, though 5 eggs failed to hatch. In a second group of nests, 6 out of 8 clutches were successful. At least 42 goslings were reared in the first group and 28 in the second. The sites and dimensions of the nests are described.

Introduction

In recent years Greylag Geese *Anser anser* have been increasing and spreading as breeding birds in south-west Scotland. The increase is probably due largely, though perhaps not wholly, to 'overspill' from the flourishing feral colony on the estate of the Earl of Stair near Stranraer, Wigtownshire. The study area, a loch and its environs, was first used by a single pair in 1951. In 1952 seven adults and five goslings were seen on 29th June. In 1953 31 geese were counted, of which only ten or twelve were adults. In 1957 there were 20 adults with seven broods. The breeding stock does not seem to have increased beyond this point, ten nests having been found in 1963 and again in 1964. The area is also used as a moulting place, counts of over 150 geese in early June being not uncommon.

This paper is concerned with the ten nests of 1964, with the dimensions of the 60 eggs they contained, and with the success of this and another group of nests elsewhere in Galloway.

Nests

All the nests were built on islands. They were built on the ground, of large twigs, withered grasses and moss, and contained considerable amounts of down. In two nests examined twig by twig on different islands there was no evidence of material having been carried to the nest. Most of the nests were near the water's edge. Five were at the bases of large trees, three beside large rocks, two in dense secondary growth and one on open ground. In a group of four on one island, the nearest nests were six feet apart and the furthest forty-five feet. The average diameter of the nests was 26 inches, with a rim of $3\frac{3}{4}$ inches and a cup $2\frac{1}{4}$ inches deep.

Clutch-size

Three single eggs were found deposited in positions where there was obviously no nest. The clutches in the ten nests were distributed as follows:

clutch-size	4	5	6	7	9
number of clutches	2	2	2	3	1

The mean clutch-size, excluding the single eggs, was 6·0. This is rather larger than would be expected from the note by F. C. R. Jourdain (in Witherby, Jourdain, Ticehurst and Tucker, *The Handbook of British Birds*, III, 1939) 'Eggs:—Number variable; usually 4 to 6, occasionally 7 or 3 only, rarely 8'. Two pure white eggs were seen in different clutches, in which the rest of the eggs were stained. The white eggs hatched at the same time as the other eggs so must presumably have been incubated for the same period.

Hatching success

All the nests were successful in producing young. 55 of the 60 eggs (91·7%) hatched, the five that failed to do so occurring in five different nests. The clutch of nine in nest VI all hatched and a brood of nine was later seen on the loch.

There were eight nests in another group in Galloway. These were not studied in detail but it is known that two clutches failed to hatch, at least one being deserted.

Fledging success

The exact number of goslings that lived to fly is not known but in the principal study at least 42 were still alive on 28th June. On the same day there were at least 28 survivors from the six successful nests in the second group.

Eggs

The eggs were measured on 25th April, ten days before the peak of hatching. The linear measurements are summarised in Tables I and II. The mean length and breadth agree very closely with those of the collection of British eggs measured by Jourdain (Witherby, *et al.*, 1939). From published data it seems as if British eggs tend to be smaller than those found in Europe but indistinguishable from those collected in Iceland.

The egg weights are summarised in Table II. Eggs with well-incubated embryos weigh substantially less than those of freshly-laid eggs. It seems likely that much of the relatively large differences in egg weights between clutches can be attributed to differences in the elapsed times of incubation, rather than to differences in egg volume.

Moult

A total of 286 birds moulted in these two areas, 75 on the main study and 211 at the second locality.

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Table I. Length and breadth of Greylag eggs from Galloway compared with those from elsewhere

locality	*number of eggs*	*length (mm)* *mean*	*range*	*breadth (mm)* *mean*	*range*	*source*
Galloway	60	84·5	78–92	59·2	54–64	
other British	100	85·32	77·0–94·4	58·04	49·5–62·5	(1)
Iceland	18+	84·9	76–92	58·7	53–63	(2, 3)
Norway	?		80–92	58 mode	53–62	(3)
Denmark	29	90·7	85–95	61·1	57–64	(3)
Russia	51	88·2	79·5–95·5	60·3	53·5–68·5	(4)

Sources:

(1) F. C. R. Jourdain, in Witherby *et al.*, 1939.
(2) G. Timmermann, 1938, *Die Vögel Islands*; P. Nielsen, 1919, *Ornith Tids.* 13: 33–79.
(3) E. L. Schiøler, 1925, *Danmarks Fugle*, I.
(4) S. Alpheraky, 1905, *The Geese of Europe and Asia.*

Table II. Differences between clutches in the dimensions and weights of Greylag eggs

nest	*no. of eggs*	*mean length mm*	*mean breadth mm*	*mean weight gm*
I	7	87·3	60·7	145·9
II	7	84·4	57·1	148·7
III	6	80·8	60·3	133·0
IV	6	83·8	58·8	147·7
V	5	84·4	55·6	149·6
VI	9	84·1	57·8	147·6
VII	4	86·0	62·3	168·5
VIII	7	87·9	60·7	161·0
IX	5	84·2	59·4	153·6
X	4	81·8	59·5	133·0
Total	60	84·5	59·2	148·9

range of individual egg weights 122–172 gms.

Organic chlorine insecticide residues in Goosanders and Red-breasted Mergansers

C. H. WALKER and D. H. MILLS

Summary

Appreciable quantities of residues of organic chlorine insecticides or their metabolites were found in eleven Goosanders and nine Red-breasted Mergansers collected in Scotland from March to July, 1964. The levels of contamination with dieldrin, which is very toxic to birds, were in most cases low compared with those reported in other birds feeding on freshwater fish in other areas of Britain.

Introduction

Organic chlorine insecticide residues were shown by Moore and Walker (1964) to be present in two fish-eating birds, the Heron *Ardea cinerea* and the Great Crested Grebe *Podiceps cristatus*. The average residue concentrations in the breast muscle of these two species were much higher than those occurring in birds of prey such as the Sparrow-Hawk *Accipiter nisus*, the Barn Owl *Tyto alba*, the Tawny Owl *Strix aluco* and the Little Owl *Athene noctua*. Because such high concentrations of residue were found in two fish-eating species it was decided to determine the concentrations present in two fish-eating ducks, the Goosander *Mergus merganser* and Red-breasted Merganser *M. serratus*.

Methods

Liver samples taken from eleven Goosanders and nine Red-breasted Mergansers were examined (by C. H. Walker) by gas-liquid chromatography (G.L.C.) as described by Goodwin, Goulden and Reynolds (1961) and de Faubert Maunder, Egan and Roburn (1964) and by paper chromatography (Evans, 1962). The extraction and clean-up for these techniques were similar to those described by de Faubert Maunder *et al.* (1964) except that a small layer of active charcoal (0·1g) was included in the alumina column when difficulty was experienced with pigmented material in the extracts. The G.L.C. results were obtained using a Perkin Elmer 452 gas chromatograph with an Apiezon column. Where the amounts of pesticide were large enough, paper chromatography was used to confirm the results obtained by G.L.C. Small amounts of pp¹DDT and pp¹TDE could not be measured, as breakdown of pp¹DDT (sometimes with formation of pp¹TDE) occurred on the Perkin Elmer instrument. Liver samples were taken in preference to breast muscle samples as higher levels of residues are usually found in the liver and it is becoming standard practice to use this organ in analysis of birds for organic chlorine insecticide residues.

Results and Discussion

The results of the analyses for organic chlorine insecticide residues in the liver are given in Table I. As in other species of bird (Moore and Walker, 1964), pp¹ DDE was the most common and abundant residue found. This compound is a metabolite of pp¹DDT and there is no evidence that it is biologically active to birds. On the other hand, dieldrin is very toxic to birds and Turtle *et al.* (1963) found 6·2 to 32·0 parts per million (p.p.m.) dieldrin to be present in the flesh of feral pigeons killed with this chemical. Dieldrin in avian tissues may come from insecticidal dieldrin, and/or from the conversion of aldrin which occurs very rapidly after entry into birds. Heptachlor epoxide is a metabolite of the insecticide heptachlor.

With the exception of two Goosanders from the Tweed, the levels of contamination in both the Goosander and the Red-breasted Merganser are quite low compared with those for other birds feeding on freshwater fish in other areas of Britain. Working with breast muscle, Moore and Walker (1964) found an average level of organic chlorine insecticide residues of 13·3 p.p.m. (wet weight) in seven Herons and 5·8 p.p.m. in four Great Crested Grebes. As pp¹DDT is used widely outside agriculture, the source of the pp¹DDE residues given in Table I is open to some doubt. Dieldrin and gamma BHC may have originated from sheep dips.

Samples of Salmon parr, which are frequently eaten by both the Goosander and the Red-breasted Merganser, were taken from two Ross-shire rivers, the Meig and the Bran and from the upper reaches of the Aberdeenshire Dee. They were analysed for organic chlorine insecticide residues by Mr. A. V. Holden of the Freshwater Fisheries Laboratory, Pitlochry, who found that 12 whole parr from the Meig and Bran contained respectively about 0·020 and 0·003 p.p.m. dieldrin (wet weight) and 0·005 and 0·003 p.p.m. pp¹DDE. The average amount of dieldrin plus pp¹DDE in 13 fish from the Aberdeenshire Dee was 0·03 p.p.m. (wet weight). In

Table I. Residues of organic chlorine insecticides found in Red-breasted Mergansers and Goosanders in Scotland in 1964.

		Residue (p.p.m. wet weight)			
Locality	*Date*	*pp¹DDE*	*Dieldrin*	*Gamma BHC*	*Heptachlor epoxide*
Red-breasted Merganser					
R. Conon,					
Ross-shire	29.4.64	0·70		0·10*	
R. Carron,					
E. Ross-shire	3.7.64	<0·20			
R. Tay,					
Perthshire	6.7.64	1·1			
,,	6.7.64	2·3	0·44		<0·10*
,,	6.7.64	0·30	0·04*		
,,	6.7.64	0·13			
,,	6.7.64	0·56	0·20*	0·28*	
,,	6.7.64	2·0	0·20*	0·30*	
,,	6.7.64	1·15	0·40*	0·27*	
Goosander					
R. Tweed,					
Berwickshire	26.3.64	9·3	10·2	<0·10*	
,,	15.4.64	43·0	3·4		
R. Orrin,					
Ross-shire	23.4.64	1·2			
R. Garry,					
Inverness-shire	9.5.64	3·7	<0·10*		
R. Dee,					
Aberdeenshire	2.7.64	0·90			
,,	2.7.64[a]	0·20*	0·20		
,,	2.7.64[a]	<0·20*			
,,	2.7.64[a]	0·30*			
,,	2.7.64[a]	0·50			
R. Tummel,					
Perthshire	6.7.64[a]	0·23			
,,	6.7.64[a]	0·27			

[a] Fledglings. * Not confirmed by paper chromatography

the River Clunie, Aberdeenshire, the values for dieldrin and pp¹DDE in Salmon parr were 0·002 p.p.m. and 0·016 p.p.m. (both unit wet weight) respectively. Though these quantities are small, they may be of biological significance because of the accumulation of insecticide residues through the food chain which has been demonstrated in the Western Grebe on Clear Lake, California (Hunt and Bischoff, 1960).

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The display flights of Shelduck

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Display flights have been described for various species of Anatidae, but the flights of Shelduck *Tadorna tadorna* have not been noted. Aerial pairing displays are most frequent in May, with the greatest volume in the first half, although I have also seen them in other months, particularly February and March. As with dabbling ducks, displays centre on a single female and involve varying numbers of males; up to eight have been observed in North Kent, but larger numbers may occur. Flights usually originate when an unpaired female rises from a fresh water fleet or pool where she has been 'attended' by a number of unpaired males. She then leads the group in wide circles over the marsh in a flight which has two main phases. Initially the female often twists and turns violently, darting into a new direction or diving steeply. The males follow as closely as they can and try in turn to fly alongside her. For a short time one will achieve this position, but then she veers away and another male then attempts to 'close'. After this rapid flighting, or sometimes between periods of it, a slower and much more graceful display occurs. The group circle and swing leisurely using regular flapping flight interspersed with periods of gliding on characteristically set wings. The 'cranked' wings are held very much like those of gliding geese with the tips hanging vertically downwards and the primaries quivering slightly. As a party of gliding birds swing overhead a subdued running note 'arnk, arnk, arnk' can sometimes be heard from the female, accompanied by an infrequent chorus of soft clear whistles from the males. The vocalization is strongly reminiscent of aerial courtship flights in Wigeon.

Single, unpaired males often fly up to join in aerial displays whilst others sometimes 'drop out', planing back to the marsh in a leisurely way. Flights of up to six minutes duration have been recorded. All the females involved have been sub-adult: flights are characteristic of the non-breeding gatherings and are a major part of the pairing displays (see also Hori, *Ibis* 106: 333–360, 1964).

Pairing display flights have to be distinguished from sexual pursuits of mated females which also occur at this period. In the latter unmated males, predominantly sub-adults, attempt to break up established pair bonds; such attempts often attract further unmated males and violent aerial pursuits can result. However, these never contain the 'gliding phase' and vocalization described above, whilst the aggressive nature is quite distinct from the 'darting' phase of the display. Further, the mated male invariably defends the pair bond, clashing with other males in mid-air and driving them off. When a single male attempts to break into a pair bond the flight is strictly comparable with 'three-bird flights' of Mallard and Shoveler (Hori, *Wildfowl Trust 14th Ann. Rep.*: 124–132. 1963); the behaviour of the participants is very close to that of Shoveler.

Wildfowl and wildfowling in Bulgaria

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Summary

Bulgaria is not very important as a breeding place for wildfowl, because it is too far south, but large numbers stop there on passage in autumn and early spring and considerable numbers remain through the winter in milder years. The drainage of marshes has greatly reduced the habitat available and the construction of hydro-electric reservoirs has done little to offset the losses. The number of wildfowlers in Bulgaria has risen from 36,000 in 1939–40 to 68,000 in 1945–46 and 100,000 in 1964. The kill has fallen from 128,000 ducks and 11,000 geese in 1939–40 to 126,000 ducks and 12,400 geese in 1945–46 and to only 25–30,000 ducks and 4–5,000 geese annually at the present time. In efforts to restore the position the shooting season has been shortened – it is now 1st September to 25th March – and a bag limit of ten ducks and three geese introduced. Further restrictions may be necessary, in conjunction with efforts in other countries. Shooting techniques are described. The keeping of Ruddy Shelduck in semi-domestication was formerly widespread, but the species has decreased greatly.

Only five species nest regularly in Bulgaria: the Greylag Goose, Mallard, Garganey, White-eye and Red-crested Pochard. The Greylag has decreased seriously and none of the others are increasing.

'*After the autumn equinox birds migrate from Pontus* (i.e. the Black Sea provinces) *and from the colder countries, wishing to escape the approach of winter. Some of them wander into neighbouring countries, but others make for more distant lands. After the spring equinox the birds return, on account of their fear of the heat. The cranes, for example, fly from the plains of Scythia* (i.e. from the direction of the Dobrudja) *to the marshes of upper Egypt and from there towards the sources of the Nile. The Pelicans also change their abode. They come from Strimon* (Struma) *to the Danube, where they rear their young. . . .*'

Thus Aristotle, more than twenty-two centuries ago, sketched in broad outline the picture of the migration of birds through Bulgaria. Because of its southerly situation (the northernmost point is on latitude 44°12′30″ and the southernmost on latitude 41°14′) and its position near the warm Mediterranean shores, Bulgaria is a land preferred for migration by many species nesting in the North. On account of its close proximity to the shores of the Aegean Sea, the presence of the 'backbone' of the Balkan Peninsula, the Stara Planina massif, which keeps it sheltered from the cold north winds, and of its immediate contiguity with the Black Sea, which also has a moderating effect on the winter, Bulgaria is not very cold, in spite of the fact that, to a considerable extent, the Rodope Mountains stop the warm south winds. Almost the whole of northern Bulgaria and the greater part of the mountainous areas have a mean January temperature below O°C. The O°C isotherm embraces eastern Bulgaria, but the larger areas of southern and central Bulgaria and also the Black Sea coast have a mean January temperature above O°C. The valley of the Struma and the Pirin district have a mean January temperature above 2°C and the southern part of the Black Sea coast, the part beyond the Strandja Mountains, has a mean January temperature above 3°C. Only on the peak of Mussalla in the Rila Mountains is the mean January temperature as low as −11° C.If we compare these data with the biological requirements for the wintering of waterfowl, it can be seen that Bulgaria presents itself as a suitable annual wintering place, particularly upper Thrace, sheltered as it is from the winds, and also the regions by the Black Sea. As is well known, in Eastern Europe the −6°C January isotherm forms the eastern limit for occasional wintering of some ducks, but for the majority of species the −2°C January isotherm serves as the effective boundary of their winter range. This boundary is determined mainly by the availability of unfrozen water where the birds can find food, and partly also by whether there are places for roosting (Bobrinski 1951). On the assumption that, on the way to their winter quarters, birds need places that are ecologically favourable to them, then even up to the present day Bulgaria really answers to their biological requirements.

In the Sofia district the appearance of wild ducks and geese depends on the climatic changes. A cool and rainy spring usually holds back the migrants. In the event of a deterioration in the weather, particularly if it turns cold in early spring, the birds that are on their way north turn back. Few large flocks winter for long by the Danube. They prefer the lakes of the Black Sea coast and the water meadows by the rivers in south Bulgaria, particularly in Thrace. Among the Sofia shooters there is a belief that when the 'Serbino' (as they call the west and south-west winds) blows, it blows the birds away to the east and then the migrants hardly ever land. On the other hand, when the 'Rumunetso' or 'Krivetso' (i.e. 'oblique wind', because it comes from the north-east, from the direction of Rumania) blows, it pushes the migrating flocks into the Sofia district and then good shooting is expected. But if the 'Moryak' (the 'seaman') or 'damp wind' blows from the south or south-west and brings the warmth of the Mediterranean Sea and thaws the ice, the migrants are expected to pass quickly through from south to north almost without stopping, since the weather is improving and it is warm.

Conservation problems

In the past Bulgaria was even more favourable for migration. The flooded areas formed by the overflowing of the rivers in their lower reaches (particularly the tributaries of the Danube and of the Maritsa and the rivers flowing into the Black Sea) and the many lakes and marshes formed a diverse and variegated landscape, which understandably lured the migrants into calling here twice a year. And since most of these expanses of water were well overgrown with hygrophytic vegetation, which provided the birds with cover in the breeding season, a variety of waterfowl nested in this country, in numbers undoubtedly greater than today. These lakes and marshes mainly originated in the Quaternary age, when subsidences of the earth took place, giving rise to depressions of various sizes. At the beginning of this century the map of Bulgaria still showed 29 large Danubian marshes, 18 large lakes and

marshes situated along the Black Sea coast and 11 in the interior of the country. Most of them have been drained through the necessity to reclaim new agricultural land and in the battle against malaria. Some of them were very large, like the Straldja Marsh in the eastern part of the plain of Sliven. This marsh, on which pelicans, swans, etc. nested, had an area of about 35 sq. km. and was over four metres in depth. Others were situated on mountain plateaux, like the Dragoman Marsh, where many wild ducks nested. Some of the marshes, such as the Batak Marsh in the Rodope Mountains, on which cranes used to nest, still exist, but not in their original state. The Mandra Marsh has been altered and the White Pelicans, which up to thirty years ago nested there, have been banished. Now they visit it only sporadically in large wandering flocks. The draining of some of the lakes in the eastern part of the country is envisaged in connection with the increased construction of holiday resorts. This could deprive us of the last suitable places of refuge where some interesting species of wild ducks and geese still nest. These are also essential resting places for waterfowl, following the line of the Black Sea migration route.

Three of the breeding places of marsh and water birds still existing in the last ten years, the Pomorie Marsh, the Mandra Marsh near Burgas and the inner part of Lake Varna (the part not made salty by the channel to the Black Sea) are not nature reserves. Only the Sreburna reserve, in the Silistra district near the Danube, is protected by statute on account of the Dalmatian Pelicans and other marsh birds nesting there. However, it has been cut off from the Danube by the draining of the connecting channel and this prevents the water from being renewed and so hastens its choking up and eventual doom. We hope that, thanks to the co-operation of the International Council for Bird Preservation, we will be able to join in the M.A.R. scheme to make possible the provision for the future of more suitable places for the nesting and resting of waterfowl.

At the present time a great hydroelectric construction programme is being carried out. Over 23 large reservoirs with areas of over 1,000 decares (250 acres) have been built. For example, the Isker Reservoir near Sofia alone has an area of about 30,000 decares (nearly 12 sq. miles) and the water held back forms a huge lake fifteen kilometres long. A few hundred small reservoirs and fish ponds have also been built. Unfortunately, for waterfowl these enticing expanses of water constitute almost aquatic deserts. The inconstancy of the water level, which varies very much, produces a changing shore line unsuitable for the dense growth of water-loving vegetation in which the birds could hide and nest. Also the food supply in these reservoirs is too poor for them to attract ducks except as roosting places. Nevertheless the presence of these reservoirs, particularly in western Bulgaria, continues to support the migration route which passes through the western part of the country.

The improvement and enrichment of the lakes with plants that are preferred by wildfowl during the moult (e.g. with *Vallisneria* sp., Water Chesnut *Trapa natans*, Duckweed *Lemna lemna*, Wild Rice *Zizania aquatica*, etc.) has not yet been attempted in Bulgaria, nor have biotechnical measures for assisting nesting, such as the preparation of artificial nesting boxes, either floating or standing on piles, and the creation of other suitable nesting places for ducks, been applied. There are, however, limitations on the gathering of reeds, the stalks and leaves of which are used to produce various woven articles and rough matting. Where this gathering is necessary, periods in the autumn and winter are set aside for it, so that it does not hinder the settling of the birds in the spring. The former savage burning of the dry reeds in early spring is now strictly forbidden, but the clearing from the banks of the lakes of the salt-loving and sand-loving vegetation with a view to improving the numerous holiday resorts, as well as the already increased visits of holiday-makers to the Black Sea coast, have an unfavourable influence on some species, particularly the Shelduck *Tadorna tadorna*. The cutting down of the old hollow trees which contained suitable nesting holes and in general the reduction of the old self-sown forests by the shore restricts both *Tadorna tadorna* and the Ruddy Shelduck *Tadorna ferruginea* in their choice of habitation.

Among the unfavourable factors might also be mentioned the turning of herds of pigs on to the marshes to feed, which undoubtedly has a bad effect on the broods of water birds and waders nesting on the ground. In most of the lakes by the Danube and the Black Sea, fishing is carried out on a large scale and this also disturbs the birds which inhabit those lakes. In spite of the purification plants envisaged for the newly constructed oil refinery near Burgas there is a danger of the oiling of birds by floating waste, particularly on Lake Vaya and Otmanli Bay. Last year we observed the first such fouled birds – a Black-headed Gull *Larus ridibundus*, a wagtail *Motacilla alba*, and wild ducks – and probably their number

will grow. The chemical waste from some factories discharged into the marshes and rivers also has an unfavourable influence on the lower animal life in the water. This necessitates the preservation of other clean coastal marshes, rich in food and protective vegetation, where birds can breed or rest during migration undisturbed.

Unfortunately Bulgaria lies below the southern limit of the breeding ranges of most species of waterfowl. It is definitely included in the breeding ranges of only *Anser anser*, *Anas platyrhynchos*, *Anas querquedula*, *Aythya nyroca* and *Netta rufina*. All the other species may have nested in slightly larger numbers in the past than they do today, but nevertheless it was an uncommon occurrence, and today the nesting of such birds in this country is quite sporadic.

The comparative warmth of recent years is probably a reason for the northward movement of the southern limit of the breeding range of some species and it may be connected with the decrease in numbers of breeding pairs in the southern regions. However the appearance of new more southerly types (particularly Central Asiatic and Mediterranean or birds known to be characteristic of lakes in the Steppes) has not been noticed. For example, the occurrence of the Marbled Teal *Anas angustirostris* has not been established, nor has the nesting of the White-headed Duck *Oxyura leucocephala*, and the numbers of Gadwall have not increased. As for the expansion of the range of the southerly species *Netta rufina*, it began about twenty years ago and there is absolutely no great increase in its frequency in this country nor is it a markedly predominant species. The disappearance of the last scattered and isolated nesting sites of the Greylag Goose *Anser anser* and of *Tadorna ferruginea* probably indicates the unhappy prospect that in the near future these birds will not be in the list of species nesting in this country.

Wildfowling

As in all the countries situated in southern Europe, the Bulgarian shooters are mainly 'consumers' of wildfowl that consists not of local but of migrating birds which are 'despatched' to this country annually from the northern lands – its 'producers'. The number of Bulgarian wildfowlers has almost doubled in comparison with pre-war years, but according to statistical data the number of ducks killed has fallen about five times and of geese two to three times. In 1939–40 there were 36,000 shooters and 128,000 wild ducks and 11,000 wild geese were shot: in 1944–45, with 55,000 shooters, 159,000 ducks and 11,300 geese were shot: and in 1945–46, with 68,000 shooters the figures were 126,000 and 12,400 respectively. At the present time the number of shooters is about 100,000 but only about 25–30,000 wild duck and 4–5,000 wild geese are shot annually. The reason for this decrease lies in the reduction in the number of suitable nesting sites, due to the draining of expanses of water in the lands situated to the north of this country where the birds mostly breed, e.g. the Ukraine, and also in the comparatively long shooting seasons and the lack of limitations on the amount of game taken in many of the southern countries. Unfortunately, in the Middle and Near East the uncontrolled and unlimited shooting of waterfowl continues and hence they become in shorter and shorter supply and the 'duck crisis' worsens. For this reason a severe shortening of the shooting season and the laying down of limits on the size of bags of game taken has recently been necessitated in this country. To each wildfowler a limit of three wild geese and ten wild ducks is allowed. In the 'Scheme of regulations and seasons for hunting in the U.S.S.R.' (1964), which has been issued for discussion, even lower limits have been proposed, which makes the future prospects of waterfowl more optimistic. It is proposed to allow, in one day's shooting, not more than five waders and snipe and only five wildfowl (ducks and geese) in the European part of the U.S.S.R., and up to ten small feathered game and eight waterfowl in the Asiatic part and in the northern regions. The acceptance of these limits would be acclaimed by all countries. In Bulgaria, while the shooting of indigenous game is allowed only two days a week and is not allowed except by groups of at least three people, migratory game (including waterfowl) can be shot on any day of the week and by individuals shooting alone.

Formerly the shooting seasons were very long – from 1st or 15th July (later, from 1st August) to 1st or 15th April. A few years ago new shooting seasons were established in this country – the shooting of wild geese begins on 1st September and finishes on 25th March. We reckon that this season is still too long and that in no case should the shooting season for waterfowl continue after 1st March, in conformity with the recommendations of the I.C.B.P. This proposal is designed to prevent the killing of birds that are preparing to breed, many of them having paired by the middle of March and some having already begun to nest, e.g. Mallard, Ferruginous Duck, and especially the Greylag Goose. This is the way in which

most harm is done to the few remaining birds still nesting in this country. We believe that, when the shooting season for wildfowl has been shortened in Rumania too, it will be even more possible to guarantee an untroubled migration for the birds returning to the North, since this measure has already been taken in the European republics of the U.S.S.R. and in almost all European countries.

The use of waterfowl is mainly for sport. Collecting their eggs is forbidden. The use of their skins is now unknown and even in the past there was only very limited and local use of skins, mainly of grebes *Podiceps cristatus*, etc., for the lining of clothes. The collecting of down from the nests of *Tadorna tadorna* is also unknown now, but for that reason no efforts at all are made to prepare artificial holes in the ground in which it can nest.

It is absolutely forbidden by law to shoot five species: *Tadorna tadorna*, *Tadorna ferruginea*, *Oxyura leucocephala*, *Cygnus cygnus* and *Cygnus olor*.

In Bulgaria wildfowling is only a sport and has no commercial aim. It is forbidden to sell or trade with the birds killed. Only organised shooters have the right to shoot. Even during the Turkish oppression, in a copy preserved in the Rila Monastery of a 'firman' (decree) issued in the town of Edirne (Adrianople) from Sultan Bayazid Hassan II to the Grand Vizier Kara Mustapha Pasha, giving him control of the lands in the Plovdiv province, we read that among the taxes from which he was exempted, besides 'resuli badihava' i.e. the right to breathe air, there was also 'resuli timar' i.e. the right to hunt birds. But with the passing of the first game law of 1880, all game, resident and migratory, were counted as state property and only a recognised hunter had the right to hunt it on payment of a tax. Hunting with special nets called 'purliga', which was carried out here and there, mainly along the Black Sea coast, principally for Quail but also for other migrants too, was limited to two months (from 15th August to 15th October) and a large tax of three gold levs was imposed. Quite soon afterwards this rapacious and commercialised form of hunting was forbidden and forgotten. Among those methods of hunting that are no longer used there are also: hunting with a circular fishing net called a 'serkme' with weights round the edge for Coot *Fulica atra* and Ferruginous Duck *Aythya nyroca;* with a net called a 'vinter' stretched on a hoop and put in the water with a live duck tied up inside it as a decoy; with snares stretched in small channels cleared among the marsh plants where the ducks swim; and with a bait of worms and a fishing line attached to a stake buried in the ground by the shore. Today these unethical poaching methods are no longer used.

At the beginning of this century the Greylag Goose was so abundant as a nesting bird that the fishermen from Tataritsa in the Silistra district, Dobrudja, killed 40–50 Greylag Geese with sticks during the moulting period and caught about 100 young birds for food. Such devastating raids on the geese continued up to just before the last war. Thus, for example, on 15th July, 1940, when the young geese had already grown almost as large as the parents and the adult birds were moulting, a gang of 70 people caught about 150 Greylag Geese, unable to fly, in the Koykusha Marsh between the villages of Belene and Oresh, again by the Danube. In 1942, young geese with clipped wings were kept in many gardens in the village of Sreburna. These birds had been caught on the neighbouring marsh, which is now a reserve for pelicans and other birds. Now that abundance of geese no longer exists and is already just a quickly fading memory. The Greylag Goose is declining as a nesting bird in this country. Hunting it by the destructive method described above is now strictly prohibited.

Shooting from a 'gyume' is a characteristic method. This is an oriental method of hunting, which formerly was used in Bulgaria only in the region of Thrace, but has now spread to the Sofia district and other places. The 'gyume' is a hut sunk into the earth by the marsh and covered with turf. Since it is almost below the surface of the earth, it looks from above something like an army bunker, merging with the background of the marsh landscape. Inside it is covered with sheet iron so as to be dry and it has a place for a small stove. There is room for two to five people. There are also portable hides, usually with walls of rushes or sticks. These cannot be heated. There are small openings like loopholes directed towards the marsh, or sometimes to all sides, so that one can shoot in various directions. This type of shooting is usually accompanied by the use of 'decoys', hybrids between domestic ducks and Mallard *Anas platyrhynchos*, which have good vocal capabilities and can quack. Rubber or wooden models of wild ducks and the use of silhouettes or whistles are unknown. The decoys are usually arranged in two diagonal lines. If they quack superfluously and without reason, they may be arranged in pairs, so that each male is with a female, when they keep quiet. If they do not quack to lure the wild ducks, some are hidden in the 'gyume' and

then the others begin to call to them. The same result can be achieved if they are arranged in two separate lines, the males in one and the females in the other. The wild ducks *Anas platyrhynchos*, *Anas acuta*, *Aythya nyroca* and, less commonly, *Anas penelope*, *Anas querquedula* and *Anas crecca* respond to the quacking of the decoys. Actually, these latter species land in front of the 'gyume' as much as the former ones, but they stay on one side, are very wary and usually soon fly away. The decoys each have on their legs a ring which is free to turn and to which is connected a cord about a metre long. This cord is tied to a ring fixed to a small stake driven into the ground. In front of each decoy is a pile of earth so that the bird can get out of the water and rest on the little hillock, or else under water there is a stake hammered into the ground and on to it is nailed a board like a little table, on which the bird may rest. The decoys are not fed much so that they are lighter and smaller in size than domestic ducks. They are most often kept with clipped wings, since sometimes when they fly away they do not return.

Shooting with decoys from a 'gyume' is a very deadly method. In the migrating season there are cases of over one hundred birds being killed in one night. For this reason the number of such erections on the marshes is limited. In the Sofia district it is no longer permitted to build new ones, but the existing ones have been left to be used as long as possible.

Having in mind the unsportsmanlike mass-productive nature of shooting wild ducks and geese from a 'gyume', which is contradictory to the ethics of the sport, we reckon every limitation on this oriental method of shooting to be a means of saving a multitude of wildfowl on their return to their homeland.

In antiquity the Ruddy Shelduck *Tadorna ferruginea* was kept in gardens as a favourite decorative bird and as a substitute for a watch-dog, since it gave the alarm on the approach of a stranger. Among discovered fragments of old Bulgarian drawings of various birds, there are some of ducks and some showing stylised forms of geese, which resemble this species. The domestication of the Ruddy Shelduck is a very interesting problem. It was still found here and there in this country until quite recently. In the village of Rousocastro in the Burgas district (1952), shelduck reared together with domestic ducks did not try to escape even though their wings were not clipped. In 1950 in the village of Tyulenovo in the Dobrudja I saw a domesticated shelduck of this kind, which honked on the approach of a stranger like a 'live alarm'. At the end of the last century a few authors (Reiser, Christovich, Lorentz *et al.*) reported the same phenomenon in the villages along the Danube, in the town of Svishtov and other places. This custom may be due to the spread of Roman influence and may have been preserved through the ages since the Roman era, particularly along the Danube in Rumania and Bulgaria. Some historians suppose that these were the sacred geese kept on the Capitol hill, the cackling of which woke the Romans and saved the old town on the approach of unfriendly forces to attack it.

