TRANSACTIONS

OF THE

NORFOLK & NORWICH

NATURALISTS' SOCIETY

S.295.

The Norfolk and Norwich Naturalists' Society has for its objects—

1. The practical study of Natural Science.

2. The protection, by its influence with landowners and others, of indigenous species requiring protection, and the circulation of information which may dispel prejudices leading to their destruction.

3. The discouragement of the practice of destroying the rarer species of birds that occasionally visit the County, and of exterminating rare plants in their native localities.

4. The record of facts and traditions connected with the habits, distribution, and former abundance or otherwise of animals and plants which have become extinct in the County ; and the use of all legitimate means to prevent the extermination of existing species, more especially those known to be diminishing in numbers.

5. The publication of Papers on Natural History contributed to the Society, especially such as relate to the County of Norfolk.

6. The facilitating of a friendly intercourse between local Naturalists by means of Meetings for the reading and discussion of papers and for the exhibition of specimens, supplemented by Field-meetings and Excursions, with a view of extending the study of Natural Science on a sound and systematic basis.

PRESENTED
2 APR 1935

TRANSACTIONS

OF THE

Norfolk and Norwich

NATURALISTS' SOCIETY

EDITED BY MISS A. M. GELDART

VOL. XIII.

1929—30 to 1933—34

NORWICH
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MARCH, 1935


BRITISH MUSEUM
NATURAL HISTORY

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With references to the Articles contributed by each

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1921 Jarrold T. H. C., Pine Banks, Thorpe St. Andrew
1891 Jarrold W. T. F., Beeston St. Andrew, Norwich
1927 Jessopp A. L., Lexham Hall, King's Lynn
1926 Jolly Ll. B., Aylmerton Hall, Norfolk
1923 Jolly T. L., Manor House, Worstead
1885 Jones Sir Lawrence, Bart., 39, Harrington Gardens, London, S.W., 7.
1926 Jourdain Rev. F. C. R., Laverstock, 4, Belle View Road, Southbourne, Bournemouth

K

1926 Keith E. C., Swanton Morley House, East Dereham
1927 Kendall O. D., Dept. of Geography, University of Bristol
1929 Ker Mrs. Rait, 42, Parkside, Cambridge
1897 Kerrison Colonel E. R. A., C.M.G., D.L., Drayton, Norwich
1925 Kerrison Mrs., Drayton, Norwich
1912 Ketton-Cremer W. C., Felbrigg Hall, Norfolk
1926 Kimberly Mrs., M.Sc., "Constantia," Elm Grove Lane, Norwich
1904 Kinder Rev. E. H., Kirby Bedon Rectory, Norfolk
1898 Knight Edward, Keswick Old Hall, Norwich

L

1925 Labouchere P., The Lodge, Burnham Thorpe, King's Lynn
1930 Lance Capt. H. W., Burnham Norton Lodge, King's Lynn
1926 Lane D. H., Framingham Pigot, Norwich
1929 Lawrence F. J., Lauriston, Mossell River, Harmanus, Cape Province, S. Africa
1926 Leconfield Lady, Petworth House, Petworth, Sussex
1921 le Strange C., Hunstanton Hall
1909 Leicester The Right Hon. the Earl of, G.C.V.O., C.M.G., *V.P.*, Holkham
1899 Leney F., Castle Museum, Norwich
1927 Lister Dr. S. R., Terrington Lodge, King's Lynn
1923 Livesay Surg.-Capt. R. N., St. Andrew's Hospital, Thorpe, Norwich

Elected

1922 Livesay Mrs., St. Andrew's Hospital, Thorpe St. Andrew
1922 Lloyd Capt. L., Taverham Mill, Norwich
1925 Lloyd Mrs., Taverham Mill, Norwich
1899 Long S. H., M.D., F.Z.S., M.B.O.U., *Hon. Sec.*, 31, Surrey Street, Norwich
1907 Long Mrs. S. H., 31, Surrey Street, Norwich
1919 *Long Miss E. M., 31, Surrey Street, Norwich
1923 Long G. S. B., St. Giles Plain, Norwich
1928 Lotbinière Mrs. Joly de, Brandon Hall, Suffolk
1921 Lucas Baroness, Woodyates Manor, Salisbury
1925 Luddington Miss, Wallington Hall, King's Lynn

M

1924 MacKenzie Miss G., The Cottage, Ingworth, Norwich
1923 *Macpherson A. Holte, 21, Campden Hill Square, Kensington, W.8
1905 Mann Sir Edward, Bart., Thelveton Hall, Norfolk
1906 Marriott F. W. P., 11, Queen Street, Norwich
1892 Marsham Major H. S., Rippon Hall, Marsham, Norfolk
1912 Mason A., Bank Plain, Norwich
1911 Master George, M.D., Bury St. Edmunds
1926 Matthews H., Whitlingham
1893 Mayfield A., F.L.S., Mendlesham, Stowmarket
1926 McCall C. Home, Upper Flat, San José, Mount Rd., Hastings
1922 McKenna Mrs. Reginald, 70, Pall Mall, S.W.1
1926 McLean Colin, Humbletoft, East Dereham
1926 Meade Miss P., Croxton, Thetford
1898 Meade-Waldo Edmund G. B., Stonewall Park, Edenbridge, Kent
1928 Mileham C. A., Aylsham, Norwich
1928 Mileham Mrs., Aylsham, Norwich
1877 Miller Henry, Bosmere House, Norwich Road, Ipswich
1928 Miller O. T., The Heath, Fakenham
1923 Minns Mrs. E., Hammond's Wood, Frensham, Surrey
1923 Moppe Lewis E. van, Cliffside, Overstrand
1928 Morel Mrs., Burnley Hall, Martham, Norfolk
1929 Morley C., Monk's Soham House, near Framlingham, Suffolk
1924 Mortimer Ernest, The Red House, Wrentham, Suffolk
1922 Mountfield Miss M., Horsford, Norwich
1929 Moxey Llewellyn
1920 *Mullens Major W. H., Westfield Place, Battle, Sussex
1921 *Murton Mrs., Cranbrook Lodge, Kent

N

1926 Nash J. E., 93, Priory Park Road, Kilburn, N.W.6
1922 Nevill Rev. R. W., Old Catton Vicarage, Norwich
1926 Nevill Mrs. R. W. ,, ,, ,, ,,
1925 Neville Sir R. J. N., Sloley Hall, Norfolk
1911 Newman L. F., St. Catharine's College, Cambridge
1889 Nicholson W. A., *Hon. Mem.*, 5, Mill Hill Road, Norwich
1915 Nightingale S. R., Scratby Hall, Great Yarmouth
1926 Norfolk and Norwich Library, Norwich
1919 Norgate Philip, Swanington, Norfolk
1915 Norwich Public Library
1927 Notcutt R. F., Woodbridge

O

1927 O'Donnell O., Great Fransham, East Dereham
1921 Offord Miss Georgina, " The Larks," Water Lane, Costessey

Elected

1914 Oliver F. W., D.Sc., F.R.S., *Hon. Mem., V.P.*, Blakeney Point, Morston, Blakeney
1924 Orgill Miss M. A., Garboldisham, Diss
1930 Owen Miss F., 80, Mundesley Road, North Walsham

P

1889 Page G. W., Walsingham, Norfolk
1919 Pain Percy, Dersingham, King's Lynn
1913 Paine Rev. N. W., Great Melton Rectory, Norfolk
1919 *Palmer Mrs. P. Hurry, " Red Roofs," North Drive, Great Yarmouth
1926 Pank A. H., Bedford Street, Norwich
1912 Parker H., 10, Aspland Road, Norwich
1925 Parker Miss Molly Hyde, Smeetham Hall, Sudbury, Suffolk
1921 Parker R. E., Marlingford, Norwich
1883 *Parkin Thomas, M.A., F.Z.S., High Wickham, Hastings
1873 Partridge Rev. W. H., M.A., " Breccles," Sandown, I. of W.
1889 Patterson Arthur H., *Hon. Mem.*, Ibis House, Lichfield Road, Gt. Yarmouth
1920 Patteson Mrs. F. E., Great Hautbois House, Norfolk
1901 *Paul J. J. Dawson, Eaton Grove, Norwich
1911 *Payler Donald, The Museum, Birmingham
1923 Peed John, Aylsham
1928 Penrose F. G., M.D., " Woodbury," East Cliff, Bournemouth
1926 Percy Lord William, D.S.O., Catfield Hall, Norwich
1903 Petre Col. B., Westwick Hall, Norfolk
1925 Petrie Mrs., The Dower House, Heydon, Norwich
1926 Phillippo G., 7, St. Philip's Road, Norwich
1925 Pilch R. G., 45, Grosvenor Road, Norwich
1930 Podmore R. E., South Park College, Wadhurst, Sussex
1923 Pope Dr. G. Stevens, Eaton Road, Norwich
1880 Preston A. W., F.R.Met.Soc., 371, Unthank Road, Norwich
1919 Preston Sir E., Bart., Beeston Hall, Norwich
1900 Preston F., 66, The Close, Norwich
1913 Purdy T. W., Woodgate, Aylsham
1925 Purnell Mrs. Ralph, 12, Clarendon Road, Norwich
1887 Pycraft W. P., A.L.S., F.Z.S., British Museum (Natural History), London, S.W.

R

1929 Ramage H. P., Ridgemont, Carrow Hill, Norwich
1928 Raywood W., 13, Upper King Street, Norwich
1930 Reeves Derek L., Honingham Hall, Norwich
1925 Reeves Hugh, Honingham Hall, Norwich
1930 Reynolds Miss J., 63, The Avenue, Watford, Herts.
1924 Richmond H. W., F.R.S., King's College, Cambridge
1925 Ringrose B., Farley, Harbridge Green, Ringwood, Hants.
1930 Ripley Mrs. Ernest, 19, Princes Street, Norwich
1924 Rippingall Neale F., Crabbe, Weighton S.O., Norfolk
1911 Rising A. P., The Manor House, Ormesby, Great Yarmouth
1908 Riviere B. B., F.R.C.S., F.Z.S., M.B.O.U., Hill] House, Saxlingham, Norwich
1908 Rogers Commander F. S., R.N., Ingham New Hall, Norwich
1909 Rogers Rev. Henry, Coltishall Hall, Norwich
1908 *Rothermere Rt. Hon. Lord, Hemsted Park, Cranbrook, Kent
1897 *Rothschild Rt. Hon. Lord, F.Z.S., Tring, Herts.
1922 Rounce G. H., The Pines, Park Road, Cromer
1930 Rowell George, 15, The Close, Norwich

Elected

1918 Rudd A. J., F.Z.S., Queen Street, Norwich
1902 *Ruggles-Brice Mrs. R., Keswick Hall, Norwich
1906 Rumbelow P. E., 27, Rodney Road, Great Yarmouth

S

1929 Sainty Miss O., 38, College Road, Norwich
1930 Scratchley Lt.-Col. V. H. S., D.S.O., The Parsonage, West Newton, King's Lynn
1925 Sewell P. E., Dudwick House, Buxton, Norwich
1925 Sexton K. F., 156, Newmarket Road, Norwich
1929 Shaw A., Bixley, Norwich
1922 Shepheard Dr. Samuel, Aylsham
1924 Shepherd Miss A. M., Convalescent Home, Lowestoft
1930 Shilcock Miss Joan R., "Maryland," Sheringham
1921 Silcock Chas., Decoy Cottage, Hoveton, Norwich
1930 Simpson Miss W., Geldeston Lodge, Geldeston, Norfolk
1919 Smith Col. H. F., Didlington Hall, Norfolk
1915 Smith Mrs., Ellingham Hall, Bungay
1891 Smith W. R., Harleston, Norfolk
1917 Sowels Miss, The Rookery, Thetford
1922 Spalding G., 9 ,St Stephen's Street, Norwich
1911 Spurrell J. T., Manor House, Newton St. Faiths, Norwich
1923 Spurrell Miss M., Manor House, Newton St. Faith's, Norwich
1923 Spurrell Miss P., Manor House, Newton St. Faith's, Norwich
1295 Steers J. A., St. Catharine's College, Cambridge
1921 Stimpson Edward, Sall Moor Hall, Reepham, Norfolk
1927 Stourton Hon. J., Cawston Manor, Norwich
1922 Sumpter Dr. B. G., Brancaster Staithe, King's Lynn
1896 Sutton W. Lincolne, F.I.C., Eaton, Norwich

T

1921 Taylor Dr. Mark R., 338, Winchester Road, Southampton
1878 Taylor Shephard T., M.B., The Mount, Edgefield, Melton Constable
1921 Thain D., West Somerton, Norfolk
1886 Thouless H. J., "Southernhay," Wroxham
1924 Thursby-Pelham Miss D., Fisheries Laboratory, Lowestoft
1929 Tillett Miss I., 2, Claremont Road, Norwich
1896 Tillett Wilfrid S., 2, Claremont Road, Norwich
1920 Todd Lt.-Col. Eardley, Mundham House, Brooke
1902 Todd R. A., B.Sc., The Retreat, Elburton, Plymouth
1923 Tomes Lady, Mannington Hall, Norfolk
1910 Tracy N., 3 King Street, King's Lynn
1925 Tucker B. W., 9, Marston Ferry Road, Oxford
1906 Turner Miss E. L., F.L.S., H.M B.O.U., *Hon. Mem.*, 13, Storey's Way Cambridge
1927 Turner Edgar, "Kuruman," Walberswick

U

1923 Upcher Rev. E. C. S., Weybourne Rectory, Norfolk
1921 Upcher H. E. S., The Gables, Upper Sheringham

V

1917 Vincent James, Hickling, Norfolk

W

1921 Wallis Rev. M. C.,
1923 Walter Mrs. Cyril, Old House, Drayton, Norwich
1921 Walton Miss, 17, Camberley Road, Norwich

Elected	
1923	Waterfield Miss, Attlebridge, Norfolk
1923	Waterfield Miss Penelope, Attlebridge, Norfolk
1928	Watson J. B., c/o Barclays Bank Ltd., Surbiton, Surrey
1926	Wemys Major, Bryn House, Wroxham
1927	Wemys Mrs. ,, ,,
1923	Wenn Miss, Ingham, Norfolk
1883	*Whitaker Joseph, F.Z.S., Rainworth Lodge, Mansfield
1928	Whitwell Miss, 1, Cambridge Street, Norwich
1922	Willett W. L., Paddock Wood, Kent
1913	Williams Miss Margaret, 28, The Close, Norwich
1929	Wilson Mrs. Gerald, Saxlingham Nethergate, Norwich
1930	Wing J. Sladen, 21, Cheyne Gardens, Chelsea, S.W.3
1909	Witherby H. F., M.B.E., F.Z.S., 326, High Holborn, W.C.
1924	Wolsey Noel G., 15, King Street, Great Yarmouth
1928	Wood M. S., M.D., Woodland House, Windermere
1923	Woolsey G. E. W., Old Catton, Norwich
1907	Wormald Hugh, M.B.O.U., Heathfield, East Dereham
1922	Wortley Francis, "Seathwaite," Sheringham
1929	Wortley Roger, "Seathwaite," Sheringham
1924	Wright B. D. Z., Hoveton St. John, Norwich
1920	Wyllys Hugh, "Shrublands," Southtown, Great Yarmouth
	Y
1915	Yarmouth Free Library, The, Great Yarmouth

TOTAL

Honorary Members	... ...	4
Life ,,	... ...	29
Ordinary ,,	... ...	383
		416

The Treasurer in Account with the Norfolk and Norwich Naturalists' Society, Year Ending 30th April, 1930

I. GENERAL ACCOUNT

Dr.

1929-30.	£	s.	d.
To Balance from 1929	46	12	8
,, Subscriptions	169	7	6
,, Sale of "Transactions"	1	5	0
,, ,, "Flora of Norfolk"	0	8	0
,, Interest on War Stock	11	7	8
,, Donation for Publication Fund	20	10	0
,, Excursion Secretary	0	3	0
	£249	13	10

Cr.

	£	s.	d
By "Transactions,"	177	5	0
,, W.B.P.F. Re-fund of two subscriptions	5	5	0
,, Postages	16	17	8
,, Printing	5	17	6
,, Books and Library Rent	7	6	6
,, Expenses of Meetings	9	18	8
,, Fire Insurance	0	13	6
,, Balance on Current a/c at Bank	26	10	0
	£249	13	10

Examined and found Correct,
(Signed) W. A. NICHOLSON,
June, 1930

LIFE MEMBERSHIP FUND

1929-30.	£	s.	d.	1930	£	s.	d.
To Balance from 1929	24	12	10	April 30 By Balance in Savings Bank	27	14	11
,, Bank Interest		12	1				
,, Interest on War Loan	2	10	0				
	£27	14	11		£27	14	11

Correct,
(Signed) W. A. NICHOLSON.

DEPOSIT ACCOUNT

1929-30	£	s.	d.	1930	£	s.	d.
Balance, Capital from 1928	22	5	3	April 20 Balance	23	11	5
2 years Interest thereon	1	6	2				
	£23	11	5		£23	11	5

Correct,
(Signed) W. A. NICHOLSON.

SPECIAL PUBLICATION FUND

1929-30	£	s.	d.		£	s.	d.
To Donations—				Transferred to General Account	20	10	0
Sir R. Neville		10	0				
W. C. Ketton-Cremer	1	0	0				
Mrs. Bagnall		5	0				
Mrs. Graves		5	0				
J. Cator		10	0				
R. J. Colman	10	0	0				
F. H. Barclay		10	0				
Dr. Burton		10	0				
Dr. Collings ... ... —	1	0	0				
D. H. Lane		10	0				
Mrs. Butler		10	0				
R. Gurney	5	0	0				
	£20	10	0		£20	10	0

List of Investments and Assets

	£	s.	d.
£155 6s. 10d. 5 per cent. War Stock 1929-47 at cost ...	150	18	1
64 War Savings Certificates dated 24.1.19	64	0	0
31 War Savings Certificates, dated 17.7.23. at cost ...	24	16	0
£191 1s. 10d., 4 per cent. Consolidated Stock, at cost ...	166	9	7
Balance in Savings Bank	27	14	11
	£433	18	7

ADDRESS

Read by the President, G. H. GURNEY, F.Z.S., F.E.S., M.B.O.U., *to the members of the Norfolk and Norwich Naturalists' Society, at their Sixty-first Annual Meeting, held at the Castle Museum, Norwich, on April 29th,* 1930.

LADIES AND GENTLEMEN,

As usual at our Annual Meeting it is customary for the outgoing President to make some remarks on the events and work of the past year. We have five losses by death to record :—Mr. Edward Bidwell, Mr. Henry Birkbeck, Mr. Herbert Goodchild, Dr. Donald Hutchinson and Mr. Alexander J. Napier. Fifteen new members have joined the Society.

During the last summer two excursions were arranged : one on June 6th, when members visited Royden Fen and Mr. Tracy's Bird Sanctuary; and the other on June 28th to Hickling.

Some valuable and distinctive papers have been read at our monthly meetings, these include a paper on " Bees," by Mr. H. Goude at the November meeting. In January, Mr. Peter Gray gave us a very interesting address on Fish Lice and their Allies, which was illustrated by Lantern Slides. The February meeting, which was held at the Stuart Hall, comprised a film of Norfolk nesting harriers and other birds, shewn by permission of Mr. Walter Higham, Mr. Jim Vincent giving explanatory notes ; while at the March meeting Miss Geldart read a paper on Countryside Preservation in Norfolk.

It is our usual custom at the annual meeting for the retiring President to make some remarks on a subject connected with natural history in which he is specially interested ; I have chosen as the subject of my address this evening some aspects and observations made on the live birds kept in the aviaries at Keswick. Owing to ill health during the past winter I have been obliged to curtail this paper, but I hope to put before you, during the short time I have the honour

of addressing you, some examples and phases of bird life which I have called

THE MENTALITY OF BIRDS, WITH SOME NOTES ON SEXUAL SELECTION

The aviculturist who keeps a large number of live birds in captivity is only justified in doing so if he, in this way, learns something more from them than he would be likely to do seeing them in their natural habitat. It is true that in aviaries and cages birds are kept under more or less unnatural conditions, but certain traits in their characters never alter and can be better observed when they are in confinement and under their owner's personal supervision ; and it is a fact that many observations and phases in their life-history have been put on record, which might otherwise have passed notice, or not been discovered. To give only one example. For many years Lort's Roller, *Coracias Lorti*, had been considered to be a different species from the Long-tailed Roller, *Coracias Caudatus* ; but a well-known aviculturist, who had several examples of both species under observation in his aviaries for several years, discovered that Lort's Roller gradually changed colour and became identical with his specimens of the other species, proving that the former is merely one phase of plumage of the latter. It is only by keeping birds in captivity and carefully observing them that such discoveries are often made.

The psychology or mentality of birds is a subject of surpassing interest and one which can be studied to advantage in birds in captivity. Even a superficial study of the psychology of birds compels us to attribute to them a highly developed intellectual and emotional life. A few examples may make this more patent, and I will mention only those which entail rather complex psychic processes Birds have remarkable memories ; it is said a pigeon will remember a person after many months, and a bullfinch has been known to recognize a voice after a year's time. Birds often dream or chatter in their sleep. There are few species of birds which do not show the emotions of love and sympathy and, what is a very rare trait amongst animals, that sincerity of affection which causes many birds to mate for life. Indeed, sympathy is the key-note in the growth of the higher intellectual and

social qualities which find their culmination in man, and Professor Shaler even goes so far as to attribute to birds a higher development of this emotion than to any other creatures below man. Reptiles can be trained to know their keeper, and an alligator will defend her buried eggs ; dogs are unusually affectionate animals, and the higher monkeys have many sympathetic habits and emotions, but birds he declared, exhibit these most. This is not so remarkable when we consider the important place which the family holds in this class of vertebrates. The building of the nest, the comparatively long incubation of the eggs and the patient feeding and the complex education of the young, all are duties which both parents often share. It is this continued association, this bridging over of generations, which has made sympathy so prominent a factor in the minds of birds. In what other class of animals are vocal signals of fear, distress or terror so widely understood, or so willingly met with efforts of assistance ? To me it seems puerile to try to believe that a bird's affection for her young (so great that she will often give her life in their defence) can be correlated with an *instinct,* using that word in the common acceptance of the term. It is no more an instinct in the sense of an uncontrollable emotion than in the analogous action of an heroic human being. I have heard of cases of altruism, pure and simple, which have governed the actions of more than one bird in a remarkable way, and that too in some cases between birds of different species. Three instances come to my mind. A female blackbird which carried a mouthful of worms to a nestful of young redwings nearby ; a black-throated diver which voluntarily risked its life to free a grebe from a nearly fatal ice-trap ; and a crowned pigeon which assumed the care of, and sheltered a nestling ring dove deserted by its parents. Another aspect of the mental processes of birds shows us examples of revenge being taken after long and patient waiting for a favourable opportunity ; while, on the other hand, rooks have been known again and again to sit in judgment upon one of their number and to sentence and punish it with death.

The language of birds is most complex and all, from the marvellous song of the nightingale and the imitative powers of the mocking bird, to the many moods and feelings reflected

in the apparently meaningless chirps of the common sparrow, tell of mental powers striving for expression. In man the various emotions depend upon language and the range of expression of the face for their outward demonstration, and it is interesting to compare with this the state of affairs among birds. These creatures, handicapped by a vocal language very inferior to our own, and faces for the most part sheathed like those of insects in expressionless masks of horn, are yet able by movements of their feathers, limbs and other portions of the body to express a wide range of emotions and clearly to communicate even delicate shades of meaning.

I may emphasize here a factor common to all animals, which in birds is very important and developed to a remarkable degree—that of extreme *individuality*. It is this plasticity or wide variation on the already high level of knowledge that gives to birds the numerous chances for new accidental opportunities, as we may call them—stepping stones on the road of deduction to some new and higher expression of psychic power. Every day accidents in the search for food may be instantly siezed upon by the quick perception of birds and turned to good account. Birds had early learned to take clams or mussels in their beaks at low tide and carry them out of reach of the water, so that on the death of the mollusk the relaxation of the abductor muscle would permit the shell to spring open and afford easy access to the inmate. Probably it needed only the accidental dropping of a few shells on the hard rocks, and a taste of the appetizing morsels within, to fix the habit which, by imitation, has spread so widely among birds at the present day.

Play and courtship afford opportunity for the vast resources of variation to be abundantly expressed, and five separate classes may be given under the head of courtship :—

1. Love-plays among young animals.
2. Courtship by acts of movement.
3. Courtship by display of unusual or beautiful colours and forms.
4. Courtship by means of noises and tones.
5. Coquetry of the female.

Amongst my own tame birds each spring, and indeed during almost every month of the year, I have observed many examples

of these courtships and displays. The dances of cranes and eagles, the magnificent showing off of pheasants and ducks, the screams of parrots, and all the songs vibrant with sentiment, in which birds strive to outdo each other in the eyes of the female, show how greatly the spirit of emulation and recognition of the respective accomplishments inspire the suitors. We should also realize how pronounced must be the discriminative power and æsthetic appreciation of the females. The display of the peacock combines the classes of movement, colour and noise ; for the beauty of its argus-eyed feathers is made more effective by their being raised in a halo above the bird, the shivering of its wing-quills forming a castenet-like accompaniment.

A genuine delight is taken in these various displays. So far from being intuitive or mechanical exercises they are conscientiously practised for weeks beforehand, and are often kept up after the period of courtship and nesting is over. For instance, in the London Zoological Gardens, when a peacock in early spring timidly erects his plumes before an appreciative rook, it is for practice in anticipation of its later use in competition with his rivals. After the period of courtship, when he struts backwards and forwards before a line of admiring people, the exercise is from pure delight and appreciation of his own beauties. Even in birds which pair for life may be noticed a coquetry and pretended courtship spring after spring.

Another interesting fact about courtship among birds, which may be noticed when they are kept in confinement, is that it is not always the most highly decorated suitor, nor the one victorious in combat, who wins the female for whom he is putting forth his utmost efforts. I have seen a peahen show a very decided preference for, and ultimately pair off with, a young cock who had but small display and was almost spurless. I have heard of an amusing instance noticed amongst mallard bred in confinement. Three drakes vied with each other for the favour of a little brown duck. One of the drakes seemed to put but faint hope in his splutterings and bowings ; and little wonder, for his showy curly tail feathers, one of the decorations of his sex, had somehow been lost or pulled out and the symmetry of his plumage had also been spoiled in other respects. The other two

drakes were large and beautiful birds, the irridescent green of their heads and necks and their immaculate plumage made them incomparably more conspicuous than the other bird. Nevertheless all their efforts were in vain, while the occasional pitiful attempts of the handicapped suitor to spread an imaginary tail and declare his everlasting devotion prevailed. He was accepted, and the pair were inseparable until the nest was finished and the duck began sitting on her eleven eggs.

Turning from birds for a moment which are confined in Zoological Gardens or private aviaries, to wild birds which often make a Zoological Gardens their home, or pay it frequent visits, we find much of interest in their changed habits and dispositions. The sight of so many birds flying unharmed in the large flight cages, or walking about their enclosures, or swimming on the various ponds undisturbed although in close proximity to man, is fraught with significance to the quick perceptions of wild birds, large and small. Their keen perceptions and superior powers of intelligence tell them that such unwonted altruistic conditions must offer advantages. The almost immediate recognition of their security in the gardens is remarkable, and I have heard of birds which seldom show themselves within sight of civilization that have come again and again and exhibited a tameness which deceives many people into thinking they must be escaped birds. The well-known instance of Canada geese visiting the New York Zoological Gardens will testify to the truth of this. Wild sea-gulls quite often drop from their loose flocks passing overhead and consort for a few days with their wing-clipped kindred. Herons and even hawks show as quick a realization of their immunity from danger in the Zoo Gardens, and in a paper I read before this society last year on the birds of Egypt, I mentioned the wonderful spectacle which might be seen any day during the winter on the lake in the middle of the Giza Gardens, where thousands of wild ducks of various species congregate amongst the pinioned ones and know they are perfectly safe.

Darwin's theory of sexual selection is that the superiority of appearance in male birds is due to the selection, through untold ages, of the handsomest males by the hens; that this fact is not always the case is shown by the few reverse

examples I have quoted, in fact it seems that there is extremely little direct evidence in favour of this view, and what little there is had been chiefly furnished by aviculturists, it seems worth while to review shortly the subject. In the first place it may be well to enumerate briefly the forms taken by sex-differences among birds, and I have chosen examples as much as possible from species well-known in aviculture, for our hobby gives us the most perfect control of the only scientific method, that of observation and experiment We find, where the male is the superior sex, the following forms of difference :—

1. Male similar to female in size and structure, but richer in colour—European Chaffinch, Scarlet Tanager and numberless others, this being by far the commonest form of sex-difference.
2. Male not only richer in plumage than female, but also possessing special structual decorations—Common Fowl, Peacock, the Birds of Paradise, and many others.
3. Male similar to female (or nearly so) in plumage, but with structural decorations—Condor, Turkey, Great Bustard and the Australian Musk Duck.
4. Male like the female, but with special weapons, i.e., spurs ; Eared Pheasants (*Crossoptilon*) and many Francolins (*Francolinus, Pternistes*).
5. Sexes alike in size and plumage, but with a difference in the " soft parts"—Budgerigar.

In some cases these differences are permanent, as in the fowl ; in others the male has a distinctive plumage only during part of the year, generally only during the breeding season, as in the Indigo Bird, the Whydahs, and many of the Ducks.

The few converse cases, where the female is the superior sex, fall under five classes :—

1. Female of same size as male but brighter—Eclectus Parrots, Paradise Duck.
2. Female both larger and brighter than male—Phalaropes, most Hemipodes (*Turnix*).
3. Females larger than male but duller—Harriers, Kestrels, Blackbird, some Bustards.
4. Female simply larger than male, otherwise similar—Emu, Cassowaries, Kiwis, Tinamous, Jacanas.

5. Female like male, but with brighter "soft parts"—Asiatic Jabirou, some Cockatoos. In these the iris is brighter in the female.

Sex similarity may be of two kinds. Both sexes may be dull, or have plumage of a type which is feminine in allied species which shew masculine superiority, e.g., Corn Bunting, Australian Wild Duck. Or both sexes may be bright, or have plumage which is masculine in species showing masculine superiority, e.g., Goldfinch, Superb Tanager. Both sexes may have special weapons, Cassowaries, Spurwinged Geese, and all spur-winged birds of any sort.

As in the case of sexually differing birds, the decorations of similar-sexed birds may be seasonal, a most striking case being the "Osprey" plumes worn by breeding Egrets and the ruff of the Great Crested Grebe. There is one case of a seasonally developed weapon in the Pheasant-tailed Jacana, in which the wing spurs are only developed in the breeding season.

There are, of course, plenty of cases which connect various classes, e.g., in the Blue Tit and Gouldian Finch, the sexes are both richly coloured, but the female is noticeably the duller of the two; in the Turkey, the cock only has well-developed structural decorations, and is also far larger than the hen.

We may now go back to the question of display. We know that most—probably all—birds display in some way or other, whether dull or bright, specially decorated or not. The display may be often provoked by emotions other than amatory passion, e.g., anger; anyone can see this in the case of the Turkey and Muscovy Duck, both of them irritable as well as amorous birds, and I have observed it in many species. Young male birds, e.g., young Peacocks and Gold Pheasants, may display before they are decorated, and birds which change their plumage may do so when out of colour (Jackson's Whydah and Blue Wren).

Display generally leads to fighting as well, as in the tournaments of Ruffs and Blackgame, but some very ostentatious birds rarely fight, though they drive each other about, e.g., Peafowl and Mandarin Ducks; while some do not even meet each other when displaying, like the Argus Pheasant,

and so cannot fight, though fierce enough. Males may assemble and display without any females being present; this has been witnessed in the case of the Cock-of-the-Rock. I have seen birds in captivity display in the autumn, but no importance need be attached to this; it simply means that they are again in breeding condition after the moult, and would doubtless breed if not checked by the oncoming winter. Hens rarely show any appreciation of the display that we can perceive. It is needless to labour this point, the apparent indifference of the hen being so much in contrast to the excited energy of the male. She may even appear to be irritated; everyone must have seen the hen sparrow attack the displaying male.

With regard to other methods of courtship or special sexual activity at the breeding season, we have to consider song and gifts of food; generally only the male sings or gives a special call; but the female usually can, and often does when alone, e.g., Virginian Cardinal. Song may be uttered under the influence of anger or even fear, as well as amatory passion; skylarks and robins sing, as cocks crow, when challenging each other. I have been told the skylark will sing in snatches when pursued by a hawk, and I myself have heard a bantam cock crow while his overgrown spurs were being pared down and he was held in the hand. Song is much noticed by females in some cases; hen canaries often annoy breeders by "pairing by the voice" with undesired mates; and the hens of some of the almost dumb (to our ears) Mannikins (*Munia*) listen intently to the song of the males. With regard to the other amenities of courtship, gifts of caresses, etc., we have to notice that the male generally feeds the female, not vice versa. Feeding may be done from the crop, in which case it often runs in families, e.g., all cock parrots and pigeons feed their females, though all finches do not. Or the food may be brought and given from the beak, in which case there are differences in the practice of members of the same family, e.g., the common Cock, the Satyr Trogopan, and the Peacock Pheasant feed their females, but the Common, Gold and Amherst Pheasants do not, nor does the Peacock. Among the ducks, the Carolina alone seems to feed the female and there is the case of the aerial passing of food amongst the Harriers. In many birds no love feeding

is ever done, as in the case of the sparrow. Among birds with masculine attributes in the female, e.g., the Hemipodes, the hen feeds the male. The custom of caressing, usually head-tickling, offers these peculiarities, both sexes do it, but the male most as a rule. It runs through groups to a great extent, e.g., Parrots and Pigeons, and the Mannkin and Waxbill groups of Ploceine Finches, are all great head ticklers; but it may crop up in more or less isolated cases, thus among the ducks, the Mandarin and Carolina, the Tree Ducks (*Dendrocycna*) and the Orinoco Goose seem to be practisers of the habit. The majority of birds do not caress their mates at all. I have already given examples of cases of birds which favoured a very highly decorated male in display, or vice versa; but a few more striking instances may be quoted, from observations on my own birds in confinement, or from birds kept in Zoological Gardens. During my experience I have seen the following cases in favour of the preference of a more highly decorated cock bird, or of a typical instead of an abnormal species.

1. A hen Avadavat twice chose a bright-coloured cock in preference to a dull one submitted to her.
2. A hen Linnet preferred a lame rich-coloured male to a duller but stronger and perfect one.
3. A hen Pekin Robin similarly preferred a weaker but brilliant cock to a duller and stronger one.
4. Of some Mandarin Ducks in the London Zoo, the females distinctly preferred the handsomest drake in at least one case.
5. A hen Bird of Paradise at the London Zoo preferred a full plumaged cock to one in the young plumage, though both shewed off.

On the other hand, a well-known observer has noticed that in the London park waters, mallard drakes with some aberration of colour (grey breast or reddish flanks) get mates as readily as normal birds, and may have mates when these cannot obtain them. The grey-breasted birds are *duller* than the normal drake.

Among a mixed lot of poultry, bantam hens preferred a half-Spanish cock nearly all black and much too large, to

bantam cocks and to a beautiful medium-sized cock coloured just like the Jungle-fowl.

A Zoo case was that of two male Red-breasted Mergansers, of which the smaller, duller and less-well-marked bird got the female. Here again the bird which was less typical was the stronger—he drove his rival ashore and would not let him go near the female. But she, though she showed no special attachment to him, did not show any sympathy with the beaten bird by keeping company with him, although a female bird does sometimes try to do this.

It will thus be seen that one cannot give any very conclusive evidence in favour of orthodox female preferences; but an extended series of experiments might show a very different result. Anyone wishing to make such should guard against the males getting at each other and fighting by confining the female and the two rival cocks in compartments separated by wire-netting with the hen in the centre; it would also be best to get hens which were strangers to the cocks, and to refer several pairs of cocks to the same hen, as well as trying these couples of cocks with different hens in succession. If a series of such experiments showed that the hens on the whole preferred the more highly-decorated males, or normal males to those with more striking but abnormal coloration, the undoubted fact would remain that strength counts for much. But there is nothing to prevent the hen migrating along with a beaten bird, and perhaps the winner might not care to follow him away from his own beat. I do not think the apparent indifference of the hen is a very serious objection; from the lateral position of most birds eyes, they are able to observe things even when they seem to be looking elsewhere, and so the hen may be observing more than we think. However, I am quite convinced that the display, like human blushing (and we all know that some birds blush, the turkey especially) is simply an instinctive expression of emotion; birds would display anyhow, whatever the result. If, moreover, the display does not please the hen, it comes in very handy for bluffing adversaries; a black and a white swan have been seen displaying vigorously to each other, obviously wishing to fight, but each too afraid of the other to come to blows. The same principle of bluff may tell with the hen,

for hen birds are rather apt to be too independent and to fail to respect a male whom they do not fear a little. In fact, the display as a bluff would justify its existence quite as much as if used as an attraction; and if this is the real use of it, it is easier to understand why the attitudes of displaying birds are generally more grotesque than beautiful. However, as I have said, there is no reason to suppose that birds have what we call refinement or good taste; personal preference they do show, but we ourselves cannot always rationally account for our preferences, so we may expect to wait a while before we can fathom those of birds.

Voice, however, appears more potent than colour, for colour varieties of the same species, and species with very different colours but the same note, such as the Mallard and its dull allies, and the Hooded and Carrion Crows interbreed with perfect freedom in captivity. If also, we consider what happens with our domestic birds, even when allowed to breed indiscriminately without selection by us, we shall see that there is a strong latent tendency to increase in conspicuousness in colour, and to the production of structural decorations in most species. Thus, most of them display a tendency to produce white or pied plumage; the soft parts often assume brighter colours, e.g., the guinea-fowls' feet tend to become orange instead of black, and the Muscovy drake's face, naturally mostly black, becomes more, or altogether red. Structural decorations may appear, like the knob on the beak of the Chinese Goose which is often orange, contrasting with the normal black of the bill, and common ducks and pigeons assume crests. Sometimes these alterations are sex-limited, e.g., cinnamon in Canaries and blue in Budgerigars tend to be female colours, while white in common geese tends to be a male colour. We can see, then, that even without selection decorative plumage and appendages, etc., tend to appear; it is true that such peculiarities are irregular, not constant as in wild species, but in the latter natural selection may come into play to limit variation. For instance, white feathers are usually soft, and so we find few birds are entirely white, or have even white quills, easily abraded quills being a dangerous possession for a wild bird. It is particularly noticeable that in the only wild bird which varies widely like

an unselected domestic one, the Ruff, the variation (except in the rare white-necked variety) is confined to the breeding season, and the Ruff, to be able to carry his cumbrous decoration at all, must surely be able to defy natural selection on his breeding-grounds at any rate. If decorations are the result of the withdrawal of the pressure of some form of natural selection we can see why they are so often concealed in repose as long as a bird has the tips of the quills, for instance, dark and tough, the concealed part may be of any colour that variation gives, proving that colour is correlated with a strong constitution—for no character can escape constitutional selection, but must always go along with power of resistance to climate, a good digestion, etc.

In the limited time at my disposal this evening, I have only been able to touch on a few of these interesting problems relating to birds in captivity; but in concluding these short notes I may again emphasize the fact that much may still be learnt from the intelligent observation of birds in confinement, and my two final examples are instances of facts, which might never have become known to science, if they had not been recorded from captive birds.

A pair of Plumed Jays (*Calocitta formosa*) in my possession, the only living examples of this species ever kept in captivity, laid two eggs; previously the eggs of the Plumed Jay, which even in the wild state is a very rare bird, had been unknown to science. The eggs were measured and described, and therefore a new fact about this rare species was put on record. The other example is the interesting case of young Parrot Finches, also discovered from birds bred in confinement, which have the insides of the mouth ornamented with four shining phosphorescent spots, which are luminous and visible in the darkness of the nest when all else seems blackness. There seems little doubt that they enable the parent birds to see where to place the food, when feeding the young, which they would otherwise not be able to do; for when the old bird stands in the small entrance hole, the young birds are practically in total darkness. Other facts of the same description might be quoted, but enough has been said, perhaps, to show to those who object to keeping birds in confinement that there may be very good reasons for taking up the hobby of Aviculture.

II

TIDES OF THE RIVER BURE

By H. Christopher Davies

It is very commonly stated that tidal action on our Rivers has had extended effect of recent years consequent on the dredging and improvement of Yarmouth Harbour, but very few accurate observations have been quoted to prove or disprove this view.

A footnote to Mr. Robert Gurney's paper on this subject read before the Society in February, 1911, to be found in Vol IX. p. 216 of our Transactions, quotes a similar opinion as then held.

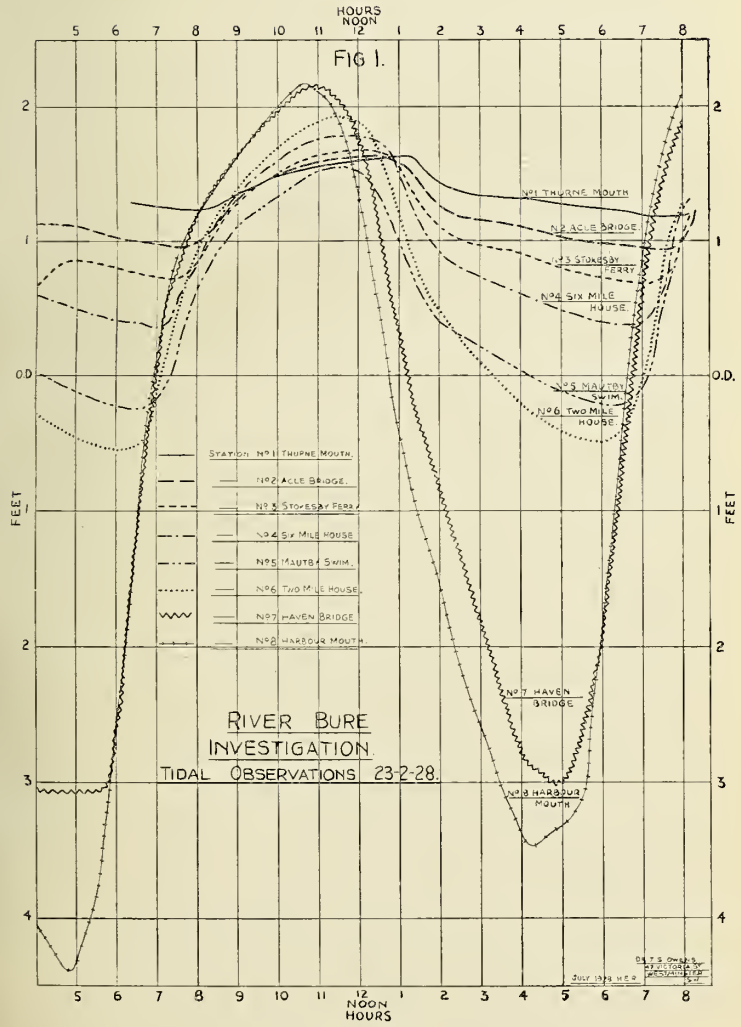
In 1883 my Father wrote: "Yarmouth Haven is being dredged and deepened and so allows a greater volume of water to pour in at each flood tide." He also suggested that the level of the drained marshes would continue to sink, owing to shrinkage. This latter condition certainly obtains in the Great Fens where improved drainage has caused such a fall in levels that areas once drained by gravitation have now to be drained by pumps; and at the present time, I believe, plans are well advanced, if not completed, for the installation of pumping plant at the Middle Level Outfall into the Ouse, where once an efficient discharge was obtained by gravity during low tide.

Such a settlement, if it occurs in East Norfolk, would certainly be shared by the Marsh walls and banks, and might make it appear that tides were higher though in fact their level compared with Ordnance Datum, may not have altered.

So far as the Bure is concerned, I have had access to some very valuable and interesting records prepared by Dr. John Owens, the eminent Engineer called in by the Norfolk County Council to advise as to what effect, if any, a new bridge at Acle, with increased waterway would have on the pressure, height or scour of the tide above the Bridge, and it is with his permission that I am able to present the following records to the Society.

Since obtaining that permission, I have seen the paper read by Dr. Robert Gurney in 1911, and have his permission to quote material from it for purposes of comparison with Dr. Owens' observations.

The two sets of records are not absolutely comparable


HOURS
NOON
FIG 1.
FEET
O.D.
No1 THURNE MOUTH
No2 ACLE BRIDGE
No3 STOKESBY FERRY
No4 SIX MILE HOUSE
No5 MAUTBY SWIM.
No6 TWO MILE HOUSE
No7 HAVEN BRIDGE
No8 HARBOUR MOUTH
STATION No1 THURNE MOUTH.
No2 ACLE BRIDGE.
No3 STOKESBY FERRY
No4 SIX MILE HOUSE
No5 MAUTBY SWIM.
No6 TWO MILE HOUSE
No7 HAVEN BRIDGE
No8 HARBOUR MOUTH
RIVER BURE
INVESTIGATION.
TIDAL OBSERVATIONS 23-2-28.
NOON
HOURS

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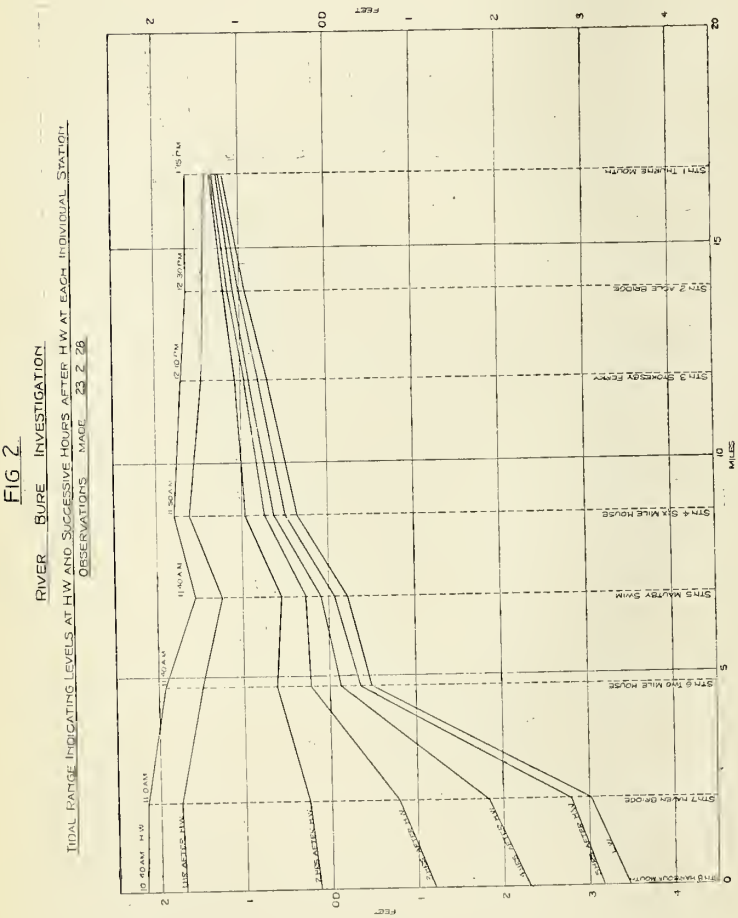

because Dr. Gurney's tidal readings give range only, without reference to Ordnance Datum (which at that time was not available at any up-river station), whereas Dr. Owens' figures are compared with Ordnance Datum in every case. The similarity in range, however, of the two sets of observations, coupled with the records of salinity obtained by Dr. Owens, which I have compared with a paper read to the Society by Dr. Innes also on Feb. 28th, 1911 (N. & N. Nat. Soc. Transactions, Vol. IX. p. 244) will, I think, convince us that little or no variation has taken place from 1911 to 1928.

I have navigated the Bure and worked the tides between Acle and Yarmouth for over thirty years, and must admit that the small range of tide at Acle, as measured by both observers, is a surprise to me, and confirms my own impression that since 1895, at least, no appreciable change in tidal range has taken place at Acle. I only wish similar comparative records could be obtained for the Yare, where, owing to deeper and straighter channels, any changes at Yarmouth would be expected to show greater results.

With this introduction I propose to give the results of Dr. Owens' investigations, comparing them with the corresponding records of Dr. Gurney when available.

Figure 1 shows the result of observations of a spring tide on Feb. 25th, 1928, at various stations from the Harbour Mouth to Thurne Mouth, the respective tidal range being about 5 feet 6 inches at the former to about 6 inches at Thurne Mouth, viz. :—

LEVELS OF HIGH AND LOW WATER AT SPRING TIDES 23/2/28

Station No. and Name	Levels reduced to Ordnance Datum		Range
	High Water	Low Water	
	Feet	Feet	Feet
No. 1 Thurne Mouth ...	1.63	1.18	0.45
No. 2 Acle Bridge ...	1.63	0.93	0.70
No. 3 Stokesby Ferry ...	1.68	0.68	1.00
No. 4 Six Mile House ...	1.79	0.37	1.42
No. 5 Mautby Swim ...	1.55	–0.22	1.77
No. 6 Two Mile House	1.92	–0.49	2.41
No. 7 Haven Bridge ...	2.16	–3.02	5.18
No. 8 Harbour Mouth ...	2.17	–3.47	5.64

The range of this particular tide at Acle Bridge was 0.70 of a foot ; call it 9 inches. This compares with Dr. Gurney's recorded range of 13–15 inches at Spring Tides, and 7–9 inches at Neaps. Dr. Owen's 0.45 at Thurnemouth (5.40 inches) compares with Dr. Gurney's 8.7 inches.

Dr. Owens' record shows that at Thurne Mouth the level of H.W.S.T. is only 6 inches lower than at the Harbour Mouth, so whatever alterations were made to the lower channel that figure probably represents the maximum possible effect of tidal action, and with a distance of 12 or 14 miles, such a result is highly improbable.

The L.W.S.T. vary 4.66 feet in level between Thurne Mouth and the Bar, and the effect of channel improvements would have far more effect in reducing this difference than in raising H.W. level.

The chief obstruction to a uniform L.W. gradient lies between Six Mile House and the Harbour Mouth, and Dr. Owens' conclusion was that the effect of Acle Bridge on the gradient was negligible.

Dr. Gurney found a difference in range of two and a half inches between two gauges above and below the Bridge and 100 yards apart.

Dr. Owens found that the surface gradient at H.W. between Acle and Thurne Mouth was 0 and between Acle and Stokesby 0.3 inches per mile and at L.W. 0.68 and 1.42 inches per mile. He admits that the restrictions of the channel by the present bridge produces some increase in velocity with corresponding small changes of surface level at points in the immediate vicinity of the Bridge (cf. Dr. Gurney's two and a half inches above and below). His conclusion is that as the levels of H.W. and L.W. are practically unaffected by the Bridge the range will be unaffected (by a new bridge).

The question of increased velocity was also raised when the idea of a new bridge was mooted. Dr. Owens goes so fully into this point that it would be unfair to shorten or paraphrase his own notes which are as follows :—

"Velocity of Ebb Current as affected by Bridge

We will now consider the probable effect on the velocity of the ebb current if the present bridge be replaced by a new

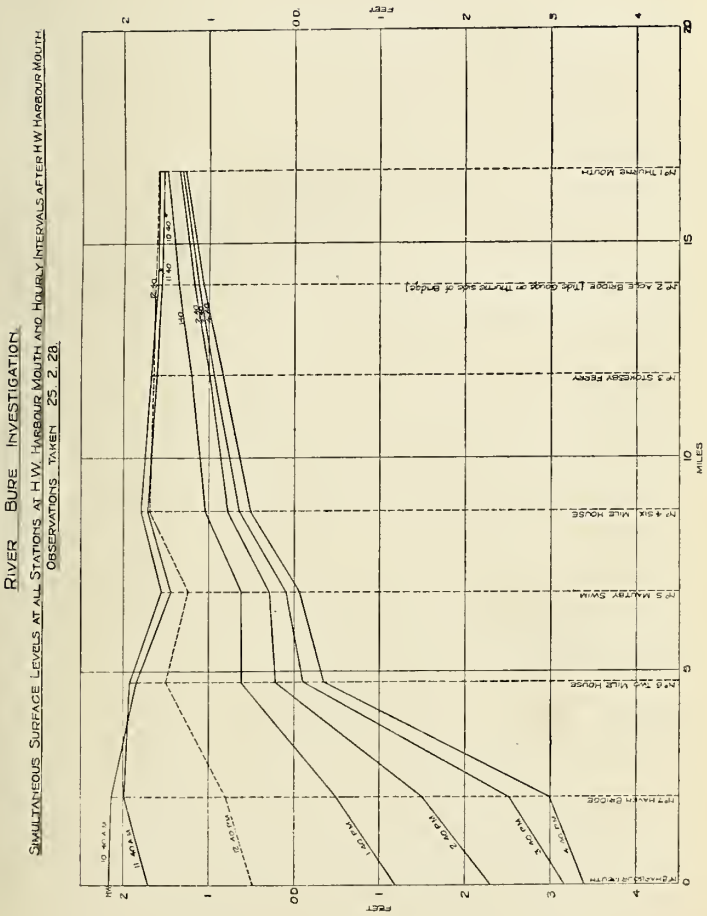
FIG 3.
RIVER BURE INVESTIGATION.
SIMULTANEOUS SURFACE LEVELS AT ALL STATIONS AT H.W. HARBOUR MOUTH AND HOURLY INTERVALS AFTER H.W. HARBOUR MOUTH.
OBSERVATIONS TAKEN 25.2.28.
FEET
MILES
No 1 THORNE MOUTH
No 2 ACLE BRIDGE (Tide does not flow past this point)
No 3 STOKESBY FERRY
No 4 SIX MILE HOUSE
No 5 MARTHY SWIM
No 6 TWO MILE HOUSE
No 7 HAVEN BRIDGE
No 8 YARMOUTH

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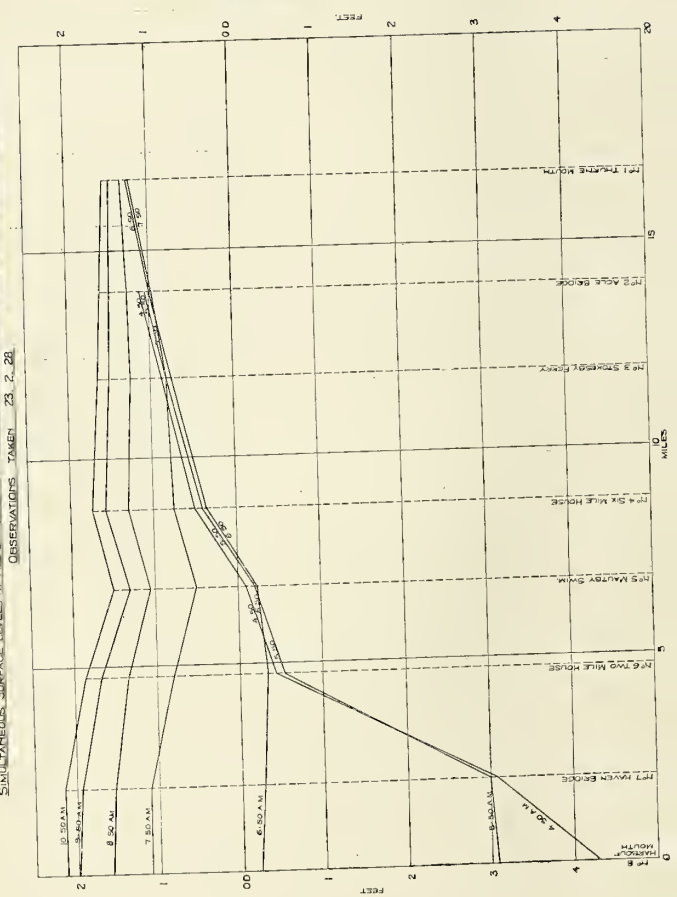
FIG 4.

RIVER BURE INVESTIGATION.

SIMULTANEOUS SURFACE LEVELS AT ALL STATIONS AT LOW HARBOUR MOUTH AND AT HOURLY INTERVALS AFTER L.W. HARBOUR MOUTH.

OBSERVATIONS TAKEN 23. 2. 28.



one which does not restrict the channel. For this purpose we are concerned with the maximum currents only and it is necessary to find at what time of the tide the ebb current has the greatest velocity. We find from the tidal observations on Feb. 23rd that the times of H.W. and L.W. at Harbour Mouth and Acle were as follows :—

	H.W.	L.W.
Harbour Mouth	10.40 a.m.	4.10 p.m.
Acle Bridge	12.30 p.m.	7.30 p.m.
	hr. min.	hr. min.
Intervals	1 50	3 20

" Referring now to the surface velocity observations on March 8th and fixing the time of H.W. and L.W. from the above intervals, this gives H.W. at Acle about 12.10 p.m. and L.W. about five hours later or 5.10 p.m. The greatest velocity of ebb current was recorded at Acle at 5.15 p.m. and was 1.449 f.p.s. on the surface. Thus it appears that the swiftest ebb current occurs about the time of L.W.

" Referring now to fig. 5 which gives the surface gradient in the vicinity of the bridge on Feb. 25th, 1928 :—We find that the steepest gradient between gauges No. 6 and No. 2 occurs at L.W. thus indicating that time of the tide as giving the swiftest current.

" There is also an indication of some banking up of the water on the Thurne side of the bridge. We have to ascertain what the effect will be if this banking up were removed, and the surface slope made uniform from Thurne Mouth to Stokesby Ferry at the time of L.W. springs. From the tidal observations of Feb. 23rd, 1928, we find that the respective levels at L.W. were :—

Reduced Level at L.W. in Feet

Thurne Mouth	1.226	above O.D. at	7.30 to 8.20 a.m.
Stokesby Ferry	0.716	,, ,,	7.30 a.m.
Acle Bridge	0.958	,, ,,	7.30 to 7.50 a.m.

" These show a surface slope between Thurne and Stokesby of 0.51 feet in 4.778 miles or 1.28 inches per mile. In calculating this the level at the bridge has been omitted and we may assume that this is the gradient which would exist if the bridge did not restrict the channel.

"We will now compare this with the actual gradient at present, and for this purpose a certain correction in the gauge reading at Acle Bridge must be made. The actual reading was as above 0.958 at L.W. but this was on gauge No. 2, which was near the bridge, and as seen from Figs. 5 and 6, is affected by the rise of velocity under the bridge.

"Had the slope been calculated from the level of gauge No. 5 Figs. 5 and 6, it would have been unaffected by the change of level due to increased velocity under the bridge. On March 10th, last at about L.W. the velocity on the surface on the Thurne side, 271 to 71 feet above the bridge was 0.540 feet p.s. at 7.15 p.m. and at the same time it was 2.463 f.p.s. under the bridge. There was thus an increase of velocity equal to 2.463 minus 0.540 or 1.923 f.p.s., which represents a fall of surface level equal to 0.06 feet, and this fall should be added to the reading of gauge No. 2 at L.W., i.e. 0.958 plus 0.06 equal to 1.018 as the corrected level, giving a slope of 0.94 inches per mile between Thurne and Acle.

"As a check on this it will be seen from the tables that the reading of gauge No. 5 was 0.842 at L.W. while No. 2 was 0.752 showing a difference of 0.09 feet. This is a sufficiently close agreement in view of the reversal of the slope between gauges 5 and 6.

"Collecting the figures above referred to, we now have :— Corrected present surface slope, Thurne to Acle 0.94 ins. per mile. Surface slope if bridge causes no obstruction 1.28 ins. per mile.

The basic formula for flow in channels is :—

$$v = c\sqrt{mi}$$

When v = mean velocity in f.s.
c = a constant depending on the nature of channel.
m = hydraulic mean depth.
i = slope in ft. per foot.

"Thus the velocity varies as some unknown constant and as the square root of the hydraulic mean depth multiplied by the slope. In the present case the value of the constant c is unaltered as is also the value of m, we find therefore that the mean velocity will vary as $\sqrt{i}$ above. The new velocity will therefore be $\sqrt{\frac{1{\cdot}28}{.94}}$ or 1.17 times the old—a quite negligible increase. For example, this would raise the maximum ebb current velocity obtained on March 8th at Thurne Mouth from

FIG 5.

RIVER BURE INVESTIGATION.

LEVELS AT HIGH WATER AND SUCCESSIVE HOURS AFTER HIGH WATER AT AGLE BRIDGE.

OBSERVATIONS TAKEN 25. 2. 28.

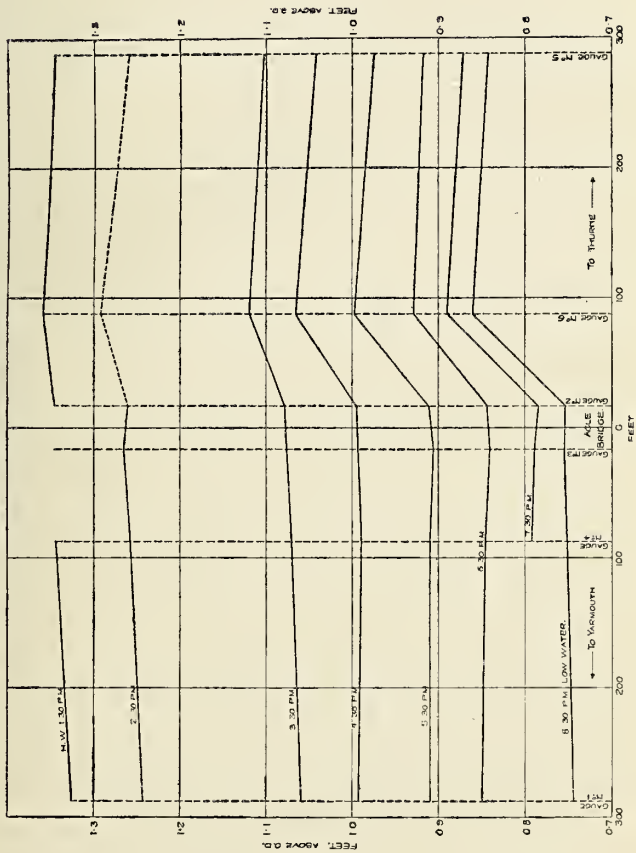


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FIG 6.

RIVER BURE INVESTIGATION.

LEVELS AT LOW WATER AND SUCCESSIVE HOURS AFTER LOW WATER AT EAGLE BRIDGE.

OBSERVATIONS TAKEN 25 2 28.

1.626 to 1.9 f.s. We may therefore conclude that there will be no appreciable increase of velocity in the reaches adjoining if the bridge be replaced by a new one which does not restrict the channel.

VELOCITY OF FLOOD TIDE CURRENT AS AFFECTED BY BRIDGE

"The part of the river where the greatest effect should appear is between Stokesby and Acle. Any obstruction to the flood current at the bridge should appear in a banking up of the water on the Yarmouth side of the bridge and a corresponding flattening of the surface slope between Acle and Stokesby. There would also be a drop in water level on the Thurne side of the bridge. These should both be most marked when the flood current is strongest.

"I find from the current observations of March 10th last that the highest flood velocity at the Yarmouth side of Acle Bridge was 1.537 ft. p.s. at 9.15 p.m. or about $3\frac{1}{2}$ hours after L.W.

"At Stokesby Ferry on a similar tide of March 8th last the highest flood velocity was 0.946 f.p.s.

"Referring now to Fig. 6 showing the levels of the water surface near Acle Bridge at L.W. and at successive intervals after this :—There are some slight errors in the readings to be corrected for, e.g., I consider possible errors in levelling are negligible ; but there are other causes such as wind drift which have to be considered and which might necessitate a correction, also, for the present purpose, the change of head due to velocity.

"I find that the highest flood velocity under the Bridge was 1.551 f.p.s. at 1.30 on March 10th, last.* The velocity on the reach between 271 and 71 feet on the Yarmouth side was, although a little doubtful, approximately 0.5 f.p.s. at the same time. Gauge No. 2 would thus read low by the velocity head represented by the difference between these two, i.e., by 1.051 ft. p.s. or 0.017 ft. head.

"In Fig. 6 the steepest up-stream slope was at 12.30 a.m. on Feb. 26th. The gauges No. 1 and 2 then read :—

No. 1	...	1.633
No. 2	...	1.577
No. 5	...	1.596

i.e., March 10th, 1928. Dr. Owen's report was written in July, 1928.

" At about the same state of tide, i.e., the same interval after L.W. on Feb. 23rd last, the Stokesby and Thurne gauges gave the following readings :—

Stokesby Ferry ...	...	1.650
Thurne Mouth	...	1.572

showing a slope of 0.078 ft. in 4.778 miles or 0.196 inch per mile. Thus if the bridge offered no obstruction this gradient should run uniformly, or nearly so, from Stokesby to Thurne.

" The actual surface levels at Stokesby and Acle as obtained from the gauge readings on Feb. 23rd last were :—

Stokesby Ferry ...	...	1.650
Acle Bridge ...	...	1.599 (No. 2 Gauge)

The latter figure however requires a correction of plus 0.017 ft. approximately, as above pointed out, to eliminate the velocity effect, so that the corrected readings become :—

Stokesby Ferry ...	...	1.650
Acle Bridge ...	...	1.616

or a difference of 0.034 ft. in 2.111 miles, which gives a surface slope of 0.193 inches per mile.

" The flood tide velocity, after removing the obstruction due to the bridge, would therefore be hardly affected at all between Stokesby and Acle, the surface slopes remaining sensibly the same after as before.

" We may therefore conclude that the velocity of the flood tide current in the reaches adjoining the bridge will not be appreciably affected by the new bridge."

In view of the already-quoted belief that tides (and consequently the conveyance of salt water) have increased of late years a comparison of the two records is of interest.

On Jan. 31st, 1928 the following samples were taken on a high S.T.

Stokesby Ferry	(15 feet deep)	15.74 grains per gallon.
,,	(Surface)	15.82
Acle Bridge	(bottom)	14.34
,,	(Surface)	14.34

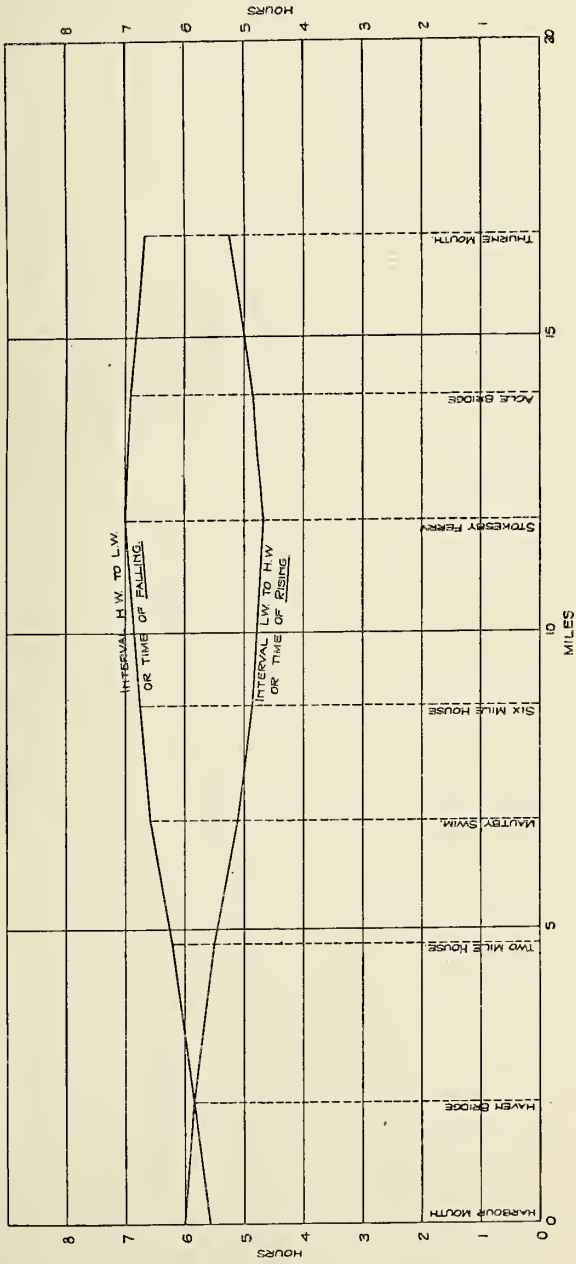
In 1906 October 1st and 2nd, Dr. Innes found at Stokesby Ferry 14.00 and 18.71, in two samples taken at 2.12 a.m. and 12 noon, at Acle Dyke 11.65 and 15.15 and above Acle Bridge (1 sample) 12.73.

As filtered water from the Thames contains eleven and a half

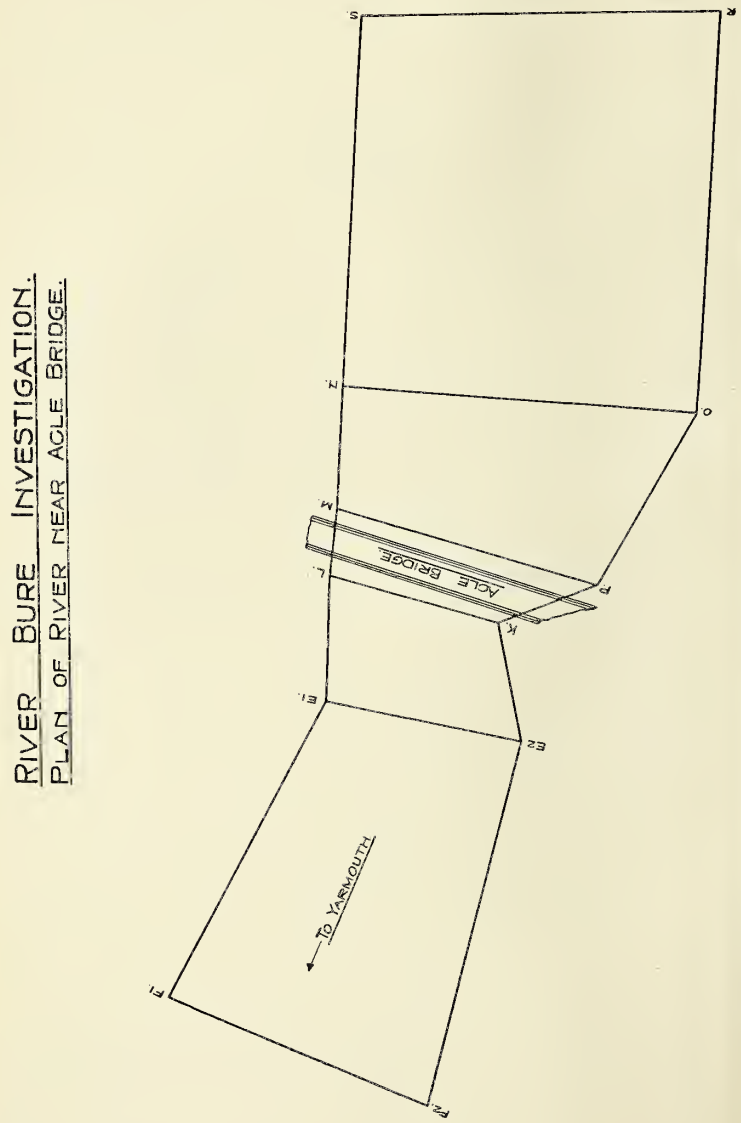
FIG 7.

RIVER BURE INVESTIGATION.

INTERVALS BETWEEN HIGH AND LOW WATER.
OBSERVATIONS MADE 25. 2. 28.



21 JUL 31
NATURAL HISTORY.



grains per gallon and sea water 6,000 to 7,000 grains per gallon, it will be seen that neither in 1906 nor 1929 is the normal water at Acle other than fresh water. No doubt in samples taken in a year like 1929, when fresh water was very deficient, greater salinity would occur.

Dr. Owen's conclusions were :—" I would summarise the probable results of removing the bridge and building a new one which does not restrict the channel as follows :—

" Upon the level of H. and L.W. respectively, there will be no appreciable effect.

" The velocity of the flood current will not be appreciably affected.

" The effect upon the velocity of the ebb current will be so small as to be negligible.

" The transport of salt water up the river will not be made easier by the new bridge, but rather the reverse.

" Since the effects on the current velocities are likely to be negligible there will be no increased erosion on the river banks.

" I think, therefore, you may safely proceed with the new bridge without anticipating any important effect upon the river."

Mr. Hogge the Engineer to the Port and Haven Commission has kindly sent me records of exceptional tides during the six years 1923 to 1929.

The three highest tides were as under :—

ACLE BRIDGE, 1923-1929.
Typical Highest Tides.

At Acle. Date.	Height of Tide above Ordnance Datum	Corresponding Tide at Yarmouth Bar. Tide Level above Ordnance Datum.	Wind	Force
1924.				
February 6th ...	4-ft. 5-ins.	5-ft. 6-ins.	N.W.	4. C.
1925.				
October 7th ...	4-ft. 7-ins.	4-ft. 6-ins.	N.E.	3. R.
1927.				
December 1st ...	*4-ft. 8-ins.	3-ft. 1-in.	E.	3. C.

and the lowest tides were :—

*Highest Recorded Tide at Acle Bridge during Period 1923-1929.

ACLE BRIDGE, 1923-1929.
Typical Lowest Tides.

Date.	Tide Level above Ordnance Datum	Corresponding Tide at Yarmouth		
		Tide Level	Wind	Bar. Force
1923.		(Minus)		
July 8th ...	*1-ft. 8-ins.	–1-ft. 7-ins.	N.W.	2. R.
1924.				
April 16th ...	1-ft. 9-ins.	–1-ft. 8-ins.	N.	2.B.C.Z.
1928.				
March 19th ...	1-ft. 11-ins.	–11 ins.	S.W.	2.B.Z.
1929.				
February 3rd	1-ft. 9-ins.	–4 ins.	S.E.	5.B.
May 22nd ...	1-ft. 9-ins.	–1-ft. 6-ins.	S.	3. B.C.
August 16th ...	1-ft. 9-ins.	–1-ft. 1-in.	S.	3. B.C.

It is curious to note that the highest Acle tide (4 feet 8 inches) on Dec. 1st, 1927, was not due to an exceptional tide at Yarmouth, though the highest Yarmouth tide of 5 feet 6-inches did cause an exceptional H.W. (4 feet 5 inches) at Acle (nearly 3 feet above a normal high Spring tide.

For purposes of record I attach all Dr. Owens' charts, which, with the headings, are self-explanatory.

III

NOTES ON THE LONG-TAILED TIT

BY HUGH WORMALD

THE severe winters of 1922 and 1928 caused a high mortality among Long-tailed Tits and Goldcrests in the neighbourhood of my garden (Mid-Norfolk) ; but both species seem to be able to recuperate their numbers very quickly and, at the present time, October, 1930, are as plentiful as I have ever known them to be. February, 1928, did not seem to kill off so many as did the winter of 1922, and the explanation would seem to be that although the cold of that month was intense it was not accompanied by wind.

*Lowest Recorded Tide at Acle Bridge during Period 1923-1929.

On an afternoon during the severe frost I was walking through some fir trees, Douglas and Nordmanianna, and saw a large colony of gnats dancing in the air as though it were a summer evening, and I came to the conclusion that they must have been hibernating under the branches of the thick fir trees, and had been stirred into activity by the sun, which had been shining for an hour or two. During hard weather I believe these hibernating gnats form the principal food of both Long-tailed Tits and Goldcrests, both of which I have watched searching for insects under the branches of fir trees. As far as my observations go, both species are entirely insectivorous, and consequently they will not come to a bird table even when mealworms are supplied. The only occasion on which I have seen a Long-tailed Tit at my bird table was in the spring of 1928, when it came to pull some string to pieces for nesting material.

I have not been without a Long-tailed Tit's nest in my garden for fifteen years, but from November to March I hardly ever see them in the garden. As soon as March arrives I begin to look out for them, and after first seeing a pair I know that I shall find the nest in about ten days' time. This year I noted a pair on March 2nd, and expected to find the nest about the 12th, but to my surprise they began to build on the 7th—about ten days earlier than usual. I can now tell by their note when they are building, and for the last five years have found the nest on the day they began to build. Individual pairs vary greatly in the amount of close watching they will tolerate ; this year they chose a bush of *Ceanothus Papillosus*, and did not like me standing nearer than five yards from them while they were building. During the four previous years they nested in the same clump of berberis and allowed me to watch them from a two-yards' range. I have often seen them take material from the nest of the previous year and make use of it. They do not work in the rain, nor if the weather becomes cold.

Considering that a Long-tailed Tit's nest is one of the greatest works of art among British birds it is amazing how the birds can construct their nests with their tiny beaks, especially when they would seem never to remain at the nest when building for longer than a minute at a time. I do not think they travel more than two hundred yards for material, except for the lining feathers. With the object of conserving their labour I stuck

feathers on fir trees near to their nest this year, and they were all used.

The nesting period covers about sixty-six days ; say, twenty-two days for building the nest ; fourteen days to lay the clutch ; another twelve to fourteen days for incubation ; and sixteen to twenty days for rearing the brood. Like all the tits, the young remain in the nest for a longer period than is the case with most small birds. They are not double-brooded, although I found a nest with young in August, 1913.

In 1927 a pair began to build in March, made the nest the size of a chaffinch's and then deserted it for no obvious reason ; however, in the middle of May they returned, completed the nest and reared a brood. During the interval they were never seen in the garden. In 1925 a pair started to build on the horizontal branch of a cedar and the nest, when nearing completion, of course blew out. They then deliberately unpicked it and carried the material about 100 yards to an oak, where they hatched a brood ; but their ill-luck still followed them, for a jay discovered the nest and destroyed the young ones.

Long-tailed Tits vary considerably in the situations and heights from the ground they choose for their nests ; I have had nests two feet from the ground, and as high as twenty feet. Gorse is a favourite nesting site, and berberis, rhododrendrons, bamboos, yew, privet hedge and high hawthorn hedges (preferably overgrown with brambles) are also popular sites. I once found a nest against the main stem of an ivy-covered oak just the place for a wren, but an unlikely site for a Long-tailed Tit.

As soon as the young are strong on the wing they leave my garden, and family parties visit me only rarely in autumn and winter. Sometimes several families join up, and I once counted fifty-three flitting across an open space from one tree to another, the largest flock I ever saw. The next day a friend four miles away told me that he had had a large flock in his garden, presumably the same birds.

I have never taken the trouble to count the feathers in a Long-tailed Tit's nest, but it has been done and, speaking from memory, I believe the total runs into thousands. When the nest contains a dozen fully-feathered young ones the heat inside must be tropical.

IV

NOTES ON THE CRUSTACEA MALACOSTRACA OF THE REGION ROUND BLAKENEY POINT, NORFOLK

By T. J. Hart, B.Sc.

These notes are the outcome of a faunistic survey of the marine invertebrate fauna in the neighbourhood of Blakeney Point, carried on at intervals whenever opportunity offered during the past five years, which it was hoped would prove to be the basis of some ecological work in the future. As my work now takes me abroad the completion of this project must wait indefinitely; but having worked up the Crustacea Malacostraca pretty throughly, I have been encouraged to present these brief notes for publication, in the hope that they may be of some use or interest to the many naturalists who annually visit the locality.

While rocky fore-shores certainly produce an infinitely greater variety of forms, there is this to be said for sandy and muddy coasts from a naturalist's point of view: they support a fauna which consists, for the most part, of animals which it is relatively easy to catch quantitatively, and the physical conditions of the environment are more or less constant over large areas. Hence the vast animal associations consisting only of one or a few species which colonise the various types of sand and mudflats. The above two factors render it possible for the naturalist to attempt to work out the relations of the dominant forms with their environment, organic and inorganic, with a much greater degree of success than with the very diverse animal communities found on rocky shores. Bearing this in mind, it would seem that the very varied types of sand and mudflat to be found round the Point present a fine opportunity for the animal ecologist, who is able and willing to deal with marine invertebrates; and, be it noted, this aspect of the biology of the district is the only one which has not already attracted much attention. These notes form part of a faunistic survey, pioneer work which must be done before detailed ecology can be attempted.

The general topography of Blakeney Point has been admirably described by Professor Oliver (Trans. N. & N. Nat. Soc., 1913, IX. p. 485), but a brief mention of the chief

collecting grounds for Crustacea may be made. These were: the large iron wreck of the Norwegian steamer Hjordis, usually lying near the harbour bar (the latter is always shifting); the masses of drifted algae, which with zostera and other vegetable detritus, are frequently found between tidemarks on the open foreshore; the waters of the harbour and tide-pools, both on the open shore and in the creeks of the sheltered flats; also burrowing forms are to be found in the sand and mudflats.

In general the salinity of the water of Blakeney Harbour is only very slightly below that of the open North Sea, even at low tide, so that the conditions are not typically estuarine; but in one area I have been able to work, known locally as Stiffkey "freshes," the dilution is very considerable. The "freshes" actually take the form of a small stream communicating by faulty sluices with a tidal creek, about three quarters of a mile along the "meals" to the west of Morston village. Here a scanty but characteristic brackish water fauna was observed.

Apart from these, the most interesting collections were obtained from the wreck of the Hjordis, which forms an oasis of a hard substratum in the midst of the vast desert of shifting sand which stretches away towards Wells and Burnham; and from the surf-beaten sand of the open foreshore off Blakeney Point proper. In spite of the inhospitable nature of this habitat, the sieve yielded two interesting species of Amphipods and occasional Polychaet worms.

For help in the actual collecting I have to thank my brothers, in particular Mr. R. W. K. Hart. In the case of some of the smaller and less known species I have given references to standard works wherever possible.

DECAPODA

Cancer pagurus. The edible crab is occasionally found inshore in sand sheltered by wreckage. They appear to come inshore and seek such seclusion before casting their shells. I have frequently found what appeared to be three crabs lying half buried close to each other, which on closer examination proved to be the cast shell of a female, the latter in a "soft-shelled" condition, and a male in attendance. (In most Crustacea fertilisation takes place after ecdysis).

On the wreck of the Hjordis the hawse-pipes are choked with dense clusters of Mytilus, and in the midst of these I have often found small edible crabs which had crept there for shelter during ecdysis. Incidentally, the mussels were so tightly packed that it was difficult to see how the greatly enlarged crabs could get out again.

Carcinus maenas. The ubiquitous shore-crab is present in countless thousands in the creeks of the salt-marshes and in the channel, and is also to be found, in lesser numbers, on the open foreshore off the headland. In the more sheltered situations great colour variation is exhibited, while on the open coast nearly all the individuals are of the dark olivaceous green most characteristic of the species. The proportion of individuals with autotomised legs is also much higher on the open coasts than in more sheltered habitats.

These crabs are a great nuisance to the line fishers in the harbour, destroying vast quantities of bait, but they are not entirely harmful. The younger individuals form a staple article of food for flatfish, and their scavenging activities prevent many a creek from becoming foul.

On the Salicornia marsh, or Beachway, on the landward side of the old headland, these "gillies" as they are locally called, are present in vast numbers, so that the highest driftline on the Long Hills—the old denuded lateral spit on the eastern side of the said marsh—is almost entirely composed of their cast shells, with a certain amount of vegetable débris. These shells are present in such quantities as to affect the acidity of the soil. The low sand-hills towards the seaward end of the Long Hills belong to the old acid type of dune (pH circum 6.8). But in the driftline of equinoctial springs the pH of the soil is 7.2, almost certainly owing to the accumulation of crab-shells. This in turn leads to an interesting zonation of the plants, the driftline being clothed with a dense belt of the Orache, thicker and more regular in some years than others, which is scarcely ever found in any other situation on this dune system.

Portunus depurator. The cast shells of this swimming-crab, the commonest of the British species, are frequently cast up on the seaward side of the main beach. I have occasionally taken living examples in the runs (large shallow

pools running parallel to the coast) in the sands off the Headland near low water.

Eupagurus bernhardus. Hermit crabs are fairly common on the open shore near low water in tidal pools, and numerous on the wreck of the Hjordis, where one of the smaller individuals was found in a shell of *Natica catena*, a mollusc I have not yet taken alive in this vicinity. Usually the smaller hermits in this district are to be found in the shells of periwinkles.

Homarus vulgaris. Lobsters coming inshore and taking shelter in holes and corners in wrecks have been frequently reported by the local fishermen, notably from the wreck of the Hjordis, but I have not yet come across one myself.

Leander serratus. The common prawn is fairly common in tidepools, especially the deep ones surrounding wreckage, where very large ones are sometimes met with.

Leander squilla. The " white-prawn " is scarcer than the last named but occasional specimens are to be found in similar situations, some of very large size.

Hippolyte varians. This species is widely distributed in tidal pools throughout the area, though never in large numbers. In the region of Stiffkey " freshes " it penetrates into a region where the salinity is as low as 3.6° per thousand, as compared with the 35.2°. per thousand of the pools in which other individuals are found.