The Ruddy Shelduck is a much-loved bird in the folklore of the southern Slavs. In Serbian songs it is extolled as the golden-winged 'utva' and in Bulgarian songs as the golden-winged 'shatka'. In one of the Bulgarian folk songs they sing about the hunting of Krali Marco, a feudal lord in western Bulgaria and Macedonia who became a vassal of the Turks after fighting against them. Here is an interesting extract from it:

Krali Marco said to the king,
'Gather your forces and feed your falcons.
Let us go to hunt game.
Let us hunt that wild game,
That wild game, the golden-winged duck'.

For this hunt they are said to have gathered 3,000 soldiers, each with a falcon trained for hunting, and Krali Marco himself had a trained Imperial Eagle *Aquila heliaca*.

They went to hunt game
And passed through a broad plain.
And they reached a great lake.
They saw the golden-winged 'shatkas'.
All the ducks fell to the bottom,
They fell to the bottom of the lake.
They could not find a single one.

A novel from the Bulgarian renaissance at the end of the last century by Tsani Ginchev mentions hunting with falcons for Ruddy Shelduck, Wood Pigeons *Columba palumbus* and Bustard *Otis tarda* in the meadows and flooded places overgrown with willows by the River Yantra. At that time, during the Turkish oppression, only important Turkish administrators and military leaders (pashas, viziers, beys, etc.) went hunting like that with trained falcons. Today that kind of hunting is forgotten, and perhaps soon the Ruddy Shelduck too will be forgotten as a Bulgarian bird. In those days it really did occur there by the Yantra, where Reiser saw it at the end of the last century.

[Editorial note: a second part of this paper, discussing the status of all species of wildfowl known to have occurred in Bulgaria, has had to be held over.]

Breeding of the Cape Barren Goose on the Anser and Glennie Islands, Victoria, Australia

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Summary

In June 1964 Cape Barren Geese were found to be breeding on the islands off Wilson's Promontory. This was the first authenticated record since 1910.

This report of the 1964 findings includes introductory notes on the known history of the species and on its notable biological significance and rarity. The desirability of increased conservation measures is stressed and proposals for such measures (including other ecological research work relevant to good management) are outlined.

Introduction

This report was written for submission to the Fisheries & Wildlife Department of Victoria, with a view to establishing a research and conservation programme. It is reprinted here, by permission, in a slightly amended form.

The Cape Barren Goose *Cereopsis novaehollandiae* is one of the rarest geese in the world. A handsome bird, standing nearly two feet tall, grey with black wing-tips and tail, and a striking yellow-green cere on the bill, it introduces a bold and rather wild note to the open landscape it inhabits. It bears a remarkable resemblance in many ways to the true grey geese of the north and as such is the only one of its type in the southern hemisphere. This 'parallelism' or convergence is of considerable zoological interest.

It received its vernacular name after being used as a source of much-needed food by survivors of the ship "Sydney Cove", wrecked on Preservation Island south of Cape Barren Island in Bass Strait early in 1797. Matthew Flinders, who travelled there from Port Jackson in the rescue schooner 'Francis', commented '... I found this bird in considerable numbers on the smaller islands, but principally upon Preservation Island; its usual weight was from 7 to 10 pounds and it formed our best repasts, but had become shy ...'. About the same time, in the summer of 1797–98, George Bass recorded taking geese on unidentified islands off Wilson's Promontory during his whaleboat voyage to Westernport. Together with mutton-birds and seals they formed an important food standby.

Early as these records may seem, they appear late in the Cape Barren Goose timescale. Recognisable waterfowl occur in the fossil record as early as the Cretaceous, 60 million years ago. Studies on its bone-structure, muscle-formation and behaviour are currently going on in an attempt to establish its relationships with the other waterfowl. Some workers have linked it with the extinct New Zealand goose *Cnemiornis*, others with the Shelducks and with the South American Kelp Geese, and others with the true geese of the north; some consider it deserves a tribe of its own. All that is certain at the moment is that the Cape Barren Goose is an unusual goose-like bird of undoubted rarity and apparently ancient origin, which possesses no close relatives and is found nowhere else on earth – a bird worth preserving.

The Cape Barren Goose in the Furneaux Group, Bass Strait, and on the Victorian mainland

The Cape Barren Goose breeds on a few islands from as far as the Recherche Archipelago in West Australia to the Furneaux Group, but the latter area is its headquarters. Aerial surveys conducted since 1957 by the Tasmanian Animals and Bird Protection Board indicate that the population in the Furneaux Group has fluctuated, counts varying from 943 in 1960 to 2,600 in 1964.

The Cape Barren Goose has a long winter breeding season. It commences laying as early as April and continues in some cases until the end of October. About September each year some flocks make an annual summer migration to the plains of Western Victoria, but the migratory habits of the species are still to be investigated, a project only now getting under way. So far as is known, at present there are only about four places where geese may be seen with any certainty during this summering period. In each case these are jealously-guarded grazing properties. In one place a flock of 100 birds appears most years but records of 50 years ago indicate that such flocks were once found over a much larger area of the Western District. There is little doubt that overall numbers have shown a considerable decline. Since the majority of Cape Barren Geese seen during this summer migration probably originate in the Furneaux Group, hitherto it seemed that

their continued presence in Victoria depended on the success of the conservation efforts of another State. It is now four years since the last shooting season of four weeks was permitted in the Furneaux Group. On that occasion 184 licences were issued and 252 birds taken, which may have represented something like 20% of the total Furneaux Group population, as the aerial count of the previous year had shown there to be about 1,200 geese in the area. Since then the bird has been declared a partly-protected species, and it has been claimed that numbers have shown an increase, although there is little doubt that some illegal shooting, destruction of eggs, and capture of goslings continues. We have observed geese in these islands, and appreciate the problems faced there by the Tasmanian conservation authorities. The goose islands are scattered, sometimes considerable distances from the nearest port, and hard to police. They are frequented by fishermen (not only local ones) and mutton-birders; some are privately owned, and farmers grazing stock are in some cases antagonistic to the presence of grazing geese. Of all these islands (about 20), one, Goose Island (about 250 acres and one of the most remote) has been declared a sanctuary; one other smaller one, Little Woody, has been reserved for wildlife purposes; and in the cases of those islands held on Crown Land leases, it is intended that restrictive clauses beneficial to the geese will be inserted when the leases become due for renewal.

The Cape Barren Goose on Victorian islands

In view of the situation in the Furneaux Group, the status of the species on islands off the Victorian coast, many of them already declared sanctuaries and none having grazing interests or being privately owned, is of some interest.

A perusal of old records, conversations with fishermen, and a brief visit by D.F.D. during the non-breeding season, indicated that the Glennie and Anser Groups of islands off Wilson's Promontory might be breeding grounds for geese. As already mentioned, Bass had taken geese on islands off the Promontory in 1797–98. More recently, in 1910, a party of Melbourne naturalists, which included Sir James Barrett, had landed on Great Glennie Island and reported geese breeding. Contemporary records in the files of the Fisheries and Wildlife Department indicated the presence of geese on several of the islands, although apparently no breeding records had been made. Accordingly, in June a party of ten visited the Anser and Glennie Groups in a fishing boat chartered from Port Franklin. High winds and rough seas made possible only an inspection by sea of Wattle, Kanowna and Anser Islands in the Anser Group and of the eastern sides of Greater Glennie, Dannevig, Citadel and McHugh Islands in the Glennie Group. Geese were seen on all these islands. Finally, a landing was made on Great Glennie Island, numerous geese were seen, and four nests with eggs discovered.

The greatest numbers of Cape Barren Geese seen at one inspection during the investigation, which took place between June 13 and 17, were as follows.

Anser Group

Wattle Island – 4 pairs, possible duplication of 1 pair; Anser Island – 6 pairs on ground, flock of 20 flying; Kanowna Island – 3 pairs.

Glennie Group

Great Glennie Island – 23 geese flew as the boat arrived. 9 pairs seen elsewhere; Dannevig Island – 3 pairs; Citadel Island – 3 birds; McHugh Island – 1 pair.

The occurrence of geese in pairs intruded itself immediately. Generally these were seen on more or less pure areas of poa tussock of anything from one to five or more acres in extent, ranging from 50 feet above sea-level, where vegetation succeeds the steep granite shoreline, to the crests of the islands which vary in height between 150 and 500 feet. With practice it became possible to predict areas where geese would appear as the boat approached. Invariably the birds were already alarmed by the time they were distinguished, and just as invariably flew before the boat approached within gunshot. In the light of the tameness of Cape Barren Geese observed on the adjacent mainland at the conclusion of the investigation (see below) this wildness would seem to indicate that on the islands at least the birds associate the approach of a boat with gunfire, or at least danger in one form or another. No flying birds were seen to cross between the islands. When disturbed they either moved directly to settle on another part of the same island, or flew about for a short time before doing so.

Since the prime purpose of the venture was to establish beyond doubt that the Cape Barren Goose still breeds on the islands, the time spent ashore on Great Glennie Island was directed entirely to a search for nests. To this end all 10 members formed a beat along the eastern slope of the island, moving northward from the anchorage. However, it soon proved that stalking

was more effective than beating, since the birds rose at extreme range and 3 of the 5 nests discovered were located by Dorward who had observed birds in pairs on two of the territories during a visit to Great Glennie in April 1964. Two nests, several hundred years apart, were sited in an area of tussock 50 ft. above sea-level directly above the steep granite slope rising from the sea. One of these nests was empty but fresh, the other contained five eggs. The other three nests were on the exposed ridge of the island, some 200 ft. above sea-level. One nest had five eggs (three stained, two clean) and a down lining. The second had two little-stained eggs. The third, only some twenty feet from the second, was empty and weathered. It lacked down and was probably at least a season old. All five nests were built in slight depressions hard against tussocks on the lee side, the wind-curved grass tending to bend over them. The nest territories appeared to be approximately 300–500 yards in diameter.

It seems reasonable to conclude that between the months of April and December the Anser and Glennie Groups form an important Cape Barren Goose breeding ground. Apart from flocks at least 26 pairs of birds were seen. The amount of available territory would seem to suggest that at the time of our visit there may have been two to four times that number of pairs actually present and about to breed. In other words, up to five per cent of the world's Cape Barren Goose population may rely on these Victorian islands for breeding purposes. This is a possibility which has apparently not been appreciated up to the present.

Conservation

Any conservation campaign to ensure the security of this breeding population of geese must rest on more than the declaration of sanctuaries, since both groups of islands have long been designated as such. The four main islands in the Glennie Group – Great Glennie, Dannevig, Citadel and McHugh – were declared a sanctuary in 1910; the Anser Group, and the two northernmost islands on the west coast of the Promontory (Norman and Shellback Islands), and in addition Rabbit, Granite, Doughboy and Benison Islands on the east coast, all became part of the Wilson's Promontory National Park in 1916. It is already becoming the practice of the hardier holiday fishermen to take light boats out through the surf from the popular Tidal River settlement, from which Great Glennie Island is a bare six miles – about 20 minutes run in a fast dinghy. Access to the islands will presumably become easier as development of the area proceeds. It would be desirable to restrict or prevent landing on the islands to minimise disturbance of breeding geese.

The anchorage at Great Glennie provides the only shelter on the west coast of the Promontory. Professional fishermen have been using this anchorage and landing on Great Glennie, and probably shooting geese, since these waters began to be worked. One of the authors has been told by fishermen in a nearby coastal town of parties taking up to 40 geese in a day, and of goslings being brought home for pets. The comparatively small size of these islands makes shooting easier; geese do not normally leave the islands on being disturbed, but fly about and offer many chances.

Hence there is need for active measures to protect the geese of these islands from shooting. Probably the cheapest method would be a non-regular aerial patrol. Such a patrol would seek to recognize any boats in the anchorage. The propaganda value of such a patrol would probably be greater than the actual policing function.

At the same time an aerial count of the geese along lines pioneered in Tasmania could be used to assess the annual fluctuation in numbers, an essential part of any wildlife management programme. Including Norman and Shellback Islands, the Groups concerned are strung over a distance of some twenty miles, and could easily be covered in a morning's flying. The air distance from Moorabbin Airport, Melbourne is 100 miles.

Another important step which could be taken at present would be irregular patrolling by a sea-going boat. Inspectors of the Fisheries and Wildlife Department are already responsible for maintaining watch on the area and the activities of fishermen. If a Fisheries and Wildlife Department vessel were available for all the Department's coastal commitments, policing of the islands could be made an additional one.

Research

The Cape Barren Goose is not only a rare animal, it is also one of considerable zoological interest. At present, ecological research is being done on its breeding biology by workers in Tasmania, and one of the authors is conducting a research programme on its behaviour, history, classification, and evolutionary relationships at Monash University. Hitherto all field work has necessarily involved travelling to Tasmania. In light of the recent discoveries, it is hoped that the emphasis of the Monash programme will shift to the

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

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

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

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

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Introduction

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

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

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

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

Numbers

Between August and November 1964 the authors made preliminary attempts to obtain an estimate of the numbers of aquatic birds (i.e. cormorants, pelicans, herons, egrets, storks, ibises, ducks and geese) on the Flats. This was done by means of numerous observations on the ground, a number of sample transects and an aerial flight. The numbers obtained are necessarily approximate due to limited time available, but these figures provide a basis for future research.

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

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

	counts		*av. no. per*
	range	*mean*	*sq. mile*
Reed Cormorant	301–348	325	5·6
Darter	74–106	90	1·6
White Pelican	1719–1999	1859	32·1
Grey Heron	32–46	39	0·7
Goliath Heron	32–37	35	0·6
Purple Heron	32–38	35	0·6
Great White Heron	124–141	133	2·3
Little Egret	42–55	49	0·8
Yellow-billed Egret	102–260	181	3·1
Cattle Egret	73–129	101	1·7
Squacco Heron	129–164	147	2·5
Rufous-bellied Heron	32–39	36	0·6
Openbill	1019–1247	1133	19·5
Saddlebill	26–28	27	0·5
Marabou	41–57	49	0·8
Wood Ibis	104–116	110	1·9
Sacred Ibis	107–129	118	2·0
Glossy Ibis	119–229	174	3·0
African Spoonbill	25–33	29	0·5
Hottentot Teal	52–72	62	1·1
Red-billed Teal	3114–5660	4387	75·6
White-faced Tree Duck	2227–3031	2630	45·3
Fulvous Tree Duck	1227–6327	3777	65·1
Knob-billed Goose	539–668	604	10·4
Spur-winged Goose	3770–4362	4066	70·1
Fish Eagle	30–36	33	0·6
African Jacana	261–597	429	7·4
Crowned Crane	106–196	151	2·6
Wattled Crane	260–264	262	4·5
Blacksmith Plover	262–574	423	7·3
Long-toed Plover	125–143	134	2·3
Stilt	97–130	114	2·0
Grey-headed Gull	437–1062	750	12·9

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

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

In the absence of more intensive observations it is not possible to make any estimate of numbers on the Kafue Flats as a whole. However, the areas censused probably carried as high a density as anywhere on the Flats; by taking an average density over both suitable (concentration areas) and unsuitable areas (dry grassland surrounding the watered zones) as has been done in the foregoing table, figures are obtained that might be taken as representative of the entire Flats area until more detailed surveys are possible. To give some idea of the potential of the area as a major wildfowl centre, the average density per square mile of 75.6 given for the most numerous local duck, the Red-billed Teal, would give a total of 189,000 individuals in the 2,500 square miles of the Flats.

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

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

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

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

	total seen	*ave. per mile of river*
Reed Cormorant	4144	25·1
Darter	282	1·7
White Pelican	50	0·3
Grey Heron	8	0·05
Goliath Heron	30	0·2
Purple Heron	3	0·02
Great White Heron	24	0·1
Little Egret	280	1·7
Yellow-billed Egret	84	0·5
Cattle Egret	4	0·02
Squacco Heron	91	0·6
Rufous-bellied Heron	2	0·01
Openbill	4354	26·4
Marabou	60	0·4
Wood Ibis	10	0·06
Sacred Ibis	275	1·7
Glossy Ibis	6	0·04
Fish Eagle	72	0·4
Spur-winged Goose	79	0·5
Crowned Crane	3	0·02
Wattled Crane	3	0·02
Grey-headed Gull	1553	9·4

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

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

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

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

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

Habitat preferences

Without the seasonal rise and fall of water level on the Flats, much of the area would be far less favoured by aquatic birds than it is. During the rains the shallow inundation of much of the Flats provides extensive and suitable feeding for most species of aquatic birds. Much of the semi-waterlogged anthill zone, and the pans in the woodland area, provide suitable conditions for several species to nest in considerable numbers. Unfortunately, the Flats are little visited during the rains, and knowledge of the breeding birds of the area is sparse. Towards the end of the rains pelicans, some herons and egrets probably breed out on the Flats, but again few data have been collected. As the water level drops steadily, new food supplies are continually uncovered for the considerable numbers of various species that feed in shallow water and along the water's edge. In a really dry year permanent streams and lagoons will provide suitable feeding until the flood waters begin to rise again.

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

Reed Cormorant and Darter

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

White and Pink-backed Pelicans

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

Herons, egrets, storks, etc.

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

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

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

Reeds: Purple Heron, Squacco Heron.

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

Ducks and geese

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

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

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

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

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

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

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

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

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

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

Movements

The whole question of the migrations or wanderings of aquatic birds on the Kafue Flats is important, and until some attempt is made to solve the many problems that arise, proper management of aquatic birds in the area cannot be hoped for.

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

Associations with Lechwe

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

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

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

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

The need for management

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

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

Acknowledgements

We should like to thank the following for their assistance: Mr. A. T. Fuller and Lt. Col. and Mrs. R. A. Critchley for facilities extended at Lochinvar and Blue Lagoon Ranches, respectively; and Mr. A. J. Tree for providing information on wildfowl in the North Kafue Basin.

Appendix 1

Breeding records of aquatic birds from the Kafue Flats

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

Reed Cormorant: March (2 records, mixed colonies, with eggs), April (6, mixed, eggs and young), May (1 mixed, eggs) and Aug. (1 mixed, eggs). All in colonies with Darter, which it outnumbers; sometimes various herons and egrets also present. Darter: Details as for previous species, than which less numerous.

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

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

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

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

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

Night Heron: Details as for Squacco Heron.

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

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

White-faced Tree Duck: At Lochinvar lays in February and March in woodland often ½ mile from water. A female shot in February contained an almost fully developed egg.

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

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

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

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

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

Appendix 2

List of scientific names of species mentioned in text

Mammals

Lechwe (Kafue Flats form) *Kobus leche kafuensis*

Birds

Reed Cormorant *Phalacrocorax africanus*
Darter *Anhinga anhinga*
White Pelican *Pelecanus onocrotaus*
Pink-backed Pelican *Pelecanus rufescens*
Grey Heron *Ardea cinerea*
Black-headed Heron *Ardea melanocephala*
Goliath Heron *Ardea goliath*
Purple Heron *Ardea purpurea*
Great White Heron *Egretta alba*
Little Egret *Egretta garzetta*
Yellow-billed Egret *Egretta intermedia*
Black Heron *Egretta ardesiaca*
Cattle Egret *Ardeola ibis*
Squacco Heron *Ardeola ralloides*
Rufous-bellied Heron *Butorides rufiventris*
Hammerkop *Scopus umbretta*
Openbill *Anastomus lamelligerus*
Saddlebill *Ephippiorhynchus senegalensis*
Marabou *Leptoptilos crumeniferus*
Wood Ibis *Ibis ibis*
Sacred Ibis *Threskiornis aethiopicus*
Glossy Ibis *Plegadis falcinellus*
African Spoonbill *Platalea alba*
Fish Eagle *Haliaeetus vocifer*
White-backed Duck *Thalassornis leuconotus*
African Pochard *Aythya erythrophthalma*
Yellow-billed Duck *Anas undulata*
Black Duck *Anas sparsa*
Cape Wigeon *Anas capensis*
Hottentot Teal *Anas punctata*
Red-billed Teal *Anas erythrorhynchos*
White-faced Tree Duck *Dendrocygna viduata*
Fulvous Tree Duck *Dendrocygna bicolor*
Pygmy Goose *Nettapus auritus*
Knob-billed Goose *Sarkidiornis melanotos*
Egyptian Goose *Alopochen aegyptiacus*
Spur-winged Goose *Plectropterus gambensis*
Red-knobbed Coot *Fulica cristata*
African Jacana *Actophilornis africanus*
Lesser Jacana *Microparra capensis*
Crowned Crane *Balearica pavonina*
Wattled Crane *Grus carunculatus*
Kittlitz's Sandplover *Charadrius pecuarius*
Three-banded Plover *Charadrius tricollaris*
Caspian Plover *Charadrius asiaticus*
Long-toed Plover *Hemiparra crassirostris*
Blacksmith Plover *Hoplopterus armatus*
Ethiopian Snipe *Gallinago nigripennis*
Curlew-Sandpiper *Calidris ferruginea*
Little Stint *Calidris minuta*
Ruff *Philomachus pugnax*
Common Sandpiper *Tringa hypoleucos*
Marsh Sandpiper *Tringa stagnatilis*
Greenshank *Tringa nebularia*
Wood Sandpiper *Tringa glareola*
Curlew *Numenius arquata*
Whimbrel *Numenius phaeopus*
Stilt *Himantopus himantopus*
Pratincole *Glareola pratincola*
Grey-headed Gull *Larus cirrocephalus*
White-winged Black Tern *Chlidonias leucoptera*
Whiskered Tern *Chlidonias hybrida*
Cape Wagtail *Motacilla capensis*
Yellow Wagtail *Motacilla flava*

Observations on some aberrant Australian Anatidae

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Summary

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

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

Introduction

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

Of the 13 genera represented, six (*Anseranas*, *Cereopsis*, *Chenonetta*, *Biziura*, *Malacorhynchus* and *Stictonetta*) are essentially limited to Australia and are monotypic. The taxonomic positions of several of these have been disputed at various times. Thus, the Magpie Goose *Anseranas semipalmata* is generally regarded as representing a distinct tribe and subfamily, a conclusion supported by abundant anatomical (Boetticher, 1943, Miller, 1919, Delacour, 1954, Woolfenden, 1961), biochemical (Sibley, 1960, Tyler, 1964) and behavioral (Johnsgard, 1961) evidence. However, Davies and Frith (1964) have

recently advanced the theory that the Magpie Goose is possibly a typical goose that has been modified through the action of convergent evolution into its present form, a view which presently appears to have little supporting evidence. The Cape Barren Goose *Cereopsis novae-hollandiae* likewise exhibits a combination of sheldgoose-like features (Delacour, 1954) contrasted with anatomical and behavioral similarities to the true geese (Woolfenden, 1961, Johnsgard, 1961). The Maned Goose *Chenonetta jubata*, once included with the sheldgeese, s now generally agreed to represent a southern hemisphere perching duck. The Musk Duck *Biziura lobata*, although large and grotesquely wattled, clearly exhibits affinities with the typical stiff-tailed ducks (*Oxyura*). The shoveler-like Pink-eared Duck *Malacorhynchus membranaceus* has, in the absence of contradictory evidence, been usually regarded as an aberrant dabbling duck, and the same applies to the little-studied Freckled Duck *Stictonetta naevosa*.

Because neither of these two latter species has been kept in captivity outside Australia, and since there was such a paucity of behavioural information regarding them, I planned a trip to Australia for the primary purpose of learning whatever was possible regarding the behaviour and probable relationships of these birds. In addition, I wanted to observe and film the displays of the Musk Duck and Blue-billed Duck *Oxyura australis*, for, although some accounts of the behavior of these species do exist, I wanted to obtain detailed information for future comparison with the South American and African stiff-tails. My notes on the displays of the Australian stiff-tails will be published separately (Johnsgard, in press), and only some general observations on them will be made here.

Pink-eared Duck

The Pink-eared Duck is regarded as a reasonably common bird in southeastern Australia, and it occurs generally over the continent as well. It is highly nomadic, however, and numbers in a particular area may vary enormously from year to year. I observed several hundred Pink-ears on the Metropolitan Farm, 30 miles southwest of Melbourne on 13th July, and had under daily observation a flock of nearly 500 birds at Kangaroo Lake, near Kerang, northern Victoria, from 16th July to 7th August, 1964.

My first impression of the species was that the duck is smaller and stockier than I had visualized, and that the tail and rump are held quite high in the water while swimming, exposing a buffy undertail colouration that is quite conspicuous. Not all the birds exhibited such markedly buffy coloring, and I suspect that this variation must have sexual or seasonal significance, but I could not resolve this point. Aside from this, the strong vertical barring on the flanks sets the Pink-ear apart from all other Australian waterfowl, and its colloquial name, 'Zebra Duck', is an apt one.

Throughout my stay the Pink-ear remained by far the shyest of the ducks I observed. Repeatedly, large flocks would take to the air at the slightest disturbance, accompanied by a chorus of whistled alarm notes. The passing over of even such innocuous birds as the Australian Pelican *Pelecanus conspicillatus* would cause a general panic among the Pink-ears, and the first sight of any raptors was certain to produce the same effect. However, I was told by several persons that at times Pink-ears are amazingly tame, and will remain oblivious to human beings only 20 or 30 yards away.

Pink-ears fly extremely well, and are reminiscent of various small dabbling ducks in their agility and manoeuvrability. Indeed, the Grey Teal *Anas gibberifrons* is often associated with Pink-ears, and the two species exhibited much similarity in flight. The long, flap-tipped bill is conspicuous in flying Pink-ears, and is often tilted slightly downwards, while the wings alternately flash their white undersides and brown upper surfaces. No speculum is present, but the secondaries and inner primaries do have a pale whitish trailing edge. Another plumage feature visible in flight that I had not anticipated is the white crescent on the upper tail coverts immediately in front of the brown tail. This feature resembles the similar crescent patterns of whistling ducks and geese which, like the Pink-ear, lack specula or contrasting upper wing patterns. I therefore wondered if this plumage feature (which is not found in any other dabbling ducks) might be of significance in coordinating the flock movements of flying birds.

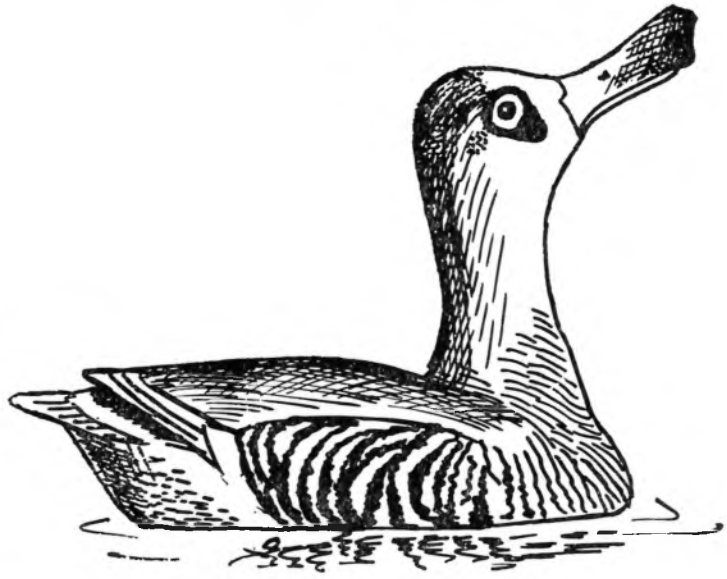
Because the birds called almost constantly in flight (and a flock of Pink-ears could often be recognized by sound long before they could be visually identified), it is almost impossible to describe the flight call as anything more than a clear, tittering whistle. I am uncertain whether both sexes can whistle, but at least the male has a pure whistled note. The trachea of the female shows no obvious specializations for whistling, but H. J. Frith informed me that the tracheal bulla of the male is very similar to that of the Grey Teal. Warham (1959) describes the male's call as a 'loud fluty

cry,' and that of the female as a purring note. I observed an apparent female utter a sharp, rapid series of 'Whe-he-he' notes towards another bird, which, although not a true whistle, was quite unlike the typical female dabbling duck calls.

Displays described in the literature for the Pink-ear fall into two categories: head-bobbing displays (Scott, 1958, Hobbs, 1957) and ritualised foraging displays (Shanks, 1953). Among the typical dabbling ducks, the shoveler group is noted for its conspicuous head-bobbing and 'mock-feeding' displays (Lorenz, 1951–1953), and I was therefore eager to compare the behavior of the Pink-ear with that of the typical shovelers.

I first observed the communal foraging of Pink-ears on July 16 at Kangaroo Lake, but I was never sufficiently close to the birds to film this interesting behavior pattern. In the typical shovelers, communal foraging (unritualised, and performed by both sexes at all times of the year) consists of several birds swimming head-to-tail, with each bird dabbling in the wake of the one before. Such foraging groups may become circular when the leading bird begins to follow the hindmost individual. Ritualised foraging, or 'mock-feeding', is performed by males to females and consists of apparent dabbling in front of or beside the female, without much forward swimming, and often terminated by calling or up-ending. In the Pink-ear, communal foraging takes a different form, for the birds tend to feed in pairs, and only rarely in trios or larger groups. Further, each bird tends to keep its body parallel to its partner, but turns its head towards its partner's tail, and the two birds forage in each other's wake as they rotate in a tight circle. Occasionally, even a single bird will attempt to feed in its own wake. This type of feeding is obviously most effective when performed by two birds, and thus accounts for the tendency of large flocks to break up into apparent pairs when foraging in this manner. However, it would be presumptuous to suggest that such foraging is totally lacking in social significance, for I often observed that when an 'outsider' attempted to enter such a feeding circle, there was a pronounced chin-lifting, clearly hostile, response from one or both of the participants. This upward bill-tilting (from 45 to 60 degrees above the horizontal), accompanied by neck-stretching and a series of rising 'we-we-we-we-we-whew' notes, closely resembled chin-lifting of shovelers and various other dabbling ducks. No lateral inciting movements were observed, and if an inciting display does occur in the Pink-ear, it probably has this same chin-lifting form as found in the shovelers.

Two probable male displays were observed. Sometimes, during a pair's foraging, a presumed male would suddenly draw its bill out of the water, stretch its neck into an erect posture, and momentarily hold this stiffened, alert position before resuming foraging. The posture reminded me of the 'At-attention' (Wall, 1961) display of various dabbling and perching ducks. This same erect posture was also often assumed after a curious bill-tossing call, which was performed only by birds I judged to be males. In this display the bird would toss its bill upwards and rapidly lower it while its neck was held vertical, and a hoarse and cat-like 'Who-



ee-oo' call was uttered. At times the call would be repeated once or twice in rapid succession. Although the call appeared frequently directed to presumed females, at other times it seemed to be uttered at random. Suggesting the possibility that this behaviour is a major pair-forming display is the fact that birds which uttered this call were often immediately attacked, or at least threatened, by other probable males. I also saw one possible male display performed as a presumed female swam past: a lateral head-shake (made conspicuous by the enlarged bill), followed by a dorsal preening in the region of the scapulars.

A few other behaviour observations might be of interest. Lateral head-shaking was the only pre-flight movement I observed. Upending was never observed by me, but two birds were seen to dive using opened wings) in the course of preening and bathing.

The Lowes have recently observed three copulations, involving two different pairs, which indicate that the species diverges markedly from *Anas* in its copulatory behaviour. In each case the male flew in from a distance and, as it landed about twelve yards from the female, greeted her with a loud flute-like whistle, to which the female replied similarly. The male immediately swam to the female and, with no apparent preliminary displays, mounted her. Following a rapid copulation both birds performed rapid, energetic dabbling and "head-tossing" movements (seven and ten in two cases counted), terminating with a single preening movement on the breast, wingflapping, and finally swimming about in small circles and up-ending as if feeding. How much of this postcopulatory behaviour represents actual display is uncertain, but in any case these observations suggest that a very distinctive copulatory behaviour exists in Pink-eared Ducks.

In summary, its behaviour suggests that the Pink-ear belongs in the large assemblage of dabbling ducks but that it is not necessarily extremely closely related to the typical dabblers. Although the body form, foraging adaptations, and, to some extent, the displays of the Pink-ear are reminiscent of shovelers, it is probable that these traits are simply splendid examples of convergent evolution in which similar ritualised behaviour patterns have evolved from independent evolutionary sources. Precopulatory behaviour has not yet been adequately described. Tom Lowe's observations suggest that an *Anas*-like precopulatory head-pumping is absent and that the postcopulatory behaviour may be unusual as well.

Freckled Duck

For nearly ten years I had cherished a dream of studying the Freckled Duck in life, for although this bird is among the least impressive of all the Anatidae in beauty, so little is known of its biology that I have long considered it the most important species of waterfowl to be investigated behaviorally.

My suspicions that the Freckled Duck was something other than just an aberrant dabbling duck were aroused by the skeletal studies of Verheyen (1953) who, in spite of his doubtful taxonomic interpretations, completed a fairly comprehensive survey of skeletal variations in waterfowl. He concluded that the Freckled Duck's anatomy was sufficiently distinctive to warrant 'family' status (corresponding in Verheyen's treatment roughly to the tribes of Delacour), but exhibiting affinities with both the whistling ducks and the pochards. The large number of 'primitive' features found in the Freckled Duck cannot be easily reconciled with the generally specialised characteristics of the dabbling ducks, and I was forced to conclude (1960, 1961a), that the species probably should be placed in the subfamily Anserinae, either in the Anserini or, more probably, in a separate tribe 'Stictonettini'. In the absence of available anatomical specimens, Woolfenden (1961) came to similar tentative conclusions, but felt that the whistling ducks might represent the Freckled Duck's nearest relatives. The contrasting downy plumages of the whistling ducks are highly distinctive and different from the weakly patterned or uniformly coloured young of swans and geese, but the absence of a description of the downy young of the Freckled Duck made this source of evidence unavailable until recently, when Frith (1964a, 1964b) described the downy plumage. Interestingly, the downy young of Freckled Ducks show no similarity to those of any dabbling ducks, but rather are a uniform silvery grey throughout. Among the ducks only the downy young of the Musk Duck nearly approaches that of the Freckled Duck, and the cygnets of Black and Mute Swans (*Cygnus atratus* and *C.olor*) are even more similar. Thus, additional evidence for including the Freckled Duck in the subfamily Anserinae is now at hand.