Crangon vulgaris. The common shrimp is present in enormous numbers on the sandy bottoms of the tidal creeks, the harbour, and the open sea. (Here it may be mentioned that even those creeks which penetrate the softest ooze have usually a sandy bottom in parts). The inshore specimens are more numerous, and of uniformly smaller size, than those found on the open coast. They form a favourite food for flat-fish—I have taken 35 from the stomach of one small flounder. They do not appear to be present where the salinity is very greatly reduced, but in some of the tidal pools in which they survive for weeks without apparent inconvenience (there being no outlet until the next springs) the range must be considerable.

AMPHIPODA

Gammarus locusta, Linn. Very common under stones

and algae in the harbour, and drifted algae on the open coast. Occasionally eaten by flatfish.

Orchestia littorea, Mont. To be found among the stones and piles of Morston quay, and the adjacent salt-marsh plants, about the level of high water springs. This species is also occasionally met with in the higher drift lines on the north side of the harbour, and on the Point itself.

Calliopius laeviusculus, Kröyer. This small Amphipod is to be found in great numbers in the dense masses of the primitive brown alga Palleilla on wooden wreckage in tide pools in the sands on the seaward side of the main beach. Here, among the ribs of old wooden ships, I have caught numbers of young bass which appeared to have been feeding largely upon these Amphipods, together with Mysids. The fish were largely parasitised by the Copepod *Lernea branchialis*.

Ampelisca spinipes, Boeck. This species is rare in the vicinity of the point, but occasional specimens have been obtained from the sand off the Headland near low water. Hunt, in an account of the bottom fauna of the Plymouth area (Jour. Mar. Biol. Ass. N.S. Vol. XIII, No. 3, p. 560) gives an interesting account of the feeding habits of this genus, and I think it probable that dredging along the sandy shores of the North Norfolk coast would reveal it in quantity—they are nowhere common between tidemarks, preferring slightly deeper water.

Bathyporeia Robertsonii, Sp. Bate. This little burrowing form is to be met with in considerable numbers in the surf-beaten sand off the headland. It is found chiefly in the top four inches of the sand, the numbers diminishing very rapidly as the depth increases. It is not found on the higher banks where the sand becomes loose and dry under the influence of sun and wind at low-water. Conversely, in places where the sand is very wet, standing water appearing almost at the surface on digging, *Bathyporeia* is also scarce. The ideal habitat seems to be sand which retains enough moisture to present a firm surface, but in which the water table is at least 1-ft. below the surface at low tide. Here also are to be found the Amphipod *Haustorius arenarius*, Slabber, and occasional Nereid worms.

Haustorius arenarius, Slabber. Sars. 3, p. 135, Pl. 46. This fine beast, very highly specialised for burrowing, is found in the same sand as *Bathyporeia*, but occupies lower levels—just above the water table for the most part. The succession is as follows: top four inches *Bathyporeia Robertsonii* up to 250 per m. sq. with odd specimens of the pelagic Isopod *Eurydice pulchra*; next four inches, few *Bathyporeia*, ca. 20 per m. sq., young and immature *Haustorius* 60-70 per m. sq.; eight ins. depth to water table adult *Haustorius* ca. 40 per m. sq. with occasional *Perinereis cultrifera* and very rarely *Arenicola marina* (the sand in question being much too pure for *Arenicola* to be present in quantity).

The largest adult individuals were carrying eggs as late as the beginning of September, while smaller individuals were not observed carrying them later than the end of August. At this time the larger individuals were themselves without eggs, which leads one to suppose that here, as in the majority of Amphipods, several broods are hatched each year. This is particularly interesting, as in a recent authoritative work on the Gammaridea (Faune de France (*a*) Gammarides), it is stated that the male of this species is as yet unknown, so that presumably the eggs develop parthenogenetically, as is often the case among more primitive crustacea.

The sand off the Headland that forms the chief habitat of Amphipods such as *Bathyporeia*, *Ampelisca*, and *Haustorius*, is particularly " clean " and free from organic matter, so that the source of their food supply is at first sight somewhat of a problem. The explanation is to be found in the fact that the species concerned are probably " suspension-feeders," having certain appendages specialised for the production of a current, from which other appendages sieve out the food particles, and pass them on to the mouth. Such a system of feeding has already been described for *Ampelisca* by Hunt (J.M.B.A. N.S. Vol. XIII No. 3 p. 560). Here the animal lies curled up in a little purse-shaped depression in the sand, held together by mucilage, and the rhythmically beating pleopods bring a current of water over the mouth parts. Dennell (as yet unpublished) has discovered a maxillary filter in *Haustorius*.

Granting some such apparatus, it is possible for these species to feed on Plankton organisms, and any fine organic

detritus present in the sand. As before stated, the latter is very clean, but scattered through it are to be found a number of small fragments of blackened Zostera, drifted away from the vast Zostera banks of the upper reaches of Blakeney Harbour, and these, with attendant micro-organisms, furnish another source of food for the denizens of this habitat.

Corophium volutator, Pallas. This interesting mud-burrowing Amphipod is often spoken of under the synonym *C. grossipes* Linn., but of late most authors follow Stebbing (Gammaridea—" Das Thier-reich ") in supporting the prior claim of *volutator*. Mr. R. Gurney found this animal far up the east Norfolk rivers in regions where the salinity was very slight. In this habitat it was found co-extensive with the Hydroid *Cordylophora*. Generally speaking, though capable of withstanding great salinity changes, the abundant occurrence of this species is limited by the nature of the substratum. In regions of coarse greyish mud or muddy sand with a fairly low organic content it abounds, but as the mud gets blacker, and the organic content increases and the pH becomes more acid, the colonies fall off rapidly in numbers, until entirely supplanted by other forms often present in countless thousands, such as Nereid worms, and the small gasteropod, *Paludestrina stagnalis*.

In July, 1929, I found a fairly abundant colony of *Corophium volutator* in the mud of the Stiffkey " freshes," where the salinity was very slight. Here also were to be found a few Nereid worms, the Isopods *Sphoeroma rugicauda* and *Cyathura carinata*, and the common " water boatman," *Corixa*. About the beginning of September there was a vast accumulation of organic detritus (mainly deciduous) from upstream, and *Corophium* began to disappear immediately, though colonies of adults in other more highly saline habitats showed little falling off in numbers. At Stiffkey freshes as *Corophium* disappeared the pH of the mud decreased from 8.6—7.7. The organic detritus blocked the stream to such an extent that it was finally dredged out later in September. It will be interesting to see if the locality becomes recolonised by *Corophium* in the future.

The best locality in the region of the Point for this beast is a small creek (" Yankee Creek ") in the Salicornia marsh on the landward side of the Headland proper. Here the

coarse muddy sand, with low organic content, barely reached by H.W. neaps, but nearly always covered with shallow puddles of water, appeared to constitute the ideal habitat for *Corophium*. Half a square metre of this mud scooped up to the maximum depth of *Corophium* burrows (ca. 15 cms.), and carefully put through a fine sieve (30 meshes to 1 in.), yielded approximately 500 *Corophium*, 200 small Nereids 12 *Tellina fragilis*, a Gammarid and a small shore-crab.

Corophium volutator is also found on the mudflats on both sides of the harbour wherever the substratum is suitable, but this is only in small isolated patches and creeks, generally a trifle below the level of H. W. neaps. From the number of cast skins one occasionally finds, one would think them abundant everywhere, but these skins are drifted about by the tide in a most deceptive manner. For instance, when collecting *Corophium* in the estuary of the R. Tamar, near Plymouth, I found numerous *Corophium* skins on mud which, as I should have known later, was manifestly unfitted to support a large population of *Corophium*, and wasted some days in fruitless search until I eventually came across large *Corophium* colonies some miles higher up the river.

Corophium volutator is preyed upon by wading birds—Redshank and probably many others, but I have not yet been able to examine stomach contents. Flounders, and occasionally Plaice, come right up the shallow creeks after them at High tide, and are often taken with their stomachs absolutely distended with *Corophium*.

ISOPODA

Ligia oceanica, Linn. Occasionally to be found crawling over rotting timber and amongst rope fend-offs, etc., on the quays at Morston and Blakeney. It retreats into crevices very rapidly when alarmed.

Idotea linearis, Pennant. Immature specimens of this species become very common on the N. Norfolk coast towards the end of August and in early September. They abound in the inshore waters, leading a semi-pelagic life and being especially abundant along the open shore among large collections of drifted algae. As the specimens found here were nearly always immature and of small size, I was at first in some doubt as to their identity,

until Dr. Collinge very kindly informed me that the above diagnosis was correct. They appear to be a favourite food of the large flocks of immature terns which congregate round the Far Point at about this time of the year before migrating south. Remains of *Idotea linearis* are plainly visible in the droppings of these birds.

Idotea pelagica, Leach. Common under stones and algae on the open beach at the foot of the main shingle bank, and in similar situations in the harbour. Rarely above half-tide unless in pools--on the open beach they are found under stones in the long "runs"—shallow pools running parallel with the shingle. They do not seem to appear in numbers until towards the end of August.

Idotea granulosa, Rathke. One specimen early in September, 1928, from loose drifted algae in the pool round the wreck of the Hjordis. Dr. Collinge informs me that this species has not been recorded before, south of Northumberland, where it was taken by Canon Norman.

Eurydice pulchra, Leach. This little pelagic Isopod appears all over this region in late summer, in the inshore surface water. It makes use of the surface-film at times in calm weather, when some of its movements resemble those of "pond-skaters," or still closer, the gyrations of certain Hyperid Amphipods I have seen further north. Characteristically it is to be found swimming rapidly just beneath the surface constantly describing circles and ellipses so as to remind one (again !) of the movements of rotifers. This species appears to breed early in September, when such numbers of them are present that they are left everywhere by the tide, and seem capable of burrowing to a considerable depth in the sand and avoiding dessication.

Cyathura carinata, Kroyer. This species was first recorded in Britain by Mr. R. Gurney, who found a few female specimens under stones and behind the bark of old piles near Acle bridge and in the Muckfleet dyke. I found a few in Stiffkey freshes near the sluice gates, in water of very slight salinity. These were apparently burrowing freely in the mud along with *Corophium volutator* and a few small *Nereis diversicolor*.

Sphaeroma rugicauda, Leach. I found one of these Isopods alive in the stomach of a flounder caught "tretting" in the

lower reaches of the harbour. Knowing it to be typically a brackish water species, I searched for it at Stiffkey freshes where flounders and occasionally plaice are known to penetrate into water of very slight salinity. I found that *Sphaeroma* was present in fair numbers.

MYSIDACEA

Mysis flexuosa. Mysids are very common inshore in late summer, and seem to be a favourite food of many fish. All the specimens I obtained appear to belong to this one species. They are very frequent in wreck-pools in the sands off the headland.

V

METEOROLOGICAL NOTES, 1929

(*From observations taken at Norwich*)

By Arthur W. Preston, F.R.Met.Soc.

JANUARY

This was a cold and ungenial month, with mean temperature 35.1 degrees, which was lower than that of any January since 1917. Snow fell on eleven days, though not heavily. Pressure was very high throughout the month, exceeding 30 ins. on every day but four, and on the 8th reached the high level of 30.74 ins. Frosts in the screen occurred on 17 nights, and on the grass on 29 nights, the lowest readings having been 22.2 degrees in the screen on the 18th, and 11.2 degrees on the grass on the 27th. The early part of the month was very dry. Of the month's total rainfall of 1.82 ins., an inch fell during the last four days of the month. Much dampness and gloom prevailed on many days, and the total sunshine was only 32 hours.

FEBRUARY

This month will long be remembered for its intense cold. It was not only the coldest February since 1895, but the coldest month since that date. The mean temperature (31.5 degrees) was 7.2 degrees below normal, and there were 23 nights with

frost in the screen and 25 nights on the ground. The lowest screen temperature registered was 13 degrees on the 15th and 0.8 degrees on the grass on the same night. Maxima under 32 degrees occurred on ten days. Continuous frost both by day and night prevailed from the morning of the 11th to the afternoon of the 18th, and again between the 25th and the 28th. Snow fell on 7 days (to the depth of 5 ins. on the 15th) and lay on the ground from the 13th to the end of the month. The total precipitation was .87 ins. only. There were 55.7 hours of sunshine only, against an average of 79 hours.

MARCH

Many unusual features of meteorological interest occurred in this month, the chief of which was the abnormal drought. The total rainfall here was only .07 in., which is the smallest amount recorded here in any month since February, 1891, when the amount was the same. There was no snow, and a good part of the trifling total was the deposit of wet fogs. Temperature showed remarkable changes. Early in the month there were sharp frosts, followed by a great outburst of warmth, the temperature rising to 70 degrees on the 9th, which was the earliest "70" ever recorded here. This warmth was accompanied by cold nights, resulting in a great range of temperature, the range on the 9th having been as much as 40 degrees. This was followed by another cold spell, succeeded by a veritable heat wave, the thermometer rising to 60 degrees or over on 11 days. On the 29th (Good Friday) it reached 69 degrees. There was much bright sunshine, the excess for the month having been 50 hours. A fine sun-pillar was seen after sunset on the 29th. There was but little wind throughout the month.

APRIL

The warm weather at the end of March gave place to another cold spell with the advent of April, some snow falling on the 3rd, and on the night of the 5th the thermometer fell to 23 degrees in the screen and to 15.2 degrees on the grass. Further snow fell on the 10th, and on the 11th and 12th the thermometer failed to touch 41 degrees by day. On the 18th and 19th two warm days occurred, with maxima of 70 degrees and 72 degrees

respectively, but, like the two previously mentioned warm periods in March, were immediately succeeded by a sudden drop of temperature, and until the end of the month the weather was very cold, with some snow on the 25th. There was much north and east wind during the month, and many days were exceedingly ungenial. Rainfall was again deficient, the month's total having been 1.18 ins. only.

MAY

The early part of the month was generally cold, with occasional ground frosts, but warm weather occurred between the 19th and 27th, the thermometer reaching 82.6 degrees on the 23rd. There was again a remarkable range of temperature on several days. The last few days of the month were unseasonably cold, with much north-easterly wind. Great dryness again prevailed. The total rainfall for the month was only .94 ins., rain falling on seven days only. There was abundant sunshine, the total for the month being 253 hours. At the close of the month the drought was greatly felt and the soil was much parched.

JUNE

Some welcome showers occurred during the first week, but they were succeeded by a "second edition" of the drought from the 8th day to the end of the month, during which period rain fell on seven days only to the depth of .10 ins., no fall being more than .02 ins. There was only one hot day during the month (81.8 degrees on the 19th), but the greatest falling off in temperature was in the last week, when a continuation of northerly winds gave many chilly days. By a singular coincidence the maximum on June 25th (55.2 degrees) was precisely the same as on the previous Christmas Day. Sunshine was 23 hours deficient. The total rainfall for the first six months of 1929 was only 3.86 ins., against an average of 9.12 ins.

JULY

A most unexpected amd welcome downpour of rain occurred on July 4th, rain falling in torrents from 6 a.m. to 2 p.m. to the total depth of 2.95 ins., or 0.03 ins. more than that of the combined months April, May, and June. During the remainder of the month but little rain fell, but the weather became very hot and

sunny, the temperature exceeding 70 degrees on twenty days and 80 degrees on five days (86 degrees on the 17th and 20th), although preceded by some chilly nights, on one of which (the 1st) the ground thermometer fell to 34.7 degrees. A severe thunderstorm passed over parts of the county on the night of the 20th-21st, but only .08 ins. of rain accompanied it here. There were 242 hours of sunshine, being 31 hours in excess of the normal. Winds were very variable, and were rough on some days, particularly during the last week.

AUGUST

This was an exceedingly fine month, an ideal one for both harvester and holidaymaker. Rarely does August give us such a sequence of fine days as were recorded in this month. During the greater part of the month temperature ranged from about 50 deg. by night to 70 deg. or 73 deg. by day, and it was not until the last week that there was any excessive heat, with the result that the mean temperature was less than a degree above normal. On the 27th the thermometer reached 80.3 degrees and on the 31st 82.9 degrees. The month's rainfall was about half the average.

SEPTEMBER

September was remarkable for its unusual heat and great dryness following such a protracted period of drought. It was the warmest September since 1865, and on the 4th the temperature rose to 88.2 degrees, which was the highest recorded throughout the summer. The thermometer reached 70 degrees and upwards on 22 days, and 80 degrees and upwards on 6 days. No rain whatever fell between August 27th and September 17th, an absolute drought of 20 days. This drought was broken by a thunderstorm on the night of the 17th, but only .16 inch of rain fell here. The total month's rainfall was only .65 ins. Winds were chiefly from the south and west, and there were 199 hours of sunshine.

OCTOBER

On the whole this was a very fine month with many warm days for the time of the year. The thermometer exceeded 60 degrees on 16 days. Ground frosts occurred on several nights

in the second half of the month, but were not of sufficient severity to do much damage to the gardens. Mean temperature was near the average, and the total rainfall for the month was 3.19 in., which was slightly above normal. Winds were generally from a westerly point and reached a gale on the 6th and 24th. Thunder occurred on the afternoon of the 8th. Sunshine (122 hours) was 17 hours in excess of the normal.

NOVEMBER

This month gave us some very fine days, with much sunshine, and some very unpleasant ones, with much rain, fog, and gales. With the exception of a short wintry period from the 12th to the 16th, the weather was mild throughout, although the mean temperature (44.1 degrees) was not so high as that of the previous November. There was no snow. The principal gales were on the 10th, 11th, 19th, and 25th. Winds were almost continuously from the south and south-west, and there were frequent depressions coming in from the Atlantic.

DECEMBER

This was a very wet and stormy month, with frequent gales, some of which were of unusual severity. Cyclonic disturbances arrived from the Atlantic in quick succession, and there was but little quiet weather. The month's rainfall (4.93 in.) was the heaviest December total since 1919, when 5.05 in. fell, but in 1914 it amounted to 6.67 in. Mean temperature was 3.6 degrees in excess of the normal, and on the 14th the thermometer reached 58 degrees. There was but little frost. Snow fell on one day only (the 21st) to the depth of about an inch, but was soon melted by the rain which followed. Sunshine was 22 hours above the average.

The Seasons

Tables of mean temperature and rainfall of the four seasons of 1929 (including December, 1928, but excluding December, 1929), and compared with those of the five previous years and with the average.

TEMPERATURE

Seasons	1924	1925	1926	1927	1928	1929	Average for 30 years.	Departure of 1929 from average
	degrees	degrees	degrees	degrees	degrees	degrees	degrees	degrees
Winter -	37·3	41·6	39·7	39·4	39·3	35·2	38·4	—3·2
Spring -	46·7	47·6	48·5	48·6	47·4	46·7	46·7	0·0
Summer -	60·2	61·5	60·6	59·7	60.8	60·5	60·2	+ 0·3
Autumn -	51·2	48·2	50·3	49·9	51·9	52·5	50·1	+ 2·4
Year - Jan. to Dec.	49·4	49·2	50·0	49·1	50·1	49·0	48·8	+ 0.2

RAINFALL

Seasons	1924	1925	1926	1927	1928	1929	Average for 30 years.	Departure of 1929 from average.
	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins
Winter -	7·40	6·06	7·26	5·64	8·05	5·90	6·21	—0·31
Spring -	6·58	6·31	4·70	4·23	5·15	2·19	5·55	—3·36
Summer -	6·08	4·65	6·92	10·62	6·06	5·68	6·89	—1·21
Autumn -	10·86	8·51	7·01	14·92	6·73	7·27	7·83	—0·56
Year - Jan. to Dec.	30·77	25·10	24·66	36·90	26·41	22·76	26·48	—3·72

It will be seen from the above that the winter was 3.2 below the average temperature and 0.31 ins. deficient in rainfall. The spring gave normal temperature and a deficiency of rainfall amounting to 3.36 ins. The summer was 0.3 degrees in excess in temperature and 1.21 ins. deficient in rainfall and the autumn was 2.4 degrees above the average temperature and 0.56 ins. deficient in rainfall owing to the very dry September.

THE YEAR

The mean temperature of the year was 49 deg. or 0.2 deg. above normal. The warmest month was September (62.8 deg.), being 5.7 deg. in excess of the normal, and the coldest February (31.5 deg.), being 7.2 deg. in defect. The warmest day was September 4th (88.2 deg.), and the coldest night February 15th (13 deg. in screen and 0.8 deg. on grass).

The total rainfall for the year was 22.76 in., which was 3.72 in. below the average. The wettest month was December (4.93 in.), and driest March (0.07 in.). The total rainfall for the last three months of the year exceeded the total of the first nine months by 0.34 in. At one time it appeared as if 1929 was going to rival 1921 for dryness. The following particulars of the monthly falls of those two years are of interest for comparison, and show how the heavy rains in the latter part of 1929 speedily overtook 1921.

	Monthly falls		Totals from Jan. 1	
	1921	1929	1921	1929
	ins.	ins.	ins.	ins.
Jan.	2.03	1.82	2.03	1.82
Feb.	0.33	0.87	2.36	2.69
March	1.19	0.07	3.55	2.76
April	1.71	1.18	5.26	3.94
May	1.27	0.94	6.53	4.88
June	0.55	0.80	7.08	5.68
July	0.50	3.73	7.58	9.41
Aug.	1.52	1.15	9.10	10.56
Sep.	1.31	0.65	10.41	11.21
Oct.	1.50	3.19	11.91	14.40
Nov.	1.84	3.43	13.75	17.83
Dec.	1.96	4.93	15.71	22.76
Year	15.71	22.76	15.71	22.76

There was an extraordinary prevalence of southerly to westerly winds, particularly after Oct. 1st to the end of the year, during which period it was continuously in that quarter almost without exception. The prevalence of gales, some very violent ones, at this time, was also almost unprecedented.

The total amount of sunshine from readings kindly supplied during the year by Mr. J. H. Willis was 25 hours less than in the previous year, but was nevertheless 140 hours in excess of the normal. When the great frost of February (the most severe since 1895), the great drought in the spring, summer and early autumn, the fine summer, great downpour of rain and accompanying gales which occurred in November and December are considered, the year 1929 will stand out as a very exceptional and interesting one from the point of view of the meteorologist.

MR. PRESTON'S METEOROLOGICAL RECORDS FOR 1929

1929 Month	BAROMETER					THERMOMETER					HYGRO-METER	SUN-SHINE	RAINFALL		WIND								
	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Mean Relative Humidity 9 a.m	Hours	Inches	No. of Days	Direction and Days								Mean estimated force
															N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
	in.		in.		in.	°		°		°	%												
JAN.	30.74	8	29.72	15	30.123	49.2	30	22.2	18	35.1	90	32.3	1.82	23	5	4	4	2	8	0	6	2	2.5
FEB.	30.74	28	29.61	23	30.078	49.4	22	13.0	15	31.5	86	55.7	0.87	11	1	3	8	5	4	4	0	3	2 9
MARCH	30.78	1	30.00	21	30.291	70.0	9	22.0	2	43.8	77	174.7	0.07	5	5	6	2	2	1	3	6	6	2.6
APRIL	30.31	17	29.49	29	29.944	72.0	19	23.0	6	43.3	75	150.7	1.18	12	8	2	5	1	1	0	4	9	4.3
MAY	30.20	30	29.50	6	29.961	82.6	23	30.3	1	52.9	72	253.3	0.94	7	4	3	4	3	6	5	3	3	3.7
JUNE	30.34	21	29.40	6	29.965	81.8	19	41.4	5	57.3	70	183.2	0.80	14	5	3	0	2	2	4	9	5	4.1
JULY	30.39	14	29.20	31	29.989	86.0	17	42.0	2	62.6	68	241.6	3.73	11	2	3	4	1	3	5	9	4	3.6
AUG.	30.20	13	29.23	1	29.941	82.9	31	44.9	19	61.7	72	184.1	1.15	10	1	0	0	2	4	9	11	4	3.6
SEPT.	30.47	25	29.52	20	30.050	88.2	4	38.9	26	62.8	74	199.0	0.65	7	4	1	0	3	7	5	7	3	2.9
OCT.	30.36	31	29.13	24	29.775	65.8	15	31.6	28	50.7	81	122.0	3.19	14	1	1	0	0	8	2	16	3	3.9
NOV.	30.37	4	29.18	16	29.691	58.1	8	27.4	15	44.1	87	61.4	3.43	21	1	0	2	0	10	8	7	2	3.4
DEC.	30.62	17, 18	28.70	7	29.649	58.0	14	25.4	18	42.5	85	65.1	4.93	21	0	0	0	0	13	4	10	4	4.7
MEANS					29.955					49.0	78												3.5
EXTREMES & TOTALS.	30.78	Mar. 1	28.70	Dec. 7		88.2	Sept. 4	13.0	Feb. 15			1723.1	22.76	156	37	26	29	21	67	49	88	48	

VI

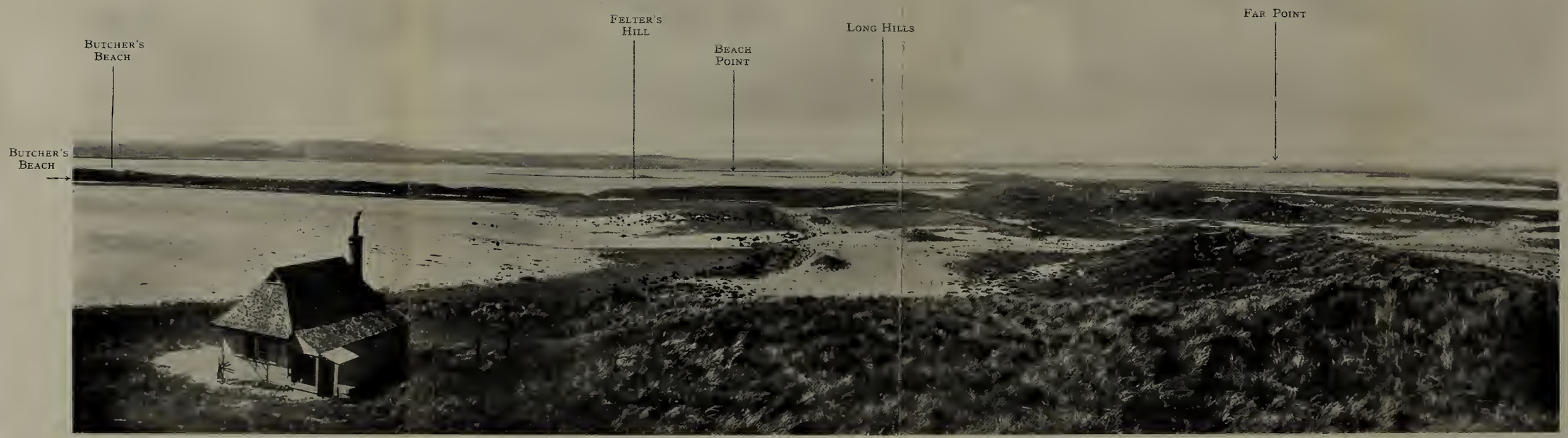
GEOGRAPHICAL WORK ON SCOLT HEAD ISLAND

By The Editor

At a Congregation at Cambridge held on May 16th, 1930, "On the recommendation of the Financial Board, the common seal of the University was directed to be affixed to a lease from The Norfolk Naturalists Trust to the University of part of the Dial House at Brancaster for a term of seven years at a rent of £10 per annum, with an option for a further term of five years." ("Times.") Thus was publicly notified the fact that the Brew House in connexion with the old "Victory" P.H. at Brancaster Staithe (situated in the parish of Brancaster), and now known as "Dial House," purchased last year by the Norfolk Naturalists Trust, has been converted into a Laboratory for use by research students of the Geographical Department of the University. This action on the part of the Trust is merely in keeping with its Memorandum of Association, wherein it is stated that one of its objects shall be "To promote research in all branches of Nature Study, and to make grants or donations for such purposes." In due course we hope the Trust will be in a position to make such donations.

The Laboratory, though by no means as yet fully equipped, has been in use this year. Mr. L. Slater, B.A., of St. Catharine's College, Cambridge, after returning from the Oxford Expedition to British Guiana, spent a good deal of the summer at Brancaster Staithe in making a preliminary survey of the deposits now forming in the waterways, creeks, etc., and on the marshes of the island. This is the beginning of what will probably be a long research, inasmuch as the physico-chemical processes involved in the process of sedimentation are not yet known. Scolt Head Island appears to form an excellent area in which to attack this problem, which naturally divides into two parts: the collecting and other field work, and the laboratory analysis. The latter cannot be completed at Brancaster Staithe, the equipment of the laboratory, at present, being insufficient for more than rough methods.

At the end of June and the beginning of July a number of permanent marks were put down on the island: these will be used for survey purposes.



[*Photo. J. A. Steers*

Panorama of Part of Scolt Head Island

At high tide, looking S.W. from the high dune behind the Hut

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VII

THE GREAT YARMOUTH AUTUMN HERRING FISHERY

1929

By The Editor

The salient feature of the Yarmouth herring fishing of 1929 was the rough weather which accompanied it and the losses this entailed. Gales were the cause of the loss of much gear, estimated, in the case of the Scotch boats, at £150,000. The Yarmouth drifters largely escaped.

The fleet as a whole have done better than in the previous year, herrings having realised a higher average price, but not yet has the industry been brought to a position in which it can thoroughly rehabilitate itself, after a series of lean years. The fleet is getting older; newer and more economical craft are required, but replacement involves capital outlays not yet possible except in the case of the strongest concerns with financial resources beyond the ordinary.

The first hand value of the season's catch was between £800,000 and £900,000.

The fleet totalled just over 800 boats, made up of 670 Scotch and 120 Yarmouth drifters, with some belonging to North Shields and Milford Haven. Several Lowestoft boats also made landings at Yarmouth. In 1928 the fleet was 748 strong and 784 in 1927. Scotch drifters increased by 47, and there were 8 more Yarmouth boats. Ninety-three Scotch curers operated this season at Yarmouth compared with 103 in 1928 and 112 in 1927. Fish workers totalled 3339 against 3357 last year and 3456 in the year preceding. Of Scotch coopers, carters, and labourers 819 were brought to Yarmouth as against 810 in 1927. The first fisher girls' special arrived from Aberdeen on September 24th and between September 28th and October 5th 14 of these trains conveyed many more, some of whom went on to Lowestoft, all being engaged to clean and pack herrings. The first Scotch boat, "Inter Nos" of Buckie, reached Yarmouth on September 20th, and all the Northern boats had left by the first week in December.

The Yarmouth boats have grossed up to £3500, and one super-drifter made a good deal more, but this vessel is in a

class by itself. The average over the fleet is estimated around £2000. The Scottish earnings have been irregular. Three Fraserburgh drifters, which were the last to get home and were in command of three brothers, made from £2300 to £1900, but this was far and above the general experience. The top Peterhead boat reached £1600, and P.D. vessels averaged £900. Probably the general average for Scotch boats was £800 in the case of steam drifters and £500 for motor boats. How wide the range was, however, is shown by the Inverallochy fleet, the top boat making £1350 and the least successful £270. In December several Yarmouth boats, making good shots, took them into Ymuiden, Holland, where there was a good market, and these trips yielded from £600 downwards.

Catches and Prices

The season's catch at Yarmouth was 529,318 crans, compared with 520,177 crans to December 8th last year, and 405,490 crans in 1927. The weekly landings are set out in the following table :—

Week ending	1929 Crans	1928 Crans	1927 Crans
Sept. 28	12,802	5,192	20,890
Oct. 5	9,237	53,554	34,242
,, 12	24,446	31,868	97,321
,, 19	81,307	89,518	40,578
,, 26	63,172	107,773	63,076
Nov. 2	92,196	124,694	52,368
,, 9	101,554	52,850	66,863
,, 16	55,732	18,855	18,771
,, 23	43,910	5,966	1,329
,, 30	19,075	5,765	6,337
Dec. 7	11,958	4,531	3,715
,, 14	179	2,241	876

The largest number of boats arriving on a single day was on October 19th when 621 berthed. The greatest proportion of the landings was made between the middle of October and mid-November, the best day being November 2nd, when 586 boats delivered 29,287 crans.

The first herrings of the season were taken on the Shields ground and arrived at Yarmouth on August 7th. Deliveries from this area continued till August 12th, when supplies came in from the Castle grounds off Scarborough. As in 1928 most of these herrings travelled well through being iced when caught. Herrings from the Dowsing grounds arrived from September 28th to October 12th. The first from Smith's Knoll were marketed on October 12th. Up to the beginning of October herrings were 70 to 40 miles from port, but by the end of this month the shoals had moved nearer.

A feature of the season's catch was the excellent quality of the herrings. The biggest shot was 307 crans taken by the Lisburn, a Lowestoft boat, on November 18th. The final landing of the season was 33 crans by the Dusty Miller on December 20th. These had been caught on the Sandettie ground.

The highest price paid for fresh herrings was £8 8s. per cran on December 12th, and the lowest figure was 24s. on November 2nd. During September and October on several days value ranged between 70s. and 76s. Iced herrings made 81s. as a top figure on September 18th, and 24s., the lowest price, was paid on September 23rd. As much as 90s. was realised for overdays on December 16th, and the lowest rate was 8s. 6d. on November 28th. Sea salted herrings were mainly landed in September and early October. The highest price for this class was 42s. on September 19th, and the lowest level was 11s. on September 28th. The average rates given by curers over the season were 34s. to 33s. per cran, compared with 29s. 1d. in 1928.

From the curing side the season is not indeed regarded so satisfactory as some past seasons. This has been due largely to the relative scarcity of herrings and then to the lateness of the arrival of the shoals off this part of the East Coast. These circumstances caused prices for fresh herrings to reach high levels. The frequent storms contributed to the irregularity of supply, which was another factor in keeping up values. There was not a single day when curers could buy cheaply. When the increased landings came in November the price for cured fish began to fall, and this caused a period of anxiety. Before the season had really got going some Continental markets, notably Danzig, sent strong recommendations for a restricted

cure for fear of over-production causing a slump. The curers appointed a committee to deal with this request, but it resolved to take no action. In the end the heavier landings during November benefited curers by affording opportunity to fill their large stocks of barrels. When the disastrous gale of Armistice Day despoiled the Scotch fleet of nets and gear and the fishermen became disheartened, the curers decided that the end of the season was in sight and gradually began closing down. The cure at Yarmouth was about 500,000 barrels, compared with 457,310 barrels in 1928 and 373,955 in 1927.

Russia Becomes a Buyer

In 1928 no herrings went to Russia direct, but this year the Soviet came into the market and bought, it is said, some sixty thousand barrels to go to Murmansk, its only ice-free Northern port. In 1928, Russia took three cargoes of the previous year's cure, which also went to Murmansk. Prior to that there had been no shipments to Russia since 1924, when ten steamers transported 150,000 barrels. It was the cessation of the Russian demand after the War that gave the first serious blow to the herring industry. In pre-war years Russia was the largest consumer of Yarmouth herrings, and the Russian demand was the backbone of the great prosperity of the industry in the decade 1904 to 1914. In 1913, Russia, for example, took 292,822 barrels and 133,559 half-barrels.

Of the value to Yarmouth of the Scotch fleet, Scotch curers, and Scotch labour, there can be no question. Herrings have to pay 6d. per cran and the drifters themselves contribute £2 10s. each. In this way probably £10,000 has been contributed to the revenues of the port. There is also a due charged on the barrels of pickled herrings exported, which also yields a substantial sum. The fish workers, coopers, carters, labourers, all have to find board and lodging. There are besides curers, salesmen, clerks, shipbrokers, coal merchants and others also temporarily residing here for eight weeks.

Freshing Trade

A feature which has given encouragement this season is the increased business done at the freshing quay. Here herrings are loaded in 2 cwt. boxes, sprinkled with salt and ice,

and carried to Germany, where this trade is developing. Large German steam trawlers were chartered to run in this trade, and several thousands of crans were lifted before the freshing season closed. The number of cases shipped was 40,979, and with some other shipments the total returned is 5279 tons.

Cured Herring Exports

The total quantity of pickled herrings shipped up to the end of November was 270,089 barrels, their principal destinations being Danzig, Stettin, Konigsberg, Libau, Riga, Hamburg, and Memel.

'Longshore herrings were not so abundant this year. The biggest day's delivery being 1376 hundreds, on October 14th.

In August the Yarmouth drifter Ascendant discovered a shoal of tunny off Scarborough, and caught three, which were taken to that port. On August 16th she brought one, 6 ft. long, to Yarmouth, which weighed 4 cwts.

The fishing has widespread collateral businesses. It must, for example, have salt, of which 19,000 tons were imported from Spain, and 5000 tons was rail-borne from Cheshire. The average price for salt was 34s. to 32s. per ton. Coal is another essential, and tens of thousands of tons came by rail and water. For bunkers 34s. per ton was paid, an advance of 2s. on last year. The motor drifters used paraffin, which at 8½d. per gallon was 1½d, dearer.

VIII

THE "NORWICH CHALK"

By R. M. Brydone, F.G.S.

Until last year I was under the impression, which there is nothing in the Geological Survey Memoir of 1904 to contradict, that the famous "Norwich Chalk," while undoubtedly in the zone of *Belemnitella mucronata*, could not be followed to its base so as to get a clue to its position in that zone. That appears to be a complete misapprehension. With *Actinocamax quadratus* occurring at Ringland and *B. mucronata* well

established at Taverham Park, just over the valley, the junction of the zones of these two fossils can be laid with certainty in the valley, and for all practical purposes in the river bed just east of Ringland. A line drawn through this point from Spring Farm, Attlebridge, to the Rookery, Bawburgh, and on to Little Melton would have to the west of it all the points, particularly Attlebridge, Ringland, Wramplingham, Marlingford (Lime kiln) and Bawburgh, where I have found granulated Belemnites (which at Attlebridge and Marlingford are certainly *A. quadratus*) and to the east of it only exposures, e.g., Taverham, Costessy, Drayton, Bowthorpe, where I have found *B. mucronata*, and such a line should correspond very closely with the junction between the two zones.

Another line, roughly parallel, drawn from Hellesdon Bridge to Cringleford Bridge, would divide all points in the zone of *B. mucronata* at which I have found *Magas pumilus* Sow, from the above mentioned points in the zone of *B. mucronata*, at which I have not found *M. pumilus*. This is a leading distinction in the south of England between the "lower" *mucronata* chalk and the "basal" *mucronata* chalk of Spencer. There is, it is true, much more significance about a failure to find *M. pumilus* in the south of England than there is round Norwich, where it is often so (relatively) scarce in the chalk in which it does occur, that even a large pit may not offer a single specimen. There is, however, another feature, possibly of great local importance, about the latter line. To the west of it lie all the places, Taverham, Drayton and Cringleford, at which I have found *Membranipora Taverensis* Bryd.; and there is a considerable probability that this sturdy and striking polyzoon (in some ways a counterpart of *Discolustrellaria Senonensis* Bryd., var. *vaccina*, which seems to be characteristic of the "basal" *mucronata* chalk in the Isle of Wight) is confined to the "basal" *mucronata* chalk in Norfolk and will serve to identify it.

I have not found in the Norfolk borderland of the zones of *A. quadratus* and *B. mucronata* any traces of the sequence in small varieties of *Echinocorys scutatus* Leske, which can be traced in Hampshire, i.e., a belt of the varieties *depressus* and *cinctus* and intermediate forms about fifteen feet below the boundary, and the variety *subconicus* appearing almost

immediately above it and rapidly becoming dominant. This southern sequence appears to continue as far north as Bramford, in Suffolk, to judge from a small collection of *Echinocorys* I have seen from there ; and the break between southern and East Anglian conditions, which is so marked from the zone of *Marsupites* upwards, may therefore have lain north of Bramford in late *quadratus* and early *mucronata* times.

IX

WILD BIRD PROTECTION IN NORFOLK IN 1930

Report of the Committee

In presenting their report for the past year the Committee desire first of all to express their appreciation of the support they receive from their subscribers for the continuation of the work they have set themselves to do. It is gratifying to them to note that the range of their subscription list is extending each year, which is an indication of gratitude on behalf of that increasing army of bird lovers that visits Norfolk every year ; and also, may we say, is a silent expression of confidence in the methods of Protection which are being put into practice in the county. The committee are well aware of the many criticisms that might be directed to them as to their sins both of commission and omission. As regards the former they can only state that until more experience is gained, there can be no hard and fast rules to guide them. The circumstances of any one area differ from season to season. There are not only the birds themselves to be considered, but also their food-supply, which is often dependent upon the vegetation of the area. In other places, for example a Broad, it is a question of maintaining a sufficiently large surface of open water. On all breeding grounds the vermin question is of the highest importance, and every device has to be resorted to to rid the ground of these pests, and in as humane a way as is possible under the circumstances. With regard to the question of what they ought to do further, but have omitted to do, for example, secure a breeding area in Breckland for the preservation of the Stone-Curlew, their

answer is that they are working in intimate association with the Norfolk Naturalists Trust, and are assured by this body that, as soon as its funds permit, it will remedy this omission. At the present time the committee has no jurisdiction over any part of this district of the county.

Broadland

It will be known to most of our subscribers that for many years the Hickling-Horsey district of Broadland has been very strictly preserved during the whole of the nesting season, under private ownership, and has now become one of the most important bird sanctuaries in this country. The present owner of Hickling, Lord Desborough, is carrying on these traditions with no less enthusiasm than inspired those who started this work, and he fortunately retains the services of Mr. Jim Vincent, who has been the head keeper on the estate since the beginning. With Horsey now in the hands of Major Anthony Buxton, ornithologists feel the greatest confidence that the continuity of protection in this area will not be broken. But there cannot, of course, ever be the same guarantee of permanency in privately owned property as in the case of that vested in a Trust, and for this reason The Norfolk Naturalists Trust seized the opportunity this year of acquiring by purchase, Alderfen Broad. This broad, often known as Oliver Broad, is one of the very few of the smaller private broads which is not in navigable communication with any of the public waterways. It is situated in the parishes of Irstead and Neatishead about ten miles north-east of Norwich. It is a circumscribed property off the main road, and consists of the broad proper with an area of about twenty acres surrounded by reed beds; some twelve acres of arable land on the north side, and the remainder litter marshes and rough ground: in all, just over sixty-eight acres. It is a freehold property and for many years has been carefully looked after as a sort of Nature Reserve. Duck resort to it at all seasons and many nest within its boundaries. The Bearded Tit has nested here, and although a Bittern's nest has never been found on the property, this bird is known to nest within a short distance of the broad. One of the characteristics of the broad are the many floating "hovers"—detached portions of the surrounding reed beds—which break

the surface of the water, and provide ideal nesting sites for the Black-headed gull in some years, for there are alternative sites in Broadland where this bird nests. For the present, at any rate, the Trust intends to keep the broad as absolute sanctuary, for experience alone can show in what direction interference may be necessary to maintain and establish those species of birds which it is especially desirable should be encouraged in this district.

We are indebted to Mr. Jim Vincent for the following notes of the bird life at Hickling during the past year.

Bittern.—It will be remembered that the severe winter of 1928–9 took heavy toll of the bitterns in Norfolk, so that it is satisfactory to hear from Vincent that their number improved during the past season. He found the first nest, with five eggs, on April 16th, and reports that " several birds reared their young."

Bearded Tit.—This bird also did well this season, the first nest, with five eggs, being found on April 8th. A good number of young ones were reared and seen from both layings, but J. V. considers that more young result from the second than from the first layings. As a breeding species he considers that it does not increase in number in the district as it should do.

Marsh-Harrier.—A male arrived on April 5th, and on the 10th a female, with which he mated. In each year that this species has nested at Hickling since 1915 J. V. has noticed that the male makes his presence known by calling and gyrating high in the air, which he considers to be " a fairly sure sign " that the birds are going to breed, for in non-breeding years he has not noticed it. This pair of birds started building as early as April 23rd, but the first egg was not laid until May 10th, and by the 24th there were six eggs. Five young were hatched, but only four reached maturity and got away. Two other males put in an appearance during the season : one an immature bird, the other an adult in exceptionally handsome plumage.

Montagu's Harrier.—There were no less than five or six pairs of these birds in the Hickling area during the past season, and on one occasion J. V. had a view of five males at one and the same time. The first birds arrived on April 23rd. By May 3rd one pair was building their nest, and on the 11th this contained two eggs. Eventually the clutch was made up to ten

eggs, which J. V. is convinced were all laid by the same bird. This clutch was stolen by some one off a yacht on June 2nd, as has already been recorded in "British Birds," Vol. XXIV, p. 82. However, eight young Montagu's Harriers reached maturity at Hickling this year and got away, which, in Vincent's opinion, "after twenty years' preserving this species, is quite enough for any bird sanctuary of the size of Hickling to carry when the Marsh Harrier is also breeding on it."

Short-eared Owl.—Two pairs nested and both reared their young.

Garganey.—Arrived on April 2nd. Is now more numerous as a nesting species at Hickling than is the Common Teal. It is also seen in August in greater numbers than anyone remembers.

Shoveler.—As a breeding species this bird has decreased in numbers at Hickling during recent years. This J. V. attributes, firstly, to the depredations of the Marsh-Harriers; and, secondly, to their having been ousted from their favourite breeding-ground—Deary's marsh—by Black-headed gulls.

Water-Rail.—This bird has not yet recovered from the great thinning of its numbers which occurred in the severe winter of 1928-9, and during the past two seasons has been very scarce; in fact, J. V. never remembers there being so few on the area.

Ruff.—A few Ruffs and Reeves arrived on April 5th, and onwards during May.

Black Tern.—Small lots of from four to eight were seen over the broad between April 24th and July 12th.

Little Gull.—A bird in immature plumage frequented the broad between May 19th and the 27th.

Black-necked Grebe.—An adult of this species was seen on May 2nd.

Common Scoter.—There were seven adults on the broad on May 4th.

Grasshopper Warbler.—These birds were in good number. A nest with six fresh eggs was found on May 19th, and another with five eggs on July 28th.

During the autumn migration several interesting birds were noted as passing through. Of these may be mentioned five Spotted Redshanks in a party on August 20th; an Osprey

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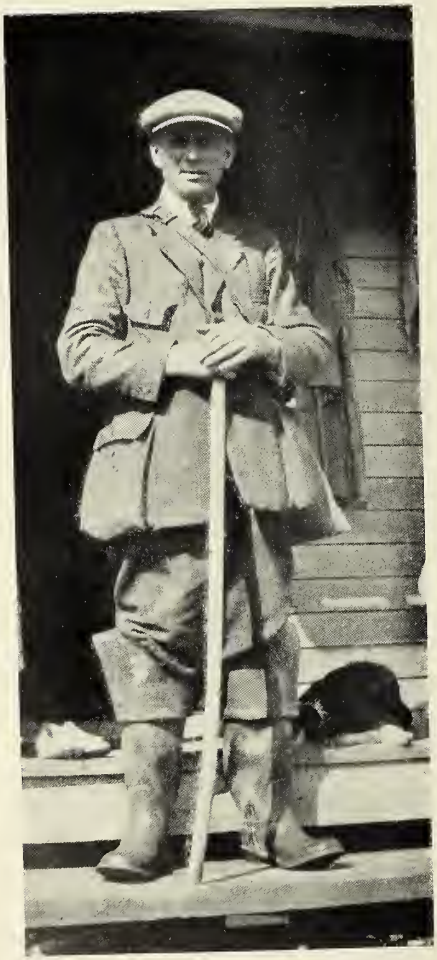

CHARLES CHESTNEY

The Watcher of Scolt Head Island, standing on the steps of the hut

which frequented the broad from September 17th to October 7th ; an immature Slavonian Grebe on Heigham Sounds on September 28th, on which date there was a heavy migration of many species, including the Hooded Crow ; a female Hen-Harrier arrived on October 3rd ; some Whooper Swans came in to the broad on November 5th ; for several days following the 12th an adult male Black Redstart remained at Whiteslea Lodge ; on the 23rd there was a Flamingo on Winterton beach ; and on November 26th J. V. saw an adult Iceland gull on Horsey Mere.

Scolt Head Island

For the following notes about the bird life on the island during the past year the writer is largely indebted to the daily diary of the watcher, Mr. Charles Chestney, to whom he tenders thanks.

At the beginning of the year there were several large flocks of Snow-Buntings on the island, but only a few Shore-larks ; the mildness of the winter was probably the reason why there were fewer of these than usual on our coast. The island is a common winter resort of the Short-eared Owl, and during January there were several in the dunes. On the 13th, Chestney flushed five. Grey Geese do not " use " the island, though they are frequently seen passing over. An interesting fact connected with the feeding of these birds was reported to Chestney by a farmer on the mainland, who found a number of these geese sitting on the top of one of his corn stacks eating the corn, a thing he had never seen before.

It is not always oil that accounts for the sea birds that are washed up on the shore-line. During February quite a number of Razorbills and Puffins were washed up on to the island, all free from oil. One could only conclude that they had died as the result of the rough weather.

In early March a Hen-Harrier was seen on the island—a not very uncommon visitor during the winter. During the winter a Kestrel roosted every night on the top edge of one of the outside shutters of the hut, and became so tame that it would allow Chestney to stroke it. Snow-Buntings and Shore-larks remained on the island to the end of March.

The first Wheatear was seen on March 26th. In Spring

the migration of this species is not as marked on our coast as it is in Autumn; indeed, it would seem generally to be seen first inland. This year the writer found two males in Breckland on March 17th. Several Mallard nest on the island, and the first nest with eggs was found this year on March 28th.

On April 5th, H. Loose, a local fisherman, saw two Sandwich terns resting on a buoy at sea about ten miles north-west of the island; it was not until the 22nd that one was seen on the island.

On the 17th, Chestney found the first Ringed Plover's nest with one egg, which hatched out on May 5th. Several Sheld-ducks had started laying by this date.

On April 24th, the first Common tern arrived, to be followed by the Little tern the next day. On the 28th, there were a number of warblers in the marrams and two Common Redstarts at the hut. By the next day the warblers had all moved on, but there was a big westward movement of Swallows and House-Martins. On this day the first Oyster-catcher's nest with egg was found.

In the early days of May a number of oiled Razorbills were picked up dead on the tide line. By the end of the second week terns were plentiful, the first Sandwich tern's egg being found on the 12th. On the 13th there was a marked movement to the westward of Turtle Doves. Two Roseate terns arrived on May 18th, and by June 3rd one of these birds was sitting on two eggs. The first Common tern's egg was not found until May 18th, and it was a week later before an egg of the Little tern was seen.

During the first fortnight of June there was great activity on the nesting ground, food was plentiful and the birds were laying well under favourable weather conditions. On the 11th a second Roseate's nest with one egg was found within about thirty yards of the first nest.

On June 14th, the writer inspected the ternery with the object of making a census of nests, not an easy thing to do when these are as numerous as they were this year. In all, 473 nests (containing eggs) of the Sandwich terns were counted, and as fresh nests were daily appearing we estimated later that not less than 500 pairs of these birds nested on Scolt Head this year. Among these were the two nests of the Roseate previously men-

Photo] [*H. M. Stone*

Ringed Plover Settling on her eggs, Scolt Head Island, 1930

Migration

The migratory movements of birds along Scolt Head Island present problems which are as yet by no means elucidated, and it is only by extended observations over years that satisfactory explanations are likely to be forthcoming.

In the case of the terns, these would seem to leave the island at the end of the nesting season by tracking along the coast eastward, and when all the home-bred birds have departed, others (mostly Sandwich terns) from further north have been noted passing in the same direction, sometimes high in the air, up to the end of September. (On October 4th, 1930, the writer watched three Sandwich terns tracking *westward* over the sea at Cley). They may be seen following the coast-line at Horsey, and as soon as August arrives they collect in large numbers on Breydon Water, where none nest. Whether they continue southward from here down the east side of England or take a short cross-country cut to the Channel is not known. On the other hand, there is the evidence of the Sandwich terns ringed on Blakeney Point in 1929 and recovered a few weeks later in the north of Scotland, ("British Birds," Vol: xxii, p. 187), suggesting that some of our Norfolk terns depart by this north-and-west coast of Scotland route. They may even arrive by this route: we do not know. The first birds that arrive in the spring are usually seen at sea by fishermen some days before they come to the island, but it is impossible to say from which direction they have arrived.

In the case of other species the direction of migration on Scolt Head is nearly always to the westward, during both the spring and autumn migration; and it is often impossible to differentiate between these two movements. For example, during the present year from the end of April to July 8th swallows and swifts were observed to be passing, irregularly, along the island, sometimes in large numbers, and all to the westward. There was then a short interval, but on July 26th the watcher records, "there have been a lot of swallows passing along to the west most of the day." On August 3rd, the writer noted a similar movement of swifts. Are these mid-summer birds arriving or departing, or are they just wandering birds? Who can say? Very much the same irregular movements to the west during the summer months have been noticed in the case of

Photo] [*H. M. Stone*

Oyster-catcher on Nest, Scolt Head Island, 1930

Photo] [*H. M. Stone*

Oyster-catcher turning her eggs, Scolt Head Island, 1930

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lapwings, though these birds arrive, doubtless from the continent, in vast numbers later in the autumn.*

With regard to the small passerine migrants, the arrival of these can perhaps be best exemplified by the experience of the writer when staying on the island this year during early September. From the 6th to the 12th the weather had been dull, rainy with north and north-east prevailing winds and with a very gradually falling barometer all the time. During these days there were several Common Redstarts, a few Pied Fly-catchers and many Wheatears on the island, and an occasional Willow-wren and Chiffchaff were disturbed in the bushes. On the 12th, the wind still in the north, there was rain on and off all day. On the 13th there was no wind, with the sky overcast and the barograph still on its downward curve. It was evident that this was the calm before the storm, but nothing happened until 5 p.m., when a torrential two hours' rain set in, to be followed by a westerly gale which continued with heavy rain all the next day.

We made an early start for a tour of the island on the 12th, making first for Butcher's Beach, a suæda-covered shingle beach bordering upon Norton Creek. Here we found the " bushes " full of small birds and it was obvious that there had been a considerable accession to their numbers during the night. As we stood watching, a small bird darted down from the northern sky and settled in the bushes just ahead of us ; it was a Whitethroat. It is only under certain weather conditions that these little migrants descend to the bushes in this way for protection and food ; under more favourable conditions the migration is probably going on in the higher regions of the air, but is invisible.

Anxious not to miss opportunities for exploring the whole of the island on this day we took the watcher's motor boat to the Overy (east) end and then searched all the bushes from this point back to the hut, doing those to the west in the afternoon. The bird that was present in the largest numbers was the Common Redstart, and of these there were probably hundreds ;

* Now and again immigrants are seen to come in straight from the sea, as on January 2nd of this year when Chestney saw about 100 Woodpigeons arrive in this way. On another occasion, in September, the writer watched a Peregrine sail in straight from the north.

they were generally distributed over the island. Although most of them were immature birds, a large proportion were adult cocks in almost full breeding dress. We failed to identify a Black Redstart, and this was the experience of observers on Blakeney Point, where a similar migration was witnessed. Wheatears were everywhere, and all of the common species. It is the experience of the writer that the larger (Northern) wheatear is more often seen later, in October. There were quite a number of Pied Flycatchers, and one Spotted Flycatcher. The latter is rarely seen on the island during the autumn migration, though the Pied nearly every year. Of warblers we were able to identify Willow-wrens, Chiffchaffs and one Garden warbler. There were several Whinchats, and one cock Chaffinch, the only chaffinch that had ever been seen on the island.

But the autumn migration on the north Norfolk coast this year will be best remembered, perhaps, for the presence of an unusual number of Bluethroats. This bird we were able to watch at close range, and it may here be noted that its chief characteristics in the field are the following. It has a very marked white superciliary stripe, and if only a glimpse of the bird is obtained it may even be mistaken for a Whinchat. Indeed, in many of its ways, and with its " tac tac " as its alarm note, it is very chat-like. But it has one very characteristic action and that is, a constant up-flicking of its rather long tail, both when perched and when running on the ground ; and at the base of the tail is a conspicuous rufous colouring. In the plumage as we saw the birds the throat was white, and below this was a bluish-brown triangular marking, but there was no " spot " within this.

On the next day, the 14th, it blew a gale from the west all day, with almost continuous rain, and under such conditions it was most difficult to discover what birds remained, for they were naturally skulking in the bushes, but it was obvious that most of them had moved on.

Cley

The following records are extracted from notes kept by Mr. Ronald M. Garnett, of Kelling ; they give a good idea of the birds that are met with in the Cley district.

Carrion Crow.—A pair were seen at Salthouse in April.

Brambling.—A late flock of about forty with other finches at Kelling on April 4th.

Snow-Bunting.—A flock of about thirty remained at Salthouse until March 20th, by which date some of the males were in breeding dress. The first autumn birds were seen on September 29th.

Rock-Pipit.—One or two were seen in January and September at Salthouse and Weybourne.

White Wagtail.—Two resting males near the Watch-house on Blakeney Point on May 20th.

Long-tailed Tit.—Common round Kelling; four nests found this spring. The severe weather in February 1929 seems not to have reduced their numbers at all.

Goldcrest.—An immigration about September 11th, and again during the last week of this month, when some of the gardens along the coast as far as Brancaster were described as being " crowded " with them.

Red-backed Shrike.—As usual, a pair nested on the Cley marsh, and the five young were ringed on June 27th.

Pied Flycatcher.—A male in breeding plumage at Kelling on May 3rd and 4th. Numerous during the migration rush September 11th to 13th, and again September 27th to 30th.

Fieldfare.—On May 7th to 8th there was a passage of a large number of these birds through Norfolk, seen at Kelling, (and at Hickling, S. H. L.).

Redwing.—First autumn bird seen on September 27th.

Ring-Ouzel.—Three were seen at Kelling between April 24th and May 8th, and another was caught in a rabbit hole at the end of April.

Wheatear.—A male was picked up dead on Weybourne Cliffs on March 15th. Very numerous at Kelling May 4th to 18th. Abundant on Autumn passage, especially September 27th, and well on into October.

Whinchat.—None seen during the breeding season, but numerous on passage in the autumn.

Redstart.—Only one nesting pair seen. Very numerous on autumn migration, especially September 11th to 13th, and 27th to 30th.

Black Redstart.—Although Common Redstarts were so

numerous during the autumn migration this year, no Black Redstarts were identified. A female was seen among the huts on Blakeney Point on April 21st.

Redbreast.—One of the features of the autumn migration was the unusual number of (Continental) Redbreasts in the bushes and generally along the coast, especially during the rush between September 27th and 30th.

White-spotted Bluethroat.—One in a cottage garden at Salthouse on April 7th and 8th (British Birds, Vol. xxiii, p. 339). This is the first record for Norfolk.

Bluethroat.—Several in the bushes from Cley to Blakeney on autumn passage, especially September 11th to 13th and 27th to 30th.

Wryneck.—One in the bushes on the Hood, September 13th.

Merlin.—A female, which wintered at Cley and was often watched hunting, remained to the end of March. A male was seen on Cley marsh on March 2nd.

Kestrel.—Seven were seen hovering over the marsh on August 30th.

Peregrine.—One was seen to come in from the sea and pass over Salthouse broad on April 10th.

Hen-Harrier.—A female was seen hunting on the Cley marsh on January 10th : it killed a greenfinch, which it stripped on the sea wall. Another was seen at the same place on February 20th, and a male on March 5th.

Spoonbill.—One was on Cley, or Salthouse, marshes on April 10th, May 12th, May 22nd and June 20th.

Bittern.—Two spent some weeks in a reed-bed at Weybourne during the winter. The first seen was flushed by a dog on January 22nd, and there were two on the 24th, and one or both were seen on several occasions in February. On February 28th, at dusk, both birds rose from the reeds, circled to a considerable height and went off in a S. E. direction. They were not seen again.

Garganey.—A male had arrived on the Cley marsh by March 7th, and on the 27th there were certainly two pairs (Bishop thinks three). It is very probable that at least one bird nested, but the nest was not sought for.

Pintail.—A pair were seen on Cley marsh on March 17th

and a drake on May 7th, but no evidence of nesting was obtained.

Scaup.—A male coming out of eclipse was on the Cley marsh on July 27th, and was shot on the Salthouse marsh early in Augnst.

Tufted Duck.—A drake on Salthouse marsh on April 11th was the only one seen.

Shag.—A rare visitor, Bishop picked up a dead one on Cley beach on January 30th ; another was watched fishing on Salthouse Broad on February 13th.

Fulmar.—An example of the dark form was picked up dead on Salthouse beach on March 27th.

Dotterel.—Two settled on Kelling Heath at 5 p.m. on August 22nd and remained for an hour.

Curlew Sandpiper.—Not nearly so numerous as last year. First seen on July 31st, a very red bird. Most numerous, September 22nd.

Little Stint.— In contrast with the last species these were numerous on autumn passage, especially on September 20th to 22nd, when six were feeding together on one small pool, and there were several elsewhere.

Common Sandpiper.—Seen many times on passage in autumn, but none during the breeding season. A late bird was at Weybourne on September 30th.

Red-Necked Phalarope.—One was seen on Salthouse Broad on September 2nd, and another at Kelling from September 18th to 24th.

Dusky Redshank.— One on Salthouse on August 19th, and two on August 20th. One on Cley marsh on September 7th.

Ruff and Reeve.—First seen August 13th ; four on the 30th, and odd ones frequently till September 25th.

Black-tailed Godwit.—One July 16th ; another on Salthouse Broad on August 23rd.

Black Tern.—Only two seen on the spring migration this year, and none in the autumn.

Sandwich Tern.—Again nested in a considerable colony on an island on Salthouse Broad. Number of nests not counted, but 313 young were ringed June 20th–21st.

Little Gull.—An immature bird frequented Weybourne Pool from January 18th to 25th, when it was unfortunately

shot. The skin was sent to the Norwich museum. An adult at Salthouse on September 20th was later picked up dead and very emaciated. The skin is in the possession of Mr. Riviere.

Landrail.—One heard on Kelling beach, May 15th.

Blakeney Point

About the usual number of Common and Little terns nested here this year, and although quite a number of Sandwich terns arrived on the nesting ground early in the season, not a single pair of these birds remained to breed, but seem to have distributed themselves for nesting on Scolt Head Island and on one or two islands on Salthouse Broad. There was a good hatching at Blakeney.

After thirty-two years of devoted service as watcher on the Point, Mr. Robert J. Pinchen resigned this position, at the age of 65 at the end of the season. As a mark of appreciation the National Trust combined with his numerous friends in a testimonial which took the form of a cheque for £53, and which was presented to him by the President of the Norfolk and Norwich Naturalists' Society at its November meeting.

Mr. Pinchen is succeeded by Mr. W. Eales, who resides on the Point.

General Information for Visitors to the Norfolk Nesting Grounds

Scolt Head Island.—This is a property of the National Trust, and the honorary secretary of the local management committee is Dr. Sydney H. Long, 31, Surrey Street, Norwich. A whole-time watcher is in the employ of the Norfolk Wild Birds Protection Committee, who is Mr. Charles Chestney, Dial House, Brancaster Staithe, King's Lynn. Visitors wishing to visit the island are advised to communicate with him at the above address to make the necessary arrangements for their transport, because the island can only be reached at certain states of the tide. Cars can be garaged at Dial House, where tea can be obtained from Mrs. Chestney.

Blakeney Point.—This is also a property of the National Trust, and the (acting) honorary secretary of the local management committee is Mr. Ronald M. Garnett, Pudding Lane Cottage, Kelling, Holt, Norfolk. An all-time watcher is

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employed, jointly, by the Trust and by the Norfolk W.B.P. Committee. He is Mr. W. Eales, Blakeney Point, Morston, Blakeney, Norfolk, who was appointed this year to succeed Mr. R. J. Pinchen, who retired after thirty-one years' service.

Except for a narrow neck of shingle connecting it with the north end of the Cley west bank, the Point may be considered as an island. The ternery can be approached on foot from Cley—a walk of about four miles along a shingle spit and through sand dunes. It may also be reached by boat from Blakeney at high water. The nearest point of embarkation is Morston Quay—about two miles west of Blakeney. Daily connection is made by boat between the Point and Morston, but intending visitors are advised to arrange their transport with the watcher, as only at certain states of the tide can the passage be made. During the nesting season visitors are only allowed on the Ternery between the hours of 8 a.m. and 8 p.m. and, obviously, dogs have to be prohibited.

The Cley Marshes.—An area of some 400 acres situated between the Cley Channel and the East Bank, which separates the marshes from Salthouse Broad. It was acquired by The Norfolk Naturalists Trust in 1926. During the nesting season the marshes are kept as absolute sanctuary, but an excellent view of the bird life on them can be obtained from the East Bank, where the watcher, Mr. Robert Bishop, is stationed. His hut is situated at the junction of the bank with the coast road.

Breydon Water.—For many years the Committee has maintained the services of a watcher on this estuary during the summer. He lives, during the while, on their house-boat moored in one of the drains, but goes to Great Yarmouth on most days for supplies, etc. Breydon is not a nesting ground, but is the resting place of a number of waders and rare visitors on migration. The name and address of the Watcher is :— Mr. W. Bulldeath, 35, North River Road, Great Yarmouth. By previous arrangement with him visitors can be taken on to Breydon to see such birds as may happen to be there.

Alderfen Broad.—This is a property of open water, marshland and three arable fields, in all about seventy acres, which The Norfolk Naturalists Trust has purchased during the year with the object of keeping it as absolute sanctuary for all

forms of wild life—ground vermin, of course, excepted. The experiment will be full of interest and will doubtless provide guidance in the management of such sanctuaries. It is situated in the parishes of Neatishead and Irstead, but at present no arrangements have been made for the admission of the public.

The Honorary Secretary of the Norfolk Wild Birds Protection Committee has no authority for giving permits to visit the Hickling Reserve, which is the property of Lord Desborough.

Signed (on behalf of the Norfolk W. B. P. Committee),

SYDNEY H. LONG, *Hon. Sec.*

LIST OF SUBSCRIPTIONS AND DONATIONS TO THE NORFOLK WILD BIRDS PROTECTION FUND FOR 1930

	£	s.	d.
H.M. THE KING	3	3	0
H.R.H. THE PRINCE OF WALES, K.G. ...	2	2	0
Adam Miss H. ...	1	1	0
Agnew C. G.	1	1	0
Allars R. W. E. ...	3	3	0
Allen J. W. ...	2	2	0
Anderson Edward ...		10	0
Anonymous	5	0	0
Attenborough, Col. J. C.M.G.	1	1	0
Back H. W.		10	0
Baker E. S. Stuart ...	3	3	0
Barclay F. H. ...	1	0	0
Barclay H. G. ...	2	2	0
Barclay Miss M. ...	1	0	0
Barlow J. Allen, C.B.	1	1	0
Barnard Mrs. ...	1	1	0
Barrow Miss		10	6
Barry W. J.	1	1	0
Barton Claud ...		10	6
Barton S. J., M.D. ...	1	1	0
Bedford, Her Grace the Duchess of ...	2	2	0
Beever Miss A. H. ...		7	6
Beevor Sir Hugh, Bart.	1	0	0
Benn Sir Ion Hamilton	1	1	0
Bewly Miss N. ...		5	0
Blackburn C. J. ...	2	0	0
Blakeney Point Collecting Box		10	6
Blatch Edward ...	1	0	0
Boake Mrs.	1	0	0
Boardman E. T. ...	1	0	0
Boileau Sir M., Bart.	2	2	0
Carried forward ...	£44	11	0

	£	s.	d
Brought forward ...	44	11	0
Brash T.	2	2	0
Briscoe Lieut. F. M. Eliot-Drake		10	0
Brittain H. ...	1	0	0
Brooks J. R.... ...	1	1	0
Brown E.	1	1	0
Brown H.	1	1	0
Buckle Lt.-Col. D. W.	1	1	0
Bullard Ernest ...	1	1	0
Bulwer Col. E. A. ...	1	0	0
Burrowes R. B. ...	1	0	0
Burrows Mrs. ...	2	0	0
Butcher R. W. ...	1	1	0
Butler R. Fawsett ...		5	0
Byne Lt.-Col. R. M. ...	1	1	0
Byers J.		10	0
Candler Charles ...		10	6
Cator, Capt. H. ...	1	1	0
Capron J. T.	1	1	0
Carr Mrs. Laurence ...		10	0
Carruthers D. ...	2	2	0
Cassie R. L.		10	0
Castle J. W.	3	3	0
Chadwick Dr. Morley	2	2	0
Chapman E. H., His Honour Judge ...	3	3	0
Christie J. A., M.P. ...	1	0	0
Churchill Mrs. Arnold		10	0
Clarke Mrs. Frank ...	1	1	0
Cleave H. P. O. ...	1	1	0
Cleminson H. M. ...	1	0	0
"Cley"		2	6
Clutton Bryan ...	3	3	0
Coe Mrs. A. E. ...		10	0
Collar Arthur ...		10	0
Carried forward ...	£83	5	0

	£	s.	d.
Brought forward ...	83	5	0
Colman Miss E. ...	1	1	0
Colman Miss H. C. ...	1	1	0
Colman R. J. ...	1	1	0
Colomb Admiral P. H., C.B.	1	0	0
Cooke A., F.R.C.S. ...		10	0
Cozens-Hardy A. ...	1	1	0
Cresswell Mrs. George	1	1	0
Cruickshank W. G. ...		11	0
Davy G.		10	0
Deacon Dr. G. E. ...		10	0
De La Warr, Lady ...	1	0	0
Dewrance Sir John, G.B.E.	2	2	0
De Worms C. ...	1	1	0
Doughty C. G. ...	1	1	0
Drury G. L.		10	6
Duncanson T. J. G. ...	3	3	0
Eccles James R. ...	1	1	0
Edwards Francis ...	1	0	0
Ely Mr. and Mrs. G. H.	2	3	0
Ennion E. F. R. ...		10	6
Everitt W. G. ...	1	1	0
Ferrier Miss Judith ...		10	0
ffolkes Sir W., Bart....	1	1	0
Finch F. R.	1	1	0
Flowers John, K.C. ...	1	1	0
Forbes H.	1	1	0
Foster, Capt. T. H., R.N.		10	0
Friedlein W. ...	1	1	0
Garrod F. W.... ...		10	6
Gay Miss C. E. ...	1	1	0
Gay Miss Ellen ...	1	1	0
Gayner Dr. J. S. ...	1	1	0
Giles C. C. T. ...		5	0
Glanville J. P. ...	2	2	0
Glegg W. E. ...	1	0	0
Goddard W. N. ...		10	6
Gowen H. P.... ...	1	1	0
Graves Mrs.	1	1	0
Green Major E. A. Lycett	1	0	0
Gresham School Nat. Hist. Soc.	1	1	0
Gurney G. H. ...	2	2	0
Gurney J. E. ...		10	6
Gurney Q. E. ...	1	1	0
Gurney R., D.Sc. ...	2	2	0
Gurney W. S. ...	1	1	0
Hannaford G. ...	2	2	0
Harding J. Rudge ...		10	0
Harker W.	2	2	0
Harmer T. Bertrand...	1	0	0
Hastings Thomas ...	1	1	0
Haydon W.		5	0
Carried forward ...	£137	19	6

	£	s.	d.
Brought forward ...	£137	19	6
Henshall Capt. Leonard		10	6
Herbert Ernest ...	1	1	0
Herbert E. G. ...		10	0
Heywood R.	1	1	0
Higham W.		10	0
Hill T. A. M. ...	1	1	0
Horsfall R. E. ...		10	0
Howlett Dr. J. K. ...		10	0
Hudson Lt.-Col. Percy C.M.G., D.S.O. ...	1	0	0
Hughes W.	1	1	0
Hunter Miss A. ...		5	0
Hyslop A. B. ...	1	1	0
Hyslop Brig.-Gen. H. G., D.S.O. ...	1	1	0
Hyslop Miss T. S. ...		10	0
Jenkins Rev. T. L. ...		10	0
Jones Sir L., Bart. ...	1	0	0
Jones Lawrence E. ...	2	2	0
Ketton-Cremer W. C.	1	1	0
Keith E. C.	1	10	0
Kerr Mrs. M. Rait ...	1	1	0
Kinder Rev. E. H. ...	1	1	0
Knight E.	1	0	0
Kolle H. W.	2	2	0
Lance Capt. H. W. ...	2	0	0
Lang Gordon L. ...	2	2	0
Lawson Harry ...	2	2	0
Lee-Elliott Rev. D. L.	1	1	0
Lees M. Mackenzie ...	1	1	0
Linnell L. G.		5	0
Littlewood Miss ...		10	0
Lister S. R., M.D. ...		11	0
Lewis J. Spedan ...	4	4	0
Lloyd Capt. L. ...	1	0	0
Long Miss		5	0
Long S. H., M.D. ...	2	2	0
McHardy Maj.-Gen. A. A., D.S.O. ...	1	0	0
Macpherson A. Holte	1	1	0
Maidment Dr. F. W. H.	1	1	0
McIlquham Miss M. ...		5	0
McKenzie Miss G. ...		10	0
McKittrick T. H., Jun.	2	2	0
McLean C.	1	1	0
Marshall J. M., J.P....	1	1	0
Matthews T. G. ...	1	1	0
Meade-Waldo E. G. B.	1	1	0
Meadows Mrs. A. H....		10	0
Mennell E.		5	0
Micholl Mrs.	1	6	0
Milne Mrs. Findlay ...	1	1	0
Mitchell Arthur ...	1	1	0
Morris Kenneth A. ...		10	6
Murton Mrs. ...	1	0	0
Carried forward ...	£192	17	6

	£	s.	d.
Brought forward ...	192	17	6
Nash John E. ...		15	0
Nash W.	1	0	0
National Trust, The...	10	0	0
Naylor W. S. ...	1	1	0
Newman Miss F B. ...		10	0
Noel-Buxton Lord ...	2	0	0
Oliver Prof. F. W., F.R.S.	1	1	0
Pain P.	1	1	0
Palmer A. J.		5	0
Parker George ...	2	2	0
Pearson S. V., M.D. ...		10	0
Penrose F., M.D. ...	1	1	0
Perry Mrs.	1	1	0
Plowright Dr. C. T. ...	2	2	0
Poole Miss D. Lane ...		5	0
Powell A. M.... ...		5	0
Preston Sir E., Bart., D.S.O.	1	0	0
Purdy T. W.... ...	1	1	0
Ransome Mrs. ...	3	3	0
Raikes Miss D. T. ...		15	0
Reeves H.	1	1	0
Reeves Derek L. ...	2	0	0
Reid Dr. E. S. ...		10	0
Report, Sale of ...	6	2	9
Richmond H. W. F.R.S.	7	10	0
Riley W.	1	1	0
Ringrose B. J. ...	1	1	0
Rippingall Neal F. ...	1	1	0
Riviere B. B., F.R.C.S.	2	2	0
Rogers Rev. H. ...	1	0	0
Rose L.	2	2	0
Royal Society for the Protection of Birds	2	2	0
St. Quintin W. H. ...	1	1	0
Savill Harry	2	2	0
Savin A. C.		10	0
Savory Mrs.		10	0
Scrope Reynolds ...		10	0
Scolt Head Collecting Box	4	2	0
Sheldon W. G. ...		10	6
Sherwood E. C. ...		10	0
Carried forward ...	£261	3	9

	£	s.	d.
Brought forward ...	£261	3	9
Soman A. E. & Co., Ltd.	1	1	0
Spalding G.		10	0
Sparrow Col. R. ..		10	6
Southwell E. B. ...	1	1	0
Steward Rev. Canon Edward (decd.) ...	1	1	0
Stimpson E. ...		10	0
Sumpter Dr. B. G. ...	2	2	0
Sunderland Miss J. ...		5	6
Tancock Canon O. W. (decd.)		5	0
Taylor Dr. Mark ...		10	0
Tennant Bernard V. A.	1	1	0
Thompson C. R. W.	1	0	0
Thouless H. J. ...		10	0
Trafford Maj. C. B. ...	1	0	0
Tuke Anthony W. ...	1	1	0
Turner Edgar ...	3	3	0
Upcher H. E. S. ...	1	0	0
Upcher Miss L. ...	2	2	0
Vincent T.		5	0
Walter C. H. ...	1	1	0
Watson J. B. ...	1	0	0
Watson-Kennedy Mrs.	1	1	0
Wells C. H.	1	1	0
Wemyss Major G. ...	1	0	0
Whittaker W. I. ...	1	1	0
Winch Major S. B. ...	2	2	0
Wing J. Sladen ...	1	1	0
Wishart E. E. ...	10	0	0
Whymper S. L. ...	1	1	0
Wolley-Dod Mrs. ...	1	1	0
Wormald H.	1	1	0
Wright B. D. Z. ...		11	0
Wright T. J. ...		10	6
Wyllys H. J. M. ...		10	0
Wyllys W. E. ...		10	0
Yeo H.		10	6
Yeo Mrs.		10	6
Young Rev. Belton ...		10	6
	306	4	9
Less : Transferred to The Norfolk Naturalists Trust	0	10	6
Total ...	£305	14	3

NORFOLK WILD BIRDS PROTECTION FUND

Year ending November 21st, 1930

Receipts	£	s.	d.
Balance brought forward from 1929	5	18	10
Subscriptions and Donations, 1930	294	19	0
Blakeney Point Collecting Box		10	6
Scolt Head Collecting Box ...	4	2	0
Sales of Report	6	2	9
	£311	13	1

Expenditure	£	s.	d.
Breydon Watcher's Wages and Insurance	42	6	8
Oil, Coal, etc., for Breydon House Boat	1	13	0
Scolt Head Watcher's Wages and Insurance	110	9	0
Blakeney Point—Contribution to Watcher's Wages	30	0	0
Bird Traps, Rat Poison, etc.—Cley Marshes...	2	0	0
Printing of Annual Report ...	17	1	6
Hon. Secretary's Postages ...	5	8	1
Cheque Books		4	0
Balance	102	10	10
	£311	13	1

Deposit

	£	s.	d.
Balance, 31st December, 1929 ...	135	2	8
Interest to 30th June, 1930 ...	3	15	2
	£138	17	10

Examined and found correct,

FRANK INCH.

Norfolk & Norwich Hospital,
Norwich, 21st Nov., 1930.

X

THE EGYPTIAN DESERT

By F. W. Oliver, F.R.S.

My task in the present article is to give some account of impressions of the Egyptian desert, a task taken up with some diffidence owing to the shortness of my stay in the country (a year), during which time I was mainly occupied with the duties which called me to Cairo. These notes consequently are very much of the nature of first impressions and should be read with indulgence.

As everybody knows, the Nile is the essential part of Egypt, and the cultivation of its banks and of the Delta constitutes the economic basis of the country. Only by direct flooding at high Nile, and by conserving and rationing the water, and leading it by numberless irrigation canals to the points where it is required, is the fertility of the Nile basin assured. But we are not concerned with the fertile area, only with the residual surface, which mostly occupies a plateau 500 or more feet above the river and is inaccessible alike to the Nile water and to the silt which it carries.

This area (some 300,000 square miles) receives at best a very small rainfall, and much of it none at all. This is the desert. For the purposes of this article what is sometimes called the "Northern Desert" is excluded. This is the coastal strip extending from Alexandria to the western frontier station of Sollum and reaching fifteen miles or so inland. This area (known also as the Mariut) being under the influence of the Mediterranean, receives a winter rainfall (four or five inches) which makes it possible for a crop of non-irrigation barley to be raised. For such areas, which revert to desert during the summer, botanists have no better name than the rather inadequate one of "semi-desert." Actually this Northern Desert produces a rich flora of astonishing beauty and interest and as a floral spectacle rivals the European Alps and the Portuguese littoral. This zone is a sort of limestone garigue with tremendous concentration of vegetation effort in both time and space. In the present notes reference to this flora is omitted, as scant justice could be done in the limited space available.

Around Cairo the desert occupies a high plateau, the Eastern Desert being diversified by numerous ranges of mountains intersected in all directions by steep-sided narrow valleys, the wadis. The Western or Libyan Desert, on the other hand (accessible from the pyramids of Giza), is mostly encumbered and consists of large, gently undulating ground, of which the summits are merely the highest points. Here and there rock outcrops in the form of collections of fantastic weathered hummocks, sometimes undercut so as to resemble huge toadstools (Pl. II., fig. 5).

A convenient spot from which to enter the desert is Helwan, standing at the edge of the Eastern Desert, and not far distant from Cairo. Climbing up on to the plateau beyond the Observatory, the outstanding feature is the bareness of the rocky ground, so far as vegetation is concerned, and the unlimited visible supply of stones, talus and debris, far in excess of the forces available for their removal

To a visitor from a "still" relatively tidy country like England, who is apt to be rather squeamish in such matters, the first impression is rather depressing. But what at first appears a disfigurement you soon learn to regard as a merit, for all these

rubbish heaps have morphology and relief, and by their constant repetition form a pattern which is the staple of the landscape. The colour of oatmeal, this landscape is very sensitive to atmospheric tints, and to light and shade according to the time of day. In the evening and the morning, effects are shown hardly paralleled elsewhere.

Having climbed up on to the plateau with the thermometer at 96°F. in the shade (only there is no shade !) you sit and gaze about you. There is stretching away for several miles a more or less level plain, with certain shallow depressions, and. near by, perhaps, the head of a small tributary wadi (Pl. I. fig. 1). Beyond, the landscape is closed in by hills, often flat-topped, and sometimes capped by slabs of more resisting materials. Here the strata are horizontal and the more resistant layers, weathering more slowly, project as ledges. These ledges are characteristically encumbered with talus fallen from above. Often buttresses stand away from the main massive as clustered columns and pyramids, intersected by projecting, horizontal tablets. But it is more refreshing to move about than to sit still in the sun, and the opportunity can be used to look at the plants.

Another Entry to the Desert

There are two ways of getting onto the desert. Commonly it is from the Delta cultivation or from the border of the Nile, when the transition is sudden. It is like stepping from a carpet on to bare, hot paving stones. But when you enter as from the Northern Desert, which is a zone where fall perhaps five inches of winter rain, the apparent passage is very gradual. This " semi-desert " differs from real desert less in the small bushes and tuft-like perennials which are dotted about, than in the continuous covering of fine, short grasses which in the fruiting stage persist far into the summer as a feathery mantle of brown or buff. As you reach the zone where these winter rains die out, this mantle becomes sparser and sparser till a moment comes when you realise with a shock that the desert has become stark naked. The gradualness of transition does not deceive our sensitive human perceptions. The difference between the thinnest grass covering and nothing is simply tremendous, and you get for a moment a recurrence of that

original feeling of loneliness you had the first time you ever set foot on the desert. It is this absence of the gauzy veil of ground vegetation that is such a distinctive character of true desert.

The Plants of the Desert

Whilst, broadly speaking, the well-watered Delta is green everywhere and at all seasons, the desert is in striking contrast in both respects. Thus, if we consider our nearly level upland plateau to the east of Helwan (Pl. I., fig. 1) having a height of 500 to 600 feet, the plants are sharply restricted to the shallow depressions, viz., to the areas where " seyl " or torrent waters accumulate after winter showers. The higher levels correspond to the region of " run off," where water does not remain long enough to penetrate the soil or to wash out the ever present salts toxic to plants. Here plants cannot establish. But with the depressions it is different. In these the excessive accumulation of salts is checked by leaching, and a ground water provided within reach of the roots. Along these lines where water gathers there is liability to erosion, and it is here that those most characteristic features of desert sculpturing occur, the progressively developing heads of gulleys and wadis (fig 1, on left.) These wadis, everywhere common in the Eastern Desert, cut deeply into the plateau as branching valleys or canyons, often hundreds of feet deep (e.g. Wadi Hof, Pl. I, fig. 2), and these and their tributaries offer the best habitat for plants —contrasting with the hills and mountains which, giving no lodgement for water, are practically sterile. This sterility, the absence of any plant covering, is correlated with an excessive atmospheric erosion—extremes of temperature, wind, rain (when it falls), and the physical nature of the unprotected rock.

A distinction may be drawn between those plants of the desert of seasonal duration and such as persist from year to year, i.e., annuals and perennials. The former are often called " ephemerals," as their period of activity is so brief. They are shallow rooting and dependent on temporary sources of water following such rainfall as is vouchsafed. It is obligatory that their life cycle should be rapidly fulfilled, otherwise they will fail to ripen seed. Germination is a response to the

FIGURE 1

Desert plateau near Helwan showing distribution of plants: on left, head of small wadi

FIGURE 2.

Wadi Hof: student excursion in progress

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wetting of the soil by winter rains together with the stimulus of the increasing temperature of early spring. The appearance of the seedlings follows instantly on this favourable conjunction and forms the most refreshing sight of the desert. Plants of this kind form sixty or more per cent. of all the desert species round about Helwan, and such numbers are typical of deserts generally. Many families are represented, of which Cruciferæ, Leguminosæ, Compositæ, Resedaceæ, Zygophyllaceæ, Ficoideæ and Plantagineæ are conspicuous in their possession of ephemerals. These plants come and go quickly, and unless, e.g., a particular wadi, be visited at close intervals many will be missed. I shall never forget a visit to Wadi Tih, about February 20th, when the little purple flowered stock *Moricandia clavata* was blooming everywhere, a scenic factor. In subsequent visits hardly a trace of it was to be found.

The provision of seed in desert soils seems unlimited. Thus, on the desert thirty miles south of the Giza pyramids at the end of January, 1930, were immense tracts of seedling *Mesembryanthemum Forskalii* coming up like mustard and cress (in sheets extending almost to kilometers). Such stretches, here and elsewhere, were that winter far more extensive than in normal years owing to the greater rainfall. It showed that the desert was chock full of seed which only required favourable conditions to germinate. Nor was this good beginning frustrated later in the season, as in high summer and in autumn there was abundant evidence that immense numbers of these Mesembryanthemums had accomplished their life cycle with rich harvest of seed. The seed, it may be conjectured, is widely distributed by the desert winds, which lift and scatter everything on the surface. Such rainy winters as 1929-30 are exceptional and have a profound influence on ephemeral and perennial plants alike. In the case of the ephemerals making much wider areas (usually barren) available for establishment ; in that of the perennials bringing the ground water to a higher level so that it becomes more accessible to the roots, with consequent increased growth, both in lateral spread and vertically.

The perennial plants occur on the upland depressions and especially in the shallower and deeper wadis. They occur dotted about in what is called open formation rather than in

continuous stands. This characteristic occurrence depends doubtless on the limitations of water supply. Those plants which first reach the necessary depth of root abstract the moisture, available within a certain distance, and are thus enabled to prevent other plants of identical requirement from effectively invading their hinterland. This does not exclude the possibility of plants of differing requirement growing together, and especially where one of them is very thorny and not much browsed on, like *Lycium arabicum*, satellites will be found surviving under its protection.

In the wadis, as in the classic Wadi Hof much visited by botanists (Pl. I, fig. 2, where a student excursion is in progress), the plants grow especially on the margins and not in the fairway. This, in narrow, ravine-like wadis, is attributable to occasional spates (" seyls ") of flood water rendering the floor too mobile for plant establishment. The larger plants include tall growing grasses and composites, bushes of Zilla and Nitraria, many Boraginaceæ, Zygophyllaceæ, Ascelpiads such as Dæmia, Cucurbitaceæ such as *Citrullus colocynthus*, Erodiums, the hygroscopic Reaumuria, Capparis, the ever present *Pithyranthus tortuosus*, occasional bulbs like Pancratium, Dipcadi, Asphodel and Gagea, and, with some luck, the only Egyptian gymnosperm, Ephedra.

In a February or March visit you may reasonably expect to get eighty species in the Wadi Hof, very many of them in flower ; some, such as the chenopods Anabasis and Haloxylon, flower much later, whilst Pancratium, now in leaf, produces its umbels of fragrant flowers in October, and Reaumuria as late as November. Whatever you may have heard of mass production and the blaze of flowers in the semi-deserts of the Mariut, here, apart from certain ephemerals, flowers have to be sought ; if you expect little you will find much—charm and interest outstrip scenic floral display.

A lasting impression gained from a deep, ravine-like valley such as Wadi Hof, is its complete isolation from the world. It is cut off from the rest of the desert, and there is no view out beyond its length and breadth. It is often stifling. This desolation is emphasised by the silence which reigns, and birds are rarely seen or heard. However engrossing the

FIGURE 3
Bare Desert north of Giza pyramids; petrified wood in foreground; pyramids on right

FIGURE 4
Typical view in Gt. Petrified Forest, Wadi Tih

FIGURE 5
Weathered sandstone blocks on desert 40 miles south of Giza pyramids

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scientific or other experiences may have been, one is always glad to return to open country at the end of the day.

An outstanding character of all this vegetation is its thorniness, high development of lignified tissues (toughness of texture), hairiness, and glaucous covering of leaves and shoots—in general the condition termed xeromorphy. Pure succulence is rare, apart from Zygophyllum and Mesembryanthemum. The succulent Cacti and Euphorbias of other deserts are wanting ; indeed such a characteristic American desert genus as Opuntia will hardly grow in the Egyptian desert unless irrigated—a tribute no doubt to its greater dryness.

The results of recent investigations point to plants of xeromorphic development (" xerophytes ") as not specially economising water when it is available. Their normal loss of water by transpiration is quite comparable to that of plants of non-desert situations (mesophytes), and the significance of xeromorphy is rather as a means of drought resistance when water is scarce and the stomata close. Then only does xeromorphy come into play, conferring a distinct survival value. The xeromorphy of desert plants seems to be a reaction in growth and tissue development to the extreme conditions imposed. That the analogous protection of so many halophytes (salt marsh plants) does not markedly reduce their transpiration, as compared with non-saline land, has been known for many years, and it is evident there exists much in common between xerophytes and halophytes, especially as they are both liable on occasions to excessive salt concentrations in the soil water.

The interior tissues of ordinary herbaceous plants of Egyptian (irrigated) gardens are much more completely differentiated than in identical plants at home. This applies especially to the vascular strands which are developed (as in Antirrhinum, etc.) on a scale comparable to the much increased water current that is required to replace excessive transpiration losses. Shoots of garden plants are consequently tough and not easily broken by hand, as they are for instance in England. Or, one sees, prone in the desert, the long, slender, radiating streamers of the gourd, *Citrullus colocynthus ;* but if you try to break one it is of the consistency of whipcord, and very different from the stem of a marrow in England.

Liability to Grazing

Another circumstance in the desert environment of profound significance is the exposure of plants to grazing. I have never seen a desert vegetation which did not bear evidence, not merely of casual but of systematic grazing by the camels, goats and sheep of the nomad tribes. The herdsmen have unrivalled, traditional knowledge, sharpened by experience, of the occurrence and suitability of desert plants to the needs of their stock, and this they utilise to the fullest extent. In some districts plants are bitten back to the bone and only those parts survive which are inaccessible, or which sprawl on the ground and would have to be eaten with grit.

Probably all the vegetations of deserts, everywhere, are more or less mutilated by grazing. From this point of view it seems highly desirable that here and there arrangements should be made for fencing and protecting against stock selected typical areas in certain wadis and elsewhere. The effects caused by rabbit browsing on, e.g. sand dunes in England, are great, but this man-inspired desert grazing is no doubt still more far reaching. The results of the study of such reservations would, I am sure, be surprising, but of course stern measures of precaution would be necessary, as the temptation to poach on these reserves as they grew greener and greener would be irresistible to the nomad herdsmen.

If the statement be well founded that the introduction of the camel into Egypt is comparatively recent (200 B.C.), then even in historic times the appearance of our deserts must have been very different from what it now is. For not only must the vegetation covering have been much more extensive, but also the desert surface must have been less subject to erosion than it is to-day. Hardly any factor causes more severe deterioration of terrain than the unrestricted activities of animals, and especially of the herbivorous sorts.

The presence of camels in large numbers in the desert depends on the fact that they can be bred and reared under nomad supervision at lower cost than on crops specially raised on fertile, irrigated ground. Sometimes you will see them in hundreds being driven to market from the grazing grounds; they appear to fill the whole landscape and to be making their way in a definite direction with perhaps a single Bedouin and

FIGURE 6
Desert on Gulf of Suez; dunes in foreground with bushes of *Tamarix mannifera* and low hummocks of *Anabasis articulata*

FIGURE 7
Grove of *Calotropis procera* on desert north of the Fayoum

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a boy in charge. Once in the desert between Wadi Natrun and Giza pyramids, when motoring, we saw, a kilometer ahead athwart the trail, what appeared to be a broken down car, unattended. As we drew alongside the supposed car suddenly disintegrated into four camels which rose to their feet and unconcernedly strode away. Their symmetrical placing on the ground gave a perfect representation of a car, which deceived us up to the moment of rising

On the Helwan system trees are not much in evidence, here and there a stunted *Acacia tortilis* and a *Retama Retam* (a white flowering broom) perhaps. South of the pyramids, as the Fayoum is approached, little groves of the asclepiad *Calotropis procera* occur (Pl. III. fig. 7), with large leathery leaves and immense, inflated fruits filled with hair-appendaged seeds. These plants are full of latex and it is amazing how plentifully this latter gushes from these desert asclepiads (Calotropis and Dæmia) when their tissues are broken.

Sand Dunes.

Sandy deserts or sand dunes, apart from small drifted accumulations of sand which make trouble for motor cars, are a characteristic of the Libyan desert and mostly rather far afield. An exception is a range some ten miles north of Cairo, accessible from El Khanker or from the Suez Road. From whatever point this range, known as the Yellow Hills, is approached, a wide tract of hard desert with shallow wadis must be crossed. The hills themselves are of the colour of crushed amber, and glow warm and ruddy in the afternoon sun. As is usual in such cases, the coarser grains of sand form a protective surface, so that the dunes as a whole are free from drifting in moderate wind velocities.* The dune system runs from north to south and has the characteristic sinuous course of desert dunes. Imagine a solitary heap of sand in a wind. The low margins which project into the wind will travel faster than the centre, so that the whole takes on the form of a crescent with the cusps pointing down wind. Such a curved dune is called a barchan, and is the form most usually found where vegetation is too sparse to retard or modify travel. Our sinuous range is

*A Portuguese Sand Dune, Trans. Norf. and Norw. Nat. Soc. Vol. xii, 1926-7, p. 282.

essentially a series of linked barchans (Pl. IV., fig. 8), the summit of each unit being on the left, and the low points or cols (where the cusps of adjacent units are joined) on the right. This state is almost diagrammatic in the Yellow Hills; in other cases, as out on the Libyan desert, numerous ranges are apt to be scattered in close order so that cross connexions and complications result—relationships not always intelligible at a glance. Why these ranges should all lie more or less north and south is a mystery, as the prevailing desert winds are in these two directions. But the effects of winds from east and west are noticeable. When our photograph (fig. 8) was taken the slope in shadow (east side) was the talus or advancing slope, though on occasions I have found the west side to be for the moment in advance. The ridge as a whole evidently pulsates according to the incidence of E and W winds, but on the whole the movement is easterly—a few yards a year perhaps. In many visits I have never noticed a reversal of the summits and cols, though this would probably come about if winds from the east were indefinitely prolonged.

Though the mobile ridge is bare of plants, these occur in plenty on the more or less level sandy plateau on which the dunes rest. These include (fig. 9) grasses such as Aristida and Pennisetum, the chenopod *Cornulaca monocantha*, and frequent bushes of *Convolvulus lanatus*. The two latter are bundles of thorns, and not easy to recognise when out of flower. Marram Grass (*Psamma australis*) I have not seen on true desert dunes, but only on the shore dunes of the Mariut (semi-desert). Here, though sparse, owing to unrestricted grazing by camels and goats, it was still effective as a holder of sand. Moreover, as the Mariut dunes consist of almost pure powdered limestone this species showed the same calcicole tendency which characterises marram in England, e.g., at Blakeney Point.*

Animal life is abundant, and includes grey and black spiders and beetles, members of the grasshopper tribe, and large bees visiting the convolulus. Small lizards are everywhere, and here and there large ones, sometimes two feet in length. These, when disturbed, bolt into their holes, and although

*Cf. Blakeney Point Report, 1924-1926, p. 17.

FIGURE 8
The "Yellow Hills" range of sand dunes, looking north

FIGURE 9
A unit of the "Yellow Hills" system from the S.W. Plateau with Pennisetum, Convolvulus and Cornulaca. The ridge stands about 80 feet above the plateau.

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the tail may stick out, the lizard is not to be got by pulling the tail. For these creatures inflate their bellies so as to make contact everywhere with the sides of the hole and defy extraction. In the same way specimens in captivity, kept as pets, have the habit of crawling under pieces of furniture where they jamb themselves tight by the same method. The Yellow Hills make a delightful excursion for an afternoon, but you have to get away betimes when the sun sets, as there are intricacies in the way and darkness soon falls.

The dark belt to the left of the dune range (fig. 8) consists of the trees grown on a sewage farm. A portion of the sewage of Cairo is pipe-lined here on to the desert and, without special chemical or bacterial treatment, irrigated between rows of orange trees. The fertility of this combination of sewage and rather sandy desert soil is miraculous, and the yield of the highest grade of Jaffa oranges, enormous. The results of this pioneer and successful horticultural effort ought to be made widely known.

In many places smaller sand dunes occur, as on the desert south of Suez (Pl. III., fig 6), where *Tamarix mannifera* and *Anabasis articulata* are effective sand binders.

Petrified Forests

One of the truly remarkable sights of the desert is one or other of the petrified forests. Slabs and splinters of wood are discoverable at numerous places easy to locate, as they are generally surveyed on the desert maps. For our purpose reference may be made to the "Great Petrified Forest," an area covering many square miles and lying between the Wadi Tih (which runs east from Maadi, south of Cairo) and the Suez Road. A random sample, perhaps twelve miles into the desert, is given in Pl. II., fig 4. The ground consists of low, stony hillocks, covered with fine loam, and scattered everywhere are chips and blocks of silicified wood. In wandering over the forest, localities will be found where the wood occurs as large trunks lying prone. Some of these I have measured up to seventy feet in length, and eighteen to twenty inches in diameter. A characteristic feature of these large trunks is that they are always (so far as my own observations go) broken into short segments, rarely exceeding two feet in length and

remaining in alignment. It is evident that these segments have arisen by the fracture of continuous stems since they came to lie where they now are. Though the planes of fracture do not correspond to nodal points in their structure I am not prepared to suggest any explanation ; at the same time, I am sceptical of the popular view that they are the result of earthquake shocks.

These trunks show varying degrees of weathering. An outer bark is never seen, and in most cases much of the outer layers of wood also had disappeared before petrifaction. Many lie in a crumbling state and disintegrate at a kick. Doubtless the small-sized pieces scattered everywhere have arisen by the degradation of the large trunks.

Coming up between these slabs are recent plants of the desert, such as Zilla and Zygophyllum, and in their season many bulbs like Pancratium and Gagea are to be found. Another area where petrified wood occurs, a few miles north of the Giza pyramids, is given in Pl. II, fig. 3. Here slabs have been built into a cairn to support a beacon on the trail leading to the Wadi Natrun. The pyramids are visible on the right, one of them showing black owing to a cloud shadow. The area depicted is almost entirely destitute of living vegetation.

The fossils lying on the desert are popularly supposed to be palms, but I have collected specimens from many localities without ever finding one. All I have examined agree with what is called *Nicolia*, supposed to be a leguminous tree related to Cæsalpinia. This genus of petrified wood was created by the palæobotanist Unger more than seventy years ago, and he records the fact that, for the Cairo district at any rate, all petrified wood is Nicolia. Its precise geological age is not certainly determined, though it is probably of eocene age. Convincing examples *in situ* would be required for a certain determination. Indeed the whole question of the origin of these stems remains a mystery. Did they grow in the regions where they are now found, or have they been drifted from much further south, and stranded to petrify in their present position ? It is hardly possible to recall any analogous phenomenon of which we have less certain knowledge than that of these baffling petrified forests, or one which has left so many people " thinking."

Desert Sunsets

The desert sunsets of Egypt have become famous from certain characteristic features which they present. At the same time, sunsets having a great deal in common with those of more northern latitudes are not infrequent—spectacular displays of colour depending on the distribution and structure of the clouds over the western horizon. And between these and the characteristic desert sunset all transitions and combinations occur. Here, the simple, uncomplicated desert type alone is described in its essential features. It is best seen in a clear, unclouded sky.

When the setting sun actually rests on the horizon it no longer casts a shadow, nor do projecting eminencies or buildings facing it appear any longer to be in direct sunshine. At the moment when the upper limb is extinguished the "green flash" is momentarily shown; but this, though easy to observe, is not especially characteristic of a desert sunset. The moment of extinction is the zero from which the times of the succeeding phases are reckoned.

Resting on the western horizon there is a narrow belt of grey, and above this a wider zone of delicate Naples yellow which passes, through a trace of pale egg-shell green, into the very translucent blue of the sky, a blue with maximum value towards the zenith. The spot at which the sun disappeared often shows a persistent ruddy or copper hue, so that you can tell where it set. On the other hand, this spot may fade away into grey in a few minutes and there is nothing to mark the place where the sun so recently was. Meanwhile, there is less light, and one unfamiliar with what is to happen, and unprompted, would have no reason to expect anything but a passage into the deepening gloom.

At about fifteen minutes from zero comes a noticeable change. The yellow zone intensifies and there spreads across it into the blue canopy above what I can only describe as a purple luminescence. Even if you are not watching the western horizon you become aware of this phase. For the sides of the hummocks and ground irregularities that face west become flooded with a ruddy light, as do rocky cliffs and buildings, if present. The veil of rosy purple rapidly spreads upwards to 30°, 45°, or even, on occasion, to the zenith, it may

be twenty minutes from zero. This after-glow is no mere colour seen as on a screen, but a coloured luminosity with pulsating texture, like an aurora. It endures from fifteen to about twenty-five minutes from zero, and then fades from below upwards. Though purple or rosy as a whole, its tint is influenced by that of the zones across which it stretches. Like a cocktail, it is the inter-play and mixing of ingredients that matter. The veil is the essential element, and being chromatically unstable cannot be depicted in a drawing. Meanwhile, this purple veil merges in the blue above, which latter shows now with a greater transparency and purity. Should there happen to be a few flecks of white clouds across the southern sky, which took a rosy colour at sundown, these will now appear intensely white on the blue ground.

As the purple vanishes (about twenty-five minutes from zero) there is disclosed a broad zone of egg-shell green, between the blue above and the yellow or even apricot colour below. This is the later phase of the sunset, and it wears an exaggerated brilliancy owing to the general darkening of the heavens—a real artifice of nature. In extreme cases the apricot may intensify to the colour of the red flesh of a melon. By thirty minutes from zero the colour will have mostly faded and night is upon us. It may be emphasised that a desert sunset is a response of the whole firmament in which every sector plays its part.

Whether the phenomenon depends on changing air and moisture densities as the sun passes away from the heated desert surface, or to fine dust suspended in the air, may be left to preciser students of the subject.

Desert sunsets may also be well observed from any of the summits of the Yellow Hills, that system of bare, barchan sand dunes to the north of Cairo (cf. p. 75) Besides commanding a wide horizon, these hills make an especially sensitive screen for after-glow effects. At zero they change from amber to a corpse-like green, and then with the after-glow come ruddily to life for a space before darkness closes in.

In long trips on the desert you are much vexed by the sun, and nothing is so refreshing as to enter a cloud shadow and be rid of it, if only for a few minutes. There is a great fall in temperature and cessation of glare for which you are grateful,

and you wish the car could keep in the shade for the rest of the day. It is pretty to watch these shadows coursing across the sunlit desert, like splodges of ink which play all sorts of antics when they cross hilly country. On a dead flat you hardly see the shadow till it is presented towards you on sloping ground. These antics we saw afar off on the pyramids (Pl. II, fig. 3). The shadows were moving from us, and we saw the black shade creep up a pyramid till it looked as if it had received a coat of tar ; presently, as the cloud passed, the base became light, and gradually the illuminated zone encroached on the shadow till there remained for an instant a blackened speck which flew off as a bird might, and we saw it no more.

XI

MISCELLANEOUS NOTES AND OBSERVATIONS

Alien Plants in Norfolk.—An alien worthy of note, *Axyris amarantoides* L., has appeared for the last two years along the side of a road in the parish of Leziate, W. Norfolk, where it appears to be established. I believe it has not been recorded for the county before. Axyris is a Chenopodiaceous genus of central and northern Asia. Beside a sand crushing mill in the same parish there occurred this year the Boraginaceous aliens *Amsinckia lycopsioides* and *A. angustifolia*, the former of which was noted for Norfolk in the last number of the Transactions. Growing with them were *Centaurea solstitialis* and *Sisymbrium pannonicum*.—Oct., 1930. C. P. Petch.

Swallows and Martins in Norfolk.—With the object of trying to form a census of the " swallow " population of Norfolk the " Eastern Daily Press " was persuaded to offer two prizes, each of two guineas, (1) for the largest number of house-martins' nests on any single building in the county ; (2) for the largest number of swallows' nests on any farmstead or homestead in Norfolk. During the last week in June we received the returns, 135 in number, giving a total of 3019 nests. We inspected many of these and arrived at the conclusion that not more than 200 of this number were swallows'

nests. The largest number of house-martins' nests were under the eaves of a farmhouse in Cringleford (Newfound Farm), a total of 106 nests, where these birds have nested in large numbers for many years. The next highest score was 89 occupied nests on a house at Beighton. The highest total, 34, of occupied swallows' nests was found in some old farm buildings at South Raynham. The returns were generally distributed from over the county, the smallest number being received from the Breckland district, where the light, sandy nature of the soil, with the absence of mud, does not provide very suitable nest-building material.—EDITOR.

XII

MICHAEL BEVERLEY, M.D.

1842—1930

With the death of Michael Beverley, which occurred at his residence at Overstrand on September 1st, 1930, in his 89th year, the Society has lost the last of its original members. After becoming qualified as a doctor at Edinburgh he returned to Norfolk and for some years was house-surgeon at the Norfolk and Norwich Hospital. Here he had pupils under his charge, and to encourage these young men in field natural history he was in the habit of taking them for botanical rambles around Norwich.

It was whilst he was holding this post at the hospital that our Society had its origin—in his room; for, to quote his own words, "it was the outcome of several conferences, and eventually the Rev. J. Crompton joined us and he was elected the first president." This was in 1869, and three years later, in 1872, Beverley himself was elected to the presidency. Except for his presidential address on that occasion, on Edible Fungi, which is published in the first volume of our Transactions, Beverley does not seem to have contributed any other paper to the Society; but that the latter felt beholden to him for his activities on its behalf in its early days is evidenced by the fact that it elected him a Vice-President in 1874, a position he held up to the time of his death.

For over fifty years, with his partner, S. H. Burton, he conducted a large general practice in Norwich and the district, and this fact probably explains why his activities on behalf of the Society were checked.

All his life he was a keen gardener, and for many years he would rise early and, previous to his day's work in his practice, go over to Brundall to lay out that riverside plot of land which he had purchased, and which, under his careful supervision, eventually became the most notable rose garden in the district, indeed, one might almost say, in Norfolk.

For the last twenty years, or so, he lived in retirement at Overstrand, where, to his delight, he had the privilege of

entry at all times to Lady Battersea's beautiful garden at the Pleasaunce.

He leaves one son, Mr. Russell Beverley, and four daughters.

ARTHUR BENNETT, A.L.S.

1843—1929

The death of Arthur Bennett removes from the Society our most distinguished botanical member. He was born and educated at Croydon where, after leaving school, he entered his father's business, that of builder and decorator, and continued to reside at Croydon for the rest of his life His fame as a botanist might be said to have been almost world-wide, and he made contributions to most of the British works dealing with systematic botany. In the preface to Sir J. D. Hooker's "Students' Flora of the British Islands" the author states his indebtedness to Mr. Arthur Bennett, F.L.S., of Croydon, for "revising the genus Potamogeton and for notes upon Carices." Also, in the preface to the 9th edition of Babington's "Manual of British Botany" by H. & J. Groves the editors are "indebted to Mr. Arthur Bennett for his frequent help with specimens and notes."

The groups he was most interested in were Naiadaceæ, Carices and Characeæ, but he was always ready to give an opinion on the status of any British plant. By correspondence he was acquainted with many distiguished foreign botanists and frequently quoted notes from different European languages, so that he was able to take a very wide view in discussing the British flora.

He was elected a F.L.S. in 1881, and in 1910 had the honour of being made an A.L.S. He joined the Norfolk and Norwich Naturalists' Society in 1883, to which he was evidently introduced by the late H. D. Geldart with whom he corresponded for many years. He was also a friend of Hampden G. Glasspole of Ormesby, a botanist of some note in his day and an original member of the Norfolk and Norwich Naturalists' Society.

Though much interested in the British Flora Bennett also studied, one might say intensively, the flora of Arctic, Scandinavian, Scottish and North American regions, even

contributing to the "Philippine Journal of Science" a paper on the Potamogetons of the Philippine Islands: in fact, Potamogetons from most parts of the world were sent to him for examination. He contributed papers, mostly on the flora of Scotland and the Faroe Isles, to the Botanical Society of Edinburgh, the Annals of Scottish Natural History and the Scottish Botanical Review. Also, from time to time, he sent Notes to the Journal of Botany.

It is interesting to Norfolk naturalists to know that notwithstanding the amount of general systematic work he was able to accomplish, one of his primary attractions was to the aquatic flora of East Anglia. He stated in one of his letters to H. D. Geldart that this attraction, especially to the fen-lands, may have been due to his early reading of Kingley's "Hereward the Wake." That this attraction bore fruit is shown by his discovery of two new plants for Norfolk, one of which was new to Britain. These were *Naias marina* L. and *Chara stelligera* Bauer. The former, which apparently has only been recorded for Norfolk, was first discovered by Bennett in July, 1883, when he was on a visit to the county with his daughter, with the determination of finding a new plant in addition to the one he had already found in July, 1880, namely, *Chara stelligera* Bauer. The finding of these two plants is well described by him in Vol. IX of our Transactions. He assisted Geldart in his paper on the Flora of Hudson's Bay; also, Feilden and Geldart in the identification of the plants mentioned in their joint papers on Kolguev Island, Lapland and Spitzbergen (Transactions N. & N. Nat. Soc. Vols. IV and VI). In all, Bennett contributed twenty-seven papers to our Transactions: the first in 1882 on the Naiadaceæ and Characeæ of Norfolk, which was the only account of these plants in the county that had been published up to that date; and his last, "Notes on the Flora of Norfolk" which appeared in Vol. XII, p. 477. His papers represent a valuable addition to our knowledge of Norfolk botany. His long correspondence with H. D. Geldart has already been mentioned: others he helped were Mr. A. W. Preston, who recently presented his own herbarium to the Castle-Museum; the late Dr. F. Long, who bequeathed his herbarium, also, to the Museum; and the writer of this notice, who maintained a correspondence

with him for over thirty years. Not only was he of material assistance in the naming and identification of plants, but also he gave valuable advice in the compilation of " A Flora of Norfolk " warning the editor as to what particular errors should be avoided, and supplying examples of the plan on which he considered the book should be modelled. Thus, he was entitled to share with the editor any merit that attached to the book.

Bennett was always an admirer of the late H. C. Watson, the author of " Topographical Botany " and the " Cybele Britannica," and during the last few years, in conjunction with C. E. Salmon, carried on the topographical botany of the British Isles since Watson's time as a special supplement to the " Journal of Botany." The " Watson Botanical Exchange Club " was started in 1884, when Bennett joined it and at once became general referee, which post he held till 1905. His opinions were always greatly valued by the club, and in consideration of his much appreciated assistance to the other members he was presented, in 1904, with a series of fascicles of Salices by the Revs. E. F. and W. R. Linton.

Arthur Bennett was one of those men who, although much occupied with his business throughout his life, was yet able to find time to pursue with zest his favourite hobby of botanical research. He gave a devoted attention to anything which he considered might advance our knowledge about plants, and that without any ulterior motive of worldly gain.—W. A. N.

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1. The practical study of Natural Science.

2. The protection, by its influence with landowners and others, of indigenous species requiring protection, and the circulation of information which may dispel prejudices leading to their destruction.

3. The discouragement of the practice of destroying the rarer species of birds that occasionally visit the County, and of exterminating rare plants in their native localities.

4. The record of facts and traditions connected with the habits, distribution, and former abundance or otherwise of animals and plants which have become extinct in the County ; and the use of all legitimate means to prevent the extermination of existing species, more especially those known to be diminishing in numbers.

5. The publication of Papers on Natural History contributed to the Society, especially such as relate to the County of Norfolk.

6. The facilitating of a friendly intercourse between local Naturalists by means of Meetings for the reading and discussion of papers and for the exhibition of specimens, supplemented by Field-meetings and Excursions, with a view of extending the study of Natural Science on a sound and systematic basis.

7. Any Member who, in the opinion of the Committee, contravenes the objects of the Society is liable to have his name erased from the List of Members.

TRANSACTIONS

OF THE

Norfolk and Norwich

NATURALISTS' SOCIETY

PRESENTED TO MEMBERS FOR

1930—31

VOL. XIII.—PART II

EDITED BY MISS A. M. GELDART

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1924 Mortimer Ernest, The Red House, Wrentham, Suffolk
1922 Mountfield Miss M., Horsford, Norwich
1929 Moxey Llewellyn
1920 *Mullens Major W. H., Westfield Place, Battle, Sussex
1921 *Murton Mrs., Cranbrook Lodge, Cranbrook, Kent

Elected

N

1926 Nash J. E., 37, Mulgrave Road, Dollis Hill, London N.W.10
1922 Nevill Rev. R. W., Old Catton Vicarage, Norwich
1926 Nevill Mrs. R. W. ,, ,, ,, ,,
1925 Neville Sir R. J. N., Sloley Hall, Norfolk
1931 Nevill Capt. G. A., The White Lodge, Swanton Morley, East Dereham
1930 Nevill Capt. G. H., Swanton Morley, Norfolk
1889 Nicholson W. A., *Hon. Mem.*, 5, Mill Hill Road, Norwich
1915 Nightingale S. R., Scratby Hall, Great Yarmouth
1926 Norfolk and Norwich Library, Norwich
1919 Norgate Philip, Swanington, Norfolk
1915 Norwich Public Library
1927 Notcutt R. F., Woodbridge

O

1927 O'Donnell O., Great Fransham, East Dereham
1921 Offord Miss Georgina, " The Larks," Water Lane, Costessey
1914 Oliver F. W., D.Sc., F.R.S., *Hon. Mem.*, *V.P.*, Ballard's Barn, Limpsfield Common, Surrey
1924 Orgill Miss M. A., Garboldisham, Diss
1930 Owen Miss F., 80, Mundesley Road, North Walsham

P

1889 Page G. W., Walsingham, Norfolk
1919 Pain Percy, Dersingham, King's Lynn
1913 Paine Rev. N. W., Great Melton Rectory, Norfolk
1919 *Palmer Mrs. P. Hurry, " Red Roofs," North Drive, Great Yarmouth
1912 Parker H., Lyncroft Road, Pakefield, Lowestoft
1925 Parker Miss Molly Hyde, Smeetham Hall, Sudbury, Suffolk
1921 Parker R. E., Marlingford, Norwich
1873 Partridge Rev. W. H., M.A., " Breckles," Leed Street, Sandown, I. of W.
1889 Patterson Arthur H., *Hon. Mem.*, Ibis House, Lichfield Road, Gt. Yarmouth
1920 Patteson Mrs. F. E., Great Hautbois House, Norfolk
1901 *Paul J. J. Dawson, Eaton Grove, Norwich
1911 *Payler Donald, The Museum, Birmingham
1923 Peed John, Aylsham
1928 Penrose F. G., M.D., " Woodbury," East Cliff, Bournemouth
1926 Percy Lord William, D.S.O., Catfield Hall, Norwich
1903 Petre Col. B., Westwick Hall, Norfolk
1925 Petrie Mrs., The Dower House, Heydon, Norwich
1926 Phillippo G., 7, St. Philip's Road, Norwich
1925 Pilch R. G., 45, Grosvenor Road, Norwich
1930 Podmore R. E., South Park College, Wadhurst, Sussex
1931 Potts F. A., La Chaumiere, West Runton, Norfolk
1923 Pope Dr. G. Stevens, Eaton Road, Norwich
1931 Pratt Alfred, The Cottage, Cliff Avenue, Cromer
1919 Preston Sir E., Bart., Beeston Hall, Norwich
1900 Preston F., 66, The Close, Norwich
1913 Purdy T. W., Woodgate, Aylsham
1925 Purnell Mrs. Ralph, 12, Clarendon Road, Norwich
1887 Pycraft W. P., A.L.S., F.Z.S., British Museum (Natural History), London, S.W.

Elected

R

1929 Ramage H. P., Ridgemont, Carrow Hill, Norwich
1928 Raywood W., 13, Upper King Street, Norwich
1930 Reeves Derek L., Honingham Hall, Norwich
1925 Reeves Hugh, Honingham Hall, Norwich
1930 Reynolds Miss J., Clipston House, Church Road, Watford
1924 Richmond H. W., F.R.S., King's College, Cambridge
1925 Ringrose B., Farley, Harbridge Green, Ringwood, Hants.
1924 Rippingall Neale F., Langham, Norfolk
1911 Rising A. P., The Manor House, Ormesby, Great Yarmouth
1908 Riviere B. B., F.R.C.S., F.Z.S., M.B.O.U., Hill House, Saxlingham, Norwich
1908 Rogers Commander F. S., R.N., Ingham New Hall, Norwich
1909 Rogers Rev. Henry, Coltishall Hall, Norwich
1908 *Rothermere Rt. Hon. Lord, Hemsted Park, Cranbrook, Kent
1897 *Rothschild Rt. Hon. Lord, F.Z.S., Tring, Herts.
1922 Rounce G. H., The Pines, Park Road, Cromer
1930 Rowell George, 15, The Close, Norwich
1902 *Ruggles-Brice Mrs. R., Keswick Hall, Norwich
1906 Rumbelow P. E., 27, Rodney Road, Great Yarmouth

S

1929 Sainty Miss O., 38, College Road, Norwich
1931 *Salisbury Prof. E. J., D.Sc., F.L.S., Willow Pool, Radlett, Herts
1930 Scratchley Lt.-Col. V. H. S., D.S.O., The Parsonage, West Newton, King's Lynn
1925 Sewell P. E., Dudwick House, Buxton, Norwich
1929 Shaw A., Bixley, Norwich
1922 Shepheard Dr. Samuel, Aylsham
1924 Shepherd Miss A. M., Convalescent Home, Lowestoft
1930 Shilcock Miss Joan R., "Maryland," Sheringham
1921 Silcock Chas., Decoy Cottage, Hoveton, Norwich
1930 Simpson Miss W., Geldeston Lodge, Geldeston, Norfolk
1919 Smith Col. H. F., Didlington Hall, Norfolk
1915 Smith Mrs., Ellingham Hall, Bungay
1891 Smith W. R., Harleston, Norfolk
1917 Sowels Miss, The Rookery, Thetford
1922 Spalding G., 9 ,St Stephen's Street, Norwich
1911 Spurrell J. T., Manor House, Newton St. Faiths, Norwich
1923 Spurrell Miss M., Manor House, Newton St. Faith's, Norwich
1923 Spurrell Miss P., Manor House, Newton St. Faith's, Norwich
1925 Steers J. A., St. Catharine's College, Cambridge
1921 Stimpson Edward, Sall Moor Hall, Reepham, Norfolk
1922 Sumpter Dr. B. G., Brancaster Staithe, King's Lynn
1896 Sutton W. Lincolne, F.I.C., Eaton, Norwich

T

1931 Talbot Sir Gerald, K.C.V.O., C.M.G., O.B.E., Burnley Hall, Somerton, Norfolk
1931 Tate Mrs., Lenwade House, Near Norwich
1921 Taylor Dr. Mark R., 338, Winchester Road, Southampton
1878 Taylor Shephard T., M.B., The Mount, Edgefield, Melton Constable
1921 Thain D., West Somerton, Norfolk
1931 Thomas J. F., Bowden House, Seaford, Sussex
1886 Thouless H. J., "Southernhay," Wroxham

Elected

1929 Tillett Miss I., 2, Claremont Road, Norwich
1896 Tillett Wilfrid S., 2, Claremont Road, Norwich
1920 Todd Lt.-Col. Eardley, Mundham House, Brooke
1902 Todd R. A., B.Sc., The Retreat, Elburton, Plymouth
1923 Tomes Lady, Mannington Hall, Norfolk
1910 Tracy N., 3 King Street, King's Lynn
1925 Tucker B. W., 9, Marston Ferry Road, Oxford
1906 Turner Miss E. L., F.L.S., H.M.B.O.U., *Hon. Mem.*, 13, Storey's Way Cambridge
1927 Turner Edgar, "Kuruman," Walberswick

U

1923 Upcher Rev. E. C. S., Weybourne Rectory, Norfolk
1921 Upcher H. E. S., The Gables, Upper Sheringham
1930 Upcher Mrs. H. E. S., The Gables, Upper Sheringham

V

1917 Vincent James, Hickling, Norfolk

W

1921 Wallis Rev. M. C.,, Beaconsfield, St. Peter's, Jersey
1923 Walter Mrs. Cyril, Old House, Drayton, Norwich
1923 Waterfield Miss, Attlebridge, Norfolk
1923 Waterfield Miss Penelope, Attlebridge, Norfolk
1928 Watson J. B., c/o Barclays Bank Ltd., Surbiton, Surrey
1926 Wemyss Major, Bryn House, Wroxham
1927 Wemyss Mrs. ,, ,,
1923 Wenn Miss, Ingham, Norfolk
1931 Wheeler G., Tatterford Rectory, Fakenham, Norfolk
1883 *Whitaker Joseph, F.Z.S., Rainworth Lodge, Mansfield
1928 Whitwell Miss, 1, Cambridge Street, Norwich
1922 Willett W. L., Paddock Wood, Kent
1913 Williams Miss Margaret, 8, The Close, Norwich
1929 Wilson Mrs. Gerald, Saxlingham Nethergate, Norwich
1930 Wing J. Sladen, 21, Cheyne Gardens, Chelsea, S.W.3
1909 Witherby H. F., M.B.E., F.Z.S., 326, High Holborn, W.C.
1928 Wood M. S., M.D., Woodland House, Windermere
1931 Woolley Miss, B.Sc., Blyth Secondary School, Norwich
1923 Woolsey G. E. W., Old Catton, Norwich
1907 Wormald Hugh, M.B.O.U., Heathfield, East Dereham
1922 Wortley Francis, "Seathwaite," Sheringham
1929 Wortley Roger, "Seathwaite," Sheringham
1920 Wyllys Hugh, "Shrublands," Southtown, Great Yarmouth

Y

1915 Yarmouth Free Library, The, Great Yarmouth

TOTAL

Honorary Members	... ...	3
Life ,,	... ...	29
Ordinary ,,	... ...	384
		416

The Treasurer in Account with the Norfolk and Norwich Naturalists' Society, Year Ending 30th April, 1931

I. GENERAL ACCOUNT

Dr.

1930-31	£	s.	d.
To Balance from 1930	26	10	0
„ Subscriptions	149	19	6
„ Sale of "Transactions"	0	15	0
„ „ "Flora of Norfolk"	1	15	4
„ Interest on War Stock	11	3	10
„ Donations to Publication Fund	6	10	0
„ Excursion Secretary	0	4	0
„ W.B.P.F. Subscriptions	7	7	0
„ Life Member Subscription	8	0	0
	£212	4	8

Cr.

	£	s.	d
By "Transactions,"	101	10	0
„ Postages	7	11	4
„ Printing	6	4	9
„ Library Rent	6	6	0
„ Expenses of Meetings, Teas, etc.	5	0	10
„ Fire Insurance	0	13	6
„ W.B.P.F. Re-fund of subscriptions	7	7	0
„ Norfolk and Norwich Savings Bank, Life Subscription	8	0	0
„ Hooker Memorial	2	2	0
„ Hooker Plaque Framing, etc.	0	19	6
„ Balance on Current a/c at Bank	66	9	9
	£212	4	8

Examined and found Correct,
(Signed) W. A. NICHOLSON,
May, 1931

II. LIFE MEMBERSHIP FUND

1930–31.	£	s.	d.	1931	£	s.	d.
To Balance from 1930	27	14	11	April 30 By Balance in Savings Bank	38	18	6
„ Bank Interest		13	7				
„ Interest on War Loan	2	10	0				
„ Life Member Subscriptions	8	0	0				
	£38	18	6		£38	18	6

Examined and found correct,
(Signed) W. A. NICHOLSON.

BRITISH MUSEUM
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III. DEPOSIT ACCOUNT

1930-31	£	s.	d.	1931	£	s.	d.
To Balance, Capital from 1930	23	11	5	April 30 By Balance at Barclays Bank	24	0	9
„ Bank Interest		9	4				
	£24	0	9		£24	0	9

Examined and found correct,
(Signed) W. A. NICHOLSON.

IV. SPECIAL PUBLICATION FUND

1930-31	£	s.	d.		£	s.	d.
To Donations—				Transferred to General Account	6	10	0
Sir R. J. N. Neville		10	0				
W. C. Ketton-Cremer		10	0				
Mrs. Bagnell		5	0				
Mrs. Graves		5	0				
H. C. Davies	5	0	0				
	£6	10	0		£6	10	0

Examined and found correct,
(Signed) W. A. NICHOLSON.

List of Investments and Assets

	£	s.	d.
£155 6s. 10d. 5 per cent. War Stock 1929-47 at cost	150	18	1
64 War Savings Certificates, dated 24.1.19	64	0	0
31 War Savings Certificates, dated 17.7.23. at cost	24	16	0
£191 1s. 10d., 4 per cent. Consolidated Stock, at cost	166	9	7
Balance in Savings Bank	38	18	6
Deposit Account Barclays Bank	24	0	9
	£469	2	11

ADDRESS

Read by the President, Miss Alice M. Geldart, *to the Members of the Norfolk and Norwich Naturalists' Society, at their Sixty-Second Annual Meeting, held at the Castle Museum, Norwich, on April 28th,* 1931.

Ladies and Gentlemen,

In vacating this chair at the termination of my second Presidency of this Society, I am pleased to be able to leave the Society in such a healthy and flourishing condition. During the year we have elected twenty-five new members, and although we have lost a few by death and resignation, our numbers are now higher than they have ever been in the history of the society. Our monthly meetings at the Castle Museum have been well attended, and during the summer we had two very enjoyable excursions. The first of these was to the beautiful azalea gardens at Stody Lodge, where we were hospitably entertained by Mr. and Mrs. R. E. Horsfall; and the second to Scolt Head Island.

In connexion with the Nature Reserves in Norfolk, I must mention the new sanctuary, Alderfen Broad, that has been purchased by The Norfolk Naturalists Trust. This is a typical piece of broadland, of about seventy acres, which is now safe for all time from the exploitations of the increasing number of trippers that visit the district during the summer. Unfortunately there still remains a debt upon the property, and I am pleased to think that our society has made a special contribution towards the extinction of this debt.

THE HOOKERS IN NORFOLK AND SUFFOLK

On Sunday afternoon, August 17th, 1930, Dr. S. H. Long and I, as honorary Secretary and President, represented the Norfolk and Norwich Naturalists' Society at the unveiling of the tablet placed on the wall of the south aisle of Halesworth Church,

Suffolk, in memory of the distinguished botanists Sir William Jackson Hooker and his son, Sir Joseph Dalton Hooker.

The tablet has an ornamental bordering of classic design, and the inscription in incised relief is :—

" This tablet records the association with Halesworth of Sir William Hooker, and of his son, Sir Joseph, who, in succession, became Directors of the Royal Botanic Gardens, Kew. Sir William lived in Halesworth from 1809 to 1820, and here Sir Joseph was born in 1817. Erected 1930."

An address was delivered and the memorial unveiled by Sir David Prain, F.R.S., formerly Director of Kew Gardens ; it was dedicated by the Bishop of St. Edmundsbury and Ipswich who preached the sermon. Also present were Dr. A. W. Hill, F.R.S., who is now Director at Kew ; Professor F. O. Bower, F.R.S., president of the British Association (1930) and formerly Professor of Botany at Glasgow ; Professor F. W. Oliver, F.R.S., honorary secretary of the Hooker Memorial Committee ; and the chairman, Lord Ulleswater. Mr. Reginald and Mr. Richard Hooker, sons of Sir Joseph, represented the family ; and all the people of Halesworth had assembled to do honour to their former fellow-townsman and his son, and to welcome well-known scientists and representatives of learned societies from all parts of the world, the ceremony having been arranged to coincide with the meeting at Cambridge of the International Congress of Botanists.

The Norfolk and Norwich Naturalists' Society had been invited to join the Royal, the Linnean and other societies in subscribing to the memorial.

It is not my intention to eulogise this remarkable father and his still more distinguished son as the Directors of Kew Gardens, nor as leaders of scientific thought in the last century, nor for their world-wide influence as collectors, teachers and writers of botanical works, but I desire to record their association with Norfolk and Suffolk. For this purpose I will amplify a portion of my Presidential Address on ' Sir James Edward Smith and some of his Friends.' (Transactions of the Norfolk and Norwich Naturalists' Society, 1913-14, vol. ix, Part v. pp. 643–692.)

For several centuries a branch of the Hooker family had been connected with the staple city of the Devonshire wool

merchants, and during the latter part of the eighteenth century Joseph Hooker (1753–1845) was a confidential clerk at Exeter in the firm of wool staplers, Baring Brothers, with whom his family was distantly connected. He was mainly a self-educated man, fond of reading and a fair German scholar.

Leaving Exeter Joseph Hooker settled among the wool staplers of Norwich. He took up his residence on the east side of Magdalen Street between St. Saviour's church and the City Gate. The house fronted immediately on to the street. The property is bounded on the north by the Woolcombers' Arms Yard at the northern limit of St. Saviour's parish. The identification of the house is fixed by a letter written to Sir R. H. Inglis Palgrave by Sir J. D. Hooker in 1889. Describing his recent visit to Norwich he says " I revisited the old School and the old house in Magdalen Street, now bisected and one half a beershop. I called at the Colmans. Mrs. Cozens-Hardy, Mrs. Colman's mother, was there, a very handsome old lady of eighty. Her father had lived in a house at the back of my grandfather's, their gardens being ' dos à dos ' separated by a wall. She remembered it all perfectly and knew my grandfather well." This Mrs. W. H. Cozens-Hardy was daughter of Mr. Thomas Theobald a merchant who lived in Peacock Street at a white house used later as the Stanley Home for Girls, and now called Stanley House. The large garden of this house extended nearly to Magdalen Street. Mr. Ernest Bullard of the Anchor Brewery has kindly facilitated perusal of deeds which prove that the ' Rose ' Inn (formerly the ' White Rose ') 77, Magdalen Street, and the adjoining No. 75, now a confectioner's shop, are the " bisected " portions formerly occupied by Joseph Hooker.

In the Norwich Pollbook of 1802 Joseph Hooker is mentioned as " merchant's clerk, freeholder, resident in St. Saviour's parish." He was an amateur gardener keenly interested in his collection of exotics and succulents, the cultivation of which was a favourite pursuit among the citizens of that time. His grandson writes " I well remember his little garden and greenhouse of succulent plants."

Joseph Hooker married Lydia a daughter of James Vincent, a worstead manufacturer of Norwich. It has been stated by Leonard Huxley in his " Life and Letters of Sir Joseph Dalton

Hooker " that Lydia was a cousin of George Vincent (born 1796), a distinguished member of the Norwich School of Artists, a landscape painter, pupil of John Crome and contemporary with J. B. Crome. But Sir J. D. Hooker in ' A Sketch of the Life and Labours of Sir William Jackson Hooker ' (Annals of Botany, vol. xvi, No. LXIV, December 1902) distinctly states that James Vincent was grandfather of George, and that W. J. Hooker was his cousin.

Joseph and Lydia Hooker had two sons, the elder of whom was named Joseph. The younger son, William Jackson Hooker, was born at Magdalen Street, on July 6th, 1785, and named after his cousin and godfather William Jackson of Canterbury, whose father had married Sarah Vincent, Lydia's sister. W. J. Hooker was educated at King Edward VI's Grammar School in the Cathedral Close, Norwich, the head master being the Rev. Dr. Samuel Forster who, as curate at St. Clement's Church, had officiated at the marriage of John Crome with Phœbe Berney in 1792. It is interesting to note that his father was the Rev. Thomas Forster, rector of Halesworth, 1747–1786.

At home young Hooker devoted his spare time to entomology, drawing, and reading books of travel and natural history.

On the death of William Jackson, in 1789, his godson inherited his property at Snodland near Chatham. For the purpose of learning estate management, on leaving school, he went as a pupil to Mr. Robert Paul, a gentleman farmer who resided at Starston Hall. Starston, fifteen miles from Norwich, is a picturesque village near Harleston on the southern border of Norfolk. At that time the village stream, a tributary of the Waveney, was crossed by ford and footbridge, the present bridge not being built till 1825. A mile to the north of the church, Starston Hall, a building in the Elizabethan style partly surrounded by a moat, stood among fields at a considerable distance from roads and lanes remarkable for the breadth of their grass verges.

During a sojourn of some years in this well-wooded and rural district Hooker was able to devote himself to the practical study of entomology and botany. He was corresponding with the most distinguished entomologists in England, among them the Rev. William Kirby who, from 1782, was curate and vicar of a village only twenty miles from Starston, Barham

in Suffolk. Having himself collected in his parish 153 wild specimens of English bees he described them in his 'Monographia Apium Angliæ' 2 vols., 8vo., published at Ipswich, 1802. In the Transactions of the Linnean Society, Kirby records that in 1805 he had dedicated to the brothers Hooker a species of *Apion*, saying :— " I am indebted to an excellent naturalist, Mr. W. J. Hooker of Norwich, who first discovered it, for this species. Many other nondescripts have been taken by him and his brother, Mr. J. Hooker, and I name this insect after them, as a memorial of my sense of their ability and exertions in the service of my favourite department of natural history."

Joseph Hooker junr., died of consumption in 1815; his tombstone is in the N.W. corner of St. Saviour's churchyard. His collection of insects was purchased by the British Museum. Sir J. D. Hooker remembered his grandmother showing him the glazed drawers of his father's insect cabinet at the Magdalen Street house. The collection was not taken to Halesworth. On moving to Glasgow in 1820, W. J. Hooker sold it to Mr. Joseph Sparshall, of Norwich. Sir Joseph Hooker states that the collection is now in the Norwich Museum. I enquired at the Norwich Castle Museum for the Hooker Collection, but nothing is known of it. There are however two tall cabinets with " collected by Mr. Joseph Sparshall " painted on the fronts, and another case of a different pattern with the figure " 3 " on it. Was No. " 3 " the Hooker cabinet ? No. 1 now contains British Lepidoptera, No. 2 has beetles and other insects, and No. 3 contains the foreigners.

In 1805 Kirby made the acquaintance of William Spence, who joined him in his 'Introduction to Entomology' which was first suggested in 1808; he was a correspondent of Hooker, as were also Alexander Macleay, secretary of the Linnean Society, and A. H. Haworth who made a great collection of lepidopterous insects and cultivated a large quantity of plants which he described in 'Synopsis plantarum succulentarum,' an 8vo. vol. published in London, 1812.

Sir J. D. Hooker says of his father that " early in life he devoted himself to ornithology, visiting the Broads and sea-coast of Norfolk, which abounded in rare birds, shooting, stuffing and drawing them, besides learning their habits and songs.

Sixty years later he knew the birds in Kew Gardens by the eye and the ear, and in a manner which surprised me. Though a keen ornithologist and as keen an entomologist, he was almost morbidly averse from taking life; he never shot for sport or for the pot, and many years afterwards when instructing me in entomology he was ever urging me to kill with the least suffering, and never to take more specimens than were necessary."

At the age of twenty W. J. Hooker was again living at home and became a frequent visitor at the Mill House at Costessey, four miles from Norwich, helping Mr. Simon Wilkin to plant his experimental botanical garden arranged under the Linnean system—the initial effort of the future Director of Kew Gardens. Hooker was well versed not only in the flowering plants, but also in the mosses, Hepaticæ, lichens, and fresh-water Algæ of Norfolk. The care and industry with which he worked are shown by his statement in Curtis's 'Flora Londinensis':—"In our earlier days we have examined, we may say, hundreds of acres in the west of Norfolk, abounding in the Primrose, the Cowslip and the Oxlip, and our attention has been continually directed to the tracing of intermediate varieties between them."

Acting on the advice of Dr. J. E. Smith, President of the Linnean Society, residing in Norwich, Hooker decided to devote himself to the study of Botany. Towards the end of December 1805, he went out to shoot in a plantation not three miles from home, at Sprowston Woods, on the borders of Mousehold Heath, where the soil is of a turfy and sandy nature. On some tree-stumps he noticed not more than ten specimens of the tiny moss *Buxbaumia aphylla* which, though recorded for Ireland by Dr. Wade, previously had not been reported for England. Neither Hooker nor any other searcher ever found it at Sprowston again, and the same scarcity distinguished its appearance at Sawley Moor, near Ripon, Yorkshire, where it was found only once. At the Meeting of the British Association in Norwich in 1868 the third record for it in England was made by Professor M. A. Lawson of Oxford, who had found six specimens on the freshly upturned clearings of a ditch skirting a pinewood at Virginia Water in April 1868. A letter lately received from Mr. H. H. Knight points out that 'The British Moss Flora'

by R. Braithwaite has for England " Ogden Clough, Tintwistle, Cheshire (Scholefield, 1867)." *B. aphylla* now has been recorded for ten vice-counties of England and Wales, and for several places in Scotland.

Dr. James Smith advised Hooker to send a specimen of the Buxbaumia to Mr. Dawson Turner, F.R.S., author of ' Muscologiæ Hibernicæ Spicilegium,' and, with L. W. Dillwyn, F.L.S., of ' The Botanist's Guide through England and Wales.' This introduction was immediately followed by an invitation from Mr. Turner to visit him at Great Yarmouth, where he was resident partner in Gurney's Bank House. Here Hooker became a frequent guest for protracted periods, was very popular with the Turner children, and devoted himself to aiding Mr. Turner in his great work, the ' Historia Fucorum.'

A young man eight years older than William Hooker was born in the modest house of a working shoemaker in Elephant Yard, Magdalen Street, Norwich. He was sent to London to learn picture frame making. Returning to Norwich when W. J. Hooker was about fifteen years of age this young man, John Thirtle by name, opened a shop close to his home, and on the opposite side of the street from the Hookers' house. The window of this shop he filled with prints, and specimens of his portraits and miniatures. Do you think that the young Hookers would always pass by on the other side? Here they could gaze upon the delicate work of the miniaturist. It is this refined delicacy of detail and colour, coupled with true exactness and accurate knowledge of the structure of the objects portrayed, that W. J. Hooker applied to his illustrations of botanical subjects.

The demand for miniatures was great when this was the best form of portable portraiture. Miniatures required great neatness of execution and close attention to detail ; and these qualities were still more essential when the brush gave place to the pencil or the hard-pointed tools used in engraving and in etching —a process resulting in reproductions which have been described as ' moins dessinées qu' écrites.'

The first exhibition of the Norwich School of Artists was held at Sir Benjamin Wrench's Court in 1805.

We usually think of the Norwich Painters as producers of portraits and landscapes in various media, but there were

others. James Sillett excelled in miniatures, but he also exhibited careful representations of fruit, flowers, birds, fish, game and insects.

Another Norwich man John Curtis began as a writing clerk, was taught to engrave, and executed the plates for Kirby and Spence's ' Introduction to Entomology.' Again we find Henry Ninham, brought up as a heraldic painter and copperplate engraver, a training which accounts for his neatness of execution as well as for his absolute accuracy in detail. These qualities, combined with a power of portraying the actual spirit and life of the plant, we find in the drawings of W. J. Hooker—the skill of the Norwich School of Painters born in him and applied to a branch of scientific work in a highly technical form. While inheriting his artistic talent from his mother, his love of plants came from his father's side.

The painting of portraits did not ensure a fixed income for the Norwich artists, and John Crome and John Sell Cotman, finding that the fees of a drawing master were essential, exerted influence over a wide circle of pupils within a radius of many miles from Norwich.

John Crome, who kept a gig and two horses, paid weekly visits to Yarmouth, where his headquarters as a welcome guest were at the house of Samuel Paget. Mrs. Paget and her children were regular pupils of Crome. The Paget House was further down the South Quay than the Bank House where Dawson Turner lived. The Misses Palgrave at Coltishall were taught drawing by Cotman, and one of them is known to us as Mrs. Dawson Turner. She and her daughters were Cotman's pupils during his weekly visits to Yarmouth, before he took up his residence at Southtown in 1811. It is probable that Dawson Turner and John Sell Cotman were cousins. Turner was not the man to let people rest when he wanted them to work for him. His daughters were expected to take a practical interest in his artistic undertakings, and I have it on good authority that his rule for them was " No dinner till you have finished your task." The eldest of these daughters at the age of eighteen became Mrs. W. J. Hooker.

In Dawson Turner's house, where the walls were not covered with bookcases they were hidden by pictures, some of which are now in the Wallace Collection. William Hooker on his

The Brewery House, Halesworth

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frequent visits to Yarmouth would find himself in even closer touch with the cream of the Norwich School of Artists than might have been possible if he had stayed at home.

In the autumn of 1806 W. J. Hooker was elected a Fellow of the Linnean Society, and he was admitted F.R.S. in 1812. He studied Buchanan-Hamilton's Nepal mosses in Dr. (afterwards Sir) James Smith's herbarium at 29, Surrey Street, Norwich, and some of these formed the subject of his first published paper read before the Linnean Society in June 1807. The following year the President dedicated a genus of mosses as follows :—" I have great pleasure in dedicating this genus (*Hookeria*) to my young friend William Jackson Hooker, F.L.S., a most assiduous and intelligent botanist, already well known for his interesting discovery of *Buxbaumia aphylla*, as well as by his scientific drawings of *Fuci* for Mr. Turner's work ; and likely to be far more distinguished by his illustrations of the difficult genus *Jungermannia*, to which he has given particular attention." The plate accompanying Dr. Smith's paper is signed " W. J. Hook : delint," The only British species is *Hookeria lucens* found in moist shady situations in various parts of England and gathered by W. J. Hooker on Holt heath, Norfolk, in wet places among grass, bearing fruit in February.

In the summer of 1807 Hooker went with Mr. and Mrs. Turner for a botanical tour in Scotland, and the following year the summer tour was again to Scotland, with his friend Mr. William Borrer. It is probable that on this occasion he became one of the founders of the Wernerian Society of Edinburgh, the memoirs of which extend from 1808 to 1832. Hooker's ' Flora Scotica' was published in 1821 as a guide for work in the field during the summer rambles of his Glasgow students, but much of the material for it had been collected during these previous visits to Scotland.

In 1772 Sir Joseph Banks had visited Iceland ; another opportunity occurred in 1809 for a naturalist to visit that country when a vessel named the " Margaret and Anne," with a letter of marque, was chartered by a London firm, for the purpose of obtaining a cargo of tallow. Iceland then belonged to Denmark, which was at war with England, and the journey was adventurous. Hooker seized the occasion to see Iceland. He took a letter of introduction and a handsome present of books

and engravings to the Governor of the Island from Sir J. Banks, who had previously helped the islanders to avoid famine when the English cruisers had prevented the supply of food from Denmark and Norway. While Hooker was in Iceland there was a revolution, and the "Margaret and Anne" on its return journey conveyed some Danish prisoners of war. When two days out in a dead calm the prisoners set fire to the ship which, being laden with oil and tallow, smoked and blazed till it was burnt out. The crew and passengers were rescued by another vessel and taken back to Iceland. Hooker lost all the collections and drawings he had made during the three months' tour, except four weeks of his journal. Soon after his return in September he commenced writing an account of the expedition, Sir Joseph Banks liberally allowing him to use the material he had collected in 1772, his own MS. journal and the drawings made by the artist who had accompanied him.

In 1811 Hooker printed, for private distribution only, an octavo volume of upwards of 400 pages with four plates. Sir Joseph urged him to publish it. The second edition with additions, in two volumes, with two maps and four plates, dedicated to Sir Joseph Banks, appeared in 1813, and 'The Journal of a Tour in Iceland' became a standard work.

Dawson Turner, anxious still to have the advantage of Hooker's help with the illustrations for the Historia Fucorum (1808–1819) and hoping to settle him permanently within reach of Yarmouth, induced him to take a quarter share in a brewery at Halesworth (Suffolk) in partnership with himself and Mr. Samuel Paget of Yarmouth, father of Sir James Paget the celebrated surgeon. For this task Hooker was totally unfitted by training, habits or taste; nevertheless, by the autumn of 1809, he was in residence at Halesworth.

To raise the money for this venture his farm in Kent was offered for sale. Difficulty about the title to the property led to much anxiety, and the estate was not finally disposed of till two years later. Hooker was not only miserable about his affairs, but the brewery did not prosper although Joseph Hooker was appointed locum tenens during his son's absence making preparations for foreign travel for which he craved. During the whole of William Hooker's connection with the brewery

James Turner, brother of Dawson Turner, was resident manager of the Halesworth bank.

In the early nineteenth century Halesworth had about 2,000 inhabitants. By its situation one might expect it to have been a centre for the Suffolk wool trade contributing to the emporium at Norwich, but a stretch of country for ten miles across the northern part of Suffolk, including the neighbourhood of Eye, grew hemp, and Halesworth was the place at which this hemp was made into huckaback. The town also carried on a considerable trade in grain, malt and timber.

This quiet market town, 100 miles from London and twenty miles from Yarmouth, extends on both sides of a tributary of the Blyth, a small river flowing into the sea near Southwold.

Under an Act passed in 1756 the river was made navigable for barges of twenty or thirty tons burthen, the level being maintained by locks. After the opening of the Southwold railway this level was no longer necessary, and the river is now several feet lower than it was in Hooker's time when the water must have been on a level with the path at the bottom of his garden. In the large brewery yard there is a bricked dock into which boats and barges could enter for loading and unloading ; this is now dry.

A long winding street leads down to the market place and to the church, a large Gothic structure with a lofty tower. The Hookers were Church people of an evangelical type, strict in the upbringing of their children and particular as to respectful manners. The father went to few entertainments and mixed little in society, preferring to foster that indomitable industry and love of knowledge for its own sake, which, united to a most charming personality, were the secrets of his success.

The Brewery House is in Quay Street and the Hookers' front door faced the brewery at right angles to the street ; the house has since been extended eastwards. The garden behind the house slopes southward to the river, and is enclosed on the east by the malthouse, and on the west by a brick wall. The garden is partly shaded by a large beech tree on the lawn.

On the occasion of the unveiling of the memorial, Miss Parry, the present occupier of Brewery House, very kindly gave every facility for visitors to go all over the house and garden, the garden where Hooker was the first person in

England to flower *Cattleya labiata* in his little stove, in 1818, as well as *Musa coccinea* and other tropical plants.

Early in 1814 Hooker accompanied Mr. and Mrs. Turner and their family to Paris, then occupied by the Allies. There he met the principal French botanists. After spending some days with M. de Candolle at Montpellier he proceeded through the south of France to Italy and Switzerland, visiting botanists, sketching and botanising. In Paris he was introduced to Humboldt, who engaged him to publish a cryptogamic volume of his ' Plantæ Equinoctiales ' ; but the publisher declined to continue the work, and Hooker produced in 1816 the first part of ' Plantæ Cryptogamicæ,' a very thin quarto volume with four plates drawn by the author and etched by Edwards. The work was expensive and unremunerative ; it was discontinued, and many of the remaining Musci and Hepaticæ were included in Hooker's less expensive ' Musci Exotici,' published in two vols. ; 1818 and 1820.

On June 12th 1815, after an engagement lasting fifteen months, W. J. Hooker married Maria Sarah, eldest daughter of Dawson Turner, and immediately started with his young bride on a long wedding tour to the Lake District, to Ireland and Scotland. They were occupied with sketching scenery and ancient buildings. On their return they settled down at Halesworth and were seldom long without botanical visitors who were occupied with inspecting his herbarium, studying the plants cultivated in the garden ; and there was plenty of time for writing. Henceforth his talented wife assisted him as amanuensis and artist, she was also a keen collector of specimens.

Among their visitors were many distinguished scientists, entomologists as well as botanists. In 1817 M. de Candolle and John Lindley were guests together at Halesworth. The latter, then eighteen years of age, a pupil of Hooker, was son of a nurseryman at Catton near Norwich. It has been stated that Hooker and Lindley were fellow pupils at Norwich Grammar School, but as there was more than thirteen years' difference in their ages this seems hardly likely. Lindley had shown such zeal and ability as a local botanist that, with a view to encouraging him in his pursuit, he was invited to Halesworth, and there he occupied himself with translating

Richard's "Analyse des Fruits," introducing the author's latest corrections, and illustrating his translation with plates and original observations. This work on the "Structure of Fruits and Seeds," was published in London, 1819, dedicated to W. J. Hooker. Lindley was taken by Hooker to Sir Joseph Banks, who gave him temporary employment in his herbarium and library, and introduced him to Mr. Cattley, a wealthy merchant devoted to horticulture, who was desirous of having his rare plants handsomely illustrated; and this again led in 1830 to the assistant secretaryship of the Horticultural Society of London, which Lindley occupied till 1858.

The Halesworth house was visited more than once by Dr. Thomas Taylor, Professor of Botany at Cork Scientific Institution, joint author with Hooker of 'Muscologia Britannica' published in 1818, with 28 plates illustrating 269 species and three tables of genera with 32 species. The work had taken eight years to prepare, as nearly every species had been personally collected by one or both authors.

In 1806 William Hooker had started preparation for the first work of any magnitude that he issued. The first part of his 'British Jungermanniæ' was not published till April, 1812, but some years earlier Sir James Smith lent him not only his own specimens but also the Linnean collection of Jungermanniæ for study. Sir J. D. Hooker describes the book as "the most beautiful of all my father's works, in point of the drawing, analyses, and engraving of the plates," the 88 plates illustrate 197 species. Plate I is inscribed "W.J.H. omnis delineavit. W. H. C. Edwards omnes sculpsit." The spirit of each plant is rendered so that we see them in all their moods absolutely living on the pages, a result due to the exquisite perspective and the delicate nuance of the outline, even where the very delicate shading has not been employed. The book was printed by J. Keymer, at Yarmouth, and it is dedicated to Dawson Turner; the final part was not issued till June 1816. The first twelve numbers appeared at monthly intervals, but in April 1813 a notice is inserted "the illness of a near relation having detained the Author in Devonshire, for three months, at a distance from his Books and Herbarium, he is obliged, however reluctantly, to solicit the indulgence of his Subscribers, for deferring the appearance of the next Number till the 1st

of June." It did not appear till August 13th. Meanwhile he was with his brother in Devonshire and Cornwall diligently exploring for Musci, Hepaticæ, and lichens especially ; he also visited the Scilly Isles in the Trinity House yacht, which had been placed at his disposal.

In 1816 Hooker began working for G. Graves' new edition of Curtis's " Flora Londinensis," the parts of which appeared at long intervals during several years. And in 1819 the last volume of Turner's " Historia Fucorum " was published. Of the 258 plates in Turner's great work, more than 230 are signed " W. J. H. delt." and a dozen are by Mrs. Turner.

The first part of Hooker's ' Musci Exotici ' appeared in January 1818. The whole work was issued during the Halesworth period, except parts 22 and 23 in April and May 1820.

But Sir Joseph Hooker says " the brewery business, as might have been expected under the management of an enthusiastic naturalist and author, had proved unsatisfactory, and some of his investments were disappointing. Personally his menage was entirely inexpensive and simple, and this was so throughout his life ; but his lavish expenditure on his own unremunerative publications, and on the purchase and beautiful binding of expensive entomological, ornithological, and especially botanical and even archæological and artistic works, had crippled his resources, and he had now a wife and family of four to provide for."

Their elder son, William Dawson Hooker, was born in April 1816. He became an ornithologist, and an M.D. of Glasgow. He died of yellow fever in Jamaica in 1840. The younger son, Joseph Dalton Hooker was born at Halesworth on June 30th, 1817, and their elder daughter was born there in May 1819. The next daughter was born on November 15th, 1820.

Sir Joseph Hooker continues :—" Under these circumstances he wrote to his friend Sir Joseph Banks, requesting that he might be informed, should he hear of any opportunity of applying his botanical knowledge to the improvement of his income. Sir Joseph promptly answered, that the Professorship of Botany was vacant in the University of Glasgow, and that he was ready to use his influence to obtain it for him should he desire to become a candidate. My father answered favourably, and

at once left for Spring Grove, where he was hospitably received by Sir Joseph, who told him that the emoluments of the Chair, though small, would certainly increase ; that it was freed from all medical duties ; that a really noble botanical garden had been formed at Glasgow, to which the University had given £2,000 and the city £3,000, and towards the development of which he could assure him that Kew would place all its resources." Hooker was appointed by the Crown to the Chair of Botany at Glasgow, and this was the main turning point in his life when he ceased to be " an enthusiastic amateur " and turned his hobby into his chief means of livelihood. Early in 1820 he left the brewery, his library and herbarium with his household effects were sent to London, dispatched thence by smack to Leith, and by canal to Glasgow, his wife and family posting by a more direct route. Except for a few short visits to Norwich and Yarmouth, his connection with Norfolk and Suffolk was permanently severed when he took up his duties in Glasgow.

In his reply to the Toast of " The Medallists " at the Anniversary Dinner of the Royal Society, November 30th, 1887, Sir J. D. Hooker says of Botanical Teaching when he was a boy:—

" With regard to Instruments and appliances for Botanical research, they were of a rude description. The dissection of a plant under the microscope was, as compared with that effected by modern manipulation and implements, a tearing of it to pieces, as a savage tears his food with his hands. I well remember my father's compound microscope ; it was a stately instrument, made by a first-rate maker, Dollond or Carey, I forget which. It was mounted on a brass pillar that communicated an oscillatory motion to whatever was seen on the stage. The optical part was a system of unacromatized biconvex lenses ; and when you looked at an object through it, all you saw was—well—darkness visible. Nevertheless with this rude instrument my father did some excellent work, and, just as the botanical teaching I had, benefited me in some ways which I think the present system of teaching would not have done, so the inefficiency of the old microscope drove me to the use of Pritchard's d oublets and triplets, and of Coddington's lenses, then recently invented; and I acquired a dexterity in analysing plants under them that has stood me, as a traveller, in good stead ever since.

I have said that my father and grandfather were both Botanists, singularly enough they both began their studies as such with the Mosses, quite independently of one another."

Dr. Joseph Dalton Hooker was president of the British Association on the occasion of its meeting in Norwich in 1868. His Presidential Address, delivered at the Drill Hall on August 19th, was remarkable for the public declaration of his belief in Darwinism and the Evolution of Species, a subject which he had for years been discussing with his friend Charles Darwin.

But the part of this Address which is the most important for our consideration is that in which Dr. Hooker assumes the rôle of a prophet in relation to Norwich. After discussing the administration of the Natural History Collections of the British Museum and pointing out that the interests of Botany have been greatly neglected there, he continues :—" Confining myself to the consideration of provincial and local museums, and their requirements for educational purposes, each should contain a connected series of specimens illustrating the principal and some of the lesser divisions of the Animal and Vegetable Kingdoms, so disposed in well-lighted cases, that an inquiring observer might learn therefrom the principles upon which animals and plants are classified, the relations of their organs, and other matters relating to their habits, uses, and place in the economy of nature. Such an arrangement has not been carried out in any museum known to me, though partially attained in that at Ipswich ; it requires some space, many pictorial illustrations, magnified views of the smaller organs and their structure, and copious legible descriptive labels, and it should not contain a single specimen more than is wanted. The other requirements of a provincial museum are complete collections of the plants and animals of the province, which should be kept entirely apart from the instructional series, and from everything else. The Curator of the Museum should be able to give elementary demonstrations (not lectures) upon this classified series, to schools and others. Did such an illustrated typical collection exist in your rich and well arranged Norwich Museum, I am sure that there is not an intelligent schoolmaster in the city who would not see that his school profited by the demonstrator's offices.

"You boast of a superb collection of Birds of Prey; how much would the value of this be enhanced, were it accompanied by such an illustration of the nature, habits, and affinities of the Raptores, as might well be obtained by an exhibition of the skeleton and dissected organs of one Hawk and one Owl, so laid out and ticketed that a schoolboy should see the structure of their beak, feet, wings, feathers, bones, and internal organs—should see why it is the Hawks and Owls are pre-eminent amongst birds for powers of sight and of flight ; for circling and for swooping ; for rapacity, voracity, and tenacity of life—should see, in short, the affinities and special attributes of Birds of Prey. I never remember to have heard of a provincial Museum that was frequented by schools.

"The museum should be in an open grassed square or park, planted with trees, in the town, or its outskirts ; a main object being to secure cleanliness, a cheerful aspect, and space for extension. Now vegetation is the best interceptor of dust, which is injurious to the specimens as well as unsightly, whilst a cheerful aspect and grass and trees will attract visitors, and especially families and schools. Norwich, I hear with surprise, has no Public Park worthy of the name. That she may soon have one should be the endeavour of every citizen, and to have a good instructional series added to your admirable Museum, and this transferred to the Park, should be the aspiration of all who are interested in the education and moral well-being of their townsmen."

I would that Sir J. D. Hooker could have seen the transfer in 1894 of the Norwich Museum from the cramped and dark quarters in St. Andrew's Street to its present glorious building situated among trees and grassy slopes, and the transformation of the interior of this building from tiers of prison cells to spacious galleries. Alas, it required a great war with its enforced darkening and privations to demonstrate the full value to the schools of the possibility of teaching nine classes simultaneously within these walls, but the principle has continued and even Dr. Hooker would approve the whole-time labours of a trained teacher who is a Fellow of the Linnean Society specially appointed by the Education Authorities of Norwich to foster the interests and develop the true love of natural history among the rising generation, with every facility for demonstrating

specimens which the students are allowed to handle for themselves.

Moreover, not only has his advice as to analysis and labels and key classification born fruit, but a "Norfolk Room" has been begun on such a scale as will require a period of five years for its completion under the assiduous care of the Curator and staff with expert helpers, and to-day this Society, which had not even come into existence in 1868, has voted from its invested funds a donation of 100 guineas towards the attainment of this purpose.

As a result of the visit of the British Association to Norwich a balance of £168 was handed over to the Museum. This amount was still deposited in Messrs. Harvey's Bank at the time of its failure in July 1870, but through the liberality of friends of the Museum the loss was turned into gain, for the bulk of the sum was made up and there were also dividends from time to time amounting to 14s. 3d. in the £.

From 1860 to 1865 J. D. Hooker collected Wedgwood ware. Writing to my father in 1896, he says, "To-day I am sending a little Wedgwood medallion of my father, which is a work of art (from a medallion by Woolner) and which perhaps the Society may think worth framing and hanging in their Library." This Society also possesses a medallion of Linneus from the same donor. The medallion representing Sir J. D. Hooker belongs to a reissue by the Wedgwood firm last year ; the order for it was given at Halesworth.

Sir William Jackson Hooker died at Kew on the 12th of August 1865. Lady Hooker retired to Norwich during her widowhood, became one of the first members of this Society, and died at Torquay in 1872. I can just remember Lady Hooker's little birds, two green budgerrigars in a cage hanging in the sunny window of a ground-floor room of a house on the north side of the street. Dr. Beverley wrote to me in 1914 :— "Lady Hooker lived I believe in my house on Prince of Wales Road, anyhow Mrs. Beverley and I have always considered she did." That is No. 54. I was too young to remember whether my mother ever took me to see Lady Hooker, but I have her autograph : "Mrs. Herbert Geldart with Lady Hooker's kind compliments."

It only remains for me to express my warm thanks to Mrs. R. V. Barker, daughter of the late Sir R. H. Inglis Palgrave, F.R.S., for her kindness not only in lending me the correspondence carried on between her father and his cousin Sir J. D. Hooker, but also for much information on the period, places, and persons mentioned in this Address. I am also indebted to Professor F. W. Oliver, F.R.S., for kindly lending the film from which the illustration of the Brewery House at Halesworth has been reproduced.

II

A FUR FARM IN NORFOLK

By P. E. T. Carill-Worsley

When my friend Dr. Sydney Long came to look over our newly-started fur farm, I little thought I should find myself invited to write an article on the subject. Let it be known at once that I do not pretend to write as an expert, but merely to give my impressions of the attractions and difficulties which attend this venture. Also, I write as one whose hobby is a business; for it was stern necessity which prompted me to embark upon it, even if it is true to say that as a mere hobby the attractions are extremely strong.

Our farm is concerned with the Silver Fox and the Chilian Coypu (*Myopotamus coypu*); the swamp beaver from which Nutria fur is made. The animals are generally, if incorrectly, called nutria, and I propose to call them nutria for the purposes of this article.

The starting of a fur farm under these conditions involves two main considerations: firstly, the care of the animals and the acquisition of the requisite amount of knowledge to make this practicable; and secondly, the commercial or financial aspect.

There are already several good text-books on the care of silver foxes, so I do not propose to go deeply into that subject, and would not presume to do so. At the same time, there

are so many conflicting theories and so many questions which may be classed as permanently controversial, that one may be forgiven for occasionally stating one's own conclusions on some of these problems. A beginner may well be puzzled by the contradictory advice he receives, but it is really a matter of experience. Experts are numerous, and some of these certainly fall into the category of those who, according to a learned judge's definition, appear to learn more and more about less and less.

One thing is generally admitted, and that is the humaneness of rearing animals in captivity and destroying them when necessary by scientific and painless means, as opposed to the trapping of wild animals with all its inevitable cruelties, not to mention waste.

As this is an article on a Norfolk Fur Farm, it ought to be said at once that the light soils of this part of E. Anglia are ideal for fox farming. As for nutria, they thrive almost anywhere where water (preferably running water) is available.

There used to be an idea that silver foxes would only thrive on high ground in a cold climate. It is now fairly certain that there is nothing in this, and that the foxes can be successfully reared almost anywhere. Certainly our Norfolk climate suits them well; and the soil, as has been said, is in many places ideal.

What is a fur farm? It may be defined as a place where one or more species of fur-bearing animals are reared on scientific lines for financial gain. I propose, in the case of foxes, to take it for granted that pedigree stock is being raised, mainly with the idea of selling the produce for breeding stock to other fur farmers. I have called it a venture, and this it certainly is. The outlay is considerable if one intends to attempt to make a living out of it. The returns are likely to be on a generous scale, and in any case (always provided the farm is properly conducted) one may expect dividends which compare favourably with those of a poultry farmer or any other of the so-called open-air employments.

But it is not advisable to go into this business too light-heartedly. Much work is involved, and also much hard thinking in order to have one's farm properly and economically equipped. As far as stock goes, it is obvious that few beginners

Cubs a few months old

Typical Silver Fox in August

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can have the necessary knowledge to select their own breeding stock. Most fox farmers can be relied upon to give the right kind of advice and assistance to this end.

A system is common whereby a beginner may purchase a pair or two and leave them on the vendor's farm, paying whatever may be agreed for their keep and care, and often being afforded facilities to study fox farming as a pupil. This is a good plan, and avoids a large outlay till the pupil is sure of his ground, and is convinced by experience that he is capable of undertaking a farm of his own.

Prices vary in different seasons, but £150 for a pair of pedigree silver foxes of good quality is not too much to pay. Nutria may be bought for about £35 per pair at six to eight months' old. Those from France—the pioneer country in Europe for nutria raising—cost about £48 or £50 per pair delivered by air mail at Croydon. Although these may appear high prices, it must be remembered that it is only a dozen or so years ago when a pair of silver foxes would fetch some thousands of pounds. As for nutria, these were unobtainable till quite recently, and even now the supply is insufficient to meet the growing demand.

It is impossible to say how long this state of things will continue, and we may all find ourselves working on a pelting basis before very long. The difference in the income is about as one to four in the case of foxes, and an even greater difference in the case of nutria. Silver fox pelts vary in value from a few pounds to £50, or even more in exceptional cases; pelts having fairly often fetched up to £100. The highest price recorded for a British reared fox's pelt is £152. Such prices, however, must be considered quite out of the ordinary. In the boom years just before the War, pelts made up to £520! But those days have gone. Nutria pelts vary between £1 and £7, and may be expected to average about £3.

Foxes average about 3 cubs reared to maturity each year and have, of course, only one litter each year, the breeding season being roughly from March to the end of May. Cubs born in May are not usually suitable for mating at the next season. In fact, there is a strongly supported opinion that all cubs should be kept until their second year before attempting to breed from them—a waiting game may pay best in the end,

but how many can afford to wait? Surplus or culled cubs may be pelted their first winter.

Nutria have five families in a little over two years, and each litter generally numbers between five and seven. Therefore, in a year, one may fairly safely count on twelve young ones reared. Males generally predominate.

A very few words are necessary to describe the manner in which foxes are kept in captivity. To begin with, they live in wooden "kennels" of which there are several good designs, nearly all of them having a "chute" attached to represent the entrance to an earth. These are placed in pens of varying sizes, usually about 400—600 square feet, carefully wired as to the sides and floor, and with either a wire-covered roof or an overlay of two feet turned over at right angles. The latter is preferable, except in the case of very narrow pens, in which an active fox might be able to jump off the top of the kennel over the wire. Most breeders bury the ground—or carpet—wire a few inches. Some trust to a mere inturn of a few feet, leaving the middle part of the pen uncarpeted. This is not a good system, as vixens may burrow out an earth in which the cubs, once deposited, are removed from all possibility of observation. But each breeder has his own ideas, and it is not within the scope of this article to do more than to hint at the difficulties of choice, and to recommend careful study of several text-books before forming any plan.

The whole farm must be surrounded by a guard wire about eight feet high with a good overturn at top, and a buried inturn of a few feet at the bottom. This serves the purpose of keeping captive any fox which may escape from its pen—not a very rare occurrence among these superactive animals—but even more important, of keeping out dogs, cattle, humans, and other creatures likely to introduce disturbance or infection.

Silver foxes require a great deal of careful attention, especially as regards their diet, but they are not costly to maintain. About £8 will cover the food bill of one animal for a year. It is only during the period just before, during and after the breeding season that extreme care is necessary. An anxious time from Christmas till April is a certainty for any fox farmer. Litters of seven cubs may be devoured by parents for no very obvious reason. Cubs must be dosed for worms when only a

few weeks old—not a very pleasant experience either for them or for their anxious and nervy parents.

Limbs may be damaged or broken by cubs that insist on climbing up wire partitions which they cannot climb down again, and many small contretemps may occur. Every animal develops an individuality which must be studied. Food rations must be varied to meet different conditions and idiosyncrasies. But none of these things should deter anybody who is keen on animals, and who has the time to spare to attend to all the interesting details.

One may be forgiven for stating an opinion on some of the more controversial questions.

First, the site. Some breeders prefer a wooded site on account of the shade and privacy. Extreme privacy is not so important as used to be imagined, so long as the foxes can be kept quiet when required. Shade can be provided by means of wattle hurdles or other devices. Anyone who has observed the dislike for dripping woodlands, which nearly all animals exhibit, may be forgiven for preferring an open site. In addition, in pens which are constantly occupied over long periods the free play of sun, rain and wind upon the soil is a great advantage. Sanitary conditions are extremely important. There are many successful farms on wooded sites but the writer is strongly in favour of an open site on light soil with a gravel sub-soil.

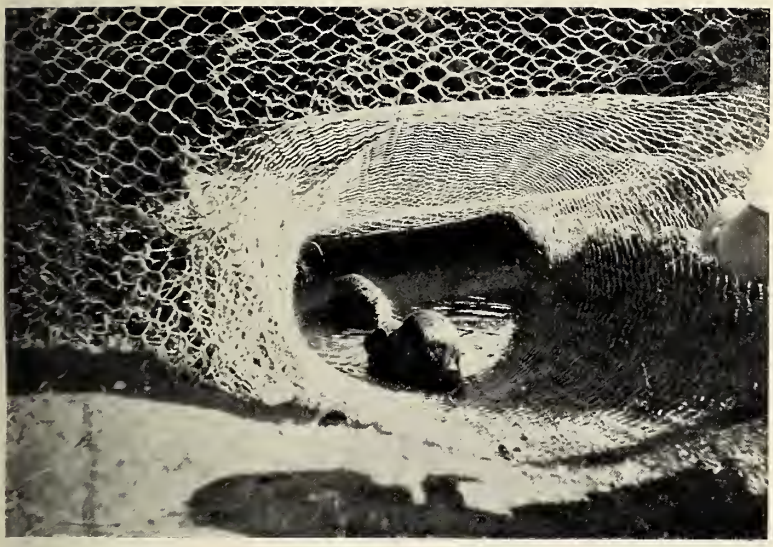
Shelter from the prevailing wind is desirable, and woods or shelter belts are useful. But even this object may be achieved by artificial shelter. Nearly all these remarks apply equally to the choice of roof wire, as opposed to open tops with an overlay. The drip off wire is very unpleasant, and there is always a chance of the whole roof being brought down by snow melting and freezing alternately and forming a heavy and unremovable canopy. It is true to say that almost any site can be made to serve. Even on clay soil floors may be made of wood or concrete, but this greatly adds to the outlay of cash. Somehow, somewhere a place may be found near almost any country home ; but if anybody were seeking a home where he intended to farm foxes, he would probably select suitable soil and other conditions. Poor land, unsuitable for any other purpose, is often eminently suitable for fox farming.