Although my major purpose in going to Australia was to locate the Freckled Duck, I had been forewarned by nearly everyone I contacted that the rarity of this species and its unpredictable movements precluded any real hope of locating wild birds. My optimism was further weakened upon

corresponding and talking with several of Australia's most active ornithologists, some of whom confided that they had never seen the species and politely wondered how I might not only locate it but also study its behaviour in the relatively few weeks I had at my disposal. Although a plea for assistance in locating Freckled Ducks had gone out from Roy Wheeler to the members of the Bird Observers Club of Victoria, no promising responses resulted, and I therefore decided to begin searching areas such as the Kerang region, where records of Freckled Ducks were fairly numerous and where Vic and Tom Lowe had promised to help me try to locate the species.

The Lowes had previously recorded Freckled Ducks in seven different months of the year, with a maximum number of 200 recorded in September 1957. Before my arrival some preliminary searches on their part had not produced any Freckled Ducks, and so it was without a high degree of optimism that we set out on 19th July to search in a few likely spots.

One promising place was Cullen's Lake, where Harry Wright of the Victoria Fisheries and Wildlife Department had observed a few birds some weeks previously. It was a cold, windy day, with periodic showers, and as we scanned the choppy waters I could see only Musk Ducks, Pink-ears and a few Grey Teal. After fruitlessly searching an area of shoreline and shallows well lined with protruding fence-posts (a favourite Freckled Duck roosting site), I suggested to Tom that we try counting the sex ratio of the Musk Ducks. As we walked up to the shore to improve our view, we flushed a large flock of ducks that had been resting in a shallow bay hidden from my vision. As the flock flew away I scanned it with unbelieving eyes; although the birds appeared nearly the size of Grey Ducks *Anas superciliosa* and were nearly as dark, I could see no trace of a metallic speculum. Tom ended my uncertainty with a shout that they were indeed Freckled Ducks! The flock of approximately 180 birds landed near the middle of the lake, but gradually swam back toward the lee shore. The birds remained in gradually declining numbers on the lake until I left the area on 7th August, by which time nearly all of them had dispersed and vanished. The following observations are based on this single flock, and include several points of doubtful significance, mentioned only because of the rarity of concrete information on the species.

General appearance

Although my first impressions of flying Freckled Ducks was to be reminded of Grey Ducks, I later decided that they have an even stronger similarity on the wing to Gadwall *Anas strepera*. Like Gadwall, they have a silvery white underwing lining and abdomen, contrasting with a rather uniformly dark breast, head and upper surface (but lacking the white speculum of the Gadwall). Their pattern of flight is generally like that of a dabbling duck, being both swift and somewhat erratic. The accompanying table shows the rate of wingbeats determined from cine footage for various conditions of flight, as compared with typical dabbling and whistling ducks. Although Frith (in Delacour, 1956) states that the wingbeat is normally slow and bittern-like, I did not find this to be the case. Rather, the rate of wingbeats is almost as rapid as a Mallard's (*Anas platyrhynchos*), and faster than a Fulvous Whistling Duck's (*Dendrocygna bicolor*). On the water the birds present a profile similar to that of a typical dabbling duck, with the tail held somewhat out of the water (but not nearly as high as in the Pink-ear). Except when alert and ready to fly, the head and neck are not held very high above the body; indeed, the birds generally present an impression of being rather sleepy, with the bill held only slightly above the level of the breast. The head appears surprisingly large, but this is the result of the elongated feathers in the occipital region, resulting in a short crest and a distinctly triangular head profile. This distinctive head profile is an excellent field mark for sitting birds, and allows for easy distinction from such species as Grey Ducks. Although the bill is high and robust

Table I. Rate of wingbeats in Freckled Ducks as determined from films

	total wingbeats	*total seconds*	*ave. wingbeats/second*
Freckled Duck			
losing altitude	58	7·7	7·5
sustained flight	91	11·4	8·0
taking off	41	3·9	10·6
Mallard			
sustained flight	75	8·7	8·6
Fulvous Whistling Duck			
sustained flight	47	6·8	6·8

at the base, the culmen profile is very concave, and the outer part of the bill is strongly flattened and almost spatulate. The nail is fairly sharp and, curiously, is slightly recurved as in the typical stifftails (*Oxyura*). In fact, the total bill shape is probably more like that of an *Oxyura* than of a dabbling duck.

Sexual differences are minor and did not allow me to determine the sex ratio of the flock. Birds that were undoubted males had a more distinct occipital crest, a tendency toward a blackish rather than brownish head (especially on the cheeks), and a variable amount of red on the bill. This last point is one which has been disputed (Frith, in Delacour, 1956), but there can be no doubt that a brilliant, sealing-wax red colour appears at the base of the bill (extending to a point just beyond the nostrils) of males during the breeding season. In the flock I observed, only two birds had brilliant red bills, while nearly 20 more had variable indications of red on the bill. Evidently the colour is retained for a very short time; Vic Lowe informed me that he has not observed it in hundreds of Freckled Ducks he has seen shot during the hunting season. This seasonal occurrence of bill colour is of interest, and it, plus the tendency of the male to assume darker, more distinctly crested head than the female's, belies the generality that Freckled Ducks do not exhibit sexual dimorphism. In this regard, therefore, they cannot be considered wholly typical members of the subfamily Anserinae (although some swans show slight amounts of sexual dimorphism). Mr. Harry Wright informed me that he believes the male loses its crest and blackish head during the non-breeding season, suggesting at least a partial double moult, which is also an anatine characteristic. Aside from the Freckled Duck, only some of the stiff-tails (*Oxyura* and *Heteronetta*) display a conspicuous seasonal variation in bill colouration, and the situation in the Black-headed Duck *Heteronetta atricapilla* is remarkably like that of the Freckled Duck. The male Black-headed Duck's bill is very similar in shape to that of the Freckled Duck, being high at the base, flattened at the tip, and with a recurved nail. Furthermore, it develops a bright orange to red colour at the base of the bill during the breeding season. Other notable similarities of males of the two species include their blackish heads, greyish to brownish body plumages, the absence of wing specula, and rusty-brown undertail coverts. The downy plumages, however, are very dissimilar, and the females are likewise quite unlike.

General Behaviour

The similarity of Freckled Ducks to dabbling ducks in flight has been mentioned, but I noticed that in leaving the water Freckled Ducks appear unable to spring directly out of the water in the manner of dabbling ducks, and instead run for several feet along the surface. By investigating my films I verified this behaviour and determined that in four cases that could be analysed up to nine steps (average seven) were taken while clearing the water. It is probable that variation does exist here, depending on wind velocity and urgency of take-off, but it was an unexpected observation and seems worth noting.

Although I observed Freckled Ducks flush literally dozens of times, often when frightened by Whistling Eagles *Haliastur sphenurus* or White-breasted Sea Eagles *Haliaeëtus leucogaster*, I never heard any alarm calls by any of the birds either while taking off or as they were milling about overhead. This is quite different from the situation in typical dabbling ducks, in which both sexes usually exhibit alarm calls.

Another surprising point was that, although Freckled Ducks were usually much more numerous than other species with which they associated, mainly Australian White-eyes *Aythya australis*, Shovelers *Anas rhynchotis*, Pink-ears, and Grey Teal, these other species seemed much more alert than the Freckled Ducks and were always the first to flush at the approach of possible danger. This evident tameness (or stupidity) of Freckled Ducks was impressed upon me the second day of my observations, when I proceeded to set up a wood and burlap blind along the shoreline some 100 yards from the birds' usual foraging area. Deciding that the only way to set up the blind was to march brazenly down and get the job done without regard for the likelihood of flushing the birds, I began to pound in the supporting stakes in full view of the entire flock. Although the Coots *Fulica atra* and other duck species had flushed at my first appearance, the Freckled Ducks remained, and about 30 of their number left the main flock and swam directly toward me, stopping and watching when they reached a distance of some 30 yards from me. I frantically finished the blind and disappeared behind it, at which time the birds lost interest and swam away in a leisurely manner! It is possible that this apparent stupidity is the main basis for the colloquial name 'Monkey Duck'; however, Harry Wright has suggested (personal com-

munication) that the tendency of the birds to climb out of water and perch on floating logs or flooded posts and timbers might also account for this name, which is commonly used by Victorian hunters.

During most of the day, the birds swam about in flocks of 50 or so near the middle of the lake, resting or sleeping and showing no interest in foraging. The lake is a shallow one, possibly ten feet deep at most, and has an extensive growth of aquatic plants which often break and drift in to form windrows along the shoreline. The only foraging I observed occurred very close to shore, while the ducks swam or stood in shallow water and immersed their bills just under the water's surface. I observed neither up-ending nor diving, but doubtless at least the former is used occasionally, since Hobbs (1957) reported upending by birds feeding in about two feet of water. Although the birds were obviously filter-feeding, I have no real idea of what they were consuming. H. J. Frith (personal communication) believes that Freckled Ducks feed largely on plankton-sized food particles. The flattened and concave-shaped bill may have functional significance here, by allowing the tip of the bill to filter-feed while still keeping the nostrils above water. While swimming from the middle of the lake to the foraging area along shore the birds showed a strong tendency to 'follow the leader', swimming in single file at a speed determined by the leading bird.

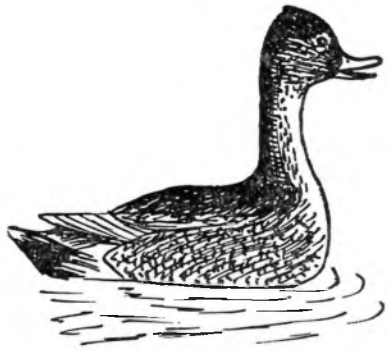
Although I did not personally observe nesting, some notes regarding nests and young were sent to me from Mr. Len Harvey. He mentions finding clutches of seven and nine eggs, and seeing three broods numbering from seven to nine young. In one instance, both parents were present with the young while in the other two, only the female was seen. Thus, it remains uncertain whether both sexes normally participate in incubation and brood care.

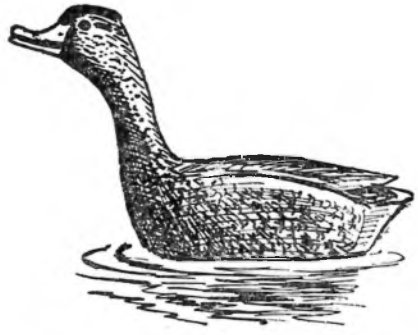
Vocalisations

Little has been recorded concerning the calls of Freckled Ducks. Delacour (1956) mentions only a pig-like grunt and a cat-like mewing note, and so I wanted to try to resolve this point. In spite of attentive listening on my part, it was not until 22nd July that Tom Lowe and I definitely identified a call as that of the Freckled Duck. This was a series of rather protracted, muttering notes, which we agreed was a 'hissing, raspy murmur', scarcely audible at a distance of over 30 or 40 yards. We also heard several sharper, flute-like calls which, we believed, emanated from the Freckled Ducks, but we couldn't locate the individuals responsible. H. J. Frith (personal communication) has also heard a number of different calls in his captive Freckled Ducks. It is certain, however, that Freckled Ducks are similar neither to dabbling ducks nor to whistling ducks in their vocalisations. Considering the almost complete absence of visual display structures, one is forced to conclude that auditory display specialisations must exist. There is a slight sexual dimorphism in the structure of the trachea, for although both sexes lack a tracheal bulla, the male does exhibit two enlargements of the tracheal tube (Campbell, 1899).

Sexual Behaviour and Displays

Considering the large number of birds under observation, the relatively long (three week) period they were studied, and the fact that, judging from bill colouration, at least some of the males were clearly coming into breeding condition, it might be expected that pair-forming activity would have been frequently observed. Yet, in spite of these favourable conditions, I saw very little that could be interpreted as pair-forming behaviour and thus was led to conclude that such activities must be poorly developed and inconspicuous at best in Freckled Ducks. An inconspicuous courtship is typical in the subfamily





Anserinae, for whistling ducks appear to lack elaborate 'courtship' postures, and among the geese and swans the 'triumph ceremonies' appear to play a major role in pair formation. In the true ducks of the subfamily Anatinae there is usually considerable dimorphism in the behaviour of the sexes, and variably complex displays are exhibited by the males.

In the Freckled Ducks I could see no indication of pair bond attachments between individual birds, and no tendency for small groups to separate out as courting parties, as might be expected among dabbling ducks. I particularly looked for, but failed to find, a female inciting display, which is of widespread occurrence in the subfamily Anatinae (Johnsgard, 1962). Likewise, I looked for evidence indicating the presence of a triumph ceremony similar to that of geese or swans, and the only clear-cut display I observed might possibly be interpreted as such. This display, seen on several occasions, is a rapid and extreme vertical neck-stretching, associated with gaping (and probably calling), performed by one bird towards another while facing it, and to which the other responds in the same manner. The display is preceded by forward neck-stretching and gaping by one bird toward the other, in what would appear to be hostile posture. In one case a red-billed male performed this display to an apparent female, who then responded by the vertical neck-stretching. This behaviour could most readily be interpreted as a mutual threat display, but it is similar in form to the triumph ceremonies of some swans and geese. The general absence of colour patterns on the wings and body and their concentration on the bill fits the supposition that Freckled Duck displays probably mainly involve head movements and possibly vocalisations, as in the triumph ceremonies of swans and geese. However, I did not observe prior attacks or threats towards other individuals of the type which usually elicit triumph ceremonies in swans and geese.

Unfortunately, no copulatory behaviour was observed, and a knowledge of copulatory displays, particularly precopulatory displays, would be of the greatest value in evaluating Freckled Duck relationships. Should a goose-like mutual head-dipping precopulatory display be present, this would strongly favour the hypothesis of anserine affinities, as would the occurrence of a mutual postcopulatory display. However, some of the true ducks exhibit head-dipping and mutual postcopulatory displays, and so even these findings would have to be viewed with caution.

In summary, although I believe that too many uncertainties remain to allow an unequivocal statement of the Freckled Duck's relationships, none of my observations suggest that the Freckled Duck is an aberrant dabbling duck, for it apparently exhibits none of the typical specialised behavioural features of that group. Furthermore, although much of what I observed could be interpreted as indicating that the Freckled Duck is an extremely generalised species with many primitive and apparently anserine features, there is no real justification for including the species in either the whistling duck tribe or that of geese and swans. Finally, and this came as a personal surprise, a few of the features of Freckled Ducks are reminiscent of the stiff-tails and particularly the Black-headed Duck. Therefore, I am led to the conclusion that the only reasonable taxonomic procedure is to erect a monotypic tribe (Stictonettini) for the Freckled Duck, and to include it within the subfamily Anserinae, as I first suggested in 1960. Nonetheless, the several obviously duck-like features of the species suggest that the bird is descended from stock that probably gave rise to the true ducks of the subfamily Anatinae, and particularly the stiff-tails. A detailed anatomical comparison of the Freckled Duck and the Black-headed Duck might shed some light on this possibility. Of greater importance than the simple relegation of this species to a convenient taxonomic niche is the need for a realisation of the Freckled Duck's evolutionary status as a surviving generalised form that needs to be studied further in all respects, and to the best of our abilities we should protect it from its present danger of extinction.

Musk Duck

The Musk Duck is a common species over much of southern Australia, and can frequently be observed off the coastline in winter. Most of my observations were obtained at Kangaroo and Cullen's Lakes, where several hundred of these birds were present throughout my stay. According to Vic Lowe Musk Ducks are seen at Kangaroo Lake throughout the year, and young have been sighted from as early as September to as late as April.

In spite of the evident abundance of the Musk Duck, information on its behaviour is surprisingly scanty and contradictory. Thus, although the Musk Duck is reputed to fly almost only at night, Vic and Tom Lowe have observed adults of both sexes fly on numerous occasions, and I observed a total of four different birds in flight. In each case, the birds, all females, flew towards shore from some distance out in the lake, first pattering over the surface

some 30 to 40 yards, then clearing the water by a foot or two, and flying 100 yards or more before 'crash landing' into the calmer water near shore. In each instance, the wind was blowing off shore at an estimated 20 to 25 miles per hour, but Tom Lowe has observed Musk Ducks take off from calm water and fly as high as seven feet above the water surface.

The calls of the Musk Duck have similarly been disputed and variously described. The whistling call of the male, a clear penetrating note rather similar to that of the White-backed Duck *Thalassornis leuconotus*, has been described by several observers. Mack (1959) describes it as a 'Chee-ip' or 'Chee-eep', and he heard it only from wattled birds (thus, adult males). Likewise, I heard this call only in birds that appeared to be adult males, and, furthermore, I observed it only in association with a specific display I have termed the Whistle Kick (Johnsgard, in press). Tom Lowe tells me that he is certain he once heard the whistle produced by a bird possessing no evident wattle, and Vic Lowe twice observed a male utter a whistle when it saw a hawk flying overhead. Interestingly, the Lowes have heard this note whistled every month of the year, and during practically all hours of the day and night. During the time I was at Kangaroo Lake it was unusual to go outside at night and not hear a Musk Duck whistling in the distance. The note can be readily heard for a half mile or more under favourable conditions.

The other sound commonly attributed to the male Musk Duck is the 'plonk call', which Gould fittingly described as resembling the noise produced by a large object falling into a deep well. Although there is little disagreement regarding the nature of the sound, its origin is far less certain. Some authorities suggest it is vocally produced, while others have attributed it to the slapping of the tail or the feet on the water. I am convinced that the sound is made by the outstretched webs of the feet as they slap downward on the water following one of the several types of kick displays (Johnsgard, in press).

To my knowledge no calls have been attributed to the female, and I personally heard none, but the Lowes and Mr. David Dent heard a female accompanied by a well-grown young utter a gabbling note as an apparent warning call. Mr. Lowe thought that the call was similar to the barking call of a Crested Grebe *Podiceps cristatus*.

There has been some speculation as to the type of pair bond, if any, found in the Musk Duck. I made a few sex ratio counts, and found an approximately equal ratio. In the absence of marked birds, no definite evidence of pair relationships could be established, but I seriously doubt that any pair bond exists, and believe that males are completely promiscuous in their contacts with females. Unlike the pair-forming behaviour of other waterfowl, in which males actively seek out and display to unpaired females, male Musk Ducks typically begin their displays alone, and apparently rely on the combination of loud splashes and vocal noises to attract females. This importance of auditory signals may explain the tendency for display to occur in total darkness, and the absence of bright colouration on male Musk Ducks. The sounds of a displaying male are clearly effective in attracting both females and other males; I have seen Musk Ducks interrupt preening or sleeping to swim promptly toward the sound of a displaying male that was completely hidden from view around a point and over 100 yards away. Why other males should be attracted to displaying birds is uncertain, but they showed a keen interest in watching such birds, and occasionally approached quite close. Displaying males would usually not attack other 'onlooker' males unless they approached too closely the females that had also been attracted to the display.

Like other stiff-tails, Musk Ducks are excellent divers, and while foraging much time is spent under water. I timed one undisturbed foraging male that spent an average of 24·4 seconds under water in 14 consecutive dives (range 15 to 32 seconds), while in the intervening 13 periods he was surfaced an average of 15·5 seconds (range 10 to 25 seconds). When frightened the submergence time is much greater.

There can be little question that the Musk Duck is a stiff-tail and that its nearest relatives comprise the genus *Oxyura*. However, I was surprised by the similarity of the whistled notes of Musk Ducks and White-backed Ducks, and impressed by the remarkable similarity of the general plumage patterning of these two species, a fact which Scott (1958) had also noticed when he first observed the birds.

Blue-billed Duck

The Blue-billed Duck is relatively rare in Australia, and is limited as a breeding bird to the permanent swamps that are well-lined with emergent vegetation. Although it nests in the Kerang area, it is far more abundant as a winter visitor. During July and early August it was easily the most common of the ducks on Lake Kangaroo. On 30th July I counted over 1,600 Blue-bills along a mile of shoreline centred on the

Lowes' property, and, considering that the lake is approximately four miles in length, the actual population was doubtless several thousand. These flocks typically arrive in early winter, but Vic Lowe informed me that there is great variation in numbers, with few birds arriving in some years, and in any case most disperse prior to the nesting season.

According to Delacour (1959) there is no record of an eclipse plumage in Blue-billed Ducks, but I am convinced that a female-like winter plumage does exist. The Lowes have noted that in early winter flocks of Blue-bills, the female-like birds may outnumber obvious males by as much as 20 to one, but that this ratio rather rapidly drops towards equality. In late July I made various sex ratio counts in which males always predominated (cumulative total 445 males to 266 females), but many of the males showed varying degrees of female-like feathering. At the time I left Kangaroo Lake (7th August) a minority of the males had assumed the brilliant blue bill colour typical of breeding birds, but pair-forming activity was becoming quite intense. The nesting season of Blue-bills is probably more restricted than that of Musk Ducks; the Lowes have observed young in the months of November, December, March and April, while Wheeler (1954) reports the nesting season at Ballarat (central Victoria) extends from November to early February.

Vocalisations in the Blue-bill are apparently poorly developed, as Delacour (1959) suggests. Shanks (1954) heard a male utter a 'quack' like a Grey Duck, as he attacked a female. Tom Lowe has heard a repeated 'Kek-kek-kek . . .' or 'Bub-bub-bub . . .' note, but is uncertain which sex was responsible. This call probably corresponds to a 'Teh-teh-teh . . .' which Tom and I heard females utter when they were gaping toward males, and which is quite different from the squeaking note uttered by female North American Ruddy Ducks *Oxyura j. jamaicensis* under the same circumstances.

Acknowledgements

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Returns from Steller's Eiders banded in Izembek Bay, Alaska

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Summary
The author has recorded observations of a large wintering population of Steller's Eiders in Izembek Bay for eight years. From 1957 through 1962 the birds arrived in early fall to complete the post nuptial moult in the Bay. Advantage was taken of the flightless period to band 833 of the eiders. Methods are described along with observations of the bird's behaviour. In 1963 and 1964 the moult was completed elsewhere on the migration route and the population arrived nearly three months later that before. Returns from the Soviet Bird-Ringing Centre indicate the moult to have taken place in Siberia, the principal nesting ground of the Steller's Eider. The remarkable fact is that in some years many of these birds migrate upwards of 3,200 kilometres before the post nuptial moult.

Wintering populations of Steller's Eiders *Polysticta stelleri* are known from the waters of Kodiak Island west along the south coast of the Alaska Peninsula and the eastern Aleutian Islands (Gabrielson and Lincoln, 1959). This writer has observed them in the area of the western half of the Alaska Peninsula where they are known colloquially as 'Scotchies'. A considerable segment of this population, aggregating roughly 200,000 birds at its peak, moves in and out of three large lagoons on the north coast of the Peninsula, dependent on freezing and thawing conditions. These are Nelson Lagoon, Izembek Bay, and Bechevin Bay (at the north end of Isanotski Strait). These, together with the intervening coast form the western end (about 125 miles) of the Alaska Peninsula. McKinney (1959) has recorded his observations of waterfowl in these areas. The peak population of the little Steller's Eider is reached in this area in April, when about half of them are in Nelson Lagoon and the other half are divided between Izembek Bay and Bechevin Bay. The peak occurs on the eve of spring migration when these lagoons are ice-free and all other water areas farther north are still frozen. In Nelson Lagoon these birds are associated in April with even larger numbers of King Eiders *Somateria spectabilis*, and several thousands of Common Eiders *Somateria mollissima v-nigra*, Scoters *Melanitta nigra americana* and *M. fusca dixoni* and Old Squaw Ducks *Clangula hyemalis*. In Izembek Bay and Bechevin Bay they are associated in April with about 30,000 Emperor Geese *Anser canagicus* and 70,000 Black Brant *Branta bernicla orientalis*.

The arrival date of the Steller's Eider population in Izembek Bay in fall has proven strikingly variable. Some years most, if not all, of these birds arrive in August to perform the post nuptial moult in the three lagoons of this area, while other years they arrive almost three months later, having completed the moult at some other point on their migration route. For six years, 1957 through 1962, the moult was conducted in these lagoons but in 1963 and 1964 only about 5% of the population appeared until after the moult. We do not have a record of the arrival date for 1963, but in 1964 between sunset 6th November and midmorning of 9th the population appeared in Izembek Bay in an avalanche migration.

In 1961 we began banding these birds during the flightless period. At low tide Izembek Bay becomes a pattern of exposed mud and sand bars with channels running between them. We found that the flocks of flightless eiders could be driven up these channels from the deeper portions where they normally rest, into the shallow water at the channel's head. Here they could be held in a compact flock while a trap was installed, generally upchannel. When all was ready, the flock could usually be driven into the trap. Anyone who has engaged in this type of endeavour will recognise that there is no certainty in capturing wild birds. These were day to day operations, taking

into account suitable weather, and scheduled to complete the drive at about low water. Large numbers of birds could not be handled because the returning tide would flood trap and crew. The largest number we ever captured was about 250, not all of which were banded. The flocks are often much larger, but we 'cut out' a group of suitable size.

We found that the males and females tended to segregate in the moult, and our catches were therefore predominantly of one sex or the other. We also found a distinct difference in behaviour under these conditions between the two sexes. The males proved relatively easy to handle, for they generally did not struggle and remained almost completely silent. The females on the other hand struggled vigorously, squawking outrageously. When we handled a flock of females our hands became severely scratched by their struggling.

A modest total of 833 birds was banded in 1961 and 1962, but little was accomplished in the next two years because there were few birds available in the moult. Accustomed as we were to very large numbers of Steller's Eiders in Izembek Bay during late August and early September we were dismayed when only about 10,000 appeared to moult in 1963. This might seem to be enough for banding on our scale of operations, and indeed it would if they were all in one channel conveniently located for our purposes. But the Bay is large and the birds did not make themselves available. They did, however, appear in time for the Christmas Bird Count and were present in April 1964 about 100,000 strong in Nelson Lagoon and a roughly equal number divided between Bechevin Bay and Izembek Bay, the latter having the larger number.

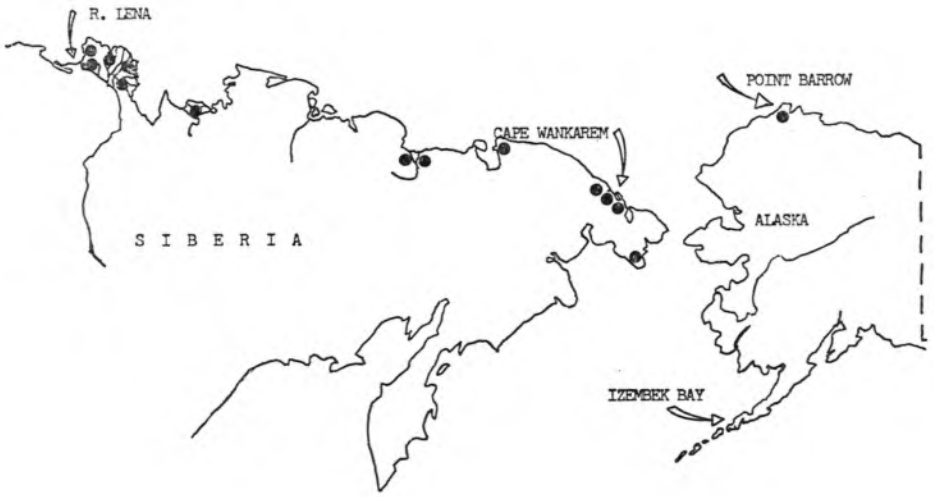
In the fall of 1964 when again the large numbers failed to materialise for the moult we were more curious than concerned. By this time we had received returns from the Bird-Ringing Centre in Moscow, USSR indicating that the bulk of the population of Steller's Eiders wintering in the Alaska Peninsula area nest on the coast of the Arctic Ocean in Siberia, some of them as far west as the delta of the River Lena. This is not particularly remarkable in itself for we have Nelson's (1883) account of large numbers about Cape Wankarem, Siberia, but it does seem remarkable that in six of the eight recorded years some of these birds should travel upwards of 3,200 kilometres before the post nuptial moult. It also seems remarkable that this behaviour is not constant from year to year.

Thus far seventeen returns have been received here, not counting our own recaptures (numbering 43) or those taken by hunters in the immediate banding area. Of these seventeen, one was recovered at Point Barrow, Alaska and the remainder came from Siberia (Table I). The locations of these recoveries in relation to the banding site are shown in the map opposite.

Fourteen of the Siberian returns are from birds taken in June and July, two in 1962, one in 1964 and the rest in 1963. The remaining two were killed at Cape Wankarem 15th September, 1963. These two are of especial interest because by this date in the six preceding years the Steller's Eiders in Izembek Bay were nearing

Table I. Recoveries in Siberia of Steller's Eiders marked in Izembek Bay, Alaska. All banded as moulting adults.

Date marked	*sex*	*recovery site*	*date recovered*
Sept 3, 1961	M	Near Nizhniye Kresty. 69°N, 157°E.	June 13, 1963
Sept 3, 1961	M	100 kilometres west of Khazach'ye. 71°N, 136°E.	June 19, 1963
Sept 5, 1961	F	Delta of the River Lena. 73°N, 127°E.	June 13, 1963
Sept 5, 1961	M	Delta of the River Lena. 73°N, 127°E.	June 13, 1963
Sept 5, 1961	F	Delta of the River Lena. 73°N, 127°E.	June 16, 1963
Sept 6, 1961	F	Delta of the River Lena. 73°N, 127°E.	June 16, 1963
Sept 6, 1961	M	Near Nizhniye Kresty. 69°N, 157°E.	July 10, 1963
Sept 6, 1961	M	Chetyrekhstolbowyy Island, Ostrova Medvezh'i, East Siberian Sea. 71°N, 161°E.	June 7, 1964
Sept 19, 1961	M	About 100 km east of Ambarchik, Magadan. 70°N, 162°E.	July 4, 1962
Sept 19, 1961	M	Cape Schmidt, Magadan. 69°N, 179°W.	July 9, 1962
Sept 7, 1962	M	Near Provideniya. 65°N, 174°W.	July 5, 1963
Sept 7, 1962	M	Near Wankarem. 68°N, 178°W.	July 24, 1963
Sept 7, 1962	M	80 kilometres east of Pevek. 70°N, 170°E.	June 00, 1963
Sept 10, 1962	F	Cape Wankarem. 68°N, 178°W.	Sept 15, 1963
Sept 10, 1962	F	Cape Wankarem. 68°N, 178°W.	Sept 15, 1963
Sept 10, 1962	F	Delta of the River Lena. 73°N, 127°E.	June 12, 1963



completion of the post nuptial moult.

These returns suggest that the eiders were moving eastward either slower or later than in the earlier years, but offer no clue as to why this disparity in behaviour should occur. In Alaska winter was slow to release its grip in the spring of 1964 and waterfowl nesting was consequently two to four weeks late. One might suppose that this was also true of Siberia. If so, it would explain the late migration in 1964, but offers no explanation for the late one in 1963. Clearly, if we are to answer these unknowns we must look to a Soviet observer in Siberia.

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The prospects for wild geese in the Netherlands

T. LEBRET

Summary

During their stay in winter quarters most species of wild geese are dependent upon the presence of suitable roosts. Various types of roosts, the factors responsible for their presence, and their prospects are discussed. Several State programmes (the 'Delta Project' and various drainage plans) will endanger a number of roosts in the Netherlands within the next 25 years.

White-fronted, Pink-footed and Bean Geese choose those localities where they may feed undisturbed rather than select special types of vegetation. Only the Brent Goose mainly feeds on the vegetation of the tidal zone of salt waters. The Greylag Goose shows a strong preference for tidal *Scirpus* fields along fresh and brackish estuaries.

Drainage and reallotment schemes tend to open up the regions concerned for agricultural development, which invariably leads to an increase of disturbance and to the departure of the wild geese. In the Netherlands great numbers of wild geese feed on well-drained fields, provided they are left undisturbed. The effect of drainage and reallotment schemes can be partly offset by the institution of disturbance-free sanctuaries elsewhere.

Since increasing numbers of wild geese will be concentrated on a decreasing acreage, the carrying capacity of the refuges must be in the focus of the protection plan for the wild geese in the Netherlands.

In the Veerse Meer, the first estuary closed as a part of the Delta Project, a nature reserve will be managed as a special goose refuge by the sowing of grasses. Further refuges of this type will be urgently required as the Delta Project goes on.

I. Introduction

The position of the wild geese in the Netherlands is a matter of concern since Atkinson-Willes (1961) has pointed out that in northwest Germany large areas where great numbers of wild geese used to winter have been permanently drained. Other areas in this region have been evacuated by the wild geese due to over-disturbance (Mörzer Bruijns, 1961). Most of these birds are now wintering in the Netherlands, so that a big proportion of the continental winter areas of the wild geese in Western Europe are now situated in this country. The Dutch Government, however, is carrying out several large-scale drainage and reallotment schemes, while others are in preparation. Moreover the Delta Project aims at the closure of the estuaries in the southwest. Started in 1954, it is to be finished in 1978. All these activities of the hydraulic and agricultural engineering services are a serious menace to the survival of wild geese in the Netherlands.

A detailed study of the factors determining the distribution of the roosts and feeding grounds of the wild geese seems urgently required. All possibilities of management in favour of the wild geese should be applied in all reserves where this is possible.

II. The roosts

In the years 1941–1946 the present writer was collecting data for an inventory of duck decoys in the Netherlands. This brought him into touch with other fowling practices, among which was the netting of wild geese. In most of the regions where it had formerly been common practice, netting had either died out or had lost most of its importance. In all cases this was said to be due to a decrease of the wild geese, attributed to the effect of drainage works carried out in the regions concerned. Formerly the meadows in these regions had been flooded from November to the beginning of March. Parts of the areas were completely inundated, while others were merely swamped. The geese were said to have fed during the day in the swampy parts of the area, concentrating at dusk on the wetter places.

Generally speaking the goose areas in the interior of the Netherlands have been evacuated. Those where the geese are still present or into which they have moved are all coastal regions, with the exception of Central Friesland, where winter floods still cover large areas. This suggests that the presence of suitable roosts is of prime importance for the distribution of wild geese in their winter quarters, in so far as they are not feeding in the tidal zone as Brent Geese and Greylag Geese prefer to do. For such species roosts and feeding grounds are more or less identical.