Then there will arise the choice of how to bring up the cubs. Some breeders leave the whole family, including the father, together until the cubs are almost old enough to be selected as mates for other cubs on the farm or elsewhere, or until they are sold; or at any rate till they are five or six months old. Foxes are considered ready to mate at ten months old.

If the dog fox is to be removed, this must be done a few weeks after mating has taken place. It is usual to have a watch-tower or other observation point from which matings may be observed in as many cases as possible, and the exact date of cubbing duly noted: an important detail for several reasons, chief among which is the question of adjusting the diet of the pregnant vixen. It has been noted that the time most frequently chosen for mating is immediately after the morning feed. It is claimed that the vixen remains happier if the dog is in attendance, and that he is sometimes a real help to her. Against this is the certain fact that you will then have two adult foxes, either of which may suddenly turn cannibal and eat all the cubs. A good compromise is to have a double pen, and to put the dog fox in one end after mating. He can then be some comfort to the vixen (only wire netting dividing him off) and cannot interfere. We are somewhat divided between this course and the removal of the male to a distant pen. The latter is possibly the best plan, as some dogs burrow incessantly in an effort to regain access to the vixen. Here again the individuality of the particular animals will probably be a final decisive guide.

Some dogs are greedy and eat the vixen's share of food; others are super-gallant and starve themselves for the sake of the vixen and cubs. In either case somebody gets too little to eat, and somebody else gets too much. Over-feeding is probably the cause of very many disasters among foxes. So why run the risks? Each breeder must choose; and even then he may have to go back on his choice owing to special idiosyncrasies. We are in favour of removing the dog in every case where it is possible, and where mating has either been observed or may be considered certain. From the watch-tower it may be hoped to observe about 70 per cent. of the matings.

Enough has been said to indicate the kind of problem which



In and out of the water all day long

They love dry bread

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one is likely to be up against, and the kind of life which is involved in fox farming.

Much could be said about the silvering of pelts, and the mating of pairs for the purpose of breeding the popular degree of silvering. This varies in different countries and at different times. It may be mentioned that a silver hair is not really silver at all, but black with a silver ring. It is this which makes it impossible to copy the hair artificially, and greatly adds to the value of silver foxes.

Nutria raising is a very different affair, and takes up far less time, nor is the outlay anything like so large. These animals are housed in pens about twenty feet by ten feet, or smaller, with some kind of wired-in water pen connected by a wire run with the land pen. It all depends on the layout of the stream or pond which is available. The water pens should be about six feet square, or eight feet by four feet, and the water should be not less than eighteen inches deep at all times. It is true that nutria can be raised without swimming baths of any kind, but it is very doubtful whether the pelts so produced would be good. For it is the under part of the nutria which carries the valuable fur, and this is because nature provides specially close and thick fur to protect them from cold in those parts which are very often submerged in cold water. The back is generally out of the water when they are swimming. A strange arrangement of Nature is that the teats on the female are placed along the back, thus allowing the young to be suckled in the water. This also helps to make the belly fur clear of obstacles or blemishes. If Nature takes all this trouble, it seems certain that it is a mistake to rear these animals where no water for swimming is available. The photographs give some idea of how our pens are arranged, but there are obviously many different ways of providing the proper accommodation.

We house our nutria in little dwellings built of concrete blocks, usually with two inlets arranged to appear like tunnels. They will make their own dwellings in a good-sized heap of earth, but this makes it difficult to keep the control which is advisable over their movements and sanitation. Whatever kind of house is provided, they greatly prefer some kind of tunnel-like entrance. Eight-inch drain pipes or old chimney

pots serve very well. Almost invariably their excretions are deposited in the water. I have never seen a house fouled in this way. But since they often run into the house from the water, it is a good plan to give them clean straw, say once a week, but even this is hardly necessary. For the most part they dry themselves very carefully on leaving the water ; in fact they spend hours performing their toilet, and very attractive they look working away with their curiously hand-like front feet. The hind feet are clumsy on land, being heavily webbed. Their foot marks are not unlike those of a huge water-hen. Their feeding is extremely simple, and is almost the same as that of a rabbit ; grass, greenstuff from the garden, roots, wind-fallen apples and pears, dry bread (brown for choice) and a little corn occasionally. They will become very tame (see photograph) and will go anywhere for a bite off a pear, and can easily be recaptured, if they escape, in a box-trap baited with a hunk of bread. They are certainly great escapers, and much care must be exercised in making their pens. They can tear a way through ordinary rabbit wire in no time ; therefore, use fifteen-gauge wire, and one-inch mesh, so that they cannot easily get hold with their very powerful teeth. They can easily climb over an eight-feet wire enclosure, therefore put an eighteen-inch inturn at the top. If this is done, five feet of wire up to the inturn is ample. Some people prefer to wire over the top and, where marauding cats or dogs are feared, this should be done.

Finally, they can burrow long distances into banks, but luckily they never seem to go deep. Therefore wire buried three and a half feet ought to suffice, or a wire carpet a few inches underground is equally, if not more, effective. Again, strong wire of not too big a mesh should be used and laced very thoroughly to the side wire.

There is one occasion when it is almost impossible to keep the male from escaping. This is just before the female is due to cub, when she will go to any extreme to drive the buck away, or so I have found in several instances. We therefore provide an alternative run into which he can escape. It may be better to shut him out entirely, but I think he will make himself scarce without further interference. This removal may be left to his own discretion, or may be arranged a week or

two before the babies are due, or on the first occasion when he appears at breakfast with a bloody nose and other scars !

Soon after the young are born, they go into the water and become amazingly independent at a very early age. The buck is generally allowed back by the mother a few days later, and they are both very affectionate with the young ones. But do not *put* the buck back. It is difficult to say what danger this may entail.

One is expected to obtain two-and-a-half litters in a year, but this year I have actually secured three litters from my original female in twelve months.

The young are born with eyes open, and a good coat of fur. They may be weaned after two to three months. It is probable that the parents will mate again during this period, so that it matters hardly at all if the young are left a month or two longer and when they are about four to five months old, the sexes ought to be separated. The age at which they may safely be mated seems uncertain, but by eight months old, although not fully grown, mating may be arranged between specimens of about the same age.

When putting a fresh buck with a strange female it is probable that they will not get on well together at first, and the screams and growls may lead one to suppose that they could never become friendly, but within a week they will in all probability be deeply attached to one another. If they do not become friendly in a fortnight, it may be well to try another combination.

Most nutria breeders in this country have not, so far, got enough stock to ring the changes easily ; but exchanges may be arranged. It is better to start with two unrelated pairs, and then the question of inbreeding will not become acute for a long time. It seems certain that inbreeding can be allowed to a surprising extent without doing harm, but it is just as well not to run too many risks, and it is quite unnecessary.

Nutria are not bred to pedigree, but any stock-breeder will realise that it is bad policy to lose sight of the strains, and a fairly flexible rule of mating should be pursued. Nutria are polygamous to some extent, and it is said that a buck may run with up to six females of even age. We have only tried two females to a buck, and this seems to answer very well. More

than this becomes rather an unmanageable unit to deal with. This question, however, may be considered still open to experiment. As plenty of bucks are usually available, it really resolves itself into a question of pen accommodation.

As the farm increases, we intend trying experiments with more or less unrestrained contact, providing the appropriate number of houses for pairs which decide to separate themselves from the rest. If one intends breeding nutria on a large scale for pelting purposes, some plan of this kind appears to be unavoidable. Otherwise the number of pens required, and the amount of attention demanded, might become out of proportion to the returns expected. It is essential, however, that they should be properly enclosed, since the damage they could do to trees, dams, canals, river banks and so forth might be very serious.

An example is to hand in the escaped musk rats which are breeding freely in various parts of the continent, and doing immense damage.

As things are at present, an escaped nutria is almost certain to return to its home after a very short time, but if there were others at large, those escaping would certainly join the outlaws, and would soon become a nuisance, and as there is every likelihood of these attractive and lucrative animals becoming far more common this warning may not be out of place.

Nutria, though tamed easily, are peculiarly quick to notice strangers. Their sense of smell appears to be far their strongest sense. They are often rather short-sighted, and their hearing is not especially keen, but they will pick up strange scents from a great distance if the wind is right. They are extremely clever at finding out any weak spot in the wire which imprisons them, either above or below ground. Generally speaking, once you get over their rather repellent appearance (mainly due to their orange-red teeth) they are very interesting and quite fascinating animals.

I seem to have been carried away by my subject, and to have taken up more space than I ought to be allowed. But I hope enough has been said to suggest that a " Fur Farm in Norfolk," or indeed almost anywhere, can be an attractive, lucrative and " worth-while " business ; and that anybody

Six months old

The Author with two adult Nutria

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who is really keen on animals and is not in too great a hurry to launch out into big things may be advised in all sincerity to try the experiment. Do not be hurried into purchasing stock from the first breeder you come across. Have a good look round, and make sure of your man before you do anything. It takes all sorts to make a world, and breeders of fur-bearing animals are not all of them angels. But there are numbers of absolutely reliable people in the business, and these are usually most willing to do all they can to help a beginner into the right paths.

It seems unnecessary to add that there are many other kinds of fur-bearing animals which can be bred at a profit in captivity. There are many more beautiful than our coypu, and very many less exacting than our silver foxes. But I am writing about our own farm, and I can honestly say that I see no reason to regret the choice of animals which we have made. They fit in well together, since the nutria require so little attention. And if one's æsthetic sense is repelled by their ugly teeth, one has only to move on and feast one's eyes upon one of the most beautiful of animals—when in prime—the silver fox. A happy life, and an employment from which you can make a living; who wants more?

III

THE COURSE OF *MARSUPITES* AND *UINTACRINUS* ACROSS NORFOLK

By R. M. Brydone, F.G.S.

In the autumn of 1930 a plate of *Marsupites* found in a pit near the Obelisk in Holkham Park gave a starting point for tracing a course for the zone of *Marsupites* and the subzone of *Uintacrinus* across Norfolk (as outlined in the Geological Magazine for 1931, p. 528). The plate was small and smooth except for very broad and gently undulating ribs, and just such as is to be expected in the base of the zone: and I had already found similar plates in the pit at Limekiln Farm, East Barsham, which pit not only from that circumstance but also

from its distance across the strike from the recorded *Marsupites* chalk at Thorpland was to be regarded as in the base of the zone ; and a line joining the Obelisk to East Barsham should mark the boundary of *Marsupites* and *Uintacrinus* for nearly six miles and give sighting points for its further course southwards.

Anyone who cares to run out this line for himself will find that while it passes within hail, so to speak, of the chalk of the upper Wensum valley from Sennowe Park to Swanton Morley; it never approaches it nearly enough to make it anything more than an off-chance that *Marsupites* chalk should be touched in the valley. However, I tried for the off-chance ; but as soon as I found that the chalk of the west side of the valley had suffered a full measure of the Great Squeeze it was obviously almost impossible for *Marsupites* to be found ; and it was not the turn of the almost impossible to happen.

Opposite Norwich, i.e., about East Dereham, the hypothetical boundary runs closely enough parallel to the line I indicated in last year's Transactions (Vol. xiii. p. 47) for the base of the zone of *Belemnitella mucronata* near Norwich to suggest that the boundary is still holding its original course : but southward from East Dereham there is no sort of check for a long way until we reach the latitude of New Buckenham. Here we find in the stringers of chalk along the Wittle and upper Thet valleys that the boundary has swung away several miles to the west and *Uintacrinus* can still be found at Linger Hill, and a little south-west of Harling Road station (where its small size indicates the extreme base of the subzone) and in the huge pit just east of East Harling, while *Marsupites* has been found at Uphall (very sparingly and of a basal type) and also just west of the old " Brick and Tile Works " (a very small and smooth plate which practically fixes the boundary). Further south even the *Uintacrinus* subzone probably fails to creep into the stringer of chalk along the north bank of the Little Ouse that terminates at Garboldisham, for the pit on Garboldisham Heath shows chalk full of black specks like that which occurs in Hampshire *below* the *Uintacrinus* subzone and I did not find in it any trace of *Uintacrinus*.

It was of course obvious from the map that there was a good prospect of picking up *Marsupites* or *Uintacrinus* in one of the

inliers scattered about North Suffolk, and after searching in vain, in dreadful weather, the whole length of the Redgrave-Wattisfield inlier for traces of *Marsupites* I pushed off late in the evening for Stanton to investigate the big pit there. I only had time to walk up to the face and put my finger on a small reddish spot straight in front of me, but with that a flourishing local legend that there were no fossils in the Stanton chalk and many people had searched in vain for them died suddenly. The spot proved, as I expected, to be the bruised end of the stalk of a spine of *Cidaris clavigera* Sor. and at a subsequent visit I found in about half an hour three other species of *Cidaris* and part of a *Conulus* among other fossils. This was conclusive evidence of the *cor-anguinum* age of the big pit; but at the eastern end of the inlier I found a few brachials of *Uintacrinus* and at Walsham-le-Willows *Uintacrinus* in full swing. I had now picked up the trail again after evidently another swing of the *Marsupites-Uintacrinus* boundary to the west. I was then led by the relative positions of Stanton, Walsham and Wattisfield to make another try for *Marsupites* at Wattisfield. I could not find it; but I found a few crinoid brachials; and something which at the time seemed almost fantastic occurred to me.

In 1915 (Geol. Mag. for 1915, p. 14) I had recorded that in the nine feet of chalk which immediately succeeded the zone of *Marsupites* in Sussex there occurred many crinoid brachials and a few plates which seemed to me to be neither *Marsupites* nor the common *Uintacrinus* and might be another species of *Uintacrinus*; and that similar plates and brachials occurred in the corresponding position at Margate, and brachials alone at several other places. In all these cases the brachials were far more abundant than they ever are in *Marsupites* chalk; and these Wattisfield brachials might possibly be analogous to them. I returned to press my search, finding for a time only more brachials; but presently I found a plate which certainly had nothing to do with *Marsupites*, and the next plate was obviously identical with some of the Sussex plates; and it was plain that my queer crinoid followed *Marsupites* as closely and surely in East Anglia as it does in the South. Presently it occurred to me that if such a wild adventure could succeed richly at Wattisfield it might have a chance at North Elmham;

and there too I found my queer crinoid, very sparingly; and the upper boundary of the *Marsupites* zone was ascertained at Wattisfield and North Elmham as surely as any zonal boundary in Norfolk, without a single plate of *Marsupites* having been found.

I have now heard that Dr. Bather considers that my queer crinoid is what I guessed it to be, a new species of *Uintacrinus*. It is to be hoped that he will presently describe it. Till then it can only be referred to as *Uintacrinus* sp. nov.

The swings of the outcrop to the west are no doubt due to broad and gentle east and west folds; of which no other evidence is available and which may be expected to affect the outcrops of all higher zones.

The Basal Norwich Chalk.—There are two points I should like to add to the notes about the Norwich Chalk that I published in the last number of these Transactions (Vol. xiii., p. 47).

(1) The line that I indicated for the lower boundary ran close to an overgrown pit at the foot of Deighton Hills about half a mile south west of Spring Farm, Attlebridge. I have since got through the overgrowth and found a face about fifteen feet high, of which the lower nine feet are accessible. All the accessible chalk is just the same small yellow stuff as is exposed towards Attlebridge and attributable to the zone of granulated *Actinocamax* (the best zonal title I can see at present for the East Anglian chalk between the zones of *Marsupites* and *Belemnitella mucronata*); but it can be found by climbing up a gully that the top four feet or so are white (as at Taverham Park Lodge); and under the highest point of the face I found two specimens of *Belemnitella mucronata* on the talus. Evidently the zonal boundary lies exactly here.

(2) The old pit in Taverham village, which used to show only chalk which had obviously suffered from the Great Squeeze, has recently been reopened by Mr. R. K. Parker for lime-burning. The new working has already yielded a very representative specimen of *Echinocorys scutatus* Leske, var *subconicus* Grif. and Bryd., the special characteristic of the lowest *mucronata* chalk south of the London basin.

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IV

THE WATER GARDEN AT STODY LODGE, NORFOLK

On the 15th of May, 1930, Mr. R. E. Horsfall entertained members of the Norfolk and Norwich Naturalists' Society at Stody Lodge for the purpose of visiting his Water Garden then in the full glory of unfolding leaf and blossom, a veritable riot of colour, yellow, orange, green and red, the latter strongly accentuated by the young foliage of Japanese maples.

It is desirable that in the Transactions of this Society some record should be made of the history of such a unique spot, and this is the more urgent as the property is offered for sale by its owner, the Marquis of Lothian, and Mr. Horsfall is leaving Norfolk during the autumn of 1931.

Stody is two miles N.E. from Melton Constable Station, and three miles S.W. from the town of Holt.

The following account and the illustration are reprinted by permission of the Editor of " Country Life " from the issue of May 22nd, 1926, page 719 :—

The owner of this wild azalea garden, Mr. Horsfall of Stody Lodge, Melton Constable, describes the making of it as follows :—

" A dark, gloomy pond of black peaty water surrounded by common rhododendrons choked with silver birch trees, a rushy swamp of about two acres covered with patches of brambles and bracken and smothered with seedling birches, a few small pools with masses of sphagnum moss ; such were the materials out of which the creation of the present water garden was begun some twenty-five years ago.

" The situation is somewhat unique, being placed in a slight depression in the middle of a 150-acre wood planted many years since on heathland with a gravel subsoil, which absorbs the heaviest thunderstorm in two or three hours. The swamp itself consists of bog not much more than two feet in depth, underneath which is a hard pan or conglomerate that retains the moisture. There are, unfortunately, no springs or running water, so it is entirely dependent on what drains in from the surrounding peaty soil. An overflow was cut some years ago which prevents its being unduly flooded in winter, but it becomes deplorably dry in any long spell of drought.

" A commencement was made by clearing a small corner of the swamp and digging out a wide channel in which the water soon collected, and making a little island with the boggy soil that was thrown out. Among other things, a few azalea mollis were planted, and thrived exceedingly, and in a year or two numerous small seedlings were observed beneath them ; these were carefully removed to nursery beds, and the foundation stones of the present garden were laid. As the stock increased and grew, more channels and islands were planned in succeeding years, and there are now some fifteen hundred home-grown azaleas from two to six feet in height. Several hybrid rhododendrons and other azaleas from English and Dutch nurseries were added from time to time, and other different plants were tried with more or less success. The ultimate collection was, however, restricted, by the Government majority of hares and rabbits, principally to rhododendrons, daffodils and azaleas. Rings of wire netting, being unsightly abominations, are limited to the favoured few, the chief of which are Lilium auratum platyphyllum, which do well, twenty-seven flowers on one spike being the record so far. The trees round the pond have been mostly cleared away, and the rhododendrons have gratefully responded, now making a bank over twenty feet high.

" Several Chinese rhododendrons raised from seed imported some years ago have been planted, and are now six or seven feet high, and form the commencement of the flowering season in February and March. These are followed in April by the daffodils, of which there are a large number of those that have been found most suitable, the biggest clumps being restricted every summer. The azaleas, which are the chief glory of the garden, come on in May, and most of the hybrid rhododendrons in June. The pond has become the home of numerous water lilies, which carry on all through the summer, and are accompanied by various iris, and subsequently by the Lilium auratum platyphyllum until the frost comes.

" A large number of common rhododendrons has been planted all round both for a background and also to complete the shelter of the wood, the big trees of which give a great variety of colour in the spring and autumn, assisted by sundry mountain ash and Japanese maples."

Writing on April 13th, 1931, Mr. Horsfall says :—" The wood in which I live was planted, I believe, more than one hundred years ago, but there are several old beeches more than twice that age. Large portions have been planted and re-planted, to make good what has been cut, or blown down. Three thousand trees were blown down in about an hour in the gale of March 25th, 1895, the day after I first came to look at it ! The robin *will* get caught in the traps I have to set for field mice, which bite off my Lilium auratum. I caught over forty mice last year in March, but this year they have not appeared for the first time on record, and though dozens of lilies are several inches high, I have as yet seen no damage. The garden has been enlarged since the article in 'Country Life' was written and I should think there must now be 4,000 or 5,000 azaleas in it."

V

THE "NORFOLK" ROOM AT THE NORWICH CASTLE MUSEUM

By Frank Leney, Curator

In the scheme of re-arrangement of the Natural History collections of the Norwich Castle Museum, the most important point is the proposal to utilize one of the large galleries as a Norfolk Room, wherein will be displayed all that is most characteristic of the wild life of the county. The Broads, Brecklands and Coast are features for which the county is famous, and it is intended to show, in cases as realistic and beautiful as the best modern craftsmanship can contrive, the plants, birds and animals which are to be found in these special surroundings. Such cases will be the main features of the gallery, and no effort will be spared to make exhibits of such beauty and interest as will attract wide attention and stimulate the desire to protect and preserve the wild life which still survives in Norfolk. There are, of course, many other exhibits that will find a place in this gallery, and the guiding principle throughout will be that each shall be as perfect of its kind as skill can make it. The Norfolk Room will give point and

purpose to the work of young naturalists and will encourage them to make the Norfolk collections as complete as possible, following the work of the members who founded the Norfolk and Norwich Naturalists' Society and compiled the Norfolk Lists of Fauna and Flora in the earlier volumes of the Transactions.

The Corporation of the City of Norwich has approved and supported the scheme of re-arrangement of the natural history collections, and the cost will be spread over a period of years. It is hoped that the county of Norfolk will show its appreciation of the generosity of the City which maintains the Museum for the benefit of all, by contributing its share of the cost. At the Annual Meeting of the N. and N. Naturalists' Society, April, 1931, the sum of one hundred guineas was voted to the scheme. As the Sub-Committee entrusted by the Castle Museum Committee to carry out the work includes Mr. Robert Gurney, D.Sc., F.L.S., Mr. B. B. Riviere, F.R.C.S., F.Z.S., M.B.O.U., Mr. H. H. Halls, Mr. H. J. Thouless, Mr. H. J. Howard, F.L.S., and Mr. Gerard Gurney, F.Z.S., F.E.S., M.B.O.U., all naturalists in the city and county may feel assured that the scheme will be carried out on scientific lines.

VI

METEOROLOGICAL NOTES, 1930

(*From observations taken at Norwich*)

By the late Arthur W. Preston, F.R.Met.Soc.

JANUARY

This month was remarkable for its mildness, and, during the first half of the month, for a continuance of the high winds and gales which had characterised the previous November and December. The mean temperature (42.6) was 5 deg. above normal and there was but little frost. On the 19th the temperature rose to 56.7 deg., which was the warmest January day recorded since these observations were commenced in 1883. The most violent of the gales occurred on the night of the 12th. Rainfall was above normal for January, and snow fell on one day only. Sunshine was 5.7 hours in excess of the average. Fogs occurred on the 15th, 16th, and 30th.

FEBRUARY

Mean temperature was in close agreement with the average, and was 3.8 deg. lower than that of January and 7.3 deg, lower than that of the previous February. There was but little frost. Rainfall was about two-thirds only of the normal amount. There was a great persistence of north-east wind throughout the month. There were many dull, gloomy days, the deficiency of sunshine having been 26 hours. Although snow fell on six days the falls were all very trifling and remained on the ground but a short time.

MARCH

The month opened with a week of fine warm weather, the thermometer reaching 60 deg. on the 3rd, followed by a cold period with some snow, but none of the snowfalls were heavy. The last week of the month was mild and dry. Mean temperature was about 1 deg. above the average, and rainfall was 0.54 in. deficient. There were 133 hours of sunshine, which was slightly above normal, but about 40 hours less than in the previous March. The coldest night of the winter occurred on the 19th, when the thermometer fell to 25.3 deg. in the screen and to 21.2 deg. on the grass. Vegetation at the close of the month was rather backward.

APRIL

After two warm days, with which the month opened, the weather became cold and unseasonable, particularly in the third week, over the Easter holidays, which was the coldest and most unpleasant for many years. After the 22nd the weather improved and the temperature rose (70.8 deg. on the 25th) and the warmth of the last week caused the mean temperature of the month to be slightly above the average. A short but sharp thunder-storm occurred on the evening of the 24th. The month's rainfall (2.13 in.) was nearly half an inch more than normal, and sunshine was 32 hours deficient. At Easter the sun shone for only 19 hours in 6 days.

MAY

The early part of the month was very wet, 2.54 in. of rain falling between the 5th and 13th. Only half an inch fell after

the latter date, making the month's total 3.06 in. Temperature was variable and was chiefly remarkable for the absence of both really warm days and really cold nights. There was no frost throughout the month, and the fruit gardens were spared the scourge of May frost. Much cloud prevailed at times and the total sunshine of the month was 31 hours deficient.

JUNE

The mean temperature of the month (61.4 deg.) was the highest of any June since 1917. The thermometer exceeded 70 deg. on 19 days and touched 80 deg. on the 18th. The total rainfall of the month was only .89 in. The want of rain was much felt at the close of the month, but the heavy rainfall of May prevented the ground from being quite so parched as at the same time in the previous year, when June had been preceded by three abnormally dry months. Thunder occurred on the 17th, 18th, 19th, 22nd, and 24th, but except on the 17th, was chiefly distant. Sunshine was 23 hours in excess of the normal, and on 13 days shone for over 10 hours. On the 5th, 6th, and 8th it shone for 15 hours. Altogether it was the finest and most beautiful June for many years, and, except in some parts of the county where there were heavy thunderstorms, it was very favourable for the hay harvest.

JULY

The month opened with a continuation of the fine, warm, sunny days which had characterised June, but on the 10th a sudden change took place, with a great drop in temperature and heavy rain. During the remainder of the month the weather continued very unsettled with frequent rain at times, particularly in the third week, and with but little warm weather. The month's rainfall amounted to 3.80 ins. Thunderstorms occurred on five days. Sunshine amounted to 163 hours, which was 48 hours below the average.

AUGUST

During the first half of the month there was a continuation of the cool, wet, and unsettled weather which had persisted since July 10th. The Bank Holiday week-end was particularly unfavourable with much heavy rain, particularly on Sunday,

the 3rd, when as much as three-quarters of an inch fell. After the 13th there was an improvement, with several bright days, although with no great heat. Many days were windy, and on the 14th there was a gale of unusual intensity for the time of year. A sudden outburst of heat occurred on the 26th and continued until the 30th, during which period the maximum readings of the thermometer were 81.8 deg., 87.1 deg., 90.2 deg., 91.7 deg., and 84.2 deg., with high readings above 60 deg. by night. On the night of the 29th the thermometer failed to fall below 65.8 deg. in the screen and 64 deg. on the grass. This heat wave broke down on the night of the 30th, when thunderstorms of great severity occurred over a large portion of England and Scotland but did not extend to Norfolk, where, however, much lightning was seen in the distance. Sunshine (216 hours) was 31 hours above normal, of which only 85 hours occurred in the first half of the month and 130 hours in the second half.

SEPTEMBER

September was a very wet month throughout, the total rainfall (5.65 in.) having been 3½ in. above the normal, and there were many dark, gloomy days even when it did not rain. There was much thunder, and a storm on the early morning of the 7th, though not of long duration, was of exceptional severity. A flash which struck Eaton Church about 3 a.m. and did much damage, was accompanied by a crash of thunder of a terrifying character. Rain fell in sheets, and the falls on several other days were of a torrential character, although in some cases very partial. For instance, on the 10th 1.82 in. fell at Sprowston, but only .02 in. at Eaton. The total rainfall for the last week of the month was 2.73 in., or .59 in. more than the average for the entire month. There were but few warm days throughout the month, the thermometer never exceeding 71 deg., and it was a great contrast to the previous September, when 88 deg. was reached. Winds were chiefly westerly, and a destructive gale blew on the 20th. Sunshine was 26 hours deficient.

OCTOBER

This month was exceedingly mild and pleasant. Mean temperature exceeded the average by 2 deg., and the thermometer exceeded 60 deg. on 13 days, reaching 64 deg. on the 30th.

There was only one night with frost in the screen. Rainfall was only .95 in. and sunshine exceeded normal by 42 hours. Strong winds occurred between the 6th and 8th, and several other days were also rather windy, but there were no severe gales. Winds were almost continually from a westerly point, except in the last week, when southerly winds predominated. An aurora borealis was seen from Norwich and neighbourhood on the evening of the 17th. Owing to the absence of frost garden flowers were in abundance throughout the month.

NOVEMBER

The first half of the month was generally fine and bright, many days being unusually sunny for November. A sudden and severe frost occurred on the night of the 4th–5th, the thermometer falling to 24.3 deg. in the screen and to 20 deg. on the grass. Such severity is very unusual so early in the season. In 1923, however, the temperature fell to 24.8 deg. in the screen, and to 20 deg. on the grass on Nov. 8th. During the second half of the month rain fell nearly every day, the total month's fall having been 3.87 in. There was a trifling fall of snow on the 17th. A fog of great density occurred in Norwich and neighbourhood on the evening of the 27th. The barometer fell below 29 in. on the 2nd and 22nd. A rise occurred on the 23rd of remarkable rapidity, from 28.99 in. at 9 p.m. on the 22nd to 29.89 in. at 9 a.m. next day, and to 30.05 in. on the evening of that day. Winds were chiefly westerly, and mean temperature was nearly normal. Sunshine was about 10 hours in excess of the average, chiefly from high readings during the first fortnight.

DECEMBER

This month was remarkable for its great prevalence of fogs, which occurred on no less than ten days during the month. The early part of the month was dry with a generally stagnant atmosphere, and was followed during the latter part by much rain, 1.27 in. falling during the last ten days. The Christmas holidays were very gloomy with much rain, .36 in. falling on Boxing Day, on which day there was also a little sleet here in the morning. Sunshine was six hours deficient, and the total recorded was less than in any December since 1920. There

were 18 absolutely sunless days and it was generally a very gloomy month. Mean temperature approximated with the average. There were no very mild days, and although frosts occurred on several nights no great severity was registered.

The Seasons

Tables of mean temperature and rainfall of the four seasons of 1930 (including December, 1929, but excluding December, 1930), and compared with those of the five previous years and with the average.

Temperature

Seasons	1925	1926	1927	1928	1929	1930	Average for 30 years.	Departure of 1930 from average
	degrees	degrese	degrees	degrees	degrees	degrees	degrees	degrees
Winter -	41·6	39·7	39·4	39·3	35·2	41·3	38·4	+ 2·9
Spring -	47·6	48·5	48·6	47·4	46·7	47·7	46·7	+ 1·0
Summer -	61·5	60·6	59·7	60.8	60·5	61·9	60·2	+ 1·7
Autumn -	48·2	50·3	49·9	51·9	52·5	51·2	50·1	+ 1·1
Year - Jan. to Dec.	49·2	50·0	49·1	50·1	49·0	50·2	48·8	+ 1.4

Rainfall

Seasons	1925	1926	1927	1928	1929	1930	Average for 35 years.	Departure of 1930 from average.
	ins.	ins.	ins.	ins.	ins.	ins.	ins.	ins
Winter -	6·06	7·26	5·64	8·05	5·90	7·89	6·21	+1·68
Spring -	6·31	4·70	4·23	5·15	2·19	6·56	5·55	+1·01
Summer -	4·65	6·92	10·62	6·06	5·68	7·08	6·89	+0·19
Autumn -	8·51	7·01	14·92	6·73	7·27	10·47	7·83	+2·64
Year - Jan. to Dec.	25·10	24·66	36·90	26·41	22·76	28·98	26·48	+2·50

It will be observed that the winter of 1929–30 was nearly 3 deg. above normal and 6 deg. warmer than the previous winter. It was the mildest winter since 1924–5 and the wettest since 1922–3. The spring was one degree above normal temperature

and the rainfall an inch in excess, the summer, owing to the warm June and the great outburst of heat at the end of August, was 1.7 deg. above the average, and the warmest since 1921. Its rainfall was only .19 ins. in excess owing to the dry June. The autumn slightly exceeded the normal temperature and the rainfall was 2.64 ins. in excess, constituting the wettest autumn since the very wet autumn of 1927.

The Year

The mean temperature of the year (50.2 deg.) was 1.4 deg. above normal and was the highest of any year since 1921, when it was 51.5 deg., although it reached 50 deg., in both 1928 and 1926. It is but rarely that the mean temperature of a year reaches 50 deg., and, with the exception of the above instances, it has only done so on two other occasions during the present century, viz., in 1914 and 1911. The warmest day was August 29th (91.7 deg.), and the coldest night November 5th (24.3 deg. in screen and 20 deg. on the grass). The warmest month was August (mean 62.6 deg.), and the coldest February (mean 38.8 deg.). But it is remarkable that with the exception of July, which was normal, the mean temperature of each month was higher than the average. The excesses were, however, very trifling, with the exception of January, which was 5 deg. and June which was 3.3 deg. above normal. Rainfall (28.98 in.) was 2.50 in. in excess of the average, and the wettest months were September (5.65 in.) and November (3.87 in.). Mr. J. H. Willis has very kindly supplied particulars of the sunshine for each month for the 20th year in succession and his figures show a deficiency for the year of 44 hours, or 194 hours less than in 1929. The winter was a mild one, the spring variable but with several cold periods, particularly at Easter. The summer, which promised in June to be an exceptionally fine one, completely broke down in the second week of July and continued cold and rainy till October, except an extraordinary outburst of tropical heat which occurred in the last week of August. September was excessively wet, with many thunderstorms, and at the end of the year the frequency of fogs and the gloom and rain at Christmas made the departure of 1930 not altogether to be regretted. It was a year that will also be remembered for its disastrous Bank Holidays, for with the exception of Whitsun, which was fine, all were very wet.

1930 Month	BAROMETER					THERMOMETER					HYGRO-METER	SUN-SHINE	RAINFALL		WIND								
	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Mean Relative Humidity 9 a.m	Hours	Inches	No. of Days	Direction and Days								Mean estimated force
															N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
	in.		in.		in.	°		°		°	%												
JAN.	30.30	16	28.92	12	29.713	56.7	19	30.2	16	42.6	86	57.7	1.91	19	1	0	1	3	8	10	8	0	4.1
FEB.	30.67	9	28.90	1	30.086	51.3	27	29.3	14	38.8	88	53.2	1.05	16	3	11	5	7	0	0	0	2	2.9
MARCH	30.50	1	29.13	16	29.804	62.7	28	25.3	20	42.6	80	132.9	1.37	13	3	5	0	4	4	3	9	3	3.3
APRIL	30.20	8	29.35	13	29.759	70.8	25	32.0	22	47.4	80	127.6	2.13	21	6	5	3	6	3	3	2	2	3.9
MAY	30.18	16	29.34	11	29.918	71.0	28	36.0	10	53.2	75	175.2	3.06	17	5	6	2	2	1	2	8	5	3.2
JUNE	30.28	15	29.60	27	29.966	80.4	18	41.8	8	61.4	71	233.9	0.89	6	2	5	3	4	1	7	4	4	3.3
JULY	30.18	9	29.33	18	29.781	82.4	6	45.8	13	61.6	71	162.8	3.80	17	3	0	1	0	4	5	10	8	3.6
AUG.	30.25	25, 31	29.37	14	29.852	91.7	29	47.0	5	62.6	75	215.8	2.39	18	1	0	0	5	5	7	8	5	3.7
SEPT.	30.36	3	29.25	20	29.880	71.0	9	41.0	3	57.9	86	122.7	5.65	21	1	6	0	5	1	2	9	6	3.0
OCT.	30.41	2	29.20	8	29.800	68.2	16	31.4	27	51.8	80	147.4	0.95	15	3	0	0	0	6	4	14	4	3.8
NOV.	30.62	12	28.73	2	29.789	59.3	9	24.3	5	43.8	87	73.1	3.87	19	1	2	1	2	5	5	8	6	3.9
DEC.	30.50	19	28.96	31	29.848	50.0	4, 19	25.2	5	39.2	92	36.8	1.91	18	0	2	3	2	7	6	7	4	2.3
MEANS					29.849					50.2	81												3.4
EXTREMES & TOTALS.	30.67	Feb. 9	28.73	Nov. 2		91.7	Aug. 29	24.3	Nov. 5			1539.1	28.98	200	29	42	19	40	45	54	87	49	

VII

SCOLT HEAD ISLAND, 1931

J. A. Steers and L. Slater

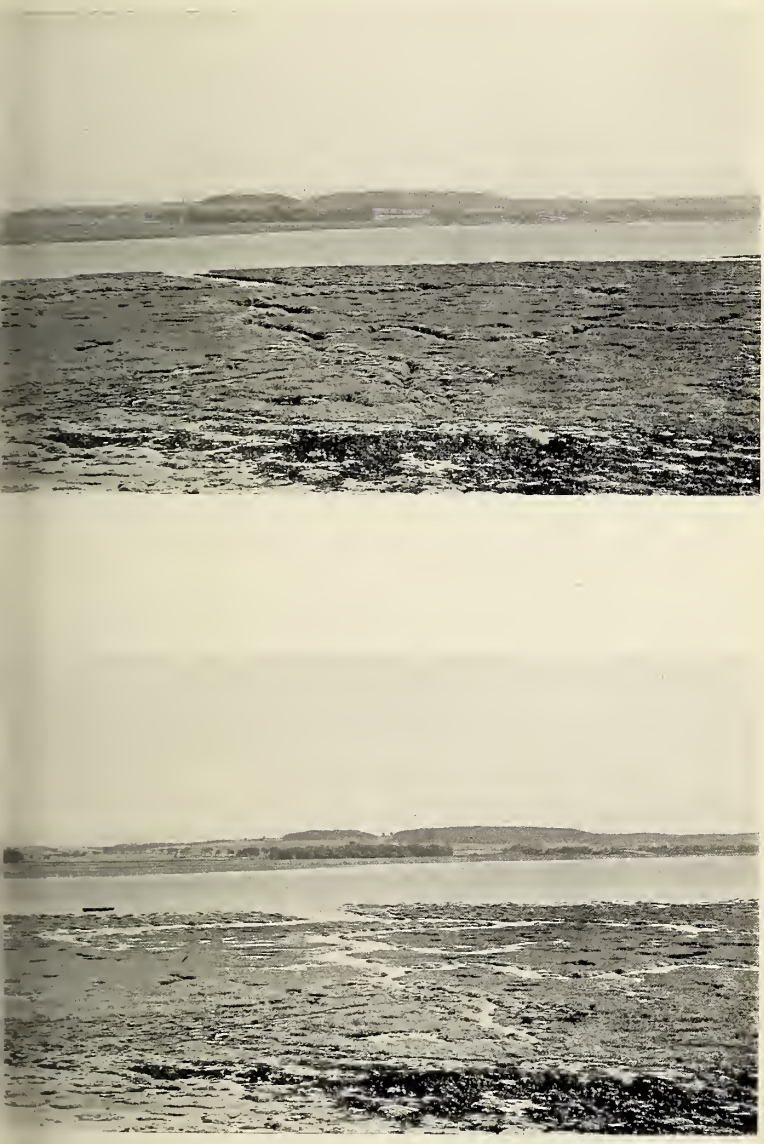
During the year July, 1930—July, 1931, some further Geographical work was carried out on Scolt Head Island.

Mr. L. Slater, B.A., of St. Catharine's College, Cambridge, was awarded a grant from the Department of Scientific and Industrial Research, and has carried out an investigation on various problems connected with the deposition of silt on the island. A fuller account of his work occurs elsewhere in this issue of the *Transactions*.

In the summer of this year further progress was made with the theodolite survey of the island. Last year a number of stations were established, and permanent marks put down. A few more such marks were added this year, and the triangulation was completed. It is unnecessary to publish here the figures of the computation of this triangulation, but a record of the co-ordinates of the fixed points on the island, referred to those of the trigonometrical stations of the Ordnance Survey on the mainland, has been compiled. Should anyone wish to make use of these figures, they are at liberty to do so, and can obtain the figures from the Editor of these *Transactions*, or from the authors of this report. The figures should prove useful in the future, not only as the basis of further mapping work which may be carried out to shew alterations in the form of the island, but also as datum-points for anyone who may undertake to examine some particular aspect of the island.

Each of the permanent marks consists of an iron tube, of one inch internal diameter, embedded in a block of concrete. A flag or other mark can thus easily be placed in these. Allowing for the curious shape of the island, the marks are so placed as to form a convenient network of triangles. The actual survey work cannot be of much interest to the general reader; nevertheless it has taken a considerable time to carry out, and has been made possible by the help of several Cambridge men.* Moreover, this survey necessarily forms the basis of future measurements on the island.

*Particularly Messrs. W. V. Lewis, B.A., of Gonville and Caius College, A. Stephenson, B.A., and L. T. Waddams, B.A., of St. Catharine's College, and C. Mace, B.A., of Selwyn College.



Photos] [*L. Slater*

Two photographs of the Marsh south of Butcher's Beach. The water level in the lower plate is 12 inches above that in the upper plate

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Photos] [*L.*

Stereoscopic pair of the Spiral Marsh

The Spiral Marsh lies to the west of the Hut Hills and to the north of Wire Hills

This year some tentative experiments were also made in a form of photographic survey. It was remarked in a former number of these *Transactions* that if it were possible to record photographically the water outline of a rising tide, a means of contouring the flat-lying marshes would be at hand. As was to be expected, such a method, whilst theoretically elegant, presented many difficulties in practice. The two photos on Plate XV shew the effect of a rise of 12 inches in the water level. Certain fixed marks (white flags or squares) can be seen on the original photographs. By mapping the positions of these marks in relation to the camera station, and by recording photographically the position of the edge of the tide for every rise of six† inches, as measured on a suitably placed graduated pole, sufficient data are obtained for drawing contour lines directly from the photographs. If such a process can be extended to a large area of marsh, the first stages of a very interesting physical and ecological map can be completed.

The practical difficulties are, however, considerable. The great marsh in front of the Hut is only completely covered at high spring tides. Probably the best tides for this purpose occur in September. Unfortunately the time of high-water is not always coincident with the best light conditions for photography. Hence, all that was attempted this year was a short series of photographs of the marsh on the south side of Butcher's Beach. These were taken from a suitable point on the dunes on Butcher's Beach. But here again, the time of high-water raised a similar problem ; the tides were the highest available at the time of our visit, but high-water occurred late in the evening and so, photographically, the records were not entirely satisfactory. There were also difficulties connected with the supply of plates, and especially with the rapid changing of unused for used plates. To photograph a reasonable area of marsh, six or seven plates had to be exposed for each successive water-level, and this process had to be repeated for each rise of six inches. Another point worth mentioning is that on the marsh selected the water edge (i.e. a contour line) was very broken and jagged on account of the creeks and the vegetation. Such a state of affairs is bound to exist until all the marsh is awash, and so it is not at all easy to pick out

† Or more or less as may be found convenient.

from a photograph the actual contour lines. Consequently, it seems that the method would be best suited to the newer marshes, i.e., those which have not yet been covered by a thick carpet of plants, and not complicated by an intricate creek system.

However, enough was accomplished to shew that there are considerable possibilities in the method, and that under favourable conditions of tide and weather, and with trained assistants, a useful map of a limited area of marsh could be obtained.

In an island such as Scolt Head, where physiographic and ecological changes are relatively rapid, even if not mildly catastrophic, it is interesting to have a series of photographs taken at intervals and in definite directions from fixed points. A further improvement is obtained if such photographs are stereoscopic. Hence, with this in view, five stereo-stations have already been established. Pl. XVI (above) and (below) shows a pair of photographs taken from one such station. Details of the procedure need not be given here ; it must suffice to say that the proper application of the method gives sufficient information for direct and accurate measurements to be made from the photographs. Thus, we have a means of estimating the change in outline of various parts of the island, the spread of vegetation over what are now bare areas of sand or mud, the growth of dunes, etc. For this purpose a photo-theodolite was used. It is probable that some slight alterations may have to be made in the positions of a few of the permanent marks ; it is feared some may be too widely spaced. It may be remarked here that although such photographs are stereoscopic pairs, they are best viewed with the help of a stereo-comparator. This instrument also allows measurements to be made on the photographs: the measurements can later be converted into actual distances, and so used for estimating changes during a period of time in a selected area.

Some interesting changes have taken place in the distal end of the island this summer. For some months the seaward side of that part of the island alongside the Ternery has been suffering erosion, and a small cliff has been formed. (See Pl. XVII and explanatory note below). This cliff is shewn as the line A.....B on the map (Pl. XVIII). During the week

Photo] [*J. A. S.*

The Small Cliff cut along the Ternery

The cliff in the foreground is 18 ins. to 2 feet high: that in the dunes somewhat higher. They are both parts of one and the same feature

The photograph was taken facing west

[*L. Slater*

The Gap cut through the Ternery

The photograph was taken from the inner side of the Ternery, looking in a northerly direction

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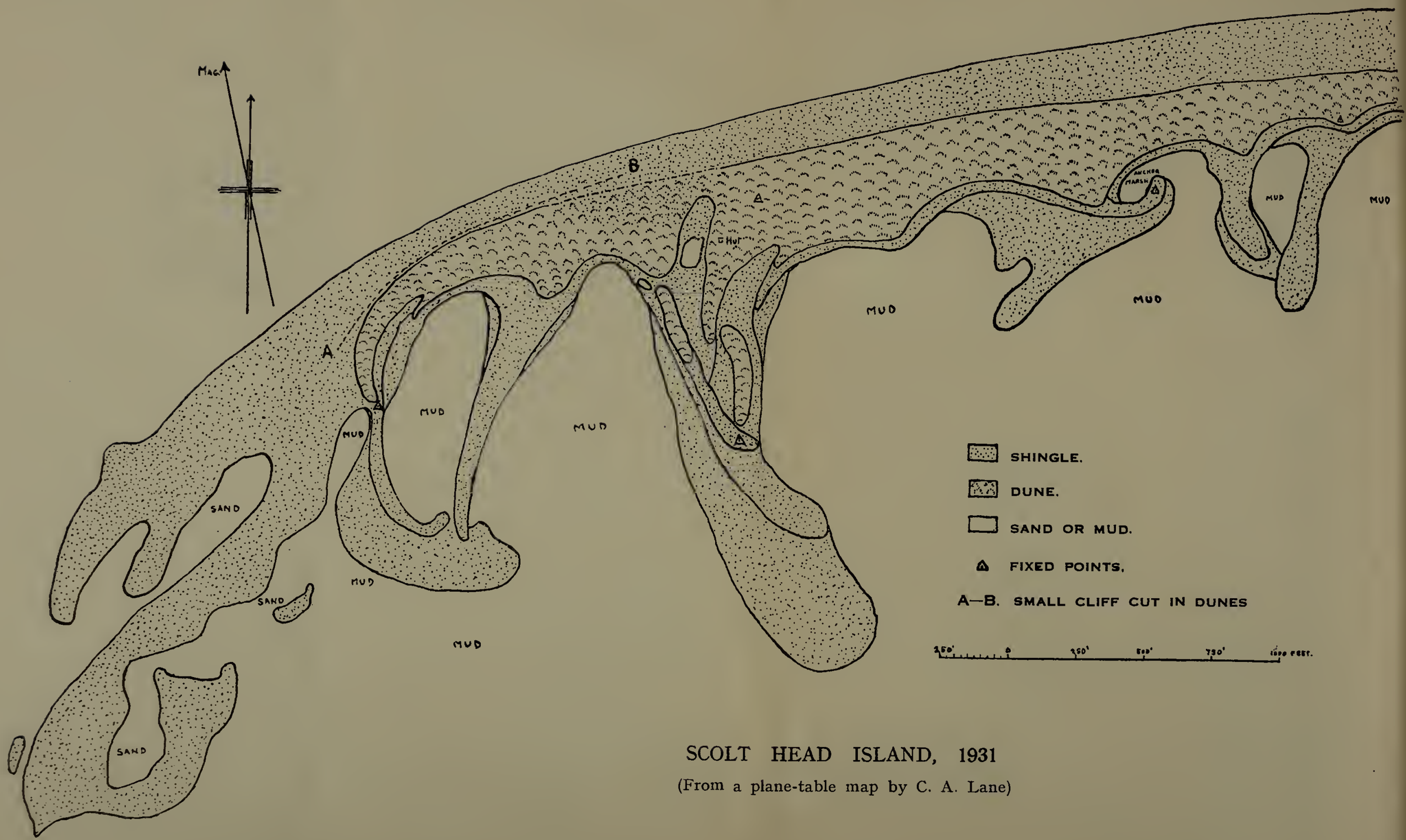

SCOLT HEAD ISLAND, 1931

(From a plane-table map by C. A. Lane)

September 12th to 19th, a complete breach was made by the sea. The general nature of this break can be seen in Plate XVII, which is based on two photographs taken from the inner side of the Ternery looking north. Fortunately the Ternery and adjacent area was re-mapped this year by Mr. C. A. Lane of Fitzwilliam House, and his map, here reproduced, shews clearly the position of the cliff, and should be compared with Mr. Kendall's map of the same area published as Plate XXXVI in Vol. XII., iv., 1927-28, of these *Transactions*. Considerable alterations in the shape of the Far Point are noticeable. The further development of this part of the island gives plenty of scope for speculation. Such long and narrow spits are very unstable structures, and it is no rare thing for large masses to be cut off, and for the material of which they are built to be redistributed in a totally different form. Much must depend upon the direction and severity of the storms in the coming winter. A severe north-westerly storm, especially if it coincided with a high spring tide, might easily lead to the total disappearance of the whole of the Ternery. On the other hand, normal weather conditions and a reasonably abundant supply of sand from the eastward might bring about the healing of the breach. Meanwhile, it is satisfactory to have Mr. Lane's map of the state of affairs prevailing this year.

VIII

SEDIMENTATION IN THE SALT MARSH ON SCOLT HEAD ISLAND

By L. Slater

During the past year the writer has been carrying out investigations on the interaction of the various factors which affect the deposition of sediment brought by the tide on to the salt marsh and into the backwater between Scolt Head Island and the mainland.

The chief processes involved in the sedimentation are: first, the transport of "new" sediment from the foreshore and, to some extent, from the mainland into the area; second,

the redistribution of this sediment so that at all points it shall be in equilibrium with, and stable under, the conditions to which it is subject ; and third, the fixation and stabilization of the sediment by settling, compression, vegetable and animal organisms and chemical processes.

The evolution of the island into its present form has already been described by Oliver,* and Steers and Kendall.† They have dealt mainly with the broader aspects of silting behind the shingle spit. The present writer conducted a more detailed investigation into the conditions under which the silt was deposited, with a view to analysing the mechanism of the processes involved in sedimentation.

In order to arrive at some understanding of the variations in the sediment with conditions of deposition, samples were collected from known places on the marsh. They were examined in various ways, including mechanical, chemical and microscopic analyses. The results of these examinations, combined with intensive observation on the island itself, lead to the conclusions which are outlined below.

The island has been divided into a series of " compartments,"‡ by lateral shingle spits (often with recurved ends), running landwards from the main shingle and dune ridge. Each compartment is, for many practical purposes, cut off from the others, except that all open to the main channel, Norton Creek. Owing to the mode of growth of the island, the older compartments are found to the east, and they have been slack-water areas for a longer period than the newer marshes to the west. In general, therefore, the eastern marshes show a later stage of development than the western.

This simplicity has been modified in many ways, especially at the proximal end of the spit, by the " break-through," which led to renewed erosion in the extreme eastern marshes. It has also caused a striking change in the flora of the adjoining marshes, the abundance of *Aster Tripolium*, which normally characterises a new and much lower zone, pointing to a

* F. W. Oliver " Scolt Head Island and Blakeney Point," Norf. and Norw. Nat. Soc. XI., v., 1923-24, 565-578.

† J. A. Steers and O. D. Kendall " Scolt Head Island," Norf. and Norw. Nat. Soc. XII., ii., 1925-26, 229-254.

‡ The word " compartment " is used to indicate the area of salt marsh between two lateral shingle ridges.

"rejuvenation" of the marshes.* Observations during a rising tide seem to indicate that these extreme eastern marshes are higher than the western Aster marshes, which have passed through the normal stages of development. This implies that within certain limits, it is the type of sediment brought to a locality, and its proximity to the source of supply which determines the type of vegetation rather than the actual height of the marsh.

Before attempting to interpret the results of detailed analyses, it is necessary to arrive at some understanding of the broader variations in the sediment on the island. One of the most important points arising from a detailed examination of the marshes is that the formation of a new recurved end to the main spit may cause a considerable change in the type of sediment deposited, by altering the conditions of deposition with comparative rapidity. The completion of a new compartment by the addition of a lateral shingle ridge along its western side has, in the opinion of the writer, resulted in the conditions of sedimentation in that compartment being much more tranquil, especially if the enclosing shingle bar extended far towards Norton Creek. More tranquil conditions generally favour a quicker rate of accretion, but they will also tend to increase the proportion of finer-grained sediment deposited, even if the silt-content of the water reaching the locality is unchanged. The grains of sediment laid down at a given place are of such a size that the "scour effect," or turbulence, is insufficient to move them. If the turbulence is decreased, particles of smaller size can be deposited.

Apart from, or probably in addition to, this effect, it seems that the prolongation of the main spit to the west would alter the silt-content of the water reaching a given locality. The "source of supply" for the sediment is the main channel through which the silt-laden water comes. As the coarser portion of the load is being deposited while the tide is flowing, the silt suspended in the water is, on the whole, finer the farther it is carried from the source of supply, and the more tranquil are the conditions.

These considerations indicate that prolongation of the spit

* F. W. Oliver, "Scolt Head and Blakeney Point," Trans. Norf. and Norw. Nat. Soc. 1923-4, pp. 573-4.

to the west, together with the formation of new recurved ends, will result in finer sediment being deposited in any compartment so formed. The comparatively rapid growth of one of these lateral ridges is probably responsible for the sudden change from coarse sediment below to fine above, such as is shown by many marsh sections and borings. As a further corollary to this general principle, it follows that adjacent compartments often show a distinct difference in the phase of their development. There is no definite line of demarcation between high and low marsh : there is in fact every gradation between the two. But there is, in general, a distinct difference between the stages reached in the evolutionary process by the marshes on each side of a lateral shingle ridge. These stages are, to some extent, artificial and accidental, the difference in development being a function of, *inter alia*, the length of time required for the formation of the intervening shingle ridge.

Apart from these broader aspects of marsh development, there is a large field for investigation which has been left practically untouched, namely, the detailed mechanism of the processes of deposition, and the consideration of the chemical conditions which govern them.

The real difficulty in this work is that observations on the actual processes of sedimentation in the field are impracticable. The processes take place too slowly and on such a small scale as to be of no use for field observations. The only means of approach is to study the results of the process, and to make deductions, or even conjectures, as to the causes of these results.

The samples of sediment collected from representative places on the marshes were therefore analysed mechanically, chemically and microscopically. By taking into account the more obvious differences in conditions at the various points when studying the differences in the composition of the sediments it was hoped to arrive at some conception of the factors which affect deposition, and ultimately of the mechanism of the process.

Such analyses take a great deal of time, which is, in many cases, out of proportion to the usefulness of the results. It is necessary, however, to proceed in this way, although many results are purely negative.

The interpretation of mechanical analyses is, for numerous reasons, far from straightforward. However, neglecting minor variations, it is possible to make some generalisations about the size of particles deposited and the conditions of their deposition. From the results of actual investigations, combined with a theoretical consideration of the process of deposition, the conclusion is reached that there will be horizontal variation in the sediment, the finest particles being found only in those places reached by the top of the tide and farthest from the main creek. There seems to be a gradual increase in the grain size of the particles recently deposited, from the higher parts of the marsh toward the main creek. Those portions of the marsh reached only by the higher part of the tide receive the greatest proportion of the finest material. The parts nearer the main creek have a larger percentage of coarse material, and there is every gradation between the two extremes. There is also a variation with height in the sediment deposited, the higher marshes receiving finer sediment, though this again may be due merely to the fact that they are farther from the source of supply.

The tide may be considered as a wave in which the sediment is arranged according to the size of the particles, the coarser particles being in the lower portion of the wave and only the finer in the upper. Consequently those parts of the marsh which are flooded only by the higher part of the wave receive merely the smaller sediment. There is a gradual increase in the proportion of the coarser particles with the decrease in level of the marshes. In other words, the general distribution of sediment is such that it may be considered as the result of deposition during the period of *incoming* tide, rather than the slack at high water, or the outgoing tide.

Chemical Considerations

The chief chemical analyses carried out on air-dried samples were for the estimation of water, loss of weight on ignition, nitrogen, phosphorus, iron, aluminium and carbonates. It was found that the amount of nitrogen present (which is a rough indication of the organic content) is approximately proportional to the loss of weight on ignition, except in certain

cases. The amount of phosphorus present was so small as to be negligible for the purpose of the investigations. The results of the microscopic analyses were mostly disappointing. The silt consists almost entirely of quartz fragments which are rather angular. There are occasional fragments of quartzite and a few grains of rutile and magnetite. Apart from these, the only interesting feature was the occurrence of a ferruginous cement, consisting of ferric carbonate with some limonite. The significance of the chemical analyses is frequently far from clear, and the general conclusions so far reached are few and uncertain. Much more extensive investigation is necessary before any full understanding of the importance of chemical processes in the marsh formation can be obtained.

Iron is of widespread occurrence all over the marsh, not only in the more obviously ferruginous red sands, but also in the fine brown sediments now being deposited, as well as in the underlying black mud, in which the black colour is largely due to the presence of ferrous sulphide. There is little doubt that the iridescent films seen on the surface of water and mud are due to the formation of ferric hydrate in the stagnant water by the oxidation of iron carbonate. Iron is probably derived from the weathering of the flint*, and goes into solution as the soluble bicarbonate, or is carried in the colloidal state as ferric hydroxide. One of the problems which requires investigation is, to what extent is the iron precipitated, and what its effect upon the deposition of sediment.

A remarkable feature of the occurrence of iron in the marsh sediments is that it tends to be present very frequently, either as a definite layer in a plane of lamination, or in nodular form, generally round a pipe-shaped nucleus. The writer suggests tentatively that the concentration of the iron deposits in layers is connected with the concentration of organic material in layers, such as is found in newly-deposited marsh muds. The pipe-like iron concretions have been formed round nuclei which can reasonably be regarded only as either plant or animal remains. More work is however required before the relationship between the formation of this ferruginous cement and the organic content is understood.

There seems to be little doubt that the mechanical condi-

* The flint has a dark brown colour due to iron staining

tions are very much more important than the chemical in determining the deposition of sediment, but chemical processes play an important part in its subsequent history.

There are abundant indications that animal organisms are active agents in stabilizing sediment. For example, it is found that mussels in the main creek accumulate remarkably fine sediment round them. It is stable in the swiftly-flowing creek by reason of some organic addition made by the organisms in passing it through their intestinal tracts.

It may be that the phenomenon of " co-precipitation " of oppositely charged colloids plays an important part in the production of the ferruginous cement in the sediment. Iron in the colloidal form, unless stabilized by some organic acid colloids, would precipitate and be precipitated by colloidal silica, and the precipitated mass would trap other silt in falling. So far no incontrovertible examples of this having taken place have been obtained, but there are indications that it does happen.

Another interesting field of research which the writer hopes to explore is the variation in the type of sediment and rate of silting with variations in salinity and in the hydrogen concentration of the water.

One of the most important criteria in a study of silting is the direct measurement of the rate of accretion in the field. So far, no very satisfactory method has been evolved for this purpose. Direct measurements almost inevitably tend to upset natural conditions and give false data. A possible method, which so far has apparently not been tried, consists in the examination of the minute laminæ such as are found in the top layers of mud recently deposited, especially in curled mud flakes and polygons. The practical technique of the measurement and counting of these excessively fine layers is undoubtedly difficult, but if they can be overcome the method should yield most interesting information about the ' periodicity " in structure, which characterises a section of these sediments. It seems unlikely that the periodicity can be directly correlated with that of the daily tides. It may, however, correspond with the period of a week or thereabouts, the alterations from spring to neap tides producing the variations in the size of the particles deposited. It will

be interesting to see whether this is in accordance with the periodic occurrence of layers rich in organic matter which can be attributed to a seasonal variation, the interval between two such layers corresponding to a year.

The most suitable examples for this line of study seem to be the curled mud flakes, many of which occur to the east of Long Hills. They are in themselves an interesting feature and seem to show a gradual upward decrease in the grain size of the particles, a variation which is rhythmic, not continuous. They therefore indicate that, as the level of the marsh is raised, the sediment deposited becomes progressively finer. Borings were made through the marsh sediments and the results have been found to support this view. In general, there is an increase of grainsize with depth, until a coarse sand is reached, which is comparable with the sand at present found nearer the mouth of the main channel. This indicates that coarser sediment does not reach the higher portions of the marsh in large quantities, which supports the view that the deposition of material takes place while the tide is flowing.

This paper is intended merely as an indication of the nature of the problems which are under review, and some of the lines along which the writer hopes to pursue the research. It is especially desirable that a more complete understanding of the laminations in marsh sediments should be obtained, as it may throw light not only upon the rate of accretion, but also on the chemical processes taking place in the sediment.

IX

THE GREAT YARMOUTH HERRING FISHERY 1930

By Sydney H. Long

The total catch for the season at Great Yarmouth to December 13th, 1930, was 540,664 crans, as compared with 529,318 crans in 1929, and the value of the catch may be placed at somewhere in the neighbourhood of £1,000,000. The highest catch of the

season was 250 crans, brought in by the Yarmouth boat, " A. Rose " on October 17th. The heaviest landing on any one day was 32,805 crans on November 7th. On the whole it was a fine weather fishing, and the losses of gear were slight.

The fleet was composed of 634 Scotch boats (against 670 last year), 120 Yarmouth boats, 40 Lowestoft boats, 6 North Shields boats worked by Yarmouth crews, 2 Milford Haven boats, and one Norwegian, a total of 803, six less than last year. The Yarmouth boats earned from £4050, by the top boat, down to £1400. The Yarmouth fishing is now largely a Scotch business since three-fourths of the herrings landed at Yarmouth are taken by the Scotch fleet, and the bulk is purchased by Scotch curers. The weekly landings for the past three seasons have been :—

Week ending	1930 crans	1929 crans	1928 crans
Sept. 27	17,336	12,802	5,192
Oct. 4	17,620	9,237	53,554
,, 11	53,783	24,440	31,868
,, 18	79,344	81,307	89,518
,, 25	98,730	63,172	107,773
Nov. 1	60,011	92,196	124,694
,, 8	106,882	101,554	52,850
,, 15	60,240	55,732	18,855
,, 22	18,763	43,910	5,966
,, 29	7,680	19,075	5,765
Dec. 6	7,443	11,958	4,531
,, 13	4,418	179	2,241

The highest price per cran for fresh herrings was 144 shillings, and the lowest figure twenty shillings. Curers paid on the average from thirty-six to thirty-seven shillings per cran, which means that the pickled herrings cost them forty shillings a barrel. " Freshing " was again carried on and 42,992 cases of fresh herrings were sent to Germany, against 40,979 the previous year.

The total cure was 524,994 barrels, compared with 493,276 last year, an increase of 31,718 barrels. Up to December 13th, 296,659 barrels had been shipped. The first steamer with " pickles," as these herrings are termed, was the Strassburg,

which went to Stettin. 114,119 barrels to Danzig, 59,310 to Stettin, 30,355 to Libau, 20,288 to Riga, 16,877 to Konigsberg, 14,646 to Hamburg, and 10,092 to Neufahrwasser. Smaller totals were sent to Reval, Memel, Wyburg, and to Dutch and Belgian ports. The United States took 359 barrels, Jaffa 315, Jerusalem 30, Haifa 55, Canada 40, Australia 35.

3540 Scotch fisher girls came to Yarmouth, the first special trains from Aberdeen arriving on September 24th, and the last returning train left on November 28th.

X

SOME NOTES ON THE TIDE AT STOKESBY

By Robert Gurney, D.Sc., F.L.S.

Although the passing of old Acle Bridge may be a matter of heartfelt regret to some of us, we can at least feel satisfaction that it has led to a serious study of the tides in the river, and to Mr. Davies' excellent account of them in our Transactions.* My own investigations, which were published in 1911,† were those of an uninstructed amateur, using rather crude instruments, and I did not then pay the attention I should have done to the currents. Although, thanks to the work of Dr. Owen, we now know all that is necessary about the tides and the currents, it may not be amiss to put on record some observations of my own made on October 8th, 1926. Taken by themselves they are not of much value, but it was intended at the time to make a series of such records at different states of the tide—an intention which will now never be fulfilled.

On that day, observations were begun at 9.45 a.m. from a boat moored just below Stokesby Ferry, in such a way that it could be easily run out into mid-stream and drawn back again without losing station. A gauge was set up by the shore, and the current was measured by means of a float. This was a piece of a stout tent-pole 4 feet long and weighted so that it floated vertically with about 4 inches above the surface.

*Vol. XIII., pp. 14-22.

†Vol. IX., pp. 216-243

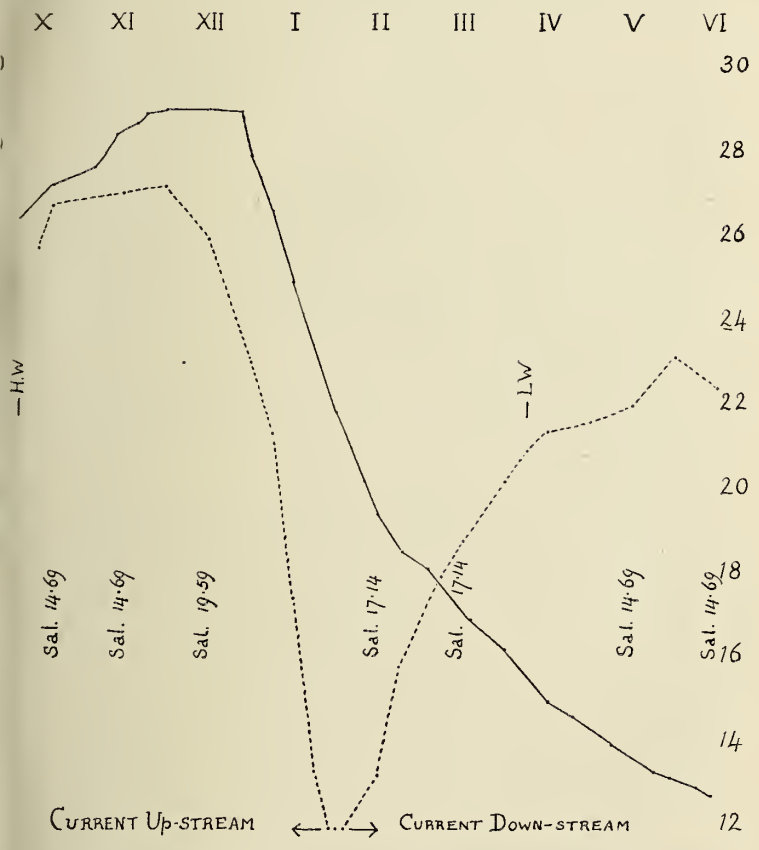

Diagram showing the rise and fall of water, and speed of current, t Stokesby on Oct. 8th, 1926.

Dotted line represents speed of current in feet per minute according o scale on left. Unbroken line gives height of water, reading from scale of inches on right. Salinities in grains of Chlorine per gallon are nserted. HW and LW give time of high water and low water at Yarmouth.

Weather was fine, but with a southerly breeze which may have caused a slight check to the float on the ebb. Unfortunately observation could not be continued after 6 p.m. owing to darkness, and actual low water could not be noted. Tidal conditions at Yarmouth were as follows :—

	Haven.	Southtown Bridge.
High water ...	9.55 a.m.	10.10 a.m.
Low water ...	3.55 p.m.	4.10 p.m.
Range	6-ft. 1-in.	5-ft. 1-in.

The facts observed are summarised in the diagram.

As will be seen, the maximum speed of current almost coincided with high water, but the upstream flow continued for two hours after the water-level had begun to fall. Slack water lasted about 23 minutes. That is to say, at 1.27 it was just possible to detect an upstream flow, and at 1.50 a definite movement downstream had begun.

The speed of the current very quickly increased, but did not reach the speed of the flood tide, and it had begun to diminish at 6 p.m.

The maximum speed observed was 76.25 feet per minute (1525 yards per hour). Dr. Owen found the highest flood velocity at Stokesby at the time of observation was 56.76 f.p.m. ; but no doubt the speed varies very much with the conditions of weather. In any case it is surprisingly small—very much less than the appearance of the stream would lead one to guess.

The water was practically fresh throughout the day, and contained a typical fresh-water plankton ; but there was a slight increase of salinity just before, and lasting a short time after, the turn of the current (from 14.69 gr. per gall. to 19.59).

Dr. Owen's observations show high water at Stokesby 1h. 30m. after Yarmouth Harbour, and 1h. 10m. after the Haven Bridge, and my own observed times agree exactly with his. As evidence of the inaccuracy of local ideas as to the tides, I should say that a Stokesby man informed me that high water was 3 hours after Yarmouth.

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Photo] [*R. Bland*

William Eales, the newly-appointed Watcher on Blakeney Point, holding a young tern

XI

WILD BIRDS' PROTECTION COMMITTEE

R. J. COLMAN (*Chairman*)
S. H. LONG (*Hon. Secretary*)
Q. E. GURNEY — CAPT. L. LLOYD
R. GURNEY — B. B. RIVIERE
LORD WILLIAM PERCY

WILD BIRD PROTECTION IN NORFOLK IN 1931

REPORT OF THE W.B.P. COMMITTEE

THE Committee of the Norfolk Wild Bird Protection Fund has much pleasure in presenting to its supporters the following Report for the year 1931.

The first spring migrant noted in Norfolk this year was a Wheatear which appeared in General McHardy's garden at Hickling on March 1st and remained for half-an-hour on a very cold day. By the 7th Ringed Plovers had returned to Breckland, one of their principal inland nesting places in Norfolk. The weather remained very cold with biting east winds during the first two weeks of March.

From accounts received, and from our own observations, we are under the impression that Crossbills are extending their nesting range in Norfolk. On March 19th we watched a colony of about six pairs in north Norfolk and it was interesting to see how a bird would cut off a cone from a lower branch of a Scots-fir, fly with it in its feet to the topmost twig and then extract the seeds. It was of a male bird in this colony that Mr. Harrison made his sketch for the Christmas card which has been published this year by The Norfolk Naturalists Trust.

On another occasion, on April 2nd, in a Scots-fir wood about a mile from the coast we found a very interesting collection of obviously migrating birds: the wood seemed full of them. Crossbills were numerous, mostly males, singing and calling from all directions: a flock of twelve flew across a road that divided the wood. There were also a large number of Bramblings, Chaffinches and Greenfinches, all appearing to be

feeding upon the split cones on the ground; whilst Siskins, Redpolls and Goldfinches were attacking the cones in the tree tops in the company of the Crossbills. It is not often that one finds oneself in the midst of such a movement of spring migrants.

It is not unusual for Cormorants to enter the Norfolk rivers during the winter months, but the other large divers are rarely seen; it is therefore worth recording that on April 6th the writer found a Red-throated Diver at Lenwade, which had been caught there on the river Wensum, about thirty miles from its mouth. It had been rescued by Mrs. Keppel and placed on one of the ponds at Weston Old Hall, where the writer saw it. It was a slightly oiled bird and although it could work its wings, it had not confidence enough in them to take to flight.

The newly-acquired sanctuary of The Norfolk Naturalists Trust, Alderfen Broad, has been placed under the supervision of Mr. Harry Callow, of Neatishead, who had kindly undertaken to look after it. Situated in a rather inaccessible district, which is but little visited, the broad suffers practically no disturbance. For many years a colony of Black-headed gulls have nested here, not on the mainland, but on the floating "hovers"—detached portions of the surrounding reed beds. This year there were about fifty nests, the birds arriving on May 20th, when previously not a gull had been seen in the district. Shovelers, Mallard and numerous Snipe nested on the surrounding marsh. Reed-Warblers, Sedge-Warblers and Reed-Buntings are commonly distributed about the broad, and it is probable that the Grasshopper warbler also nests on the property, for on the evening of July 3rd the writer found one singing from an osier bush on the edge of the broad.

The number of summer migrants visiting Norfolk this year was about the average, though Red-backed Shrikes and Spotted Flycatchers were sparingly distributed. Two of the Norfolk terneries are now practically extinct—namely those at Wolferton and at Wells. On July 4th we made a whole-day visit to the Wells marshes and dunes but failed to find a single tern's nest. About half a dozen Common Terns and one or two Little Terns were seen, and only one or two Ringed Plovers, which formerly nested in numbers on this ground.

Breydon Water

William Bulldeath has continued to act as the watcher on this estuary during the past summer. He resided in the committee's house-boat moored in the estuary.

Except that Spoonbills paid irregular visits to the estuary, as they have been accustomed to do for many years, there is little in his diary of ornithological interest. The first Spoonbill arrived on June 1st and remained for five days; and a party of five arrived on August 28th. The watcher ends his report with the following note :—

"The weather this summer on Breydon has been very rough, with a great deal of wind, and rain almost every day. There were very few fine nights, and it has been very cold most nights."

Cley and Salthouse

From the point of view of the bird watcher this part of the north Norfolk coast-line is one of the most interesting. The Cley marshes are owned and protected by The Norfolk Naturalists Trust, and the greater part of Salthouse Broad is in the hands of Mr. Roy Pope. Both properties are undisturbed throughout the nesting season and are visited by many migrants, which often stay for a few days. For some of the following notes referring to this district we are indebted to Mr. R. M. Garnett, of Kelling. On January 9th, seventeen Bewick swans, calling as they flew, passed over the marshes. (On the 19th the writer found eight Bewicks and three Whoopers on one of the west Norfolk meres). During the last week of February the weather was very cold with strong northerly winds, and many oiled birds—chiefly Guillemots and Puffins—were washed up at Cley. Amongst these was an adult male Velvet Scoter.

A female Merlin was hunting over the Cley marshes on February 16th, and on March 16th a Hen-Harrier was seen over the same marshes. During April Mr. Garnett undertook, for identification purposes, the trapping of small rodents on the marshes, when several field voles, common and water shrews were caught. As the voles did not appear to be numerous and the shrews are entirely insectivorous and therefore not destructive, trapping was discontinued.

A full-winged Common Crane flew in from the sea on the afternoon of May 6th and remained for the night on the Salthouse marshes: it was seen by the writer and several others. It is believed to have escaped from captivity in Sussex. On the same afternoon there were several Black terns on the Broad. On the 23rd another rare visitor, a Flamingo, came in from the sea to the Cley marshes, where it remained until the night of June 6th. It is not unlikely that the earthquake on the early morning of June 7th, which was very evident at Cley, determined its departure.

Ruffs and Reeves have visited the marshes during the summer, but cannot yet be induced to stay to nest. Mr. Garnett found a Ruff on the Cley marshes on April 8th, and the writer a Reeve feeding in the company of a Greenshank on August 13th: others were seen.

Avocets were only seen this year on the Autumn migration. On August 12th two were seen by Mr. Garnett and Miss Barclay, and on October 13th Mr. T. Hyde Parker watched three feeding on the Cley marshes; two of these remained until November 19th, when they were seen by the writer. Mr. A. H. Patterson got to within twenty yards of one feeding on the banks of the Yare, near Cantley, on July 23rd.

It is probable that one or more pairs of Quails nested in Norfolk this year. During June one was heard daily in a barley field near the East Bank at Cley, but was never seen; others had been seen and heard in neighbouring fields. In September two out of a bevy of a dozen were shot by Colonel Oliver Birkbeck at Massingham. His bailiff had seen them in the same field last year, but did not know what they were.

Kingfishers are not uncommonly seen on the Cley marshes, and on February 12th, with a cold S.W. gale blowing, the writer watched two fly up the ditch by the watcher's hut; one settled on the water and swam to the edging reeds, and then flew up and settled on a reed.

Two colonies of Sandwich Terns nested on islands on Salthouse Broad, and 380 of the young birds were ringed by Mr. Garnett. A considerable number of Common Terns also nested on the broad. There were no tern's nests on the Cley marshes this year.

A locust was found in a cornfield at Salthouse on August 23rd, and was identified at the British Museum as "*Locusta migratoria* in its most migratory form." Several others were found about this date in Norfolk, Suffolk and Yorkshire, showing that there had been a small invasion from the Continent.

A Red-necked Phalarope was seen amongst the breakers off Cley beach on September 27th. Grey Crows were first seen on September 27th.

With the object of trying to make the Cley marshes more attractive to ducks and waders, certain areas which were becoming choked with herbage have been mown this autumn, ditches cleaned out and several banks repaired so as to allow of a better control and distribution of the freshwater entering the marshes.

Mr. Robert Bishop continues as the watcher of the Cley area.

Blakeney Point

As has happened more than once in the past since the ternery on Blakeney Point has been under supervision, there was this year a high mortality amongst the newly-hatched chicks. The food supplied to the young of the Common Tern would seem to be chiefly whitebait—young herrings—and the in-shoring of this small fry appears to be dependent upon the sea temperature. June this year was an exceptionally cold month with rough seas and, during the period of hatching, the old birds were unable to obtain food, except far out at sea, with the result that the chicks died of starvation within twenty-four hours of being hatched. It was estimated that not more than twenty-five per cent. of the first hatchings survived, but in many cases second clutches were laid, which fared better. In the past it has been noted that after such a high death-rate the strength of the colony has not been affected in the succeeding year, so that it will be interesting to see what happens next season.

One of the greatest trials to a nesting colony of terns is four-footed vermin, and even to such an exposed area as is the Far Point at Blakeney, rats and stoats will travel for miles to obtain food. A single rat, and even more so a stoat, will in the course of a night destroy a score of nests, so that it is necessary to wage continuous warfare on these pests, and

this must be carried out during the winter months. During last winter over 200 rats and eight stoats were accounted for by the watcher, and as result of this clearance the birds remained free from all disturbance by these vermin during the past nesting season.

On June 11th a census was made of the nests on the Point, with the following results :—

Common terns	...	1000 nests (8 with 4 eggs)
Sandwich terns	...	4 nests (all forsaken)
Little terns ...	...	20 nests
Oyster-catchers	...	22 nests
Ringed Plovers	...	56 nests
Redshanks ...	...	6 nests

The Common terns' nests were widely distributed over the Point, though chiefly concentrated at the Far Point.

The first egg was found on May 15th, and the first chick on June 11th.

Scolt Head

During the winter of 1930-31 an unusual number of Short-eared Owls visited Norfolk. On January 1st, Chestney, the watcher, flushed nine at one spot on Scolt Head, and on February 27th he put up fourteen on the island. There is no evidence that any of these birds nested on the island this year, though one remained until the middle of July and paid evening visits to the ternery.

When the writer paid a visit to the island on February 22nd an unusual sight presented itself. As the result of a N.W. gale four days previously the shore-line had become strewn with innumerable "horse" mussels varying in size from half an inch upwards. Gulls, chiefly Herring-Gulls and Lesser Black-backs, had discovered these and, as far as one could see in both directions, the beach was covered with these birds—in the aggregate some thousands. Grey Crows had also come to the feast, and we watched them rising in the air with a mussel and dropping it, repeating the process until the mussel fell on to a stone and was broken.

By the middle of March Ringed Plovers had started courting and "scraping," but it was not until May 4th that the first clutch of eggs was found. After this numerous nests were found on the shingle ridges. The terns began to arrive about

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[G. Marples

Avocet turning its eggs,
The Avocet visits Norfolk yearly, and it is hoped that it may return to nest in the county

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fortnight earlier than last year, the Sandwich, as usual, eing the first, on April 11th. Three days later the Common ern was seen.

A delayed Woodcock was flushed in the dunes on April 24th nd flew straight out to sea.

On April 15th the first chick was hatched in an Oyster-catcher's est on Butcher's Beach. The total number of Oyster-atchers' nests was twenty-four and these all hatched off. ne of these, on the Nod, was situated within three inches of ie wheel-track of a cart which passed it daily on its way to a ockle lay, and although the eggs became bespattered with ud the birds did not forsake. This incident is recorded as an vidence of the interest that the local fishermen now take in ie protection of nesting birds.

The first Redshank's nest with eggs was found on May 1st ; ere were about the usual number of these on the island this ar.

The first Sandwich tern's egg was found on May 19th—a eek later than last year, and two days later the Common rns started to lay. This backwardness in laying was probably ie to the exceptionally cold weather experienced during e whole of May.

Egg-pecking was evident again this year among the first-d eggs of the Sandwich tern and it was thought to be due to e shortage of food, but no satisfactory explanation has t become obvious for this.

The Sandwich terns all nested on the newly-formed dunes the extreme west end of the island, and the total number unted was 203, of which 182 hatched out : the remainder came buried by a sand-storm on June 23rd. The chick rtality was very low, in spite of the high death-rate from od-shortage amongst the young Common terns here and, ere especially, on Blakeney Point. This may be due to the t that the young of the Sandwich tern are fed chiefly on nd-eels, whereas those of the Common tern would seem to fed on Herring syle.

The number of Common terns' nests on the island was proximately 500. Although the large majority of these re situated on the ternery at the west end, quite a number re found scattered amongst the dunes between the Hut and

the ternery, and a small colony—about fifty pairs—nested on the shingle ridge to the south of Smugglers' Gap. During the last fortnight in June there was no in-shoring of Whitebait owing to the cold weather, and scores of Common tern chicks died of starvation within twenty-four hours of hatching. In a number of instances second clutches were laid, from which the young were successfully reared.

Two Roseate terns were identified on the ternery on May 24th, and on June 5th a nest was found with one egg. On the 7th a second egg was laid and the bird started sitting. The first egg hatched out on June 27th and the second on the 28th. These two chicks were ringed on July 9th. During the incubation period the bird on the nest was seen to be fed six times on one morning with sand-eels brought by its mate. These fish, rather than whitebait, seemed to be the food with which the young Roseates were fed.

There is a larger colony of Little terns nesting on Scolt Head than anywhere else on the Norfolk coast-line, and this year eighty-four nests were counted at the west end of the island, and thirty-four in the neighbourhood of Smugglers' gap.

On the salt-marshes to the south-east of House Hills the colony of Black-headed gulls that have nested here for some years show signs of increasing, and this year ninety-seven nests were counted. Being distant by about two miles from the ternery, they make no attempt to interfere with the latter. On the other hand, the larger gulls, of which there are always a number of immature birds on the island throughout the summer, are a constant source of annoyance to the terns, and will take advantage of any unguarded opportunity for robbery; indeed, a Great Black-backed gull has been seen to pick up a young Common tern and swallow it whole.

By the middle of August all the terns had left the ternery, but were to be seen fishing in the creeks for some weeks later.

A pair of Garganeys were seen on the island several times during the summer and it is probable that they nested here, for two were shot on August 1st.

Of Sheld-ducks' nests there were scores, but it is impossible to estimate their numbers: 100 is probably a conservative estimate.

A pair of Swallows again nested in the coal-house at the back of the Hut, and another pair in the old rabbiters' hut on House Hill.

The trees and bushes planted with the object of affording resting places and shelter for passerine birds have made good growth this year, and twenty-seven Corsican pines from the nursery on House Hill have been transplanted to the Overy end of the island.

It has been the custom of the writer to spend a fortnight on Scolt Head in September to observe the autumnal migration which, as last year, is sometimes very evident amongst the passerine birds. But this year we had, as if to make up for the cold, wet, windy summer, an almost continuous spell of six weeks of warm sunny weather under anti-cyclonic conditions extending well into the middle of October. Under such circumstances the migrating birds remain in the upper regions and are not visible. On September 6th in company of several Common Wheatears, was one Greenland bird, and on the 9th a male Red-backed Shrike was seen at House Hill, where it remained several days.

On most days there was a westerly movement of Swallows.

Mr. Charles Chestney of Dial House, Brancaster Staithe, continues as watcher on the island.

Broadland

To Mr. Jim Vincent, Lord Desborough's head keeper at Hickling, we are indebted for the following notes on the birds in the Hickling district.

The Bittern was first heard booming in the third week in March. At one time an attempt used to be made each year to locate all the nests of this bird for census purposes, but this practice has now been given up, because there is every reason to believe that their numbers are not decreasing. For example, on May 1st, Vincent heard seven different male birds booming on the reserve.

The nesting of the Bearded Tit was, in Vincent's words, "better than was anticipated" in spite of the wet and cold summer. Several nests were found, the first, containing seven eggs, on April 6th.

Four pairs of Short-eared owls nested at Hickling, the first nest with one egg being found on April 16th. A pair of these birds were frequently seen just outside the boundary of "Starch Grass" during the summer.