Roosts being of such dominant importance it seems necessary to have a clear picture of the ecological components of the roosts in this country. For this reason the roosts which have so far been described (Lebret, 1959, Philippona, 1962, 1963 and *in litt.*, Den Daas, 1963, Timmerman, personal communication) are listed below (Table I), classified according to their origin. The list is, of course, not a complete one, but includes practically all important roosts.

Table I. Goose roosts in the Netherlands. Locations with more than 500 roosting geese are printed in capitals. Wildfowl reserves are indicated by an asterisk.

GL Greylag Goose *Anser anser*
WF White-fronted Goose *A.a.albifrons*
BE Bean Goose *A.f.fabalis* and *A.f.rossicus*
PF Pink-footed Goose *A.brachyrhynchus*
BA Barnacle Goose *Branta leucopsis*

A. *Roosts on the Waddenzee*
Type: tidal sands and mudflats

1.	LAUWERSZEE	GL	WF		
2.*	MUDFLAT off the BANTPOLDER	BA			
3.*	Mudflat off the Noorderleegh	WF			

B. *Roosts in the Biesbos, on the Hollands Diep and the Haringvliet*
Type: sands and mudflat in tidal, fresh and brackish waters

4.	BIESBOS	GL	WF	BE	
5.*	SASSE PLAAT in the Hollands Diep	GL	WF	BE	
6.	TIDAL MARSH CROMSTRIJEN	GL	WF	BE	
7.*	VENTJAGERSPLATEN	GL	WF	BE	BA
8.	BENINGEN	GL	WF	BE	
9.	SANDBAR DIRKLANDSE SAS	GL	WF	BE	BA
10.*	SCHEELHOEK	GL	WF	BE	BA

C. *Roosts in the salt water estuaries in the southwest*

Type: sandbars

11.	ZEEHONDENPLAAT in the Volkerak	BE		
12.	ROGGEPLAAT in the Oosterscheldt	BA		
13.	SANDBARS in the Grevelingen	BE		
14.*	KATSE PLAAT in the Zandkreek	BE	WF	
15.	HOGE PLATEN in the Westerscheldt	WF	BE	
16.*	SANDBARS in the upper part of the Westerscheldt	WF	BE	

D. *Roosts on the IJsselmeer off the province of Friesland*

Type: sandbars in static shallow fresh waters of the IJsselmeer

17.	SANDBARS off GAAST	PF	GL	
18.	STEILE BANK near OUDE-MIRDUM	GL	WF	BA

E. *Roosts on the border lakes between the former coast of the IJsselmeer and the new IJsselmeerpolders*

Type: shallow places in static fresh waters

19.*	Shallows in the Zwarte Meer	WF	
20.*	Shallows in the Veluwe Meer	BE	

F. *Roosts in flooded meadow areas*

Type: floods

21.	FLOODS west of BEETSTERZWAAG	WF		
22.	FLOODS near the GROTE BREKKEN to the north of Tacozyl	WF		
23.	FLOODS in the HAAGSE BEEMDEN	WF	BE	
24.	FLOODS in the PUTTING, Zeeuws-Vlaanderen	WF	BE	
25.	FLOODS on the GROOT-EILAND, Zeeuws-Vlaanderen	WF	BE	

G. *Roosts in 'closed estuaries'*

Type: former tidal sands in static waters, closed from the sea as a part of the Delta Project

26.*	MIDDELPLATEN in the Veerse Meer	WF	BE
27.*	Shallows in the Braakmankreek	WF	

H. *Lakes and 'vennen'*

Type: static fresh waters of some size; 'vennen' are oligotrophic waters in the pleistocene

28.	IDSEGASTERPOEL, province of Friesland	PF	BA
29.*	Vennen near Duurswoude, east of Beetsterszwaag	WF	
30.*	Vennen in the Kampina, province N. Brabant	BE	
31.*	Vennen in the Strabrechtse Heide, N. Brabant	BE	

J. *Roosts on extensive frozen waters*

Type: any of the roosts mentioned above, most lakes in Friesland and

32. IJSSELMEER, west of the Noordoostpolder

General characters of the roosts

The roosts in our list have some basic characters in common. (a) The geese want to be surrounded by an extensive area of open waters, ice, sands or bare mudflat, where (b) vegetation is absent or at least very low and thin; and (c) they want to be undisturbed.

A fourth component should be mentioned here, as has been pointed out by Mulder (*in litt.*). This is (d) the geese want to roost where firm soil is present.

The significance of these components may be the following: Component (a): first of all the geese want to be safe from predators and during the hours of darkness they have to retreat to the most open type of habitat. Completely open surroundings make it impossible for them to be approached unperceived. Component (b) may have the same significance.

Components (c) and (d) are closely related, as tidal sandbars and extensive coastal shallows, where the geese can stand on firm soil when roosting, are as a rule free from all kinds of disturbance. Deeper waters, lakes and streams in the Netherlands are for the greater part integrated into the national transport system and therefore greatly disturbed by all kinds of shipping, nocturnal fishing, etc. It is with some doubt that component (d) – the possibility for the geese to stand on firm soil – is mentioned, but it is striking that it is present in all types of roosts in our list except in type H (lakes and 'vennen'). This suggests that the geese have a very pronounced preference for roosts with firm soil. The cause of this preference could be that it allows them to stand or to lie sleeping without sinking in the mud. They may stand sleeping with the water up to

their bellies, but apparently they prefer not to be afloat. In tidal waters, however, this may occur for a few hours before and after high tide. Markgren (1963) describing the behaviour of Bean Geese *A.f.fabalis* on their roosts in southernmost Sweden says: 'Particularly when geese sleep on the water, involuntary collisions must occur comparatively often...The repeated contact notes that are heard periodically from flocks lying on open water, are much rarer when the geese roost on ice'. These observations suggest that the preference for a roost where the geese can stand or lie on firm soil or on ice might also be due to the fact that it allows them to maintain individual distance and prevents involuntary collisions. On the Swedish roosts described by Markgren, the geese have no opportunities to stand on shallows with firm soil in places where they are surrounded by open waters of sufficient size.

There is detailed information on the roosting habits of the geese in Scotland and England (Boyd, 1963). Greylags have most of their roosts on inland lakes, only a small proportion roosting on estuaries. Whitefronts in England roost on estuaries and floodwaters, but there is an increasing use of large reservoirs as roosts. Bean Goose roosts are all inland, on floodwater or hill lochs. Pinkfoot roosts are about equally distributed between the coast, nearly all in estuaries, and inland, mostly on lakes but several on peat mosses.

All these data from S. Sweden, Scotland and England suggest that the habit of roosting on firm soil, so pronounced in the Netherlands, is not a general one. The conclusion may be that the wild geese have a strong preference for such roosts, though they may well do without it, but that in the Netherlands with its dense human population, the presence of shallows is extra favourable as a safeguard against disturbance.

All this does not apply to Brent Geese and to those Greylags living in extensive tidal areas, which follow a tidal cycle and do not roost at night.

Ecological factors favouring the presence of roosts

The combination of the factors mentioned under (a), (b) and (d) is not a probable one. It is unlikely to occur except in very special conditions and even where the combination does occur at a given time, it is unlikely to be permanent. On the contrary, it tends to be short-lived by nature, because shallow places are either gradually eroded by the current or the effect of the waves or they tend to be grown over by Cord Grass (*Spartina* sp.), Club-rush (*Scirpus*) or Reed (*Phragmites*). In static waters shallow places with firm soil are practically always densely overgrown.

If the various types of roosts are compared, the following factors appear to be responsible for their existence.

Those of group A, B and C are a result of the influence of the tide. In types D and E it is the size of the waters and their exposure to the southwestern winds which favour the presence of these shallows. The roosts of group F (floods) seem to be a stable type. Grazing keeps the vegetation short during the summer. The turf, soaked though it may be, seems sufficiently firm for the geese to roost. In group G, the 'closed' estuaries, the roosts have what might be called a 'tidal past' and this, no doubt, is responsible for their present state. Lake roosts of type H are a matter of wind effect, but they are different from all other roosts, extensive open surroundings (factor a) being the only advantage they offer.

Prospects for the future

We still have to study the prospects of the various roosts, as their survival is not beyond all doubt. Moreover a number of them will be affected by the Delta Project and the drainage schemes.

1. The factor tide which plays such an important role, will be eliminated by the Delta Project in the roosts of group B and numbers 11–14 of group C, in which group only roosts numbers 15 and 16 will remain untouched. Where the tide is eliminated, the sand bars will either be too deep under water or they will be overgrown by rushes and reeds. In some cases new roosts will come into existence and it will be of great importance to manage such places by grazing and mowing so as to prevent the development of vegetation. It is not improbable that the water level in these closed estuaries will be lowered considerably during winter, so that bare mudflat might be available. These future roosts might be of the same type as those of group G. Our experience of these roosts is very short, as the Veerse Meer (No. 26) has been closed only since 1961 and the Braakman (No. 27) since 1952. In the former the water will be salt until 1978, which will prevent the development of a high and dense vegetation.

2. The main body of the Waddenzee (group A) will remain tidal for some 30 to 50 years and the wild geese will probably find excellent roosting conditions here for a long time. The present roosts in the Waddenzee area, however, will be lost within a few years. In the Lauwerszee a roost of type G might be possible, but all shooting should be abolished there.

3. The roosts in the IJsselmeer area have good prospects, though there seems to be a gradual increase of the vegetation. As the size of the IJsselmeer seems to play a part, it should be mentioned here that in the near future this size will decrease from some 200,000 ha to about 100,000 ha, which may decrease the wind effect and consequently favour the increase of the vegetation. Our experience of roosts of type E is short, but they may survive for a considerable time.
4. Floods (group F) are considered to be an anachronism in the Netherlands. The present co-operation between the owners of important parts of the roosts of No. 21 and the State nature protection is therefore very welcome. Some purchases of land by the State in area 21 and others in areas 23 and 24 are also very important, though in the latter cases much has still to be done.

Summarising the prospects we might say that serious losses are to be expected in several regions. There will be a general shift from tidal waters to static ones, where both the abolishment of shooting and careful management will be necessary.

III. The feeding grounds

Some species of wild geese are highly specialised in food habits, while others are capable of adapting themselves to various types of human land use. In the case of the latter, the 'natural' habitat selection may be obscured and has to be 'reconstructed' from incidental clues.

On the basis of experiences in the Netherlands (Lebret, 1964) the species might be classified as follows.

Specialists

BRENT GOOSE

Almost entirely a bird of the tidal zone of salt waters, feeding on *Zostera*, *Enteromorpha*, *Ulva* and *Puccinellia*. In one case a group of some 130 birds was feeding in arable country on a grass-seed production field some 300 m. behind the sea wall for several months.

Semi-specialists, with a preference for "natural" habitat but capable of adaptation to agriculture

BARNACLE GOOSE

Timmerman (1962) thinks the specise to be specialising on saltings where brackish and fresh water are in regular contact and where the plant communities of the Agropyro-Rumicion crispi predominates. Philippona (*in litt.*) thinks that the species may also thrive on the same habitats where White-fronted Geese have their main haunts.

GREYLAG GOOSE

In the Netherlands and in north-west Germany (Harrison, 1952) Greylags have a distinct preference for the *Scirpus*-pioneer vegetations of fresh and brackish estuaries. In most localities pasture land is used as a secondary habitat. On both banks of the Hollands Diep estuary there is an increasing preference for arable country, but *Scirpus* fields are still the major food stock here. Only in the province of Friesland and in the State Reserve Boschplaat on the Frisian Isle of Terschelling (Tanis, 1963) are Greylags feeding entirely on grasses. This as well as the situation of the Greylags wintering in the British Isles (Boyd, 1963) suggests that the species might well survive on grasses only.

Non-specialists

WHITE-FRONTED GOOSE

Formerly typical for floods. Recently the majority has moved to areas within flighting distance from coastal roosts. Here they may feed on dry pasture land in great numbers for several months if undisturbed. This suggests that the floods have another significance than food habitat only, their excellence as roosts being of primary importance while they also provide good protection against all types of disturbance.

PINK-FOOTED GOOSE

Since the 'come-back' of the species in the Netherlands in 1956 Pinkfeet have been feeding entirely on pasture land in the southwest of the province of Friesland in a region between the IJsselmeer in the west and a number of lakes in the south and east. In this way this region is well isolated and human disturbance is small. There seems to be no ecological relation with floods. A detailed description of the ecology of the Pink-footed Goose in this area is given by den Daas (*loc. cit.*).

BEAN GOOSE

In the Netherlands this species is to a great extent using arable country, especially on the modern farms with extensive fields, within flighting distance from the estuaries. Pasture land seems to be of secondary importance. The species, therefore, might be classified as the one most adapted to present-day farming.

From its ability to dig out waste potatoes and sugar beets, it may be supposed that the natural food of the species might to some extent consist of tubers of *Scirpus* and other marsh plants. Indeed, some cases of this feeding method are known (Lebret, 1959). Feeding on Cord Grass roots and stems has been mentioned by Maebe and van der Vloet (1956).

Prospects for the future

After the feeding grounds of the various species of wild geese have been briefly described, we have to study the effect of the Delta Project and a number of other hydraulic engineering schemes.

1. Brent Goose

The main feeding grounds of this species are found in the tidal marshes of the Waddenzee, especially near the Isle of Terschelling. Some 3,000 birds may be found here (Tanis, 1963) and fortunately the area will remain untouched. The feeding grounds in the south west of the Netherlands will be lost after the Delta Project has been completed in 1978, as the tide will be eliminated and the waters will become fresh. The number of Brents involved is not likely to exceed 500 birds.

2. Barnacle Goose

This species will lose practically all its present feeding grounds within the next 5–10 years. Its main haunt, the Bantpolder, harbours some 15,000 birds, but it will be partly drained in 1965 or 1966. There is a possibility that a new feeding area may be created in the Lauwerszee after this has been closed, in 1967, by sowing special pastures for the species and by managing them as a sanctuary. There will, however, remain a gap of some 4–5 years between the loss of the Bantpolder and the possible effect of a sowing programme. In these years the species might temporarily fall back on the nearby Anjumer Kolken. It would be advisable that all goose shooting should be temporarily forbidden there, as in this region the Barnacles, though fully protected by law, are mixed with Whitefronts and other geese and hence are liable to the disturbance caused by Whitefront shooting. The Barnacle feeding areas in the southwest of the Netherlands (Dirklandse Sas and St. Anthoniegorzen) will be lost due to the Delta Project, which will be finished in this sector in 1969. Some 3,500–7,500 birds may now be feeding here (Timmerman, 1962). These birds may find a new haunt on the Kwade Hoek State Reserve. Moreover on the Hompelvoet State Reserve, now a sandbank in the Brouwershavense Gat estuary, goose pastures may be created after this estuary has been closed in about 1970. Here again a sowing programme would not be effective until some 4 years after the closing of the estuary.

3. Greylag Goose

This species will also be highly affected by the results of the Delta Project. It will lose all the tidal marshes with a pioneer-vegetation of *Scirpus*. This type of habitat will disappear practically altogether in the Netherlands after 1968. Some 10,000 Greylags used to feed here. In the two IJsselmeerpolders still to be drained there may be a temporary revival of comparable pioneer vegetation, but each of them will last only some 5–8 years, unless a special reserve is created. This should be managed by extensive grazing during summer and slightly flooding it in September–March.

If the Greylag Goose proves capable of holding its own on pasture land – and there are several indications that it may do so – it will be of the utmost importance that sufficient grazing opportunities are created and maintained in nature reserves. There are good prospects on the Bosplaat State Reserve, where the numbers of Greylags are gradually building up and will have reached 1,000 birds. Rabbit shooting has been abolished during the presence of the wild geese in this reserve (Tanis, personal communication). The Kwade Hoek and the Hompelvoet Reserves mentioned in reference to the Barnacle will be of positive value for the Greylag Goose as well. The maximum numbers of the species occur in October–November, when cattle are still in the fields, and March–April, when the grass is starting into growth, while the other species have their maximum in December–March. Hence the Greylags may be in conflict with agricultural interests. In October other human outdoor activities may be still in full swing at or near their haunts. The birds may thus be more affected by human disturbance and hence more dependent upon nature reserves than are other species. Consequently they may have to feed in greater concentrations and the carrying capacity of these Greylag reserves will need special attention.

4. White-fronted Goose

The feeding grounds of the White-fronted Goose will not be seriously affected by the Delta Project, but drainage and reallotment schemes further inland will do so. Partial compensation may result from a sowing programme which was started on the Middelplaten State Reserve in May 1964. This reserve has been created in the former tidal zone of the Zandkreek, the first estuary closed as part of the Delta Project. It is the first case where such a sowing programme has been brought into practice. On 4th January 1965 some 600 geese (Bean, White-fronts and Barnacles) arrived, the numbers rapidly building up to well over 2000. On 13th January the flocks departed, after all the food had been

consumed. Taking into account that the turf was still in its initial state of development, the result seems encouraging.

We have found that drainage and reallotment schemes are affecting the wild geese especially by causing an increase of disturbance. Hence a possibility of compensation for loss of feeding grounds may be found by the reduction of disturbance elsewhere. This has proved to be successful in the case of the private reserve of Count Lippens and others between the village of Damme and Bruges (Belgium), where all goose shooting has been stopped since 1959 and wild geese, especially Whitefronts, have increased from a few hundreds to several thousands. The creation of this reserve came just in time to cope with the permanent loss of an important goose feeding area in the near vicinity in the Netherlands (Suetens, 1961)

5. Pink-footed Goose

The prospects for the Pink-footed Goose area in Friesland have been discussed in detail by Den Daas (1963). His recommendations are the following: (a) total stop of shooting at and near the roost on the Idsegaster Poel (roost No. 28); (b) a feeding area of some 5 sq. km. within 3–10 km. of the roost should be managed in the present state; (c) in case jetcraft activities may be increased, flying under 750 m. should be prohibited.

6. Bean Goose

The prospects for the Bean Goose are relatively good. Large-sized arable fields cover wide areas within flighting distance from the present roosts. The only unfavourable aspect is a strong tendency among farmers in the regions visited by the Beans to switch from the usual crops to orchards and the acreage of the latter is rapidly increasing. As far as can be foreseen these developments are not likely to become a menace for the species.

Generally speaking the non-specialists (Whitefront, Pinkfoot and Bean) and probably also the Greylag and perhaps even the Barnacle, could be helped greatly by reducing the disturbance caused by indiscriminate shooting. In this way a considerable degree of tameness might develop in these species and this might increase the number of areas accessible for them. The readiness of a number of wild fowlers to co-operate gives good prospects for the future.

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Spacing and chasing in breeding ducks

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Summary

The behaviour of breeding ducks is described in terms of the relationship of the pair to its home range and the responses of pairs to one another. There are specific, sex, and seasonal variations in the characteristics of the home range. Interactions between pairs involve five types of response: displays, attack, escape and avoidance, sexual pursuit, sociability. Chasing activities of paired males can be hostile or sexual in nature, the latter involving attempts to rape strange females. The characteristics of aerial pursuits ('three-bird flights' and 'attempted rape flights') of *Anas* species are believed to be determined by variations in the pursuing male's tendencies to (*a*) stay with or near his mate, (*b*) attack other males, (*c*) rape strange females. Male hostility is associated with the existence of a strong pair-bond; raping is associated with a weak bond. A typical 'three-bird flight' results from conflict between the pursuing male's tendency to chase the female of a strange pair (with intent to rape and/or possibly attack her) and his tendency to remain near his mate.

Parts of the home range of each pair are shared with other pairs. Where a shared resource is localised in distribution, such as an island suitable for nesting, pairs tend to aggregate. Colonial nesting develops as a result of strong homing tendency in adult and young females, and high productivity in an area with light predation. The behaviour of a number of species appears to be adapted to the various types of resource-sharing required in different habitats.

Chasing activities – both hostile and sexual in nature – are believed to bring about dispersion of various types. In a species with a small home range, a high level of hostility, and a strong pair-bond (e.g. Shoveler), a pattern close to classical 'territorialism' is apparent. In more mobile species, there is much overlapping of ranges and the degree of dispersion of pairs (and resulting dispersion of nests) can vary considerably with local conditions.

The primary function of chasing and the spacing resulting from it is thought to be the dispersion of nests as an anti-predator mechanism.

Introduction

Ducks are primarily social birds but during at least part of the breeding season pairs of many species show a tendency to spread out over the nesting habitat. Chasing behaviour often coincides with the break-up of flocks and the period during which pairs are dispersed. The occurrence of both spacing and chasing is well established for many species, but the survival value of these phenomena and the behavioural mechanisms involved are still uncertain.

In 1924, Geyr von Schweppenburg suggested that certain aerial chases of the Mallard *Anas platyrhynchos*, described originally by Heinroth (1911), represent attempts by a paired male to drive off other pairs from the nesting area. He believed that such behaviour helps to preserve an exclusive breeding area for each pair, ensuring an adequate food supply for the young. Although Geyr's interpretation of Mallard pursuit flights has been questioned by several authors, and his paper provided the stimulus for a long controversy on all types of aerial behaviour, the idea that ducks are territorial has come to be widely accepted. This is particularly true in North America where the territory concept provides the basis for 'the breeding pair count' method of censusing populations. The major credit for development of the theory of duck territory must go to Hochbaum (1944), who stressed the importance of the phenomenon in the species breeding on the Delta Marsh in southern Manitoba.

Hochbaum applied to ducks the theory of territory propounded in detail by Howard (1907–14, 1920) and subsequently developed by other ornithologists, especially Lack (1939), Nice (1943) and Tinbergen (1939). 'Territory' was defined, in the same way as it is today, as 'a defended area'. Hochbaum contended that each paired male defends a certain stretch of water against intrusion by other sexually active birds of the same species, the main function of this behaviour being to prevent interruption to the pair 'during the copulation link of the reproductive cycle'. Hochbaum believed that 'the nesting population of any breeding marsh is determined by the territorial distribution of pairs'.

Subsequent research by Sowls (1955) and Dzubin (1955), on individually marked birds, showed that Hochbaum's original conception of territory was too rigid. There are not always 'definite boundaries to defended areas' and the home ranges of neighbouring pairs often overlap. Recent studies by Lebret (1961) and Hori (1963) on the Mallard have indicated that aerial pursuits, of the type called 'territorial defense flights' by Hochbaum, sometimes occur away from the nesting grounds. As a result of this discovery, Lebret has suggested that the term 'territory' should not be applied to the Mallard, while Hori believes that neither the Mallard nor the Shoveler *Anas clypeata* holds territory. Bezzel (1959) has also criticised Hoch-

baum's theory, concluding that 'the territory plays a small part in the structure of a breeding population'. Gates (1962) believes that in the Gadwall *Anas strepera* territorial behaviour was ineffective in limiting the number of pairs nesting on his study area in Utah.

These findings appear to cast considerable doubt on the validity of the concept of duck territoriality. In fact, however, the main criticisms have been directed at (a) the use of the word 'territory' where evidence for a *defended area* is not obvious, and (b) the idea that behaviour involved in the defence of an area has an important effect on the density of breeding populations. Thus much attention has been given to inquiring whether and how ducks 'defend areas' and how chasing behaviour (especially aerial pursuit) is related to such areas. The broader biological problems of pair-spacing – the pattern of pair distribution on the breeding grounds, the mechanisms by which this is achieved, and the survival value of the different patterns found in different species – have received less emphasis.

As Tinbergen (1957) has stressed, it is important to distinguish between the components of what we call 'territorial behaviour'. In most birds these appear to be (a) attachment to a site and (b) hostility, two distinct forms of behaviour which, when they occur simultaneously, give the impression of 'defence of an area'. It seems best to avoid 'a purely speculative assumption that the area carries special significance to the bird as an object to be defended' (Emlen, 1957).

In this paper, I will discuss the factors which appear to be involved in pair-spacing in those species of duck which have been studied in some detail. I have avoided the words 'territory' and 'defence' except in referring to the ideas of other workers. In this way, I hope to concentrate attention on 'doings and happenings rather than objects and entities' (Emlen, 1957).

The pair and its home range

During the main part of the breeding season – egg-laying, incubation, and rearing of the brood – female ducks must restrict their movements to an area quite close to the nest-site. For at least part of this period, the male occupies approximately the same region. Sowls (1955) called this area the 'home range', a term previously applied to mammals, defining it as 'the area within which a bird spends its period of isolation between the break-up of spring gregariousness following spring arrival and the reformation of fall gregariousness'. During this 'period of isolation', however, there are seasonal changes in the relationship of each duck to the area it occupies, and there are also important differences between the ranges of males and females. In some species, the places visited by each bird probably change to some extent from day to day, and many factors influence the location, size, and permanence of the various 'ranges' occupied successively by each individual. An understanding of these changing relationships between the members of the pair and the areas they occupy is fundamental to the study of pair-spacing. Unfortunately, only a few studies of marked birds have been made, and surprisingly little is known about the daily movements of individual ducks during the breeding season.

Homing

Tendencies for adult females to return to breed in the same area in successive years and for young females to breed close to the area in which they grew up have been demonstrated for a number of species and are probably general in ducks. In hole-nesting species such as the Goldeneye *Bucephala clangula* (Siren, 1957), Bufflehead *Bucephala albeola* (Erskine, 1961), Wood Duck *Aix sponsa* (Bellrose, Johnson and Meyers, 1964), and Shelduck *Tadorna tadorna* (Hori, 1964) some females have been shown to use the same site in successive years. Mendall (1958) believes that Ring-necked Ducks *Aythya collaris* will also do this but, as Bellrose *et al.* (*loc. cit.*) have shown for the Wood Duck, an unsuccessful nesting attempt may cause a bird to choose a different site the following year. The Eider *Somateria mollissima* also shows faithfulness to the nest-site (Gudmundsson, 1932; Cooch, 1957) but other ground-nesters select new sites each year (Koskimies and Routamo, 1953; Sowls, 1955).

In most migrant ducks, precise homing by males is thought to be a rare event, but there is little direct evidence since few males are banded on the breeding grounds. Most pairs are formed on the wintering grounds or during spring migration, the bonds being broken again when the male leaves his mate in the middle of the breeding season. (It is possible that some pair-bonds remain intact through the summer when a female loses her clutch and does not attempt to re-nest, but this has not been proved with marked individuals). Thus unless the members of the pair meet again on the wintering grounds or at some stopping place on migration they must form a new pair-bond each year. Many birds from a particular section of the breeding range tend to follow similar

migration routes and winter in approximately the same areas, but nothing is known of the frequency with which mates reunite. No doubt there is much variation between species and between populations. Some re-pairing of the same individuals occurred in a resident population of Mallards (Weidmann, 1956). In a captive flock of Shovelers, some birds re-paired while others deliberately chose new mates (McKinney, in prep.). Erskine (1961) has shown that male Buffleheads tend to return to the same wintering areas in successive winters, and if their mates are faithful also to these places, pair-bonds could be renewed. On present evidence, however, it is likely that most ducks change mates annually, females returning to a familiar home range, males following their mates to an unfamiliar breeding area each year.

Sea Ducks (*Mergini*) do not breed in their first year, but sub-adults are seen on the breeding grounds and presumably youngbirds gain valuable experience during their period of maturation. In Anatini, young birds do breed in their first spring, but they have several disadvantages. In plumage development and time of pairing, young Shovelers lag some weeks behind adults, and they tend to be less successful in competitive pairing situations (McKinney, in prep.). In the Pintail *Anas acuta* (Sowls, 1955) and Gadwall (Gates, 1962), adult females return early to their breeding home ranges, young birds arriving later. Under crowded conditions, late arrivals may have to move some distance from the area with which they are most familiar. Thus experienced, adult ducks probably have 'first choice' of mates and of home ranges, and in general adult females will have the greatest familiarity with the breeding home range.

When breeding habitat deteriorates or disappears, homing traditions are broken and pairs must establish new home ranges. This is a rare event in Eiders, colonies remaining on the same islands for centuries, but it is a common phenomenon in species dependent on water areas in regions which fluctuate between conditions of drouth and flood. The drying-up of a pothole may cause a pair to move only a few hundred yards, but widespread drouth on the North American prairies or over wide areas in Australia can cause massive movements of breeding populations (Frith, 1959).

The pre-nesting period and nest-site selection

The interval between arrival in the general vicinity of the breeding area and the beginning of nesting varies between species and also in accordance with variations in weather and habitat conditions. The Mallard and Pintail are early spring migrants and early nesters, and in southern Manitoba laying normally begins soon after the break-up of migrant flocks (Hochbaum, 1944; Sowls, 1955). In the Gadwall, however, Gates (1962) found that an interval of a month may elapse between the arrival of residents and the laying of the first eggs.

There is little information on the movements of pairs during this pre-nesting period. In many species, it is difficult to distinguish returning residents from migrants on passage. Limited observations on marked Canvasbacks *Aythya vallisneria* by Dzubin (1955) and on Gadwall by Gates (1962) suggest that pairs are more mobile during the period before nesting than after breeding begins.

Pairs assumed to be involved in selecting a home range or a nest-site are seen making flights over the nesting terrain. Hochbaum, (1944) saw 'nuptial flights' performed by pairs of all species of *Anas* and *Aythya* that he studied, and it seems likely that these are, at least in part, reconnaissance flights. Sowls (1955) noted Mallard and Pintail pairs making evening flights over nesting cover a few days before egg-laying began. Mendall (1958) suggests that aerial reconnaissance by Ring-necked Duck pairs occurs mainly during the period between arrival and the beginning of nest-site selection, which may be as long as two weeks. Smith (1963) describes 'exploratory flights' in Pintail pairs, and similar manoeuvres occur in the Velvet Scoter *Melanitta fusca* (Koskimies and Routamo, 1953) and Common Eider (Cooch, 1957; McKinney, 1961).

In species which nest some distance from water, parts of the habitat suitable for the nest-site are presumably selected during these reconnaissance flights. The final selection of the site is made on foot in the case of ground-nesters, by swimming in species using emergent vegetation, and by flying from tree to tree in the case of hole-nesters (see descriptions in Hochbaum, 1944; Mendall, 1958; Leopold, 1951). In all species studied to date, the male accompanies the female during her exploration of potential nest-sites. I have found no precise information on the area covered by a pair of any duck species during this period of pre-nesting flights.

Nest-construction and laying

In the Canvasback (Hochbaum, 1944), Redhead *Aythya americana* (Low, 1945), Blue-winged Teal *Anas discors* (Glover, 1956), and other *Anas* species (Sowls, 1955) nest-construction may begin several

days to a week before laying starts. Information is scanty, however, and it is quite possible that some individuals select the site, scrape the nest-bowl, and lay the first egg, all on the same day. Eggs are usually laid in the morning hours, the male remaining in the vicinity while the female is at the nest. At this stage, the pair-bond is still very strong and Hochbaum (1944) noted that males may have special waiting places close to the nest.

Dzubin (1955) found considerable specific differences in the ranges occupied by Canvasback, Mallard, and Blue-winged Teal pairs during the pre-nesting and laying phases, the Canvasback being most mobile, the Teal least.

Range during incubation

Once the female begins to incubate, the male sees her only for short periods when she leaves the nest. Most species have one or two such periods each day, when the female feeds, bathes and preens. (Incubating Eiders do not feed; the female leaves the nest only briefly at 2 or 3-day intervals, to drink). Especially during morning and evening hours, males spend much of their time on certain water areas – 'waiting areas' (Dzubin, 1955), where dry-land 'loafing spots' (Hochbaum, 1944) are used by many species. It is to one of these places that the female flies when she comes off the nest. If the male is there, the two birds remain together until the female returns to the nest. The pair-bond remains intact only as long as the male frequents these areas.

Females seem to travel no farther than is necessary when they leave the nest. Ground-nesters often fly to the nearest water, and this is where many male 'waiting areas' are situated. There are variations in the distances involved, some species such as the Pintail nesting much farther from water than others. The distance between nesting cover and feeding grounds also varies with local conditions (Bezzel, 1959; Gates, 1962).

There are specific differences in the mobility of paired males during the incubation period. In Manitoba pothole country, Dzubin (1955) found that drakes of Canvasback, Mallard, Pintail, and Redhead ranged widely during the incubation period but Blue-winged Teal did not. At Ogden Bay, Utah, Smith (1955) and Gates (1962) noted that Mallard ranged most widely, Cinnamon Teal *Anas cyanoptera* and Shoveler least, while Gadwalls were intermediate in range. In Maine, Mendall (1958) found that Ring-necked Ducks have a much smaller range than Black Ducks *Anas rubripes*.

Break-up of the pair

Dzubin (1955) found that the drake Mallard's range increases once his mate has begun to incubate and he gradually spends less and less time at the waiting areas. So the members of the pair meet less often, and the pair-bond appears to become progressively weaker until it is finally broken when the male moves away. The break-up may be more abrupt in other species, but there is little precise information on this point.

The stage of the breeding cycle at which the male breaks off contact with his mate varies between species (Table I), and there are also considerable individual variations (e.g. Stotts and Davis, 1960). In most species, the male leaves at some stage during incubation. During late nestings or re-nesting attempts, the male leaves earlier than in the case of early nests.

Striking effects of the chronology of the breeding season have been noted by Alex Dzubin (*in litt.*). He reports that in the early mild spring of 1958 in southern Saskatchewan, when Mallard broods began to appear by 15th May, he recorded 15–20 cases of males accompanying broods; in most years, when hatching peaked after 25th May, only 1–3 records were obtained.

Since most ducks will re-nest if the first clutch is lost, the stage at which the male deserts his mate may have an important effect on the female's behaviour between nesting attempts. If the male has left, as must often be the case in species where the bond breaks early, the female must either find a new mate or be fertilized by a male other than her mate. Re-pairing with a new mate has been recorded for Gadwall (Gates, 1962) and Pintail (Smith, 1963). In species such as the Shoveler, in which the male remains until late in incubation, the original pair-bond is probably maintained through all nesting attempts.

Range of the female and brood

After the ducklings leave the nest, the factors controlling the female's mobility change. She is no longer tied to the nest-site and its immediate surroundings, but as she leads her brood her movements are now restricted to ground and water surfaces. In some cases, the areas frequented by the female and brood are close by the nest site. Mendall (1958) noted that some Ring-necked Duck families spent the entire rearing period within an area a few hundred yards long, provided adequate food and cover were available and there was no disturbance. Other Ring-necks, which nested on small marshes, had to lead their ducklings a mile or more to suitable habitat.

Table I. The stage of the breeding cycle at which the pair-bond breaks.

Species	*First week of incubation*	*Mid-incubation*	*Last week of incubation*	*After hatching*
Anas acuta	X[3,6,13]			
Anas platyrhynchos	X[3,6,8,13]	X[2]	Rare[2]	Rare[15]
Anas rubripes				
early nests:	X[6,13]	X[4]	X[4]	
late nests:	X[14]	X[14]		
Anas strepera				
early nests:		X[4]	Rare[4]	
late nests:	X[4]			
Anas discors		X[2]	Rare[2,3,6,13]	
Anas cyanoptera			X[12]	
Anas clypeata			X[5,6,10,12,13]	Once[12]
Aythya vallisneria	X[6]	X[2]		
Aythya americana	X[6]			Once[6]
Aythya collaris				
early nests:			X[11]	
late nests:	X[11]			
Aythya affinis		X[6]		
Aix sponsa				
early nests:			X[1] X[9]	
late nests:	X[9]			
Melanitta fusca	X[7]			
Oxyura jamaicensis				X[6]

[1] Dixon, 1924; [2] Dzubin, 1955; [3] Evans and Black, 1956; [4] Gates, 1962; [5] Girard, 1939; [6] Hochbaum, 1944; [7] Koskimies and Routamo, 1953; [8] Lebret, 1961; [9] Leopold, 1951; [10] McKinney, unpublished; [11] Mendall, 1958; [12] Smith, 1955; [13] Sowls, 1955; [14] Stotts and Davis, 1960; [15] Dzubin (*in litt.*).

On pothole nesting terrain, where many water areas of different types are located close together, families regularly make overland crossings of several hundred yards. Evans, Hawkins and Marshall (1952) reported specific differences in the mobility of broods on the Minnedosa pothole country of Manitoba: Pintails moved most, Ruddy Ducks *Oxyura jamaicensis* did not move, while other species of *Anas* and *Aythya* moved varying distances during the course of the brood period.

In some species, spectacular travels are undertaken by very young ducklings. Leopold (1951) observed newly-hatched Wood Ducks being led across the Mississippi River to secluded feeding areas. Allowing for the current, the families had to swim a distance of about three-quarters of a mile, and they accomplished the trip in about 20 minutes. The Eiders of the Inner Farne lead their young ducklings across 1½ miles of open sea to the mainland coast of Northumberland, where they spend the rearing period. Black Duck broods hatched on Ile aux Pommes, Quebec make a crossing of 3½ miles to the mainland shore of the St. Lawrence immediately after leaving the nest (Reed, 1964). Dzubin (*in litt.*) has records of newly-hatched Mallard broods moving 3 miles and 3½ miles in two days.

Exclusiveness of the home range

Except in the case of very isolated pairs, home ranges are shared to varying degrees with other members of the same species. The greatest overlap is probably found in the colonial-nesting Eiders, in which areas used for feeding, resting, nesting, and brood-rearing are occupied by many birds at the same time. Most species of ducks freely share brood-rearing areas. In some species, such as the Gadwall (Hammond and Mann, 1956) and Black Duck (Stotts and Davis, 1960) nesting concentrations are found on islands, and in these situations there is much overlap. In *Aythya* species, such as the Canvasback (Dzubin, 1955) and Ring-necked Duck (Mendall, 1958), several paired males may share the same waiting areas while their mates are incubating. Among the *Anas* species which have been studied, the home ranges of Shoveler pairs probably overlap the least, as a result of the energetic chasing activities of paired males (see pp. 93-4). Even favoured loafing spots may be shared by pairs of Gadwall, Mallard and Blue-winged Teal, being occupied by different pairs at different times (Sowls, 1955; Dzubin, 1955; Gates, 1962).

The behaviour of the pair in relation to other birds

Social responses appear to play an important role in determining patterns of pair-spacing. In attempting to understand the pattern found in each species, it is particularly important to know how pairs behave when they encounter other birds, how the behaviour varies with the stage of the breeding cycle, and how the encounters are related to the components of the home range occupied by the pair.

Types of response

Five types of response can be distinguished when pairs come in contact with other ducks: (a) visible and/or audible displays, (b) attack, (c) escape and avoidance, (d) sexual pursuit and/or rape, (e) sociability.

There is strong circumstantial evidence that certain displays of paired males are expressions of hostile tendencies and that they have threat function. Hochbaum (1944) noted the association of the male Canvasback's 'Sneak' with hostility. Similar postures, with the neck stretched forward over the water, are seen in male Goldeneyes and Buffleheads immediately before an underwater attack. Hostile Pumping in the Blue-winged Teal and Shoveler is closely linked with aggression. The threat function of these displays is indicated by the observed avoidance responses in other birds. No doubt other species have similar displays, but although there may be evidence that the performing bird has a tendency to attack, threat function is often more difficult to prove e.g. 'Rab-rab' palaver of the Mallard (Weidmann, 1956), Cooing-movements of the Eider (McKinney, 1961).

Overt attack and escape are commonly observed in paired ducks. Attack behaviour patterns vary greatly in intensity and duration, from momentary intention movements to prolonged pursuits. Chasing can occur on land, over the surface of the water, underwater, and in the air, but there are variations from species to species. In certain highly aquatic species (e.g. *Aythya* species, Ruddy Duck) showing a relatively low level of aggressiveness, encounters generally involve at most a rush across the surface of the water. At higher intensities, a short attack flight can occur, and in the Shoveler vigorous aerial pursuits are seen. Underwater attacks are performed by aggressive male Goldeneyes and Red-breasted Mergansers *Mergus serrator*. The response to an attack is usually retreat by the other bird, but occasionally this does not occur and fighting ensues.

Inter-specific hostility is rare. It occurs in Barrow's Goldeneye *Bucephala islandica*, males threatening and chasing a variety of other species (Myres, 1957; personal observation). Generalised aggressiveness toward other birds is also shown by some incubating ducks and by females with broods, but only when they are approached closely.

The role of 'avoidance', in the sense of an active search for isolation from other birds, is very difficult to assess. Mendall (1958) has observed pair-spacing in the Ring-necked Duck without obvious hostility, but the possibility should not be ruled out that this results merely from 'retreat without being involved in a hostile encounter'. Avoidance of this type may well be a common phenomenon in many species. It is possible to find an 'isolated pair' of a certain species, and breeding populations may be so thinly distributed that pairs seldom encounter other members of the same species. But the factors responsible for such situations are unknown. In some years, only a few Green-winged Teal *Anas crecca carolinensis* breed on an area of the Delta Marsh occupied by hundreds of Blue-winged Teal pairs. This pattern of distribution could result from precise homing by a few females during a period of low population numbers, rather than a deliberate attempt by these pairs to isolate themselves.

Aggressive behaviour is identified on the basis of the movements involved and the result of the encounter. Rushes across the water or aerial pursuits involving two males, or intention movements of advancing performed by a female toward a strange male clearly fall into this category. Similar activities performed by a paired male and directed toward a strange female present a different problem. Some of these chases end in rape of the strange female. I have records of rape in the Mallard, Pintail, Gadwall, Shoveler, Blue-winged Teal, Cinnamon Teal and Baldpate *Anas americana*. Very often, however, these chases end inconclusively; the male chases for some distance and then gives up. In other species, in which rape has not been recorded (e.g. Lesser Scaup *Aythya affinis*), paired males make rushes toward strange pairs on the water, directing their attention to the female. In these cases, it is very difficult to determine whether the male's intention is rape, attack, or a combination of the two. Some authors (e.g. Weidmann, 1956; Bezzel, 1959) believe that all such chases in the Mallard are sexually motivated; Lebret (1961) believes that some chases 'have no other source than intolerance' while others are the result of an attempt to rape (see pp. 93-4).

In most species, pairs are sociable during

spring migration and immediately after arrival on the breeding grounds. Flocks break up when pairs begin to establish their home ranges. At the same time, aggressive or sexual chasing appears in many species, and these activities clearly conflict with sociability. The balance between these opposing tendencies – to associate with other birds and to chase them – is different in various species. At one extreme, Eiders remain sociable even during the selection of nest-sites, pairs walking about close together with only mild indications of hostility. Male Shovelers, on the other hand, remain intolerant of the approach of other Shovelers until late in the incubation period. Dzubin (1955) noted one form of 'compromise' in Blue-winged Teal pairs which he believed were distributed in 'communities'; although hostile encounters were frequent, the strife did not seem to discourage community gatherings. In most species of *Anas* and *Aythya*, paired males begin to associate in groups, for parts of the day at least, soon after incubation begins.

Responses on the wintering grounds and during spring migration

In many species, it is known that aggressive behaviour accompanies the process of pair-formation which takes place several weeks or even months before the breeding season begins. Males are aggressive toward other males, and females threaten males which they are rejecting. These responses continue after the pair-bond is formed, both male and female making threat movements or chasing unpaired males which show an interest in the female. The details vary from species to species, but the pattern is basically the same in all ducks that I have watched. Such behaviour is usually referred to as 'defense of the mate' or 'mated female distance' (Koskimies and Routamo, 1953).

Hostility between pairs can also occur both on the wintering grounds and during spring migration. This was a common reaction between pairs of Blue-winged Teal and Shoveler that I watched in Louisiana in March, before the birds started on their northward migration. I have seen similar behaviour among newly-arrived pairs of Shovelers and Canvasbacks at Delta in late April. I have also seen intense hostility among Common Goldeneyes as early as mid-April in Manitoba, males driving other birds away from stretches of ice-free water to which they were temporarily confining their activities. (I do not know if these birds stayed to breed nearby, but I suspect that they did not). In contrast, Hochbaum (1944: p. 43) was impressed by the absence of friction in migrant flocks of Mallard, Pintail, and Lesser Scaup pairs at Delta. This could reflect true specific differences, but temporarily reduced hostility might also be expected in tired migrants and in response to cold weather. A cold snap in early spring brings aerial chasing to a halt in Mallards, when pairs are forced to congregate on small open-water areas (Dzubin, *in litt.*).

Lebret (1961) has observed chases by a paired male directed at the female of another pair in European Teal *Anas crecca crecca* and Pintail during spring migration, before the birds had reached their breeding grounds. These chases had the same appearance as Hochbaum's 'territorial defense flights' (see p. 93).

Responses of the pair on the breeding grounds

(a) Behaviour toward unpaired males. Paired males continue to show hostility toward unpaired males after arrival on the breeding grounds, and in general this response seems to persist as long as the pair-bond remains intact. Again there are specific and individual variations which have not been studied in detail. Sometimes a lone male is tolerated close to a pair. Hochbaum (1944: p. 70) distinguished two types of unmated males, those which are 'sexually active' and those which are not ('novice drakes'), and he believed that the latter are tolerated while the former are driven off by paired males. There have been no studies of marked birds and this point needs further investigation.

(b) Behaviour toward other pairs. Most studies of interactions between breeding pairs have been made on *Anas* species, and almost all attention has been concentrated on the aerial pursuits which are so striking in this group. These are discussed below, but I will first refer to the characteristics of encounters on the water which are important in many species.

In spite of their strongly social habits, Eider pairs engage in frequent mildly hostile encounters: both sexes give displays, make threatening movements, and males in particular peck at males of other pairs when groups of pairs come close together on land or on the water. In the Canvasback and Lesser Scaup, similar encounters occur between swimming pairs, but in most cases males seem to direct their attention to the female of another pair. These chases seldom involve more than short rushes across the surface of the water and chasing males rarely take to the air. Aerial pursuits appear to be absent also in the European Pochard *Aythya ferina* and Tufted Duck *Aythya fuligula* (Bezzel,

1959). In the Ring-necked Duck, Mendall (1958) noted very little aggression between pairs; it was apparent only in crowded habitats and was confined to the period of nest-site selection. Hostile encounters between pairs are frequent and often energetic in Barrow's Goldeneye (Munro, 1939), Bufflehead (Munro, 1942), and American Goldeneye (personal observation). In these species, males direct their threat postures and underwater attacks toward other males; at times they will take wing, flying short distances to attack.

In the Shoveler and Blue-winged Teal, paired males on their home ranges usually react to the appearance of swimming birds of the same species (pairs, solitary males or females) by giving Hostile Pumping, swimming toward the intruder(s), and if necessary by chasing with a rush across the water or an aerial pursuit. When two well-matched males meet on the water and neither retreats, spectacular fights occur, the birds thrashing around one another with circular manoeuvres.

The most obvious feature of encounters between pairs in many *Anas* species are the aerial pursuits. Most observers have distinguished two types:

(i) *three-bird flights* involve pursuit of the female of a pair by a paired male, the female's mate being the third bird in the group. The chases are often brief, the pursuing male returning to his starting point after flying a short distance. This descriptive term was first used as an adaptation of 'three-bird chase' (Dzubin, 1957) at the 1958 Delta Seminar, and it has since been adopted by Hori (1963). These flights have been called 'Vertreiben' by Geyr (1924), 'territorial defense flights' by Hochbaum (1944), and 'expulsion flights' by Lebret (1961).

(ii) *attempted rape flights* (1957 Delta Seminar; Lebret, 1961) are prolonged, vigorous chases, involving the pursuit of a female by a number of males. These flights often range far from the original starting place and they have been observed to end in promiscuous rape of the female, after she was forced to the ground.

The distinction between these flights, their relationship to other aerial behaviour patterns, and the motivation of the pursuing male(s), have been subjects of argument for many years and there are still conflicting opinions (for references see Geyr, 1961; Lebret, 1961). Recent studies on the Pintail (Smith, 1963) and Shoveler (McKinney, in preparation) suggest that a comparative approach may be helpful in elucidating these problems.

During the period when aerial chases occur (pre-laying, laying, and incubation phases), paired males are observed in four basic types of 'social' activities: (a) accompanying the mate (or remaining nearby while she is at the nest), (b) behaving aggressively toward other birds (males in particular), (c) pursuing females other than the mate, and (d) associating peacefully with other males. The amount of time spent in each of these activities varies between species and also with different stages of the mate's breeding cycle. In wild populations, of course, the situation is enormously complex as a result of individual variation in the timing of the reproductive cycle and the procedure of re-nesting after the loss of a clutch (in some cases with a new mate). The need for a complete knowledge of the 'history' of the individual birds under observation is obvious.

A comparison of paired-male behaviour in the Pintail, Mallard, and Shoveler (Table II) suggests that specific variations in tendencies to stay with or near the mate, to attack other males, to associate with other males, and to rape strange females can account for many of the different characteristics of pursuit flights in the three species.

In the Pintail, Smith (1963) found that paired males are not aggressive to one another, and many can use the same water areas without friction. They frequently leave the mate to pursue and attempt to rape strange females. Many of these pursuits are energetic and prolonged, the birds covering great distances. The sight of such a flight stimulates other males to join in. Thus three-bird flights frequently develop into attempted rape flights and Smith could not draw a sharp distinction between the two. Many flights proceed to a great height and come to an end when the female makes a spectacular dive toward the ground. Males are most active in chasing strange females at the same stage of the breeding cycle when their mates are being chased, i.e. the period just before and during egg-laying.

In the Mallard, paired males do show overt aggression toward other males (Dzubin, 1955; Gates and Beer, 1956; Lebret, 1961), although such behaviour is considered rare by Dzubin, and it was not recorded by Hori (1963). The distinction between three-bird flights and attempted rape flights is clearer in this species: immediately before and during laying most pursuits are brief, they cover a small area, and the pursuing male generally returns to his starting point after flying a distance of up to half a mile (Dzubin, 1957). Males begin to associate in groups during parts of the day early in the incubation period, although the pair-bond may still be intact.

Attempted rape flights are common, once incubation has begun, and Lebret (1961) believes that they are associated especially with the time when the pair-bond is breaking. They have not been recorded reaching the great heights that they do in the Pintail. In general, Mallard pursuits are less prolonged and cover less ground than those of the Pintail.

In the Shoveler, paired males are hostile toward other males and vigorous pursuits occur as long as the pair-bond remains intact, which is usually late in incubation. Females of strange pairs are also pursued but, at least while the pair-bond is strong, rape is rare. Three-bird flights are common, the pursuing male centring attention on the strange female, but her mate often threatens and pecks toward him in flight. These pursuits are typically short, the chasing male returning quickly to his starting point.

The behaviour of some other Anatini seems to fit fairly closely to each of these three types, although the evidence is even less complete and each species will have to be studied very carefully. The Green-winged Teal is similar to the Pintail in that paired males frequently leave their mates to join in energetic attempted rape flights. The Blue-winged Teal and Cinnamon Teal, on the other hand, show their close phylogenetic relationship to the Shoveler by their strong development of aggression between males, long-lasting pair-bonds, and typically short pursuit flights. The distinction between three-bird flights and attempted rape flights is apparently as clear in the Gadwall (Gates, 1962) as in the Mallard, but in the former overt hostility between males is frequent in flight.

The motivation of chasing behaviour

In general, aggressive behaviour in paired males is associated with the presence of a strong pair-bond. This is illustrated well by the relationship of male aggressiveness to the presence and location of the mate. In the Velvet Scoter, Koskimies and Routamo (1953) described an area around the pair which is defended by the male and moves with the pair. Dzubin (1955) described a 'moving territory' in the Canvasback – an area around the female, about six feet in diameter, in which the male is aggressive toward other birds: paired males rest peacefully together while their females are at the nest, but as soon as one male is joined by his mate he becomes aggressive. Similar behaviour was recorded by Mendall (1958) in the Ring-necked Duck. As a result of studies on Mallard, Gadwall, Shoveler, and Cinnamon Teal, Smith (1955) concluded that there is 'an area of intolerance around the breeding pair which moves as the pair moves'.

In the Blue-winged Teal, Dzubin (*loc. cit.*) noted that males are aggressive toward other birds in the absence of the mate, but 'the presence of the female increases the male's aggressiveness'. I have noted the same phenomenon in a male Shoveler; after his mate's clutch was removed and she began to spend all her time with him during the 're-nest interval', the male showed increased hostility, apparently as a response to the female's presence. Gates (1962) observed that 'territorial chasing' (= three-bird flights) in the Gadwall 'normally occurred only when the pair was together', and he concluded that this type of chasing 'appeared to represent the defense of the mated hen rather than defense of the nesting area'.

Many paired males also behave aggressively while the mate is on the nest, but there need be no fundamental difference in the cause of the hostility. These males know where the nest is situated and intense hostility in the vicinity of the nest, as recorded in male Canvasback and Blue-winged Teal by Dzubin (1955), is probably related primarily to the female's presence there. Thus the aggressive responses of paired males on the breeding grounds are basically similar to those shown by males during pair-formation, and by paired males on the wintering grounds and during spring migration. There may be threshold differences, but I suggest that the restriction of the male's responses to a certain area is primarily a result of the female's attachment to the area she selects for breeding and subsequently her attachment to the nest.

A male Shoveler can be found day after day on the same small pothole, spending much time resting on a certain log. But when this bird pursues a passing male or pair there is no need to suppose that he is 'defending' either the water area or the log. The approximate location of 'waiting areas' is determined by the position of the mate's nest; their precise location, by the habitat preferences of the species and the individual's relationship with other birds. If conditions are favourable, the waiting areas are on the nearest piece of water (Dzubin, 1955; Stotts and Davis, 1960), but in other cases they must be further away to satisfy the requirements of the waiting male. Thus the use of 'loafing spots', 'waiting areas', or 'territories' (in Hochbaum's sense) is dependent on the existence of the pair-bond, and I believe that hostility of males using them regularly is primarily an expression of the male's attachment to his mate.

Participation in attempted rape flights is characteristic of males with a weakening pair-bond. In the Mallard and Gadwall, attempted rape flights are seen once incubation has begun when paired males are showing less attachment to the mate and to the waiting area near the nest. In the Pintail, this behaviour appears even earlier (before and during laying), but in this species the pair-bond is weak and hostile reactions are absent.

The 'three-bird flight' appears to have evolved as a form of 'compromise behaviour' resulting from conflicting tendencies. This is indicated by the various 'levels of intensity' in these flights detected by Hori (1963) and Smith (1963). The diagnostic feature of Hochbaum's 'territorial defense flights' was the return of the pursuing male to his starting point. This is the pattern so typical of the Blue-winged Teal and Shoveler, in which pursuits are short. Again the importance of the pair-bond is shown, the quick return reflecting the male's attachment to his mate.

In theory, the pursuit of the female of a strange pair by a paired male could be motivated by either attack tendency, rape tendency, or a combination of the two. As I have suggested (Table II), these two tendencies conflict with the sociability of males and with the male's attachment to his mate, respectively. Thus while I agree with the general belief that many pursuits are motivated primarily by 'sexual tendency', it should be stressed that this is specifically a '*rape* tendency' which is in conflict with the pursuer's 'tendency to remain with or near the mate'. I cannot agree with the proposal of Hori (1963) that predominant sexual tendency is coupled with a 'social tendency' in the case of three-bird flights (though the latter may be a factor inducing some males to join in attempted rape flights). In the Shoveler particularly, three-bird flights occur at a time when the pursuing male is intolerant of other males and a tendency to be sociable is virtually absent.

Since overt hostility toward the male of a pair can be associated with the pursuit of his mate, the possibility that chasing males are responding (at least in part) aggressively to the female should not be overlooked. The phenomenon of 're-directed aggression' (Bastock *et al.*, 1953) may be involved: when a male's tendency to attack another male is inhibited, he re-orientates his hostility toward the female.

Table II. A comparison of the broad features of social behaviour and some characteristics of pursuit flights in three species of *Anas*.

Amount of time paired male spends	*stage of mate's breeding cycle*	*Pintail*	*Mallard*	*Shoveler*
Alone on waiting area	Early	X	XX	XXX
	Late	o	o	XXX
Associating with other males	Early	XXX	X	o
	Late	XXX	XXX	X
Attacking other males	Early	o	X	XXX
	Late	o	o	XXX
Attempting to rape strange females	Early	XXX	X	X
	Late	XXX	XXX	X
Characteristics of pursuit flights				
Average height		XXX	XX	X
Average duration		XXX	XX	X
Average distance covered		XXX	XX	X
Frequency of flights involving only 3 birds		XXX	XXX	XXX
Frequency of flights involving many males		XXX	XXX	X
Aggression between males in flight		o	X	XXX

The ratings X, XX, XXX represent relative degrees of development of each behaviour pattern (or characteristic) in the three species (o = absent). These approximate ratings are based on the studies of Dzubin (1955), Hochbaum (1944), Lebret (1961), Smith (1963), Sowls (1955), and on my own observations. 'Early' = pre-laying, laying and early incubation; 'Late' = late incubation.

Dispersion and aggregation of pairs

All ducks lead semi-aquatic lives: they need both water areas and adjacent land areas to satisfy all their needs. The detailed nature of these requirements vary between species, in accordance with different ways of life. Extreme cases are represented by the Ruddy Duck and the Laysan Duck *Anas laysanensis*. The former is almost exclusively aquatic, but it is dependent on marsh edges for nesting and brood-rearing cover. The Laysan Duck is predominantly terrestrial: it makes only limited use of salt water and apparently is capable of surviving without fresh water (Warner, 1963). Most species fall between these extremes, making daily use of water areas and shorelines, but each has slightly different habitat-preferences. Above all, the ecology and behaviour of each species are influenced by the pattern of land-water interspersion in the habitat.

These relationships between land and water areas can be extremely complex. Even for one species they may differ from one region to another; frequently they change in the course of one season, and from one year to the next. The need for most species to be adaptable to varying conditions is obvious, and it is not surprising to find that some parts of the breeding range of each pair are 'shared' with other pairs. To understand the pattern of pair-spacing, it is necessary to know the degree to which this sharing occurs and the way in which it is achieved. Particularly important is 'the distribution of the breeding requirement which is most limited' (Smith, 1955). This sharing is obvious where the requirement takes the form of 'an island' – whether it is a true island in the sense of an isolated land mass, or whether it is an isolated water area, food source, waiting area, or tract of nesting-cover.

The sharing of one or more breeding requirements by a number of pairs may be advantageous or disadvantageous to the species, and complex 'mechanisms' have evolved which tend to preserve the optimum condition of adaptedness. In ducks, as in many other animals, social behaviour patterns appear to be of prime importance in the operation of these 'mechanisms' (see Wynne-Edwards, 1962).

Homing by both adult and young females must produce a tendency for breeding pairs to become concentrated. If the homing is precisely to the nest-site, a dense colony would tend to form; if the birds return merely to the 'home range', a less concentrated aggregation of nests would result. In many environments, however, concentrations of nests are especially vulnerable to predation and in practice such sharing of a localised nesting area occurs only on islands or in other situations where nesting losses are low.

Precise homing to the nest-site and the establishment of dense nesting colonies do occur as a typical pattern in the Common Eider. A major factor producing such colonies seems to be the lack of mammalian egg-predators. On mainland areas, Eider nests are farther apart (Lack, 1954). The social behaviour of this species is adapted to colonial nesting, pairs showing only mild hostility toward one another. In contrast, male King Eiders *Somateria spectabilis* are more aggressive in the nest area (Pettingill, 1959), and this species does not form colonies on islands.

Nesting concentrations occur on islands in lakes, the most famous being at Myvatn in Iceland (Scott, 1952). A hatching success of 90% has been recorded in 160 nests on Gadwall Island, North Dakota, in contrast to an average of 50% for the same species (mostly Gadwall) on the mainland nearby (Hammond and Mann, 1956). Comparatively dense breeding populations of Goldeneye and Wood Duck have been built up gradually over a number of years in various places in Europe and North America by saturating an area with predator-proof nesting-boxes. In addition to homing and high productivity, an additional factor in producing these nesting concentrations may be a tendency for females to be faithful to a site where a nesting attempt has been successful (Mendall, 1958).

Hammond and Mann (*loc. cit.*) found that the Gadwall was especially prone to form island nesting concentrations. Mallard, Pintail, Lesser Scaup, and Redhead also used these same islands but the numbers of Shoveler and Blue-winged Teal were no greater than on nearby mainland habitat. At Myvatn, Greater Scaup *Aythya marila* and Oldsquaw *Clangula hyemalis* were the most abundant nesters, but here also many other species used the islands (Scott, *loc. cit.*). In southern Alberta, Keith (1961) found that Lesser Scaup and Mallard favoured islands, while Black Ducks are known to concentrate on islands off the coast of Maine (Gross, 1945) and in Chesapeake Bay (Stotts and Davis, 1960). In other regions, all these species may be found nesting in a dispersed pattern; their use of islands apparently results from local traditions built up gradually as a result of especially favourable conditions for high production.

For the *Aythya* species, the increased proximity of pairs caused by nesting on islands probably presents little difficulty

since these birds show a low level of aggressiveness and they do not engage in aerial pursuits. Gadwall, Mallard, and Black Duck do show these responses, however, and in some ways their behaviour must be modified to enable nesting concentrations to occur. The mobility of pairs is probably important, so that not all activities need be accomplished on the island. Hammond and Mann believe that many Gadwalls use the islands only as a place for a nest-site; they fly to and from feeding and resting places on the mainland. On the other hand, the Black Ducks of Chesapeake Bay have waiting areas on the island shore at the spot nearest to the nest; although aggressive encounters and aerial chases were observed, these were considered to be 'surprisingly infrequent' (Stotts and Davis, *loc. cit.*).

In the grassland area of Kindersley, Saskatchewan, Alex Dzubin (*in litt.*) has studied the behaviour of a high Mallard population in which many pairs are forced to share small water areas (e.g. 25–30 pairs to a 5-acre pothole). In contrast to the behaviour of this species in parkland habitat where there are many potholes close together, the Kindersley Mallard drakes are unable to exclude other pairs from specific waiting sites. There is frequent shifting of areas from which males begin chases and, because of the constant presence of other pairs nearby, chasing is directed mainly at birds flying overhead, especially females going to and from their nests. Dzubin concludes that some pairs are forced to delay nest-initiation when they are constantly chased away from such a water area. When the chasing activities of early breeding males wane in intensity, there is a chance for other pairs to become established and begin breeding. I have observed the same phenomenon when Shoveler pairs are crowded in pens.

In contrast to the Mallard, which may be found breeding in a wide variety of habitats, the Pintail appears to be specially adapted to nesting in the vicinity of a 'water island'. Pintails prefer open prairie and tundra where nesting cover is sparse and water areas few and often isolated. The studies of Smith (1963) in southern Alberta show that the lack of aggressiveness between males allows many pairs to make use of one lake for feeding and nesting, but the extreme development of raping activity tends to cause dispersion of females at the time of nest-site selection, thus producing dispersion of nests. Smith believes that this nest dispersion has survival value in reducing the level of egg-predation. The mobility of Pintail broods and the grey cryptic coloration of the ducklings are presumably adaptations for the long overland trips necessary to reach water. At Kindersley, Dzubin finds similar wide dispersion of nests in the Mallard (up to 1 mile from water), probably as a result of intense chasing activity. Although egg-predation may be reduced by this dispersion, duckling mortality is high in dry seasons, up to 40% of broods never reaching water.

In contrast to the Mallard and Pintail, the Shoveler behaves in a way much more like that of a territorial passerine. The home range is small, and males are aggressive toward any intruder. The pair-bond is strong and promiscuous tendencies are weak. This type of behaviour produces a clear pattern of pair-spacing, the nest being situated close to the mate's waiting area. Thus, largely through hostility between pairs there is a tendency for nests to be spaced out. The behaviour of this species appears to be adapted to marsh habitats which provide all requirements of the pair within a relatively small, discrete area. For this reason, the Shoveler is a good example of a species with highly developed 'territorial behaviour' of the type envisaged by Hochbaum.

The functions of chasing

In ducks, as in other birds (Hinde, 1956), there is little direct evidence on the effects of chasing. The frequency and intensity of chasing by males have been observed to increase as the number of pairs in an area increases (e.g. Hammond and Man, 1956; Mendall, 1958; McKinney, in prep.), or when habitat changes enhance the visibility of adjacent pairs (Hochbaum, 1944). It is generally assumed that, under such conditions, the density of breeding pairs is being limited by chasing, and that the same process is effective to a lesser degree at lower densities. In some instances, however, it appears that breeding populations can increase in density almost indefinitely in spite of chasing (Hammond and Mann, *loc. cit.*; Gates, 1962) and some authors (e.g. Bezzel, 1959) have suggested that chasing has little effect on duck populations.

In this paper, I have tried to show how such contradictory views can be reconciled. Although the evidence is circumstantial, I believe that chasing tends to produce some degree of dispersion and that it has a significant effect on breeding densities. The absence of a neat pattern of exclusive territories with defended boundaries does not necessarily conflict with this generalisation. The ability of pairs to share certain parts of their home ranges and to adapt their behaviour to local habitat conditions

can be essential, adaptive attributes. The behaviour of each species must be the result of a compromise between the advantages of spacing-out and those derived from sharing the available resources.

Hochbaum (1944) suggested that the primary function of territorial behaviour in ducks is that it permits uninterrupted copulation between the members of the pair, but there is little evidence to support this theory. Eiders successfully accomplish copulation under the crowded conditions prevailing at colonies, and I found the same to be true in artificially crowded pairs of Blue-winged Teal and Shoveler. It is true that interruptions occur but, viewing the problem from an evolutionary point of view, it is difficult to believe that it had to be 'solved' through the enormous expenditure of energy involved in chasing.

Hochbaum's argument depended mainly on the timing of chasing behaviour; it peaks in frequency and intensity just before and during egg-laying, at the time when fertilisation must be occurring. This generalisation has since been confirmed in a number of species (e.g. Sowls, 1955; Dzubin, 1955; Mendall, 1958; Gates, 1962; Smith, 1963). As well as being the period of fertilisation, however, this is the time when nest-sites are selected. In the Pintail, Smith (1963) believes that dispersion of nests over the available habitat is a direct consequence of sexual chasing activity, but in other species the effect is probably indirect. In the Shoveler, Mallard, and Gadwall, chasing appears to produce a spacing of pairs at the time when they are establishing home ranges. On mainland habitats, where preferred nesting-cover is dispersed, this will lead to a dispersion of nests. Evidence from nesting concentrations (p. 96) strongly suggests that such nest dispersion has survival value as an anti-predator device. This suggestion was made with respect to gulls by Tinbergen (1952) and the same idea was proposed by Hammond and Mann (1956) for ground-nesting ducks. The survival value of nest dispersion in Black-headed Gulls *Larus ridibundus* has since been demonstrated experimentally by Tinbergen *et al.* (1962).

In areas where many species of duck nest side by side in the same nesting cover, it is perhaps surprising to find that interspecific territorialism (Simmons, 1951, 1956) is not widespread. Presumably the advantages of such responses in producing dispersion of all duck nests are outweighed by the disadvantages of the time and effort which would be required. Furthermore, the species-composition varies so much from one area to another that the response would have to be very generalised. In many cases, such behaviour would entail 'wasted' energy, chases being directed at birds which are not using the same type of nesting cover. The same principle seems to apply in other groups of birds, interspecific territorialism having evolved only where its advantages are great. The occurrence of interspecific hostility in Barrow's Goldeneye is of great interest and it deserves further study.

Geyr (1924) suggested that territorial behaviour in the Mallard ensures an adequate food supply for the brood. In theory this could be an important ultimate function of pair-spacing, but the evidence suggests that it is of secondary importance in ducks. Broods have considerable powers of mobility and, in most duck breeding habitats, food supply is abundant. The argument that pair-spacing produces nest dispersion may apply in some cases also to broods, high densities being more vulnerable to predation, but again direct evidence is lacking. On the whole, dispersion of pairs is more likely to be primarily an anti-predator device; if young are not produced, there is no need for a food supply.

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Breeding success of geese in west Spitsbergen, 1964

M. NORDERHAUG, M. A. OGILVIE and R. J. F. TAYLOR

Summary

Details are given of the distribution of breeding Pink-footed, Barnacle and Brent Geese in Spitsbergen and of their past status. Counts were made in the south-west of Spitsbergen in the summer of 1964. Few young Barnacle Geese were reared but Pink-foot were more successful. Many nests were found and the factors affecting the choice of nest site are discussed: freedom from snow cover is the most important.