For the fifth year in succession Marsh-Harriers again nested in Norfolk and we are able to record three nests in 1931. The first, containing three eggs, was found in the Hickling-Horsey district on April 18th; eventually six eggs were laid and six young reared. A second nest, containing three young and one egg, was found by Mr. Charles Dallas; and the third nest, with three eggs, was situated on the Horsey estate. In the same district were nesting five pairs of Montagu's Harriers, the first bird being seen on April 24th.

Although Henning Weis in his "Life of the Harrier in Denmark" describes and illustrates nests of the Montagu's Harrier amongst pine trees in Jutland, in Norfolk the nest is usually found in sedge or reed beds, or on open heathland. It is therefore of interest to place on record two nests that were found in Breckland this year. The first was found by Mr. David Lack on June 21st "in a fir plantation, with the eggs hatching." Mr. Lack also located "a second pair nesting in another fir plantation about a mile away." He failed to find this nest, but it was eventually discovered by Mrs. Rait Kerr. Both pairs of birds succeeded in rearing their broods.

During the year a number of migrants pass through the Hickling district, and the following are some that were noted. During the second week of April Ruffs and Reeves and a White Wagtail were seen, and a week later several Ring Ouzels. On May 5th four Black-tailed Godwits were about the broad, and on the 11th a Rough-legged Buzzard was seen. A Dusky Redshank—a "good black one"—arrived on May 17th, and two days later an adult male Goldeneye was found on the broad.

On September 12th a Hoopoe took up its temporary residence near Whiteslea Lodge and remained for several days. Later, early in October, another Hoopoe was reported from his garden at Thornham by Mr. Victor Ames. Vincent flushed a Spotted Crake on Rush Hills (a part of Hickling broad) on September 14th, and the next day, at a duck shoot, a Chiloe Wigeon was shot. It was assumed to be an escape. On

Photo] [*G. Marples*

So-called "floating" nest of the Black Tern

Photo] [*G. Marples*

Black Terns at nest. A bird it is hoped to regain as a breeding species in Norfolk

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September 20th a Red-footed Falcon was watched near Whiteslea catching insects off a recently-mown marsh and using a post as a resting point.

We cannot conclude this report without placing on record the death in London of John William Castle on March 25th, 1931, his sixty-eighth birthday.

Although known to very few of our members, Castle was, nevertheless, one of the most generous of our supporters in the matter of wild bird protection. It can confidently be stated that without his munificent contribution of £4,000 towards the purchase money, the Cley Marshes could not have been acquired as a bird breeding reserve, and the formation of The Norfolk Naturalists Trust would have been indefinitely postponed. On several occasions afterwards he gave substantial sums to help us, and only a few months before his death sent £50 towards the purchase of Alderfen Broad. He was one of the best and most reliable of field ornithologists, and it is with deep regret that we have to record his death.

Signed (on behalf of the Norfolk W.B.P. Committee),

SYDNEY H. LONG, *Hon. Sec.*

LIST OF SUBSCRIPTIONS AND DONATIONS TO THE NORFOLK WILD BIRDS PROTECTION FUND FOR 1931

	£	s.	d.
H.M. THE KING	3	3	0
H.R.H. THE PRINCE OF WALES, K.G. ...	2	2	0
Adam Miss M. E. ...	1	1	0
Agnew C. G.	1	1	0
Allars R. W. E. ...	3	3	0
Allen J. W. ...	2	2	0
Anderson Edward ...		10	0
Anonymous		8	5
Attenborough, Col. J. C.M.G.	1	1	0
Back H. W.		10	0
Baker E. S. Stuart, O.B.E.	3	3	0
Barclay F. H. ...	2	0	0
Barclay H. G. ...	2	2	0
Barclay Miss M. ...	1	0	0
Barlow J. Allen, C.B.	1	1	0
Barnard Mrs. ...	1	1	0
Barnardiston G. ...		5	0
Carried forward ...	£25	13	5

	£	s.	d.
Brought forward ...	25	13	5
Barry W. J.	1	1	0
Barton S. J., M.D. ...	1	1	0
Bedford, Her Grace the Duchess of ...	2	2	0
Beevor Sir Hugh, Bart.	1	0	0
Benn Sir Ion Hamilton	1	1	0
Bewly Miss N. ...		5	0
Blackburn C. J. ...	2	0	0
Blake H.	2	2	0
Blakeney Point Collecting Box	3	11	0
Bland Miss R. ...		10	0
Blatch Edward ...	1	0	0
Boardman E. T. ...	1	0	0
Bourne T. W. ...		10	0
Brash T.	2	2	0
Brereton Miss E. D. ...		19	9
Briscoe Lieut. F. M. Eliot-Drake ...		10	0
Carried forward ...	£46	8	2

	£	s.	d.
Brought forward ...	46	8	2
Brooks J. R.... ...	1	1	0
Brown E.	1	1	0
Brown H.	1	1	0
Buckle Lt.-Col. D. W.	1	1	0
Bullard Ernest ...	1	1	0
Bulwer Col. E. A. ...	1	1	0
Burrowes R. B. ...	1	0	0
Burton G. Murray ...	1	1	0
Butcher R. W. ...	1	1	0
Butler R. Fawsett ...		10	0
Buxton W. L. ...	2	0	0
Byne Lt.-Col. R. M. ...	1	1	0
Byers J.		10	0
Capron J. T.	1	1	0
Capron Miss J. ...		2	6
Carr Mrs. Laurence ...		10	0
Carruthers D. ...	1	1	0
Cassie R. L.		10	0
Castle J. W. (the late)	3	3	0
Chadwick Dr. Morley	2	2	0
Chapman E. H., His Honour Judge ...	3	3	0
Churchill Mrs. Arnold		5	0
"Cley"		2	6
Clutton Bryan ...	3	3	0
Coe Mrs. A. E. ...		10	0
Collar Arthur ...		5	0
Collier Dr. W. ...	1	0	0
Colman Miss E. M. ...	1	1	0
Colman Miss H. C. ...	1	1	0
Colman R. J. ...	1	1	0
Colomb Admiral P. H., C.B.	1	0	0
Cooke G. J.		5	0
Cox Major General Sir Percy, G.C.M.G.		10	0
Cozens-Hardy A. ...	1	1	0
Cresswell Mrs. George	1	1	0
Dallas C. C.	1	0	0
Deacon Dr. G. E. ...		10	0
De La Warr, Lady ...	1	1	0
De Worms C. ...	1	1	0
Doughty C. G. ...	1	1	0
Drury G. L.		10	6
Duncanson T. J. G. ...	3	3	0
Eccles James R. ...	1	1	0
Edwards Francis ...		10	0
Ely Mr. and Mrs. G. H.	2	2	0
Ennion E. F. R. ...	1	1	0
Enock A. G.	1	1	0
Everitt W. G. ...	1	1	0
Ewing Miss J. Orr ...		5	0
Ferrier Miss Judith ...		10	0
Finch F. R.	1	1	0
Flowers John, K.C. ...	1	1	0
Forbes H.	1	1	0
Carried forward ...	£102	15	8

	£	s.	d.
Brought forward ...	102	15	8
Foster, Capt. T. H., R.N.		10	0
French Miss E. M. ...		10	0
Friedlein W. ...	1	1	0
"Friend"		5	0
Garnett R. M. ...	1	10	0
Garrod F. W.... ...		10	6
Gay Miss C. E. ...	1	1	0
Gay Miss Ellen ...		10	0
Gayner Dr. J. S. ...	1	1	0
Giles C. C. T. ...		10	0
Gill Mrs.		3	2
Glanville J. P. (the late)	1	1	0
Glegg W. E. ...	1	0	0
Goddard W. N. ...		10	6
Gowen H. P.... ...	1	1	0
Graves Mrs.	1	1	0
Green Major E. A. Lycett	1	0	0
Gresham School Nat. Hist. Soc.	1	1	0
Groom H. A.		10	6
Gurney G. H. ...	2	2	0
Gurney Q. E. ...	1	1	0
Gurney R., D.Sc. ...	2	2	0
Gurney W. S. ...	1	1	0
Hannaford G. ...	2	2	0
Harding J. Rudge ...		10	0
Harker W.	1	1	0
Harmer T. Bertrand...	1	0	0
Hastings Thomas ...	1	1	0
Haydon W.		5	0
Heywood R.	1	1	0
Hill Nettleship ...		10	6
Hill T. A. M. ...		10	6
Holland C. B. ...	1	1	0
Home Miss M. Logan		2	6
Horsfall R. E. ...		10	0
Hulse Mrs. M. W. ...		10	0
Hulse Miss E. M. ...		10	0
Hyslop A. B. ...	1	1	0
Hyslop Brig.-Gen. H. G., D.S.O. ...	1	1	0
Hyslop Miss T. S. ...		15	0
Jago Cyril		10	6
Jenkins Rev. T. L. ...	1	0	0
Jessop A. L, ...	2	2	0
Johnston Mrs. J. ...		12	6
Jones Commander B. E., R.N.		10	0
Jones Sir L., Bart. ...	1	1	0
Jones Lawrence E. ...	2	2	0
Ketton-Cremer W. C.	1	1	0
Keith E. C.	1	10	0
Kerr Mrs. M. Rait ...	1	1	0
Knight E.	1	0	0
Carried forward ...	£149	19	10

	£	s.	d.
Brought forward ...	149	19	10
Kolle H. W.	2	2	0
Lance Capt. H. W. ...	2	0	0
Lang Gordon L. ...	2	2	0
Law E. W. B. ...		5	0
Lawson Harry ...	1	1	0
Lee-Elliott Rev. D. L.	1	1	0
Lees M. Mackenzie ...	1	1	0
Lendrum Mrs. T. J. ...	2	0	0
Linnell L. G.		10	0
Littlewood Miss ...		10	0
Lister S. R., M.D. ...		11	0
Lewis J. Spedan ...	2	2	0
Liddell-Grainger Capt. H. H.	5	0	0
Lloyd Capt. L. ...	1	0	0
Long Miss		5	0
Long S. H., M.D. ...	2	2	0
McHardy Maj.-Gen. A. A., D.S.O. ...	1	0	0
Macdonald Malcolm, M.P.		10	0
Macpherson A. Holte	1	1	0
Madoc Col. H. W. ...	2	0	0
Maidment Dr. F. W. H.	1	1	0
Marshall E. H. ...	1	0	0
Marshall W. K. ...	2	2	0
McIlquham Miss M. ...		5	0
McKenzie Miss G. ...		10	0
McKittrick T. H., Jun.	2	2	0
McLaren Mrs. ...		10	0
McLaren Miss Shiela		2	6
McLean C.	1	1	0
Marshall J. M., J.P....	1	1	0
Matthews T. G. ...	1	1	0
Meade-Waldo E. G. B.	1	1	0
Meadows Mrs. A. H....		10	0
Mennell E.		5	0
Micholl Mrs.	1	1	0
Milne Mrs. Findlay ...	1	1	0
Mitchell Arthur ...	1	1	0
Molteno D. J. ...	1	1	0
Mortimer Gilbert ...		5	0
Murton Mrs. ...	1	0	0
Nash John E. ...		5	0
Nash W.	1	0	0
National Trust, The...	10	0	0
Naylor W. S. ...	1	1	0
Newman Miss F. B. ...		10	0
Oliver Prof. F. W., F.R.S.	1	0	0
Palmer A. J.		5	0
Pearson S. V., M.D. ...		10	0
Penrose F., M.D. ...	1	1	0
Perry Miss	1	1	0
Phelps Mrs. B. ...		10	0
Plowright Dr. C. T. ...	2	2	0
Carried forward ...	£215	8	4

	£	s.	d.
Brought forward ...	215	8	4
Poole Miss D. Lane ...		5	0
Powell A. M.... ...		5	0
Pratt Alfred	1	1	0
Preston Sir E., Bart., D.S.O.	1	1	0
Previté A. W. ...	1	0	0
Purdy T. W.... ...	1	1	0
Ransome Mrs. ...	1	1	0
Raikes Miss D. T. ...		10	6
Reeves H.	1	1	0
Reeves Derek L. ...	1	10	0
Reid Dr. E. S. ...		10	0
Report, Sales of ...	2	17	2
Riley W.	1	1	0
Ringrose B. J. ...	1	1	0
Rippingall Neal F. ...	1	1	0
Riviere B. B., F.R.C.S.	1	1	0
Rogers Rev. H. ...	1	0	0
Royal Society for the Protection of Birds	2	2	0
Rushton Miss... ...		10	6
St. Quintin W. H. ...	1	1	0
Savill Harry	2	2	0
Savin A. C.		5	0
Savory Mrs.		10	0
Scolt Head Collecting Box	2	3	0
Scott R. R.		10	6
Sheldon W. G. ...		10	6
Smith Col. H. F. ...	1	1	0
Soman A. E. & Co., Ltd.	1	1	0
Spalding G.		10	0
Sparrow Col. R. ...		10	6
Southwell E. B. ...	1	1	0
Stimpson E. ...		10	0
Sumpter Dr. B. G. ...	1	1	0
Talbot Sir Gerald F. K.C.V.O.		10	0
Tate Mrs.	1	0	0
Taylor Dr. Mark ...		10	0
Tennant Bernard V. A.	1	1	0
Thompson C. R. W.		10	0
Thouless H. J. ...		10	0
Times W. O.	1	1	0
Trafford Maj. E. B. ...	2	2	0
Tuke Anthony W. ...	1	1	0
Turner Edgar ...	2	2	0
Upcher H. E. S. ...	1	0	0
Upcher Miss L. ...	2	2	0
Vincent T.		5	0
Walter C. H. ...	1	1	0
Watson-Kennedy Mrs.	1	1	0
Wells C. H.	1	1	0
Wemyss Major G. ...	1	0	0
Wheeler G.		12	6
Carried forward ...	£266	13	6

	£	s.	d.
Brought forward ...	266	13	6
Whittaker W. I. ...	1	1	0
Winch Major S. B. ...	2	2	0
Wing J. Sladen ...	1	1	0
Whymper S. L. ...	1	1	0
Wolley-Dod Mrs. ...		10	0
Wormald H.	1	1	0
Wright B. D. Z. ...		10	0
Carried forward ...	£273	19	6

	£	s.	d.
Brought forward ...	273	19	6
Wright T. J. ...		10	6
Wyllys H. J. M. ...		10	0
Wyllys W.		10	0
Wyllys W. E. ...		10	0
Yelf C. W.	1	1	0
Young Rev. Belton ...		5	0
Total ...	£277	6	0

NORFOLK WILD BIRDS PROTECTION FUND

Year ending 19th November, 1931

Receipts

	£	s.	d.
Balance brought forward from 1930	102	10	10
Subscriptions and Donations, 1931	268	14	10
Blakeney Point Collecting Box	3	11	0
Scolt Head Collecting Box ...	2	3	0
Sales of Report	2	17	2
	£379	16	10

Expenditure

	£	s.	d.
Breydon Watcher's Wages and Insurance	41	0	6
Oil, Coal, etc., for Breydon House Boat	3	6	9
Scolt Head Watcher's Wages and Insurance	124	4	0
Blakeney Point—Contribution to Watcher's Wages	30	0	0
Oilskins and other requisites for Watchers	5	7	6
Bird Traps, Rat Poison, etc.—Cley Marshes...	2	5	6
Printing of Annual Report ...	13	2	6
Hon. Secretary—Stationery and Postages	5	10	0
Cheque Book		5	0
Norfolk Naturalist Trust—grant towards purchase of Alderfen Broad	100	0	0
Subscription to "British Birds" for Watcher	1	0	0
Balance	53	15	1
	£379	16	10

Deposit

	£	s.	d.
Balance, 21st November, 1930 ...	138	17	10
Interest to 30th June, 1931 ...	2	15	6
	£141	13	4

Examined and found correct,

FRANK INCH.

Norfolk & Norwich Hospital,
Norwich, 20th Nov., 1931.

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Well-drilling Gear in position, near Gennah

XII

OASIS IMPRESSIONS, BEING A VISIT TO THE EGYPTIAN OASIS OF KHARGA

By F. W. Oliver, F.R.S.

The Kharga Oasis is off the beaten track in Egypt and, although connected with the Nile Valley by a narrow-gauge railway, the existence of a weekly train has failed to attract travellers in appreciable numbers from their accustomed round of Nile Valley temples. A consequence of this neglect is that the habits of oasis-dwellers remain much as they must always have been ; their cultivations primitive and unprogressive ; whilst the numerous temples and other architectural remains have been less intensively investigated than their merits deserve.

The occasion which provides the subject matter of the present paper was a visit of a fortnight's duration (first half of February, 1931) undertaken by eight members of the botanical department of the Egyptian University. As the majority of the party were Egyptians, it was possible to get on close terms with the inhabitants, and to see oasis life from an inside point of view.

The Oasis of Kharga, otherwise the Great Oasis, is reached in twenty hours from Cairo. The Nile Valley is left at Farshut, and the journey continued by narrow-gauge across the Libyan Desert Plateau and down into the oasis to the principal village of Kharga, where is the seat of Government. This desert journey, in addition to the actual crossing of the high plateau (nearly 100 miles), includes the necessary ascent and descent of ravines or wadis, which provide splendid view points—especially the Wadi Refuf, which leads down to Kharga. Thus, without effort, the traveller obtains an excellent impression of the utterly desolate character of the Libyan Desert. Moreover, there being numerous " stations " or water dumps, which are replenished from the train, the passengers have frequent opportunities of stretching their legs. The Libyan Desert is practically dead ground, and, once out of the entering ravine, we saw no plant till we reached the oasis.

Our first view of the oasis, a thousand feet below, was from the upper part of the Wadi Refuf. It appeared as a great

plain spread out below, essentially a deep-lying desert within a desert. From the edge the expected date palms and green fields are barely perceptible ; for although the oasis has an area approaching 4,000 sq. miles, not more than 1% of this area is cultivated, the little patches being associated with villages strung out on the major (north and south) axis of the oasis, more than 100 miles in length. The plain at our feet seemed the colour of oatmeal ; we judged it generally level, with occasional island mountains standing up from the floor, especially in its northern part. To the west and south it merged in the surrounding desert, whilst to the north and east it is steeply enclosed by the precipices of the 1200 ft. escarpment.

Our party was accommodated at the Government Rest House at Kharga village, which in all respects we found most comfortable. It may be added that there is another rest house, or small hotel, near the station, which is available to visitors who prefer to be catered for.

General Physical Characteristics

Like the Libyan Desert, the oasis is rainless, and cultivation depends on artesian wells drilled to a water-bearing sandstone, 500 ft. below the floor. Many of these wells (or ains) date back to the Roman occupation, and some probably belong to an earlier date. Land, as such, is of no value here ; it is the man with water who is king. The inhabitants number less than 8000, a fraction of the former population. In area, the oasis is comparable to the combined counties of Norfolk, Suffolk and Cambridge, though in out-line it is very different, being a narrow rectangle, 120 miles from north to south, and about 35 miles across. The principal village (Kharga) is roughly on the latitude of Luxor (25° N.) Though more or less level, the floor varies in height from an average of 150 ft. to occasional points where it closely approaches sea-level. Away to the south, where there is no escarpment, the floor gradually rises to the level of the plateau.

In the process of excavation of the oasis certain important isolated hills survive, notably Jebel Tarif and Jebel Ter to the N., and Ghennima and el Ghennaim to the E. of Kharga village. The first two are important as sheltering Kharga from the wind and driven sand, which are the bane of the oasis. Further S.

s the Gorn of Gennah, an accessible view point, most useful
is a land mark.

Text-figure 1

Sketch map of Kharga Oasis and the adjacent Nile Valley. North and east of Kharga village are the four isolated hills referred to in the text, that nearest to Kharga being Jebel Ter. Kasr el Ghuata is just S. of Gennah. D, el Dabadib; M, Meheriq. In the S. are the two villages of Maks, N. and S.—From Beadnell.

The limestone forming the plateau is of Eocene age, and beneath this the chalk of the Upper Cretaceous, followed by various shales and sandstones, till the artesian water bearing sandstone is reached at a depth of 4–500 ft. below the oasis floor.

Conspicuous surface features of the floor are the sand dunes, lacustrine sands and clays, and, on the escarpment, calcareous tufa.

Possibilities of cultivation depend entirely on water from deep artesian wells, of which there are more than 200 in the oasis, with an aggregate daily discharge of $11\frac{1}{2}$ million gallons, as estimated by Beadnell in 1909. The water is discharged under sufficient pressure to bring it to the surface, and is led by irrigation channels where required. The water comes up

warm, 86°—90° F., and is often highly ferruginous, so that deposits of ochre are found along the channels. These wells are mostly ever flowing, and many are of extreme antiquity. The actual drilling is effected by lengths of boring rods screwed together as requisite—the whole system of rods is suspended from a derrick, and raised and dropped by a squad of men operating a lever. This percussion method is slow, and to reach the artesian water may take six months or a year. Still, time is nothing in the oasis. Old, choked wells are reopened and made efficient by the same means; the drilling rig in place at an Ain near Gennah is shown in Pl. I. (The iron tools lie at the left-hand corner, and the lever for raising is the oblique pole touching the ground by the seated figure. The little tree behind the standing figures is a Doum Palm.)

Sand Blowing

An outstanding and enduring feature of the physical environment, and a perpetual menace to the inhabitants of the oasis, is the eternal drifting of sand. The Libyan desert plateau is one of the world's great open spaces; being rainless, it is barren; and its surface continually disintegrates under the influence of heat, cold and wind. The prevalent wind in our region is N.N.W., and this arrives laden with sand from the plateau. Wind velocities rule high, and every third day are sufficient to transport sand. As a consequence the escarpment is smothered with sand drifts, along which fresh supplies are continually transported to the oasis floor. The photograph (Pl. IV above) of part of the escarpment at the Wadi Refuf illustrates this condition. It might be supposed that the whole excavation was rapidly filling up, and it is certainly true that more sand enters the oasis from the N. than leaves it from the S. At the foot of the escarpment most of the sand is reorganised into travelling units or dunes of characteristic form, called barchans (or, locally, *Ghouroud*). These barchans are of crescentic plan, with the concavity in the forward (leeward) direction. They represent the primitive form-type of the travelling dune, unfettered in its free movement by any retarding action of vegetation. A barchan is the natural form assumed by a heap of sand driven by the wind in a definite direction. The projecting slopes travel faster than the main body and move in advance, and these cusps are kept fed with

Sand Dune overwhelming Date Palms at Gennah

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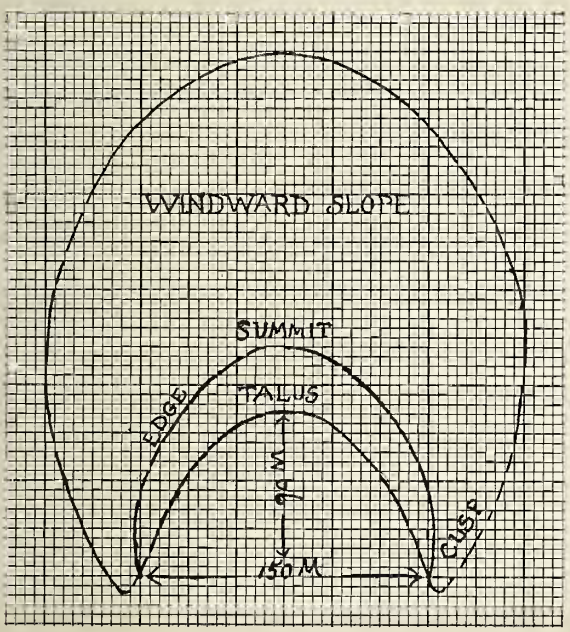
Typical travelling dune or Barchan

Wind breaker at Kharga

and which slides along the perimeter on either flank of the lune.

Seen on the oasis floor, these isolated dunes, arranged in lines or corridors, and all facing S., present a strange spectacle. They are beautifully modelled, smooth and delicately shaded. The high lights are yellow whilst the shaded portions appear blue and purple, effects which are exaggerated as the sun approaches the horizon.



Text-figure 2
Plan of medium sized Barchan.

Here are measurements of a small, typical example :—cusp to cusp, 150 metres ; from centre of chord to foot of talus slope, 90 M. ; thickness, front to back, 200 M. ; height of crest 5 M.

The inner (talus) slope stands at the angle of repose of loose sand (about 33°), and from the summit appears to be very steep indeed, an illusion depending on its smooth surface and perhaps on the austere architecture of the whole. The angle of slope on the windward (convex) side does not exceed 10°.

The rate of travel of barchans, according to observations by Beadnell, ranges from ten to twenty metres per annum. So that supposing a barchan to maintain its individuality for the whole period, it should take from 10 to 20,000 years to travel the full length of the oasis.

Reference has been made to the fact that barchans are not promiscuously scattered over the oasis, but tend to run in definite tracks or corridors. These must be largely determined by the facilities which the relief of the escarpment gives to the feeding of sand into the oasis, and also by the distribution of the dunes on the plateau itself. We had no opportunity of exploring these spots, in view of the shortness of our visit and the numerous objectives. An aerial photographic survey of barchan distribution would be a useful starting point for further study. It could be accomplished in a few days.

Barchans vary much in size and rate of progression, and sometimes seem to overtake one another and coalesce. From favourable view points, twenty or thirty may be seen at once, and their total number must be large.

In their travel barchans are liable to impinge on villages and cultivated land, and when this happens, evasion seems impossible, and the settlements are overwhelmed.

Nor is the wandering dune the only method of sand-travel. In addition to the organised progression of the barchans, there are isolated sand grains drifted by the stronger winds. Some protection from this flying sand is obtained by building V-shaped walls in front of important objects, such as wells. These walls are given a rough and irregular surface, with large holes or concavities left, whereby it is supposed that the wind is more effectively broken up and deflected, and in such a way that the flying sand is shepherded harmlessly to right and left of the critical point. The idea of these walls tradition ascribes to the Romans. An example, near Kharga railway station, protecting a well, is shown in the photo on Pl. III (below). It seemed to be fulfilling its purpose. Should this tradition be well founded, these must be the world's oldest constructions in sand defence. So far as Europe is concerned the treatment of the problem was not seriously considered till the 18th century and actively in its closing years. The foundation of modern dune technique was laid down mainly between 1795 and 1830.

A clear distinction has to be drawn between flying sand and the slowly moving barchan. As long as the latter keeps out of the way it doesn't matter. It only becomes significant when it makes a direct hit on human settlements and cultivations. Its course is determined by the location of points of sand-supply and by the direction of the wind. If a village is originally located with sound judgment, this evil can be evaded.

Flying sand is a more constant nuisance and menace, especially in exposed situations. The village of Kharga itself is relatively fortunate, being screened and sheltered by the island mountains Jebel Tarif and Jebel Ter, but further south such defences are lacking. Consider the case of an original village, established beside its well at ground-level. With the beginning of cultivation and the establishment of crops and trees, a stabilising agency has been created. The shelter thus provided breaks the velocity of the wind and the burden of sand is dropped on the village. To some extent the evil is mitigated by arranging the settlements end on to the wind, so that a minimal face is presented for sand accretion.

The phenomenon precisely parallels the growth of any vegetated sand dune, and so from year to year the level of the ground is raised by constant accretion. If this growth be only one centimeter a year, this means twenty metres in 2000 years. Consequently nearly all cultivated places rise in level to form low hills. In some degree this accretion is favoured by the cultivators, as the new matter operates as a continuous fertiliser of the soil. But it has the inherent draw-back that both the well head, and the ground to be irrigated, being raised, a height will be reached to which the artesian pressure can no longer raise the water, and irrigation becomes ineffective. This trouble is aggravated by the accumulation near the well heads of their periodic cleanings. These mounds, together with wind-drifted sand and dust, have reached a height of perhaps twenty-five metres at, e.g., Ain Ramah (a very ancient well). The well flows at a lower level in a deep gorge, constantly threatened with destruction by the collapse of the sides. To remove such an enormous mound to-day would be too great an operation. The position of affairs will be understood from the photo of Ain Ramah on Pl. IV.

Even during the short period of our visit, on two occasions we encountered dust storms. A calm morning followed a calm night (nights are always calm here), when at 9 a.m. there was a rustle in the crowns of the palms. The distant cliffs of the escarpment became obscured by the rising dust, and by 9.30 general darkness and discomfort ruled. On another occasion such a storm overtook our three cars when returning to Kharga from Beris, in the far south of the oasis. Though we travelled in close order, it was impossible for the cars to keep in sight of one another, and it had to be arranged, for mutual safety, that we should rendezvous at pre-arranged points on the route. The Sudanese drivers of the Government Fords that had been placed at our disposal deserve great praise for the knowledge of direction they showed on all occasions on ill-marked desert trails, even at great distances from their H.Q. at Kharga.

Anyone sceptical of the magnitude of the dust menace has only to experience one of these storms on the open desert to become completely convinced.

A further example of the effect of retention of drifting sand by vegetation, and one of some economic importance, is the fate of irrigation channels. These when first laid down are bare, banked channels leading from a well to the lands to be cultivated. With the wetting of the banks, wind-drifted seeds are able to germinate, and the banks become clothed with plants. These collect sand and the channels are gradually raised. Eventually a height is reached at which the channels can function no longer and have to be replaced by a fresh system. With supervision through the ages from the beginning, such channels would be constantly weeded and this defect avoided.

Our photograph Pl. V. (above) shows a short stretch of such an irrigation channel leading from Gennah to land several miles away, near the Gorn of Gennah. This channel is of recent origin and, having attracted tamarisks, is rapidly building up its banks. Its predecessor, a few hundred yards away, derives from Roman times, and was overtaken by the same fate.

> " No more thy glassy brook reflects the day,
> But, choked with sedges, works its weedy way ; "

Escarpment smothered in drift sand, Wadi Refuf

Ain Ramah; Well encumbered with accumulations of mud clearings ; a Balanites tree on left

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Irrigation channel with Tamarisks crossed by a desert trail; near Gorn of Gennah

Sand dune on lee side of Kasr el Ghuata

Lacustrine Deposits

A strange scenic feature, common in many parts of the oasis, especially in the N. near Meheriq, and further S., stretching from Bulaq to Beris and Dush, is the remains of a surface deposit which, once forming a continuous plateau, is now carved into fantastic ridges and blocks through the action of wind-driven sand. In the region S. of Beris this layer has been cut by the wind into long, steep-sided ravines with occasional lateral connections. In such places a motorist may easily lose himself, and this is the more tantalising as the villages stand on hills and are perfectly visible. At the worst he can reach security by a rough scramble across country and get a guide to extricate the car. The carved blocks often stand fifteen to twenty ft. high, broad and high in front (i.e. N., to windward) and tapering behind characteristically (for 100 ft. or more) where the flying sand has chiselled away the soft deposit. They often resemble rude sphinxes, and it may be that this is the primordial form which suggested the sphinx to the mind of the artist. They are represented in the photos. on Pl. VI.

The precise origin of this deposit is unknown. One view is that it is a lacustrine deposit dating back to a period when the floor of the oasis held a lake ; on the other hand it may be wind-borne.

When intact, the sediment provides valuable land for cultivation ; it is also quarried and added as manure to the fields.

About the Villages

The inhabitants of the oasis, everywhere so far as our experience went, give the stranger a cordial and stately welcome. Our visit to Bulaq was characteristic. On the day of the dust storm referred to above our cars formed up a few hundred yards from the entrance to this village.* Speedily a group of Sheikhs and leading people had assembled and were pressing us for a visit. The invitation was accepted for the morrow. We were received in state by the Omda (Headman) and a score of leading men, in a grove of date palms where chairs had been placed. At the reception dried dates and sugared tea were

* In the absence of a suitable photograph of the approach to Bulaq, there is given on Pl. X (above) a view of the village of Dush, in the far S. of the oasis ; it may be accepted as characteristic.

served (tea which makes the normal beverage seem insipid), hospitality which was renewed at intervals during the visit. Alike, whether we were being conducted round, or had come to anchor for another collation, in addition to our official hosts, we were accompanied by a silent crowd of dignified villagers, alert and observant (cf. Pl. VII). Inquisitive visitors are always rare birds, and when these include a few Europeans, it becomes almost an historic occasion. The Omda told us of a certain English Professor who had found his way to Bulaq in a previous year and had promised to write a book on his experiences—the appearance of which was still eagerly awaited!

We detected no trace of the apathetic or even hostile attitude of the inhabitants recorded by travellers of a hundred years ago (e.g., Edmondstone, Hoskins), but, as they came in parties armed to the teeth, it is hardly remarkable that the inhabitants should have been a little shy. We found our hosts eager to show and tell us everything, their houses, fields and gardens, date palms and wells. We were shown their handicrafts, which include all sorts of fibre products of the Doum Palm (trays, baskets, mats) and some rush matting of excellent quality, which compare favourably with similar products at home.

The oasis people are sometimes charged with laziness, but the charge certainly does not apply to the women. You will see a woman sitting under an improvised shelter from the sun, suckling a baby, goats grazing under her command, several chickens perched on her shoulders, all the time busy with the weaving of a Doum palm basket of admirable workmanship. These pieces, often tastefully decorated with coloured wool, are sold to strangers for a few piastres, perhaps one twentieth of the price they would fetch at such a shop as Liberty's. Bulaq is a great centre of this industry, and thousands of the familiar fibre-bags, used all over Egypt in place of wheel barrows, come from this village. The wholesale price is about three farthings apiece.

The mainstay of the village, with its 1000 inhabitants, is its grove of date palms, numbering 20,000 trees. As the produce of these has an average value of 60 piastres (12s.), the crop is worth something of the order of £10,000. Beside the date and fibre products, the nuts of the Doum and Citrullus fruits (medicinal) are exported, together with Acacia fruits for tanning,

and some turkeys. Thus we bought an excellent turkey of fifteen pounds at Beris for four shillings.

Scattered about in the palm groves are numerous private gardens. These are entered by low square doors in the mud walls, which can be squeezed through, stooping. We found the owner of the one we visited in the act of planting a vine, and proud to do the honours. There were also isolated trees of orange, lemon, fig, guava and apricot, with potatoes, sweet potatoes and tomatoes. Fruit growing, though the product is excellent, is quite unorganised—not in ordered orchards, but anyhow. Here and elsewhere we convinced ourselves of the unlimited potentialities of the oasis for fruit farming, far in excess of present production. Field crops are referred to in a later section.

The irrigation arrangements at Bulaq seemed modern and efficient and, judged by oasis standards, distinctly progressive.

At one point on the outskirts I noticed a bony-looking cow grazing on rushes, whilst a plump donkey near-by was having freshly mown, green wheat fed to it. On enquiring the reason for this difference in treatment, the owner replied " Well, you see Sir, the cow is content to eat rushes, so we let her. But the donkey has to carry burdens to other villages and have a smart appearance ; moreover he declines to eat anything else at this season, so we are obliged to give him wheat."

Women were not much in evidence here unless we surprised them in courts and alleys. I remember at Gennah we suddenly rounded a corner of the village where women were sitting at ease with their children and occupations ; they instantly packed up and skedaddled. In the lanes among the palm groves at Kharga if we met a woman out walking, she would draw into the wall and avert her face whilst we passed.

Near the well at Bulaq an Acacia Tree had formerly split in two and the halves, falling in opposite directions, had both taken root and continued to flourish. As the spot had acquired merit from this miracle, we asked the local notables to group themselves about the prostrate trunks, when the photograph shown in Pl. VIII was taken. The female figure on the right is Miss Hilda Kern, a young Dutch lady who was acting as scientific assistant to Dr. J. P. Lotsy. She had run into the picture at the last moment to mark the point of origin of the

right-hand section of the stem. The inhabitants had never seen a fair-haired European girl before, and could hardly take their eyes off her. Her presence also had this advantage, that when the women at a moment of surprise fled to their quarters, Miss Kern was able to follow them up without impropriety, take photographs and explore the inmost recesses.

Miss Kern, having kicked over the traces with the sanction of all, was able to advance further. She would, for instance, command dignified sheikhs to sit for portrait studies, and was never repulsed. On the other hand, breaches of etiquette on their side would be sternly repressed. Thus at Beris, a village in the extreme south, on arrival at the Rest House, the Omda and others assembled to receive us. When the ceremony was at its height a quaint, dwarfish figure of fun, carrying a walking stick larger than was necessary, suddenly appeared in our midst, a sort of Charlie Chaplin, giving a welcome touch of comic relief to a solemn performance. All his movements seemed to caricature (perhaps unconsciously) the mannerisms of his chief, and had just the right degree of exaggeration to indicate their source. His intrusion, though fully appreciated on our side, was distasteful to our hosts, and this impish figure disappeared from our midst under the escort of a suddenly improvised Serjeant-at-Arms. I heard later that the intruder was " only the village schoolmaster," and that his intervention at this early stage was considered premature by the master of the ceremonies. This explanation is hardly convincing. We had frequently met schoolmasters in the first flight, so this one was hardly suppressed, *qua* schoolmaster. It was the (to them) well known exuberance of his comic gift, combined with the uncertainty of its direction, that had brought about Charlie Chaplin's downfall, lest sheikhly dignity should suffer in the eyes of strangers.

After spending four hours at Bulaq, we parted from our hosts with expressions of mutual good will.

Another village stroll was round Kharga itself, where the population is four times as numerous as at Bulaq. Our guide on this occasion was Sheikh Ismail Ibrahim, who in addition to holding an influential position in the regulation of the wells and water, had a garden with several curious plants in which he was interested. He demonstrated to us some of the dis-

[Sphinx-like block carved by sand-blast in Lacustrine Deposit, near Beris

Tamarisk Dune and (on right) eroded Plateau, Maks Bahari

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Botanical controversy, Bulaq

tinctive characters between male and female date palms, when not in flower. In the former the leaflets are somewhat further apart, and the spines begin to be sharp from the very base of the frond (or " branch " as it is commonly termed). The expert recognises the sexes in the palm probably without conscious analysis, as one recognises the face of a friend. But like most keen gardeners our Sheikh was really interested in the rarities and treasured oddments of his garden. The everyday things of oasis cultivation he took for granted. It was as though having strayed into a garden where there were rock plants, we had asked to be shown the roses, cabbages and potatoes ! He also showed us his diary which contained mention of political events, news of which had drifted to the oasis from outer Egypt, with references to any unusual visitor or occurrence, as well as occasional notes on plants, in which he was interested. Being requested to indicate the most striking entry in the diary, the Sheikh pointed to a record of two German students who arrived in the oasis on foot, without guide or transport, and carrying rucksacs. They crossed from N. to S., and continued their journey in the same manner. Their safe arrival in the Sudan was afterwards reported. The episode was post-war, and in the Sheikh's opinion such a thing had never previously been known. A member of the Desert Survey, to whom I related the matter, said that in his opinion such a feat was impossible, from lack of water.

The village itself is a dense cluster of mud huts, accessible by a labyrinth of narrow passages, partly underground.† It is cool in summer and useful for retreat in case of a Dervish raid. We visited the potter in his shed, and I noticed in one of the streets a whitewashed wall where the village artist had recorded his impressions of such objects as railway engines, camels, etc. Among them was a sketch of an airship, which suggests the possibility that the German Zeppelin, which cruised far S. into upper Egypt during the War, may have crossed the oasis.

† Cailliaud, in " Travels," 1822, writes :—" To secure a degree of coldness, and guard against the sands, the inhabitants have laid planks, and raised floors over the streets ; here and there are some openings, but so obscure are these passages, that in midday, we have to grope along the walls with our hands : this is an odd idea, which I never met with elsewhere."

Many children accompanied us on our rounds (Pl. IX) and when we reached an open space containing the village shop Dr. Lotsy purchased a large bag of sweets, which he distributed to those who had accompanied us and to others who were recruited when his largesse became noised abroad (Pl. IX). Presently, meeting the head nurse of the hospital, Dr. Lotsy, wearied by his exertions, handed over the residue so that she might continue the good work.

Passing the school, the Master in charge invited us in. A geography lesson was in progress, and the children's books showed sketches of volcanoes, lakes, isthmuses and peninsulas. Among the wall diagrams and charts, I noticed one showing a St. Bernard dog going forth into the snow on his errand of mercy, with the Matterhorn unmistakable in the background. It was evident that the oasis dwellers were being taught more about the outside world than we had ever learnt about an oasis! Drawing books were also produced, and the style of work showed much in common with certain ancient mural decorations I had seen in a ruined Sheikh's tomb. One of the scholars recited with feeling some lines from the contemporary Egyptian poet Herrawy; being in Arabic, I understood not a word, but was greatly impressed by the delivery. In another room boys were reciting the Koran in a sort of sing song. When a boy can recite the Koran by heart and pass a test thereon, he is qualified to proceed to the University of El Azhar at Cairo, whence, after ten years' study, he will return to his village with sheikhly rank.

The children of the oasis are most engaging, but they seemed rather pinched and not as robust as country children should be. Sometimes, on the outskirts of a village, we encountered them in charge of goats grazing on the desert herbage. We generally called them to us and gave them small coins. When asked what they would spend them on, the invariable answer was "tea and sugar." Every child carried a small wallet, and when these were opened the contents were always the same, a single dry crust of slender proportions. As this was the ration for the day, sunrise to sunset, it seems that the children are underfed. No race could exceed the Egyptians in kindness to children, so if the children are underfed, it must be in consequence of shortage. Perhaps the crops raised are

calculated on too narrow a basis, so that if an opportunity arises of selling a crop for cash, the temptation is too great and the community suffers. It may be added that the children of the oasis never importuned us for backsheesh. Malaria is another frequent scourge, owing to the pools of stagnant water that accumulate from the wells not being under control and running to waste. However, we saw many signs of the benevolent goodwill of the government in welfare work, and in time, no doubt, these defects will be overcome.

The Botany of the Oasis

Essentially, Kharga Oasis is a desert within a desert, though at a lower level. Rain falls so rarely as to be negligible. In the Libyan desert much of the ground is dead, i.e., if watered there is no response, owing to the failure of seed to survive over the long interval between two successive showers. The fertility of the oasis depends on the presence of artesian water sealed in a layer of sandstone at a depth of 400 to 500 feet below the floor. Some genius in the uncharted past had the inspiration to drill a deep hole, water gushed to the surface, and cultivation by irrigation became possible. Or, the discovery may have been accidental. To the Romans is attributed the development of well-boring technique, and many of the existing wells date from their time.

From what we saw in our journeyings about the oasis, we formed the opinion that plants grow only within the limits of existing irrigation, or in places no longer watered, which in former times were subject to irrigation. In saying this it is not intended to imply that recent viable seed, if brought by wind to a spot moistened by a rare shower, would not germinate and establish, but such occurrences must be exceptional.

The conspicuous plants of the uncultivated desert include *Calotropis procera*, *Hyoscyamus muticus*, *Citrullus colocynthis*, whilst the camel thorn, *Alhagi maurorum*, is extremely common, especially on sandy areas where it builds small dunes (Pl. X, below). The tamarisk (including *T. mannifera*, *arborea* and *articulata*) also establishes in such areas, and is capable of building up fairly high dunes (Pl. VI, below). Unquestionably the roots of these two genera penetrate very deeply into the soil. Direct evidence of the depth is not available, but roots of Alhagi, sometimes two inches thick, can be traced six feet

down without perceptible tapering. Long extension of course occurs on a rising surface of accreting sand, but good evidence exists that this plant can penetrate even hard ground to considerable depths. Information on such points is hard to get ; actual digging is out of the question, but the experience of quarrymen and well-diggers might help to an answer.

Most notable of the semi-wild trees is the doum palm (*Hyphæne thebaica* [Pl. XI below]). Unlike the date palm, its stem forks repeatedly, and it has fan-shaped leaves. It is to be found especially on the outskirts of villages and on land left long fallow. Its fruits are hard nuts the size of goose eggs. The outer pericarp, unattractive though it be, is used as food. The leaves and fibre find enormous application in the weaving of mats and baskets, as already mentioned. It evidently roots deeply and is tolerant of dry places.

The phanerogamic flora of the oasis numbers 260 species and varieties, according to the enumeration in Muschler's "Manual Flora," of which about 150 were found in the course of our visit.

The large number of aquatic plants was an unexpected feature, the following genera occurring in the little streams and wet meadows :—Potamogeton, Ruppia, Zanichellia, Naias, Typha, Phragmites, Heleocharis, Lemna, Nymphæa, Samolus, *Veronica Anagallis*, Utricularia.

In the salty pools, where the waste from the irrigation collects, of higher plants only tamarisk, Ruppia and Zanichellia occur. The floors of these pools are mainly carpeted with Chara, bright orange in colour at the time of our visit from their dense covering of antheridia.

The pools of the wells (Pl. XI, above) are rich in blue-green and other algæ. Collections of these were made by the algologist of the party, Nayal Eff. and are in course of determination. In the case of a newly-drilled well (near Meheriq), that had been running for only fourteen days, a rich flora was already established, including Ulothrix, a Cosmarium, a Chlamydomonas, Lyngbya and other blue-green forms. This shows that the oasis soil must be well stocked with the resting germs of these organisms.

The richness in aquatic flora impressed us all. We could not help wondering whether what we were finding might not be the direct survival of a more ancient flora deriving from the days when the oasis had a moister climate than now, and might

The notables of Bulaq beside their miraculous Acacia

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Children, Kharga

Largesse of sweets to children, Kharga

even have contained lakes. That a wetter period ruled since the oasis came into existence as a depression, and not so long ago (geologically speaking), seems to follow from the leaf impressions so richly preserved in the calcareous tufa of the escarpment. What these plants were should be known in good time ; that they were not extreme xeromorphs is certain from their general *facies*.

Further, the existing aquatic flora of Kharga seems more fully representative of an aquatic flora than is the existing oasis desert flora representative of a desert flora, as we know it near Cairo. Though certain types are plentifully represented, they are specifically not very numerous, and include few of the more distinctive desert types.

To give definiteness to these statements we have analysed the list of 191 desert plants enumerated by Schweinfurth in his well known list in Page May's Guide to Helwan. The number of species of all the principal families for Helwan is given in the annexed table and, alongside, the number of these same species which are either recorded for the Kharga oasis, or were found there by us. Of the 191 plants, forty-one occur at Kharga. The detailed figures are striking, and show that a large majority of the most outstanding desert types are unrepresented.

Even when generous allowance has been made for the difference in latitude between Kharga and Helwan (300 miles) it is evident that the oasis desert flora is uncharacteristic and can only be termed meagre. Here is the table :—

	Helwan (Schweinfurth)	Kharga.
Cruciferæ	10	1
Resedaceæ	6	1
Caryophyllaceæ	7	0
Paronychiaceæ	7	1
Geraniaceæ	6	1
Zygophyllaceæ	10	1
Papilionaceæ	10	1
Ficoideæ	3	1
Compositæ	32	7
Convolvulaceæ	2	0
Boraginaceæ	13	1
Scrophulariaceæ	3	0
Labiatæ	5	0
Plantaginaceæ	6	1
Salsolaceæ	17	6
Polygonaceæ	3	3
Euphorbiaceæ	2	0
Liliifloræ	3	1
Gramineæ	19	3
Other Families	27	12
Total species	191	41

The position which we were disposed to accept provisionally is this : Is it possible that the oasis is not yet fully settled with desert types ? If the desert aspect is more recent than the aquatic, then we seem to have an explanation. Evidently the establishment of a desert flora is a difficult operation when a waterless barrier like the Libyan desert everywhere surrounds the area of colonisation. So far, although a few species have obtained a firm hold of the ground, the desert population as a whole has lagged behind. To what extent colonisation has been retarded by the grazing of stock it is impossible to say, though I imagine this influence is appreciable.

Fossil Plants, so often found as silicified wood on Egyptian deserts, seemed to be relatively rare in the areas visited by us. The only piece we found (N. of Kharga) turned out on sectioning to be a well preserved conifer (*Dadoxylon egyptiacum*) ; it was destitute of annual rings. This is the first piece of petrified wood I have examined in Egypt that was not Nicolia, the staple of the " petrified forests," a timber often compared with a modern Caesalpinia. As the fragment was lying on the surface there is no information of the actual horizon.

In the limestone tufa which overlies parts of the escarpment numerous impressions of dicotyledonous leaves occur. We had no opportunity of visiting the escarpment, but on my return to Cairo I was shown a very fine block by Miss Gardner, who, unknown to us, had been staying in the oasis about the time of our visit, on an archæological and geological mission. These impressions will be well worth careful determination, whilst further search should be made for petrifactions.

Trees and Crops

The tree of the oasis, *par excellence*, is the date palm. It gives character to all cultivated spots. The sale of dates is the main economic prop of the district. We were told that there were some 100,000 bearing trees, about 12 per head of the population. At Bulaq, which is well furnished, there are 20 trees per head of the population. The yield per tree should be at least 100 lbs., worth 60 piastres (12s.). So that the entire crop of the oasis should be worth £60,000—roughly £7 per head of the population. These dates, most of the Saidi variety, go away as dried dates and find a ready sale. We found them

excellent eating, and an open tin which stood on the table of our mess needed constant replenishing. The great occasion of the year is in autumn, when the Bedouin merchants come with strings of camels to buy the crop.

Hoskins (Great Oasis p. 37) does justice to this tree in the following passage :—" The beauty of an Arab village depends almost entirely on the luxuriant groves of graceful palm trees which surround it. The variety of the tints, the symmetry of the branches hanging gracefully like the feathers of the ostrich, and the constant freshness of the foliage, gives a peculiar charm to these trees ; and when they are agitated by the breeze, their rustling noise is as the gentle murmuring of a stream ; well may the Arabs delight in reposing under their shade."

If the beauty of the date palm is largely a collective one, that of the Doum palm is individual. Commonly it is rather sparsely scattered on the borders of cultivation, and invades areas no longer irrigated. Though wild and able to look after itself, I doubt if there is a single specimen in the district without an owner, as it is valued alike for its nuts and its fibre. A good tree should carry 1000 nuts, having a value of perhaps thirty piastres.

Cultivated fruits include orange, lemon, guava, vine, apricot and olive, all capable of extended development. Conspicuous by all the wells is *Acacia arabica* (Pl. VIII), giving a valuable timber, durable for casing the wells. It was surprising how quickly these acacias grow into large trees. Thus at Jaja we made enquiries as to the age of a particularly fine group and were told by the Sheikh that he had planted them himself about thirty years ago. In Egypt generally the rate at which trees grow when properly irrigated is amazing to those accustomed to European standards.

Salix safsaf is frequent in similar positions. Occasionally the Bito tree (Balanites) is to be found, with its good tasting drupes, carried on a tangle of thorns (Pl. IV, below).

The staple cereals include wheat, barley and rice. The last named can grow in salty places and, being extravagant of water, has an indirect value, as through it the soil gets well soaked and the surplus salts washed out.

Sorghum (Millet) we found traces of in many districts, especially S. of Kharga, though in the N. at Meheriq, which

is exposed, it is broken by the wind. Mais we heard of nowhere.

Of leguminous crops lucerne is the most general, and this is in conformity with dry farming practice elsewhere. Bersim was much less general, though progressive communities were handling it. The usual reply about bersim was that "Our fathers did not use it." The lucerne provides one cut a month. Vigna was in use as a summer fodder. Peas and Arachis are also grown. Sesamum, we were told, was not successful.

Cotton was known only in single specimen plants, so that the recent slump in the commodity does not affect the equanimity of the inhabitants. Their conservatism had staved off an economic crisis.

Sand Control

The general phenomena of sand-drifting have already been described. Sand annoys the inhabitants in three distinct ways.

1. As flying particles which lodge wherever the conditions are stabilised, especially by vegetation, raising the level.
2. As an agent of erosion.
3. As wandering dunes which overwhelm dwellings, cultivation and wells.

It is a cardinal principle of perfect sand control that the *source* must be controlled; then the sand cannot leave the ground and the nuisance is abated. The source here, though unexplored, is evidently the thousands of sq. miles of desert surface to the N. of the oasis. This could only be controlled by planting, which is not feasible.

So we are driven to the next best thing, which is to deal with the sand after it has entered the oasis, but before it reaches vulnerable objectives. Such stabilisation, so far as flying sand is concerned, could be effected by laying out certain protection belts to windward of cultivated and inhabited areas. To do this means the methodical planting of the belts with such things as are known to thrive under the conditions, viz., alhagi and tamarisk. These at any rate in the first instance; they might have to be followed by further afforestation. In this connection Eucalyptus might be considered.

For the establishment of such protection belts a *special*

Dush Village

Tamarisk and (smaller) Alhagi-dunes at Maks Bahari

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Well at Beris, with Date Palms

Doum Palms, Jaja

supply of water would have to be provided. Wells would have to be sunk for this purpose alone, and reserved for the cultivation of the contemplated protective dunes. The positions to be occupied by all these protective measures would be determined after observation and experiment by the controlling officers of the service of protection, whilst suitable labour could be obtained in the oasis itself, provided, always, that a means of activating the inhabitants could be discovered. The simpler problem is the stabilising of flying sand by the protection belts aforesaid. In the event of large access of sand it might be desirable to lay out a second belt, later on, to windward of the first, thus sharing the burden ; but this is a detail of tactics within the judgment of the officer.

With a wandering dune (barchan) on the march we are faced with a different problem. If it is approaching a village the matter may be urgent. Owing to its height, abrupt talus and rapidity of movement, it would hardly be prudent merely to let it advance into a prepared belt of tamarisks, etc. It would probably overwhelm them. The principle of dealing with the source has to be obeyed here. The belt must be laid, not to leeward, but *on the windward side* of the barchan, and as close up to it as possible. This will have the effect of preventing fresh sand from reaching it, and also of gradually depriving the barchan of its motive force (wind). The new growing dune, that will arise to windward and the plants with which this dune is covered, will give shelter to the barchan, and by immobilising it, strip it of its terrors. As in the previous case, a second windward belt may become necessary. But tactics will evolve *pari passu* with experience. The great thing is to keep tactics from getting stereotyped.

Whilst satisfied that salvation is to be found by operating along the above lines, where living screens that will keep pace with the work are employed, experiments with passive screens are to be encouraged. These, as before, must be to windward, the object being to discover to what extent it is possible, e.g., by using variously curved or sloped hoardings (or erections of palm stems) to deflect the wind so that it may pass harmlessly over the dune.

It is difficult anywhere to arouse people to take precautions against contingencies that will materialise fifty or a hundred

years hence. The local attitude towards sand is the same as that of land owners at home towards coast erosion. Nothing is done till too late, and then there is grumbling because somebody else didn't intervene, and because there is no compensation. The most acute case in the oasis is at Gennah, where village, palm plantations and the finest ain in the oasis are threatened. Our photo Pl. II shows the situation. An expedient, commonly employed at the eleventh hour, is to place a screen of palm leaves on the brow of the talus slope. One such is visible on the left, and another at the centre of the picture. One might as well try to avert the consequences of an impending collision at sea by hanging out a fender at the point of impact as place reliance on this ancient heresy. Fences on the crests of dunes were tried in northern Europe (Denmark and Germany) in the dark ages of dune control, and have been abandoned for 150 years. A further example of this device is to be seen on a dune near Kharga station—a well chosen site for an object lesson !

When disaster comes, the inhabitants rebuild their habitations elsewhere ; a well can be drilled by co-operation in a year ; the most serious item is replanting the date palms, as it takes 20–25 years before they can come into full bearing ; the date forms of course the financial and nutritive mainstay of the people.

Any special service of dune control would have to be self-supporting, i.e., a charge upon the locality. For this to be successful it is probable that there would have to be an expansion of cultivation and especially of fruit growing. During our stay we formed the impression that, with careful planning, the oasis could produce much more than it does at present, and that the possibilities of fruit production, under methods adapted to the conditions, were most promising. For success in this field an outside element, unfettered by tradition, is essential ; but it remains to be proved that such extraneous elements could rise superior to the isolation and to the dead weight of conservatism and lethargy of the population.

As it was, we noticed differing degrees of progressiveness at the various villages, and were surprised on the whole that a population so long isolated, and confronted always with such inexorable conditions of life, should be holding their own so well. Moreover, it was noticeable everywhere that the general bear-

ing towards strangers was very different from that described by travellers of a century ago.

Most encouraging were the agricultural and horticultural experiments and introductions in progress on the Western Desert Corporation Estate in the N. of the oasis, near Meheriq—an effort ably seconded by the authorities of the Horticultural Section at Giza. We were particularly beholden to Ahmed Hamdi Eff., the active spirit here, who showed us a well he had recently re-opened, and a number of experimental gardens in which a variety of economic plants are being tried out.

Antiquities

The presence of numerous temples, Roman buildings and relics of the Christian period, proves that the oasis has a long and important history. As these, apart from the temple of Hibis, near Kharga, have been only partially excavated, it is evident that a rich field awaits antiquarian and egyptological research ; whilst even for the casual visitor, who is generally more interested in ruins than in the physical features of a country or the occupations of its inhabitants, they form an obvious attraction.

A great merit of these oasis remains is that they lie for the most part remote from habitations, amid beautiful surroundings, as in the case of the Temple of Hibis (Pl. XII above).* This Temple though belonging to the Persian period (Darius, *circa* 500 B.C.) appears to be the evident work of old Egyptian craftsmen, and holds its own with more celebrated examples in the Nile Valley. To visit such a charming and secluded

* Cailliaud, the French traveller, is worth quoting on this matter ; Travels in the Oasis of Thebes, 1822.

" At present, this fine monument seems as though placed in the midst of a garden ; on all sides, the avenues are obstructed by date, doum and palm-trees, acacias, and yew-trees ; citron-trees are growing under the porticos ; and a murmuring stream of fresh water serpentines amidst a multiplicity of shrubs. After long and toilsome marches in the desart, where the eye can glance at nothing but boundless solitudes—when on a sudden, palm-trees are seen—when we are drawing near to houses and cultivated lands—when we hear the singing of birds ; and that object so longed for, a spring of sweet water appears, the constitution is as it were—renewed and it becomes impossible to express the effect produced on the animal spirits ; the scene appears more joyous and gay than in any other possible situation. Hence I enjoyed a satisfaction more ardent than what even the spectacle of the monuments afforded although they diffused a novel charm over the rich vegetation of this spot ; in short the whole face of Nature was embellished by the sun's lustre glittering on the adjacent mountains in a thousand picturesque forms."

place, amid groves of date palms and rice fields, without being hustled and importuned by would-be guides, donkey boys and trinket sellers, is a happy and unusual experience.

About a mile north of the temple of Hibis, on a barren hillside is the Christian Necropolis, a large collection of tombs and mausolea, arranged more like a city than a burying place. These structures are built of sun-dried bricks and are gracefully decorated with pilasters, arcading, etc., whilst many of them are domed (Pl. XIII). Formerly, one supposes the brick to have been covered with plaster, but this has disappeared, eroded by the constant sand blast—which in due time must demolish the bricks also. The cemetery was in use in the 3rd or 4th century of the Christian era, and evidently corresponds to an important Christian settlement in the oasis in those days. In one of the mausolea the dome still carried a coloured decoration, including many biblical figures, such as Abraham, Isaac and the goat, Sara, Adam and Eve, Noah, etc., good enough for recognition even if the names were not given in contemporary Greek characters in the appropriate sectors. These paintings are somewhat defaced by later arabic inscriptions, whilst others must have been destroyed. When properly explored, it would seem likely that much valuable history about an interesting period should emerge. It is a desolate and impressive spot.

One more ruin may be mentioned, the temple of Quasr el Ghuata, situated on an isolated, rocky eminence a few miles S. of Gennah. This belongs to the Ptolemaic period (*circa* 240 B.C.). It is small but has beautiful capitals and other carving. As our photograph shows (Pl. XII) it has not been excavated—indeed this picture agrees faithfully with a lithograph from the same view point, in Hoskins' "Great Oasis," published in 1837 (Pl. XIX), proving that the inhabitants themselves have a proper regard for their antiquities. Such disfigurement as occurs is at the hands of a more literate class, who carve their names and scratch inscriptions! Even some of the earlier travellers (famous names !) set a bad example at Hibis. But, as Beadnell remarks, as many of these incisions are dated, they have a value as showing the progress of erosion from sand blowing.

The temple at Quasr el Ghuata is congested with perhaps

Temple of Hibis

Ptolemaic Temple, Qasr el Ghuata

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Sheikh Nagati (Kharga) sitting between two members of Botany Staff, Egyptian University

Part of Christian Necropolis, near Kharga

an acre of brick huts or cubicles, which Beadnell supposes to have been a Roman barracks. These appear to have little special interest, and might be demolished when the temple comes to be excavated. Were the outer containing-wall of the castle left, the temple would then stand isolated in a worthy and spacious courtyard, the surround giving it protection from blowing sand. The southern face of the castle, outside, has a slope of bare sand piled against it, like the lee side of a marram dune (Pl. V., below). I understood from the guardian that in the seventeen years of his service it had never fluctuated. Such accumulations are usual in similar positions.

Plans of many of the oasis antiquities have been published by early explorers, and more recently by Dr. John Ball of the Desert Survey. They are mentioned here to show that there are large attractions from the antiquarian standpoint.

Some Personal References

At the very outset of the visit we suffered a sad blow in the loss of Mahmoud Hamada, one of the University servants who accompanied the party. Early in the morning of the first day, Mahmoud was reported as being unconscious, and on taking the pulse it was obvious there was little hope for him. On the arrival of the Egyptian doctor from the nearby hospital, Mahmoud was dead, and the body was shortly moved to the mortuary for an autopsy. Later, the whole party attended at the little square by the hospital to await its result (which was heart failure), and by midday the funeral procession was making its way to the cemetery on the borders of the village. Mahmoud was followed to the grave by the Mamur and other Egyptian officials, by the notables and numerous villagers, as well as by the members of our party. At some distance from our destination, the procession wheeled into a desert area, where the bier was placed on the ground for a brief period, whilst certain prayers and responses were uttered. Resuming, we reached the cemetery where the body of Mahmoud was laid in the shallow excavation that formed his grave. The service, as indeed all the proceedings, was simple, impressive and sincere.

I am inclined to attribute this untimely loss of a faithful and much respected departmental servant, to whom we were all attached, to a too scrupulous discharge of his religious

obligations. We were still in the period of Ramadan (the Moslem Lent) and contrary to the normal practice of discontinuing the diurnal fast when on travel, Mahmoud persisted in continuing it for one day more. This, combined with his exertions on our behalf, explains the sequel.

It seems proper to mention here that it came to my knowledge, subsequently, that Mahmoud had been setting aside as much as one third of his slender wages for the training of a son as a craftsman in metal work—wages which in all did not exceed £40 a year. On returning to Cairo, it was a great satisfaction to receive grateful assurances from members of his family that they fully approved all the steps we had been compelled to take without the possibility of consulting them.

In this sad affair, as in all matters relating to our convenience and welfare during the visit, we were much beholden to the officials, and in particular to Gobran Girgis Eff., the Mamur, who at the moment was acting as Governor. He was invariably helpful, efficient, and prompt in service. On leaving, he told me he was to be transferred shortly to Amria in the Mariut (as Mamur), a district I often visit. A month or two later, when passing this station in the train, true enough, there he was ; and it was a pleasure to renew the acquaintance.

We also received many favours at the hands of Sheikh Nagati, acting Omda of Kharga, who was greatly interested in our enquiries and gave us much information. His is the central figure in the portrait group on Pl. XIII—a very good likeness.

H. E. the Governor arrived on the last day of our stay, transferred from a similar post in another oasis. In spite of the fatigue of the journey, he entertained us hospitably, and told us it was an added attraction to the post that the Residence had so fine a garden attached to it, he being a great lover of flowers. He was quick to detect the absence of the lady member of the party, whom, not knowing better, we had omitted from our ranks on this occasion. On returning to the Rest House, we found the Governor's tactful rectification of our error in the form of a bouquet of sweet peas, which he had caused to be delivered to Miss Kern in our absence. At the hands of the sheikhs and village officials we received a perfect hospitality on all occasions. To the Rest House and the good food locally available, reference has already been made ; but not to

the excellent services of Pharaoni Eff. (of the botanical staff) who as caterer made it possible for us to enjoy these advantages to the full.

Of the climate, rainfall is so rare as to be negligible. The highest day temperature recorded during our stay was 96° F., and the lowest night minimum, 36° F. By day there is generally a wind blowing, often strong, from the N., whilst the nights are calm. Kharga may be described as being at least as windy a place as Blakeney Point, and with the higher velocities the air is charged with blowing sand. As a party, we all felt braced, and developed keener appetites than elsewhere in Egypt. But of course in summer the oasis must become very hot indeed. The great blot, I suppose, is malaria; but as every drop of water comes from wells and follows an appointed path, it should be possible under benevolent supervision to control this scourge.

* * * * *

We left reluctantly. The little train crawled up to the escarpment in the blinding morning sunshine. At the stations inhabitants had collected to sell produce and have a gossip. All the same, they were feeling the cold at this early hour and were swaddled in extra wrappings. From the Refuf the striking panorama showed in full detail with the sunlight falling in the direction we were leaving; and by tea-time we were once more in the Nile Valley. From the junction five of us proceeded to Luxor, whilst the rest of the party returned to Cairo. A few days later I followed in their tracks, making the journey to Cairo by a day train, which was a new experience. This surely is an experience not to be missed: to follow the green ribbon of the Nile for hundreds of miles, with its teeming population. Thus, in one day is obtained an ineffaceable picture of the richness of Egypt.

Previous Records

On the subject of the Kharga Oasis a number of papers and books have accumulated. Apart from the references by writers of classical antiquity, the modern accounts may be divided into two groups.

First, there are those of pioneer travellers who "rediscovered" the Oasis, set down their general impressions in the form of an itinerary, and devoted their special attention to the more

accessible of the antiquities. These were (like our own) of the nature of flying visits, and are illustrated by the books of Cailliaud, Edmondstone and Hoskins. Of these the book of Hoskins gives a spirited and appreciative account of his experiences, and is of conspicuous value.

The *second* group includes contributions of later date by persons who resided in the Oasis for much longer periods, concentrating on particular objectives, often under government auspices. These include the contributions of Schweinfurth, John Ball and Beadnell. The last named has published an informative and well-written handbook, which is the best available guide to the physical and economic problems of the Kharga Oasis, and is not too technical for the general reader.

F. Cailliaud.—" Travels in the Oasis of Thebes, 1815—1818." Trans. in New Voyages and Travels, Vol. VII, London, 1822.

Sir A. Edmonstone.—" A Journey to two of the Oases of Upper Egypt." Murray, London, 1822.

G. A. Hoskins.—" Visit to the Great Oasis of the Libyan Desert." Longmans, 1837.

G. Schweinfurth.—" Notizen zur Kenntniss der Oase El-Chargeh." Petermann's Mittheilungen, XXI, 1875.

John Ball.—" Kharga Oasis—its Topography and Geology." Survey Dept., Cairo, 1900.

H. J. L. Beadnell.—" An Egyptian Oasis." Murray, 1909.

* * * * *

The illustrations accompanying the paper are from photographs taken during the visit. I am indebted to Miss Kern for Pl. III (above) and Pl. IX (above); to Dr. Lotsy for Pl. III (below) and Pl. XII (above); to Younis Sabet Eff. for Pl. XI (both), Pl. XII (below), Pl. XIII (above). The others are by the writer.

Cairo, *October*, 1931.

XIII

ARTHUR WATERS PRESTON, F.R.Met.Soc.
1855—1931

Mr. Preston spent nearly the whole of his life in Norfolk. Descended on his father's side from a Yarmouth family, he was a native of Norwich, went to school at Bury St. Edmunds, spent his early married life in Thorpe Hamlet, a suburb of Norwich, lived at Blofield and Brundall, moving in 1905 to Christchurch Road, Eaton, and finally to Unthank Road, Norwich.

Arthur Preston was a partner with his father in a firm of solicitors practising on Bank Plain, Norwich, and he served the Presidency of the Norfolk and Norwich Law Society.

For many years he was a sidesman, and for a short time a church warden, of Christ Church, Eaton ; and for a long period he was on the Committee of Management of the Jenny Lind Hospital for Sick Children.

But we think of him specially in connection with the country and outdoor life. For half a century he took an active practical interest in botany, gardening and meteorology. For fifty years Mr. Preston was a member of the Norfolk and Norwich Horticultural Society, filling the post of Secretary from 1881 to 1888, and later that of President of the Society ; and he was a member of the Norfolk and Norwich Naturalists' Society from 1880 till his death in 1931. For many years he was the recorder for the Royal Meteorological Society's Climatological Station at Norwich, and as Secretary of the Norwich Rainfall Organisation he was in touch with people holding approved rain gauges all over Norfolk ; his reports were regularly supplied to the British Rainfall Society, and his Records of the Climate of Norfolk have been a special feature of the "Eastern Daily Press."

In the Transactions of the Norfolk and Norwich Naturalists' Society, Notes on the Meteorological Observations recorded in Norwich from 1870 to 1879 are by Mr. John Quinton, junr., Registrar to the Norwich Meteorological Society. No Weather Report, as such, was published in these pages for 1880

and 1881, though Mr. Henry Stevenson, F.L.S. added to his Ornithological Notes for 1880 a footnote to the effect that 'in the unavoidable absence of Mr. Quinton's "Meteorological Observations," I have devoted more space than usual to the general character of the weather during each month of the year' (Trans: III, 392, n). Mr. Stevenson (III, 542–545) gives a graphic account of the frost and snow of January 1881. He prefaced his Ornithological Notes for 1882 (III, 771) by saying 'In the absence of Mr. Quinton's elaborate and valuable Meteorological Notes, I cannot help feeling personally indebted to Mr. Preston for his "Summary" to compare with my own weather records.' With this "Summary," under the title of "Meteorological Notes, 1882" (III, 505–510) Mr. Preston began the series of Annual Reports which he continued without intermission until the Report for 1930, written in January 1931, read before the Norwich Science Gossip Club on February 4th only eight days before the commencement of his fatal illness, and printed in the current Part of these Transactions. It was his custom to read his Annual Meteorogical Report to the Science Gossip Club, of which he was at one time the President, and then to forward it to the Norfolk and Norwich Naturalists' Society for publication. It is satisfactory to know that these observations are being continued by his son Mr. Richard J. Preston of Norwich.

Mr. A. W. Preston contributed to the Norfolk and Norwich Naturalists' Society's Transactions special records of the Great Frosts of 1890–1 (V, 191) and of 1894–5 (VI, 95), also of the Great Gale of March 1895 (VI, 99), and of the Norwich Flood in August 1912 (IX, 551). He was President of this Society for 1897–8, and his Presidential Address (VI, 331–349) contained a summary, for the preceding ten years, of not only the weather but also phenological phenomena, the result of his own observations at Blofield and Brundall, five miles from Norwich. In this summary he tabulated temperature, rainfall and wind, the first leafing of deciduous trees, the first flowering of garden and indigenous plants, and gave records of other natural occurrences.

Summer outings of this Society had somewhat fallen into abeyance, but a special feature of Mr. Preston's presidential year was an excursion of the Naturalists' Society conjointly

with the Norwich Science Gossip Club, to Mundesley and Trimingham for the purpose of studying the geology of the cliffs of the Norfolk coast under the direction of Mr. F. W. Harmer, F.G.S.

Mr. Preston passed away at the age of 76, leaving a widow, three sons, four daughters and eleven grandchildren.

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1. The practical study of Natural Science.

2. The protection, by its influence with landowners and others, of indigenous species requiring protection, and the circulation of information which may dispel prejudices leading to their destruction.

3. The discouragement of the practice of destroying the rarer species of birds that occasionally visit the County, and of exterminating rare plants in their native localities.

4. The record of facts and traditions connected with the habits, distribution, and former abundance or otherwise of animals and plants which have become extinct in the County ; and the use of all legitimate means to prevent the extermination of existing species, more especially those known to be diminishing in numbers.

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1889 Patterson Arthur H., *Hon. Mem.*, Ibis House, Lichfield Road, Gt. Yarmouth
1920 Patteson Mrs. F. E., Great Hautbois House, Norfolk
1932 Patteson Miss, Great Hautbois House, Norfolk
1911 *Payler Donald, The Museum, Birmingham
1923 Peed John, Aylsham
1926 Percy Lord William, D.S.O., Catfield Hall, Norwich
1925 Petrie Mrs., The Dower House, Heydon, Norwich
1926 Phillippo G., 7, St. Philip's Road, Norwich
1925 Pilch R. G., 45, Grosvenor Road, Norwich
1930 Podmore R. E., Maynards, Matfield, Kent
1931 Potts F. A., Trinity Hall, Cambridge
1931 Pratt Alfred, The Cottage, Cliff Avenue, Cromer
1932 Preedy Mrs., 49, The Close, Norwich
1919 Preston Sir E., Bart., Beeston Hall, Norwich
1900 Preston F., 66, The Close, Norwich
1913 Purdy T. W., Woodgate, Aylsham
1925 Purnell Mrs. Ralph, 12, Claremont Road, Norwich
1887 Pycraft W. P., A.L.S., F.Z.S., British Museum (Natural History), London, S.W.

R

1929 Ramage H. P., Ridgemont, Carrow Hill, Norwich
1928 Raywood W., 13, Upper King Street, Norwich
1930 Reeves Derek L., Honingham Hall, Norwich
1925 Reeves Hugh, Honingham Hall, Norwich
1930 Reynolds Miss J., Clipston House, Church Road, Watford
1924 Richmond H. W., F.R.S., King's College, Cambridge
1925 Ringrose B., Farley, Harbridge Green, Ringwood, Hants.
1924 Rippingall Neale F., Langham, Norfolk
1911 Rising A. P., The Manor House, Ormesby, Great Yarmouth

Elected

1908 Riviere B. B., F.R.C.S., F.Z.S., M.B.O.U., Woodbastwick Old Hall, Norwich
1908 Rogers Commander F. S., R.N., Ingham New Hall, Norwich
1909 Rogers Rev. Henry, Coltishall Hall, Norwich
1908 *Rothermere Rt. Hon. Lord, Hemsted Park, Cranbrook, Kent
1897 *Rothschild Rt. Hon. Lord, F.Z.S., Tring, Herts.
1922 Rounce G. H., The Pines, Park Road, Cromer
1930 Rowell George, 15, The Close, Norwich
1902 *Ruggles-Brice Mrs. R., Keswick Hall, Norwich
1906 Rumbelow P. E., 27, Rodney Road, Great Yarmouth

S

1929 Sainty Miss O., West Runton, Cromer
1931 *Salisbury Prof. E. J., D.Sc., F.L.S., *President*, Willow Pool, Radlett, Herts
1930 Scratchley Lt.-Col. V. H. S., D.S.O., The Parsonage, West Newton, King's Lynn
1925 Sewell P. E., Dudwick House, Buxton, Norwich
1929 Shaw A., Bixley, Norwich
1922 Shepheard Dr. Samuel, Aylsham
1930 Shilcock Miss Joan R., "Maryland," Sheringham
1930 Simpson Miss W., Geldeston Lodge, Geldeston, Norfolk
1919 Smith Col. H. F., Didlington Hall, Norfolk
1915 Smith Mrs., Ellingham Hall, Bungay
1891 Smith W. R., Harleston, Norfolk
1917 Sowels Miss, The Rookery, Thetford
1922 Spalding G., 9 ,St. Stephen's Street, Norwich
1911 Spurrell J. T., Manor House, Newton St. Faiths, Norwich
1923 Spurrell Miss M., Manor House, Newton St. Faith's, Norwich
1923 Spurrell Miss P., Manor House, Newton St. Faith's, Norwich
1925 Steers J. A., St. Catharine's College, Cambridge
1921 Stimpson Edward, Sall Moor Hall, Reepham, Norfolk
1932 Stone Miss I., 42, Sandringham Road, Norwich
1922 Sumpter Dr. B. G., Brancaster Staithe, King's Lynn
1896 Sutton W. Lincolne, F.I.C., Eaton, Norwich

T

1931 Talbot Sir Gerald, K.C.V.O., C.M.G., O.B.E., Burnley Hall, Somerton, Norfolk
1931 Tate Mrs., Lenwade House, Near Norwich
1921 Taylor Dr. Mark R., 338, Winchester Road, Southampton
1878 Taylor Shephard T., M.B., The Mount, Edgefield, Melton Constable
1921 Thain D., West Somerton, Norfolk
1931 Thomas J. F., Bowden House, Seaford, Sussex
1886 Thouless H. J., "Southernhay," Wroxham
1929 Tillett Miss I., 2, Claremont Road, Norwich
1896 Tillett Wilfrid S., 2, Claremont Road, Norwich
1920 Todd Lt.-Col. Eardley, Mundham House, Brooke
1902 Todd R. A., B.Sc., The Retreat, Elburton, Plymouth
1932 Todd Mrs., Mundham House, Brooke, Norfolk
1923 Tomes Lady, Mannington Hall, Norfolk
1910 Tracy N., 3 King Street, King's Lynn
1925 Tucker B. W., 9, Marston Ferry Road, Oxford
1906 Turner Miss E. L., F.L.S., H.M.B.O.U. *Hon. Mem.*, 13, Storey's Way, Cambridge
1927 Turner Edgar, "Kuruman," Walberswick

Elected

U

1923 Upcher Rev. E. C. S., Weybourne Rectory, Norfolk
1921 Upcher H. E. S., The Gables, Upper Sheringham
1930 Upcher Mrs. H. E. S., The Gables, Upper Sheringham

V

1917 Vincent James, Hickling, Norfolk

W

1923 Walter Mrs. Cyril, Old House, Drayton, Norwich
1923 Waterfield Miss, Attlebridge, Norfolk
1923 Waterfield Miss Penelope, Attlebridge, Norfolk
1928 Watson J. B., c/o Barclays Bank Ltd., Surbiton, Surrey
1926 Wemyss Major, Bryn House, Wroxham
1927 Wemyss Mrs. ,, ,,
1923 Wenn Miss, Ingham, Norfolk
1931 Wheeler G., Tatterford Rectory, Fakenham, Norfolk
1883 *Whitaker Joseph, F.Z.S., Rainworth Lodge, Mansfield
1922 Willett W. L., Paddock Wood, Kent
1913 Williams Miss Margaret, 8, The Close, Norwich
1929 Wilson Mrs. Gerald, Saxlingham Nethergate, Norwich
1930 Wing J. Sladen, 21, Cheyne Gardens, Chelsea, S.W.3
1909 Witherby H. F., M.B.E., F.Z.S., 326, High Holborn, W.C.
1928 Wood M. S., M.D., Woodland House, Windermere
1931 Woolley Miss, B.Sc., Blyth Secondary School, Norwich
1923 Woolsey G. E. W., Old Catton, Norwich
1907 Wormald Hugh, M.B.O.U., Heathfield, East Dereham
1922 Wortley Francis, Half-Year, West Runton, Norfolk
1929 Wortley Roger, "Seathwaite," Sheringham

Y

1915 Yarmouth Free Library, The, Great Yarmouth

TOTAL

Honorary Members	.. ...	5
Life ,,	... ...	28
Ordinary ,,	... ...	364
		397

The Treasurer in Account with the Norfolk and Norwich Naturalists' Society.

Year Ending 30th April, 1932

I. GENERAL ACCOUNT

Dr.

1931–32.	£	s.	d.
To Balance from 1931	66	9	9
„ Subscriptions	184	19	6
„ Sale of "Transactions"	1	4	4
„ „ "Flora of Norfolk"	0	7	0
„ Interest on War Stock and Consols	11	0	0
„ Donations to Publication Fund	4	5	0
„ Excursion Secretary	0	18	0
„ W.B.P.F. Subscriptions	6	6	0
„ Withdrawn from Savings Bank	35	0	0
„ Proceeds of Sale of 31 War Savings Certificates	35	5	3
„ „ „ 64 „ „	93	1	4
„ Income Tax repaid	4	15	4
	£443	11	6

Cr.

	£	s.	d.
By "Transactions,"	119	9	0
„ Postages	18	13	3
„ Printing	4	5	3
„ Library Rent	6	6	0
„ Expenses of Meetings, Teas, etc.	5	1	9
„ Fire Insurance	0	13	6
„ W.B.P.F. Re-fund of subscriptions	6	6	0
„ The Norfolk Naturalists Trust for Alderfen Broad Purchase Fund	50	0	0
„ The Norwich Museum Committee for The Norfolk Room Fund	105	0	0
„ Books	16	5	9
„ Legal Charges for reclamation of Income Tax	1	1	0
„ Placed on Deposit at Barclays Bank	100	0	0
„ Balance on Current a/c at Bank	10	10	0
	£443	11	6

Examined and found Correct,
(Signed) W. A. NICHOLSON,
May, 1932

II. LIFE MEMBERSHIP FUND

1931-32.	£	s.	d.	1932	£	s.	d.
To Balance from 1931	38	18	6	April 30 By Transferred to General a/c	35	0	0
,, Bank Interest		7	9	,, Balance in Savings Bank	6	16	3
,, Interest on War Loan	2	10	0				
	£41	16	3		£41	16	3

Examined and found correct,
(Signed) W. A. NICHOLSON.

III. DEPOSIT ACCOUNT

1931-32	£	s.	d.	1932	£	s.	d.
To Balance, Capital from 1931	24	0	9	April 30 By Purchase of £108 18s. 2d. 4 per cent. Consolidated Stock	104	0	9
,, Bank Interest		10	5	,, Balance at Barclays Bank	20	10	5
,, Transferred from General a/c	100	0	0				
	£124	11	2		£124	11	2

Examined and found correct,
(Signed) W. A. NICHOLSON.

List of Investments and Assets

		£	s.	d.
£300	£155 6s. 10d. 5 per cent. War Stock 1929-49 at cost	150	18	1
	£191 1s. 10d. 4 per cent. Consolidated Stock, at cost	166	9	7
	£108 18s. 2d. ,, ,, ,, ,, ...	104	0	9
	Balance in Savings Bank	6	16	3
	Balance on Deposit Account at Barclays Bank	20	10	5
	Balance on Current Account at Barclays Bank	10	10	0
		£459	5	1

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NATURAL
HISTORY.

Phot. E.J.S. *Natural size*

Lizard Orchid, Orchis hircina

ADDRESS

I

The EAST ANGLIAN FLORA: A Study in comparative Plant Geography

By Prof. E. J. Salisbury, D.Sc., F.L.S.

Being the Presidential Address delivered April 26th, 1932

With Plates I—VIII, three text figures and 106 Maps

Contents

INTRODUCTION AND GENERAL FEATURES

The especial object of this address is to consider the more characteristic features of the East Anglian Flora and to enquire as to how far the presence of its components can be correlated with the conditions of the present or with the environmental factors of the past. In so doing I make no apologies for extending our enquiry beyond the limits of Norfolk itself since the county boundaries have been determined by historical and political considerations and do not correspond to limits of biological importance. A still more pertinent

consideration is that, however natural the delimitation of our area may be, the significance of its plant population can only be appreciated in relation to that of Britain as a whole and of the entire European Flora of which it forms a part.

Enquiry into the causes of the geographical distribution of species is essentially a comparative and extensive study, which often itself furnishes clues to the requirements of individual species; but nevertheless the ultimate elucidation of the facts usually demands an intensive study of the biology of the different species combined with experimental culture.

To no department of knowledge have Natural History Societies in general contributed more in the past than to the study of geographical distribution, and their members could do much in the future to further our accurate knowledge of the biology of individual species, without which the underlying causes of their more detailed distribution must remain obscure.

At the outset we may remind ourselves that the occurrence of a species in a particular part of England, and not in another, may be an accident of dispersal rather than an indication of especial fitness for the area in occupation. Furthermore, the absence of one species may be of equal significance to the presence of another, provided we can be sure that for both species there have been equal opportunities for invasion and establishment. Information of this character can for most plants, however, be acquired only by the deliberate introduction of wild species beyond their existing range. The strong objection which some students of geographical distribution have to such introductions, whilst it may have some sentimental justification, cannot be defended on scientific grounds, though it is of course essential that such introductions should be properly recorded.

Experimentation of this character can alone afford us definite data as to the capacity of species to exist beyond their present limits, and may also yield information as to whether the limiting factors are climatic, edaphic, or biotic.

The importance must be stressed of distinguishing between the occurrence of species in natural plant communities and their occurrence where the environmental conditions, particularly with respect to the pressure of competition, have been directly or indirectly disturbed. The great majority

of the published records of the rarer species lose much of their value because the environment and plant community in which they were discovered have not been stated. We all know that many alien species are to be met with, year after year, on rubbish heaps, by waysides and on cultivated ground where human activities maintain an open community and preclude the degree of competition which exists in the closed communities of undisturbed vegetation. Such data have their scientific value, but this is probably little more, though certainly no less, than that obtaining from the deliberate culture of wild species in gardens. This does furnish us with information as to the climatic tolerance of a species and may, and often does, enable us to discover that species grow in nature where they must and not where they will. For, in the absence of competition, species often flourish exceedingly under conditions very different from those in which they occur in the wild state; the natural inference being that these favourable conditions are still more beneficial to their natural competitors.