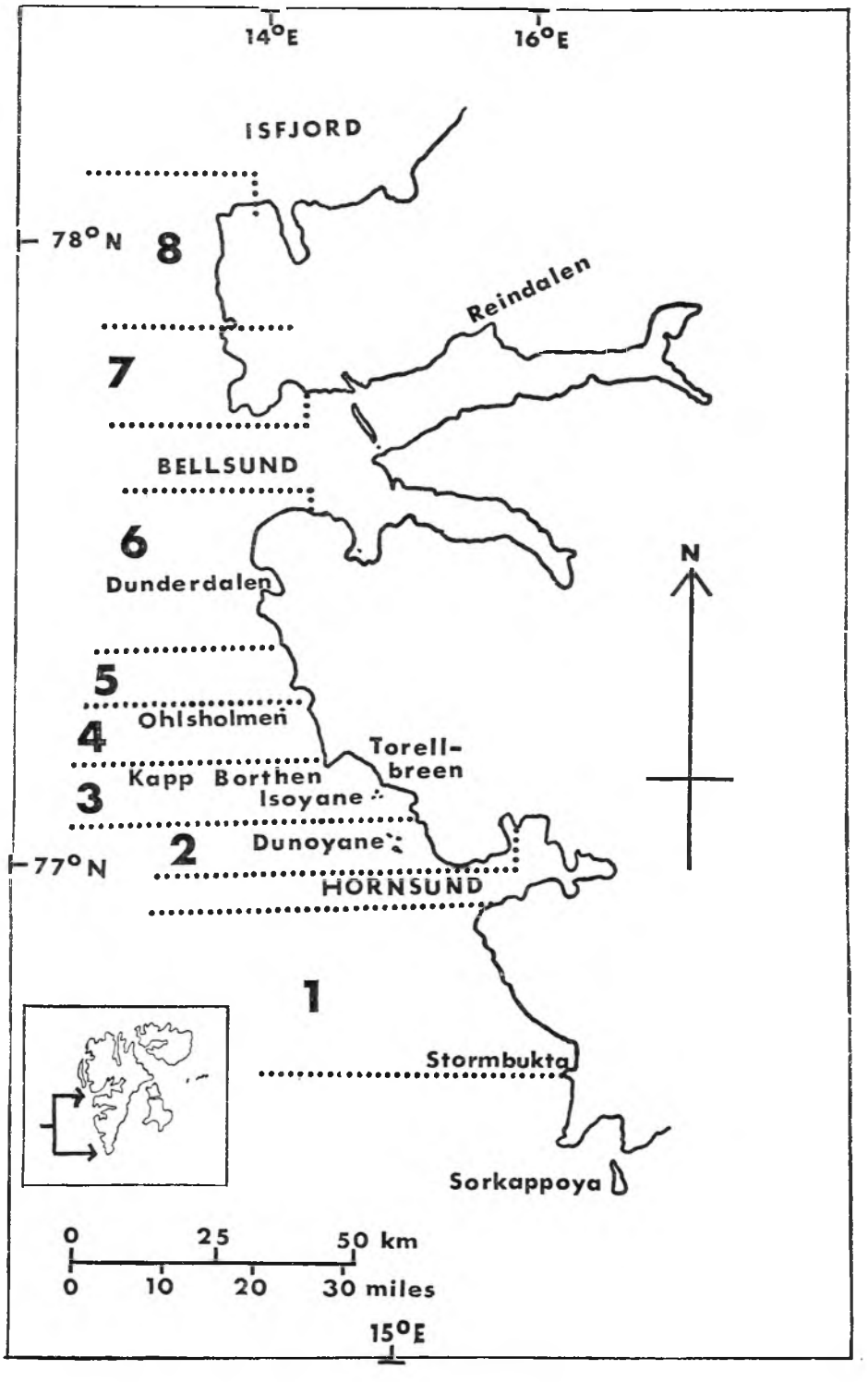
Introduction

In the summer of 1964 two expeditions, one from Norway and one from Britain, visited adjacent parts of West-Spitsbergen with the object of investigating the status, distribution and breeding success of the Barnacle Goose *Branta leucopsis* Pink-footed Goose *Anser brachyrhynchus* and Brent Goose *Branta bernicla hrota*.

The Ornithological Group of the Norsk Polarinstitutt, consisting of L. Ljøterud, B. Mathiasson (assistants) and M. Norderhaug worked from 7th July to 31st August in the coastal region from Stormbukta north to Ohlshomen/Kapp Berg (areas 1–4 on map). They also continued their Little Auk *Plautus alle* studies, begun in 1962. The Wildfowl Trust Expedition of R. J. F. Taylor and M. A. Ogilvie covered the coastal area between Isfjord and Bellsund (partially) and from Bellsund south to Kapp Borthen, from 18th June to 26th July. The two expeditions worked independently, but study methods had been co-ordinated beforehand.

Topography

The topography of the south-west coast of West-Spitsbergen is characterised by a flat plain varying in width from one to six miles and never rising above 300 feet. Steeply sided mountains reaching 3,000 feet form a boundary on the eastern edge of the plain. Two wide and extensive fjords, Bellsund and Hornsund, and one large glacier, Torellbreen, break the area into three distinct parts, geographically but not ecologically. There are numerous offshore islets and rocks, of which the largest such as the Dunöyane and Isöyane groups and Ohlsholmen are barely one square kilometre in area. They are low, grass-covered and with a few small, shallow ponds. Large parts of the coastal plain are nearly barren or with scant vegetation. It is only round ponds and streams and close to the foot of the mountain cliffs with their very large colonies of sea-birds, mostly Little Auks, that the richest vegetation is found. An association between these lush areas and the distribution of the geese is


14°E
16°E
ISFJORD
78°N
8
Reindalen
7
BELLSUND
6
Dunderdalen
N
5
Ohlsholmen
4
Torell-
breen
Kapp Borthen
Isoyane
3
Dunoyane
2
77°N
HORNSUND
1
Stormbukta
Sorkappoya
0 25 50 km
0 10 20 30 miles
15°E

apparent. The single large valley of Dunderdalen, over ten miles long, has considerable areas of poorly vegetated bog with small lush bits round the few ponds. The middle and upper parts of the valley are more barren still. The inner regions of the two fjords were not visited.

Weather conditions

The winter of 1963–64 was characterised by heavier than normal snowfall and an unusually cold spring resulted in a late thaw, with 100% snow cover still present at the Radio and Meteorological Station at the mouth of Isfjord until 5th June. The thaw was rapid when it came, with only 50% cover by 25th June, and the snow had gone completely from the coastal plain by 17th July. The end of June and the first half of July was generally fine with little snow or rain. Thereafter until the end of August the weather was predominantly wet with comparatively warm winds. Most of the drift-ice disappeared from the south-western coasts during the first week of July.

Barnacle Geese

Ringing of Barnacle Geese in the Hornsund area in the summer of 1962 (Larsen and Norderhaug, 1963) and on the Solway Firth, Scotland, in the following winter (Boyd, 1964) had confirmed an earlier inference that the flock of Barnacle Geese wintering on the Solway Firth, numbering 3,000 in 1962–63 and 4,300 in 1963–64, came from Spitsbergen and was a population entirely separate from the stock breeding in east Greenland and wintering in west Scotland and Ireland, and from that breeding in Arctic Russia and wintering in Holland and Germany.

Apart from the non-breeding flocks totalling 1,100 birds found in the Dunöyane Islands off Hornsund in 1962 (Larsen and Norderhaug, 1963) and the much smaller numbers found breeding there (at least 35 pairs) in 1963 (Norderhaug, 1964), records from Spitsbergen were scanty and gave little indication of where the birds might now breed in numbers. Løvenskiold (1964) summarises the pre-war position and gives his own observations from many parts of the Svalbard archipelago which, however, were mostly made in the early 1950's when the Barnacle Goose population was much smaller than at present (Atkinson-Willes, 1963). He indicates two known breeding areas, both small. The colony in Longyeardalen was exterminated before 1931, probably by human activity from the nearby mine. The maximum size of this colony is unknown, but possibly not more than 50 pairs. 23 Barnacle Geese were caught and ringed whilst moulting in Reindalen in 1954 and geese in small numbers have been recorded breeding in Sassendalen and adjacent valleys. Reindalen has been visited by oil prospectors in the past few years, but it is not known what effect this has had. Breeding was recorded from the Isöyane islands in 1924 (20 pairs) and from the nearby Dunöyane group in 1952 (12 broods). Another known breeding area is in the extreme north-west of the archipelago, where 20 pairs were found on a small islet off Dansköya visited by the Norsk Polarinstitutt expedition ship in June 1964.

Breeding success of the Barnacle Goose

In area 1 of the map, no Barnacle Geese were found breeding or with young. In areas 2–4 all likely breeding localities were visited and searched during August and all used nests counted. It is unlikely that many sites or nests were not found. In area 5 no nests were located, but accurate counts were made of the number of broods of goslings. There were no records of Barnacle Geese in areas 6–8. Table I shows the numbers of geese and nests found. The total population counted was in excess of 1,511 with a gosling proportion of 10·0%.

Table I. Numbers of Barnacle Geese and their nest-sites counted, West-Spitsbergen 1964

	Parents seen or estimated	*Goslings*	*Nests and broods*	*Non-breeders*
Area 1	–	–	–	–
2	332	62	166	250+
3	180	–	90	?
4	40	71	20	220
5	50	18	25	289
total	602	151	301	759+

The main hatching period occurred before the breeding areas were visited, and only a handful of nests still in use were found. At Dunöyane on 14th July a few nests with eggs and one with hatching eggs were recorded. From observations of the age of goslings seen, the main peak of hatching was probably 4th to 11th July. There is excellent agreement between independent records made in areas 2, 4 and 5. Counts were made of the number of goslings in each brood seen, and the mean size of 59 broods was 2·6. It was not possible to estimate the proportion of goslings in the flocks in areas 2 and 3, but in areas 4 and 5 it was 13·4%.

Because of the incomplete counting in some areas and the unknown rate of failure of nests, it is not possible to use these figures to make a reliable estimate of the total population.

The great majority of the nests were on islets and skerries off-shore. Cliff-nesting, common in Greenland, has only been recorded in Spitsbergen from the Longyeardalen colony. In areas 4 and 5 many of the family parties were on and around large lakes on the mainland. Although no geese were found in areas 6–8, there seems no major ecological difference between these areas and where the Barnacle Geese were found. There thus seems to be no barrier in this part of Spitsbergen to further increases in the Barnacle Goose population.

Pink-footed Goose

Birds of this species were breeding in areas 1, 2 and 4 to 7. Nests were found in areas 6 and 7. The numbers of young and non-breeders were accurately counted in areas 4–7. The peak hatching period estimated from nests found and age of young seen was 1st–7th July, a few days earlier than for the Barnacle Goose. The choice of nest-site was very varied, including rock outcrops, the tops of low cliffs and 100 feet or more up steeply inclined grass-covered mountain slopes. Table II shows the numbers of adults and young counted. The proportion of young in areas 4–7 was 41·4% and the mean brood size in all areas was 2·7 (70 broods).

The Pink-footed Goose breeds almost throughout Svalbard wherever conditions are suitable (Løvenskiold, 1964). From ringing in West-Spitsbergen in 1953 and 1954 (Goodhart, Webbe and Wright, 1955, Holgersen, 1956) it is known that these birds winter in Germany and Holland. The size of this population is between 7,000 and 10,000 (Dr. M. F. Mörzer Bruijns and J. Phillipona, *in litt.*).

Table II. Numbers of Pink-footed Geese counted, West-Spitsbergen 1964

	Parents	*Young*	*Non-breeders*	*Total*
Area 1	8	10	270	288
2	30	38	116	184
3	–	–	–	0
4	16	21	3	40
5	0	0	25	25
6	106	146	170	422
7	8	11	60	79
total	168	226	644	1038

Brent Goose

This species is scarce in the areas visited. Six used nests were found in area 2 and the probable number of birds in this area was under 70. A short visit was made on 31st August to Sorkappoya south of West-Spitsbergen where 120 geese were seen. Some of these had been there the whole summer but most had only arrived during the last week of August, probably gathering prior to migration (Dr. S. Siedlecki, pers. comm.).

Choice of nest-site by Arctic-nesting geese

Selection of nest-site is probably governed by numerous factors. Freedom from snow-cover at the time of laying (calculated peaks in 1964 were 25th May to 2nd June for the Pink-footed Goose and 2nd to 9th June for the Barnacle Goose) is the most important. As mentioned above, the choice of site by the Pink-footed Goose is far more catholic than that of the Barnacle Goose and this is clearly an adaptation brought on by the longer incubation and, in particular, fledging periods of the former necessitating an earlier start to breeding. The interval from first laying to the final fledging of young is about 88 days for the Pink-footed Goose and 75 days for the Barnacle Goose. The Barnacle, with its preference for islands, can afford to wait. Islands, of course, are more likely to be free from Arctic Foxes, though there are records of these animals crossing to islands on sea-ice and causing great damage to nesting birds (Løvenskiold, 1964). The Pink-foot seems unworried by foxes; in one area six nest-sites were found within 400 yards of a fox earth containing a vixen and three two-months-old cubs. Eggshells in the nest and goslings in the neighbourhood suggested successful hatching of at least some of these nests. Thus the Pink-foot's varied choice of nest-site seems governed by the dominant factor of lack of snow cover, and the previously documented requirements for freedom from predators and also of a vantage point for the gander (Løvenskiold, 1964) seem to be consequences of this rather than criteria in their own right. Good feeding, both for the nesting birds and for their young within a reasonable distance is an obvious consideration; proximity to an expanse of water, fresh or salt, can be assumed to be secondary to this. 200 yards was the maximum recorded for the distance from nest-site to good vegetation. The immediate nest-site sometimes included a modicum of shelter for the sitting bird, a low rock for example, but the influence of this in the

selection of the site would only seem to be in terms of the final few inches.

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The numbers of waterfowl in Estonia

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Summary

About 27,000 pairs of ducks of 14 species, 500 pairs of Greylag Geese and 10 pairs of Mute Swans have bred annually in Estonia in recent years. Mallard (10,000 pairs) are most numerous, though they and Velvet Scoters (1,100) and Pochard (400) are decreasing. Eiders (3,500 pairs), Shoveler (2,500) and Scaup (90) are increasing. Much larger numbers occur on passage in spring and autumn, including over a million Long-tailed Ducks and Velvet and Common Scoters, over 100,000 Bean Geese and over 50,000 Whooper Swans. Few wildfowl winter, 3,000 Mallard being the most plentiful.

Introduction

The intensive ornithological research of the last ten years may now be summed up to furnish provisional data on the numerical strength of the waterfowl in Estonia.

Counts of local breeders have been taken in a number of Estonian habitats. The most accurate returns we possess cover the bird population nesting in the archipelago. Estonia possesses nearly 800 small islands with a surface area not exceeding 100 hectares (250 acres), of which the majority are densely populated. Ornithological researches of a more detailed character have been carried out in the four areas where the population is densest. Together they contain some 180 islets, sandbanks, etc. (Figure 1). In each of these areas counts have been taken in from two to six years in the course of the past decade (Table I), and the nests of most of the local breeding ducks have been traced.

The data for the littoral are less complete. At least two-thirds of the Estonian coast, that extends for about 3,400 kms (2,100 miles), are uncongenial as a breeding ground for the majority of the geese and ducks, which exhibit a marked preference for the deeply indented shores of the numerous coastal lakes and those sectors of the western seaboard and the south coast of Saaremaa Is., where coves, inlets and bays are thickest. Counts of the waterfowl in these regions were mainly taken along chosen routes during the nesting season. But more exact figures are available for the ducks in the Matsalu National Park, where most of the nests in a number of sample areas were traced and charted. The information obtained was sufficiently re-

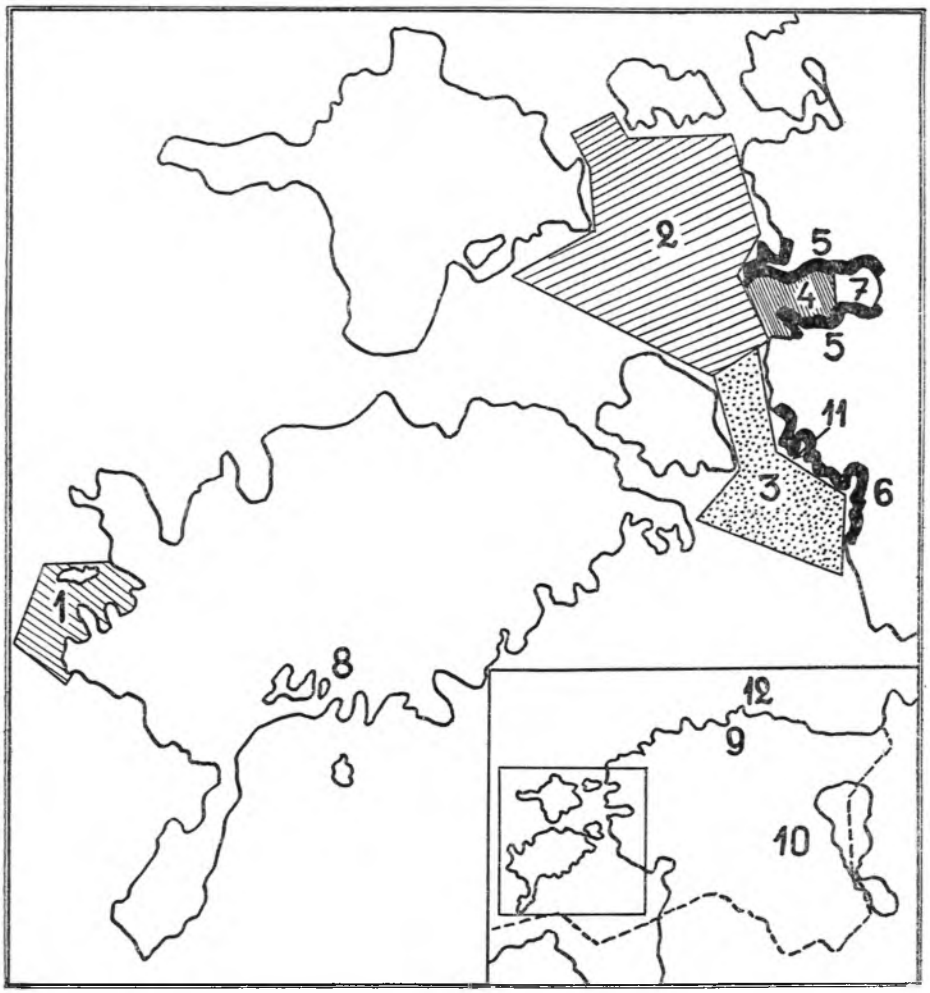


Figure 1. The Estonian SSR – I maritime islands covered by ornithological research: 1. Vilsandi and environs. 2. The Väinameri (Muhu Sound). 3. The Suur Väin (Great Sound). 4. Matsalu Bay. II Investigated sectors of the littoral: 5. Matsalu National Park. 6. Environs of Puhtu Bird Station. III Bays and coastal lakes rich in vegetation 7. Matsalu Bay, 8. L. Linnulaht, 9. L. Kahala, 10. L. Soitsjärv. IV Counts of migratory ducks: 11. Puhtu, 12. Viinistu.

presentative to justify the use of correction coefficients to calculate population densities. Apart from Matsalu, where counts have been made every year, beginning from 1957, a number of other short stretches of the coast have been similarly dealt with from time to time (see Figure 1 and Table II).

There are about 1,100 lakes in Estonia with a surface area exceeding one hectare. Most of them are oligotrophic and sparsely vegetated, with the result that they are unable to support any considerable population of waterfowl. On the other hand we have about 50 eutrophic lakes, and about the same number of bays, inlets and coastal lakes that merge with the sea at high water. These have dense breeding populations, and most of our lacustrine and maritime ducks are concentrated here. The largest of the bays is Matsalu, with about 2,000 hectares (5,000 acres) of reed beds, where the bird population has been calculated with reasonable accuracy over a number of years. At the same time we have data for the breeding populations of most of the so-called Estonian 'bird-lakes' in certain years. The larger and better known of them are marked in Figure 1, and a few indications concerning the predominant species will be found in Table III.

Only approximate figures can be given

Table I. The population of breeding geese and ducks on the smaller maritime islands of Estonia

	Environs of Vilsandi	*Väinameri (Muhu Sound)*	*Suur Väin (Great Sound)*	*Matsalu Bay*
number of islands	50	70	50	10
Somateria mollissima	2500	450	5	–
Aythya fuligula	5	220	300	80
Melanitta fusca	150	250	100	–
Anas clypeata	50	110	150	35
Mergus merganser	150	130	10	5
Anas platyrhynchos	50	90	90	40
Anser anser	120	40	5	15
Mergus serrator	60	80	25	2
Anas querquedula	5	35	30	20
Anas acuta	10	15	15	2
Aythya marila	50	5	5	1
Tadorna tadorna	20	30	5	–
Anas crecca	5	10	10	–
Aythya ferina	–	–	5	1
Anas strepera	–	–	–	2

Table II. The population of breeding geese and ducks on the most suitable stretch of the Estonian shore

	Matsalu National Park (120 kms.)	*Puhtu Bird Station and environs (30 kms.)*
Anas platyrhynchos	165	20
Anas clypeata	160	20
Mergus merganser	55	50
Anas querquedula	160	10
Melanitta fusca	2	70
Aythya fuligula	2	15
Anas crecca	–	5
Anas acuta	35	1
Mergus serrator	–	–
Tadorna tadorna	2	1
Anser anser	5	3
Somateria mollissima	–	–

Tables III. Ducks and geese breeding in richly vegetated biotopes (coves, bays, coastal lakes) near the Estonian coast

	Reed-beds in Matsalu Bay	*L. Linnulaht*	*L.Kahala*	*L. Soitsjärv*
area (in hectares)	2000	117	345	223
Aythya fuligula	–	50	70	15
Anas platyrhynchos	250	10	5	5
Aythya ferina	150	25	3	15
Anser anser	170	2	–	–
Anas querquedula	–	10	2	3
Anas clypeata	–	10	4	1
Anas crecca	–	2	1	1
Melanitta fusca	–	5	5	–
Mergus serrator	–	2	–	–
Aythya marila	–	3	–	–
Cygnus olor	2	–	–	–
Anas acuta	2	–	–	–
Mergus merganser	5	–	–	–
Anas strepera	2	–	–	–

for the numbers of breeding ducks in the remaining habitats, though the data for the peatbogs and about 100 of the bigger lakes may be regarded as fairly satisfactory. Elsewhere we can piece together little more than a fragmentary picture, in spite of the small size of the local nesting communities. As for the lakes and bogs investigated, no more than 17, or at the most 18, of the 35 species of geese and ducks (with 37 subspecies) found in Estonia can be shown to breed here. Approximate numbers giving a rough idea of the distribution of the breeding geese and ducks in the above-mentioned groups of biotopes are given in Table IV. In presenting the data, the figures, wherever possible, cover the past ten years. However, it should be borne in mind that important modifications are at present taking place in the numbers of several local breeding species. The Eider, and probably also the Scaup, shows a marked upward trend. The numbers of Shovelers have persistently risen during the last two decades. In recent years some species, such as the Mute Swan and Gadwall, have shown a tendency to expand over Estonian territory. On the other hand the numbers of Mallard, Velvet Scoters and Greylag Geese are steadily diminishing. The Pochard, which between ten and twenty years ago was rapidly increasing as a local breeder in Estonia, has during the last decade entered on a new decline.

As for the migratory geese and ducks which appear in Estonia as birds of passage only, 26 species have been recorded in transit. These are shown in Table V, arranged more or less in order of numerical strength.

During the last ten years the regular observations carried out at a number of points on Estonian territory during the autumn flight have produced abundant data for the numbers of migratory geese and ducks. Of particular interest are the results obtained at Puhtu and some of the observation posts along the north coast (Figure 1). For several years counts have been taken of the diving-ducks passing Puhtu in the spring, and of the ducks and geese halting to rest in the Matsalu National Park. The total strength of the migration is rather difficult to determine in the case of the surface-feeding ducks, which move mainly at night. All we have to go by here are the results of daytime counts taken at the more popular halting-places. The data for these species, therefore, represent no more than an approximate estimate.

With these reservations we may now proceed to sketch in a broad statistical outline of the migration. The average figures for the spring flight at the Puhtu Bird Station are as follows: Long-tailed Ducks 300,000, Common Scoters 200,000, and Velvet Scoters 150,000. On 20th April, 1957, counts taken in the central part of Matsalu Bay yielded 40,000 Whooper and Bewick's Swans, 30,000 Goldeneyes, 20,000 Mallards, 12,000 Pintails, 10,000 Tufted Ducks, 9000 Wigeon, 8,000 Scaups, 1,000 Shovelers and 800 Goosanders.

The autumn flight, observed at Viinistu on the north coast in 1960 and 1962 (16th September to 15th October), gave the following averages: Long-tailed Ducks 400,000, Velvet Scoters 23,000, Common Scoters 16,000, Wigeon 6,000, Scaups 6,000 and Brent Geese 4,000 (data supplied by A. Jogi). The 1957 figures for Puhtu and its immediate environs during the same period were: Long-tailed Ducks 100,000, Velvet Scoters 17,000, Scaups 12,000 and Common Scoters 10,000.

The Long-tailed Duck and the Velvet and Common Scoters are mainly concentrated along a narrow route closely following the littoral, and muster in huge flocks on the north-western coast. Most of the birds keep to the west of the islands, though a considerable channel of the spring migration flows down the straits separating the islands from the mainland. Only a few individuals prefer to strike overland in the direction of Lake Peipsi (Peipus). Other species that cling to the seashore are the White-fronted and the Lesser White-fronted Goose, and the Barnacle and Brent Goose, the last of which is rarely met with outside the north-western coastal area. The other birds may be observed in almost any part of the country, while the Smew actually occurs most frequently in the region of Lake Peipsi.

In the last few years a special network of observers has taken counts of wintering ducks in Estonia. The most populous of these is the Long-tailed Duck, which may be seen flocking in tens of thousands in the open sea. Other prominent wintering ducks are the Goldeneye and Velvet Scoter. The Goosander, Eider and Red-breasted Merganser are somewhat less numerous. The Smew, Scaup, Tufted Duck and Common Scoter rarely winter in Estonia. When the weather is mild the Whooper Swan, and of recent years the Mute Swan also, may occasionally be met with on the seaboard.

The commonest duck wintering inland is the Mallard, of which about 3,000 individuals linger in the vicinity of the ice-free streams and watercourses, where they are accompanied by a few solitary specimens of the Teal and Bean Goose.

Table IV. The numbers of geese and ducks nesting in Estonia

	Small maritime islands	*Coastal area open shore*	*bays & lakes*	*Other biotopes*	*Total of breeding pairs*	*Recent changes*
Anas platyrhynchos	3	4	4	4	10,000+	decreasing
Somateria mollissima	4	1	–	–	3500	increasing
Aythya fuligula	4	2	4	1	3000	
Anas clypeata	4	4	2	–	2500	increasing
Anas crecca	2	2	1	4	2000	
Anas querquedula	2	4	3	2	2000	
Mergus merganser	3	4	1	–	1200	
Melanitta fusca	4	3	1	–	1100	decreasing
Anser anser	3	1	3	–	500	decreasing
Aythya ferina	1	–	3	–	400	decreasing after increase
Mergus serrator	3	2	1	–	400	
Anas acuta	2	3	1	1	350	
Tadorna tadorna	2	2	–	–	150	
Aythya marila	2	–	1	–	90	increasing
Bucephala clangula	–	–	–	2	50	
Cygnus olor	–	–	1	–	10	increasing
Anas strepera	1	–	1	–	5	
Anas penelope	–	–	–	1?	?	

4 = numerous (over 500 breeding pairs); 3 = common (100–500 breeding pairs); 2 = scanty (25–100 breeding pairs); 1 = a few solitary individuals (less than 25 breeding pairs).

Table V. Strength of the passage of geese and ducks through Estonian territory

Clangula hyemalis	several millions
Melanitta nigra, *Melanitta fusca*	about 1 million
Anas platyrhynchos, *Bucephala clangula*, *Aythya marila*, *Anas penelope*, *Anas crecca*	100,000–500,000
Anser fabalis, *Cygnus cygnus*, *Anas acuta*, *Aythya fuligula*, *Anser albifrons*	50,000–100,000
Branta leucopsis, *Mergus serrator*, *Cygnus bewickii*, *Mergus merganser*, *Branta bernicla*, *Anser erythropus*	10,000–50,000
Aythya ferina	5,000–10,000
Anas clypeata, *Anas querquedula*, *Mergus albellus*	1,000–5,000
Somateria mollissima, *Anser anser*	less than 1,000
Anas strepera	occasional strays

The nesting and some other habits of *Alopochen*, *Nettapus*, *Plectropterus* and *Sarkidiornis*

Captain C. R. S. PITMAN

Summary

African 'geese' are catholic in their choice of nest-sites. Most Egyptian and Spur-winged Geese nest on dry ground, but may use holes in trees, or old arboreal nests of other birds. Pygmy Geese occasionally nest on the ground but more often in trees or on buildings. The Knob-bill nests in trees and in Africa at least also on the ground. Clutch-sizes and parental behaviour are discussed.

There is some evidence that *Sarkidiornis* may often be polygamous in Africa, though apparently not in India.

Alopochen and *Plectropterus* roost on water, the latter also sometimes on dry land. *Sarkidiornis* roosts chiefly in trees, though sometimes on mudbanks or floating islets. The roosting places of *Nettapus* are not known.

Flocks of *Alopochen* and *Plectropterus* sometimes cause serious damage to crops, by trampling or nibbling maize, beans, and sweet potatoes and pulling up entire ground-nut plants.

Introduction

Commonly known as 'geese' the members of the four tropical genera *Alopochen*, *Nettapus*, *Plectropterus* and *Sarkidiornis* differ in many respects from those of *Anser* and other closely allied genera. Delacour (1954–64) and other authorities, treat the Egyptian Goose *Alopochen aegyptiacus* as a member of the tribe Tadornini, which includes the sheld-ducks and South American sheldgeese, and puts the other three genera in the tribe Cairinini, along with the wood ducks and the Muscovy Duck. But in its nesting, feeding and social habits, with which this paper is concerned, *Alopochen* is much like the perching geese.

Nesting habits

Nettapus auritus – AFRICAN PYGMY GOOSE OR DWARF GOOSE

This particularly lovely little goose – the male with its exquisitely handsome head – is found on lakes, lagoons, dams and backwaters. I knew it well in many parts of Uganda and, though widespread, less commonly in Northern Rhodesia. When I first went to Entebbe (on Lake Victoria), Uganda, in 1925, I knew of four nests which I did not disturb. One was in a hole in an ironstone cliff and the others 30 to 40 feet up in holes in large trees. These were all in the same locality where Sir Frederick Jackson (a Governor of Uganda) had previously found a nest at arm's length in a hole, seven feet above the ground in an ironstone cliff. This same hole and others near by in the low ironstone cliff had been regularly tenanted by wild Grey Parrots *Psittacus erithacus* until systematic robbing of their nearly fledged young eventually drove them away. Jackson found other Pygmy Goose nests in trees at Entebbe respectively at 30 feet and 60 feet above the ground – the latter in a hole at the end of a dead branch. Another nest site I was shown near Entebbe was some 30 feet above the ground in the crown of a palm and was only discovered when the goslets were seen falling from it. All these sites were close to water, but in South Africa a nest three feet up in a 'mopane' tree was 200 yards from water. An unusual site was in the thatch of an occupied African hut; the dry grass of the thatch was pushed up to form a tunnel about a foot long and the nest – there were no eggs – was lined with down. Nests have been found in ant-heaps and in the tree-nests of other birds, in particular, inside the huge structures of the Hammerkop or Hammerhead Stork *Scopus umbretta*. In South Africa a nest – of grass but with no down in the lining – was found in a heavy clump of grass on a river bank; and one in Northern Rhodesia, by a shallow 2½ acres pan in 'mopane' woodland, an untidy grass structure under a log, on mud, and about 20 yards from the water's edge. At the same pan there was another Pygmy Goose nest – a rough structure of grass containing six eggs, but no mention of down – in fairly deep water. These last two records are of particular interest as they indicate that the Pygmy Goose will nest on the ground even when there is woodland – and the probability of suitable nest holes – near at hand. There is an important factor, however, which may have influenced these Pygmy Geese for in this locality there is a considerable population of large, deadly, predatory Black Mambas which freely explore holes in trees. In the virtually treeless vast open and swampy country of Nigeria where the Pygmy Goose is common, it can only nest on the ground or in swamp.

The nest is variously described as constructed of dry twigs, coarse grass and leaves, etc., sometimes lined with down and (Jackson records) with a little green

moss. The usual complement of pale creamy-white eggs varies from 6 to 9, though Delacour (1959) records up to 12; and from the data available the African Pygmy Goose lays fewer eggs than either the Cotton Teal or Green Goose-Teal.

So few nests have been found, that as yet little is known about the breeding behaviour of the African Pygmy Goose. At Entebbe, a brood of eight newly hatched goslets was caught by an African who had trapped the parent; an attempt to keep them in captivity failed as the parent escaped and the brood died. The African Pygmy Goose is as agile as the Cotton Teal when entering its nest hole in a tree or cliff, *vide* Jackson's graphic description 'shot in as nimbly as a Sand Martin or Kingfisher'; he also recorded that the mother goose was accompanied to the cliff face by the drake. The female must be able to check itself in a remarkable way so as to enter a small aperture and its restricted space seemingly at top speed. Watch as assiduously as I might, during the breeding season, rarely did I see the brooding female – she was not always accompanied by the male in her flight – enter the elevated cliff-hole. The approach was not direct and when the two birds were together they flew several times to and fro at the correct level until one suddenly swerved into the hole. If one did not watch carefully one missed the split second entry on the realisation there was only one bird visible instead of two!