The association of species with " open " communities only does not, however, necessarily imply the alien character of the species in question. It has too often been assumed that the occurrence of a species chiefly in arable land, roadsides, disturbed soil, etc., necessarily implies its adventive character. But it should be emphasised that many so-called weeds are probably natural constituents of the earlier open phases of the succession in perfectly natural conditions. In this connection one may cite the occurrence of Corn Salad (*Valerianella olitoria*), Chickweed (*Stellaria media*), Groundsel (*Senecio vulgaris*) on the early phases of dune systems, although these species are more usually associated in our minds with the artificial conditions of arable land and gardens, roadsides and railway embankments. It is perhaps more likely that many such species have extended their range of occupation to these artificial habitats than that they have emigrated from such artificial homes to the natural loci. Even in those instances where a species is found at the present time in artificial habitats alone, it by no means follows that this is not an outcome of the restriction or obliteration of its former natural habitats. In the more sophisticated areas of the

earth's surface the control exercised over natural forces necessarily involves a great reduction in the area of land slides, erosion-fans and the like. To-day, many admittedly native species characteristic of the woodland marginal flora find suitable conditions in the hedgerow which is the representative, usually artificial, of the natural scrub margins which have well-nigh disappeared from the edges of our woodlands and, indeed, in highly agricultural districts these hedgerows furnish the only sanctuary for woodland species. The time may be not far distant when the hedgerows of S.E. England will be the sole stations for some of these marginal species, yet, because thus confined to an artificial habitat, botanists of the future would be in error in supposing these species to be aliens. Many species natural to the early stages of succession are intolerant of severe competition, which is here at a minimum ; and such species find an equally favourable environment in the early phases of colonisation of rubbish shoots, waste ground, and cultivated soils. Further, it must be emphasised that many English species are at or near their geographical limit, so that the balance in the struggle for supremacy between species is easily weighted, in one direction or another, by factors that towards the centre of a species range might have little or no effect.

Species towards the boundaries of their geographical range exhibit two extreme types of occurrence. Some, as might perhaps be normally expected, become gradually more rare as they reach their climatic limits. Such are exemplified in the British Flora by the northern shingle-beach species *Mertensia maritima*, towards its southern limit ; or by the southern species *Matthiola sinuata*, *M. incana*, and *Polycarpon tetraphyllum* of sand-dunes at their northern limits. Or, again, amongst woodland species by the southern *Euphorbia hiberna* and *Ruscus aculeatus* ; amongst aquatics by *Damasonium stellatum*, all these at their northern limits for Europe which they attain in Britain.

By contrast with such definite diminution towards the limit of a species' range we may note the abundance of the northern *Cornus suecica* at its southern limit at the Hole of Horcum in Yorkshire ; the dense growth of the woodland Oxlip (*Primula elatior*) at its western limit in East Anglia and of

Physospermum cornubiense at its northern limit in Buckinghamshire. The last named is the more striking since the northern limit of this species on the continent is northern Spain.

The Perennial Glasswort (*Salicornia perennis*), the Dorset Heath (*Erica ciliaris*), and the Cornish Heath (*Erica vagans*) alike illustrate similar abundance at the limit of the species range. How can we explain this apparent contradiction? It is always rash to generalise with regard to species which differ in so many respects as to their more detailed ecological requirements and biotic associates; but it is not without significance that the species which become gradually more rare as they approach their geographical limit are not infrequently characteristic of habitat conditions where the pressure of competition is manifestly not severe owing to the open communities they frequent. On the other hand, those species which are abundant at their geographical limits are often social species of relatively advanced phases of succession characteristic of more closed plant communities. It may be suggested that where the species is abundant at or near the climatic limit of its range, this may often be due to its benefiting by a reduction in the pressure of competition, either through elimination of the competitors or diminution of the vigour of these competitors to a much greater degree than that of the species in question. Moreover, the decreased reproduction by seeds often shewn not only by southern species at their northern limit but also by northern species at their southern limit, is commonly accompanied by an increased rate and vigour of vegetative multiplication. This is well seen in the case of *Rubus arcticus* which rarely fruits even in southern Sweden and never, so far as I am aware, when cultivated in this country, but its vegetative vigour is such that it may well be placed in the English gardener's *Index expurgatorius*. Similarly the southern *Ulmus campestris*, which according to the late Dr. Henry fruits freely in the high central plateau of Spain, shews with us great vegetative vigour but only produces fertile seed very exceptionally and sparsely in hot seasons. M. Beyle (1928) has called attention to a number of species which do not fruit in northern Germany, and in the case of some (e.g. *Acorus*) the temperature factor is evidently involved.

The increasing rarity of a species not subject to appreciable competition is probably the natural outcome of increasing unfavourability of the climatic factors upon the vegetative vigour of the species, its reproductive capacity, etc. In the presence of any significant competition the species could not under such circumstances survive, but in the absence of competition it may still persist with diminishing frequency and vigour. This is strikingly illustrated by *Mertensia maritima* at its most southerly station for Britain on the shingle bank at Blakeney. Here there is rarely more than a single individual in any one season occupying an area otherwise bare of vegetation. On more than one occasion the single individual has been destroyed by burial under shingle in severe storms. Nevertheless the species reappears as a consequence of the survival of an occasional seedling presumably arising from seed previously buried and exposed by the same storm that had destroyed its parent. It can scarcely be doubted, however, that such tenuous survival would not be possible if competition were added to the other unfavourable factors of the habitat.

Those species which belong to the more advanced stages of plant successions where the community is more or less closed cannot survive beyond the limit where their vigour and frequency is adequate to withstand the competition pressure, and hence their diminution at the climatic limit will tend to be abrupt rather than gradual. If, further, the climatic depression of their competitors be greater than their own, a temporary increase in frequency may occur under suitable edaphic conditions and thus accentuate the abruptness of the species' diminution at its climatic limit.

Both extremes of marginal occurrence are represented in the East Anglian Flora. The gradual diminution is exemplified, as already mentioned, by *Mertensia maritima*, by *Dianthus prolifer*, by *Gastridium lendigerum* and *Trifolium suffocatum*. It may be noted that both the last named species, in the south of England, attain locally to a considerable degree of abundance where the edaphic conditions are especially favourable. All the species mentioned are characteristic of more or less open phases of the plant succession. The other extreme, the abrupt limitation, is represented by such plants as *Primula*

elatior, *Frankenia lævis*, and *Salicornia perennis*. All of these, which are present in considerable abundance at their limit, are members of the more advanced stages of succession and grow in close association with other species. Between these two extremes are many species which, like *Silene conica* and *Medicago minima*, are neither markedly rare nor yet abundant towards their climatic limit and occupy partially closed communities. Whilst in general the competitive factor appears to explain the differences observed, it must nevertheless be emphasised that the hypothesis advanced does not appear to cover the facts of distribution in every case. In illustration of such discrepancies we may cite *Statice reticulata* which is a salt marsh species of a relatively early phase in the succession, yet we find it growing with considerable frequency on the Norfolk coast and in some localities in great abundance. It is, however, noteworthy that the exceptional vigour and abundance of this species in certain "lows" at Blakeney Point and particularly at Scolt Head is associated with the almost complete absence of competition, whereas in other "lows" where the competition is more severe, the plants of *Statice reticulata* are both fewer in number and much smaller in size.

The view here advanced can therefore be stated in these terms :—*The later the stage of succession to which a species belongs* (*i.e.*, *the more closed the community*) *the more abundant will that species tend to be towards the climatic limit of its range, which will in consequence tend to be abrupt, especially if the species be a social one.*

The abundance of the various tree species which are at or near their climatic limits in Great Britain, and which amounts to almost pure dominance in their respective edaphic conditions, may be regarded as a further illustration of this generalisation.

It is, however, a necessary corollary to the foregoing statement that, since it is assumed that competition plays so large a part in determining frequency and abundance at the limit of a species' range, the degree to which this operates will depend both on the nature of the species as regards susceptibility to competition and on the nature of its competitors. The degree in which species vary as to their tolerance of competition is largely, though perhaps not entirely, indicated by the phase of succession to which they belong. But the nature of the

competitors will depend not only on their climatic and edaphic limitations, but also on the respective facilities for their dispersal. Since reproduction by seed is often markedly diminished towards the geographical limits (and dispersal by vegetative means is often very precarious except over short distances) the accidents of dispersal may often play a considerable part in determining the abundance of particular species.

Apart from these general considerations it will be necessary, before passing to the more detailed consideration of the East Anglian Flora, to examine briefly the past history and present character of the environment which this part of England presents.

In common with the rest of England north of the Thames valley East Anglia was subject to glaciation during the Pleistocene. The stratigraphy of the Glacial deposits in our area has been admirably summarised by Prof. Boswell in a recent paper (Boswell, 1931). He concludes that there have been four Glacial periods in East Anglia. One corresponding to the Norwich Brick-earth; a second, which formed the Chalky-Jurassic Boulder Clay and which was followed by the most important interglacial period, probably corresponding with the Mindel-Riss interglacial of the Continent and characterised by implements of derived Mousterian and Acheulian types.

The third Glaciation formed the Chalky Boulder Clay; and the fourth the Hunstanton Boulder Clay corresponding to derived Upper Aurignacian and possibly Lower Magdalenian types of human artifacts. The river alluviums corresponding to the advent of Neolithic Man represent the temperate period which succeeded this last glaciation. East Anglia was thus apparently subjected to a series of glaciations with one prolonged and marked climatic amelioration following the second glaciation, during which a temperate flora was re-established. At Hoxne, Suffolk, where the succession of strata was worked out by Clement Reid (Rep. Brit. Assoc. 1896, pp. 400-415, 1897, and J. Reid Moir. Proc. Prehist. Soc. East Anglia, Vol. V., pp. 137-165, 1927), it seems clear that hardy species (such for example as *Rubus idæus*, *Ceratophyllum demersum*, *Sparganium ramosum*, and *Scirpus lacustris*, which occur in all but the most recent of the plant bearing zones) could probably have survived throughout the successive climatic

changes, but it must be emphasised that an examination of the Drift Map of East Anglia shews practically the whole of Norfolk, Suffolk and the greater part of Essex as far as Epping and Chelmsford on the south, and Swaffham, Thetford, Linton and Stevenage on the west, to be occupied either by Boulder Clay or, as in the north-east of Norfolk, by Glacial Drift. It is hence highly probable that the whole of this area was in one or other glaciation covered by ice. Any suggestion therefore that an appreciable number of the present-day species comprise survivors of the preglacial Flora is too speculative to be seriously considered until some positive evidence in support of their perglacial character is forthcoming, accompanied by evidence as to the probability of an unglaciated area which might have served as an adequate sanctuary.

In the reaction from the view that the whole of the Flora of these islands was destroyed by the Pleistocene glaciations we must avoid too facile an acceptance of the theory of persistence. Whilst, however, it is improbable that any appreciable proportion of even the hardy species survived in East Anglia itself it is very likely that, as Woodhead (1929) has suggested, arctic and alpine types may have survived on "nunataks" in other glaciated areas, and quite probably a considerable number of the more hardy species in the unglaciated southern part of England. From such survivors of the pre-glacial Flora re-colonisation would naturally take place in the areas gradually exposed by the receding ice sheet and, in view of what we know respecting the importance of priority of occupation in relation to competition, the widespread distribution of many of these hardy types may well owe not a little to the advantage they derived from immigration into unoccupied ground. When we bear in mind the vast territory that was thus gradually exposed and the considerable area of moranic deposits that must have fringed the extensive European ice front throughout the pleistocene glaciations, we cannot but realise that this must have been the heyday of the plants of open communities and may well have been the chief period, not only of their evolution, but also of their geographical extension. It is not improbable that this was the primary home of species which to-day are mainly, if not exclusively,

associated with the artificial conditions of cultivated and disturbed soil. The numerous microspecies of *Capsella bursa-pastoris* agg. and *Senecio vulgaris* agg., all normally self-fertilised, would be peculiarly fitted for success in climatic conditions unfavourable for insect pollination as are the parthenogenetic and apogamous *Alchemillas, Antennarias* and *Hieraciums* of the arctic and alpine conditions of to-day.

The fact that *Picea excelsa* and *Trapa natans*, which have been recorded in the pre-glacial Cromer Forest Bed from several localities in Norfolk, (c.f. Clement Reid, The Origin of the British Flora) have vanished from our Flora is testimony to the rigour of the subsequent climatic conditions. But having regard to what has already been said as to the probable extent of the ice sheet in East Anglia, it is hardly surprising that there are scarcely any plant remains, so far as I am aware, which can be definitely assigned to the actual period of a glaciation. A single exception is afforded by the record of *Salix polaris* at Beeston, near Sheringham, which appears to have been actually in the lowest part of the Boulder Clay. Perhaps also the zone containing *Hippuris vulgaris* and *Salix polaris* at Mundesley and that containing *Betula nana, Salix polaris, Hippuris vulgaris, Potamogeton and Carex sp.* should also be included. But it is clear that the majority of the so-called glacial plant beds, as we should expect, correspond to land surfaces immediately before or subsequent to a period of glaciation, being situated either immediately above or below the glacial beds themselves. The so-called late-glacial bed at Hoxne in which Clement Reid recorded *Salix myrsinites, S. herbacea,* and *S. polaris*, together with a number of other species, chiefly of a hardy temperate character, would appear from Prof. Boswell's stratigraphy to belong to the period of climatic oscillation between the first and second Glaciations and certainly not to the period of glaciation itself. Such horizons therefore represent transition floras which can thus give us no idea from their composition as to how rigorous the climatic conditions may have been at the height of the respective glaciations that they precede or follow. Wilmott (1931) has pointed out the possibilities of error in the determination of *Salix polaris*, which is the only species (in these alleged glacial beds) not present in the British Isles to-day. Nevertheless

other species present, such as *Betula nana* and *Salix herbacea*, are dwarf species intolerant of competition which are only found in this country in situations, such as high altitudes furnish, which simulate the rigour of the arctic where they find their chief home. The evidence for the climatic conditions rests on the much surer foundations of the widespread occurrence of boulder clays, coastal pack ice, etc., though the occurrence of biological types, such as *Arctostaphylos Uva-ursi* and *Betula nana* in Devon, and the record of the definitely arctic *Ranunculus hyperboreus* in the Isle of Wight have a real significance and cannot be dismissed as lightly as Mr. Wilmott would have us believe. Prof. Seward, in discussing the Pleistocene glaciation and its effect on the distribution of plants, has recently (Seward 1931) called attention to the growth of warm climate species in juxtaposition to the foot of a recent glacier and, from analogy, has suggested the possibility of the temperate flora having survived not far distant from the ice front in glacial times. The analogy, though suggestive, is, however, hardly valid since the area occupied by a modern glacier is in no way comparable with the vast extent of the ice sheet in glacial times, and hence the effect on the climate of adjacent land in the two cases would be of an entirely different order.

What proportion of the hardy species which extend to-day into the arctic may have persisted throughout the Pleistocene, our evidence is clearly not adequate to assess; that more may have survived the later and less severe glaciations is quite probable, but there is no scientific justification for assuming such survival for any of the definitely southern members of our Flora, nor would such survival materially aid in overcoming difficulties in explaining existing distribution. What, however, may have been of the first importance were the climatic fluctuations during the Pleistocene and Neolithic periods. For the study of plants in cultivation, in the presence and absence of competition, has shewn that plants can survive under conditions much further from the optimum than those necessary for successful invasion. What applies to edaphic and biotic factors doubtless applies also to the climatic environment, so that we can, I think, justifiably assume that each marked change in the climatic conditions would have facilitated

the invasion of Britain by species having particular climatic limitations. Once established, these species would withstand considerable climatic change, especially if adverse climate were ameliorated by the interaction of local topographical and edaphic conditions, a point to which we shall return. Thus the successive glaciations would facilitate the invasion of arctic and alpine types, some of which have survived the warmer and drier intervals in situations where the altitude, or the soil, or both, permitted. Thus the present distribution of the alpine *Cherleria sedoides* and *Gentiana verna* or of the northern and arctic *Salix herbacea*, *S. reticulata*, *Saxifraga oppositifolia* and *Saxifraga cernua* (only on the summit of Ben Lawers) are rendered comprehensible if (as Forbes first suggested) they are assumed to be survivors from a glacial period when their area of occupation was more extensive and their establishment facilitated. The arctic element is doubtless the more ancient and represents species which were driven south with the onset of the first glaciation, but it is significant that these are not present on all mountain summits, but only where the soil conditions are peculiar. This is particularly noticeable on Lawers where the schist, to which most of the arctic types are confined, probably owing to its physical more than its chemical characteristics, has enabled these species to endure there the subsequent climatic oscillations and the conditions of to-day. The peculiar flora of the "Sugar Limestone" of Teesdale, of the dry sandy heaths of Dorset and Suffolk, of the Mountain Limestone of North Wales, of the Serpentine of Cornwall, are further examples of the association of local species with special edaphic conditions upon which their survival, in the face of competition, presumably depends. The occurrence in these islands of *Gentiana verna* (N.W. Yorks; Durham; Westmorland: Cumberland) and *Cherleria sedoides* (Scotland only, from Perth northwards) is particularly significant as to the past climatic conditions, for, at the present day, these are both species of the mountains of southern Europe which were almost certainly their original home. On the Continent *G. verna* occurs in central and southern Europe and in Asia in the west and north, whilst *C. sedoides* is confined to the Pyrenees, the Alps, and the Carpathian Mountains. Their northward migration during the cold

period and subsequent disappearance from the intervening lowlands is the obvious explanation of their present discontinuity, but this inevitably demands climatic conditions in northern France far different from those of to-day, and argues a modification of the climatic conditions during the most severe glaciation very far south of the limits of the ice-sheet itself. The fact that one of these species (*G. verna*) grows almost at sea-level on the coast of Galway does not, as Wilmott has suggested (loc. cit.), really invalidate its use as a climatic indicator. The case is the converse of the occurrence of maritime species near the summits of some mountains and bears witness to the fact that the climatic complex of the sea shore may have much in common with that of a mountain habitat and, given the requisite combination with particular soil conditions, a species may be equally at home in either environment. *G. verna* in its lowland stations in Galway grows on limestone or sand-dunes. The latter, I have elsewhere pointed out, have much in common with definitely calcareous soils, not only because of the shell fragments, but also by reason of the physical properties. We might therefore possibly have found this species likewise persisting, *under peculiar edaphic conditions*, between its British stations and the mountains of southern Europe, but since nowhere does this plant occur throughout this extensive area, it is in the highest degree improbable that conditions, other than the climatic ones known to favour its occurrence, could have enabled the species to bridge this wide gap. In these two cases there seems no reason to doubt that identical ecotypes occur in both Scotland and the Alps.

Just as the arctic climate of the glacial epoch rendered possible the spread of these arctic and alpine species, so too the dry continental type of climate which supervened in post-glacial times probably enabled continental species to migrate into these islands. These in their turn have persisted in areas rendered possible as sanctuaries by the combination of local climate and soil. Later, when the post-glacial continental dry conditions gave place, in the Atlantic period, to a moist oceanic climate, the invasion of Britain by species characteristic of oceanic conditions was facilitated, and these in their turn have persisted, especially in such communities as woodlands

where favourable climatic and edaphic factors are accentuated by the biotic conditions. The fossil record is too incomplete to afford us either confirmation or denial of this hypothesis of successive invasion by different geographical elements as facilitated by climatic fluctuation, but the presumptive evidence is so strong in favour of this explanation for the present distribution of the arctic and alpine element that it is not unreasonable to suppose a similar explanation for the other elements; for these, though the fossil evidence is less satisfactory, exhibit similar restriction to areas having definite environmental conditions.

Nevertheless we must recognise that the discontinuity of distribution which many species now present is witness only to the efficacy of purely local conditions in determining survival, and though such discontinuity may often be due to the relic nature of the species it may be but a tribute to the efficiency of long-distance dispersal. The vagaries of distribution are, for example, well illustrated by the occurrence in Norfolk of *Physarum carneum*, a species of Mycetozoon only recorded elsewhere from the Cheyenne mountains and from Portugal (c.f. Howard, 1928, p. 394).

We can recognise in the British Flora the following geographical elements mainly based upon the areas in which they characteristically occur on the Continent :—

(*a*) The Alpine Component. (Species characteristic of the Alpine area).

(*b*) The Northern Component. (Elements with a northern trend in their distribution).

- (1) The Arctic Element. (Species characteristic of Arctic regions).
- (2) The Northern Element. (Species characteristic of Northern Europe).
- (3) The Continental-Northern Element. (Species of Northern and Central Europe). These grade into the Northern Continental Element, and the inclusion of certain species in one or the other element is a matter of opinion.

(*c*) The Southern Component. (Elements with a southern type of distribution).

- (4) The Southern Element. (Species characteristic of

Southern Europe, exclusive of the Mediterranean Element).

(5) The Mediterranean Element. (Species whose chief centre of distribution is the Mediterranean region).

(6) The Continental Southern Element. (Species chiefly found in central and southern Europe).

(*d*) The Oceanic component. (Elements with a definite western trend in their distribution, apparently preferring oceanic conditions).

(7) The Western Element. (Species characteristic of Western Europe).

(8) The Southern-Oceanic Element. (Species characteristic of Western and Southern Europe).

(*e*) The Continental component. (Elements chiefly occupying Central Europe and apparently favoured by Continental climatic conditions).

(9) The Steppe Element. (Continental species characteristic of Steppe communities).

(10) The Continental Element. (Continental species exclusive of [9]).

(11) The Northern Continental Element. (Species chiefly occupying Central and Northern Europe).

(*f*) The Western Central Component.

(*g*) The Endemic Component.

(*h*) Recent Immigrants.

(*i*) The Generally-Distributed Component.

It should be emphasised at once that the terms "Southern," "Northern," "Western," etc., as used here, are not employed in the sense that some of them were used by H. C. Watson, as referring to the distribution of the species within these Islands (Watson, H. C. *Cybele Britannica* 1847); and it is to avoid confusion that I have therefore employed the terms "Western" and "Continental" which respectively correspond, in part, to Watson's "Atlantic" and "Germanic" types. At the time when Watson wrote the *Cybele* the continental distribution of the members of our flora was less well known than now and the then existing data not readily accessible, so that his somewhat parochial treatment was perhaps inevitable; but the clue to this local distribution must clearly be sought in the entire range of the species and its environmental preferences

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Map 3

Map 4

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Maps 5, 6 & 7

?Denizen
Peucedanum palustre
Map 7
Goodyera repens
Map 6
Stellaria nemorum
Map 5

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It will be noted that all these species are rare, or very rare, in East Anglia, and that most occur with greater frequency in Ireland than in England. The percentage frequencies represent the percentage of vice-counties and counties in England and Ireland respectively in which the species has been recorded and is clearly a measure of frequency, but not of abundance. These figures shew that the only species, except the dubious *E. variegatum*, which has not a wide distribution in England is *Mertensia maritima*.

(2) The Northern Element

Of definitely Northern types, other than arctic species, there are six species, together with three Rubi, which should probably be included here. They are as follows :—

	Frequencies in East Anglia	Percentage frequencies in England	Ireland	Scotland
Antennaria dioica	v.r.	70%	97.5%	97.6%
Carex pulicaris	f.c.	100%	100%	100%
Goodyera repens (Map 6) ...	v.r.	8.4%	Absent	53.6%
Lycopodium clavatum ...	r.	88%	67.5%	90%
Menyanthes trifoliata (Pl. VII)	c.	99.5%	100%	100%
Parnassia palustris	l.c.	67.6%	82%	97.6%
Rubus Lindleyanus		...	...	... Present
Rubus Rosaceus		...	...	... Present
Rubus Schlechtendalii ...		...	...	... Present

It is noteworthy that the species which have the widest distribution also attain the highest altitudes, whilst *Goodyera repens*, which is absent from Ireland, only attains 1000 feet, in Scotland.

Considering the northern and arctic types collectively, three are more or less common, the remainder either rare or very rare. All but two are species of wide distribution in Britain, and the exceptions attain their southern limit in Norfolk. These are *Mertensia maritima*, which has its most southern station for Britain on the shingle-beach at Blakeney Point, and *Goodyera repens*, for which five Norfolk stations have been recorded. We may note that *Stellaria nemorum* which, though definitely northern in Britain (Map 5), has but a slight northern trend on the continent, attains its southern limit in Lincolnshire. These three species furnish examples of the three types of southern boundary in Britain. *Goodyera repens* has an oblique southern limit in a N.W.-S.E. direction (Map 6),

that of *Mertensia maritima* is approximately East and West (Map 3), whilst the southern boundary of *Stellaria nemorum* is oblique in the N.E.-S.W. direction. The last is a species of moist woodlands, whilst the first is a species of dry woodlands. One may suggest that the differing direction of their oblique margins is indicative of the fact that, though both are northern types, the one (*S. nemorum*) is a slightly oceanic northern type, whilst the other (*G. repens*) is more of a continental species. Indeed, as we shall see in other elements, the obliquity of the margin of distribution in Britain, with its marked contrast between the oceanic character of the west and the relatively continental climate of the east, is indicative of the preferences of species in these respects. As the sequel shews, similar distinctions can be recognised amongst other geographical elements. The British Islands do in fact present us with a considerable range in temperature between North and South and of rainfall between East and West. As so many species attain their climatic limits in these islands, the change from a rather continental climate in the east to the oceanic conditions in the west and the warm conditions in the south and south-west giving place to cooler conditions as we pass north-eastwards, enables us to judge, by the greater extension on one side or the other, what aspect of the climatic complex preponderates in its influence on the distribution of a given species. In this connection it is, however, important to recognise that the east and west of England differ in other respects than the meteorological. The east is relatively more cultivated than the west, it is in general more densely populated, and whilst the east is frequently calcareous or exhibits soils rich in nutrient salts, the soils of the west are often siliceous in character and relatively poor in electrolytes. Again, whilst the east is prevailingly lowland the west is largely upland. But despite all these complications, which might be thought to invalidate any conclusion, the number of species involved is sufficiently large and the species so varied in their edaphic and habitat requirements that analysis is rendered possible.

(3) The Continental—Northern Element

Of the species with a northern and central European distribution, eight are represented in our area. These are shewn in the accompanying table.

TABLE III. Continental-Northern species in East Anglia

	Frequencies in East Anglia	Percentage frequencies in England	Ireland	Scotland
Comarum palustre (Map 8)	l.c.	85.8%	100%	100%
Gentiana campestris... ...	r.r.	83%	75.2%	95%
Lathyrus palustris (Map 9)	r.r.	29%	35%	2.4%
Oxycoccus vulgaris	r.	64.8%	85%	70.7%
Peucedanum palustre (Map 7)	l.c.	22.5%	Absent	? 2.4%
Silene noctiflora Pl. VII. D.	f.c.	72%	25%	17%
Stellaria glauca (Map 10) ...	l.c.	73%	55%	29.2%
Vicia sylvatica (Map 4)	(?Extinct)	73%	57.5%	83%

It may be supposed from the northern and central European distribution of these species on the Continent that they are markedly tolerant of continental climatic conditions, and two of them (*Peucedanum* and *Silene noctiflora*) are in fact more characteristic of the drier eastern side of England. *Lathyrus palustris* does not occur in Scotland, but, though present in Ireland, it is found in some twelve counties and vice-counties on the east side of England, as compared with only six on the west.

Many of the arctic species, at the present day, have a circumpolar distribution and, having regard to the much more favourable conditions for plant life in the arctic regions in pre-glacial times, it is reasonable to suppose that they had their origin in the north and were driven southwards *pari passu* with the increasing severity of the climatic conditions as the Pliocene gave place to the Pleistocene. The arctic types present on the mountains of southern Europe bear witness to the extent of the migration thus initiated. Moreover, the area of the ice-sheet in the arctic regions during the maximum glaciation renders it probable that, despite nunataks and similar sanctuaries, many of the species which had their origin within the arctic circle may only owe their presence in the arctic regions to-day to re-immigration as the ice-sheet once more contracted towards the pole.

It has been shewn by Turesson that some apparent glacial relics are ecotypes of probably much more recent origin (Turesson, 1927 and 1931), and Gurney has called attention to the fact that the occurrence of the northern Crustacean *Canthocamptus cuspidatus* associated with the northern Planarian *Polycelis cornuta* in a spring at Holt Lowes in Norfolk, though both cold water species, cannot be regarded as glacial relics (Gurney, 1929, p. 569).

The changed climate during the Glacial epoch, which rendered possible the occupation of the European plains by northern types, also made possible the northward migration of southern alpine types, such as *Cherleria sedoides*, *Gentiana verna*, etc. Hence it is not always possible to differentiate between the alpine species which have invaded the arctic, and the arctic species which have invaded the alps. Nevertheless, though an alpine species may find an even more congenial home in the arctic than in its place of origin, a circumpolar distribution is strong presumptive evidence for the northern origin of a species. We have recent fossil records from eastern England of *Betula nana* and perhaps *Galium boreale* from the base of the first glacial, at Beeston; of *Betula nana*, *Salix myrsinites*, *Salix herbacea*, *Salix polaris*, *Scirpus pauciflorus* and ? *Carex incurva* from between the first and second glaciations at Hoxne; of *Salix polaris* from Mundesley; and *Salix polaris* and *Betula nana* from Ostend. Even if the alleged *Salix polaris* be in reality another northern willow, it is evident that arctic types were at one time or another widely spread in East Anglia, but of the species cited not one survives to-day. Of the northern and arctic types in the existing flora (excluding the northern *Rubi*, the distribution of which cannot be accurately assessed) only one does not occur in America. It is therefore probable that these circumpolar types have immigrated, either directly or indirectly, from the north in early post-glacial times.

Why have these species survived? With the object of testing the causes of restriction of such arctic types the writer has cultivated the following in a lowland garden:—*Juncus biglumis*, *Thalictrum alpinum*, *Cerastium alpinum*, *Salix reticulata*, *Salix herbacea*, and *Saxifraga oppositifolia*. The two first could be grown quite successfully under conditions which ensured a continuous supply of soil moisture. The remainder, when grown under the same conditions, were liable to "damp off" after frost, although capable of withstanding very low temperatures when grown in well-drained soil. Under the latter conditions these species can be grown for years provided the surrounding air is not too dry.* Thus in lowland

*The presence of the Alpine species *Gentiana verna* on the sand-dunes of Galway and of the arctic species *Dryas octopetala* also almost at sea-level on the limestone (c.f. A. G. More, Cybele Hibernica pp. 111 and 238, 1898) further illustrate this capacity to flourish in lowland situations on well drained soils in a humid climate.

Map 8

Map 9

Maps 8 & 9

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Map 10

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habitats such plants are liable to be killed by the early spring droughts. If these species experimented with are representative, it would then appear that the northern types are limited mainly by the moisture relations of the soil or the air, though competition factors certainly play a part. The poor fruiting of some northern types in southern gardens further suggests that they are probably " long-day " plants and that, as between situations of appreciably different latitude, photoperiodism may come into play as a limiting factor to reproduction and maintenance of the race. Of the sixteen arctic and northern types of our area no less than eight are marsh plants, species thus normally tolerant of high soil moisture, and in such situations the relative aridity of lowland habitats at certain seasons is minimised. These, as might be expected, include the most frequent and southernmost types in lowland habitats. Paradoxical as it may appear, *Mertensia maritima* can perhaps be placed in the same category, since the internal dew formation in the shingle which it occupies and the water stored in its succulent leaves ensure it against excessive drought. The remaining species comprise four woodland types (three *Rubi* and *Goodyera repens*), *Antennaria dioica*, a heath plant, now probably extinct, and the two species of *Lycopodium* which are probably diminishing. *Lycopodium clavatum* is extinct in Suffolk, Berks, Herts, Warwick and Oxford, and has diminished in Leicester, Bucks., Kent and Hants. *Lycopodium Selago* (Map 2) is extinct in Berks., Bucks., Oxford, Leicester, Worcester, N. Somerset and probably Kent. The northern element would thus appear to be an ancient and diminishing constituent of the East Anglian flora, even the marsh species sharing in the general diminution of plants of damp habitats in England as a whole (Salisbury, E. J. The Waning Flora of England, Trans. S. E. Union of Scientific Societies 1927, pp. 35-54).

The author so far succeeded in cultivating *Lycopodium Selago*, in a lowland garden in Oak humus, that in the year following its introduction the plant produced numerous sporangia and subsequently a terminal rosette of bulbils. The plant nevertheless died abruptly, following a prolonged dry period. It is probable, then, that the Lycopodiums, though not marsh plants, have, like these, shewn marked diminution owing to the

lowering of the permanent water table and, taken in conjunction with experience of other northern and arctic species, this suggests that dryness of the air, or of the soil, or of both, may in general be the most detrimental factor to northern types. In this connection it should be noted that Turesson found that the alpine race of *Poa alpina* in Scandinavia has a high water requirement, in contrast with the lowland race the water requirement of which is low (G. Turesson. 1927).

If this is true, then it is scarcely surprising if the northern and arctic species persisted at low levels through the "Atlantic Period" since, even though the temperature was probably appreciably higher, the humidity was higher also. Further, if the submerged forests correspond to this period of maximum climatic amelioration, then the isostatic elevation of the land, which they attest, though only sixty to eighty feet (c.f. G. Slater, in "Handbook of the Geology of Great Britain," London 1919), would increase the efficacy of the upland sanctuaries. Assuming that these northern and arctic types are mostly relics from glacial times, it is less easy to understand their persistence through the warm and dry "Boreal Period," and, therefore, the presence of this element in the lowlands at the present day may well represent a recolonisation, either from the highest altitudes or from the European continent, at some time subsequent to the "Boreal Period," when the humidity had again increased, perhaps even as recently as the cold moist period of Sub-Atlantic times. Such a comparatively recent origin of the lowland stations might account for the widespread persistence of these species, despite the rather abnormal character of their present environments. In any case there can hardly be any question that the northern flora is diminishing in the southern and eastern counties, and a recent visit to certain localities in North Wales, after an interval of twenty years, revealed an appreciable elevation of the lower limit of some arctic species which may be further evidence of this retreat, although the human factor is doubtless in part responsible.

If there be any correlation in this component between age and area it would appear to be negative rather than positive. For the most pronouncedly arctic species in the British Flora were probably the earliest immigrants after the retreat of the ice, even if not present during the glacial epoch

Fig. 1

Mean Max. Temperature Aug.-Oct.

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itself; yet the majority of these are the very species which are most restricted in their area of occupation.

(*c*) The Southern Component

(4) The Southern Element

The species included here, regarded as southern without qualification, are those characteristic of the south European region, but excluding the more definitely Mediterranean types and those species which, though southern, are also of pronouncedly central European or western character in their distribution. Of southern species in this restricted sense there are in Britain as a whole some twenty-two species, whilst a further fifteen species exhibit a central European trend. Of this total of thirty-seven species, there occur in East Anglia eighteen or 48.6%. The proportion of those having a slight central-European trend being the higher. They are as follows :—

Table IV. Southern Species of East Anglia (exclusive of Mediterranean types)

		Habitat	Northern limit for Britain.
Adonis autumnalis (S&C) ...	r.	Dry cornfields	Edinburgh as casual
Althæa officinalis (S&C)	r.	marshes	Clyde isles
Antirrhinum majus (S)	alien	walls	
Calamintha nepeta (S)	r.r	Dry banks	North Lincoln
Carex strigosa (S)	r.	woods	Cumberland
Cystopteris fragilis (S)	v.r.	Old walls	Shetlands
Dianthus prolifer (Map 12) (S&C) ...	v.r.	Sandy soil	Norfolk
Gnaphalium luteo-album (S) ...	r.	Sandy soil	S.W. Yorks.
Hippocrepis comosa (S&C) ...	v.r.	Chalk pasture	Kincardine
Hydrocotyle vulgaris (S&C) ...	c.	Marshes	Shetlands
Iberis amara (Map 13) (S&C) ...	r.	Wood margins on Chalk	S. Lincoln
Lythrum hyssopifolium (Map 16 (S)	Extinct	Marshes	Stafford
Papaver argemone (S&C) ...	r.r.	Cornfields	Hebrides
Polypogon monspeliensis (S) ...	v.r.	Sandy shores	Kincardine
Rumex pulcher (S&C)	l.c.	Dry places	N.W. Yorks.
Salvia pratensis (Map 11) (Pl. III)	v.r.	Chalk pasture	S.E. Yorks.
Smyrnium olusatrum (S)	c.	littoral	Dumbarton
Specularia hybrida (S&C)	r.r.	Cornfields on chalk	Cheviotland

Two of these southern species attain their northern limit in Norfolk, and two others in Lincolnshire. The remaining species shew varying degrees of northward extension, two even occurring as far as the Shetlands. Three of the species are marsh plants, but the remaining species, with the one exception of *Carex strigosa*, are plants of dry habitats where the character

of the soil compensates for climatic deficiencies. It will, however, be convenient to defer consideration of the significance of the distribution of these species until the other southern elements have been considered.

(5) The Mediterranean Element

Fifteen Mediterranean species occur in East Anglia, representing approximately 40 per cent. of the Mediterranean plants of Britain. The species represented are the following :—

TABLE V. The Mediterranean Element of East Anglia

				Northern limit for Britain.	
Bromus madritensis	v.r.	Fields (Casual)	As casual, Fife	+
Carduus pycnocephalus v. tenuiflorus	l.c.	Dry banks near Sea	Elgin	+
Centaurea solstitialis	r.	Lucern fields		−
Delphinium ajacis	r.	Cornfields	Caithness	+
Demazeria loliacea	l.c.	Shingle	Hebrides	+
Festuca ambigua	r.	Sandy soil	Norfolk	−
Filago spathulata	r.	Sandy soil	Norfolk	+
Frankenia lævis (Map 19) ...	l.	Shingle-lows	Norfolk	−
Gastridium lendigerum (Map 14)	v.r.	Sandy soil	Norfolk	−
(Inula crithmoides)	Extinct	Shingle	Wigtown	+
Linum angustifolium	r.	Dry sandy or or chalky soil	N.E. Yorks.	+
Salvia verbenaca	c.	Dry places near Sea	E. Ross	+
Spergularia atheniensis ...	v.r.	Sandy soil	Suffolk only	−
Statice reticulata (Map 18) ...	l.c.	Salt marshes	Lincoln (if not Ext.)	−
Suæda fruticosa (Map 17) ...	l.c.	Shingle beaches	N.E. Yorks.	−
Teucrium scordium (Map 80)	v.r.	Marshes	N.W. Yorks.	+

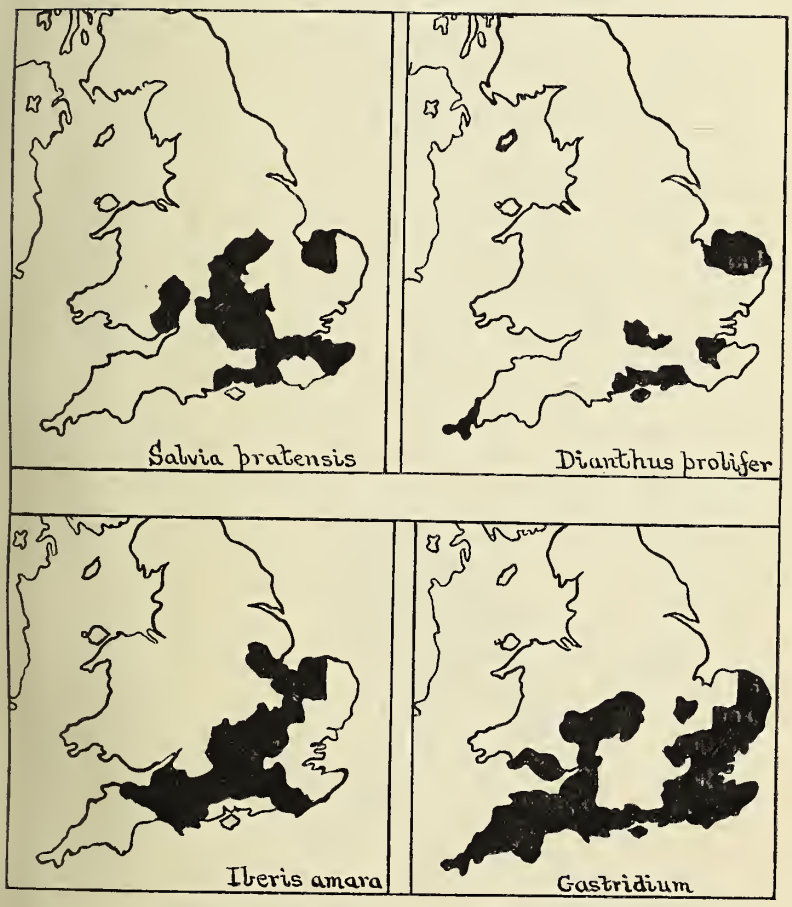
+ = Recorded from Ireland. − = Absent from Ireland.

Of these Mediterranean species four, and perhaps five, (if *Statice reticulata* be extinct in Lincolnshire) have their northern limit for Britain in Norfolk, whilst three more extend as far as Yorkshire and the remainder into Scotland.* Seven of these species which occur in Ireland are also those with an appreciable northward extension. In addition to the above *Antirrhinum calycinum*, a Mediterranean species found in Portugal, Spain, S. Italy and North Africa, was found in Norfolk by the Rev. R. Forby. This is a close ally of *Antirrhinum orontium*, of which the genetics have been studied by Miss Saunders (E. R. Saunders, A Study of *Antirrhinum orontium*. Hereditas, pp. 17-24, IX. 1927) and is distinguished by its larger

* It is suggestive of one cause of the restricted distribution of these species that *Frankenia laevis* produces few fertile seeds in its natural habitats in Norfolk and, if grown on ordinary soil, flourishes vegetatively but fails to flower (c.f. Dymes, 1927).

Map 11

Map 12



Map 13

Map 14

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Map 15

Map 16

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Map 17

Map 19

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flowers, which are white with coloured striæ. A red flowered strain was bred by Miss Saunders, but this differs from *A. orontium* in the more or less glabrous character of the stem. All the Mediterranean species occupy habitats that are either physically or physiologically dry.

It is not in any degree probable that these Mediterranean species represent ancient relic types from a remote warm period. If the set of the surface currents during the autumn period of seed dispersal be considered it will be found that these pass from the straits of Gibraltar up the English Channel and impinge upon the coast of Norfolk. The means of recent introduction is thus at hand, and special local conditions render that introduction effective. In relation to this it should be noted that from a study of the Bryophytic flora Cardot (1930) concludes that the Mediterranean element was introduced into Britain after the Glacial epoch and does not represent survival from either preglacial or interglacial times.

(6) The Continental-Southern Element

Under this heading are included species which are definitely Central European as well as south European, and constitute a transition group between the definitely southern on the one hand and the definitely continental types on the other. They form an appreciable portion of the British Flora numbering about ninety-five species, of which no less than sixty-six, or about 70 per cent., occur in East Anglia.

TABLE VI. The Continental-Southern Element

			British Northern limit.	General direction of limit. Ireland.	
Aceras anthropophera ...	v.r.	Chalk pasture	S.W. Yorks.	(*a*)	/
Ajuga Chamæpitys	(Camb.)	Chalk pasture	Cambridge	(*a*)	/
Arenaria tenuifolia (Map 20)	r.	Dry fields	Linlithgow N.W. York	(*p*)	–
Arum maculatum... ...	c.	Woods	N. Perth	(*p*)	–
Atropa belladonna ...	r.	Chalk woods	Cheviotland N. Durham	(*p*)	/
Bryonia dioica	f.	Woods	S. Northumberland	(*a*)	/
Bupleurum rotundifolium (Map 22) (Pl. VII, C) ...	r.	Fields	Kirkcudbright	(*a*)	–
Butomus umbellatus* ...	r.r.	Aquatic	N. Perth	(*p*)	–
Calamintha officinalis ...	l.c.	Dry banks	Cumberland	(*p*)	\
Centaurea Calcitrapa ...	r.	Dry fields	Norfolk	(*In*)	/
Cheiranthus Cheiri ...	l.c.	Old walls	Caithness	(*In*)	\
Chenopodium ficifolium	r.	Cult. gr.	Selkirk	(*a*)	/
Colchicum autumnale ...	r.	Wet woods	Cumberland	(*p*)	–

* Butomus umbellatus has recently been recorded from Finland where, however, it remains sterile c.f. J. Montell, 1927).

			British Northern limit.	General direction of limit. Ireland.	
Daphne laureola	f.	Woods	Durham	(*a*)	/
Diplotaxis tenuifolia ...	r.	Waste ground	Ayr	(*a*)	–
Dipsacus sylvestris ...	r-l.e.	Woods	N. Perth	(*p*)	–
Euphorbia amygdaloides	l.c.	Woods	Cheviotland	(*p*)	/
Filago gallica ...	r.	Dry ground	Suffolk	(*a*)	/
Fœniculum vulgare ...	r.r.	Cliffs	Antrim	(*p*)	–
Fumaria capreolata ...	f.c.	Fields	Shetlands	(*p*)	–
Galanthus nivalis ...	r.r.	Woods	Elgin	(*a*)	/
Galeopsis ladanum ...	r.r.	Fields	Aberdeen	(*p*)	/
Galium anglicum (Map 25)	r.	Walls	Norfolk	(*a*)	/
Geranium lucidum ...	r.r.	Walls	Caithness	(*p*)	/
Geranium pyrenaicum ...	r.r.	Waste gr.	Elgin	(*p*)	/
Glaucium luteum ...	l.c.	Shingle	Kincardine	(*p*)	/
Helociadium nodiflorum	c.	Ditches	Shetlands	(*p*)	/
Herniaria glabra (Map 24)	l.f.	Sandy soil	Lincoln S.	(*a*)	/
Inula pulicaria (Map 15)	r.	Wet places	Merionith	(*a*)	/
Isatis tinctoria	v.r.	Fields	Cambridge	(*a*)	/
Lathyrus aphaca (Map 23)	r.	Fields	Flint	(*a*)	–
Lathyrus hirsutus ...	r.	Waste gr.	Edinburgh	(*a*)	/
Lathyrus nissolia ...	r.	Grassland	S.E. Yorks.	(*a*)	/
Leucojum æstivum (Map 21)	r.	Wet woods	Suffolk E.	(*In*)	/
Linaria cymbalaria ...	r.r.	Walls	Caithness	(*In*)	–
Linaria spuria	r.	Fields	Lincoln N.	(*a*)	/
Lithospermum purpureo-coeruleum	r.	Woods	Denbigh	(*a*)	/
Lonicera caprifolium ...	c.	Woods	throughout	(*p*)	–
Lotus tenuis	f.	Dry places	E. Sutherland	(*p*)	/
Lotus uliginosus	c.	Meadows	Hebrides	(*p*)	–
Luzula maxima ...	r.r.	Woods	Almost throughout	(*p*)	–
Mentha rotundifolia ...	r.	Waste gr.	Forfar	(*In*)	/
Narcissus pseudo-narcissus	r.r.	Woods	Cheviotland	(*a*)	/
Oenanthe lachenalii ...	l.c.	Marshes	Hebrides	(*p*)	–
Ophrys apifera	l.c.	Chalk pasture	Lanark	(*p*)	\
Ophrys aranifera (Pl. II)	v.r.	Chalk pasture	Denbigh	(*a*)	/
Orchis hircina (Map 69) (Pl. I)	v.r.	Chalk pasture	Lincoln	(*a*)	/
Orchis pyramidalis ...	l.c.	Chalk pasture	Mull	(*p*)	–
Ornithogalum pyrenaicum	v.r.	Woods	Norfolk	(*a*)	/
Orobanche picridis ...	r.	Pastures	Norfolk	(*a*)	–
Orobanche reticulata ...	r.	Chalk pasture	Yorks	(*a*)	/
Oxalis corniculata ...	r.r.	Waste gr.	N. Aberdeen	(*a*)	/
Plantago coronopus ...	f.c.	Sandy gr.	Shetlands	(*p*)	–
Ruscus aculeatus ...	r.r.	Woods	?Caithness	(*In*)	/
Salix purpurea	r.r.	Riversides	Caithness	(*p*)	–
Silaus pratensis	l.c.	Meadows	Fife	(*a*)	–
Silene anglica	r.r.	Dry ground	Elgin	(*p*)	–
Spiranthes autumnalis ...	r.r.	Chalk pasture	Westmorland	(*p*)	–
Tamus communis ...	f.c.	Woods	S. Northumberland	(*a*)	–
Torilis nodosa	f.c.	Dry banks	Ross E.	(*p*)	/
Trifolium medium ...	r.r.	Pastures	Orkneys	(*p*)	–
Trifolium scabrum ...	r.	Sandy soil	Kincardine	(*p*)	/
Tulipa sylvestris	r.	Pastures	Fife	(*a*)	/
Valerianella auricula ...	o.	Fields	Fife	(*In*)	/
Viburnum lantana ...	r.	Chalk scrub	N.E. Yorks.	(*a*)	/
Vicia lutea	v.r.	Dry places	Kincardine	(*a*)	/
Vinca minor	r.r.	Woods	Caithness	(*a*)	/

(*p*)=present. (*a*)=absent. (*In*)=Introduced.

/ = General direction of Northern limit in Britain is from the S.W.—N.E.
– = General direction of Northern limit is from E. to W. \ = General direction of Northern limit is in the S.E.—N.W. direction.

Map 20

Map 21

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Bupleurum rotundifolium

Map 22

Lathyrus aphaca

Map 23

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HISTORY.

Phot. E.J.S. $X\frac{3}{4}$

Spider Orchid, Ophrys aranifera

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Phot. E.J.S.

Chalk down with Cratægus scrub and Salvia pratensis

Photo E.J.S.

Pasque flower, Anemone pulsatilla

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Map 24

Map 25

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Of these sixty-seven species no less than forty (60 per cent.) agree in having a diagonal north-eastern limit in England, attaining a more northerly station on the east than on the west. The frequency and very marked character of this feature in so many instances calls for explanation and is probably indicative of definite climatic preferences (c.f. later).

The Flora of East Anglia is interesting as including a number of species which here attain their northern limit for Britain. Of those which belong to the southern component, and which shew this feature, nine attain their northern limit in Norfolk, two in Suffolk, two in Cambridgeshire, whilst four more extend into Lincolnshire. In addition, one species of the Continental-Southern element, namely *Typha minima*, formerly occurred at Wicken Fen, its only known British locality (c.f. Gilmour, 1931).

It is a noteworthy feature that so many of the southern species in the British flora as a whole exhibit a comital and vice-comital distribution, which is mainly south of a line extending from the Wash in the east to the Bristol Channel on the west. It should be emphasised that, apart from the common factor of association in many instances with relatively dry habitats (a frequent feature of southern types since in such environmental conditions the climatic complex is ameliorated), the species in question are characteristic of diverse plant communities and of various soils. Moreover, these conditions extend beyond the range which the species occupy. As illustrating the diverse types shewing such distribution we may instance *Iberis amara*, which is a calcicole; whereas *Herniaria glabra* is a silicicole. *Dianthus prolifer* will, however, grow equally on both calcareous or siliceous soils of a dry character. Other examples might be cited, and in almost every case apparently suitable habitats could be instanced beyond the existing range of the species.

It is true that twelve per cent. of these southern species are calcicoles in this country (c.f. E. J. Salisbury, The significance of the Calcicolous Habit., Jour. Ecol., Vol. VIII, P. 202,-215, 1920) and that the major part of the calcareous soils of Britain are in the south-eastern area. But that we are not therefore warranted in attributing the restriction of these species to this region to soil factors alone, or even as the master factor, is

shewn by the extension of equally calcicolous species, more tolerant, however, of oceanic conditions, over most of western Britain. Thus *Orchis pyramidalis* and *Spiranthes autumnalis*, though more local in the west of England, are almost as widespread as on the eastern side and have an approximately horizontal northern limit, with a northward extension on the west as great as on the east. Still more striking is the distribution of the Bee Orchid (*Ophrys apifera*), especially as contrasted with *O. aranifera*, which even exhibits a diagonal northern limit in the N.W.-S.E. direction. All these three calcicolous orchids occur in Ireland and their wide distribution in the west is partly a consequence of the calcareous character of sand dunes (c.f., E. J. Salisbury, The soils of Blakeney Point. Annals of Botany Vol. XXXVI, pp. 391-431, 1922), and in this connection it is of interest to note that the markedly calcicolous mollusc *Pomatias* (*Cyclostoma*) *elegans* also extends as far northwards on the west as on the east (c.f. Roebuck Memorial Number, Jour. Conchology, Vol. 16, Pl. VII, 1921 ; and A. E. Boycott, Oecological notes, Proc. Malacological Soc. Vol. XIV, p. 128, 1921). It is clear, then, that the distribution of calcareous soils is inadequate to explain the restriction, even of the calcicolous species, to the south-east of England.

Either these southern species have not yet attained their possible range, or the limiting factors are climatic rather than the direct consequence of either soil conditions or biotic influences. The more southerly limit on the west, as compared with the east, is in harmony with the preference of many of these species for dry habitats. Their extension into southern Britain, like the extension of some of them into southern Scandinavia, (e.g., *Dianthus prolifer, Herniaria glabra* c.f. Sterner l.c.) is made possible by their association with situations that are rendered arid both by the physical features of the soil and by topography. Together these diminish the effect of humid climatic conditions and enable the species concerned to extend towards the north and west. Such edaphic factors will, however, diminish in their ameliorating efficacy as the humidity of the climate increases.

If this hypothesis is correct, it follows that in passing from the drier conditions of the east to the humid conditions of the west the northward range should diminish. As already pointed

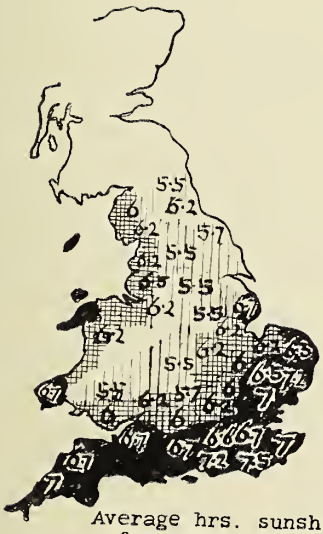
Average hrs. sunshine
from May to August
Over 6.5 to 7.5 hrs.sun
per day
Over 6.0 to 6.5
Over 5.5 to 6.0

Fig. 2

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out, this is actually the case and results in a general diagonal S.W.-N.E. trend for the northern limit in Britain.

If further confirmation were needed it is to be found in the fact that the northern limit in Europe as a whole for many of these southern types has the same S.W.-N.E. trend (c.f. R. Sterner, The Continental element in the Flora of S. Sweden, Geografiska Annaler, H. 3-4, 1922). Moreover, Matthews, in his interesting analysis of the species confined to England and Wales, furnishes a map shewing the concentration of the 266 species involved, many of which are southern continental types, and the general diagonal character of the limits of equal concentration are obvious (Matthews J. R., The Distribution of Plants restricted to England and Wales, Ann. Bot. p. 283, 1923). It is noteworthy that of the species here considered exhibiting this obliquely north-eastern limit over 68 per cent. are absent from Ireland. A fact which suggests that this absence is not due to inefficient dispersal, but to climatic intolerance of the extreme oceanic conditions in Ireland which soil factors are inadequate sufficiently to ameliorate. On the other hand, those species which do not shew any appreciable differences in their northern limit on the east and west sides of Britain, and may therefore be presumed to be tolerant of oceanic conditions, are well represented in Ireland, 66 per cent. being present (18 species in Ireland, 6 species absent).

Nevertheless, it should be noted that the relation to the climatic complex, though sufficiently obvious, does not shew a simple correlation with the usually recorded meteorological data, whether of rainfall or of temperature considered either as annual or monthly means, or from the point of view of their extremes. It is, however, perhaps significant that the region of England south of the line from the Wash to the Bristol Channel is approximately the area of maximum sunshine (Fig. 2); and, if we exclude those regions where the rainfall is high, the correspondence of sunshine duration with the distribution of these southern species becomes very close, particularly if the sunshine during the summer months is alone considered. This is very striking if we compare the distribution maps for the more restricted southern species with the map for hours of bright sunshine per day during August (c.f. Meteorological

Office Book of Normals Section III, p. 139, 1920). In view of the importance of sunshine, especially to southern species, for the formation of flowers and fruit it may well be that the limiting factor for further northward and westward extension is set by the power of adequate reproduction by seed (in this connection c.f. p. 236). Our interpretation is strengthened rather than weakened when we turn to the southern species which are normally associated with damp habitats. The range of these will clearly not be so markedly affected by higher rainfall as such; and these do in fact extend to varying limits on the west, which may even be more northerly than the limit on the east, but, for those of more limited range, still within the area of relatively high summer sunshine.

TABLE VII

Distribution	Species absent from Ireland.	Species present in in Ireland.
Limit North of Moray Firth	2 spp. (8.3%)	22 spp. (91.7%)
Limit in mid Scotland (Between Moray Firth and Firth of Forth)	7 spp. (35%)	13 spp. (65%)
South Scotland	8 spp. (57%)	6 spp. (43%)
North England (Limit N. of Humber)	177 spp. (63%)	10 spp. (37%)
Limit in England south of the Humber	21 spp. (100%)	0 spp. (0%)

A perusal of the distribution data with respect to Ireland shews another interesting feature. Taking the entire Southern Component of the East Anglian flora and grouping them according to their northward extension (c.f. Table VII), we see that there is a steady decrease in the proportion of species which occur in Ireland as we pass from the species with an extended northward range in Britain to those with a restricted range. In general it is true that the more extended the range northwards the more the species tends to extend westwards. This is in conformity with the conclusion of Lutz (Bull. Amer. Museum., Nat. Hist. pp. 335-366) that there is a high correlation between the east-and-west extent of a species and its north-and-south range. Two explanations are possible. Either that the differences in range are a real expression of differences in climatic tolerance, or that they are an indication of differences in the rate of dispersal and

furnish examples of the relation between age and area. That the former is the more probable explanation is indicated by the fact that the differences in range in Britain correspond in general with the differences in climatic tolerance exhibited by these species on the continent. Further, some of the more restricted species have a more efficient means of dispersal than those which extend into Ireland, and pairs of comparable species can be cited, such as *Salvia pratensis* and *S. Verbenaca*, *Ophrys aranifera*, and *O. apifera*, of which one is restricted and the other has a wide range, although the dispersal mechanism must be practically identical. But the strongest argument in favour of the dominance of the climatic factor in determining the limits of these species, is to be found in the correspondence of the direction of these limits in Britain with the climatic preferences as evidenced by their range in Europe.

Analysis of the southern component according to the type of habitat and the degree of northward extension furnishes the following percentages :—

TABLE VIII

	S. England. 100%	N. England.	S. England.	N. Scotland.	No. of Spp.
Damp habitats	66%	50%	53%		15
Woods	99%	45%	45%		11
Calcareous Soils	92%	25%	0%		15
Sandy Soils	55%	33%	33%		9
Other dry Soils	87%	56%	34%		23
Other habitats	84%	77%	81%		26

These data shew that the rate of diminution is greatest for the calcicolous species which are unrepresented, so far as East Anglian plants of this group are concerned, in the north of Scotland. But the species of sandy soil shew an even greater initial diminution, though, having regard to the small number of species involved, no great importance can be attached to these proportions. It should, however, be noted that the diminution is generally most marked for the species of dry habitats, which in total number 47, or nearly 48 per cent. of the entire southern component. On the other hand, if we exclude the miscellaneous class (chiefly arable, waste ground, etc.) the lowest rate of diminution is shewn by the damp habitat species. Since these latter might be expected to be least affected by the increasing humidity directly, the contrast between the damp habitat and dry habitat species in this respect would appear

to lend further support to the view that the diminution is an outcome of increasing climatic unfavourability. The following southern species are stated by Nicholson to have become extinct in Norfolk: *Lythrum hyssopifolium, Salvia pratensis, Erodium moschatum, Inula crithmoides.* The disappearance of the two last, which are littoral species, and of the second which is a very conspicuous plant, is probably to be attributed to the increased pressure of the human factor and cannot be regarded as indicative of a diminished climatic or edaphic suitability. The extinction of the relatively inconspicuous *Lythrum hyssopifolium*, which grows in situations that are wet in winter but dry in summer, may be due to a lowering of the water-table in Norfolk as elsewhere in England.

(7) The Oceanic Component

The West European Element in the East Anglian Flora

The extreme West-European species in the British Flora constitute a group of distribution types which includes the so-called Lusitanian element with a distribution restricted mainly to the Iberian Peninsular, Brittany, the Cornish peninsular and the west of Ireland. This group numbers some twenty-three species. Of this total two only are met with in East Anglia, viz., *Ulex nanus* and *Ulex Gallii*. Both species have a continental distribution from Spain and Portugal to France and Britain. *Ulex Gallii* in France has its northern continental limit in Normandy and is restricted to the maritime departments. *Ulex nanus* has a more extended range with the Seine inferieure as its northern limit and tending eastwards almost as far as the Rhone. In the British Isles this difference in the continental distribution of these species is reflected in their respective western limits. For whereas *Ulex Gallii* extends into Ireland and is there widespread, *Ulex nanus* is absent from Ireland. The former species is most abundant in the south-eastern counties, whilst *Ulex Gallii*, though present in the east of Britain, is only common in the west. In East Anglia *U. nanus* is occasional to frequent and is found both in the western drier vice-counties as well as in the eastern moister vice-counties of Norfolk and Suffolk. *Ulex Gallii*, on the other hand, is confined to the eastern portions of these counties and is nowhere in the east of England more than rare.

In view of these facts with regard to the continental and English distributions it is very significant that the one should be common in Ireland and the other absent. Both have similar seeds and probably depend on precisely the same agencies of dispersal. Except that *U. Gallii* is probably more tolerant of calcareous soils, these two closely allied species are almost identical in their edaphic requirements and occupy similar communities. It is therefore most probable that the absence of *U. nanus* from Ireland is not due to its failure to reach Ireland, but to unsuitability of the climatic conditions. The case of these two congeners is so striking that it throws considerable doubt upon the commonly adopted explanation of the absence of species from Ireland as due to failure of the agencies of dispersal. Further, as we have already seen in the southern component, the absence of species from, or their presence in, Ireland is generally correlated with the climatic preferences of the species as indicated by its continental range.

The absence of *Euphorbia portlandica* is noteworthy, since suitable dune areas are abundantly provided in that part of East Anglia where the climate shews the nearest approach to oceanic conditions. Its absence, and that of the remaining Lusitanian types, may, with a considerable degree of certainty, be attributed to climatic conditions alone.

When we turn to the west European species in which the oceanic distribution is less marked, the representation in the East Anglian Flora, as might be expected, is very different. The British Flora as a whole includes about sixty-nine such species and of these thirty-nine are present in our East Anglian Flora. Naturally the degrees of restriction to western Europe in this western element exhibit a wide range. Some species, such as *Scilla nutans*, *Genista anglica* (Map 26), *Anagallis tenella* (Map 27), *Erica cinerea*, *E. tetralix*, etc., although definitely western in their geographical distribution, do nevertheless by their extension towards Central Europe display a considerable degree of tolerance for continental climatic conditions. Others, such as *Corydalis claviculata*, *Sedum anglicum*, *Verbascum virgatum*, etc., are more markedly oceanic and constitute transitional types, as regards distribution, to the Lusitanian element just considered. Here again the absence of certain species is noteworthy. Thus, the markedly

western *Agrostis setacea*, a grass of sandy heaths, is absent, although suitable edaphic conditions are well represented and these indeed constitute the habitat of a closely allied grass, namely *Apera* (*Agrostis*), *spica-venti*, which is a continental species occupying a similar " niche," but with different climatic requirements. Other absentees, noteworthy because their absence cannot be attributed to the absence of suitable soils, are *Orobanche hederæ* and *Daucus gummifer*. The rarity of *Wahlenbergia hederacea* (Map 36), *Luzula Forsteri*, and *Ranunculus Lenormandi* is also significant. Of the western species present in East Anglia most are of wide distribution in the British Isles. The complete list of western species present in East Anglia is given in Table IX. It will be noted that some of these, despite their west-European distribution, have a definitely eastern distribution in Britain. Thus *Glyceria Borreri*, *Salicornia perennis* (*radicans*), and *Spartina stricta* belong to Watson's " Germanic " group, suggesting affinity with the South-Western species which, whilst shewing a preference for oceanic conditions, are intolerant of the restricted sunshine associated with the more extreme oceanic climate.

TABLE IX. West-European species present in East Anglia

Species.	Frequency in East Anglia.	Eng.	Watson's Type.	Frequency in Ireland.	Habitat.
Anagallis tenella (Map 27)	f.c.	99%	Btsh.	100%	Marsh
Anchusa sempervirens ...	r.	?	Eng.	27.5%	Waste ground
Anthemis nobilis ...	r.	70%	Eng.	52.5%	Dry heaths
Barbarea præcox	r.	?	?	22.5%	Waste ground
Carex arenaria	l.c.	97% of Litt.	B.	90% of Litt.	Sandy soil
Carex binervis	r.r.	99%	B.	100%	Dry heaths
Carex trinervis	v.r.	?	G.	25%	Wet sandy so
Carex punctata (Map 40)	v.r.	14%	Atl.	12%	Damp Littor
Cerastium pumilum ...	v.r.	31%		0%	Heaths
Cirsium anglicum ...	f.	69%	Sctsh.	100%	Wet places
Conopodium denudatum	l.c.	97%	B.	100%	Woods
Corydalis claviculata ...	l.c.	84%	B.-Atl	15%	Woods
Crambe maritima ...	v.r.	62% of Litt.	E.	33% of Litt.	Shingle beach
Crithmum maritimum (Map 28)	v.r.	64% of Litt.	Atl.	80% of Litt.	Shingle beach
Erica cinerea	l.c.	96%	B.	97.5%	Heaths
Erica tetralix	l.c.	98.6%	B.	100%	Damp heaths
Erodium maritimum (Map 31)	r.	46.4%	Atl-E	27.5%	Littoral
Genista anglica (Map 26)	l.c.	91.5%	B.-E.	0%	Damp heaths
Glyceria (Sclerochloa) Borreri (Map 29) ...	r.	19.7%	Germ.	7.5%	Salt marshes
Glyceria maritima ...	c.	59% of Litt.	B.	100% of Litt.	Salt marshes
Glyceria procumbens ...	r.	39%	E.-G.	0%	Salt marshes
Hypericum elodes (Map 37)	l.c.	79%	Atl-E.	62.5%	Bogs
Lastræa æmula	v.r.	34%	Atl.	92.5%	Gogs

Species.	Frequency in East Anglia.	Eng.	Watson's Type.	Frequency in Ireland.	Habitat.
idium heterophyllum					
Smithii)	l.c.	97%	B.-E.	65%	Hedge-banks
ula Forsteri (Map 32)	v.r.	42%	E.	0%	Woods
riophyllum alterniflorum		77%	B.	92.5%	Ponds, etc.
anthe crocata ...	r.r.	90%	B.E.	85%	Stream-sides
roselinum segetum ...	r.	47%	E.	0%	– Damp chalky soil
unculus hederaceus ...	f.	100%	B.	100%	Ponds
unculus Lenormandi	r.	70%	E.	32.5%	Ponds
hanus maritimus					
Map 42)	v.r.	44.7% of Litt.	Atl.	56% of Litt.	Sea Cliffs
us affinis	o.	?	?		Woods
cornia perennis ...	l.c.	32% of Litt.	Germ.	0%	Salt marshes
a nutans	c.	98.6%	B.	100%	Woods
phularia aquatica ...	c.	97%	E.	95%	Stream-sides
m anglicum (Map 30)	l.c.	48%	Atl.-B	75%	Shingle
tina stricta ...	r.	15.5%	Germ.	0%	Salt-marshes
phytum tuberosum...	r.	21%	Int.		
			Scot.-abs		Woods
ium humifusum					
Map 33)	v.r.	33.8%	E.-G.		– Chalky heaths
europæus	c.	100%	B.	100%	Heaths
ascum virgatum ...	r.	1.5%?	Atl-E.		– Gravelly soil
Curtisii (Map 52) ...	r.	35%	Atl.	50%	Dunes
lenbergia hederacea	v.r.	62%	Atl.	17.5%	Woods
ap 36)					

No less than ten of these species have a more or less marked western distribution in Britain. *Carex punctata* has its northern limit for eastern England in Suffolk, where it is very rare. Apart from this station its eastern limit extends from Kirkcudbright to S. Hampshire (Map 40). In Ireland it is confined to Cork and Kerry. *Crithmum maritimum* also has its nothern limit on the east coast in Suffolk, but extends into the Hebrides on the west. In Ireland, with the exception of the north-east, it extends all round the coast (Map 28). *Erodium maritimum* has a similar distribution with its northern limit extending from Wigton on the west to Norfolk on the east (Map 31). *Hypericum elodes* is more generally distributed but, except for its rare occurrence in east Yorkshire, its limit is again a diagonal one extending from the Hebrides to Norfolk (Map 37). *Lastræa æmula* probably owes its western distribution in Britain more to increased frequency of the boggy habitats it frequents than to the direct effect of climatic conditions. In suitable habitats it extends into E. Yorkshire, the eastern border counties, Perth and the Orkneys. *Raphanus maritimus* occurs very rarely on the east coast from N.W. Yorkshire southwards, extending on the west as far as the Hebrides (Map 42). *Sedum anglicum* is present on the

east coast of Scotland and only exhibits a slight western tendency (Map 30). *Viola Curtisii* has its eastern limit from Cheviotland to Dorset, except for its East Anglian occurrences in Breckland (Map 52). *Wahlenbergia hederacea* is markedly western in Britain and only extends on the east as far as S. Essex (Map 36).

It is thus evident that the west European element in the East Anglian Flora can, with respect to their distribution in Britain, be placed in two categories, viz. :—(*a*) Those which are widely dispersed and which constitute about three quarters of the total; (*b*) those which exhibit a definite western trend in Britain itself and which mostly present a geographical limit which passes diagonally from East Anglia in a north-westerly direction. These species may be conveniently referred to as the *Diagonally-Western* Group. The greater extension of these species on the west, as compared with the east, cannot be attributed to the absence of the appropriate communities or soils in the north-eastern area, since suitable conditions are as frequent there as further south. Furthermore, the population factor cannot be invoked since these species occur in the south-east, where the human factor is most intense; whereas the north-east and the west present comparable conditions in this respect, although the species in question are present in the one and not in the other. It is clear then that we must attribute this diagonally-western distribution to climatic causes. The fact that a whole group of species shew this same feature is very significant, the more so since in the case of *Carex punctata*, *Crithmum maritimum* and *Erodium maritimum*, the East Anglian stations are in the nature of outliers from the main area of occupation and are situated in the damper eastern vice-counties. The higher rainfall of this area and the presence of the large expanses of water are responsible, doubtless, for the fact to which this distribution bears testimony, that the climatic conditions are here relatively oceanic in character as compared with the east of England generally, and particularly contrast with the dry and continental conditions in the adjacent area of west Suffolk and Cambridge.

It is noteworthy that these west European species, when considered from the point of view of the moisture relations of

Map 26 Genista anglica

Map 27 Anagallis tenella (Continental distribution after Ludi)

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Map 28

Map 29

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Map 30

Map 31

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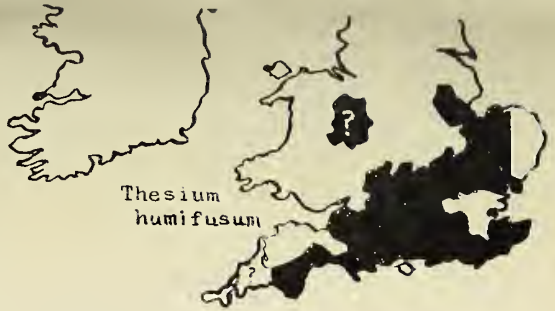

Map 34

Map 35

Maps 32, 33, 34 & 35

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HISTORY.

Map 36

BRITISH
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HISTORY.

Map 37

V.R.
Ex

Map 38

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Map 39

Map 41

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Map 42

Map 43

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Phot. E.J.S. $X\frac{1}{2}$

Wood Rush, Luzula Forsteri

Phot. E.J.S. $X\frac{1}{2}$

Oxlip, Primula elatior

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Phot. E.J.S. $X\frac{1}{4}$

Fen with Orchis incarnata and Cirsium anglicum

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the habitat, fall into two rather strikingly extreme types of habitat. Seventeen, or over 43 per cent. of the total, occur in damp or wet habitats of one type or another and therefore in situations where the edaphic conditions tend to ameliorate the ill effects of high temperatures and low precipitation, of which species, characteristic of oceanic climatic conditions, might be intolerant. So too the woodland species, which number six or 15.3 per cent., occupy a habitat where the climatic conditions are far less extreme than in the open, and in this connection we may note that *Wahlenbergia hederacea* is confined to damp woodlands in the drier conditions of the east of England, but is found in the open on damp heaths in the moister climate of the west. Thus we see that 59 per cent. of the total west-European species grow in situations where the full effect of the climatic conditions of East Anglia are minimised. It is therefore the more surprising to find that thirteen species, or a third, representing all but three of the remaining species, are definitely associated with dry types of soil, which seems paradoxical, in view of their association with oceanic conditions. It should, however, be noted that, whereas many of the damp habitat species are frequent or common, the dry habitat species are with three exceptions rare or very rare. One may suggest then that, unlike some southern types, these species are not associated with sandy, or gravelly soil, or shingle, because of their dry character, but because of other physical qualities of the soil, such as good aeration or because they here escape undue competition. But, not being highly xerophytic types, (the succulents *Crambe maritima, Crithmum maritimum, Sedum anglicum*, are probably all dependent upon internal dew formation in the shingle), it is not unlikely that a more or less oceanic climate is essential for their welfare on these dry soils. Such an interpretation of the facts is strengthened by the much greater frequency of several of these species in the west of England.

It should be noted that several of these West-European species are definitely associated with soils which are not only deficient in, and sometimes totally devoid of, carbonates, but also with soils which are usually deficient in exchangeable calcium and often of high acidity. Such species as *Erica cinerea, E. tetralix, Anagallis tenella, Hypericum elodes, Genista*

anglica, and *Ranunculus Lenormandi* afford examples, and it is possible that the climatic limitations of these species are in part indirect, in the sense that their particular soil requirements are realised in temperate regions, only under oceanic climatic conditions.

The prevailingly "diagonally western" limit of the western species offers a striking contrast with the "diagonally eastern" limits of so many of the members of the southern component, and this contrast is perhaps the most convincing testimony to the significance of these limits as expressions of specific requirements.

(8) The Southern Oceanic Element

The species included here are characteristic of southern and western Europe and, though their segregation from the southern component is somewhat arbitrary, they would seem to be more appropriately considered as part of the Oceanic component; since, though exhibiting a definite southern tendency, a more or less oceanic climate seems to be the dominating factor in their distribution. The absence from Scotland of fifteen, out of a total of thirty-two species in this category, sufficiently attests to their southern tendency in Britain. Of those which occur in Scotland, several only reach the southern Scottish counties (e.g., *Helminthia echioides*, Map 53, *Statice binervosa*, Map 60). The oceanic character is clearly shewn by the number of species which occur in Ireland, namely, twenty-seven, or nearly 82 per cent. Five of these species actually exhibit a greater frequency in Ireland than in England, and this wider distribution not only emphasises further the climatic preferences of this group, but, taken in conjunction with the fact that eight species which occur in Ireland do not occur in Scotland, points again to the presence in, or absence from Ireland, as determined in most cases at least by climatic preferences, and not by the efficacy, or rate, of dispersal. The two species which just extend into Scotland occur in 17.5 per cent. and 30 per cent., respectively of the Irish counties and vice-counties.

It is evident then that the distribution of these species is not a consequence of their possible recent arrival during the Atlantic Period, but must be attributed mainly to climate. It seems

therefore surprising that, having regard to the rather continental character of the East Anglian climate, so many of these species should be represented. In this connection it is necessary to appreciate the striking contrast which is afforded by the climatic conditions of the eastern portion of East Anglia, particularly the area of the Broads, and the south-western area occupied by the Breckland heaths (c.f. Map Fig. 3). It is this climatic contrast, accentuated by soil differences, which is responsible for the richness of the East Anglian Flora and the juxtaposition of oceanic and continental types. This climatic segregation within our area is reflected in the Sphagnaceous flora. Eight species of Sphagnum are recorded from V.C. 27, six from V.C. 25 and V.C. 28, only five from V.C. 26 and none from Cambridge. (J. B. Duncan, Census Catalogue of British Mosses, 2nd Ed., 1926.) Similarly for the mollusca : whereas 110 and 111, species respectively have been recorded from E. Norfolk and E. Suffolk, only ninety-four and ninety-eight have been found in W. Norfolk and W. Suffolk. (Boycott. 1911.)

TABLE X. Species of Southern and Western Europe (Southern Oceanic types) in the East Anglian Flora.

cies.	Frequency in E.A.	Habitat.	% Freq. in England.	% Freq. in Ireland.
opyrum junceum	l.c.	Shingle	76% of Litt.	76% of Litt.
opyrum pungens (Map 45)	l.c.	Shingle	57% of Litt.	32% of Litt.
a maritima	r.r.	Shingle	87% of Litt.	100% of Litt.
ssica oleracea (Map 43) ...	4.	Cliffs	30% of Litt.	0%
itriche obtusangula ...	r.	Aquatic	69%	40%
ex extensa	r.	Salt marsh	78% of Litt.	94% of Litt.
ora perfoliata (Map 46) ...	r.	Calc. past.	86%	67.5%
ndia filiformis (Map 35)	v.r.	Sandy heaths	12.7%	7.5%
yledon umbilicus (!Suffolk)		Walls and cliffs	69%	97.5%
nasonium stellatum (Map 48)	(Extinct)	Ponds	21%	absent
horbia paralias (Map 44)	v.r.	Dunes	65% of Litt.	60% of Litt.
uca uniglumis (Map 50)	v.r.	Sandy shore	46.8% of Litt.	20% of Litt.
ninthia echioides (Map 53)	r.r.	Dry places	89%	20%
ericum androsæmum [ap 55)	r.	Woods	90%	100%
fœtidissima (Map 54) ...	r.r.	Woods	72%	57.5%
us acutus (Map 34) ...	v.r.	Dune-slacks	36% of Litt.	20% of Litt.
icago maculata (Map 47)	r.r.	Dry banks	65%	10%
lotus altissima	r.r.	Waste ground	94%	25%
iola millegrana (Map 35)	r.r.	Damp heaths	80%	50%
unculus Baudotii ...	r.r.	Ditches	65%	40%
unculus parviflorus ...	r.r.	Dry soil	84.5%	17.5%
na maritima	l.c.	Salt marshes	63%	57.5%
pus Savii (Map 39) ...	r.	Damp heaths	28%	65%
ice binervosa (Map 60) ...	l.c.	Salt marshes	55% of Litt.	48% of Litt.

Species.	Frequency in E.A. Habitat.		% Freq. in England.	% Freq. in Ireland.
Statice Humile (rariflora) (Map 61)	l.f.	Salt marshes	49% of Litt.	84% of Lit
Tillæa muscosa (Map 48) ...	l.f.	Damp heaths	12%	absent
Trifolium glomeratum (Map 58)	r.r.	Gravelly heaths	28%	5%
Trifolium maritimum (Map 51)	r.	Salt marshes	53% of Litt.	absent
Trifolium subterraneum (Map 59)	r.r.	Gravelly heaths	60.5%	2.5%
Trifolium suffocatum (Map 41)	v.r.	Sand dunes	34% of Litt.	absent
Trigonella purpurascens (Map 56)	r.r.	Gravelly banks	45%	15%
Urtica pilulifera (Pl. VII B)...	v.r.	?Ex. Waste gr.	1.4%	absent
Averages of frequency for species common to England and Ireland			63.4%	46.6%
Average all English sp.			56.5%	

That the extension of many of these species to Ireland is an indication of a greater range of climatic tolerance, is attested by the higher average frequency of these in England as compared with those absent from Ireland. The species represented grow in a great diversity of environments, and both dry and moist habitats are represented, alike in the species confined to Britain and in those extending to Ireland. The three species *Scirpus Savii* (Map 39), *Juncus acutus* (Map 34), and *Cicendia filiformis* (Map 35), all of which occupy most sandy habitats, are of exceptional interest as shewing a diminishing range, in the order named, both in Britain and in Ireland. All three species are entirely absent from the eastern side of Britain north of the Thames estuary, except for their East Anglian stations, and all are absent from West Suffolk. *Radiola millegrana* (Map 38), however, a species of similar habitats, has a wide range both in Britain and in Ireland, although often extremely local in its distribution and depending for its persistence on special topographical and microclimatic conditions. It is notably less abundant in the eastern counties than in the western, and is probably a diminishing species already extinct in Cambridgeshire, Bedfordshire, and Hertfordshire. Of the two woodland species *Hypericum androsæmum* (Map 55), and *Iris fœtidissima*, we may note that the former tends to grow on siliceous soils and the latter on calcareous soils. *Iris fœtidissima* (Map 54) certainly has a more continuous range, but there is no indication of the diagonally S.W.-N.E. limit

Map 44

Map 45

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Map 46

Map 47

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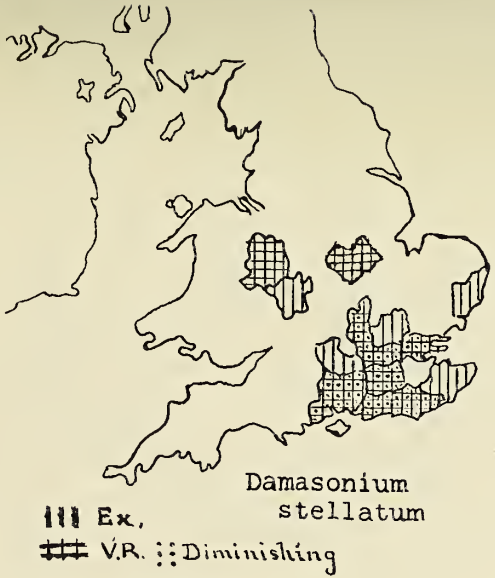
Damasonium
stellatum
Ex.
V.R.
Diminishing

Map 48


Tillaea
muscosa
l. frequent
Rare

Map 49

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Map 50

Map 51

Maps 50 & 51

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Map 52

Map 53

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Ex
Iris
foetidissima
Rather Rare
Rare

Map 54

Hypericum
androsaemum
Rather Rare
Rare

Map 55

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Medicago
maculata

Trifolium
subterraneum

Map 59

Trigonella
ornithopodioides

Trifolium
glomeratum

Map 58

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Map 60

Map 61

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which is so marked a character of the continental-southern calcicoles. So too the calcicole *Chlora perfoliata*, though absent from the non-calcareous north-eastern part of Ireland and from four of the Welsh counties, has nevertheless as extended a range on the west side of Britain as on the East (Map 46). The six West-European littoral species common to East Anglia and Ireland all exhibit a similar distribution, although two (*Statice binervosa* Map 60, and *S. Humile* Map 61) are salt-marsh plants; one, *Euphorbia paralias* (Map 44), is characteristic of the dune face, *Festuca uniglumis* of sandy shores, whilst the Sea Cabbage (*B. oleracea* Map 43) is a cliff plant, *S. binervosa* and *F. uniglumis* (Map 50) both shew a marked N.W.-S.E. limit in Britain.

The presence in this group of no less than five leguminous plants, all characteristic of dry gravelly or sandy habitats, is a striking feature. The species are *Trigonella purpurascens* (Map 56), *Medicago maculata* (Map 57), *Trifolium subterraneum*, (Map 59), *Trifolium glomeratum* (Map 58) and *Trifolium suffocatum* (Map 41). In the order named they shew a diminishing range in Britain and, except for transposition of the third and fourth, the same order holds for Ireland from which the last species is absent. All these five species are very low-growing plants and may well be restricted to such situations, by reason of the relative immunity they enjoy, in these very arid situations, from undue competition; but their capacity to grow in such places may well be conditional on the climate being of a sufficiently oceanic character, particularly with respect to adequate humidity and not too severe a winter (all these species are winter-annuals).