Nettapus coromandelianus – COTTON TEAL or INDIAN PYGMY GOOSE, and in Australia, where it is usually classified as *N.c. albipennis*, WHITE-QUILLED PYGMY GOOSE or WHITE-QUILLED GOOSE TEAL.

When serving in the Indian Army, prior to the First World War, I was familiar with the little Cotton Teal of south-east Asia, New Guinea and Australia in the course of several shooting expeditions to the Central Provinces. As it breeds during the monsoon when the rains make the jungle impassable I had no opportunity of investigating its breeding habits. In these jungles when there is no other permanent water the widely scattered villages are each sited alongside a 'tank'. A 'tank' may be either quite small or of considerable size according to the terrain and is an artificial expanse of water created by an earth dam to retain the rainy season's surface flow. On these 'tanks' were populations of Cotton Teal in pairs or groups, or in small concentrations not large enough to be designated flocks. Around them, in mango and other trees, I was shown many hollows and holes, some eight to twelve feet above the ground, which contained the remains of their nests and which were said to be used year after year. Various authorities on Indian birds describe the nests as constructed of twigs, grass, dead leaves and feathers – but no down – and at any height above the ground from water level to 30 feet up, though the majority are at about six to twelve feet; a nest sited as high as 68 feet has been found in a hole in a building at Rangoon, Burma and another at 40 feet was in a niche in a factory chimney. A nest has also been recorded in an ant hill at the base of a tree and another – a nest of grass – on top of an ant hill. Nest holes usually have a wide entrance, yet when they are as small as four inches across these birds fly into them with the greatest accuracy, without pause or hesitation.

In Burma, a Cotton Teal with five eggs was found nesting in the same tree-hole as a Comb Duck, which had six eggs; all eleven eggs are in the National Collection at the British Museum (Natural History). Nests may also be placed in ruined houses, temples and old chimneys, but Stuart-Baker challenges the authenticity of two nests described as 'a semi-floating nest on the water, among the rushes or lotus leaves, of weed, grass, etc., all together'. This is an observation of days long bygone, since when there has been no other such Indian record. But this does not mean that the record is valueless, for in Australia *N.pulchellus*, the Green Pygmy Goose, will nest on the ground and in swamp, as *N.auritus*, the Dwarf Goose, also does in Africa.

For the size of the bird the complement of pale creamy-white eggs – usually varying from six to fourteen – is relatively large, and as many as 16, 18 and 22 have been recorded. A nest containing a total of 40 eggs suggests competition for a nesting site and more than one female responsible. The male, though often accompanying the female to the nest hole, never enters.

Sarkidiornis melanotos – KNOB-BILLED GOOSE, KNOB-BILL, COMB DUCK or NUKTA.

I knew the Knob-Bill much better in Africa than in India, where its nesting habits have long been well known, whereas in Africa reliable records are almost as few as those of the Dwarf Goose. In India, with rare exceptions, nests are in trees, usually in holes and hollows mostly within six to twelve feet of the ground, but occasionally even as high as 30 feet. Occasionally the Knob-Bill appropriates the nests of other birds, sometimes at considerable heights, for its eggs have been found in a Vulture's nest, in the nest of the White-tailed or Pallas' Fishing Eagle

Haliaëtus leucophyrys and once in a nest of the Woolly-necked Stork *Dissoura episcopus*. Other sites include holes in ruined forts and amongst rocks, once a nest was found in a hole in a bank and a deep grass nest has been recorded in a swamp amongst thick growth. As a rule nesting trees are near water – though occasionally at a considerable distance – or even standing in water. The nests are of small sticks and grass lined with dead leaves and a few feathers, but no down; at times there may be virtually no nest. Seven to twelve eggs is the usual complement. 40 and 47 eggs, which have been recorded, are presumably attributable to more than one female. But the most astonishing total of 54 was found in a hole in a mango tree, with a nine inches wide entrance, six feet above the ground and nearly four feet deep. The eggs did not hatch and were deserted. The finder suggested that it might be a communal nest and certainly one could reasonably claim that no less than four females must have produced so large a total. This suggests the possibility of more than one female attempting to brood at the same time, which would explain why some of the deserted eggs were cracked. The idea of a communal nest, apart from possible competition for nesting sites, raises the question of polygamy, more especially as this record refers to one male with five females being observed nearby. The subject of polygamy will be referred to below (p. 119). In various parts of south-east Asia, according to the local inhabitants whose reliability can I think be accepted, communal nests containing multiple egg clutches are well known and two females have been seen to enter the same nest-hole.

In Nyasaland, at the commencement of the rains, Knob-Bills arrive in hundreds along the Lower Shire river and its adjacent swamps, and it may be that they are attracted to suitable nesting sites in the numerous *Hyphaene* and *Borassus* palms. This is a well-defined movement though I doubt if it is a migration. A nest with eight eggs was found in a hole 12 feet up in a dead *Hyphaene*, but it was one mile from water, and the finder realised too late that had he made a thorough search of the many dead palms he might have found more nests. In this connection the question arises as to how the young got to the water one mile distant. It is categorically stated, with reference to South Africa 'Young removed from nest on parent's back' but I am unaware of the evidence on which this is based. Nest sites in South Africa include holes in trees and boles, in long grass and among stones on a low hill. A nest of ten eggs found in Southern Rhodesia was in a tree hollow, several feet deep, and quarter of a mile from water. As these little goslings are skilful climbers and as a distance of 440 yards is not beyond the bounds of possibility of the brood having walked to the water, it is a faulty premise 'Undoubtedly carried out of this cylindrical hollow by the male and female'. Another nest in a hollow tree in Southern Rhodesia was at a height of 50 feet and it was said that the young tumbled out of the nest. Some of the young were caught, but easily escaped by climbing out of an open, deep packing case. Eleven eggs have also been taken from a hollow tree in a swamp in Nigeria. Seven eggs recorded from nests in thick reeds over fairly deep water in Nyasaland are of dubious authenticity. In Nigeria a nest has been found in reeds. Only once did I find a nest in Uganda – in a deep hollow amongst the stone blocks of a disused pier – on Lake Victoria; it contained two fresh eggs. The Knob-Bill, in small numbers, breeds regularly along the northern Lake Victoria littoral – but as the local inhabitants are disinterested – I was unable ever to locate a nest, though I was once told about one in a hole in a tree which I was unable to visit. Every year near Entebbe, in September, when out in a launch I used to come across broods, and I was sometimes surprised to find how far out on the lake they would be. On one occasion I spent the best part of a day, when engaged on fishery investigation on a small lake in south-west Uganda, in searching the numerous hollow trees on tiny islets where these geese were said to nest, although I was warned that it was the wrong season. It was not a particularly healthy pursuit for these islets were infested with Puff Adders – on what they fed I did not find out – and some were a few feet up in hollows in the trees. The Puff Adder is a powerful swimmer and buoyant as it partially inflates itself when in the water. It was not an attractive lakelet for the only craft available were bundles of reeds tied together and these soon became water logged, while at the edge of a swamp the overhang of a huge sloping rock – above which in a small, shrubby tree was a nest of the Goliath Heron *Ardea goliath* – was covered with dozens of combs of vicious wild bees.

The same nesting holes are said to be used year after year; this is well known in India.

In Africa the usual complement of creamy or pale yellowish eggs varies from six to eleven, which differs little from the seven to twelve recorded in India.

Plectropterus gambensis – SPUR-WINGED GOOSE

The nests of Spur-winged Geese though occasionally in trees or on cliffs are mostly on the ground, sometimes a considerable distance from water. I used to know of a number of tree-nests, none higher than 20 feet, in old raptor nests in the woodland at the southern end of Lake Nakuru, in Kenya. Like the Egyptian Goose, the Spur-wing will lay on top of the Hammerkop's massive structure, from which I imagine the young are called down. The Spur-wing, too, nests in rather arid conditions on elevations of nearly 6,000 feet above the 3,000 feet high western scarp of the great Rift Valley, at Uganda's extreme north-east corner. Goslings are seasonally seen there on some of the numerous pools, many of them saline. Ground nests are usually well hidden in dense, long grass, not far from water, or in reed beds, but the Spur-wing seems to prefer to nest on dry ground rather than on the water – where standing space on a nest is extremely limited. Nests vary from large, bulky grass structures, when in swamp, to shallow hollows scantily lined with grass; there is no down. Nests have been found on termite hills; another was under a low bush 15 yards from a river bank.

The usual complement of large, ivory-white eggs is hard to judge as records vary from six to twelve, but sets of six and seven *fresh* eggs do seem to suggest incomplete sets. Unusually large sets of 15 and 16 eggs are known, but as a rule I think sets consist of eight to twelve eggs. This goose and its young are much preyed on by crocodiles.

The Spur-wing will lead its brood to water from a considerable distance; both parents look after the brood. At the Whipsnade Zoological Park, in Bedfordshire, one of these geese hatched her brood of ten some half-a-mile distant from the nearest water and when the parents and their goslings, on the move, were set upon by a pair of aggressive Sarus Cranes *Grus antigone* the geese successfully saw off the attackers.

Alopochen aegyptiacus – EGYPTIAN GOOSE

The nesting habits of this well-known, noisy, quarrelsome species are bewildering in their diversity for it may nest on the ground or as high as 80 feet in trees or in a variety of other sites, and at altitudes from sea level to nearly 13,000 feet, though the latter occurrence (Hachisuka, Bull. B.O.C., 52: 18-19, 1931) is quite exceptional. Tree-nesting is a characteristic of this goose, but as nests above the ground are likely to attract attention it is possible that undeserved prominence has been given to its tree-nesting proclivities. I am inclined to believe that only a relatively small proportion of Egyptian Geese nest in trees and that the majority of nests are on the ground where they are rarely found. Nests are of grass and similar material, profusely lined with the parents' down which is used to cover the eggs when the bird is away from the nest. Nests on the ground or at ground level may be in a reed bed, in grass or rushes, on floating water plants, on low, flat grass-covered islands, in matted vegetation near water, amongst rocks on islets, in a rocky cleft on a river bank, among boulders in a rock cleft in a cave, frequently on a river bank, amongst the broken stonework of a lake pier, on an ant-heap, in the disused burrows of porcupines and ant-bears, and in an old boat-house.

The Egyptian Goose is thoroughly at home in the trees and is equally adept at perching on the tops of flat-topped thorny acacias as on solid boughs. It frequently appropriates the old nests of other species. Nests of my own finding include: in a Fish Eagle's nest at the top of a flat-topped acacia 80 feet above the ground and a Goliath Heron's nest at the top of an *Albizzia* about 60 feet up – in both these cases the goose nests which are usually well shaded were very exposed to a fierce sun, but I also found another goose nest on the flat top of a lofty rock which must have been excessively hot for the brooding bird except when it was dull or raining. On a ledge a few feet below this goose nest was the occupied nest of a Lanner *Falco biarmicus*, but its young flew before the goslings hatched. Others were in a hollow of a cliff face some 12 feet above water level on an islet; on top of Hammerkop nests (several); in the broken stonework of a pier; on a tiny islet, in scrub, amongst several nesting crocodiles – all about 11 feet; and on another islet which harboured many sluggish, massive Puff Adders and large (6 feet to 8 feet) Black-lipped Cobras – how the eggs successfully hatched and the brood survived, as it did, was quite astonishing. But at certain seasons ample food was available for the snakes from a large nesting colony of Grey-headed Gulls *Larus cirrocephalus* and ground-nesting colonies of Sacred Ibis *Threskiornis aethiopicus*. Crocodiles are accustomed to lie above their buried eggs (incubation period c. 90 days) to protect them from predators such as the voracious Monitor Lizard *Varanus niloticus* and Hyenas. These crocodiles always return to the water by the same runway. The goose nest found on the Crocodile breeding islet was

in an old runway, with runways in use on either side of it. How did it know where it would be safe? An unusual site in South Africa was on a small islet in the centre of a breeding colony of some 300 pairs of the Greater Flamingo *Phoenicopterus ruber*. Even stranger is a 1963 record from South Africa of an Egyptian Goose unmolested sitting on ten eggs on a small island where a female Cape Otter *Aonyx capensis* and three young were living. The island was strewn with hundreds of duck eggs which the otters had collected for food from nearby islands. Layard (1875–84) records finding a nest in South Africa on a ledge of rock amongst a breeding group of eight Cape Vultures or Kolbe's Griffons *Gyps coprotheres* from which it possibly derived a measure of protection, as the Vultures were friendly disposed towards it.

Other nests have been recorded in the fronds of a palm tree about 15 feet above the ground; 10 feet from the ground in a stunted thorn tree on a kopje overlooking a perennial stream; in hollow trees; on flood debris in a bush; at various heights on cliffs; and on precipices sometimes as much as 200 feet above water. It is unusual for nests to be far from water; occasionally they may be a quarter of a mile distant and rarely as much as a mile; all the nests I found were close to water. Egyptian Geese nest very commonly on the top of the enormous structures built by the Hammerkop. Van Ee (1963) records finding three Hammerkop nests occupied *inside* by Egyptian Geese which contained 6, 10 and 15 eggs, all of which hatched with the exception of two infertile eggs in the last. He records 'In watching the approach of the geese to the nests I noticed that one flew straight in to the somewhat bigger opening while the other two clung to the nest before entering'. Ten goslings in one nest 25 feet above the ground, in the Zoological Gardens at Bloemfontein, were not carried down by the parents but fell, after the two parents were observed calling from the ground. Even when goose nests are as high as 60 and 80 feet there is a possibility that the goslings may be 'called' to jump down, for I noticed there was always an abundance of secondary growth, to break the fall of the youngsters, beneath such heights – but this is just a conjecture.

In the western region of the Serengeti National Park in Tanganyika Myles Turner (*in litt.*) has twice seen an Egyptian Goose and a Hammerkop using the same nest. The Hammerkop on arrival perched on a low branch below the nest, which was about nine feet above the ground and then dived into the nesthole. The sitting goose fussed a bit, but not unduly. Another time a Hammerkop was seen to emerge from a nest on which an Egyptian Goose was perched. The goose and Hammerkop were never observed to come into contact on the top of the nest. According to Turner, the Egyptian Goose seems to breed all the year round in the Seronera region of the Western Serengeti, in Tanganyika.

The usual complement of creamy-white eggs varies from six to ten, but sets of 11, 12 and 15 (two were infertile) are known. Nests of my own finding varied from seven to nine eggs. Records I have of several dozen nests include more than two dozen sets of nine and over a dozen of eight, figures which may indicate the normal clutch size; sets of six and seven, too, are numerous.

Early wastage amongst the broods seems common, for though 7 to 11 goslings may hatch and reach the water and are constantly guarded by both parents, they are subject to attacks by four-footed, feathered and aquatic predators, and are soon reduced. In the water coarse fish such as Cat-fish (Silurids) and Eels, Nile Perch (*Lates*), (which in the past annually took the whole gosling broods which hatched in the Giza Zoological Gardens at Cairo), Monitor Lizards (*Varanus*), Water Tortoises *Pelomedusa subrufa*, which cause much loss to goslings in parts of South Africa, and Crocodiles (where they occur) are all responsible for considerable wastage. Crocodiles too have been seen to take adult Egyptian Geese and at Entebbe, on Lake Victoria a 5½ foot, enormous Lungfish *Protopterus aethiopicus* choked itself to death trying to swallow a full-grown Egyptian Goose.

Polygamous behaviour of *Sarkidiornis*

Many dams were created all over Uganda, from 1945 onwards. Most of these attracted small populations of Knob-Bills, but I never came across any nests, though seasonally broods would be seen on them. The most interesting feature of these populations was their composition, which definitely suggested polygamy, for the Knob-Bills were always in groups – rarely more than one or two groups unless a dam was of considerable extent – which consisted of one male and three or four females. Much of the day was spent by a group perched in one dead tree. There is no evidence of polygamy in South Africa, but this may be due to the sexes being equally represented, for where the females preponderate – as has been recorded in West Africa – polygamy is likely. It has been recorded that to keep Knob-Bills successfully in captivity there must be a considerable preponderance of females to males,

otherwise a male will constantly pursue and exhaust a female during the breeding season. This behaviour seems to indicate a natural tendency towards polygamy. The male is more than twice the size of the female.

Major Ian Grimwood, Chief Game Warden of Kenya, has kindly sent me the following comments. 'I have no evidence pointing to Knob-bill being polygamous and the only three nests I have found have all been solitary in position. Even in the breeding season these birds seem most frequently to be found in parties but sex-ratios seem to be completely flexible, e.g. three males in "full knob" with five females or 1 male and three females which were on my dam at various times last rains.

'Curiously enough a professional hunter was yesterday, 27 February (1964), talking of a small pan on which he had just been camping in Tanganyika which was occupied by two males, four females and two broods of Knob-bill ducklings compared with one male, three females and two broods last year.'

Despite Major Grimwood's opening remarks, these records do seem to suggest a degree of polygamy, more particularly the occurrence of a male with three females and two broods.

Polygamy by *Sarkidiornis* in India does not seem to have been suggested. This divergent behaviour may not be so strange as might at first seem for in India the curious Painted Snipe *Rostratula benghalensis* is polyandrous which my own observations certainly indicate, yet in East Africa where I, and others, have had considerable experience of this species there is no evidence to suggest that it is other than monogamous.

Roosting and flighting

Sarkidiornis

The Knob-bill is not so nocturnal as most ducks, though resting a lot by day. In India where its habitat is normally associated with trees it has been described as 'strictly tree-loving' and it is probable that there it always roosts in trees; but in the tree-less swamp regions of Africa it rests on mud-banks and floating islets. In the well-treed parts of Africa where I was familiar with this species it certainly spent much of the day perched on trees, particularly dead trees standing in the water of recently created dams. A check with a torch revealed that the Knob-bills roosted on these trees for much of the night.

Plectropterus and *Alopochen.*

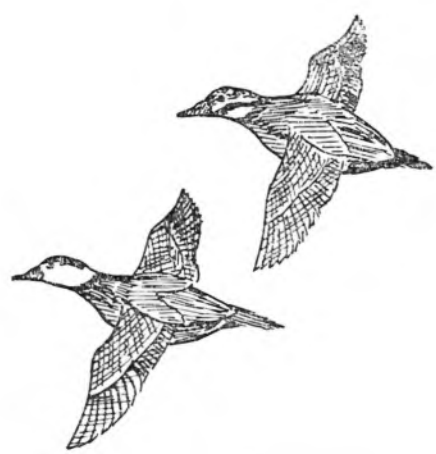
When the white man first penetrated Southern and Eastern Africa *Alopochen* and *Plectropterus* were widespread, abundant and tame, but the introduction of firearms quickly put an end to such a happy state and numbers all too rapidly dwindled. Only fifteen years ago I still knew of utterly wild places in Uganda where in the early morning dozens, mainly in pairs, of confiding, fearless *Alopochen* grazed right up to one's tent and would scarcely move out of the way to let one pass. This is a wonderful recollection of something which will never happen again for 'progress' long ago decreed the disappearance of these refuges. In East Africa I have exceptionally come across flocks (or concentrations) respectively of *Alopochen* and *Plectropterus* of several hundreds, though as a rule they are a good deal smaller. These flocks mostly consist of a number of family parties and are usually seen either in shallows, on sandbanks, on land close to water or when feeding. It has been recorded that *Alopochen* by night rests on the water – it would be safe from crocodiles where the water is about 20 feet deep and over – and that *Plectropterus* roosts on a convenient bank or similar safe site. My comment is that I have often come across *Alopochen* far out on a lake late at night, and have occasionally in the darkness disturbed *Plectropterus* roosting on land, but I hesitate to say more than that my own experience would sometimes appear to support the record. Before leaving the subject of flocking it can be mentioned that where the three larger species are common one will sometimes see – especially *Alopochen* and *Plectropterus* – several broods together in the water particularly when the juveniles are fairly large. Parents may be absent, but there is usually an adult or a sub-adult with them. Associated with flocking is flighting and where *Alopochen* and/or *Plectropterus* are numerous there will be evening and morning flights to the feeding grounds whether they be natural grazing, cultivated grassland or stubble. In the Chad region of Northern Nigeria it has been recorded that in these evening and morning flights *Alopochen* invariably preceded *Sarkidiornis* and *Plectropterus*. Some forty years ago near Lake Nakuru in Kenya I was able for several weeks to witness the flights of *Alopochen* and *Plectropterus* to the maize stubbles and I can confirm that it was the former which first flighted on to the feeding grounds; the regularity of their timing was remarkable. The flight, varying considerably in intensity according to the weather, usually lasted from twenty to thirty minutes, and inevitably in the middle of the flight there was an overlap of the two species. Skeins varied in size from about a dozen to a few score birds, some of which were calling as they flew. Although these

geese regularly were shot at they did not become unduly wild, and seemed reluctant to change their normal lines of flight. One authority has recorded how wary is *Plectropterus* when flighting to a feeding ground which it will circle more than once before coming down. This was not my experience at Nakuru where both *Plectropterus* and *Alopochen* despite much shooting habitually flew straight to their goal and when unmolested settled immediately.

Feeding and damage to crops

The Egyptian Goose is usually found in pairs or groups of pairs or in small flocks of sub-adults but in parts of South Africa it joins up seasonally into vast flocks to raid the wheatlands where it becomes a real pest and causes tremendous damage. Spur-wings can also cause severe damage, by trampling, when feeding in flocks in growing crops. Like Egyptian Geese, they are very partial to ground-nuts and to sweet potatoes. The tops of the sweet potatoes are eaten and the tubers are ruined by nibbling.

Spur-wings are mainly nocturnal feeders, though by day they are sometimes found on grasslands far from water. These big birds can create havoc amongst growing crops of beans and ground-nuts which they are accustomed to visit as dusk falls and just before dawn, but though easily scared from cultivation, I have frequently seen them unconcernedly raiding a particularly tempting crop in broad daylight. Geese and ducks are incredibly destructive to ground-nut plots, for to get at the nuts they destroy the plant. The birds do not dig for the nuts but pull out the plant, with the nuts attached to the roots. I imagine that the nuts were originally found by chance when a goose accidentally pulled up a plant. It is a simple matter for the powerful goose to jerk the plant out of the ground, but not so easy for a duck. Not being strong enough to uproot the plant directly, the duck, having firmly seized the plant in its bill, gyrates around it, meanwhile pulling hard, until achieving the desired result. This is an example of the type of curious complaint so often received by a Game Warden in Africa – havoc caused by ducks to numerous ground-nut plots. It sounds highly improbable, but investigation confirmed its truth; and the culprit, the Fulvous Tree-Duck or Whistling Teal *Dendrocygna bicolor* was not only caught in the act, but had a crop stuffed with ground-nuts; every plot examined had really been devastated and around each uprooted and discarded plant were the unmistakable signs of the *modus operandi* of the marauder.



White-headed Ducks in West Pakistan

CHRISTOPHER SAVAGE

Summary

An influx of White-headed Ducks *Oxyura leucocephala* was observed in West Pakistan in December, 1964. Five specimens were caught and sent to Slimbridge. Some notes are given on their behaviour and measurements.

The White-headed Duck *Oxyura leucocephala* is known in India and Pakistan from less than thirty published records over the last hundred years, from which it is classi-

fied as a fairly regular winter visitor by Ripley (1961). The author, however, counted about 470 on the lakes of the Punjab Salt Range on 6th December, 1964. The lakes are quite large in extent and it is possible that without a powerful telescope on a stand the stiff-tails might easily have been overlooked amongst the thousands of other waterfowl. It is probable therefore that the number seen may not have been as unusual as would appear, particularly as two weeks later most had dispersed and one lake had only 90 whereas previously it had held 373. In view of the increasing rarity of the species in Europe (Hoffmann, 1964) some notes on its ecology and behaviour are of interest.

The lakes used by the stiff-tail are the less brackish of those in the Salt Range, namely Khabbaki, Kallar Kahar and Nammal (with total dissolved salts of 1,760, 8,060 and 3,180 parts per million respectively). They are for the most part four to six feet in depth with little cover vegetation but extremely rich in submerged water herbs such as *Ruppia maritima* L., *Melilotus indica* (L.) All., *Hydrilla verticillata* Poir. and *Potamogeton nodosus* Poir. as well as yellow-green algae. No stiff-tails were found at Uchhali (with total dissolved salts of 37,520 parts per million) which seemed devoid of submerged vegetation but rich in blue-green algae. The algae no doubt attracted the flock of 390 Greater Flamingoes *Phoenicopterus ruber roseus* which was present.

The stiff-tails generally kept very much to themselves, being preoccupied with feeding almost throughout the day, while the majority of other ducks present spent the day resting. They could be easily approached in a boat to within thirty to forty yards whereupon they dived to escape pursuit. Only occasionally would they take to wing and then usually because other birds nearby were doing so. Their take-off and flight was grebe-like with a long run before getting airborne and even then they flew heavily with very fast wing beats and seldom attained a height of more than five feet. On the water they held their tails at an angle of 45° except when disturbed and often had a puffy look like the African White-backed Duck *Thalassornis leuconotus*.

The white head of the male is very conspicuous in December but the bill is a slaty colour, not the bright blue of illustrations which presumably is only present at the height of the breeding season. The black markings on the head of the male also showed considerable individual variation, particularly over the eye and at the back of the head. Some individuals had the black extending down the neck to meet the dark collar at the base of the neck, and one had a black spot on the cheek behind the ear coverts. The females were much duskier than usually illustrated and also showed some variation in head marking. Examination of birds in the hand suggested that their autumn moult was complete but when skinning a casualty some new growing feathers were found.

Table I. Measurements of White-backed Ducks caught in the Punjab Salt Range, December 1964

weight gms	*wing mm*	*culmen mm*	*tarsus mm*	*tail mm*
Male				
865	168	46	45	87
794	170	46	46	85
553	159	45	45	92
Female				
631	159	45	43	81
610	160	46	41	82
539	160	43	45	75

None showed any recognisable juvenile characteristics

Five specimens were obtained for the Wildfowl Trust and were dispatched with the minimum of delay through the cooperation of the Pakistan authorities. The birds were in fair condition, but the one which was skinned had hardly any subcutaneous fat and it is probable that they had not long arrived from their autumn migration. The gizzard of the dead bird was found to contain beside gastroliths a quantity of small black seeds believed to be of *Ruppia maritima* and two kinds of buff coloured seeds, one of which could be of *Melilotus indica*. This contradicts Stuart Baker (1929) who describes their diet as 'mainly animal' but does support Dementiev and Gladkov (1952) who mention *Ruppia maritima* as a food source in the south east of the Caspian Sea. Measurements of the birds handled are given in Table I.

Additional note. Numbers continued to build up to a peak of over 700 in February, 1965, and that in spite of heavy mortality from shooting to which ten ducks were an easy prey. These numbers are a complete surprise to local ornithologists, but local hunters say that the species has been as common as this for some years now. This is no cause for complacence as it is highly probable that the increase is due to changes in distribution forced upon them by disturbance from the Hamun-e Hirmand (see p. 125).

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Wildfowl Survey in south-west Asia: a progress report

CHRISTOPHER SAVAGE

Summary

A private survey was started by the author during 1964, with the advice and encouragement of the Wildfowl Trust, to study the distribution and status of wildfowl species in southwestern Asia particularly in the context of the human changes which are taking place. The scope of enquiries includes the Middle East, India and Pakistan but ringing of birds will be confined to Iran and Pakistan through the Game Departments of these countries. A reconnaissance was made of the Hamun-e Hirmand in Iranian Sistan where recession of the swamp affects the local economy as well as wintering waterfowl. Information, particularly details of game bags, would be welcomed from Members.

Introduction

In recent years many changes have been taking place in south-west Asia which affect wildfowl. Increasing human population, improvements in communications and greater availability of modern firearms have increased 'hunting pressure' more than in other parts of the world, while changes in land use have been destroying old habitats and creating new. In West Pakistan, for example, drainage of some 'jheels' much favoured by many species in the past has been more than compensated by water-logging elsewhere, to the detriment of pochards but to the benefit of the surface feeders. This inter-relationship of engineering, agriculture and wildfowl ecology, and its implications in terms of conservation, has been little studied as yet and it is as a contribution to this study in Asia that the author, a civil engineer by profession, initiated this survey during the summer of 1964.

The scope of the survey was originally limited to West Pakistan but it soon became obvious that a more useful contribution could be made by the general study of the region and the coordination of cooperative efforts of corresponding observers. At the same time close liaison was established with the Game Council of Iran (now the Game Department) and the Game Department of West Pakistan, both of whom were anxious to start a programme of ringing and are now conducting departmental wildfowl enquiries of their own, and also with the vigorous Bombay Natural History Society, who have contributed so much to the knowledge of wildlife in the whole region.

The main object of the survey at present is to obtain and evaluate information on distribution and status of species – information which is needed before any real progress can be made in wildfowl conservation. The scarcity of qualified observers and lack of continuity in most cases precludes anything approaching the 'wildfowl counts' which are so valuable in Europe, but an attempt is being made to map species and habitat distribution on the lines used in the recent Nature Conservancy Monograph *Wildfowl in Great Britain.*

Progress to date

Searches have been made through available literature to determine where possible the position in the past and the extent of gaps in current knowledge. Although the searches are not complete it is already clear that even today surprisingly little is known except from the museum curator's viewpoint. A most valuable source of information however has been the game books of sportsmen. A number of sportsmen responded to a letter in *The Field* and many more have replied to personal enquiries. Many records unfortunately seem to have been lost at the time of Partition and during the 1939–45 war, and few people in recent years have kept notes in such detail as in the old days. Information of any kind, particularly any old records and details of game bags, would be welcomed from Members and should be forwarded direct to the author c/o 11F Gulberg, P.O. Bag 704, Lahore, West Pakistan.

Details of 78 recoveries of ringed geese

Table I. Published recoveries of ringed wildfowl marked or found in south-west Asia

	Russian rings found in			*Bombay N.H.S. rings found in*		
species	*India Pakistan*	*Iran Iraq*	*'Middle East'*	*USSR Abroad*	*India Pakistan*	*Total*
Bar-headed Goose *Anser indicus*	2	–	–	–	–	–
Ruddy Shelduck *Tadorna ferruginea*	1	–	–	–	–	1
Common Shelduck *Tadorna tadorna*	1	–	–	–	–	1
Pintail *Anas acuta*	6	2	–	–	–	8
Common Teal *Anas crecca*	2	–	–	4	3	9
Mallard *Anas platyrhynchos*	1	7	–	3	1	12
Gadwall *Anas strepera*	3	3	1	2	2	11
Wigeon *Anas penelope*	–	–	1	7	1	9
Garganey *Anas querquedula*	5	–	–	3	–	8
Shoveler *Anas clypeata*	1	–	8	2	1	12
Red-crested Pochard *Netta rufina*	–	–	–	2	–	2
Common Pochard *Aythya ferina*	–	–	–	3	–	3
	22	12	10	26	8	78

and ducks have been traced which throw some light on migrations in the area and it is hoped that appeals in the local press may bring in more. Recoveries to date are summarised in Table I. This is no more than a beginning and many more records are required before even a general picture can be put together. Ringing in Pakistan will certainly help, but no great advance can be expected before Soviet authorities extend their ringing programme further east, which it is believed they intend to do.

Sistan reconnaissance

In April 1964 a reconnaissance was made of the Hamun-e Hirmand in Sistan, south eastern Iran, which is a great swamp on the border of Afghanistan. This area, though an important wintering ground for waterfowl of all kinds, has been ornithologically unexplored since it was visited by Zarudny at the turn of the century. Few waterfowl were present in April and most of the Hamun was inaccessible for lack of a suitable boat. However, some wounded geese were found in captivity: Greylag Geese with pink bill and legs of the eastern race *Anser anser rubrirostris*, and also Lesser White-fronted Geese *Anser erythropus*. Both species were said to be abundant in winter. A large swan with yellow and black bill, presumably a Whooper *Cygnus cygnus*, had recently died in captivity after being captured a few weeks earlier when wounded. The fishermen and herdsmen said that in summer they collected the eggs of the Greylag Goose, of which they said a number stayed to nest, of the White-headed Duck *Oxyura leucocephala*, which they knew well, and of Coots.

Heavy shooting and netting of duck in February and early March is an important local industry though not quite so much as on the Caspian (Savage, 1963). The crop of reeds in spring furnishes building materials for housing and boats, and reed products such as mats and sun blinds from Sistan are marketed all over Iran. Fishing and grazing by amphibious cattle continue all the year round and provide protein for the whole district. Thus there is no doubt that the Hamun is an inseparable part of the local economy.

The area of swamp today however is much reduced and now depends entirely on winter floods on the Helmand River. Water storage projects in Afghanistan and intensified irrigation in both countries will continue to reduce the surplus flood waters reaching the Hamun and further recession of the swamp is inevitable. This is already causing concern as no alternative grazing exists for an estimated 100,000 head of cattle and the exposed shores of the northern part of the swamp are being eroded by the famous 100-day wind in summer, only to aggravate the already appalling problem of galloping sand dunes which engulf villages and canals. A more telling example of the need for coordination of technology and conservation could hardly be found.

A reconnaissance was also made of the lakes in the Punjab Salt Range. From both areas small collections of swamp plants have been identified by courtesy of the British Museum of Natural History, and water samples have been analysed by Sir Alexander Gibb and Partners in Sistan and the Water and Power Development Authority in West Pakistan.

Acknowledgement

Finally a special acknowledgement is due to the Wildfowl Trust whose staff have spared no efforts to assist in every possible way the launching of this survey.

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The geese of Wrangel Island

Dr. S. M. USPENSKI

Summary

In 1960 there were about 130,000 occupied nests of Lesser Snow Geese in their main colony on Wrangel Island. In 1964, when the spring weather was extremely unfavourable for reproduction, about 114,000 nests were in use, with about 300,000 geese in the nesting areas. In 1964 the average clutch-size was 3·27 eggs, compared with 5–6 in normal years. Nests in areas where the snow persisted longest and where the bird population was less dense contained fewest eggs. A large number of mature birds failed to nest although their gonads were normally developed. Non-breeders were most numerous in areas where the snow melted late. The average size of young broods was 2·7 goslings, range 1–5. Nesting in 1958 was probably even later than in 1964. 1–2,000 pairs of Pacific Brent Geese were nesting on the island in 1964 and another 10,000 non-breeders were moulting there. Moulting Brent caught included four previously ringed in Alaska, also when moulting.