Of the southern oceanic species of East Anglia which do not occur in Ireland, three are species of wet habitats, viz., *Trifolium maritimum* (Map 51), *Damasonium stellatum* (Map 48) and *Tillæa muscosa* (Map 49), and therefore it is unlikely that their distribution, which is chiefly in the south-east of England, is limited by the higher humidity of the west and north. Neither is it probable that temperature is the master factor, since in this respect the east is more favourable than the west. It is more probable that the amount of sunshine is the master factor involved, influencing the distribution mainly by its effect on reproduction (c.f.p 236). If this be the true

explanation, then we can understand why damp and dry habitat species, a few species which require an oceanic climate as well as the majority of those associated with a continental climate, alike may shew this same type of south-western limitation in the British Isles. *Damasonium stellatum* has become extinct in five counties or vice-counties and has diminished in four others. *Trifolium maritimum* is also a diminishing species. *Radiola millegrana* has become extinct in two counties and has appreciably diminished in another. These extinctions correspond with the diminution of damp habitat species in general. Of the other representatives of this element *Beta maritima*, *Trigonella purpurascens*, and *Urtica pilulifera* (this species was once plentiful at Lowestoft, Henslow and Skepper, 1860 p. 75) have become extinct in two counties: *Chlora perfoliata*, *Iris fœtidissima*, and *Ranunculus parviflorus* in one. These facts are, however, probably not indicative of any general tendency for this element to diminish, except in so far as drier conditions tend to diminish the oceanic character of the climate. Of the other elements of the "Oceanic Component" eight species have shewn extinction or diminution in one or more of the English counties, and of these six are damp habitat species and the other two are littoral species. The former are to be attributed to lowering of the water-table, the latter to human interference.

Braun-Blanquet (1923 p. 129) has called attention to the diminution in frequency of these Oceanic types towards their eastern limits, and to the fact that the range of a number of them is tending to retreat westwards rather than to extend eastwards. His conclusion, that the Atlantic types are not of very recent origin, appears justified, and their western restriction cannot be attributed to these species not having yet attained to their climatic limit. Matthew's study of the Anglo-Irish species in the British Flora (1926), which largely comprises oceanic types, has shewn that on the Continent these chiefly occupy the south-west, and on other grounds Braun-Blanquet (l.c.) also regards South-Western Europe as the probable home of these plants.

Of the 102 species comprising the Southern Component of the East-Anglian flora almost all are definitely lowland types. Only six species namely *Arum maculatum* (1200), *Galeopsis*

ladanum (1050), *Geranium lucidum* (1850), *Luzula maxima* (3000), *Orchis pyramidalis* (1050) and *Salix purpurea*, have been recorded from altitudes of over 1000 feet in England (A. Wilson, 1931). The general uniformity in this respect is clearly correlated with the southern climatic preferences of these species.

(e) The Continental Component

To understand the occurrence of the continental species it is necessary to study somewhat closely the distribution of rainfall in East Anglia. This distribution, as already noted, is markedly unequal, and three regions can be distinguished with respect to precipitation. The first, in the east and north-east, of which Norwich is the approximate centre, extends from Ipswich, Yarmouth and Cromer on the east, to Sudbury, Hawkedon, Ixworth, Swaffham and Sandringham on the west. In this area the total annual rainfall ranges from 24-ins. to 28-ins., and in the northern half is in general over 26-ins. In marked contrast with this moderate rainfall is the low rainfall of the belt of country extending from the Wash over the Breckland heaths to the coast from Felixstow to Shoeburyness. Here the annual precipitation is usually from 21-ins. to 24-ins. and may be as low as 18.4 ins., which is the lowest recorded mean for the British Isles. Data over a period of years are not available for the heart of the Breckland area, where it is probable that the amount of precipitation is lower than the data available from the stations at its margin indicate. The published data for Thetford suggest that the line of demarcation between the low and higher rainfall areas may be comparatively abrupt. Thus, in Thetford itself the mean annual rainfalls for Ford Street Gardens (44-ft. altitude) and the Waterworks are 23.4 and 23.8 ins. respectively. (The latter station is at an altitude of 165-ft., which accounts for the higher rainfall.) At Kilverstone Hall, less than two miles N.E. of Thetford and at an altitude of 70 ft., the mean annual rainfall is only 21.7 ins. A further area of low rainfall is furnished by the coastal strips of the north and south-east where mean precipitations of about 23 ins. are the rule (c.f. British Rainfall for 1930). The accompanying map (Fig. 3) shews that these coastal strips are in reality extensions of the

larger low-rainfall area which more or less enclose the area of higher rainfall.

The striking disparity between the precipitation in these two regions is accentuated by several factors, of which the chief is the sandy character of the soil in the dry area where the soil, owing to the coarse size of the soil particles has, apart from the organic content, a low water-retaining capacity; whereas the soil in the area of higher rainfall is often, from its fine-grained clayey texture, or high organic content, or both, very retentive of the water it receives. We have no available data respecting the humidity of the air in the two regions, but it is probable having regard to the large areas of standing water in the neighbourhood of Norwich, that differences in this respect still further accentuate the differences in available water supply for the vegetation in the two areas. Furthermore, and this is probably of considerable importance, the lowest annual rainfalls are mainly the consequence of reduced precipitation during the winter months. Comparison of the monthly means for Bury St. Edmunds, Norwich, England as a whole, and Wales shews that, in the order named, there is not only an increasing total precipitation, but also that this is mainly the outcome of increase during the winter months when evaporation is low. Thus we may conclude that the sandy area, shewn dotted in the accompanying map, Fig. 3, is considerably drier than the rainfall data alone suggest. It therefore follows that the conditions obtaining on these sandy heaths are definitely continental in character as regards humidity.

When we turn to the influence of temperature the same juxtaposition of a region of relatively continental character in the west of our area and a more oceanic climate in the east is again indicated. For the purpose of this comparison we may take Cambridge as typical of the dry low rainfall belt, and Yarmouth as typical of the eastern area. In the accompanying table (Table XI) the extremes of temperature and rainfall for these towns and for other parts of the British Isles of similar latitude are quoted from the official books of Normals. It will be at once evident that the climate of Cambridge is definitely continental, whereas that of Yarmouth is somewhat more oceanic than that of Oxford. The minimum

Fig. 3. Map of East Anglia, shewing rainfall distribution and occurrence of species. Figures represent av. rainfall in inches

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temperature recorded at Yarmouth is 22° of frost, whereas at Cambridge 32° of frost have been recorded.

TABLE XI. Extremes of Temperature (°F.) and Rainfall (mm.) for various stations.

ation.	Longtitude.	Min. Temp.	Max. Temp.	Range	Degrees of Frost.	Min. Rain.	Max. Rain.
erry	10°15 W.	20	81	61	12	1078	1756
ublin	6°15 W.	13	87	74	19	422	980
nglesey	4°39 W.	17	86	69	15	610	1431
xford	1°16 W.	6	95	89	26	380	912
mbridge ...	0°8 E.	0	96	96	32	308	795
armouth ...	143 E.	10	89	79	22	494	1122

The general amelioration of the climatic conditions as we pass westwards from Cambridge is to be expected, but the almost abrupt change to oceanic conditions on the east is as surprising as the magnitude of the change itself. It is therefore significant that, though we have markedly oceanic species in the east of our area, already dealt with, on the sandy heaths of our area where the soil conditions accentuate the definitely continental type of climate, we find the characteristic species are mostly plants of steppe conditions, chiefly found in areas where the climatic conditions are markedly continental. These, whilst usually capable of withstanding severe cold when the conditions are dry, are often very intolerant of cold humid conditions which obtain in the midlands during the spring. Several of the more characteristic species, such as *Silene conica*, *Teesdalia nudicaulis* and probably *Medicago minima*, are winter annuals; others, such as *Silene otites* and *Veronica spicata*, are winter green perennials. *Medicago falcata* is, I gather from Dr. Mills, a hemi-cryptophyte. It is probably the dry character of the winter months and the high summer temperature and amount of sunshine that limit these species to the continental area. In this connection it is necessary to recognise that extreme conditions as to sunshine, temperature, and humidity, are often of more importance than the means.

For several years the writer has cultivated the continental steppe species *Silene conica* on sandy loam at Radlett, Hertfordshire. This species is a winter annual and the soil where the plants grew was left undisturbed, the seedlings germinating in abundance each autumn. From the autumn of 1928 to that of 1930 the number of self-sown plants steadily

increased, and in the summer of 1931 there were more plants and probably a much larger output of seed than in any of the previous years. Laboratory tests of the seed produced in the summers of 1929 and 1930 shewed the germination capacity to be very high, the average of a large number of tests being over 98 per cent. In the summer of 1931, however, although the amount of seed produced appeared to be larger than ever, not a single self-sown seedling appeared in the autumn.* Fortunately seed had been again collected and this, when tested in the laboratory, shewed a maximum germination of only 0.5 per cent.

I am much indebted to Sir John Russell for supplying me with the meteorological data recorded at Rothamstead (the nearest Station to Radlett which records the sunshine) for the appropriate periods of 1930 and 1931. If we consider the whole period from the beginning of flowering to the shedding of the seed, i.e., the months of May, June, July and August, the number of hours of sunshine was respectively 909.1 and 729.7 ; the rainfall was 9.012 ins. and 13.108 ins., whilst the mean temperatures were 57°.3 and 56°.2 F. The most significant months for the seed production of *Silene conica* are, however, probably June and July, for which the hours of sunshine were 450.4 and 372.8 ; rainfall 3.63 ins. and 4.56 ins. ; temp. 59.1 and 58.6 These totals shew, what is even more obvious from the weekly data, that there was but little difference in the two seasons as regards temperature ; and the difference in respect to rainfall, though appreciable, would, from the period of its incidence in 1931, in all probability, be beneficial rather than the reverse. The difference in the two seasons as regards the number of hours of sunshine is however very striking, and the deficiency in this respect during 1931 may well account for the failure of *Silene conica* to produce good seed. It is not, indeed, improbable that the failure of many southern and continental types to produce a crop of fertile seed, except in abnormally sunny years, may depend on an inadequate supply of radiant energy, especially of short wave-length.

Recently O. H. Volk has given an account of the ecology

*A certain number of seedlings appeared in September, 1932, after disturbance of the soil, probably from buried seeds of 1930 or earlier years, shewing that this species may in this way survive an unfavourable season.

of the vegetation of the sandy area of the Upper Rhine valley, in which the striking resemblance of the plant communities, as to species in the two areas, is obvious. Amongst the more characteristic species common to both may be cited *Silene otites, S. conica, Medicago minima, Artemisia campestris, Teesdalia nudicaulis, Scleranthus perennis, Holosteum umbellatum,* and *Veronica verna.* (O. H. Volk, Zeitsch f. Botanik B.24, pp. 81-185 1931).

Stomps had previously suggested as a cause of the floristic resemblance that these East Anglian species owe their presence to the fact that they are relics from the former valley of the Rhine and thus represent a remnant of what was at one time a continuous distribution. Prestwitch, Harmer, Van Steen and others have advocated the view that, in the transition period between the Pliocene and the Pleistocene, when the North Sea was mainly land, the Rhine followed a course through East Anglia entering the area of present land-surface near Walton and, passing through Essex and Suffolk, emerged at Cromer. It must be noted, however, that the Chillesford sands, which Harmer considers to have been formed by the distributary of the ancient Rhine delta (F. W. Harmer, Proc. Geol. Assoc. Vol. XVII, pp. 451-479, 1902), are late Pliocene overlain by Clay; whereas the sandy soils of Breckland, which these plants now occupy, are of Post-glacial origin and possibly derived from the ancient dunes which occupied the former south-eastern margin of the Wash (c.f. Map in E. P. Farrow. On the Ecology of the Vegetation of Breckland). The lack of continuity in time and space between the siliceous habitats weakens the force of the argument for the persistence of these species. Furthermore, the resemblance of these Rhenish communities to those of Breckland, though so striking, is not more so than to the siliceous grasslands of the Vexin Francais described by Allorge (P. Allorge. Les Associations, Vexin Francais pp. 342, Nemours 1922) in which *Veronica verna, Silene otites, Artemisia campestris, Teesdalia nudicaulis, Holosteum umbellatum, Medicago minima* and *Veronica triphyllos* also occur on siliceous soils ; whilst *Herniaria glabra, Agrostis spica-venti, Medicago falcata, Muscari racemosa* and *Phleum Boehmeri* are found in the same region where the soil is more calcareous. The communities described both by Volk and Allorge which

shew the closest resemblance to those of the Breckland heaths are characterised by the dominance of *Corynephorus canescens*, which is also a feature of the East Anglian continental element, although here, almost, but not entirely, littoral in its occurrence (Photo, Pl. VIII). It is, therefore, noteworthy that in the Corynephoretum described by Braun in the Cevennes we find a similar group of species (J. Braun, Les Cevennes Meriodionales, pp. 208, Geneva, 1915).

It is evident, then, that the floristic resemblances to which Stomps attaches such importance are of ecological, rather than historical, significance. Further, we may point out that one of the species to which Stomps calls attention, viz., *Silene otites*, is represented in our area by a strain which, according to Newton, agrees most closely with plants from Denmark (W. F. C. Newton, Genetical Experiments with *Silene otites* and related species, Journal of Genetics pp. 109-120, Vol. XXIV, 1931). Stomps' hypothesis involves survival from preglacial times, a view which is also accepted by Wilmott (l.c.); but, quite apart from any difficulties of climatic tolerance, it has already been pointed out that the major part of East Anglia was glaciated and rendered edaphically unsuitable for these psammophiles. It is only the more recent post-glacial covering that has provided the suitable conditions for these plants. It is not improbable that their immigration was as early as the Boreal Period, when the continental climate favoured the formation of loess and wind born sand and the colonisation of this country by species characteristic of continental conditions. Their survival since that period has only been rendered possible by the peculiar combination of local climatic and edaphic conditions.

(9) The Steppe Element

Table XII. Steppe Species in the East Anglian Flora

Species.	E. Anglia	% Freq. in Eng.	* Freq. in Ireland.	Habitat.
Agrostis spica-venti (Map 62)	l.c.	32.4%	absent	Sandy soil
Arnoseris pusilla	r.	27%	absent	Sandy soil
Artemisia campestris	v.r.	5.6%	absent	Sandy soil
Corynephorus canescens (Pl. VIII)	l.f.	9.8%	absent	Sandy soil
Dianthus deltoides	r.	63%	absent	Dry heaths
Eryngium campestre	Extinct	14%	casual	Dry heaths
Holosteum umbellatum (Pl. VIIA)	Ext.	1.4%	absent	Dry heaths
Hypochœris glabra	r.r-l.c.	62%	2.5% v.r.	Sandy soil

Map 65

Map 66

Map 67

Maps 62, 63, 64, 65, 66 & 67

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Map 68

Map 69

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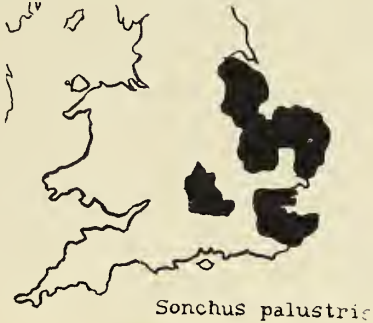
Trifolium
ochroleueum

Scleranthus
perennis

Silene conica



Sonchus palustris

Map 73

In the first and third map the solid black indicates frequent; cross-hatching indicates rare; diagonal shading indicates very rare.

Silene otites

Map 74

Maps 70, 71, 72, 73 & 74

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	E. Anglia	% Freq. in Eng.	* Freq. in Ireland,	Habitat.	Watsonian Type.
licago falcata (Map 66) ...	r.	7%	absent	Sandy heaths	Germ.
licago minima (Map 63) ...	l.f.	14%	absent	Sandy heaths	Germ.
ampyrum arvense (Map 65)	v.r.	11.2%	absent	Cornfields	Germ.
nchia erecta	r.	83%	absent	Dry heaths	Eng.
scari racemosa (Map 64) ...	v.r.	8.4%	absent	Sandy soil	Ger.-l.
his ustulata	v.r.	63%	absent	Dry pastures	E.-G.
eum bœhmeri (Map 68) ...	l.	10%	absent	Sandy heaths	Germ.
entilla argentea	l.c.	67.6%	absent	Dry heaths	Eng-Ger.
ranthus perennis (Map 71) ...	r.	7%	absent	Sandy heaths	Eng.-Ger.
ecio campestris	r.	33.8%	absent	Chalk downs	Eng.
li libanotis ... (Camb.)	v.r.	5.6%	absent	Chalk downs	Ger.-l.
ne conica (Map 72) (Pl. VIII)	.lr.	14%	absent	Sandy soil	Ger.-Eng.
ne otites (Map 74)	l.r.	5.6%	absent	Sandy soil	Germ.
sdalia nudicaulis	l.c.	77.4%	12.5%	Sandy heaths	B.-E.
nica spicata	v.r.	7%	absent	Chalky heaths	Eng.-I.
nica triphyllos	v.r.	8.4%	absent	Sandy fields	Germ.
nica verna ...(Map 67) ...	v.r.	5.6%	absent	Sandy heaths	Germ.

sdalia nudicaulis occurs plentifully in certain sandy habitats in Ireland (c.f. Praeger).

In his account of the Continental Element in the flora of South Sweden, Rikard Sterner shews that there, too, it is the combination of local climate and soil conditions which enables such species as *Phleum Boehmeri* and *Veronica spicata* to extend their range into southern Scandinavia (Geografiska Annaler H.3-4 1922).

Of the steppe species which occur in East Anglia only two occur rarely as probable natives in Ireland, whilst some of those with a very high frequency in England, such as *Mœnchia erecta* and *Potentilla argentea*, are entirely absent. *Dianthus deltoides* has been found in two Irish counties as an escape. Most of these species are absent, or rare, even in the west of England and belong to the Watsonian Germanic type. It is thus evident that the distribution in Britain is mainly limited by climatic factors, but that the occurrence of the more extreme steppe species is dependent upon the combination of suitable edaphic and climatic conditions is shewn by the map giving the distribution of Mean Annual rainfall for a number of stations in East Anglia and the distribution of the sandy heaths, together with the distribution of some of the more characteristic species, Fig. 3. It is evident that these occur exclusively where there is a combination of low rainfall with soil of a very porous character.

That the absence from Ireland of so large a proportion of this

Element, namely twenty-two species, or just over 88%, is due to environmental factors is indicated by the respective frequencies of Continental species common to both England and Ireland (Table XIII). Of these latter there are twenty-four; and twenty of these show a higher frequency in England, the remaining four comprise three damp habitat species and one Heath species. For the total twenty-four species the average frequencies are 78.7% for England and 57.1% for Ireland. Thus just over ninety per cent. of the continental species of East Anglia show a diminution westwards, amounting to entire absence from Ireland in 44.2%.

Of other groups, besides the higher plants, central European species are represented in East Anglia. For example, the Mid-European Syrphid Fly, *Chilosia globulipes* Beck, is found in Suffolk, and *C. fasciata* Egger, a species of mid- and southern-Europe, extends from Kent to Cambridgeshire (Fordham 21). Breckland is also the home in this country of *Dianthcia irregularis, Agrophila sulphuris, Lithostega griseata, Spirodes sticticalis* and the beetle *Diastictus vulneratus.*

TABLE XIII. The Continental Element in the East Anglian Flora (Exclusive of Steppe spp.)

Species.	Freq. in E. Anglia.	% Freq. in Eng.	Ireland.	Habitat.	Watsonian Type.
Acorus calamus	... f.	48%	absent	Marshes	Eng.
Allium vineale	... r.	93%	40%	Dry soils	Brit.
Anemone Pulsatilla (Map 76)	... r.r.	26.7%	absent	Chalk downs	Ger.
Antirrhinum Orontium ...	... r.r.	66%	7.5%	Dry fields	Eng.
Aspidium aculeatum ...	... l.c.	97%	92%	Woods	Brit.
Astragalus glycyphyllos ...	... r.	69%	absent	Woods	Brit.
Bupleurum tenuissimum ...	... r.	39.6%	absent	Dry banks	E.-G.
Carpinus Betulus	... r.r.	54%	absent	Woods	E.-G.
Centunculus minimus ...	... r.	80%	40%	Moist sand	E.-B.
Dipsacus pilosus	... r.r.	74.6%	absent	Moist woods	E.-G.
Epipactis palustris ...	... l.c.	87.3%	75%	Marshes	E.-B.
Fritillaria meleagris ...	... r.	36.6%	absent	Wet meadows	Eng.
Gagea lutea	... r.	49%	absent	Moist woods	I.-B.
Galeobdolon luteum ...	... l.c.	91.5%	10%	Woods	Eng.
Galeopsis speciosa	... r.r.	76%	52.5%	Fields	Scot.-B
Genista tinctoria	... r.	98.6%	absent	Heaths	Eng.
Gentiana germanica (Map 79)	...	18%	absent	Downs	Ger.
Geranium Phæum ...	... r.	62%	25%	Woods	
Hypericum montanum ...	... r.	70%	absent	Dry woods	Eng.
Lamium hybridum ...	... r.r.	86%	65%	Fields	Brit.
Liparis Lœselii (Map 78) ...	... r.	12.7%	absent	Bogs	Ger.
Lonicera periclymenum ...	... o.	100%	100%	Woods	Brit.
Malva rotundifolia ...	... c.	98.6%	57.5%	Waysides	Br.-En

Map 75

Map 76

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Map 77

Map 78

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Gentiana germanica

Map 79

Teucrium scordium

Map 80

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Map 81

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Map 82

Map 83

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Euphrasia Pseudo-Kerneri

Phot. E.J.S. X $\frac{3}{8}$

Fen with Liparis Loeselii

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Fig. A. Holosteum umbellatum; B. Urtica pilulifera; C. Bupleurum rotundifolium; D. Silene noctiflora; E. Menyanthes trifoliata

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Species.	Freq. in E. Anglia.	% Freq. in Eng.	Ireland.	Habitat.	Watsonian Type.
ione pedunculata ...	? Extct. Recorded from				
		11%	absent	Salt marshes	Ger.
nanthe Phellandrium ...	... l.c.	73%	87.5%	Ditches	Eng.-Ger.
chis incarnata	...r.r-l.c.	73%	100%	Marshes	Brit.
eopteris montana ...	... r.	93%	75%	Wet heaths	Brit.
nithogalum nutans ...	... r.	7%	absent	Woods	Eng.
obanche major	... r.r.	90%	12.5%	Heaths	Eng.
ygonum minus ...	... r.	73%	57.5%	Wet places	Eng.
ygonum mite	... r.	42%	12.5%	Wet places	Ger.
ercus sessiliflora ...	... f.	85.5%	absent	Woods	Brit.
nunculus Lingua ...	... f.	91%	75%	Marshes	Brit.
sa rubiginosa	... f.c.	80%	70%	Hedges	Eng.
sa spinosissima ...	... r.r.	84.5%	95%	Dry heaths	Brit.
mex Hydrolapathum ...	... c.	91.5%	92.5%	Riversides	Eng.
on amomum (Map 47)	... f.	79%	absent	Wood-margins	Eng.
nchus palustris (Map 73)	... v.r.	17%	absent	Marshes	Ger.
rbus torminalis	... r.	73%	absent	Woods	Eng.
ratiotes aloides	... l.c.	25%	7.5%	Dykes	G.-E.
ifolium ochroleucum ... (Map 70)	r.-l.c.	20%	absent	Dry pasture	Ger.
ymus chamædrys ...	... r.r.	42%	27.5%	Dry heaths	Brit.
ronica montana ...	... r.	93%	95%	Damp woods	Brit.

The members of the continental component shew a continuous series with regard to the extent of their range in Britain, from those like *Hypochaeris glabra* and *Teesdalia nudicaulis* which extend into Scotland and Ireland (though doubtfully native in the latter country), through species with a wide distribution in England only, such as *Mœnchia erecta* and *Sison amomum* (Map 47), to species, as for instance *Apera spica-venti*, *Medicago minima* (Map 63), *Muscari racemosa* (Map 64), *Melampyrum arvense* (Map 68), *Medicago falcata* (Map 66) and *Veronica verna* (Map 67), which shew increasing restriction to the east of England. Matthews, in his valuable cartographic analysis of the British Flora (Matthews' 1923), has suggested that East Anglia may represent the centre of immigration of the members of this element into this country. Whilst this is not in itself improbable, it must not be lost sight of that, as we have seen, the presence of these species in East Anglia is adequately accounted for by a peculiarly favourable combination of soil and climate; and in this connection it should be noted that, of the definitely continental types which occur in the British Flora as a whole, only about fourteen per cent. are not found in East Anglia, and these are nearly all very rare and local in their English distribution (e.g. *Arabis turrita*, *Cephalanthera rubra*, *Leucojum*

vernum, Orchis militaris, Phyteuma spicata, etc.). Whilst, therefore, it is quite probable that these species may have first entered East Anglia from the Continent and subsequently spread, their presence here cannot be adduced in support of such a view. The varying extent beyond the confines of East Anglia, does however, raise the question as to whether their ranges in Britain represent differing degrees of tolerance for the more oceanic conditions of the west and north, or whether these varying ranges are due to different rates of spread or different times of immigration. In other words, are these differences in range an outcome of the time factor or of the environment ?

Two types of evidence support the view that the causes are ecological rather than temporal. Firstly, it should be noted that some of these species, e.g. *Apera spica-venti, Medicago minima* (Maps 62 and 63) definitely occur as temporary casuals beyond the area of their permanent occupation, so that for these the opportunity of further extension has already offered, and their lack of persistence must clearly be attributed to unfavourability of the environment. Secondly, most of these species exhibit a decreasing abundance as the western and northern peripheries of their ranges are approached. If the existing distributions of these species were but an expression of the efficiency of dispersal in relation to time, the respective species might at the peripheries of their ranges shew a low frequency, i.e. the species might be quite local in its occurence ; but the abundance should be similar to that which the species exhibits in the east of England. A striking exception to this generalisation is the occurrence of several of these continental species in Dorset, exhibiting an abundance comparable to that in East Anglia. But the Dorset heaths where they occur probably also have a low rainfall and certainly exhibit a soil of extreme porosity and aridity.

(11) The Northern Continental Element

The species belonging to this element are characteristic of central Europe, but with a definite northern tendency. It is evident that their separation from the continental-northern element is somewhat arbitrary, as the two groups taken together show gradations from those in which the continental

Tussocks of Corynephorus canescens

Silene conica

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preference is the more marked to those in which the northern tendency predominates. But, though opinions may differ regarding certain species, this does not invalidate conclusions regarding the elements as a whole.

The first and most prominent feature of this group is the very high proportion of aquatics or species of damp habitats. Out of the total of thirty species these number no less than twenty-one. Further, of these wet habitat species, only five are absent from Ireland, whereas five of the nine species of other habitats are absent, and two more of these are only found in a single Irish county. The damp habitat species similarly preponderate in Scotland, and of the species present in the different countries the average percentage frequency is 42.9% for England, 42.8% for Ireland and nearly 63% for Scotland. In other words, members of this group, when they extend beyond England, tend to occur with slightly lower frequency in Ireland, but even more frequently in Scotland.

TABLE XIV. Table Northern Continental Species of East Anglia.

Species	Percentage frequencies for Eng.	Ireland.	Scot.	Habitat.	Watsonian Type.
gelica sylvestris	100%	100%	100%	Damp woods	British
ragalus danicus (Map 75) ...	38%	2.5%	53.7%	Downs and Dune	Ger.
amagrostis stricta	4.2%	10%	9.8%	Bogs	
mpanula patula (Map 94) ...	42%	absent	absent	Copses	English
rex canescens	73%	2.5%	90%	Bogs	British
rex disticha	86%	100%	68%	Marshes	English
rex elongata	29.6%	2.5%	absent	Damp places	English
rex ericetorum	4%	absent	absent	Heaths	Ger.
rex filiformis	39.4%	57.5%	58.5%	Marshes	British
rex limosa	19.7%	62.5%	70.8%	Bogs	Scottish
rex paradoxa	14%	5%	2.4%	Marshes	English
rysosplenium alternifolium ...	74.6%	absent	56%	Wet places	British
uta virosa	36.6%	40%	46.3%	Wet places	British
tillaria meleagris	36.6%	absent	absent	Wet meadows	
tiana amarella	93%	80%	56%	Downs and Dune	British
tiana Pneumonanthe ...	45%	absent	absent	Wet heaths	English
minium monorchis	32%	absent	absent	Downs	Ger.
bericum hirsutum	87%	10%	63%	Chalky woods	British
pericum quadrangulum ...	98.6%	85%	83%	Damp places	Eng.-Br.
stræa uliginosa (Map 81) ...	11.3%	absent	absent		
nosella aquatica	62%	5%	12%	Aquatic	Ger.-Eng
lorella lacustris	80%	90%	92%	Aquatic	British
laxis paludosa (Map 77) ...	41%	30%	56%	Bogs	British
lampyrum cristatum ...	15.5%	absent	absent	Calcareous woods	Ger.
rola rotundifolia	28%	2.5%	39%	Woods	Scot-Ger.
es nigrum	86%	absent	61%	Wet woods	Interm.

Species	Percentage frequencies for Eng.	Ireland.	Scot.	Habitat.	Watsonian Ty
Sedum rupestre	19.7%	30%	absent	Dry places	Engli
Utricularia intermedia (Map 83)	15.5%	60%	70%	Aquatic	Britis
Utricularia minor (Map 82) ...	66%	97.5%	80%	Aquatic	Britis
Utricularia ochroleuca	8.5%	5%	57%	Aquatic	Britis
Average frequencies ...	Av. 42.9%	42.8%	62.6%		
Total species	30	21	21		

Since the species common to the three countries mostly occur in wet habitats, their tolerance for the moist climatic conditions of the west and north is scarcely surprising. A high summer temperature is apparently essential for the fruiting of *Utricularia*, and it is possible that this applies also to other members of this group.

The drier habitat species have very varying ranges. That of *Melampyrum cristatum* is of the same restricted type as those of more strictly continental species. *Campanula patula* has a wide range in England (Map 94), whereas *Limosella aquatica*, (Map 81), *Cicuta virosa* and *Carex limosa*, in the order named, have an increasing range in Scotland.

It is of interest to compare the distributions of continental species with those of northern-continental types occupying the same habitats. Thus, if we compare the distribution of the Continental *Liparis Loesilii* (Map 78 and Pl. VI) with that of *Malaxis paludosa* (Map 77), both orchids of similarly very wet bogs; or, to instance the other extreme, the Continental *Anemone Pulsatilla* with the northern-continental *Astragalus danicus*, (Map 75), we find a similar relation, despite the disparity of conditions, which again emphasizes the minor rôle played by the edaphic factors in determining the major features of geographical distribution.

Attention may be called to the fact that several of these northern-continental species are shy fruiting plants, except in favourable seasons; and a number of them have an effective alternative in vegetative reproduction. This is notably the case for the Utricularias, but vegetative spread is also a salient feature of *Astragalus danicus*, the various Carices, *Cicuta virosa*, *Hypericum quadrangulum*, *Limosella aquatica*, *Littorella lacustris*, *Sedum rupestre* and *Pyrola rotundifolia*. The erratic appearance of *Limosella* is apparently dependant

Map 84

Map 85

Map 86

Map 87

Maps 84, 85, 86 & 87

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upon the drying of the seeds present in the mud (c.f. Salisbury, 1921), whilst *Littorella lacustris* only flowers as the "land-form," reproducing entirely by runners when submerged (Arber, 1920 p. 232). The advantages of a continental climate with its hot dry periods is therefore obvious in the case of these particular species, but the vegetative propagation of the one and the prolonged dormancy of the seeds in the other (*Limosella*, although exhibiting a strawberry-like vegetative multiplication, is an annual) enable these species to have an extended northern and western range.

The importance of the temperature factor is also shown by the northern continental Utricularias. Dr. Robert Gurney has furnished evidence that the flowering of members of this genus is associated with high temperatures (and perhaps exceptional sunshine) in the early part of the year (R. Gurney *Utricularia* in Norfolk, Trans. Norfolk and Norwich Nat. Soc. Vol. XI., pp. 259-266, 1922) ; a conclusion which is strengthened by the observations of F. C. Gates on *Utricularia resupinata* in North America, who finds a correlation between the flowering of this species and high summer temperatures (F. C. Gates, Heat and the flowering of *U. resupinata*, Ecology Vol. X. p 353).

(f) The Western-Central Component

This is an ill-defined group of few species which have their main home in western and central Europe, and would appear to be favoured by climatic conditions of an intermediate character between continental and oceanic extremes. The ill-defined character of this element would scarcely justify its separation, were it not that species of this geographical provenence are not infrequently characterised by a markedly local distribution. In the East Anglian Flora the following species are perhaps appropriately placed in this category :—

Table XV. Species of W. Central Europe.

	English % Frequency.
Apium inundatum	98.6%
*Carum bulbocastanum (Map 87)	7%
*Cirsium tuberosum (Map 85)	5.6%
Drosera intermedia	59%
*Genista pilosa (Map 84)	9.8%
Hypericum humifusum	100%

	English % Frequency.
Hypericum pulchrum	98.6%
Malva moschata	100%
Ornithopus perpusillus	97%
*Primula elatior (Map 86) (Pl. IV)	11.2%
Scirpus fluitans	90%

All of the four species marked (*) are very local in their distribution, but, whereas *Primula elatior* (Pl. IV, Map 86) and *Carum bulbocastanum* (Map 87) are restricted to a few adjacent counties, *Cirsium tuberosum* and, still more *Genista pilosa*, exhibit a striking discontinuity of range in this country. Miller Christy has pointed out the close correlation in the distribution of the Oxlip and the area occupied by the chalky Boulder-clay (Christy 1922); and the apparently erratic character of many distributions may, in reality, be connected with very local changes in soil and climate, which only intensive study of the biology of the species and of the habitat conditions can elucidate. Drude (1912) has commented upon the occurence of west-central European types in Great Britain and emphasized the apparent capriciousness of the selection which are represented in the British Flora. Nevertheless, he concludes that all this makes very much more the impression of ordered distribution than of chance invasion. Some of the species cited above have, it will be noted, a wide distribution in England; but it should be emphasised that though Coste (Flore de France) gives these as species of western and central Europe, their inclusion here is less certain than that of the local species just cited.

(g) The Endemic Component

The relatively facile immigration into Britain, which the colonisation by continental types from the Glacial epoch to the present day attests, implies a similar facility for emigration to the Continent of new species or varieties which may have arisen in the past within the British Isles. The very small number of British endemics, either of specific or lower taxonomic rank, (probably less than twenty-five, inclusive of sub-species and varieties) may therefore be but a small proportion of those which have originated in Britain. On the other hand, this small number may not be the outcome of loss of endemic status, by emigration of new types produced in the more remote past,

but may be a true indication of the slow rate of origin of such, which the relatively short period that has elapsed since the Pleistocene has been inadequate to furnish in greater numbers.

If former British endemics existed to-day, which have now extended to the Continent, we should certainly expect to find them amongst the more extreme oceanic types presenting an appreciably lower frequency on the Continent than in Britain. *Oenanthe fluviatilis* fulfils these conditions in a striking degree. It has been recorded in thirty-two English counties and vice-counties (Map 89), whilst on the Continent it is very rare, being confined to west Jutland and a few locations in Germany(near Colmar, Metz and Illingen). This species may well be of British origin, but it is perhaps unique in its exemplification of these features. As already noted, the Oceanic component as a whole bears no indications of recent origin and is tending to diminish rather than to extend its range.

If then, as seems probable, the rate of production of new types be slow, it might seem reasonable to suppose that those elements which have been longest in occupation of this country would be the most prolific in endemic types. But such a probability is only capable of being tested if the new forms, produced by members of each element, exhibited a distribution in Britain of a corresponding character. But that such an assumption is far from being true is shewn by the interesting case of *Cirsium eriophorum*, of which three sub-species are recognised. The sub-species *vulgare* has a range extending from Holland and southern France to eastern Germany and Poland. Beyond the westward range of this sub-species we have the sub-species *britannicum* (Map 90), which is endemic to Britain and is found from East Anglia to Somerset, Pembroke and Durham ; whilst on the eastern limit of the sub-species *vulgare* the sub-species *decussatus* has a range through Poland and part of Continental Russia (c.f. Map page 871 Vol. VI, Hegi. Flora Von Mittel Europa). It is most probable that the wide-ranging sub-species *vulgare* has given rise both to the endemic western type on the one hand and, on the other, to the markedly continental sub-species *decussatus* ; but, whichever be the parental stock, the non-conformity of the climatic tolerance in these three allies, evinced by the absence of overlap in their ranges, shews that new types may have different

climatic demands from the stock from which they are derived. The majority of British endemics (about two thirds) are western in their distribution, whilst about a quarter are northern types. Only four have an eastern distribution, whilst one other of general distribution in England and one southern type also occur in East Anglia. The endemics found in East Anglia are as follows :—

TABLE XVI. Endemic British Types present in East Anglia.
Bromus interruptus Druce. South-Eastern (Map 88).
Cirsium eriophorum sub-sp. *Britannicus* Petrak. General (Map 90).
Euphrasia anglica Pugsley. Southern (Map 92).
Euphrasia Pseudo-Kerneri Pugsley. South-Eastern (Map 93).
Polygala Babingtonii Druce. Southern.
Ulmus sativa Mill (*U. Plottii*). Eastern (Map 91).

It is extremely improbable that any of these endemics represent plants of an erstwhile wider distribution that have become extinct, except in Britain. Therefore, it is noteworthy that these autochthonous types present the same categories of distribution as shewn by species which have immigrated from without. *Bromus interruptus* exhibits the diagonally south-eastern type (c.f. Map 88), with a northern limit extending diagonally from S.E. Yorkshire to Somerset ; and the distribution of *Euphrasia Pseudo-Kerneri* is of the same character (c.f. Map 93 and Pl. VI) (c.f. Pugsley 1930. *Ulmus sativa* Mill (*U. Plotii* Druce) (c.f. Moss 1912) have the distribution of a continental species (Map 91). The aquatic *Oenanthe fluviatilis* (Map 89), in common with some continental-southern types of wet habitats, has a distribution which, though mainly south-western, has a more or less horizontal (E. to W.) northern limit. *Euphrasia Anglica* is a southern type, whilst *Cirsium eriophorum* sub-sp. *britannicus* extends almost throughout England (Map 90) ; but its greater frequency on calcareous soils in the west than in the east is of interest in relation to what has been already noted as to its distributional relation to the sub-species *vulgare*.

Amongst the endemics not represented in East Anglia there are examples of the western type (e.g. *Aconitum anglicum* c.f. Stapf. in Bot. Mag. T. 9085, 1926) and of the northern

Map 88

Map 89

BRITISH
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HISTORY.

Map 90

Map 91

BRITISH
MUSEUM
2 FEB 33
NATURAL
HISTORY.

Map 92

Map 93

BRITISH
MUSEUM
2 FEB 33
NATURAL
HISTORY.

(e.g. *Cochlearia Scotica* and *Carex Sadleri*). The probability is, therefore, far greater that the distribution of these endemics is mainly determined by climatic factors than that these depend in any appreciable degree upon either their place of origin or their rate of dispersal.

(h) Recent Immigrants

The distributions of species which are known or suspected to have been introduced into Britain in modern times have many features of interest. Primarily, they afford evidence as to the rate of spread of species, and since they include representatives of various types of dispersal, they provide a means of estimating as to whether the rate of spread and the direction of migration show any marked correlation with the type of dispersal mechanism. Secondly, such recent introductions are of great importance as shewing whether the spread of species is more readily effected in one direction than another. Moreover, since for the more recent immigrants the location of their first introduction into Britain probably corresponds with the first recorded stations, it is possible to judge as to whether the centre of dispersal affects the type of distribution in Britain. In other words, whether the area at present occupied by a species, either recent or ancient, can be taken as any indication of the direction of its immigration.

In the following list the undoubted and probable alien species are listed in the order of the earliest available record. (In most cases taken from W. A. Clarke, First Records of British Flowering Plants, 1900). These dates, so far as the early nineteenth century and perhaps the latter part of the eighteenth century, probably correspond roughly to the date of first introduction. The earlier dates have only a very limited value as guides to the length of time which the species has been in the country. Nevertheless, considered as a whole, the order may be taken as a sufficiently close approximation to the sequence of their immigration or introduction into Britain. In the columns on the right of the table the number of comital and vice-comital divisions in which the species has been recorded is given. Here we may note that some of the annual species are very impermanent, and the numbers cited have only a general significence. Nevertheless, allowing for all such

possible sources of error, it is at once apparent that there is no definite correlation between the area occupied by individual species and the time of their occupancy of the country. It is true that *Aegopodium podagraria*, which has been in this country from the sixteenth century, is found throughout the British Isles but this is now probably also true for *Veronica Tournefortii* (*Buxbaumii*), which did not appear till 1825. A more valid comparison can, however, be made, since in the genera *Senecio* and *Impatiens* two species with quite comparable methods of dispersal have been introduced into this country at different dates. Actually *Senecio viscosus*, first recorded in 1660, has a more extended range than *S. squalidus* which is first recorded over a hundred and thirty years later; but both occur in Ireland, and actually the distribution of these species in Britain corresponds with their continental range, for whereas *Senecio viscosus* is perhaps native as far north as Belgium, *Senecio squalidus* is of Mediterranean origin. The two species of *Impatiens* (Maps 100 and 101) shew the reverse relation, since the more recently recorded species has the wider range. But here, too, the difference of range in Britain corresponds with the occurrence of these species in Europe and America respectively. *Impatiens parviflora* is a native of Siberia, whereas *Impatiens fulva* has its chief area from Nova Scotia and Oregon to Florida and Missouri, although extending along the western limit as far as Alaska. The two species of *Claytonia*, both quite recent introductions, occur in Britain in almost the same number of comital and vice-comital divisions; but *Claytonia alsinoides* also occurs in Ireland. Both are natives of Western North America, but *Claytonia alsinoides* has a more northerly range from Alaska to South California, as compared with *C. perfoliata* which extends from British Columbia to Mexico. It is therefore significant that *C. alsinoides* has a more northerly limit in Britain (viz. The Orkneys) than its congener (Elgin); and that, whereas *C. perfoliate* attains its greatest abundance on the Surrey heaths, *C. alsinoides* is most abundant in the north. It is clear from the distribution of these and other recent additions to our flora (c.f. *Matricaria suaveolens*, *Veronica Tournefortii*, Maps 102 and 106) that not only is the range in Britain apparently unconnected with the time of occupancy, but also that the area colonised shews little if any relation to the location of the first

introduction, as judged by the earliest record. On the contrary, as we have already seen, the range observed appears to be correlated with the native provenance, even in the case of species whose sojourn in Britain has been relatively short. A striking feature of these recent acquisitions, in which they exhibit a contrast to most of those long-established in this country, is the rather discontinuous character of their geographical distribution. This suggests that the spread of a species does not usually radiate gradually from a single centre, but that, either there is multiple introduction from abroad, or the spread from the original locality is commonly discontinuous, though from each centre thus established more or less continuous spread may ensue. It would therefore appear extremely unlikely that the area occupied by a species, or any group of species, can be taken as a criterion of the direction of their immigration.

TABLE XVII. Introduced species

ord.	Species.	Comital and Vice-comital occurrences in Britain.					
		1-20	21-40	41-60	61-80	81-100	101-112
	Oenothera biennis	–	–	50	–	–	–
	Mercurialis annua	–	–	53	–	–	–
	Aegopodium podagraria ...	–	–	–	–	–	112
	Erysimum cheiranthoides	–	–	–	73	–	–
	Camelina sativa	–	–	45	–	–	–
	Scrophularia vernalis (Map 96)	–	32		–	–	–
	Urtica pilulifera	–	25 (?Ex.)		–	–	–
	Linaria Cymbalaria ...	–	–	–	–	88	–
	Senecio viscosus (Map 97) ...	–	–	–	69	–	–
	Erigeron canadensis (Map 95)	–	–	40	–	–	–
	Antennaria margaritacea ...	–	21	–	–	–	–
	Malva pusilla	–	32	–	–	–	–
	Crepis taraxacifolia ...	–	–	–	64	–	–
	Oxalis corniculata	–	35	–	–	–	–
	Centranthus ruber	–	–	43	–	–	–
	Cynosurus echinatus ...	–	38	–	–	–	–
	Coronopus didymus ...	–	–	–	62	–	–
	Senecio squalidus (Map 98)	–	31	–	–	–	–
	Juncus tenuis	–	–	43	–	–	–
	Euphorbia Cyparissias ...	–	34	–	–	–	–
	Petasites fragrans	–	37	–	–	–	–
	Euphorbia virgata	–	26	–	–	–	–
	Lepidium Draba (Map 99)	–	33	–	–	–	–
	Impatiens fulva (Map 100)	–	22	–	–	–	–
	Veronica Tournefortii (Map 102)	–	–	–	–	–	100
	Mimulus guttatus (Map 103)	–	–	–	–	89	–
	Claytonia alsinoides (Map 104)	–	–	43	–	–	–
	Bromus arvensis	–	40	–	–	–	–
	Elodea canadensis	–	–	–	–	87	–

First Record.	Species.	Comital and Vice-comital occurrences in Brita					
		1-20	21-40	41-60	61-80	81-100	101
1849	Poterium polygamum ...	–	–	43	–	–	
1852	Melilotus indica ..., ...	–	–	46	–	–	
1852	Claytonia perfoliata (Map 105)	–	–	45	–	–	
1858	Impatiens parviflora (Map 101)	–	27	–	–	–	
1871	Matricaria suaveolens (Map 106)	–	–	–	77	–	
1872	Geranium versicolor ...	–	24	–	–	–	
1872	Sisymbrium pannonicum ...	–	–	–	–	96	
1883?	Azolla filiculoides	?9	–	–	–	–	
1887	Prunella laciniata	9	–	–	–	–	

The distribution maps of *Matricaria suaveolens* (Map 106) *Lepidium Draba* (Map 99). *Impatiens* spp. (Maps 100 and 101) *Mimulus guttatus* (Map 103) and *Scrophularia vernalis* (Map 96), which by means of differential shading shew in general the rate and manner of spread of these species in England, illustrate this discontinuity of extension in a striking degree. Moreover, they demonstrate that the types of distribution in Britain, even of species known to be recent immigrants, is no criterion of the direction of their spread, and disposes at once of any suggestion that the types of distribution of "native" species which we have already considered are in any significant degree determined by the length of time which has elapsed since they came into Britain.

Turning to the relation between the range of recent immigrants and the mechanism of dispersal it is noteworthy that the species whose rate of spread has been very rapid are very diverse in this respect. *Matricaria suaveolens* has fruits which are mainly dispersed in mud, upon the feet of cattle, boots, tyres, etc.; and it is very probable that the rapid extension in area of this species subsequent to 1900 was in no small measure due to the coincident increase in motor transport. The patterned tread of the motor tyre is a peculiarly efficient means of dispersal for mud containing seeds, which may be conveyed long distances before the shrinkage on drying results in its dislodgement from the depressions of the pattern.

Impatiens parviflora, another species which has spread rapidly, possesses explosive fruits like its congener, yet these two species have extended their range at very different rates (see Maps 100 and 101). The remarkable extention of *Elodea canadensis* within a few years of its introduction,

Map 94

Map 95

Maps 94 & 95

BRITISH
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NATURAL
HISTORY.


1788
1774
Scrophularia
vernalis
1769-'88
1800-1809
1831
1840-1860
1880-1890
Prob. After 1890

Map 96

BRITISH
MUSEUM
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NATURAL
HISTORY.

Map 98

Map 97

BRITISH
MUSEUM
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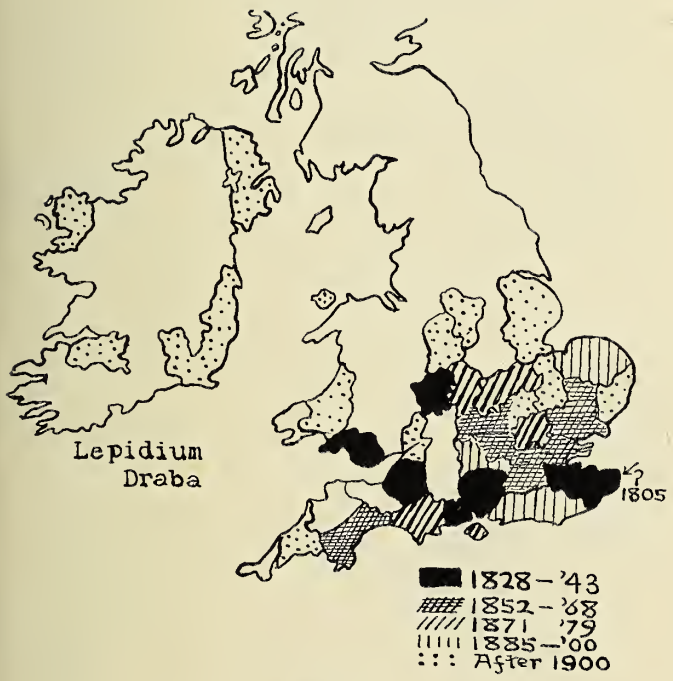
NATURAL
HISTORY.


Lepidium
Draba
1805
1828 – '43
1852 – '68
1871 '79
1885 – '00
After 1900

Map 99

BRITISH
MUSEUM
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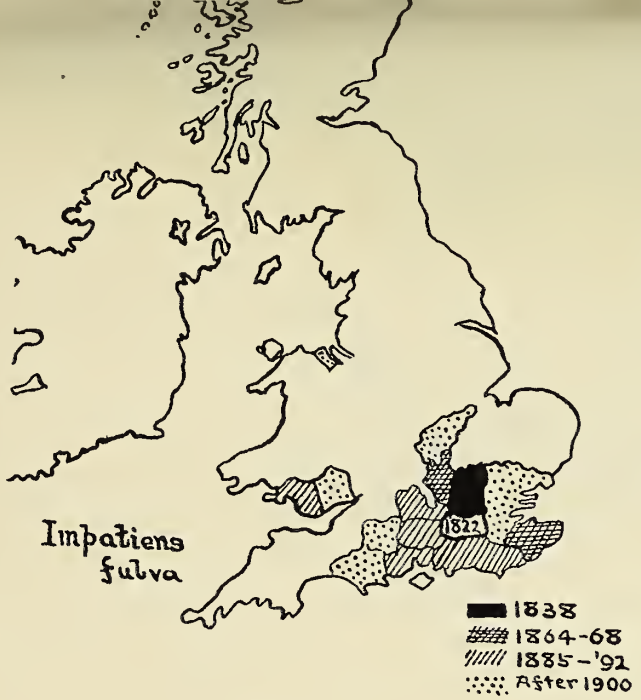
NATURAL
HISTORY.



Map 100

Map 101

BRITISH
MUSEUM
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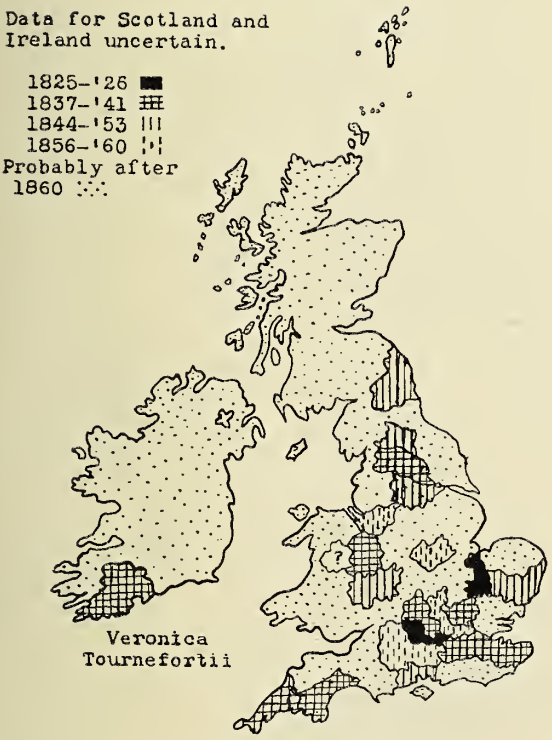
NATURAL
HISTORY.


Data for Scotland and
Ireland uncertain.
1825-'26
1837-'41
1844-'53
1856-'60
Probably after
1860
Veronica
Tournefortii

Map 102

BRITISH
MUSEUM
2 FEB 33
NATURAL
HISTORY.


Mimulus
guttatus
1830
1840–'59
1863–'67
1879–'87
1890–1900
Prob After 1900

Map 103

BRITISH
MUSEUM
2 FEB 33
NATURAL
HISTORY.

Map 105

Map 104

BRITISH
MUSEUM
2 FEB 33
NATURAL
HISTORY.


Matricaria
suaveolens
Before 1900
1900 — '09
1910 — '19
1920 — '24
After 1924
? Absent

Map 106

BRITISH
MUSEUM
2 FEB 33
NATURAL
HISTORY.

entirely by vegetative propagation, is too familiar to need more than recalling. On the other hand, the rate of spread of the two species of Groundsel (*Senecio viscosus*, Map 98 and *S. squalidus*, Map 97) and *Erigeron canadensis* (Map 95), which might, from the efficiency of their wind dispersal mechanisms, have been expected to have been rapid, has been in reality comparatively slow. In contrast with these compositæ the Speedwell, *Veronica Tournefortii* (*V. Buxbaumii*) does not appear to possess any special mechanism for dispersal, although ants may assist in the spread of its seeds; yet this species shewed a remarkably rapid spread after its first appearance in this country just over a century ago. The same is true of *Mimulus guttatus*, first recorded in Wiltshire in 1830 (Map 103).

Whilst, therefore, it cannot be said that the study of recent additions to our flora affords evidence that one method of dispersal is significantly more efficient than another, it does appear to warrant the conclusion that the diverse modes of dispersal of species are, in general, so efficient that only in the case of the most recent introductions is one justified in postulating vagaries of dispersal to explain peculiarities of distribution. In time, the opportunities for immigration and extension are probably manifold, though the opportunities for survival in competition may be few. The most recent additions to our flora thus confirm the conclusion that environmental conditions determine the presence or absence of species.

The species known to have immigrated into Britain, or to have been introduced in recent years, are but the last of a long line of immigrants extending back through the centuries to glacial and pre-glacial times, so that whether we call a species "native," "denizen" or "alien" is often a matter of degree, rather than of kind. Such distinctions may not only have little value, but also may even be very misleading. Whether the species occupies natural habitats and communities or can only survive under conditions that are artificially maintained, is of real importance, though native species, as we have seen, may be partial to artificial conditions; whereas recent introductions, such as *Elodea canadensis* and *Mimulus guttatus*, occur as constituents of quite natural communities. Nevertheless, though such a criterion of indigenous origin is invalid, the fact that very few recent additions to our flora can survive in

the more advanced phases of plant succession (the introduced continental strain of *Pinus sylvestris* so rapidly colonising the sandy heaths of Devon and Surrey is a notable exception) suggests that such continental species of these later succession phases as do not occur, are absent rather because the conditions of the environment are unsuitable than because the opportunity for their introduction has been lacking. It is true that additions to the comital records of our "native" species are constantly being made, but there is reason to believe that these are, usually at least, due to inadequate knowledge in the past, rather than to recent extensions of range. Most such records indeed concern critical species and segregates, the distinction and distribution of which has only recently been studied. On the other hand, such additional records of Benthamian species as have accrued, apart from their occurence as casuals, have not significantly modified our concepts of their British range.

(i) Species of General Distribution

The species of general distribution in Europe present in the East Anglian Flora are too numerous to cite individually. Most have a similarly wide distribution in Britain and, though of interest from the point of view of their marked plasticity and wide climatic tolerance, they have little significance for our present purpose of comparative study of geographical distribution. Attention should, however, be called to one very noteworthy exception to the above generalisation viz., *Naias marina*, which has its only known British localities in three of the Norfolk Broads, where it was first found in 1883. Whether this represents a recent introduction or was previously overlooked cannot be ascertained, though the former is quite probable in view of the very wide range of this species abroad.

SUMMARY

The East Anglian Flora has, in the foregoing pages, been considered from the comparative geographical standpoint of the constituent species which are here classified into Eight Components, of which four are further subdivided into eleven elements (P. 204). These groups are based on the main area of occupation by the constituent species on the Continent of Europe.

The value of experimental introductions is stressed as the only means of definitely ascertaining whether the absence of species is due to unsuitability of the environment. The need is emphasised for more data as to the type and phase of succession of the communities in which rare species are found. The status of species mainly associated with artificial habitats is discussed and the view advanced that many of these may be truly native to early phases of the plant succession. The importance of the waning phases of the Pleistocene epoch for species of this type is indicated.

The mode of occurence of species at the limit of their range is held to depend mainly on the competition factor, and that in general the later the stage of succession to which a species belongs the more abundant does the species tend to be towards its climatic limit.

The recent geological history in East Anglia is briefly considered and the conclusion drawn that it is highly improbable that any considerable proportion of the Flora survived from Preglacial or Interglacial times. Such few as may have survived were almost certainly hardy northern types. It is suggested that the widerspread character of many of these hardy species may be due to (1) their survival in the unglaciated parts of England, and (2) their priority of immigration into the unoccupied ground exposed with the retreat of the Ice-sheet.

The importance of the Post-glacial climatic fluctuations for facilitating the immigration of the various geographical components is emphasised. The survival of the more specialised types, under a less favourable climatic complex, has been rendered possible by local and peculiar edaphic conditions.

Lists are furnished comprising species of all the more important elements, and the distribution of characteristic members is illustrated by means of maps. The comparative analysis of the various elements clearly demonstrates *the dominance of the climatic factor in determining the distribution of species within Britain*. The importance of edaphic conditions and, less markedly, of topography and the biotic factor in modifying the climatic complex is shewn especially where these accentuate the meteorological tendencies.

The following generalisations appear to be justified from the data furnished :—

(1) That the type of distribution in Britain can usually be correlated with the climatic preference (or tolerence) as indicated by the Continental distribution of the species.

(2) The northern limits of southern species in Britain and the southern limits of northern species can be grouped naturally into three categories according as the limit is diagonally S.W.—N.E.; Diagonally N.W.—S.E. or approximately E.—W. The direction of these limits is shewn to be generally symptomatic of the climatic tolerance, or preference, of the species for Continental or Oceanic climatic conditions.

(3) The evidence is in favour of the present distribution of most species being due to the suitability of the climatic-edaphic complex, and not to any influence of the time factor on dispersal.

(4) The Watsonian groups, from their purely insular basis, are liable to obscure the true geographical distribution affinities.

(5) The absence of a species from, or its presence in, Ireland corresponds in general with the intolerance, or tolerance, of Oceanic conditions; and it therefore would seem that the absence of species from Ireland is not in general to be attributed to accidents of dispersal. This is clearly indicated by the fact that, whereas of the Oceanic and Southern Oceanic elements, together representing over seventy species, over eighty per cent. extend into Ireland, only fifty-eight per cent. of the continental species extend into Ireland; whilst of the markedly continental Steppe element the proportion reaching Ireland is only 12 per cent.

Of the land and fresh-water mollusca, for which the facilities for dispersal are probably less than for seed plants, 80 per cent. occur in Ireland and of these most shew approximately the same extension in England on the east as on the west; only about 11 per cent. of these Irish species shew any appreciably diagonal northern limit in the S.W.-N.E. direction and about an equal number shew a diagonal limit in the S.E.-N.W. direction. On the other hand the former type of limit preponderates in those species which are confined to England. Probably the nearest approach to the type of distribution shewn by plants with their limit in E. Anglia is that of *Theba cartusiana* which extends from East Anglia to Hampshire and is perhaps the nearest approach to a steppe species amongst our British land mollusca.

(6) The distribution of many continental and southern species is shewn to exhibit a marked similarity to the distribu-

tion of the number of hours of sunshine. Evidence is afforded that certain continental species fail to produce any appreciable proportion of fertile seed in a season deficient in sunshine, and it is suggested that this may be an important factor in determining the geographical limits of southern and continental types.

(7) East Anglia is shewn to possess two strikingly contrasted climatic areas, in which the marked difference in precipitation is accentuated by differences of the soil and topography. Hence the striking juxtaposition within East Anglia of both continental and oceanic types, which renders the flora so rich, is no indication of indifference to climatic factors in the species concerned. On the contrary, their distribution within the county of Norfolk alone emphasizes the importance of climatic distinctions and the part played by soil conditions in ameliorating or accentuating them.

For purposes of comparison within the British Isles the concept of "Comital frequency" has been found useful. This is the number of counties and vice-counties in which a given species has been recorded expressed as a percentage of the total number. Owing to the latitudinal equivalence of England and Ireland comparisons of comital frequency between them are especially significant.

(8) It is shewn that, though calcareous soils are chiefly encountered in the South-eastern parts of England, even markedly calcicolous species may have a wide distribution in Britain, if tolerant of oceanic conditions. Amongst the species associated with each of the marked soil types, there are representatives of all the distribution types, so that it is unlikely that the latter are appreciably affected by the former.

(9) The evidence afforded by species of known or presumedly recent immigration into Britain gives no support to the view that the type of distribution is influenced by the length of their occupancy of this country, except in some though not all of the most recent arrivals.

(10) The recent immigrants support the view that the extension of a species to its climatic limits is commonly discontinuous, though local continuous extension occurs from the centers thus originating. It follows that the type of

distribution is no indication either of the time of occupation or of the direction of dispersal.

(11) On the assumption that the earliest record for Britain represents the approximate location of the first introduction of recent immigrants, there appears no ground for regarding dispersal as taking place more readily in one direction than another.

(12) The Northern Component (p. 206), which comprises some two dozen species, would appear in general to be a diminishing one, and evidence is offered that low humidity is an important factor in their restriction. Although probably comprising the most ancient members of our Flora, the arctic element consists of some of the most restricted species.

(13) The Southern Component comprises about one hundred species, of which about fifteen per cent. are Mediterranean, eighteen per cent. southern in the less restricted sense, and sixty-seven per cent. continental southern types. Sixty per cent. of the Continental-Southern Element exhibit a diagonal limit in the S.W.—N.E. direction, indicative of their comparative intolerance for oceanic conditions. Many have a distribution south of the line from the Bristol Channel to the Wash. Comparison between different calcicoles indicates that soil types play little, if any, part in determining this distribution, except in so far as well-drained soils render possible their northward extension.

(14) A parallel is shewn to obtain between the northward extension of range and the western extension. Comparison between pairs of species having comparable modes of dispersal indicates that the causes are environmental rather than temporal.

(15) The Oceanic Component comprises seventy-four species, of which about fifty-eight per cent. are species of Western Europe and forty-two per cent. species of the Southern-Oceanic Element. The majority of these exhibit a diagonal limit passing in a S.E.—N.W. direction thus offering a marked contrast to the Continental-Southern Element. It is suggested that the restriction of certain species to arid habitats in oceanic conditions is determined by the competition factor.

(16) The Continental component comprises twenty-five Steppe species, forty-four central European species and thirty

Northern-Continental species. Only two of the first named occur in Ireland, where they are rare. The view that these Steppe species are in part a survival from the preglacial flora of the ancient Rhine distributary is held to be untenable; their occurrence is associated with a combination of low rainfall and favourable edaphic conditions. The Northern-Continental species include a number of wet habitat types which mostly extend into both Scotland and Ireland.

(17) The West-Central European Element comprises few species; but some of these are local and exhibit marked discontinuity, indicative of peculiar requirements which the compromise between Continental and Oceanic conditions suggests.

(18) The endemic Component comprises six species, and it is suggested that *Oenanthe fluviatilis* may formerly have belonged to this category. These endemics include types of distribution similar to those representative of the diverse elements, so that their distribution is unlikely to be connected with their presumedly recent origin.

(19) The study of the diverse elements confirms the view that the distribution of species in Britain is determined by environmental factors, and thus constitutes a useful clue to specific requirements.

In conclusion the author would like to express his indebtedness to the Society for having made possible the reproduction of distribution maps of so large a proportion of the more interesting species of the British Flora, which it is hoped will prove valuable to students of geographical distribution generally. Also to Dr. S. H. Long for valuable assistance in seeing the manuscript through the press.

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II

WILD BIRD PROTECTION IN NORFOLK IN 1932

Report of the Committee

Once again the Committee has to express its appreciation of the support it continues to receive for its work of Bird Protection in Norfolk, and thanks all subscribers for continuing their subscriptions in a specially difficult year.

The Norfolk Terneries

For many years Terns have nested in varying numbers on different sites on the Norfolk coast line, and since these have been placed under the care of watchers their numbers have very largely increased. At the present time there are three principal terneries :—on Scolt Head Island, Blakeney Point and Salthouse Broad. These three areas offer alternative sites, and there appears to be no obvious reason which will be selected when the birds arrive. All are very exposed, but the eggs of Terns and of other shore nesting birds, such as the Oyster-catcher, would seem to be very resistant to changes of temperature. Success in rearing the chicks is dependent upon an adequate and easily-obtainable food supply which, in the case of the Common tern, is " whitebait " (young herrings, etc). The inshoring of these small fry usually takes place about the time the young are born—towards the end of June—but this year it did not do so until about a week after the first clutches of eggs were hatched. This necessitated both parents flying far out to sea to get food ; the weather was very cold at the time and in scores of instances they returned to dead chicks—dead from exposure and starvation. On June 19th, for example, Chestney, the Scolt Head watcher, went round the ternery and picked up scores of dead newly-hatched birds. A similar experience is recorded from Blakeney Point. Many of the birds laid second clutches, but a big tide on July 6th washed out a number of these on Scolt Head, and a sand storm covered many eggs.

During the past two years a small island on Salthouse Broad has been the site chosen by the Sandwich terns, and here there were about 600 nests this year, all so close together that it was impossible to walk between them. The eggs hatched out well and there was no undue mortality amongst the chicks. Several hundred of the latter were ringed. A few Black-headed gulls also nested on the island. On Blakeney Point there were twenty-eight Sandwich terns' nests containing thirty-eight eggs and on Scolt Head 204 nests.

The largest colony of Common terns in Norfolk is still at Blakeney Point where, on June 8th, Mr. Marples and the watcher made a careful census and counted 1459 nests containing 3797 eggs. There were five nests with four eggs in each, and 974 with three eggs. The tendency of the birds is to extend their nidification area from the Far Point and the nests are now distributed in the lows, dunes and shingle ridges as far east as the Beachway. On Scolt Head Island the Common Terns nest over a wide area, so that it is impossible to make an accurate census, but from 500 to 600 nests would be a conservative estimate for the past year.

Nests of the Little Tern are found dotted about in many places along the Norfolk coast line, but they are in greatest number on Scolt Head, where 122 nests were counted this year ; and on Blakeney Point, where there were twenty-one nests.

A Roseate tern was identified on the Scolt Head ternery on May 26th and was seen, on and off, until June 30th ; but a second bird never arrived, and there is no evidence of the Roseate having nested in Norfolk in 1932.

Gulls are, perhaps, the most formidable enemies of the terns during the breeding season, and repeated attempts of the Black-headed gull to obtain a nesting footing on the terneries have to be frustrated. A small colony nest on the marsh about two miles to the east of the ternery on Scolt Head, out of range, and are allowed to remain ; but this year all the nests, and second and third layings, were washed out by high tides. On the other hand, a considerable number of the larger gulls—immature Black-backed and Herring gulls—hang about the sands near the ternery all the summer and make periodic raids upon the eggs and chicks. It is difficult to control these robbers.

Cley and Salthouse

The following notes on the rarer birds seen on or near Salthouse Broad between January 1st and September 17th, 1932, are supplied by Mr. R. M. Garnett, of Kelling.

Ruff.—A ruff (or reeve) was feeding among Redshanks during a spell of squally wintry showers and frost on February 11th, an unusually early date; another was seen on May 31st; a little party of three on August 2nd and a pair together on September 7th.

Long-Tailed Duck.—Three, probably young males, on February 15th, and a young male on March 5th. Conditions cold.

Goosander.—An adult drake on February 15th. It had been seen on the previous day by A. L. Hodgkin, who told me of its presence. Wind north for several days previously.

Goldeneye.—Six, one an adult male, on March 13th. Cold, with snow. Five days later the male was seen displaying, with a cold north wind blowing.

Black-Tailed Godwit.—Two, not yet in summer dress, on May 16th, and another on August 13th and 27th.

Spoonbill.—An adult was seen by E. Cohen and myself on May 18th. This bird remained in the vicinity for about a fortnight, being last seen on May 30th. Dr. Ennion reported to me that a second bird joined it on May 26th. On July 7th another arrived, and departed on the 10th.

Black Tern.—One, on a very cold day with N.-E. wind, on May 24th. An immature bird, with a white patch completely surrounding the base of the bill, was seen by Miss M. Barclay, myself and others on June 16th; the wind had been N.-E. for several days. Two others during the first half of September.

Gadwall.—One was seen on August 3rd, an unusual duck on this broad. On August 15th one was shot.

Spotted Redshank.—Two, in autumn plumage, seen in August, and one on September 7th.

Greenshank.—One seen on July 9th; an early arrival.

Bluethroat.—A female, somewhat decomposed, was picked up by Holman, the keeper, on Salthouse beach on May 31st. It was shown to me.

Hoopoe.—On June 5th one was found by Holman resting on "Little Eye," and was seen, later, by Mr. John Armitage and myself. This is the first June record for Norfolk.

Quail.—On June 12th I heard a male calling in a strip of oats opposite Salthouse Broad. I have no evidence of nesting.

On the night of August 20-21 a migration of small passerines was held up by a sea fret, and on the 21st there were seen on "Little Eye" Pied flycatcher, Whinchat, Common Redstart, Blue-headed wagtail; and among other passerines were counted twenty-two Wheatears. On August 23rd a dun-coloured swallow was seen at close quarters.

To these records may be added a Great Grey Shrike seen at close quarters on Blakeney Point by Mr. A. Holte Macpherson and Dr. Carmichael Low on September 16th, and two Lapland Buntings seen by the same observers on Salthouse beach on September 18th.

Broadland

The following notes from the Horsey-Hickling district have been supplied by Major Anthony Buxton, of Horsey Hall, and to these he has added some notes supplied by Mr. Jim Vincent, of Hickling.

I have had so many dealings with birds this summer, that it is a little difficult to know what to include in these notes and what to omit. As a newcomer to the district, I will start with one or two general impressions.

The following birds, which were once threatened with extinction, seem to have got a good hold as breeders, at any rate in the Hickling-Horsey area: Bittern, Montagu's Harrier, Bearded-Tit, Garganey. The Marsh-Harrier is just reaching, but has not quite reached, the same position. In my opinion we shall not have long to wait before we get back the Black-tailed Godwit, Avocet, Ruff and Black Tern. A fair number of these birds pass through in the spring, on their way to Denmark, Holland, or other parts of the Continent, and rest sometimes for several days on the broads. In any year, by some lucky chance, a pair or two may stop and thus form the nucleus of a nesting colony. One of the puzzles of the broads is the absence of Tufted Duck, Gadwall and Pochard as breeders. Why is it that they prefer West Norfolk to East Norfolk in the summer, whereas Tufted Duck and, still more so, Pochard, swarm in certain places on the broads in winter?

There is naturally a difference of opinion with regard to Harriers and other birds of prey. As long as the present worship of pheasants and partridges (and to a less, but increasing, extent of ducks) continues in England, and the gamekeeper is allowed a free hand, human sportsmen will ensure that most of their winged competitors come to a speedy end. From what I have seen this year there is an equal antagonism between the birds of prey themselves. A cock Montagu's Harrier or a cock Marsh-Harrier has fairly to sharpen his claws and keep himself in good flying trim, if he is to succeed in securing a breeding territory, and a wife wherewith to rear a brood. Apart from rivals of his own kind and his near relations, there are the egg-clutchers, the sentimentalists who are all over the song birds, and in honesty I must admit the photographers.

There were, to my knowledge, four egg-clutchers on my property at different times this summer, and no doubt others that passed unsuspected. One pair was caught just in time, and as the nest was a Marsh-Harrier's, I dared not risk letting them get far enough to provide evidence for prosecution. Another was accosted and apparently frightened out of the district; eyes were on his boat from 5 a.m. till he left at midday. A third, judging by tracks, hunted hard for a Bittern and probably took its first eggs, but it later had a brood. A sentimentalist endangered, but did no harm to a Montagu's Harrier's nest. A photographer—myself—caused the desertion of a Marsh-Harrier; in part I blame the bird, and so I believe does her husband, but I have little doubt that the lady blames me. The whole of that peculiar story, together with the story of the second nest, which we saved from the egg-clutchers and eventually filmed, has been told in "Country Life." A good deal has been written about bird photographers this summer, some of it by people of very limited experience, but it is a fact that photographers need keeping in order. In my opinion they can learn more than anyone else about birds, if they behave themselves, and—more important—can pass on their knowledge to a wide circle of the public, thereby creating an increased interest in the subject.

To go into detail of individual species:—

Warblers.—I did not realise until I came to the broads

that there were quite so many Sedge-Warblers in the world ; they literally swarmed this summer. There were also great numbers of Reed-Warblers in certain places, but they were not distributed over nearly such a wide area as the Sedge-Warblers. Why there are no Great Reed-Warblers in England is a puzzle to me. Grasshopper-Warblers, while common, were not quite as numerous as I expected. Every harrier's nest seems to have at least one pair of these birds in close attendance.

My garden looks ideal for the Blackcap, and the following record seems to me peculiar. A single cock arrived on April 25th, but stayed only a day or so. There was no other Blackcap until June 3rd, when, again, a cock appeared. A second arrived a few days later, seized the other end of the garden and eventually secured a wife, the other cock remaining a bachelor and singing his heart out all the summer, as bachelor warblers always do. Being so late in arriving, I imagine that these birds were individuals driven away by rivals from a good blackcap district, which the broads evidently are not.

At Horsey there were a few pairs of Garden-Warblers, considerably more Lesser Whitethroats, and a large number of Common Whitethroats. A cock Wood-Wren stayed three days in my garden and then passed on. Very few Chiff-chaffs passed and none stayed (one was heard going south on September 18th), but there were, of course, plenty of Willow-Wrens. No Goldcrests in the summer, but nearly always one or two in the winter, the first arriving this autumn on September 11th. Blue-tits lived all round the broads throughout the winter, as well as in the gardens, etc. The stock of Great Tits was much larger in the winter than in the summer. One pair of Marsh-Tits nested at Horsey, and a few Coal-Tits appeared occasionally in the garden in winter. There have been great numbers of Long-tailed Tits this Autumn, but not a single pair nested on the property.

There were about ten pairs of Bearded-Tits breeding at Horsey, and about twenty-four pairs at Hickling. In the spring they seem to feed entirely upon a fly and its grub which live on the lesser Reedmace.

WAGTAILS.—Yellow-Wagtails, arriving April 17th and following days, were local and not so common as the country seems to warrant. Possibly they need more cattle than at present exist to attract insects.

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CHATS.—Stonechats bred wherever there was a suitable spot, but the rarity of Whinchats was noticeable. Numerous Wheatears passed in spring and autumn, but it is doubtful if any bred on the property.

SHRIKES.—There were several pairs of Red-backed Shrikes breeding in what might be described as isolated colonies.

BUNTINGS.—Corn-Buntings were common, too common for my tastes, in certain places. I understand that the Hen-Harriers prey on them; if so, I wish them the best of sport, for no uglier bird and no uglier note is known to me. Two pairs nested close to a Montagu's Harrier's nest. Reed-Buntings were very nearly, but not quite, so numerous as Sedge-Warblers. The young appear to be much enjoyed by Marsh-Harriers, and are no doubt very easy to catch. A Snow-Bunting was seen on September 13th.

WATER-RAILS.—Water-Rails are very common, but there are said to be less than formerly. I have never been in a country where there were more.

PIPITS.—Mr. J. Vincent saw a Water-Pipit on April 8th.

BITTERN.—On one occasion seven male Bitterns were heard booming simultaneously from Horsey Staithe, and seven between Catfield and Blackfleet broads. Bitterns were heard booming as late as August 2nd. There were certainly four broods on the Horsey property. One of the nests contained six eggs; five were hatched naturally, and I personally hatched the sixth, but neither its mother nor any of the rest of the family took any interest in the infant either before or after it was hatched; it squealed loudly both before and after hatching. Four young were reared from these six eggs. I believe that all the first nests of bitterns at Horsey were destroyed by high water.

Bitterns appear to be the worst of mothers, casual and neglectful to a degree, relying on the first-hatched chicks to keep the later ones warm, which they are quite incapable of doing. Some of the cocks boom fairly near the nests, but in one case no cock was heard to boom within 400 yards of the nest. Booming, therefore, seems to be an unreliable guide as to the situation of the nest. Booming deteriorates into a few feeble grunts after the young are hatched.

A good deal has recently been published about the "powder-

puffing of the Bittern," and it is indeed strange that no one in Norfolk had apparently seen it before this year.

Despite their intense stupidity Bitterns are quite amusing to look at, particularly while feeding their babies ; first with clear soup sucked from the base of their bills, and then with eel or other fish out of their crops. One bird, with five young, disgorged eight eels simultaneously, handed round one to each baby and then re-swallowed the remaining three for a future occasion. I saw and filmed one baby being taught to fish for a dead roach out of the water round the nest. The best part of the performance, however, is the departure of the parent bird from the nest by means of a slow climb up to the top of the reeds, whence it takes its flight. Nobody looking at a bittern would expect it to be a mountaineer, and nobody looking at the reeds would expect them to bear the weight of a bittern. To what extent a cock bittern assists in the rearing of a family is doubtful, but in one case at least he visited the nest in my presence, and in another he came very close. He was not seen to provide any food nor anything else of value.

GREBES.—There were four pairs of Great Crested Grebes nesting on Horsey mere this year. The nest that was kept under observation had three eggs, all of which hatched ; but after getting two young safely off, the parents were not in favour of having any more and left the third egg to hatch in the sun, never taking any further interest in it. Judging by the normal size of grebe families, this would seem to be a common practice. When hatched the young were taken for a turn on the mere on their father's back, and occasionally on their mother's. To the best of our belief the only food given to them during the first day of their existence consisted of feathers from the back of their father's neck, carefully selected and pulled out by that bird and handed to the babies, which nibbled them slowly up. The cock grebe seemed to be rightly regarded by the hen as being inefficient at everything, particularly nest-building, except the business of taking the babies for a row on the mere. This was clearly his job, and he did it very well, seeing that the babies kept themselves well tucked up in his feathers when the weather was cold by poking their foreheads down with his bill. These incidents are all recorded on the film. Grebes have apparently very good ears, and this

pair could quite obviously recognise the sound of my motor-boat from that of any other motor-boat on the mere.

DUCKS.—It was a bad spring for Garganey, but a good one for Teal and Shoveller. At Horsey there were from ten to fifteen pairs of Shovellers breeding, but only three pairs of Garganey. Large numbers of Shoveller appeared at Ranworth at the end of January, but they did not spread about the broads until considerably later. The first Garganey appeared at Ranworth on April 1st, and a pair of Gadwall were seen the same day. During the winter there were always a few Goldeneye and a certain number of Scaup with the large flocks of Pochards and Tufted Ducks on Horsey Mere. Two Common Scoters appeared on the mere in April and stayed a day or two; others were seen at the end of October. A small flock of Tufted ducks were seen up to the end of April, but none of them bred at Horsey, although a lone hen, probably a pricked bird, remained through the summer.

GEESE.—White-fronted geese were seen in the middle of September.

WADERS.—Redshanks and Green Plover nested on the marshes, also a good number of Snipe. I heard the first Greenshank on April 23rd, and others passing south on September 11th. Grey Plover were heard migrating at the end of April, and again in the middle of September. A Ruff was seen on March 22nd, and two Reeves, at both Hickling and Horsey, between August 2nd and September 12th. They were absolutely silent whenever I saw them. Amongst other waders seen were the Wood-Sandpiper, Little Stint, Turnstone, Spotted Redshank and Red-necked Phalarope.

A Spoonbill was seen on May 17th at Hickling.

GULLS AND TERNS.—Black Terns were passing through from April 28th for about a week; they were hawking gracefully about over the mere, catching insects and were very tame. A small colony of Little Terns shared Horsey beach with the Ringed Plovers and did a lot of fishing on the mere, as well as in the sea.

Vast quantities of Greater Black-backed Gulls come to rest, wash, and brush up, on the mere every day during the herring fishing season, arriving soon after sunrise.

BIRDS OF PREY.—Birds of prey have always appealed to

me and there has been quite a good show. A pair of Hen-Harriers and a pair of Rough-legged Buzzards spent the winter and did not leave until the end of March. Common Buzzards were seen at intervals throughout the winter and early spring.

Peregrines seemed to appear and disappear with Mallard and Teal. Short-eared Owls were in considerable numbers in November, but only one pair is believed to have bred in the neighbourhood, and as they were not on my property I do not know how they fared.

There were at one moment five pairs of Marsh-Harriers on the Hickling-Horsey area, but one pair, after twice thinking of nesting just where sailing boats tie up for the night, apparently left the neighbourhood. They probably did not go very far, for the cock, who had very white patches on head and shoulder, was seen in September. This bird would have undoubtedly been killed by a cock Montagu, but for the timely arrival of his wife. He had ducked into the rushes to avoid the Montagu, which tilted up to about forty feet, shut his wings, and swooped on him like a Peregrine. The hen Marsh bustled up and got the Montagu off. We looked for the cock Marsh, but he must have been squatting, for he never got up. In any event he escaped, for I saw him next day.

The cock of the pair, whose nest was deserted, owing to the approach of my guide was a very pugnacious bird. We found the corpse of the first cock to arrive in the spring floating in a dyke under his preening post, no doubt slain by his rival, who apparently lost a wing feather in the process. I saw him on September 12th with the wing feather still missing. This pair must have nested again, for the cock was seen up to about July 20th carrying kills regularly into his particular marsh, but they subsequently disappeared and nothing is known as to what occurred, for we were then too busy on another pair. This other pair consisted of a cock about the colour of a Red Kite and a very dark hen with a yellow head. She was a fiend in temper, he was a very good sort.

After being saved from egg clutchers by us, the hen proved entirely lacking in gratitude and a most difficult creature to deal with. After six weeks' work and twice retiring the hide we got our first bit of filming when the young were about a fortnight old. Ten days later the hen, after every display of temper and sulks, struck work for good and literally

Photo] [*A. Buxton*

Cock Montagu's Harrier throwing prey to young in nest

(The prey is the black-and-white striped object which has hit the young bird on the left of the picture)

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passed us the babies, which the cock and we successfully reared between us. The story is recorded in "Country Life," and these notes must be confined to the cock's gamebook, which we have practically complete for ten days, thanks to his habit of making a larder thirty yards from the nest.

The main prey was young water-hens, but there were also a few young partridges, one or two pheasants, hares, rabbits, blackbirds, starlings, young reed-buntings, young sedge-warblers, water-rails, water-rats, short-tailed field-mice and one frog. All the family, except the old hen, were about up to September 20th and were killing land rats. We never saw her again after July 19th, and never wish to. These feelings are doubtless reciprocated. There were two nests of Marsh-Harriers at Hickling; one with three eggs, which were forsaken; the cock of the other nest disappeared about July 4th, and may have been shot.

I watched two nests of Montagu's Harriers in the neighbourhood, within fifty yards of each other.

During long observation of the best looking pair of Montagu's Harriers I ever saw, we came to the conclusion that the cock only visited the nest when his wife's hands were full, or when she was absent. In short, if he could find no one to pass to, he came on, not otherwise. The main prey was skylarks and meadow-pipits, but the cock had one good morning with my partridges and got two brace in quick succession, apparently just as they left their shells. Better than anything else, however, the Montagu's—both the young and their mother—liked sandwiches, ham, egg, cheese or sardine. The hen would be down to a sandwich on the nest directly she saw it. This nest contained five young, all of which got away safely. The hen who appeared to be a very old bird, carried a ring on her right foot, but we could not read it and did not like to catch her, as it might have spoiled the very friendly relations we had established. On several occasions she appeared either smoking a cigar or using a tooth-pick—either description would do. She held a bit of dead rush in her mouth, at the angle of an American's cigar, and kept rolling it round with her tongue. She was one of the nicest individual birds I have ever met, and a first-class mother.

We were once treated to a flying display by this pair of

Montagu's. The performance centred on the manœuvre of the "pass." Nothing was in their claws, but they swirled and swooped, often sideways and on their backs, at each other, screaming with excitement. This cock was the bird that nearly slew the cock Marsh-Harrier, and it was probably he who slew the rival cock found on June 9th and carrying a ring put on him at Hickling in June, 1930. The second nest of Montagu's Harriers belonged to what appeared to be a much younger pair of birds. They nested about a fortnight later than their neighbours and hatched all four eggs, but two of the young died in infancy. The other two were successfully reared. I am told that both Montagu's Harriers and Short-eared Owls feed mainly on short-tailed field-mice, and that when this rodent is plentiful in the spring, there is a good breeding stock of both of these birds. This year there would seem to have been a short supply of mice, Short-eared Owls and of Montagu's Harriers.