Introduction

Wrangel Island (71°N, 180°), which has long remained uninhabited, is now the main world nesting centre of the Lesser Snow Goose, *Anser caerulescens caerulescens*. Up to the middle of the last century the bird was widely distributed over the continental tundra of Siberia and on islands in the Arctic Ocean west to the lower reaches of the River Ob (75°E), as well as along the Arctic coasts of North America. The birds wintered at this time in Japan and apparently on the shores of the Caspian, as well as in southern North America. The drastic reduction in numbers and restriction of habitat of the Siberian geese are due principally to their annihilation in their wintering grounds, especially in the Far West, on the North American prairies, which were extensively colonised by European emigrants in the middle of last century. Another contributory factor was obviously the changes in the terrain caused by ploughing the prairies.

The birds' breeding grounds on Wrangel Island were studied for the first time by the author in 1960. Land and air surveys revealed that the main colony was in the valley of the River Tundrovaya, near the foot of Tundrovoi Peak. The total number of occupied nests in the colony was assessed at approximately 130,000. In addition to the main colony there were several small colonies on the island, and the total number of nests of this species on the island was approximately 200,000, the number of nesting birds being 400,000 (S.M. Uspenski, 1963). In 1964 we carried out fresh investigations to obtain more complete and up-to-date information on the ecology, distribution and numbers of *A.caerulescens caerulescens*.

It should be noted that the spring of 1964 was delayed on Wrangel Island. An adverse maximum air temperature was maintained until 27th May and blizzards occurred up to the end of the month. The snow began to melt only on 24th May, and the break-up of the snow covering was delayed by subsequent cold spells. The adverse weather conditions disturbed the normal life cycle of the geese, reducing the size of the clutches and causing a large number of birds to refrain from nesting. There have, of course, been years in which weather conditions were even less favourable; for example, according to A. I. Mineev (1945, p. 364), in 1931 'as had never happened before, the tundra was completely covered with snow during the whole of June and part of July, and there was a blizzard even in mid-June. We saw enormous numbers of geese flying around in search of nesting sites, but without success'.

According to the results of questionnaires and our own observations, these geese arrive and lay their eggs at the periods shown in Table I.

Observations show that in spring the birds fly to the island on a broad front, from the south-east and south-south-east. Following this direction, they reach the main nesting site.

On arrival, the oviducts of the females contained fully formed eggs; the ovaries usually also contained 6–8 large ripe follicles. However, the birds were unable to utilise these, and the follicles were reabsorbed during the first few days after arrival. Whereas in years of normal weather the clutches consist of 5–6 eggs, the clutch in 1964 was 3 eggs in most cases. It was a characteristic feature that the nests in parts of the colony where the snow disappeared last and where the bird population was not dense contained the smallest numbers of eggs. On the other hand, breeding was relatively satisfactory where the snow melted early and where the birds nested densely (Table II).

The failure of a large number of mature birds to nest, although they were well fed on arrival and had normally developed

Table I. Timing of events in the breeding cycle of Lesser Snow Geese on Wrangel Island, 1955–64

year	*start of migratory arrival*	*start of mass arrival*	*start of laying*	*start of mass laying*	*Observations*
1955	–	–	–	June 2	
1957	May 22	May 25	May 26	June 2	
1958	–	–	June 10	June 13	much snow during winter, late spring
1959	–	–	–	June 1	
1960	–	–	May 31	June 6	
1962	–	–	June 2	–	
1963	May 21	May 25	May 30	June 3	
1964	May 21	June 4	June 5	June 8	long late spring

Table II. Variations in clutch-size with nesting density of Lesser Snow Geese on Wrangel Island, 1964

nesting site areas	*no. of nests examined*	*maximum no. of eggs in nest*	*average no. of eggs in nest*
Low nesting density (up to 20 pairs per hectare)	133	5	3·18
Average nesting density (20–50 pairs per hectare)	190	6	3·24
High nesting density (50–100 pairs per hectare)	322	7	3·55
Total	645		3·27

Table III. Nest occupancy and nest density of Lesser Snow Geese on Wrangel Island, 1964

nesting site areas	*no. of occupied nests*	*no. of unoccupied nests discovered*	*percentage of nests unoccupied*
Low nesting density	133	44	24·8
Average nesting density	190	32	14·4
High nesting density	322	20	5·8
Total for nesting site	645	96	12·9

Table IV. Total number of nests of Lesser Snow Geese on Wrangel Island in use in June, 1964

nesting site areas	*total area (hectares)*	*average no. of nests per hectare*	*total no. of occupied nests*
Low nesting density	1,200	12	14,400
Average nesting density	1,900	36	59,400
High nesting density	600	64	38,400
Total for nesting site	3,700		114,200

gonads, was shown by the results of dissection and by the fact that many nests were not used by the birds (although the geese occupy the last year's nests first). It was typical that non-breeding individuals reached the highest percentage in areas where the snow was late in melting and nesting density was at its lowest (Table III).

We have intentionally dwelt on some details of the effect of weather conditions on goose breeding rates, taking the view that these facts throw some light on an interesting but little studied phenomenon –'arctic failure to nest' in birds.

According to the periods at which the eggs were laid, the first goslings appeared in the nests of these geese on 1st–2nd July, 1964. The colony began to break up on 3rd–4th, and the mass departure occurred on 6th–8th; the colony was practically deserted by 10th July, although individual late broods were still being encountered here on 14th–15th. According to surveys carried on 7th–8th July, the average number of goslings per brood (based on 33 families) was 2·7, varying from 1 to 5. Birds which have not bred finish their moult and start to leave the island during the first ten days of August, whereas the birds which have bred and the young of the year start to leave during the second ten days of August. The departure of the birds usually ends between 20th and 30th August.

In 1964 we were able to conduct a more careful survey of the birds in the main colony. It was carried out (by marking out 50 test areas of 0·25 hectares each, evenly distributed over the nesting site) immediately after the birds had finished laying (15th–20th June) and gave the results shown in Table IV.

In addition to surveying the nests, a continuous visual count was made during this period of the birds on the nesting site. Their numbers were assessed at 300,000 (150,000–160,000 pairs), so the results of surveying the nests and of counting the geese themselves more or less coincided.

A wildlife reserve was set up on Wrangel Island in 1960, to protect the nesting sites of the geese (and the Polar Bears, large numbers of which make their dens here). Since then, collection of goose eggs and other forms of exploitation have ceased, and this has undoubtedly contributed to the increase in the birds' numbers. This is clearly shown by a comparison of our 1960 and 1964 survey results (especially when one remembers that some of the birds did not nest in 1964).

The second type of nesting site used by *A.c.caerulescens* on the island is the small separate colony, or even single pairs, which sometimes nest with Brent Geese and Eiders *Somateria mollissima v-nigra* near the nests of Snowy Owls. The Arctic Fox is the main cause of loss of eggs, and this was apparently the reason for the formation of the two types of nesting site. In the first case the safety of the eggs is in some measure assured by the relatively effective collective self-defence measures adopted by the birds; observations show (we have no large-scale figures) that predators do most damage to pairs nesting on the edges of the colony or in its sparsely populated areas. The birds in the nucleus of the colony suffer practically no loss from predators. The small separate nesting sites (in 1964, breeding on these sites was even less successful) can exist only because of the energetic defence of their own and the goose nests by Snowy Owls.

It was stated above that nesting density in the main colony fluctuates within very wide limits. It depends both on relief and exposure, which determine when the snow melts, and on the condition of the grass. Throughout the incubation period the birds feed only in their own nesting areas (among the plants eaten by them are several species of grass, *Equisetum* and the green parts of creeping willow). Thus the dimensions of these areas are directly determined by the state of the grazing, by the supply of plant life.

The large-scale ringing of these geese, both on Wrangel Island (where it started in 1960) and in North America has given a fairly complete picture of the migration routes and wintering grounds of this population. In particular it is clear that the main wintering grounds are in northern California, the Willows and Tule Lake National Parks; data on ringing this species have been analysed by T. P. Shevareva (1959, 1961).

The second species of goose inhabiting the island is the Brent Goose *Branta bernicla orientalis*. It was known previously that these birds nested here, but in much smaller numbers than *A.caerulescens* (for example, L. A. Portenko mentioned it in 1937). In 1964 large numbers of unmated, moulting Brent Geese were discovered, which had not been observed previously.

The birds nest, in single pairs and small colonies, in many parts of the island, principally in the large river valleys. The Brent nests are either in colonies of *A.caerulescens* or close to Snowy Owl nests. The birds' selection of nesting ground of a suitable colour is particularly striking. The nests are usually made on bare black or dark brown patches of earth or lichen. The bird itself, and in its absence the nest, thickly lined with dark brown down, are thus very well camouflaged. The times of

migratory arrival and commencement of laying are several days later than in the case of *A.caerulescens*. A fairly detailed survey of the island shows that the total number of Brent Geese nesting there in 1964 was at best 1,000–2,000 pairs.

We found gatherings of unmated Brent Geese in mid-July, in the intensive moulting period. During this period they congregated in flocks of several hundred birds on the shores of shallow lakes in the flat tundra in the northern part of the island. Among them were birds of at least two age-groups, judging by the plumage. It should be mentioned that four ringed Brent Geese were caught in one flock; all had been ringed in Alaska (Lower Kachunuk River), two males (1963) being marked as sub-adult, one male (1962) marked as adult and another bird, also ringed in 1962 without indication of age or sex. Judging by the dates of ringing (11th July–5th August), they had also been caught in Alaska during the moult. These finds are interesting for a number of reasons, although the data are insufficient for final conclusions.

The total number of moulting, unmated Brent Geese could be approximately assessed at not less than 10,000 birds.

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Shinhama - the Imperial Duck Decoy

PETER SCOTT

The Japanese duck decoy or *Kamoba* was evolved from the European type during the 19th century. The major difference is that in the Japanese form the ducks are caught individually with a hand net, which is regarded as a sporting activity and a social occasion.

Two such decoys are maintained by the Imperial Household, one on fresh, the other on brackish water. On a bright sunny day in October 1964 my wife and I were privileged to visit the brackish pool at Shinhama in company with Mr. Dudley Cheke – the British Minister – and Mrs. Cheke. The *Kamoba* lies just across the river Edo from Tokyo, no more than half an hour from the city, in a large area of paddy fields, and adjacent to the estuary mudflats. It was mid-morning as we approached but nevertheless there were springs of Teal and parties of Pintail and Shoveler flighting across the rice fields and the reedy pools surrounding the decoy wood. As we stopped the car to watch them we could hear the loud quacking of what were evidently, from the nature of the sound, a great many 'farmyard ducks'. We could also see large numbers of herons and egrets sitting in the tops of the trees surrounding the decoy. There turned out to be six species of these: Grey and Night Herons just like our own and four species of white ones – Great White, Plumed, Little and Cattle Egrets.

The rough track through the rice and lotus fields passed a tidal creek full of small boats and ended at a pair of large gates. A short drive of grey gravel led to an attractive reed thatched house – the headquarters of the decoy. Here we were met by the decoyman, a cheerful smiling man who offered us tea on a beautiful lawn overlooking a brackish pool of perhaps three or four acres fringed with bamboos. This was outside the decoy and empty of ducks. The only signs of life on it were some large fish which frequently jumped. Along the lawn was a row of artificially stunted pine trees completing a delightful Japanese scene. The decoyman brought out and demonstrated one of the hand nets which are the basis of the duck catching method – a rather large 'butterfly net' which was very light and beautifully balanced.

Briefly the principle of the *Kamoba* is that, as in European decoys, the ducks are perennially undisturbed on a quiet pool, surrounded by dense thicket. In this case additional attractions are a supply of millet seed, and the continuous quacking of 200 large 'farmyard' ducks. Radiating from the pool (or *tamari*) are a number of narrow vertical-sided ditches (*hikibori*) about 5 feet wide and 25 yards long, which bend sharply where they leave the pond and pass through the bamboo thicket. The rest of the *hikibori* is straight with a grassy space on either side and across the end of

each is an observation hut (*konozoki*) with a 'tube' down which millet seed is rolled to lead the ducks on. The catchers, who in the Imperial decoys are for the most part distinguished politicians and diplomats, assemble behind a bank and when the decoyman decides that enough ducks are in, they are deployed, each with a 'butterfly net', on both sides of the little channel. At a given signal they run in and catch the ducks as they rise (or, quite often, we are told, each other). This much of the method we knew before the decoyman led us along a grass patch flanked by a 25 foot bamboo 'wall', through a gate, and across a causeway into the *Kamoba* itself.

Our first view was along an external, rectangular, partly-reed-grown pool which constituted the buffer area between the outer belt of trees and the 'pipes'. A few Teal and Pintails rose and flew over into the *tamari*. The trees were full of egrets. The broad straight path we took was separated by a tall hedge from the buffer pool on our left. On our right was the first *konozoki* – the little concrete observation hut, camouflaged in a grass-covered bank, which commanded a view down the first of a row of eight pipes which flank the north-west side of the main pool. Through the peephole we could see a few of the enormous piebald tame ducks which act as decoys. At the third *konozoki* a five foot yellowish-brown rat snake moved into the open-backed hut ahead of us. It was at first cornered and could have been caught, but just as I had decided it was non-poisonous and was about to pick it up, it found a mouse hole in one corner and was down it and gone in two seconds.

Half way along the north-west side of the decoy was a different kind of observation hut, called an *onozoki*, one of six which stand at the very edge of the *tamari* giving a view through peepholes over the open water of the decoy. The whole rectangular pond seemed to be rather less than 300 yards long and about 100 yards across – perhaps six acres in all – and had some 6,000 ducks on it, mostly Common Teal with a number of Shoveler, a sprinkling of Pintails and a very few Garganey – perhaps 50 all told. In spite of a careful search through the tiny peepholes, poorly suited to binoculars, we were unable to find any Baikal Teal or Falcated Ducks. Nor, surprisingly, were there any Chinese Spotbills which were common on the Imperial Palace Moat in Tokyo, though we later saw a small bunch flying outside the decoy over what must have been the shore. There also we saw a small flock of Wigeon. Mandarins, which later arrive on the Imperial Moat – though not apparently nowadays more than 70 or 80 – do not come to Shinhama, perhaps because the water is brackish.

In the middle of the *tamari* are two square artificial islands called *Nakajima* which were covered with cormorants, egrets, Night Herons and Shovelers. Teal were crowded on the steep banks between the pipes. From the *onozoki* we were looking down on Teal and Shovelers not more than 10 feet away. A bin in the corner of the hut contained millet and if some of this was poured down the little wooden tube (made of three boards and triangular in section) the decoy ducks came at once to eat it, and so did Teal and Shovelers, picking it up as it drifted away on the surface.

During our two hours in the decoy there were several large movements of ducks, mostly into the decoy, but once from one end of the *tamari* to the other.

Several times during the morning a small group of 23 White-fronted Geese flew over the decoy – just the same White-fronts as we see at Slimbridge, where the first 25 had arrived immediately before our departure for Japan.

Towards the end of our time in the decoy we could hear great quackings from the tame decoy ducks. This was feeding time. An assistant decoyman was pouring millet down the tube from one of the *onozoki* huts to the accompaniment of loud hammering with a wooden mallet on a special wooden block in the hut.

The noise was evidently a feeding signal to which the ducks were well used. It was so loud that when I entered the hut to see the reaction of the wild birds through the peephole, I was forced to block my ears – yet the wild Teal and Shovelers were crowded round the hut, the nearest less than 10 feet away from the source of this shattering sound.

Perhaps more remarkable was the fact that the decoyman and his assistant conversed in a loud voice during and after the hammering, and seemed only to attract the wild ducks by doing so. When we left the *onozoki* there must have been 500 birds clustered around us within 20 or 30 yards.

The decoyman's estimate of the numbers on the decoy was about the same as mine – about 6,000 – but he said that on some days later in the winter he believed there might be 20,000. The annual catch during recent years had been about 3,000 birds, the great majority Teal.

We feel greatly honoured to have been allowed to see his interesting place and we are especially grateful to Mr. Kikkawa of the Imperial Household for making the arrangements and for sending on the details of duck catches (Table I).

Table I. The numbers of ducks taken in the Japanese Imperial Duck Decoys 1947–64

*Hunting Season**	*Saitama Preserve*				*Shinhama Preserve*				
	Mallard	*Teal*	*Other Ducks*	*Total*	*Mallard*	*Teal*	*Other Ducks*	*Total*	*Grand Total*
1947–48	2630	1035	32	3697	797	1756	75	2628	6325
1948–49	3554	1479	146	5179	517	2985	51	3553	8732
1949–50	1320	1527	232	3079	411	3803	191	4405	7484
1950–51	1609	1377	67	3053	386	3154	130	3670	6723
1951–52	1208	2043	223	3474	209	2293	91	2593	6067
1952–53	2044	1919	246	4209	549	3266	91	3906	8115
1953–54	1686	1529	108	3323	474	1873	124	2471	5794
1954–55	1396	1844	354	3594	254	2712	35	3001	6595
1955–56	1343	2488	234	4065	239	3551	157	3947	8012
1956–57	1761	1707	91	3559	374	3839	51	4264	7823
1957–58	2331	1080	84	3495	334	4256	162	4752	8247
1958–59	2167	1081	64	3312	273	2980	170	3423	6735
1959–60	1982	1211	83	3276	237	2075	201	2513	5789
1960–61	2650	700	280	3630	258	2216	418	2892	6522
1961–62	1671	899	225	2795	165	2500	151	2816	5611
1962–63	1883	747	172	2802	181	2844	136	3161	5963
1963–64	956	547	170	1673	97	2062	128	2287	3960

* From 1947–48 to 1952–53 the season lasted from 1 November to 28 February; from 1953–54 to 1963–64 it lasted from 1 November to 15 March.

Book Reviews

It is not a regular policy to publish book reviews with the Annual Report. However, a number of important publications have recently emerged, bearing on wildfowl conservation and/or closely associated with the Trust and its personnel. We therefore feel it is not out of place to draw attention to them. We would also remind members that orders placed through our Shop benefit the Trust financially.

Waterfowl Tomorrow. Ed. Joseph P. Linduska. pp. xii + 770, many photographs and line drawings. U.S. Department of the Interior, Washington. 1964. $4.00.

Many people interested in wildfowl know that a great research and conservation effort has been directed to ensuring the survival of worthwhile numbers of these birds in North America. Yet the depth and detail of this massive programme has been apparent only to the specialist, for, as the Preface says, 'most of the pertinent literature is not generally available in libraries'. This book performs an extremely important function in making this knowledge, albeit of necessity in outline, available to all – and at a remarkably low price.

The sensitive reader must suppress his shudders at some of the gay little chapter headings such as 'Cousins by the Dozens', 'Talon and Fang', 'They also serve', 'Carp, a sometimes villain'. He must also force his way past puce passages with which even the soberest experts seem constrained to open their chapters. When he gets to the meat it is wholesome and enormously informative. A hundred leading researchers and conservationists have been mobilised to survey every aspect of the subject.

In eleven logical chapters the wildfowl production areas of the North American continent are described and their importance to the general picture and to the individual species assessed. The wealth of detail available to the conservation planners contrasts starkly with our near complete ignorance in Europe. We do not even know if there is the equivalent of the prairie pot-holes and marshes, producing greatly varying numbers of ducks according to the rainfall trends, or whether we depend on low density but more stable production areas similar to the northern forests and tundra.

Next are described the four 'flyways', Atlantic, Mississipi, Central and Pacific, and the wintering grounds in which they terminate, including Mexico. The natural, biological flyways overlap and vary, so fixed administrative flyways, generally agreeing with the biological ones, are used as the basis for waterfowl management by regulation of season length and bag limit. Such a system could well be adopted in Europe. Again it is astonishing how much is known about the amount of habitat that is available

to wildfowl. For each State the area of high-value wetlands and permanent water is known to within a thousand acres. In Europe we have only just completed a simple list (Projet MAR) of important wetlands – and this is certainly far from complete.

The book now turns to consideration of the natural controlling factors; those of glacial history, water, weather, plant succession, traditional behaviour; of the influence of muskrats, beavers and predators; of diseases, parasites and lethal algae. Then is considered the biggest perturbative factor of all, Man himself. Some of his activities, as in draining for agriculture, are inimical, others, as in building reservoirs and ponds, are incidentally beneficial. The products of agriculture itself are shown to provide a rich living to those birds adaptable enough to take advantage of them. But we return to the inimical in chapters on pesticides, water pollution, and lead poisoning from spent shot.

The establishment of Federal, State and private refuges is described in historical detail. Their management and the way in which they are made to provide both sanctuary for the birds and places where they may be shot is also expounded clearly. The more intractable long-term problem of ensuring the continued existence of the breeding grounds is stressed.

Some of the most fascinating chapters are those which describe the ways in which Man can manipulate habitat to suit wildfowl. Controlled flooding can result in fantastic congregations of waterfowl, more than a million duck (perhaps as many as we ever now have in Great Britain) on 2,000 acres in one instance. Knowledge of the chemistry of marshland ecology is increasing and much progress has been made in the art of planting suitable vegetation and discouraging other forms. In America the lavish technique of growing farm crops *for* waterfowl has produced spectacular results. Thus a 100 acre field of maize fed 85,000 ducks and 15,000 geese for a week. Even a like area of oak woods, flooded temporarily, not uncommonly supports 25,000 Mallard. All this may seem dream-like to us, cramped as we are by lack of birds and lack of money. But it does show what can be done by determined men who are not unwilling to pay for their pleasures.

Two thoughtful chapters setting out the reasons for research and the ways in which hunting regulations are decided upon each season conclude the factual part of the book. The future outlook for wildfowl and their hunters in North America is then discussed, the key to the whole problem being in the words that end the last chapter, 'If enough citizens believe that the perpetuation of waterfowl is important, the job will be done. It is not too late.'

Looking at the contemporary European scene one might well despair. We have such a terribly long way to go in terms of public appreciation and international co-operation even to approach present American standards. But this book will help if it can reach a wide European readership, making them aware just how piffling many of our present efforts are and spurring everyone to the efforts and sacrifices that must be made if great flights of wildfowl are not to be a thing of the past.

Proceedings of the First European Meeting on Wildfowl Conservation. St. Andrews, Scotland, 16–18th October, 1963. Ed. J. Swift. pp. 289. 14 black-and-white photographic plates, 28 text figures. H.M. Stationery Office. £1.4.0. (obtainable from the Nature Conservancy, 19 Belgrave Square, London, S.W.1., 25/– post free)

As part of the growing tide of international co-operation the Nature Conservancy and the International Wildfowl Research Bureau convened a gathering of 72 research biologists, naturalists, wildfowlers and administrators, representing 17 different countries and a number of international organisations. This meeting was 'the first to have before it a reasonably comprehensive and authoritative picture of the wildfowl situation in Europe, on the three vital levels of scientific data about wildfowl movements and ecology; information about the use of the wildfowl resource for food, sport, amenity, scientific and other purposes; and a review of the existing legal and administrative status of European wildfowl'.

These vital data are made generally available in this publication, together with a record of the discussions and resolutions. Anyone with a serious interest in wildfowl should have a copy for reference.

The Trust played a considerable part in preparing the conference and in the editing of these papers to publication, as well as providing those on 'The wildfowl situation in England, Scotland and Wales'; 'The present status of the Brent Goose in Europe'; 'A summary of the known European situation, with suggestions for future work''; and 'Adverse and beneficial developments affecting wildfowl in Great Britain'.

A New Dictionary of Birds. Edited by Sir Landsborough Thomson. pp. 928, 16 coloured plates, 32 photographic plates, many text figures. Nelson, London, 1964. £5.5.0.

It is an understatement to call this staggering volume a Dictionary (in deference to that of Newton, which it superbly supersedes), containing as it does well over four hundred major articles of encyclopaedic length, ranging up to seven thousand words apiece. It is even more of an understatement for Sir Landsborough to be designated simply as Editor. The whole enterprise is his from the initial choice of headings. He it was who coerced more than two hundred authorities into providing articles on their special subjects. He wrote innumerable linking sections and was responsible for the intricate cross-references. Not content with that, he produced full-length articles on Accentor; Aves; Bee-eater; Classification; Cormorant; Crow; Cuckoo; Darter; Distribution; Flightlessness; Gannet; Gull; Hammerhead; Heron; Hoopoe; Hybridization; Ibis; Kingfisher; Locomotion; Migration; Name, English; Nomenclature; Numbers; Ornithology; Passeriformes; Pelican; Plover; Range Expansion; Rhythm; Roller; Sandpiper; Senses; Sexual Dimorphism; Shoebill; Size; Species; Spoonbill; Swallow; Tameness; Young Bird. Few men today could have competence over such a wide spectrum of ornithology.

This is not simply an erudite work of reference; though that is its *raison d'être* and why no ornithological library will now be complete without it. Sixteen beautiful colour plates embellish and functionally illustrate the text. They are contributed by eight artists (Peter Scott has one on King Eiders) which in itself makes possible some fascinating comparisons of style. Further, there are more than two hundred text figures, mostly from the talented pen of Chloë Talbot Kelly (who also contributed five colour plates). Lastly, there are sixty-eight superlative black-and-white photographs whose very excellence bespeaks the mass of material from which these faultless selections were made.

It would be pointless to try and assess the merits of the different articles. Coming from many contributors they vary in clarity, readability and succinctness. There will be disagreement with some of the selections made or with the extent of cross-referencing. But taken as a whole, this book is a triumph, and unique. To be associated with it in any way is a matter of pride. Sir Landsborough has, of course, been the Chairman of our Scientific Advisory Committee since its inception and it is gratifying to see that members of that Committee have contributed a further fifty-four major articles. From the pens at Slimbridge itself derive those on Count; Decoy; Duck; Food Selection; Gamebirds; Homing Pigeon; Navigation; Swimming and Diving; Time Measurement; Wildfowl.

Although rather awkward to handle in bed this book is one to dip into for odd delight as well as for cold factual information. Read, for instance, of the 'Emu War' from which a 'crestfallen field force [7th Heavy Battery, Royal Australian Artillery] . . . withdrew from the combat area after about a month'.

Ornithology has received many services from Sir Landsborough, culminating in this great work. And she has been placed further in his debt by his arranging that the British Ornithologists' Union, who commissioned it as part of their Centenary celebrations, shall receive *all* the royalties. These will be paid into a special fund that will be used to support further research and special publications.

The World of Birds. A comprehensive guide to general ornithology. James Fisher and Roger Tory Peterson. pp. 288. Coloured lithographs of 668 spp., 200 maps, many half-tone illustrations. Macdonald, London. 1964. £5.5.0.

The first third of this handsome book is a *tour de force* which leaves the viewer breathless. Throughout ninety-five pages the vigorous, colourful, faithful paintings coruscate, constantly startling by the originality of posture, by the ingenuity and artistry of their positioning, by their relevance to the text – a text which whips us from facet to facet of bird biology and evolution. One stands in awe as intricate subjects like population studies and instinct are audaciously thumb-nailed into a few hundred crisp words, yet always with high regard for the selected facts.

Following such a stimulating eruption of interwoven talents, two chapters on Bird Watching and on Birds and Man, taking up a third of the book, seem rather grey and less original. Nevertheless there are informative discussions on the study of migration and of behaviour, on the history of bird sanctuaries, on commercial utilisation, sport, birds in conflict with Man and, finally, detailed lists of threatened and recently extinct birds.

The remaining third is certainly colourful and original again. Maps, mostly of global coverage, display the distribution of families of living birds and of sites where fossil ones have been found. These maps are elegantly and clearly composed and must represent a vast deal of painstaking research. Their value to the specialist in avian systematics should be great. For the general reader, at whom the rest of the book appears to be aimed, the purpose of

these maps is much less clear, particularly as no interpretations are offered as to their zoogeographical interest.

Certainly this is a book which has something to please everyone. Perhaps one is just being greedy in wishing that the first brilliant section had been expanded at the expense of the remainder.

On every copy that is sold a royalty is being paid by the publishers to the World Wildlife Fund.

Know Your Wildfowl Food Plants. pp. 32. Published by the Wildfowlers' Association of Great Britain and Ireland. 1964. Produced jointly by W.A.G.B.I. and the Wildfowl Trust. (Obtainable from either organisation, 2/6d. incl. post and packing)

This little pamphlet is in itself further evidence of the growing co-operation between sporting and conservation interests in Britain. Its aim is to provide sketches (27) of the main food plants as an identification aid to those who have the desire and opportunity to improve wetland areas by judicious planting and control programmes. For each plant there is a short description of the usual habitat, the flowering season, the seed sizes and the range of seed colour. The species of wildfowl known to feed on the plant are also shown. Its preparation was undertaken by Mr. Peter Olney.

Wildfowl in Great Britain. A survey of the winter distribution of the Anatidae and their conservation in England, Scotland and Wales. Prepared by the Wildfowl Trust, edited by G. L. Atkinson-Willes and illustrated by Peter Scott. pp. xiv + 368 14 colour plates, 28 photographs, 5 text figures, 61 maps. (Monographs of the Nature Conservancy No. 3). London. H.M. Stationery Office. 1963.

Our monograph was published at the end of 1963 and only received passing mention in the 15th Annual Report. It marks such an important stage in the development of our research programme, however, that we feel justified in giving it more formal notice now. It is hardly our place to enlarge on its merits ourselves, so we have modestly selected, from the dozen reviews that have come our way, some statements of other people's opinions:

ALAUDA. Le travail constitut une base remarquable pour l'etude de l'évolution des Anatidés en ce qui conserne leur population et leur importance au point de vue de la chasse.

ARDEOLA. Fruto de persistentes estudios cuantitativos sobre Anatidas que se vinieron realizando en Gran Bretaña.

BIRD-BANDING (U.S.A.). . . . a comprehensive survey of England's waterfowl resources, the first ever made for any part of Europe. The book is handsomely produced, nicely proofed and printed and beautifully illustrated . . . presents a most graphic assessment of the status of waterfowl in the British Isles today, and should assist greatly in their preservation.

BIRD NOTES. There are 368 pages of text in this book and not one of them wasted. It is a classic – a milestone from which one can measure populations of wildfowl, the progress of the Wildfowl Counts, management techniques and so on. It will be an important reference book for many years to come.

BRITISH BIRDS. . . . however much one may lament the gaps, they are in fact surprisingly few and it is astonishing how much information has been collected . . . In such a monumental task there is little to cavil at and few books can be better value.

IBIS. This magnificent book . . . establishes this country's lead in European wildfowl conservation, for no country has assembled such a mass of data, involving an unprecedented co-ordination of amateur effort over the past 14 years; nor is there such excellent co-operation between wildfowlers and conservationists, which is reflected throughout this book . . . The whole team, under the guiding influence of the Director-General of the Nature Conservancy, is to be congratulated on a first-class effort. The book should stimulate all wildfowl-counters to continue their work with undiminished zeal, for it marks a fine beginning to a task without end.

JOURNAL OF ANIMAL ECOLOGY. The results of the survey are well presented and it is particularly pleasing to find few errors in a work of this size and which has been based upon a very large number of counts (55,000 reports). The reviewer agrees with Mr. E. M. Nicholson who, in the Foreword, states that 'this production reflects credit on all concerned . . .' The Nature Conservancy have set a high standard in their monograph series and this book can do no other than enhance their reputation and that of the Wildfowl Trust.

NATURE. The monograph is well produced, with numerous maps, diagrams and relevant photographs. It is also pleasantly decorated with drawings by Mr. Peter Scott . . . and his previously published colour plates of all the species are also included. This enterprise in 'quantitative ornithology' was well worth undertaking and its outcome deserved such handsome presentation.

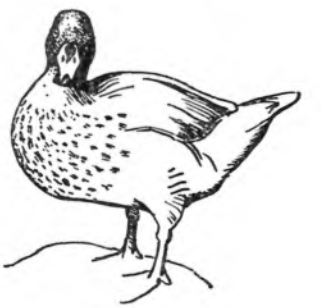
SCOTTISH BIRDS. The mass of accumulated data must be enormous, and that it is presented in such readable form is a tribute to the editor ... The quality of this book and the amount of information it contains, gives it a deserved place on the bookshelf of every ornithologist, conservationist and wildfowler alike.

TERRE ET VIE. ... une pléiade d'ornithologistes professionnels et amateurs se penchent sur l'étude du statut hivernal des Ansériformes en Grande Bretagne ... Leurs efforts viennent d'être récompensés par le travail remarquable de l'éditeur et de ses collègues du Wildfowl Trust sous la forme de cette magistrale monographie.

TIMES LITERARY SUPPLEMENT. This handsome volume ... fully upholds the high standard we have come to expect from the Nature Conservancy ... Part II ... is by far the most important section of the book and is accompanied by beautifully clear maps of the areas under discussion. It is thus easy to refer to any part of the country without wading through a mass of irrelevant matter. The whole work has been well edited ... a first-rate contribution to knowledge of the Anatidae, and a valuable pointer how best such a wonderful heritage can be conserved. The book is beautifully produced by H.M. Stationery Office and is furnished with two serviceable indexes.

DIE VOGELWARTE. Grossartige Darstellung und prächtige Ausstattung des Buches entsprechen der Anstrengung, Passion und Gründlicheit der britischen Entenvogelzähler; sie stehen aber auch im Einklang mit den einmaligen Entenvogel-Landschaften dieses Inselreiches. Der Verf, hat hier mit umfassender Kenntnis, mit grosster Liebe zur Sache und mit ausserordentlicher Klarheit der Darstellung einen 'Klassiker' geschaffen, der für die gesamte europäische Vasservogelforschung – im Dienste der Erhaltung der Anatiden – Markstein und Ansporn zugleich werden dürfte.

We are informed that the first printing of 3,000 has been sold out, a most unusual fate for a specialised monograph. However, a second printing has been made and copies may be obtained from the Trust at the published price plus 2/6d. post and packing.



Section 3

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