Breckland

The extensive afforestation that has already taken place, and is still being pursued, by the Forestry Commissioners in Breckland has for some years been a matter of concern to the Committee, from the point of view of the preservation of the Stone-Curlew, so that it is highly satisfactory to be able to report that during the year The Norfolk Naturalists Trust has negotiated an arrangement under which some 2,000 acres shall remain free from planting. The area referred to is Lakenheath Warren, one of the most typical bits of Breckland. In this report we reproduce photographs of two of the most characteristic birds of the district—the Stone Curlew and Wood-Lark—taken by Mr. Hugh G. Wagstaff during the past nesting season.

A Woodland Bird Sanctuary

At South Wootton, near King's Lynn, Mr. N. Tracy owns, and lives in, a small wood of about seven acres which he purchased eleven years ago with the object of making a sanctuary for birds. That he has succeeded is evident to all who have had the pleasure of visiting his wood in the nesting season. We extract the following from his notes of the past year :—

Photo] [*H. G. Wagstaff*

Wood-Lark running from nest, which is in the dark patch behind the bird

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He found the nests of the following thirty species of birds in his wood in 1932, as compared with twenty-one species in 1923.

Blackbird—many
Song-Thrush—many
Mistle-Thrush—several
Robin—three
Wren—several
Hedge-Sparrow—one
Starling—one
Great Spotted Woodpecker—one
Chaffinch—many
Redpoll—several
Willow-Wren—three
Redstart—three
Tree Creeper—four
Goldcrest—two
Long-tailed Tit—one
Great Tit—twelve
Blue Tit—six
Coal Tit—two
Marsh Tit—two
Wood-Pigeon—many
Stock-Dove—several
Turtle-Dove—one
Moor-Hen—one
Tawny Owl—one
Pheasant—several
Spotted Flycatcher—three
Greenfinch—one
House-Sparrow—one
Goldfinch—one
Cuckoo

The Long-tailed Tits started nesting on January 24th, and the female was seen carrying nesting material when there was an inch of snow on the ground. The young left the nest on May 9th.

Towards the end of April several pairs of Redstarts arrived in his wood, but only three pairs remained to nest. Some unknown robber took the eggs, and sometimes the nest lining, from all the boxes in which they were placed, even though the birds nested a second and a third time. Mr. Tracy came to the conclusion that the culprit was a female cuckoo, for cuckoos were numerous in the wood throughout June, and on June 27th he found a cuckoo's egg in one of the robbed nests. Mr. Tracy adds, " In the ten years that I have had the wood I have had between thirty and forty redstarts' nests and only two have come to grief through accident."

A pair of Great-Spotted Woodpeckers were turned out of their first nesting hole by starlings, even though Mr. Tracy shot ten of these intruders and hung them round the tree hole as a warning to others ! He came to the conclusion that the male woodpecker alone did all the boring. This pair of woodpeckers eventually reared a brood in another hole, and it is interesting to note that Mr. Tracy found that the young were fed with flies which the parents extracted from oak apples. These were wedged in the clefts of branches so that they could be

pulled to pieces. The parent birds also split open the oak root galls for the grubs contained in them, and to get at these they went down to the ground and attacked them *in situ*.

Mr. Tracy had three pairs of Wood-wrens just over his boundary, and a pair of Wood-Larks outside his wood. He located only one Crossbill's nest, which was in building by the hen bird on January 17th. The young hatched off safely. He found the usual number of Siskins in his district, and on February 14th saw a large flock feeding on larch cones.

Miscellaneous Notes

The Chaffinch was first heard singing, in Norwich, on February 9th.

On March 4th eleven Waxwings were seen by Mr. G. J. Cooke in the grounds of the Norfolk and Norwich Hospital. This little colony remained in the gardens of Norwich for several weeks, and regularly paid visits to some hawthorn bushes in the grounds of the castle until they had stripped these of all berries. They were very tame. The last was seen by the writer on April 11th. There has been a further immigration of these birds this year. Mr. Victor Ames reports " many " in the lanes around Thornham on November 11th, and on the 30th Major S. W. Trafford showed one to the writer which had that day been picked up dead at Wroxham.

The Hawfinch is not a common bird in Norfolk, so that it is interesting to record that Mrs. Smith, of Ellingham Hall, found six young ones with three old birds on the lawn of the house on April 6th.

On April 15th, Mr. D. J. Thomas, of the London Nat. Hist. Soc. had a good view of a Golden Oriole on the roadside hedge between Morston and Stiffkey.

Black Terns, though regular passing migrants in spring and autumn, are not often seen to the number of eighteen over one small piece of water, as was witnessed by the writer at one of the West Norfolk meres on April 28th. On July 2nd a Black Tern visited Scolt Head Island and remained at the ternery all the day.

The Common Scoter (Black duck), except in the nesting season, is essentially a sea duck, and is infrequently seen on

inland waters, so that it is of interest to record that, on August 2nd, the writer found a male on one of the inland waters of Norfolk, in about the centre of the county.

On August 11th a flock of between twenty and thirty small birds flew in from the sea to Blakeney Point and settled on and around the watcher's house. One entered and was caught, but was released. They were described as being from three to four inches in length, with blood-red bills and blood-red spectacles. After resting, they all passed inland. So far, they have remained unidentified, but they were certainly foreign birds and had probably escaped from some ship taking them, perhaps to Hamburg, or other ports in Europe.

A small colony of Black-headed gulls—about fifty pairs—nested again on Alderfen Broad this year. When visiting the broad on May 26th the writer found that about half the nests had been robbed of their eggs—there were no broken egg-shells—and there were several half-eaten gulls lying about on the floating hovers on which the nests were built. It was concluded that this was the work of an otter. (Query, do otters eat eggs ?).

During the winter of 1931-32 there were several Common Buzzards in Holkham Park, and on March 6th he writes saw three of these birds soaring over a wood that they frequented. They appeared to live on rabbits and by the instructions of Lord Leicester were in no way molested. It was hoped that one or more pairs would remain to nest, but there is no evidence of their having done so. In another part of the county fifteen Buzzards are said to have been shot during that winter.

The past year has not been what is sometimes called an osprey year, so that it is worth recording that early in September, when duck shooting on Buckenham Broad, Mr. E. C. Keith saw one of these birds, and a bittern. He says, " it flew round the broad twice and was very little disturbed by the shooting." It had been there about ten days, and left a few days after the shoot.

An unusual number of Common Buzzards visited Norfolk last winter, and on March 6th the writer saw three of these birds in Holkham park, soaring over a wood which MacEwan, the keeper, said they frequented. On one day MacEwan had

seen ten of these birds. By instructions from Lord Leicester they were in no way molested, and it was hoped they would remain to nest, but the last two departed at the end of April. On one estate in the county it is reported that fifteen buzzards were killed last winter, but we have not heard whether these were " Common " or " Rough-legged."

Prosecution for Taking Sandwich Terns' Eggs at Salthouse

At the Holt Petty Sessions on August 5th, Henry James Knightley Burne, described as a solicitor's articled clerk, of The Nunnery, Diss, was summoned for taking eggs of the Sandwich Tern from a colony of nesting terns on Salthouse Broad. The defendant was represented by Mr. W. C. F. Brundell and pleaded guilty.

Robert Bishop, of Cley, the watcher of the Norfolk Naturalists Trust, gave evidence that he, with two others, saw the defendant walking over the marshes. He blew his whistle and waved to the defendant to turn back, but he did not do so and, instead, took off his boots and crossed a dyke to the island. He saw him stoop and put something into his pocket. On his return Bishop waited for him and said, " Have you got leave to go on there ? " Burne replied, " No." Bishop then asked, " Why did you not come back when I called to you and waved to you to come back ? " Burne answered, " I did not hear you." Bishop remarked, " You must have heard me." When asked for the eggs Burne said, " I have not got any." Bishop stated that he could see there were eggs in Burne's pocket and told him so, and defendant then pulled out six eggs of the Sandwich Tern. Mr. Hugh Thompson, of Thursley, Godalming, gave evidence corroborating Bishop's statements.

The Chairman (Lieut.-Col. F. Watson Kennedy) said that the magistrates looked upon this as a bad case for a man of defendant's position, especially as he had denied that he had taken the eggs. " We are determined to stop the taking of eggs," continued the Chairman, " Defendant will be fined £1 for each egg, £6 in all."

The Committee cannot conclude this report without expressing their thanks to the loyal watchers who so ably assist them

in carrying out their work. For the information of those to whom they are not known, they are :—

For Scolt Head Island.—Mr. Charles Chestney, Dial House, Brancaster Staithe, King's Lynn.

For Blakeney Point.—Mr. William Eales, Blakeney Point, Morston, Blakeney, Norfolk.

For the Cley Marshes.—Mr. Robert Bishop, Hill Top, Cley, Norfolk.

For Breydon Water.—Mr. W. Bulldeath, 35, North River Road, Great Yarmouth.

The first three are employed as whole-time watchers ; the last during the five summer months—April to August.

Signed (on behalf of the Norfolk W.B.P. Committee),

SYDNEY H. LONG, *Hon. Sec.*

LIST OF SUBSCRIPTIONS AND DONATIONS TO THE NORFOLK WILD BIRDS PROTECTION FUND FOR 1932

	£	s.	d.
H.M. THE KING	3	3	0
H.R.H. THE PRINCE OF WALES, K.G. ...	2	2	0
Adam Miss M. E. ...	1	1	0
Ainslie Mrs.		5	0
Allars R. W. E. ...	3	3	0
Allen J. W. ...	2	2	0
Allen T. H.	1	0	0
Anderson Edward ...		10	0
Attenborough, Col. J. C.M.G.	1	1	0
Back H. W.	1	0	0
Barclay F. H. ...	1	0	0
Barclay H. G. ...	2	2	0
Barclay Miss M. ...	1	0	0
Barlow J. Allen, C.B.	1	1	0
Barnard Mrs. ...	1	1	0
Barrow Miss		5	0
Barry W. J.	1	1	0
Barton S. J., M.D. ...	1	1	0
Beevor Sir Hugh, Bart.	1	0	0
Beevor Thomas ...		15	0
Benn Sir Ion Hamilton Bart., C.B., D.S.O.	1	1	0
Bewly Miss N. ...		5	0
Blackburn C. J. ...	2	0	0
Blake H.	2	2	0
Bland Miss R. ...		10	0
Blatch Edward ...	1	0	0
Boardman E. T. ...	1	0	0
Carried forward ..	£33	11	0

	£	s.	d.
Brought forward ...	33	11	
Boileau Sir Maurice, Bart.	1	1	0
Bourne T. W. ...	0	5	0
Brash T.	2	2	0
Briscoe Capt. F. M. Eliot-Drake		10	0
Brooks J. R.... ...	1	1	0
Brown E.	1	1	0
Brown H.	1	1	0
Bruce Mrs.		10	0
Buckle Lt.-Col. D. W.	1	1	0
Bullard Ernest ...	1	1	0
Bulwer Col. E. A. ...		10	6
Burrowes R. B. ...		10	0
Burrows Mrs. ...	2	0	0
Burton G. Murray ...	1	1	0
Butcher R. W. ...	1	1	0
Butler R. Fawsett ...		10	0
Butler Richard W. ...	1	1	0
Buxton W. L. ...	2	0	0
Buxton Major Anthony Proceeds of Lecture	6	16	8
Byers J.		10	0
Caffyn D. E. ...		10	0
Calder Sir James C., C.B.E.	1	1	0
Capron J. T.		10	0
Capron Miss J. ...		2	6
Carr Mrs. Laurence ...		10	0
Carried forward ...	£61	17	8

	£	s.	d.
Brought forward ...	61	17	8
Carruthers D. ...	1	1	0
Cassie R. L.		10	0
Cator John		11	0
Chadwick Dr. Morley	2	2	0
Chapman E. H., His Honour Judge ...	3	3	0
Churchill Mrs. Arnold		5	0
Clarke Mrs. Frank ...	2	2	0
Cleminson H. M. ...	1	0	0
"Cley"		2	6
Clogstoun H. P. S., M.B.E.	1	1	0
Clutton Brian ...	3	3	0
Coe Mrs. A. E. ...		10	0
Collar Arthur ...		5	0
Collier Dr. and Mrs. W. T.	1	0	0
Colman Miss E. M. ...	1	1	0
Colman Miss H. C. ...	1	1	0
Colman R. J. ...	1	1	0
Colomb Admiral P. H., C.B.	1	0	0
Cook Miss Margaret ...	1	1	0
Cooke G. J.		10	0
Cox Major General Sir Percy, G.C.M.G.		10	0
Cozens-Hardy A. ...	1	1	0
Cresswell Mrs. George	1	1	0
Dalgety Christopher T.	1	1	0
Dallas C. C.	1	0	0
Davis H. L. N. and P.	1	2	0
Deacon Dr. G. E. ...		10	0
De La Warr, Lady ...	1	1	0
Drury G. L.		10	6
Duncanson T. J. G. ...	3	3	0
Eccles James R. ...	1	1	0
Eddison C. R. ...	1	1	0
Edwards Francis ...		10	0
Edwards G. C. ...		5	0
Edwards Michael ...		5	0
Elphick Dr. G. ...	2	2	0
Ennion E. F. R. ...		10	6
Ennion Mrs.		10	6
Enock A. G.	1	1	0
Everitt W. G. ...	1	1	0
Ewing Miss J. Orr ...		5	0
Ferrier Miss Judith ...		10	0
Finch F. R.	1	1	0
Fisher H. H., F.R.C.S.		10	0
Fletcher Miss R. ...	1	1	0
Flowers John, K.C. ...	1	1	0
Forbes H.	1	1	0
Foster, Capt. T. H., R.N.		10	0
Fox F. Douglas ...	1	1	0
French Miss E. M. ...		12	6
Carried forward ...	£111	6	2

	£	s.	d.
Brought forward ...	111	6	2
Friedlein W. ...	1	1	0
"Friend"		5	0
Garnett R. M. ...		10	0
Garrod F. W.... ...		10	6
Gay Miss C. E. ...	1	1	0
Gay Miss Ellen ...		10	0
Gayner Dr. J. S. ...	1	1	0
Giles C. C. T. ...		10	0
Giles Rev. A. Linzee		10	6
Gilman Randon ...		10	6
Glegg W. E. ...	1	0	0
Goddard W. N. ...		10	0
Gowen H. P.... ...	1	1	0
Graves Mrs.	1	1	0
Green Major E. A. Lycett	1	0	0
Gresham School Nat. Hist. Soc.	1	1	0
Gurney G. H. ...	2	2	0
Gurney Q. E. ...	1	1	0
Gurney R., D.Sc. ...	2	2	0
Haig Mrs. Donald M.		5	0
Hamilton Miss M. E.		2	6
Hannaford G. ...	2	2	0
Harding J. Rudge (the late)		10	6
Hardy Mrs. H. F. H.		5	0
Harker W.	1	1	0
Harrison Mrs. M. ...		10	0
Hastings Thomas ...	1	1	0
Haydon W.		5	0
Heywood R.	1	1	0
Hill Nettleship ...		10	6
Hill T. A. M. ...	1	1	0
Holland C. B. ...	1	1	0
Homere Miss (In Memoriam, J. W. C.)	3	3	0
Hopwood Miss M. ...		5	0
Horsley Miss S. ...		10	0
Hudson Rev. J. Clare		5	0
Hulse Mrs. M. W. ...		10	0
Hulse Miss E. M. ...		10	0
Hyslop Brig.-Gen. H. G., D.S.O. ...	1	1	0
Hyslop Miss T. S. ...		10	0
Jago Cyril		10	0
Jenkins Rev. T. L. ...	1	0	0
Jones Commander B. E., R.N.		10	0
Jones Sir L., Bart. ...	1	1	0
Jones Lawrence E. ...	2	2	0
Ketton-Cremer W. C.	1	1	0
Keith E. C.	1	10	0
Kerr Mrs. H. M. Rait	1	1	0
Knight E.	1	0	0
Kolle H. W.	2	2	0
Carried forward ...	£157	0	2

	£	s.	d.
Brought forward ...	157	0	2
Lance Capt. H. W. ...	2	0	0
Lang Gordon L. ...	1	1	0
Lawson Harry ...	1	1	0
Lee-Elliott Rev. D. L.	1	1	0
Lees M. Mackenzie ...	1	1	0
Littlewood Miss ...		10	0
Lister S. R., M.D. ...		11	0
Lewis J. Spedan ...	2	2	0
Linkhorn James ...		5	0
Lloyd Capt. L. ...	1	0	0
Long Miss		2	6
Long S. H., M.D. ...	2	2	0
Low Dr. G. Carmichael	2	2	0
McHardy Maj.-Gen. A. A., D.S.O. ...	1	0	0
Macdonald Malcolm, M.P.		10	0
Mackay Dr. Helen M.		10	0
Macpherson A. Holte	1	1	0
Madoc Col. H. W. ...	1	0	0
Maidment Dr. F. W. H.	1	1	0
Marples George ...	1	1	0
Marshall E. H. ...	1	0	0
Marshall W. K. ...	3	3	0
McIlquham Miss M. ...		5	0
McKenzie Miss G. ...		10	0
McKittrick T. H., Jun.	1	1	0
McLaren Mrs. ...		10	0
McLaren Miss Sheila		2	6
McLean C.	1	1	0
Marshall J. M., J.P....	1	1	0
Matthews T. G. ...	1	1	0
Meade-Waldo E. G. B.	1	1	0
Meadows Mrs. A. H....		10	0
Medlicott Miss ...		5	0
Mennell E.		10	0
Micholl Mrs.	1	1	0
Milne Mrs. Findlay ...	1	1	0
Mitchell Arthur ...	1	1	0
Molteno D. J. ...	1	1	0
Mortimer Gilbert ...		5	0
Murton Mrs. ...	1	0	0
Nash W. (the late) ...	1	0	0
National Trust, The...	10	0	0
Naylor W. S. ...	1	1	0
Newman Miss F. B. ...		10	0
Noble E.		5	0
Noel-Buxton Lord ...	2	0	0
Norwich High School for Girls	1	9	0
Oliver Prof. F. W., F.R.S.	1	1	0
Palmer A. J.		5	0
Parson S. V., M.D. ...		10	0
Carried forward ...	£213	12	2

	£	s.	d.
Brought forward ...	213	12	2
Penrose F., M.D. (the late)	1	1	0
Perry Miss M. ...	1	1	0
Phelps Mrs. B. ...		10	0
Pilkington Mrs. Hubert	1	1	0
Plowright Dr. C. T. ...	2	2	0
Poole Miss D. Lane ...		5	0
Powell A. M.... ...		5	0
Pratt Alfred	1	1	0
Preston Sir E., Bart., D.S.O.		10	6
Previté A. W. ...		5	0
Prior A. V.		10	0
Purdy T. W.... ...	1	1	0
Ransome Mrs. ...	1	1	0
Raikes Miss D. T. ...		10	6
Reid Dr. E. S. ...		10	0
Richmond H. W., F.R.S.	2	0	0
Riley W. (the late) ...	1	1	0
Ringrose B. J. ...	1	1	0
Rippingall Neal F. ...	1	1	0
Riviere B. B., F.R.C.S.	1	1	0
Rogers Rev. H. ...	1	0	0
Royal Society for the Protection of Birds	2	2	0
Rushton Miss... ...		10	6
St. Quintin W. H. ...	1	1	0
Savill Harry	2	2	0
Savin A. C.		5	0
Savory Mrs.		10	0
Sawyer H. C. ...		10	6
Sewell P. E.	2	2	0
Sheldon W. G. ...		10	6
Soman A. E. & Co., Ltd.	1	1	0
Spalding G.		10	0
Sparrow Col. R. ...		10	6
Southwell E. B. ...	1	1	0
Stimpson E. ...		10	0
Sumpter Dr. B. G. ...	1	1	0
Tate Mrs.	1	0	0
Tawse Mrs.		10	0
Taylor Dr. Mark ...		11	0
Tennant Bernard V. A.	1	1	0
Thouless H. J. ...		10	0
Times W. O.	1	1	0
Tomlinson J. R. ...	2	2	0
Tracy N.		10	0
Trafford Maj. E. B. ...	2	2	0
Tuke Anthony W. ...	1	1	0
Upcher H. E. S. ...	1	0	0
Upcher Miss L. ...	2	2	0
Vincent Miss. G. H. M. M.	2	2	0
Carried forward ...	£262	9	2

	£	s.	d.
Brought forward ...	262	9	2
Walter C. H. ...	1	1	0
Walters Lewis ...	1	2	2
Watson-Kennedy Mrs.	1	1	0
Wemyss Major G. ...	1	0	0
West, Leonard H., LL.D.		10	6
Whittaker W. I. ...	1	1	0
Winch Major S. B. ...	2	2	0
Carried forward ...	270	6	10

	£	s.	d
Brought forward ...	270	6	1
Wing J. Slade ...	1	1	
Winter Gordon ...		10	
Wolley-Dod Mrs.		10	
Wright T. J.		10	
Wyllys H. J. M. ...		10	
Wyllys W.		10	
Young Rev. Belton ...		5	
Total ...	£274	3	

NORFOLK WILD BIRDS PROTECTION FUND

Year ended 31st October, 1932

Receipts

	£	s.	d.
Balance brought forward from 1931	53	15	1
Subscriptions and Donations, 1932	274	3	4
Blakeney Point Collecting Box		14	0
Scolt Head Collecting Box ...	3	7	6
Sales of Report	3	7	10
	£335	7	9

Payments

	£	s.
Breydon Watcher's Wages and Insurance	40	7
Oil, Coal, etc., for Breydon House Boat	1	6
Scolt Head Watcher's Wages and Insurance	110	17
Blakeney Point—Contribution to Watcher's Wages	30	0
Oilskin for Watcher	2	4
Workmen's Compensation Insurance Premium	1	0
Yarmouth Port and Haven Commissioners—Registration fees for boats		15
Printing of Annual Report ...	11	15
Hon. Secretary—Stationery and Postages	4	17
Cheque Books		10
Transferred to Deposit Account	100	0
Balance	31	14
	£335	7

Deposit

	£	s.	d.
Balance, 20th November, 1931 ...	141	13	4
Interest to 30th June, 1932 ...	3	9	1
Transferred from Receipts and Payments Account (as above)	100	0	0
	£245	2	5

Examined and found correct,

FRANK INCE

Norfolk & Norwich Hospital
Norwich, 1st Nov., 1932

III

THE ZONE OF GRANULATED *ACTINOCAMAX* IN EAST ANGLIA

By R. M. Brydone, F.G.S.

The zone of granulated *Actinocamax* for East Anglia covers the chalk between the top of the zone of *Marsupites* and the base of the zone of *Belemnitella mucronata;* and I so defined it when proposing it in the last issue of the Society's Transactions (Vol. XIII p. 118). Of course it is essentially a negative conception, depending in truth upon the absence of *Marsupites* at one end and *B. mucronata* at the other end, rather than on any positive character (in that way much resembling "space," which is primarily the negative idea of absence of matter, and is therefore incapable of the positive and physical attributes, such as expansion and curvature, freely attributed to it by speculative physicists, who must surely be using the term in some sense other than the primary one, without warning that they are doing so). Even so the zone is not closely defined. The top of the zone of *Marsupites* has been fixed in many ways. Barrois placed it on the Sussex coast at least 200 feet above the last *Marsupites*, as he brought into the zone of *Marsupites* all the accessible chalk. Elsewhere he seems to have regarded his zone of *Marsupites* as ended only by the deposits of the "mer à *Belemnitelles*" (by which he meant apparently the chalk of the zone of *B. mucronata*). He does not seem ever to have linked either its top or its base with the range of *Marsupites*. Rowe, not recognising any question as arising on the Kent coast, first grappled with the problem in Sussex where he placed the top of the zone about 20 feet above the last *Marsupites* because of the local peculiarity of a line of *Offaster pilula* about 5 feet higher which neither marks the first appearance of that fossil nor its permanent establishment in force. In other coast sections extending upwards beyond his zone of *Marsupites*, he seems to adopt the highest *Marsupites* as determining the boundary of the zone: but neither standard will account for his including in it the highest chalk in Thanet where there is chalk at the top of the cliff in which *Marsupites* almost certainly does not occur. It would be very interesting to know by what

criterion Boswell recognised that upper boundary of the zone of *Marsupites* which he represented in the map in Vol. XI. of the Society's Transactions, at p. 24, to the west of Botesdale and therefore somewhere in the middle of a five-mile tract of chalk with *Uintacrinus*.

The base of the zone of *Marsupites* was fixed in Kent by Barrois, and Rowe, at a local sponge bed, which is almost more a lithological than a palæontogical base, Rowe expressly saying that it was below the downward range of *Uintacrinus*, and by Barrois in Sussex at a flint bed a long way below the range of *Uintacrinus ;* but it has generally been fixed by the downward range of *Uintacrinus*. The net result is that the term " zone of Marsupites " standing alone is devoid of any precision either as to its top or bottom. I have always maintained that the last *Marsupites* is the only possible criterion of universal service for fixing the top of the zone of *Marsupites* and by it I define the level immediately above which the zone of granulated *Actinocamax* begins.

Unfortunately the end of the zone of granulated *Actinocamax*, which can only be fixed by the beginning of the zone of *Belemnitella mucronata*, cannot be closely defined in terms of the latter zone owing to the uncertainty as to what distinguishes *B. mucronata* Schlot. from *B. lanceolata* Schlot., and whether they overlap. The best that can be got out of current opinion is that " Sharpe was all wrong about *B. lanceolata*," which has little constructive value. I did once wring from the late Dr. Blackmore, who had rejected my identification of some very black and smooth Trimingham belemnites with *B. lanceolata*, the statement that *B. lanceolata* widens steadily from the point and that its vascular markings tend to be longitudinal while those of *B. mucronata* are transverse : but I have not found these points always satisfactory in practice, and I have no idea whether they are the standard on which other people who claim to be able to identify *B. lanceolata* rely. But I think that to Dr. Blackmore *B. lanceolata* was predominantly and perhaps wholly a fossil of the zone of *Actinocamax quadratus*, displaced, like *A. quadratus*, by *B. mucronata*.

The zone of granulated *Actinocamax* is practically co-extensive with the zone of *Actinocamax quadratus* as that term was employed for many years in the South. But two zones are

now recognised as distinguishable in that body of chalk in the South, those of *Offaster pilula* and (restricted) *Actinocamax quadratus*, and it is an important question whether any corresponding division can be traced in East Anglia. As Belemnites appear to be far more abundant in East Anglia than in the South at all horizons above the zone of *Micraster cor-anguinum*, and better preserved, it is very unfortunate that there is a serious lack of correspondence between the Belemnites at this level in the two districts. The scanty evidence in the South (which is amazingly scanty considering the enormous areas exposed under very favourable conditions) seems all to point to *Actinocamax granulatus* surviving from the *Marsupites* chalk (or zone) some way into the zone of *O. pilula* in slightly increasing numbers and being then replaced for some 20 or 30 feet by intermediate forms whose alveolar cavities are round like those of *A. granulatus* and deep like those of *A. quadratus*, which are replaced in the subzone of abundant *O. pilula* by *A. quadratus* which from that point is the only granulated Belemnite occurring up to the top of the (restricted) zone of *A. quadratus*, *A. granulatus* being therefore a sure indication of the lower part of the zone of *O. pilula*. In the East Anglian area it has been positively stated by the Geological Survey that at Bramford *A. granulatus* persists right up to the base of the zone of *B. mucronata*. It is unfortunately not clear whether they mean *Actinocamax* with round shallow cavities (which is the current standard of *A. granulatus*), or with round deep cavities (the intermediate form of the South), or both, but it may well be both. As I have seen strong indications of " quadrature " low down in the zone of granulated *Actinocamax*, and " quadrature " is definitely present even in the *Marsupites* chalk (or zone)—the relations between *A. granulatus* and *A. quadratus*, so apparently simple in the South, are very complicated in East Anglia. Indeed there is hardly any more crying need than that for a thorough study of the belemnites of the Upper Chalk. There may easily be ten or a dozen species, not one of which has been described in England in relation to others of its group and only about four of which have even been reliably described in isolation. I do not, for example, know of even an isolated description of such a widely quoted form as *Actinocamax Westfalicus*, or of any study of the even

more popular *Act. granulatus* in relation to its neighbours in the granulated group: and there must be a great abundance of material available from East Anglia.

On the question whether there is any trace of a dividing line within the zone of granulated *Actinocamax* which might correspond to that between the zone of *Offaster pilula* and the (restricted) zone of *Actinocamax quadratus* it is difficult to give anything more than a very vague answer. Out of the various strings of sections across parts of the zone, only two, that along the upper Wensum valley and that along the north coast, cut across the lower half of the zone; and of these the Wensum Valley series has an interval of about two and a half miles between Swanton Morley and Sparham, just at the crucial horizon, without a single section. Only along the north coast have I found any testing sections. Here, at Wells, in the pit in Bases Lane mentioned in the 1904 Survey Memoir, which cannot be far above the *Marsupites* chalk (or zone), we have obviously the chalk with abundance of *Ostrea incurva* Nilss., and generally abundance of *Actinocamax*, which can be followed through Walsingham in the roadside pit at Towns End, Great Walsingham and the railway cutting by Large Half Moon Plantation, Little Walsingham (there only a little way above the *Marsupites* chalk of Houghton and Barsham) by Guist and Bintree Mill (there only a little way above the *Marsupites* chalk of North Elmham) to Quidenham Home Farm and Banham old Lime Kiln (at the first place very little above *Marsupites* chalk at Quidenham old Lime Kiln). [Boswell's zonal map (supra Vol. XI. p. 24) *seems* to show the *Marsupites* chalk extending a considerable way west of East Harling. If so, a number of good sections in the zone of *M. cor-anguinum* and the *Uintacrinus* and *Marsupites* chalk in the neighbourhood of East Harling must have been taken for something quite different from what they are]. This chalk offers a remarkably close correspondence with the chalk immediately succeeding the *Marsupites* chalk in the South and which is probably the most prolific horizon there for *A. granulatus*. (At the top of the Bases Lane pit can be clearly seen the base of the magnificent raised beach of Wells.)

None of the succeeding sections about Wells have any parallel elsewhere in East Anglia.

In the railway cutting above the Bases Lane pit and about 40 feet higher the chalk, which is finely exposed, is about as barren as any that it has been my misfortune to meet. I could not find any significant fossil : and it afforded considerable evidence that the special fauna of the subzone of *Echinocorys scutatus* var. *depressus* never penetrated as far as this. Assuming this cutting to straddle part of the chalk corresponding in time to the above subzone, the cutting south of Wells Rectory may be fairly expected to be in chalk at the level of some part of the subzone of abundant *Offaster pilula*. The surface is very dirty but I found it possible to get a fairly extensive sample of the fauna, which did not contain a single instance of any of the striking fossils characteristic of the subzone of abundant *O. pilula*, except for a single fragment which might be a fragment of *Offaster pilula*. The next section to the east across the assumed strike is that at the old lime-kiln on the opposite side of the railway line to the Leicester Lime Works. There is not much chalk now exposed there, not enough to offer an expectation of fossils, though I found a *Bourgueticrinus* joint of exceptional size ; but it is sufficient to show the presence of a thick marl bed. Marl beds are extremely rare in the upper chalk all over East Anglia, so much so that I know of no other below the zone of *B. mucronata*. On the opposite side of the railway line the Leicester Lime Works show a splendid section some 30 feet high, which must start a very few feet above the marl bed, in rather gritty and locally hardened chalk in which *Echinocorys* is, for the first time above the *Marsupites* chalk, a regular feature of the fauna, *Pteria tenuicosta* Roem. occurs freely (for it) and *Offaster pilula*, Lam., rather small, occurs most erratically (I found five at one visit and none at two other visits). From this point eastwards granulated *Actinocamax* occurs at Wells Harbour (with *Pteria tenuicosta*) Cocklestrand Drove, Stiffkey, Cockthorpe Common and Fox Covert, near Morston, being found in each case in a single visit, and the top of the zone can be located pretty closely in the village of Morston, as *B. mucronata* has been found at Morston Downs. This chalk from Stiffkey eastwards, cannot but correspond with the (restricted) zone of *A. quadratus* in the South. It seems rather barren in comparison, even allowing for the superficial character and dirty condition of most of the

exposures; but I have been able at Stiffkey to establish that it contains several of the usual free Polyzoa, *Retispinopora arbusculum* Bryd* and irregular *spinoporæ*. The only ambitious section is that at Stiffkey Hall Farm, already sadly overhung by trees and dirty and doomed apparently to further steady deterioration: this was the scene of a triumph and a catastrophe. The triumph was the finding of three specimens of *Belemnitella* which seemed clearly *B. lanceolata* by the standard given above, and which were relieved from any suspicion of being *B. mucronata* by an accompaniment of three fine specimens of granulated *Actinocamax*. This find strongly confirms the assumption I had already made that the Belemnite or Belemnites from Wells which Jukes-Browne (the Cretaceous Rocks of Britain, Vol. III, p. 259) records as having been identified as *B. mucronata*, without in any way committing himself to that identification, was (or were) *B. lanceolata*. The catastrophe was a finding of a specimen of *Membranipora Taverensis* Bryd., a species which I had hoped would prove to be rigidly confined to the basal section of the zone of *B. mucronata*, of which it is so characteristic. The extreme scarcity in this chalk (above the Leicester Lime Works) of even fragments of *Echinocorys* is strictly in accordance with experience in the Gipping valley near Ipswich (as soon as the immediate proximity of the zone of *B. mucronata* is left) and of course robs us of a valuable source of information as to adherent forms; but even this fact leaves the total absence (closely paralleled in the Gipping valley) of such Polyzoa as *Membranipora pellicula* Bryd., *Semieschara Pergensi* Bryd., *Semieschara Woodsi* Bryd., *Onychocella* (*Cellepora*) *Parisiensis* d'Orb, and *Cribrilina Gregoryi* Bryd., which are almost literally massed at this horizon in the South, indicating a radical separation of the two areas or a radical difference in their conditions.

It seems to be the inevitable conclusion that no clear parallel

*It seems that Lonsdale's "new genus" *Spinopora* really covered a mixture of forms of *Neuropora* Bronn and *Spinopora* Bronn (which latter he must have overlooked), and that it is doubtful whether there is any room for my genus *Retispinopora*. But I think that it can be usefully retained for isolated regular forms such as these for which it was employed at its foundation: and I am now convinced that the form with an upright lower part and conical upper part (Brydone, The Stratigraphy of the Chalk of Hants., Pl. III, figs. 30f and g) should be a separate species to which I give the trivial name of *columnaris*.

exists in East Anglia to the division (of the importance of a break between stages according to Jukes-Browne, with only part of the evidence before him) between the zones of *Offaster pilula* and (restricted) *Actinocamax quadratus* in the South. It is, however, distinctly tempting to speculate that whatever causes were responsible for the disappearance of marl and *Offaster pilula* at the end of the zone of *O. pilula* in the South effected a temporary (in the case of marl, momentary), transfer of them into the East Anglian area and that the marl bed of Wells marks the level corresponding to that at which the change took place in the South. This will fit very well with the distribution of *Pteria tenuicosta* in the Gipping valley as a notable fossil of the upper part of the zone, and with the occurrence of *Pycinaster magnificus* Spen. of a zone-of-*Offaster-pilula* typed, in the Rectory cutting and *Stauranderaster senonensis* Spen., which is believed to appear first above the zone of *O. pilula*, in the Leicester Lime Works pit.

I have referred above to the magnificent raised beach at the west end of Wells, which rises to some 75 feet at least above O.D. It is almost inevitable that to the same submergence should be attributed the thick bed of sand (coming on at about 60 feet above O.D. but apparently lying in a local hollow in the chalk) through cuttings in which the Fakenham line approaches Wells. This bed can still be seen to consist almost entirely of sand with a few flints scattered through it at considerable intervals and it can hardly be anything but a seaside sand dune. In the siding for the Leicester Lime Works its base, resting on undisturbed chalk, consists largely of little rounded pellets of chalk corresponding very closely with the normal base of banks of blown sand beside a chalk foreshore. A comparatively recent sea level at Wells 50 feet or more above the present level would account almost perfectly for the absence of any crushed zone crowning the chalk round Wells, as such a sea would have quickly swept away any crushed chalk and any glacial deposits overlying it. That such a crushed zone once existed over the Wells area may be inferred with practical certainty from the fact that at Great Walsingham where the chalk rises to about 100 feet above O.D. it is crushed to at least the full depth of the roadside pit, at the bottom of which a tabular flint vein is seriously dislocated, i.e., nearly down to

80 feet above O.D. which still is above the probable high level of the chalk at Wells.

A sea which probably reached up to 70 feet or more above O.D. at Wells would almost certainly have covered a lot of land now dry about Holkham and this might explain the presence of at least 10 feet of laminated marl in Holkham Park (close to Great Barn) within a quarter of a mile of undisturbed chalk at the same level, and the water must have been deepish over the 105 feet or so above O.D. to which the marl reaches.

In the same way it becomes probable that all the low ridges of chalk fringing the marshes eastwards of Wells were at one time submerged by this sea, in which case the various outliers of gravel and sand left here and there along them, including the " town " pit at Stiffkey, are likely to be relics of raised beach.

Such a submergence at Wells would, if the land had then its present contours, also carry the sea some considerable way inland and in this connection it is worth noting that the pit at the north end of " Old Wells Road " near Great Walsingham at about 100 feet above O.D. and marked in the ordnance map as a chalk pit appears to be in sand very closely resembling that by the Leicester Lime Works (which we have seen is probably blown sea sand).

There seems to be a good case for the examination of all patchy post-chalk deposits in this neighbourhood less than about 100 feet above O.D. with an eye to the possibility of their being of beach or marine origin.

A possible chronological link with these earth movements is afforded by the presumably neolithic chalk caves of Stiffkey. Little has been recorded yet about them but I do know that one of them at any rate was situate nearly at the top of the chalk in the side of the valley, which here rises to about 70 feet above O.D., not at the bottom of the chalk valley. It may fairly be presumed that the glacial age left all chalk in this neighbourhood buried beneath a substantial covering of glacial debris and it seems to follow that this chalk could never have been accessible to neolithic man until it had been cleared of the glacial deposits by the submerging sea and then left dry at the edge of the same sea at some early stage of its recession. We may reasonably attribute to this period the excavation of

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Marsh fauna of the island. Probably the ideal way would be to issue these papers separately, but for general convenience it has been thought best to collect them in one volume, later editions of which can be made more comprehensive. The handbook will be fully illustrated, and will also contain some detailed maps. A new map of the island, on a scale of six inches to the mile, is in preparation, and this map also includes a good deal of the adjoining areas, so that anyone using it can more easily relate the island to its environment than can be done at present.

It has also been agreed that papers on the island should appear—as they do for the first time in this issue—as a Report. Mr. V. J. Chapman, B.A., of Pembroke College, Cambridge, has been working on the island this summer, and is carrying on field research throughout the year. He has contributed a preliminary paper, in which several new plant species are catalogued. Mr. D. L. Serventy, of Gonville and Caius College, carried out some interesting work on the salt marsh fauna in the Long Vacation, and hopes to continue the work next year. He will be able to contribute an account of this work later on.

The Ternery has been re-mapped by Mr. R. F. Peel of St. Catharine's College. The chief point of interest is the big gap cut through the dunes. This gap first began to form last September (1931), and a reference was made to it in the previous number of these *Transactions*. The gap has increased in size, and on October 2nd, 1932, it was more than 200 paces (approximately 200 + yards) wide. The big tides of that week-end did not do a great deal of damage to the island, but if a north-west wind corresponds with a big tide during the coming months, interesting changes will take place. The small dune left beyond the gap is, at the best, a very temporary structure.* Apart from the gap itself, the dunes just east of it are suffering a good deal of erosion.

Although not actually on the island, a word must be said about the erosion now taking place to a considerable extent on the Brancaster Golf Course. Just around the Club House, and for a few hundred yards west thereof, the sea has seriously cut into the dunes, and is undoubtedly a menace. Several bathing huts have had to be moved back. Prolonged attack here would

* This dune practically disappeared on October 31st, 1932

THE TERNERY AND FAR POINT, SCOLT HEAD ISLAND, June, 1932

(From a Plane-table Map by R. F. E. W. Peel)

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Photo] [*E. Winsl*

The Erosion near the Club House, Brancaster Golf Links

The distance between the figure and the dunes represents the approximat amount of erosion between 1930 and 1932

ead to a complete break in the dunes, and would render the Golf Course an island at high water. This, however, is not ikely to come yet, if at all. Unfortunately there is apparently no local beach material coming to this part of the coast which can be held up by groynes to provide an efficient means of protection. It is notoriously unsafe to predict what is going to happen on such a coast; but it seems fairly certain that extensive, and expensive, defence works will be necessary if this end of the course is to be adequately defended.

The attack of the sea is very local. Only about a quarter of a mile west of the Club House accretion is taking place, probably at the expense of that which is lost at the vulnerable spot. New shingle ridges and dunes are growing quite quickly near the entrance to the north-south reach of Brancaster Harbour. It is interesting to speculate on the connection between these changes and the recent growth of Scolt Head Island. As can be seen from recent maps published in these *Transactions* since 1925-26, the island has grown rapidly westwards; and the growth is perhaps greater than is apparent, because the shingle and sand ridges at the far end extend very considerably farther than the dunes. The result has been to deflect Brancaster Channel west and south. Part of the cause of the erosion of the links may possibly be sought in this way, even though the distal point of the island is opposite the unattacked part of the Golf Course. If, as is by no means impossible, the gap in the Ternery increases to such an extent as to cut off the end of the island, and possibly to divert the Harbour mouth eastwards again, the shingle which would be left west of such a new harbour would be "dead." Such shingle might possibly be driven on the beach along the Golf Links and, if so, may be of use as a natural protection to that shore. Whether it would do so depends on several important factors, many of them unknown. However, interesting changes are likely to take place here in the near future. The maps to be published in the proposed Handbook will indicate these changes in more detail.†

† Since this note was written, the sea has cut farther into the Links, especially during the high tides of 30th and 31st October, 1932.

V

RECENT ADDITIONS TO SCOLT HEAD FLORA

By V. J. Chapman, B.A., Pembroke College, Cambridge

The chief interest attaching to these additions is concerned mainly with a knowledge of what plants have been able to obtain a footing on the island. Now that the island is largely covered with vegetation, it is very difficult for new species to grow successfully. These new species of flowering plants are additions to the flora prepared by Deighton and Clapham (1). They were found during a short survey of the flora made during visits to Scolt Head Island in June, July and August, 1932.

Dr. S. H. Long brought me *Thymus chamædrys*, Fries., which he had found on the dunes near the watcher's hut. *Carduus pycnocephalus*, Jacq. was found on the western slope of House Hills. *Centaurea cyanus*, Linn. was found by Mr. J. A. Steers on the small portion of the ternery which was cut off by the break through in 1931, and it was growing on the young dune remaining there. At the entrance of the channel to the spiral marsh *Zostera marina*, Linn. was found growing; there is quite a large patch, which may have been overlooked by Deighton and Clapham. In July *Cnicus palustris*, Hoffm. was found in abundance in the marsh in Norton Hills. In the same place, in August, *Epilobium parviflorum*, Schreb. was found, there being only about four plants. *Epilobium angustifolium*, Linn. was found by the watcher, C. Chestney, on House Hills, where there is a small patch, which has probably been there for a few years, and is slowly spreading. On the Hut Massif two new species were recorded. There are several plants of *Capsella bursa-pastoris*, Mœnch. growing in the shingle just in front of the hut; and in the middle of the Massif a patch of *Thalictrum minus var. dunense*, Dumort. was found flourishing in the dense Psamma. In August plants of *Atriplex hastata*, Linn., and *Atriplex patula*, Linn., were found at the edge of the dunes bordering the small marsh behind the hut.

In the copy of Deighton and Clapham's paper in *Vol. XI* of the *Transactions* of the Norfolk and Norwich Naturalists

Society which is kept in the hut, the following additions have been marked in in pencil by previous visitors :—

Trifolium pratense, Linn. Ternery, August 1931.

Geum urbanum, Linn.

Filago germanica, Linn. Ternery, August 1931.

These were looked for, but were not found. It will be noted that a number of these new additions come from the Ternery, which is the area where most of the birds are to be found. In several cases they are not found again, and it is doubtful whether *Centaurea cyanus* will be found next year, the two plants that were found being small and weakly. It is probable that a number are stray visitors brought as seeds by the birds, and they only manage to survive one year in the dry conditions. It would therefore seem advisable, in a case like this, not to place plants as a permanent component of a flora until they have been recorded for two or more successive years. Those that occur only periodically should be put down as sporadics. It seems probable that the bulk of these will be brought by the birds or wind, and this particularly applies to the Ternery, where the chances are very great of seed being brought by birds, especially in mud on their feet.

In connection with the flowering plants, it was noted this year that *Senecio jacobæa*, Linn. was very badly attacked by caterpillars of the cinnabar moth, *Euchelia jacobææ*, and to a much less extent by caterpillars of two other species. The attack on the plants of House Hills was by far the worst, and, as the photograph shows, the plants were completely denuded, no fruits being produced. In view of the vast quantity of ragwort on the dunes and elswehere in the country, the exploitation of the cinnabar moth suggests itself as a method of biological control of the ragwort. Its success would depend on all the plants in the neighbourhood being attacked, so that no seed was set, and then the rootstocks of the dead plants should be pulled up.

For future workers it seems advisable to record here that all the trees (except Elder, and the Privet on Privet Hill) on the Island have been planted, including all those round the pool in House Hills (2). The reason for recording this is that in time these trees will look as if they had occurred naturally (as some

of them already do) and future workers may be in doubt as to their origin.

One new fern was added to the flora. This is *Dryopteris dilatatum*, Desv., which was found on House Hills. I am grateful to Mr. Gilbert-Carter for this identification.

A preliminary survey was made of the algal flora, which is a large one. This is surprising, seeing it is a mud and sand region. The bulk of the algæ are in the mussel beds in Norton Creek, but there are also three patches on the foreshore, where algæ have become attached to stones embedded in the sand, and these patches also have a rich flora. On the marshes the following Phæophyceæ are found :—*Fucus volubilis*, Baker, which is most abundant on the Aster marshes : *Pelvetia canaliculata forma libera*, Baker, occurring on most of the marshes, being absent only from the very lowest and very highest. Lastly, there is *Fucus coralloides*, Baker, recorded as being found once by Deighton (1) to the south-east of House Hills. The above three algæ have been described by Miss Baker (3) for Blakeney, and it is probable that they are characteristic of the East Anglian salt marshes. The Pelvetia is also recorded by Dr. Carter (4) for Canvey Island. Also on the marshes the Rhodophyceæ are represented by *Bostrychia scorpioides*, Kütz., which occurs in much the same places as the Pelvetia.

The green algæ along the creeks are mainly Enteromorpha and Vaucheria. *Enteromorpha intestinalis*, Link, may be found growing on stones in the main creeks, especially those of the Great Aster Marsh. The list of algæ recorded so far is given at the end of this account. No attempt has been made to group them according to habitat, but this may be possible later on.

Galls

Three galls have been seen on the island, and they all come from House Hills. *Taphrina aurea*, Fries., a fungus, has attacked the leaves of *Populus nigra*, planted by the pool, giving the golden blisters on the under surface of the leaves. *Rhodites rosæ*, Linn. is found on *Rosa rubiginosa*, which occurs wild, and also on the leaves of this rose is *Rhodites eglanteriæ*,

Hartig. which forms round, red growths, chiefly on the under urface of the leaves.

Lastly, some little while ago, Professor Salisbury suggested hat when an ecological study was being made of an area, one art of the work should be the collection of an ecological erbarium, which should be kept in a place for reference for uture workers. Such an herbarium has been started for colt Head Island, and it will be kept at Dial House, Brancaster taithe.

My thanks are due to Miss Dickinson of Kew, who identified our of the algæ, and to Mr. Steers for the photograph; also to Ir. T. Tutin, who identified the two species of Atriplex.

IST OF PLANTS RECORDED SINCE 1925

LGÆ. (5)

Chlorophyceæ.	Ulva lactuca, var latissima, D.C. (U. latissima, J. Agardh).
	Ulva linza, J. Agardh.
	Enteromorpha intestinalis, Link.
	Enteromorpha compressa, Grev.
	Enteromorpha clathrata, J. Agardh.
	Cladophora utriculosa, Kütz.
	Percursaria percursa, Rosenv.
	Vaucheria sphærospora, Nordst.
	Rhizoclonium implexum, Batt.
Phæophyceæ.	Fucus spiralis, Linn.
	Fucus vesiculosus, Linn.
	Fucus ceranoides, Linn.
	Fucus spiralis var platycarpus, Thur.
	Fucus fasiculosus megecad limicola ecad volubilis, Baker.
	Pelvetia canaliculata megecad limicola ecad libera, Baker.
	Ectocarpus siliculosus, Harv.
	Ectocarpus fasiculatus, Harv.
Rhodophyceæ.	Bostrychia scorpioides, Kütz.
	Hypoglossum Woodwardii, Kylin. (Delessaria hypoglossum, Lamour).
	Ceramium rubrum var pedicellatum, J. Agardh.

	Ceramium rubrum var corymbiferum, J. Agardh.
	Lomentaria clavellosa, Gaill.
	Griffithsia setacea, C. A. Agardh. (G. flosculosa, Batt).
	Callithamnion byssoides, Arn.
	Polysiphonia urceolata, Grev.
	Polysiphonia nigrescens, Grev.
	Porphyra umbilicalis, J. Agardh.
FILICINÆ	
Polypodiæ.	Dryopteris (Nephrodium) dilatatum, Desv.
PHANEROGAMS.	
Ranunculaceæ.	Thalictrum minus, var dunense, Dumort.
Cruciferæ.	Capsella bursa-pastoris, Mœnch.
Leguminosæ.	Trifolium pratense, Linn.
Rosaceæ.	Geum urbanum, Linn.
Onagraceæ.	Epilobium parviflorum, Schreb.
	Epilobium angustifolium, Linn.
Compositæ.	Filago germanica, Linn.
	Centaurea cyanus, Linn.
	Carduus pycnocephalus, Jacq.
	Cnicus palustris, Hoffm.
Labiatæ.	Thymus chamædrys, Fries.
Chenopodiaceæ.	Atriplex hastata, Linn.
	Atriplex patula, Linn.
Naiadaceæ	Zostera marina, Linn.

FUNGI

A few fungi had been noted on the island, but recently some observations made by Deighton in 1925 came into my hands and the opportunity is now taken of publishing his list, and am very grateful to him for permission to do so.

ERYSIPHACEÆ

Erysiphe horridula, Lev. This attacks *Cynoglossum officinale* occurring on both sides of the leaves. Perithecia occur on the under surface. This year it was most abundant on plants on the dunes of Butcher's Beach.

Erysiphe polygoni, D.C. on *Trifolium dubium.*

Erysiphe communis, E.F. This occurs on *Statice limonium*. In 1925 it was very abundant on plants in the Spiral Marsh

The leaves shrivelled, and the plants rarely flowered. There were abundant perithecia on both sides of the leaves.

Erysiphe umbelliferum, de Bary. Found on *Pastinaca sativa* on the Hut Massif east of the hut. It was sparingly present on the upper sides of the leaves.

Sphærotheca mors-uvæ, Berk. Found on the plant of *Ribes uva-crispa var grossularia* behind the Hut. It caused a die-back of the twigs, and there was a sterile mycelium on the fruit.

Sphærotheca humile, Burr. This was found on a variety of *Taraxacum officinale*. Perithecia were on both sides of the leaves.

Microsphæra grossulariæ, Lev. on the leaves of the gooseberry plant behind the Hut. Perithecia were present.

UREDINEÆ

Puccinia schœleriana, Plow. The aecidia are found on *Senecio jacobæa*. In 1925 it was abundant all over the dunes, but this year it was found only on the dunes of Butcher's Beach.

Puccinia pulverulenta, Grev. Aecidia and teleutospores on *Epilobium tetragonum*, which grows in the marsh in Norton Hills. There were six plants, and three were infected.

Puccinia hypochœridis, Oud. Uredospores on *Hypochœris radicata*. It occurred as small pustules towards the tips of the leaves, being found on young plants near the Burnham Harbour end of the island.

Puccinia taraxaci, Plow. on *Taraxacum officinale* in the dune hollow east of the Hut.

Puccinia violæ, Schum. Teleutospores and Uredospores on *Viola riviniana* on House Hills.

Puccinia sonchi, Rob. Uredospores on the leaves of *Sonchus asper* on the Hut Massif.

Puccinia dispersa, E. et H. Uredospores on *Holcus lenata* on the Hut Massif. There was only a little of this rust.

Phragmidium violaceum, Schultz. Uredospores on *Rubus fruticosus* on the Hut Massif, but not found on the plants on House Hills. There was a little on a bush at the Burnham Harbour end of the island.

Coleosporium sonchi, Pers. Uredospores and Teleutospores on the leaves of *Sonchus asper* on the Hut Massif.

Coleosporium senecionis, Pers. Uredospores on *Senecio*

sylvaticus and *Senecio vulgaris*. It was also very abundant this year.

Uredo ammophilina, Kleb. Uredospores on *Ammophila arenaria*.

Uredo agropyrii, Preuss. Uredospores on *Agropyrum junceum* growing on the embryo dunes at the Ternery.

Uromyces limonii, Lev. Aecidia and Teleutospores on the leaves of *Statice limonium*. The Aecidia occur only the midrib, and this year they occurred on some leaves in such quantity as to distort them. It does not attack the variety *pyramidale* to anything like the same extent.

Uromyces betæ, Pers. Small pustules on the leaves of *Beta matriima*, of which there was one plant on Long Hills in 1925.

Uromyces behenis, *D.C.* Aecidia on the leaves of *Silene maritima*. It occurred on only a few plants and was not common.

USTILAGINEÆ

Ustilago hypodytes, Fr. On the stems and leaf sheaths of the flowering shoots of *Elymus arenarius*. There was only one patch, near the watcher's hut.

Ustilago macrospora, Desm. On the grain and glumes of *Agropyrum junceum*, causing the spikes and glumes to be elongated and twisted. Found on plants at the south end of Long Hills.

PYRENOMYCETES

Pleospora herbarum, Rabh. Perithecia on the leaves and stems of dead *Arenaria peploides*.

HYPHOMYCETES

Fusarium roseum var calystegiæ, Sacc. In a soft rot of the old corolla and fruit of *Calystegia soldanella*.

Fusarium lolii, W. G. Smith, on old leaves of *Holcus lanatus*.

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VI

THE GREAT YARMOUTH HERRING FISHERY 1931

By Sydney H. Long, M.D.

For much of the information contained in this report of the Great Yarmouth Herring Fishery for 1931, I am indebted to the columns of the " Eastern Daily Press."

Europe's economic distress has had a repercussion on Yarmouth herring industry, which mainly depends upon the foreign demand, and the season of 1931 was one of the worst in living memory. The bulk of the catch is made by the Scottish fleet, which began operating later than usual, and closed its season earlier. Curers last year lost heavily, and this season they cast about for ways and means to avoid a repetition of this experience. They shortened the season at both ends, reduced their staffs in order to produce a smaller output, and they would only buy fresh herrings at lower rates.

The catch decreased from 540,644 crans last year to 389,740 crans this season, while the prices paid for herrings were on the average only one-half what they were in 1930. The first-hand value of herrings landed at Yarmouth is estimated by the Ministry of Fisheries to have been £585,310 less than last year.

October provided the biggest landings, the heaviest day being 33,075 crans on October 27th, 24,555 crans the following day, and 21,535 crans on October 24th. The fleet comprised 612 Scotch boats, 22 less than in the previous year, 122 Yarmouth boats, 165 Lowestoft boats against 40 in 1930, and one Milford Haven drifter, making a total of 900 boats as against 803 last year. The Yarmouth boats earned from £1900 down to £600. As in 1930, the Scotch fishing was practically a failure. Three-fourths of the herrings landed are taken by the Scotch fleet, and the great bulk is purchased by Scotch curers who follow the herrings.

The weekly landings for the past three seasons were as follows :—

	1931	1930	1929
	Crans	Crans	Crans
Oct. 3	13,144	17,620	9,237
,, 10	14,379	53,783	24,446
,, 17	68,611	79,344	81,307
,, 24	69,617	98,730	63,172
,, 31	92,064	60,011	92,196
Nov. 7	44,609	106,882	101,554
,, 14	25,651	60,240	55,732
,, 21	10,946	18,763	43,910
,, 28	18,160	7,680	19,075
Dec. 5	5,420	7,443	11,958
,, 12	4,583	4,418	179

The first herrings taken on the Shields grounds reached Yarmouth on June 27th. Herrings came to the market from this area until August 20th, when supplies were brought from Whitby, the Castle grounds off Scarborough, Flamboro' Head, and the Silver Pits. By the middle of September, the shoals had reached Cromer Knoll and Haisbro'. No herrings from the Dowsing grounds were permitted to be landed, as they were "spawny" and therefore poor quality. Some boats which brought herrings from this ground had to take them back to sea and dump them or let them go at manure price. The icing of herrings on board as soon as caught was not done so much as in previous years.

The first shot from local grounds came to hand on September 25th. At the beginning of October the herrings had arrived at Smith's Knoll.

The highest price per cran for fresh herrings was 118s. on November 4th, and the lowest figure 5s. on October 3rd and October 17th. Values for iced herrings ranged between 51s. on December 15th and 6s. on October 6th. "Overdays" reached 48s. 6d. on December 15th and touched bottom on October 17th, when the price was 2s. Sea-salted herrings realised 34s. 6d. on September 8th, the top price of the season, and the lowest figure was 3s. on September 24th. Curers paid on the average 18s. 6d. per cran, compared with 37s. 6d. in 1930, 33s. to 34s. in 1929, and 29s. 1d. in 1928.

Of Scotch girls, 2,566 were employed at Yarmouth, the first train arriving on October 8th, and they started to return in the middle of November. This figure compares with 3,540 in 1930 and 3,339 in 1928. Of Scotch coopers, 602 were employed, against 899 in 1930 and 819 in 1929. The number of curers operating at Yarmouth was 75 and at Gorleston 7. In 1930 the figures were 81 and 15 respectively and 76 and 17 in 1928. Of fishery salt, 19,180 tons arrived from Spain, Scotland, and Cheshire, and the average price was 32s. per ton. Coal for bunkers cost 32s. per ton ; paraffin for the motor boats was 6d. per gallon.

CURING AND FRESHING

Curing commenced on October 12th and ended on November 10th, so far as the Scotch operators were concerned. The total cure at Yarmouth was 288,470 barrels against 524,994 last year. Up to December 15th the quantity shipped was 184,264 barrels. The total quantity exported fresh to Germany was 20,245 crans.

VII

METEOROLOGICAL NOTES, 1931

(*From observations taken at Norwich*)

By Richard J. Preston

JANUARY

The mean temperature was about normal, and while there were few mild days, there was an absence of severe frost. Rainfall was about half an inch above the average, and snow fell on only two days. Fogs occurred on the 3rd, 10th, 21st, and 30th. There was a heavy gale on the night of the 16th. Sunshine was in excess of the average.

FEBRUARY

There was again an absence of any severe wintry weather, and although frost occurred on the ground on 20 nights, the lowest reading was 20.4 deg. on the grass and 25 deg. in the screen. Snow fell to the depth of about half an inch on the 5th and 7th, and there were showers of sleet and snow at the end of the month. Mean temperature was almost exactly in

accordance with the normal, rainfall was three-quarters of an inch in excess, and sunshine 29 hours deficient. Thunder occurred on the 11th and 21st.

MARCH

This was in many respects a remarkable month. The mean temperature of the first fortnight was below 34 deg., and very cold winds prevailed during this period. On the night of the 9th the screen thermometer fell to 13.1 degrees, and that on the grass to 9.5 degrees. The latter reading would have been much lower, but for a slight covering of snow over the thermometer. Mr. Willis recorded a reading of 1.2 deg. at Ipswich Road. This was the severest March frost for nearly 30 years. Snow fell on 7 days out of the first 11, and was 4 ins. deep on the 10th. On the 18th there was a change to summer-like conditions, and the thermometer reached 64.4 degrees on the 19th, although patches of snow were still to be seen in shady spots. On the 27th the thermometer rose from 25 deg. in the early morning to 64.2 deg., giving the extraordinary range of 39 deg. The mean temperature of the month was 1.8 deg. below normal. The total rainfall was only .58 in. (of which only .03 was rain, the remainder being melted snow) and was 1.33 in. deficient. With the exception of March 1926 (.37 in.) it was the driest March since these observations were commenced in 1883. Only .03 in. fell from the 12th to the end of the month.

Sunshine was 67.8 hours in excess of the average, and it was the sunniest March ever recorded locally.

APRIL

This month kept up its reputation for showery weather, and the rainfall was an inch and three-quarters above the average. Some snow fell on the 17th. Summer time was ushered in on the 19th by a wintry day of continuous rain, when the maximum temperature failed to exceed 41.6 deg. Thunder occurred on the 22nd, 26th, 27th and 28th. Sunshine was 29 hours deficient.

MAY

Although there was no really hot weather, there were many warm and summerlike days. The mean temperature was nearly 2 deg. above normal. The rainfall was about double

the average, largely accounted for by 1.57 in., which fell on the 16th and 17th. Sunshine was 27 hours deficient. Thunder occurred on the 23rd and 28th.

JUNE

The most important occurrence during this month (though perhaps not strictly of a meteorological nature) was the earthquake in the early morning of the 7th. A severe shock was accompanied by an ominous rumbling noise, causing great alarm, and some slight damage was caused to buildings. There was again an absence of anything in the nature of a "heat wave," although the thermometer reached 70 deg. on several days. The mean temperature was 1.6 deg. above normal. Rainfall was .26-in. above the average, and sunshine 17 hours deficient. Thunder storms occurred on the 1st, 6th and 8th, and there was distant thunder and lightning on the 19th.

JULY

Apart from a few showers, the first fortnight was fine and dry, but the weather broke down on the 14th, when there was a heavy downpour registering nearly an inch. On the 19th there were heavy thunderstorms yielding .70 inches. The 22nd to 24th were fine and hot, the thermometer reaching 78 deg. on the 23rd.

Rainfall was again above normal by about three-quarters of an inch. Sunshine was 46 hours deficient.

AUGUST

During the first week the weather was fine and warm, the maximum on the 5th reaching 79.5 deg., the hottest day of the year. The rest of the month was unusually cold, and the thermometer failed to reach 60 deg. on four days, and on the 27th the maximum was as low as 57.6 deg.

On the night of the 22nd the screen thermometer fell to 36 deg., the lowest August reading since these records were started, and in exposed situations there were ground frosts on several nights. Further inland as many as six degrees of frost were recorded. The mean temperature was 58.9 deg., over 2 deg. below the average.

Rainfall was again above the normal, and on the 8th heavy

rain was followed by thunderstorms, and 1.64 in. was measured Sunshine was below the average.

In addition to the storms on the 8th, thunder occurred on th 4th, 5th, 15th and 16th.

SEPTEMBER

This was another cold month, the mean being 2.8 degree below normal. 70 deg. was reached on only three days Rainfall was again above the average, the total having bee 2.36 in. more than two-thirds of which fell during the firs six days. In the latter part of the month there were man dull gloomy days, with slight rain and drizzle, which were ver depressing. Sunshine was 40 hours deficient, the total o 109.4 hours having been the lowest for September ever recorde by Mr. Willis. There were thunderstorms on the 3rd and 4t and early morning fogs on the 15th and 16th.

OCTOBER

The most remarkable feature of this month was the extra ordinarily severe frost during the last week. On the nights o the 27th-28th, and 28th-29th the screen thermometer fell t 22.9 deg. and 24.4 deg. and the grass thermometer to 18.6 deg and 16.9 deg. respectively, these being the coldest Octobe nights in these records. During the month there were frosts o 7 nights in the screen, and on 10 nights on the grass. Th earlier part of the month was mainly mild, and the mea temperature was only slightly below normal. Rainfall w 2.09 in. below the average, and sunshine 25 hours in excess.

NOVEMBER

This was the warmest November since 1899, the mea temperature working out at 3.3 deg. above normal. Temper ture reached 50 deg. every day during the first fortnight, an on 22 days during the month, as compared with 23 days i the previous mild Novembers of 1928 and 1899. The maxim on the 3rd and 4th were 61.5 deg. and 60 degrees respectively There were few frosts, and no snow fell. Rainfall was nearl three-quarters of an inch below normal. There was som thunder and lightning on the 11th, and the wind reached ga force on the nights of the 3rd and 26th. There was an almos entire absence of the fog and gloom usually associated with thi month.

DECEMBER

The mild weather of the previous month continued for the st fortnight, after which there were a few rather colder days. ›ringlike weather again prevailed during the Christmas ›lidays, but on the 29th there was a sudden change to wintry nditions, which lasted till the end of the month. The ean temperature was 2.3 deg. above normal. The maximum the 4th was 58.5 deg., and this appears to have been the armest December day locally since 1856. No severe frosts ere recorded but the minimum for the 24 hours ended 9 a.m. January 1st, was 19.4 deg., and on the grass the thermometer ring that night fell to 4.9 deg. Rainfall was again deficient. ow fell on the 29th and 30th and at the end of the month as 3 in. deep. Sunshine was approximately in agreement ith the average. The mean barometrical pressure (30.21 in.) as unusually high.

The glass stood at 30.70 in. on the 22nd and 23rd. The ly gale was on the night of the 24th. There were very few gs.

THE YEAR

The mean temperature of the year (49.2 deg.) was slightly ›ove the average. The warmest day was August 5th (79.5 g.) and the coldest night March 10th (13.1 deg. in screen and 5 deg. on the grass).

The warmest month was July (61.9 deg.) and the coldest nuary (38.1 deg).

It is very rarely that the thermometer fails to reach 80 deg. ring the summer months, and the only previous years in which is has occurred since these observations were started were 927 and 1920.

Rainfall was 1.70 in. above normal, the wettest months being pril (3.49 in.) and May (3.57 ins).

The sunshine readings again very kindly supplied by Mr. H.Willis, show that the year's deficiency was 154 hours.

A winter of normal temperature with little really cold weather as followed by a very dry and bitterly cold early Spring. April nd May were warmer, but very wet. A most disappointing ummer was to some extent compensated for by a fine October nd an unusually mild and open November.

MR. PRESTON'S METEOROLOGICAL RECORDS FOR 1931

BRITISH MUSEUM

1931 Month	BAROMETER					THERMOMETER					HYGROMETER	SUNSHINE	RAINFALL		WIND							
	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Mean Relative Humidity 9 a.m	Hours	Inches	No. of Days	Direction and Days							
															N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
	in.		in.		in.	°		°		°	%											
JAN.	30.45	8	29.14	24	29.81	52.7	16	25.7	8	38.1	90	62.3	2.42	25	**3**	2	0	1	3	1	13	8
FEB.	30.26	5	29.25	16	29.81	57.0	25	25.0	6	38.8	88.3	50.0	2.36	21	1	3	1	1	3	5	11	3
MARCH	30.47	26	29.51	1	29.96	64.4	19	13.1	10	39.7	84.7	191.9	.58	7	2	3	8	5	5	0	7	1
APRIL	30.24	10	29.30	26	29.82	65.5	11	31.8	1	47.1	79.0	131.3	3.49	19	8	2	1	2	4	4	6	**3**
MAY	30.17	9	29.38	4	29.83	73.0	26	36.7	21	54.1	76.7	179.3	3.57	12	6	1	4	4	4	5	6	1
JUNE	30.26	26	29.66	8	29.94	78.0	27	38.6	26	59.7	74.0	189.4	2.19	13	3	0	4	1	0	8	11	3
JULY	30.06	1	29.35	15	29.75	78.0	23	44.5	21	61.9	80.0	164.6	3.28	16	0	1	0	0	**3**	9	16	2
AUG.	30.39	27	29.41	20	29.87	79.5	5	36.0	24	58.9	84.4	171.7	3.24	14	7	3	6	4	0	2	8	1
SEPT.	30.48	20	29.36	4	30.10	71.9	16	37.0	8	58.3	88.0	109.4	2.36	17	8	2	0	1	2	3	9	5
OCT.	30.60	15	29.35	24	30.09	71.0	6	22.9	27	49.6	86.0	132.5	1.03	13	8	2	1	1	3	3	9	4
NOV.	30.34	16	28.86	11	29.78	61.5	3	30.0	17	46.7	90.4	59.0	1.87	17	0	2	2	5	10	5	5	1
DEC.	30.69	22, 23	29.25	29	30.21	58.5	4	26.0	31	41.2	90.0	41.7	1.79	17	5	0	1	1	1	**3**	16	4
MEANS					29.91					49.2	84											
EXTREMES & TOTALS	30.69	Dec.	28.86	Nov.		79.5	Aug.	13.1	Mar.			1402	29.10	191								

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OF THE

Norfolk and Norwich

NATURALISTS' SOCIETY

PRESENTED TO MEMBERS FOR

1932–33

VOL. XIII.—PART IV

EDITED BY MISS A. M. GELDART

NORWICH

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JANUARY, 1934

PRICE 10/-

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3. The discouragement of the practice of destroying the rarer species of birds that occasionally visit the County, and of exterminating rare plants in their native localities.

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1926 Hammond C. R. A., Sprowston Grange, Norwich
1932 Hamond A., c/o Barclays Bank, Norwich
1906 *Hamond Major Philip, D.S.O., Morston, Holt, Norfolk
1929 Hamond C. E., c/o Major P. Hamond, Morston, Holt, Norfolk
1932 Harbord The Hon. Doris, Harbord House, Cromer
1928 Hardinge Lt.-Col. T. S. N., D.S.O., Flaxmoor, Caston, Attleboro'
1908 Harker William, Blofield Hall, Norwich
1923 Harmer Russell T., The Grange, Rackheath, Norwich
1881 *Harmer Sir Sidney, K.B.E., F.R.S., *V.P.*, The Old Manor House, Melbourn, near Royston, Herts.
1906 Harris Rev. G. H., 9, Huntingdon Road, Cambridge
1925 Hartcup Miss, Dial House, Cathedral Close, Norwich
1923 Hastings Lord, Melton Constable Park, Norfolk
1925 Hemingway P. H., Bureside, Wroxham
1928 Hendy E. W., Holt Anstiss, Porlock, Somerset
1925 Hewitt H. Dixon, F.I.C., 25, Croxton Road, Thetford
1925 Heywood R., Pentney House, Narborough, Norfolk
1923 Hibberd Rev. H., Burnham Thorpe Rectory, King's Lynn
1919 Hinde Dr. E. B., 31, Mount Pleasant, Norwich

Elected.

1891 Hinde F. C., *Hon. Librarian*, 49, Earlham Road, Norwich
1932 Hinde Miss I., 31, Mount Pleasant, Norwich
1923 Hines E. S., 21, Park Lane, Norwich
1915 Hitchcock Arthur, Tamworth House, Tennyson Road, King's Lynn
1919 Horsfall Charles, c/o Lloyds Bank, 3, Broad St. Place, E.C.2
1923 Hoskins Maj. Gen. Sir Reginald, Ashridge House, Berkhamsted, Herts.
1919 Howard H. J., F.L.S., 6, College Road, Norwich
1926 Howlett J. K., The Beeches, East Dereham
1930 Hudd Miss W. F., The Training College, Norwich
1927 Hudson Lt.-Col. P., C.M.G., D.S.O., Martincross, Sheringham
1923 Hunter H. M., Mattishall Hall, East Dereham
1931 Hulse Mrs. M. W., Park Lodge, Bromham, Beds.
1931 Hulse Miss E. M., Park Lodge, Bromham, Beds.
1929 Hyslop A. B., Burnham Norton, King's Lynn

J

1921 Jarrold T. H. C., Pine Banks, Thorpe St. Andrew
1891 Jarrold W. T. F., Beeston St. Andrew, Norwich
1926 Jolly Ll. B., Aylmerton Hall, Norfolk
1923 Jolly T. L., Yarmouth Road, North Walsham
1933 Jolly Miss E., Holly Grove House, Worstead, Norwich
1885 Jones Sir Lawrence, Bart., 39, Harrington Gardens, London, S.W., 7.
1926 Jourdain Rev. F. C. R., M.A., F.Z.S., M.B.O.U., Whitekirk, Southbourne, Bournemouth

K

1932 Kay Dr. A., Halfway, Blakeney, Norfolk
1926 Keith E. C., Swanton Morley House, East Dereham
1927 Kendall O. D., Dept. of Geography, University of Bristol
1929 Ker Mrs. H. M. Rait, The Cottage, Fernhurst, Haslemere, Surrey
1897 Kerrison Colonel E. R. A., C.M.G., D.L., Birds Place, Buxton, Norwich
1925 Kerrison Mrs., Birds Place, Buxton, Norwich
1931 Ketton-Cremer R. W., Felbrigg Hall, Norfolk
1926 Kimberly Mrs., M.Sc., "Constantia," Elm Grove Lane, Norwich

L

1930 Lance Capt. H. W., Burnham Norton Lodge, King's Lynn
1931 Lawfield F. W., 219, Hills Road, Cambridge
1932 Leake Mrs., The Gables, South Wootton, King's Lynn
1909 Leicester The Right Hon. the Earl of, G.C.V.O., C.M.G., *V.P.*, Holkham
1899 Leney F., Castle Museum, Norwich
1931 Liddell-Grainger Capt. H. H., Ayton Castle, Berwickshire
1927 Lister Dr. S. R., Terrington Lodge, King's Lynn
1923 Livesay Surg.-Capt. A. W. B., R.N., St. Andrew's Hospital, Thorpe, Norwich
1922 Livesay Mrs., St. Andrew's Hospital, Thorpe St. Andrew
1922 Lloyd Capt. L., Taverham Mill, Norwich
1925 Lloyd Mrs., Taverham Mill, Norwich

Elected

1899 Long S. H., M.D., F.Z.S., M.B.O.U., *Hon. Mem.* (*Hon. Sec.*), 31, Surrey Street, Norwich
1907 Long Mrs. S. H., 31, Surrey Street, Norwich
1919 *Long Miss E. M., 31, Surrey Street, Norwich
1923 Long G. S. B., St. Giles Plain, Norwich
1933 *Low G. Carmichael, M.D., F.Z.S., M.B.O.U., 66, Brook Street, London, W.1
1921 Lucas Baroness, Woodyates Manor, Salisbury

M

1924 MacKenzie Miss G., The Cottage, Ingworth, Norwich
1923 *Macpherson A. Holte, 21, Campden Hill Square, Kensington, W.8
1931 Maidment Dr. F. N. H., Harleston, Norfolk
1905 Mann Sir Edward, Bart., Thelveton Hall, Norfolk
1931 Maples Ashley K., 33, London Road, Spalding, Lincs.
1906 Marriott F. W. P., 11, Queen Street, Norwich
1931 Marshall E. H., 5, Council House St., Calcutta
1931 Marshall W. K., Radburne Estate Office, near Derby
1892 Marsham Major H. S., Rippon Hall, Marsham, Norfolk
1931 Martin A., Keswick Hall, Norwich
1912 Mason A., Willow Lane, Norwich
1911 Master George, M.D., Bury St. Edmunds
1893 Mayfield A., F.L.S., Mendlesham, Stowmarket
1926 McCall C. Home, Upper Flat, San José, Mount Rd., Hastings
1933 McHardy Maj.-Gen. A. A., C.B., C.M.G., D.S.O., Hickling, Norfolk
1933 McHardy Mrs. A. A., Hickling, Norfolk
1922 McKenna Mrs. Reginald, 70, Pall Mall, S.W.1
1926 McLean Colin, Humbletoft, East Dereham
1926 Meade Miss P., Quidenham, Norwich
1898 Meade-Waldo Edmund G. B., Stonewall Park, Edenbridge, Kent
1928 Miller O. T., " Heathcote," Norwich Road, Fakenham
1923 Minns Mrs. E., Hammond's Wood, Frensham, Surrey
1932 Moore R. F., Stowmarket, Suffolk
1923 Moppe Lewis E. van, Cliffside, Overstrand
1929 Morley C., Monk's Soham House, near Framlingham, Suffolk
1922 Mountfield Miss M., Horsford, Norwich
1929 Moxey Llewellyn
1920 *Mullens Major W. H., Westfield Place, Battle, Sussex
1921 *Murton Mrs., Cranbrook Lodge, Cranbrook, Kent

N

1922 Nevill Rev. R. W., Old Catton Vicarage, Norwich
1925 Neville Sir R. J. N., Sloley Hall, Norfolk
1931 Nevill Capt. G. A., The White Lodge, Swanton Morley, East Dereham
1911 Newman L. F., St. Catharine's College, Cambridge
1889 Nicholson W. A., *Hon. Mem.*, 5, Mill Hill Road, Norwich
1915 Nightingale S. R., Scratby Hall, Great Yarmouth
1926 Norfolk and Norwich Library, Norwich
1932 Norgate Mrs., Cranworth, Shipdham, Norfolk
1919 Norgate Philip, Swanington, Norfolk
1933 North The Hon. Mrs. J., Stiffkey, Norfolk
1915 Norwich Public Library
1927 Notcutt R. F., Woodbridge

Elected

O

1927 O'Donnell O., Great Fransham, East Dereham
1914 Oliver F. W., D.Sc., F.R.S., *Hon. Mem., V.P.*, Ballard's Barn Limpsfield Common, Surrey

P

1919 Pain Percy, Dersingham, King's Lynn
1913 Paine Rev. Canon N. W., Great Melton Rectory, Norfolk
1919 *Palmer Mrs. P. Hurry, "Red Roofs," North Drive, Great Yarmouth
1912 Parker H., Lyncroft Road, Pakefield, Lowestoft
1921 Parker R. E., Marlingford, Norwich
1873 Partridge Rev. W. H., M.A., "Breckles," Leed Street, Sandown, I. of W.
1889 Patterson Arthur H., *Hon. Mem.*, Ibis House, Lichfield Road, Gt. Yarmouth
1920 Patteson Mrs. F. E., Great Hautbois House, Norfolk
1932 Patteson Miss, Great Hautbois House, Norfolk
1911 *Payler Donald, The Museum, Birmingham
1933 Payne T. P. H., 75, St. Stephen's Road, Norwich
1923 Peed John, Aylsham
1926 Percy Lord William, D.S.O., Catfield Hall, Norwich
1925 Petrie Mrs., The Dower House, Heydon, Norwich
1926 Phillippo G., 7, St. Philip's Road, Norwich
1925 Pilch R. G., 45, Grosvenor Road, Norwich
1930 Podmore R. E., Maynards, Matfield, Kent
1931 Potts F. A., Trinity Hall, Cambridge
1931 Pratt Alfred, The Cottage, Cliff Avenue, Cromer
1932 Preedy Mrs., 49, The Close, Norwich
1919 Preston Sir E., Bart., Beeston Hall, Norwich
1933 Prior A. V., Green End Dell, Boxmoor House, Herts.
1913 Purdy T. W., Woodgate, Aylsham
1925 Purnell Mrs. Ralph, 12, Claremont Road, Norwich
1887 Pycraft W. P., A.L.S., F.Z.S., British Museum (Natural History), London, S.W.

R

1929 Ramage H. P., Ridgemont, Carrow Hill, Norwich
1933 Rate L. R., Milton Court, Dorking, Surrey
1928 Raywood W., 13, Upper King Street, Norwich
1930 Reeves Derek L., Honingham Hall, Norwich
1925 Reeves Hugh, Honingham Hall, Norwich
1924 Richmond H. W., F.R.S., King's College, Cambridge
1925 Ringrose B., Farley, Harbridge Green, Ringwood, Hants.
1924 Rippingall Neale F., Langham, Norfolk
1911 Rising A. P., The Manor House, Ormesby, Great Yarmouth
1908 Riviere B. B., F.R.C.S., F.Z.S., M.B.O.U., Woodbastwick Old Hall, Norwich
1908 Rogers Commander F. S., R.N., Ingham New Hall, Norwich
1909 Rogers Rev. Henry, Coltishall Hall, Norwich
1908 *Rothermere Rt. Hon. Lord, Hemsted Park, Cranbrook, Kent
1897 *Rothschild Rt. Hon. Lord, F.Z.S., Tring, Herts.
1922 Rounce G. H., The Pines, Park Road, Cromer
1930 Rowell George
1902 *Ruggles-Brice Mrs. R., Keswick Hall, Norwich
1906 Rumbelow P. E., 27, Rodney Road, Great Yarmouth

cted

S

929 Sainty Miss O., West Runton, Cromer
931 *Salisbury Prof. E. J., D.Sc., F.L.S., F.R.S., Willow Pool, Radlett, Herts
930 Scratchley Lt.-Col. V. H. S., D.S.O., The Parsonage, West Newton, King's Lynn
925 Sewell P. E., Dudwick House, Buxton, Norwich
922 Shepheard Dr. Samuel, Aylsham
930 Shilcock Miss Joan R., "Maryland," Sheringham
930 Simpson Miss W., Geldeston Lodge, Geldeston, Norfolk
919 Smith Col. H. F., Didlington Hall, Norfolk
917 Sowels Miss, The Rookery, Thetford
922 Spalding G., 9 ,St Stephen's Street, Norwich
911 Spurrell J. T., Manor House, Newton St. Faiths, Norwich
923 Spurrell Miss M., Manor House, Newton St. Faith's, Norwich
923 Spurrell Miss P., Manor House, Newton St. Faith's, Norwich
925 Steers J. A., M.A., St. Catharine's College, Cambridge
921 Stimpson Edward, Sall Moor Hall, Reepham, Norfolk
932 Stone Miss I., 42, Sandringham Road, Norwich
922 Sumpter Dr. B. G., Brancaster Staithe, King's Lynn
896 Sutton W. Lincolne, F.I.C., Eaton, Norwich

T

931 Talbot Sir Gerald, K.C.V.O., C.M.G., O.B.E., Burnley Hall, Somerton, Norfolk
931 Tate Mrs., Lenwade House, Near Norwich
921 Taylor Dr. Mark R., 338, Winchester Road, Southampton
878 Taylor Shephard T., M.B., The Mount, Edgefield, Melton Constable
933 Taylor Commander M., R.N., 338, Winchester Road, Southampton
921 Thain D., West Somerton, Norfolk
931 Thomas J. F., Bowden House, Seaford, Sussex
929 Tillett Miss I., "Sunnymead," Buxton, Norwich
896 Tillett Wilfrid S., "Sunnymead," Buxton, Norwich
933 Tindall Miss E., Kettleby Lodge, Sheringham
920 Todd Lt.-Col. Eardley, Mundham House, Brooke
902 Todd R. A., B.Sc., The Retreat, Elburton, Plymouth
932 Todd Mrs., Mundham House, Brooke, Norfolk
910 Tracy N., 3 King Street, King s Lynn
925 Tucker B. W., 9, Marston Ferry Road, Oxford
906 Turner Miss E. L., F.L.S., H.M.B.O.U. *Hon. Mem.*, 13, Storey's Way, Cambridge
927 Turner Edgar, "Kuruman," Walberswick

U

923 Upcher Rev. E. C. S., Weybourne Rectory, Norfolk
921 Upcher H. E. S., The Gables, Upper Sheringham
30 Upcher Mrs. H. E. S., The Gables, Upper Sheringham

V

917 Vincent James, Hickling, Norfolk

Elected

W

1923 Walter Mrs. Cyril, Old House, Drayton, Norwich
1923 Waterfield Mrs., Attlebridge, Norfolk
1926 Wemyss Major, Bryn House, Wroxham
1927 Wemyss Mrs. ,, ,,
1931 Wheeler G., Tatterford Rectory, Fakenham, Norfolk
1932 Wheeler Engineer-Capt. S. G., R.N., Lower Hellesdon, Norwich
1922 Willett W. L., Paddock Wood, Kent
1929 Wilson Mrs. Gerald, Saxlingham Nethergate, Norwich
1909 Witherby H. F., M.B.E., F.Z.S., 326, High Holborn, W.C.
1931 Woolley Miss, B.Sc., Blyth Secondary School, Norwich
1923 Woolsey G. E. W., Old Catton, Norwich
1907 Wormald Hugh, M.B.O.U., Heathfield, East Dereham
1922 Wortley Francis, Half-Year, West Runton, Norfolk

Y

1915 Yarmouth Free Library, The, Great Yarmouth

TOTAL

Honorary Members	... ...	5
Life ,,	... ...	28
Ordinary ,,	... ..	341
		374

The Treasurer in Account with the Norfolk and Norwich Naturalists' Society, Year Ending 30th April, 1933

1. GENERAL ACCOUNT

Dr. 1932-33.	£ s. d.	£ s. d.
To Balance from 1932		10 10 0
,, Subscriptions	165 7 6	
,, Sale of Transactions	7 6	
,, Sale of Reprints East Anglian Flora	7 6 5	
,, Interest 4% Consolidated Stock	12 0 0	
,, ,, 5% War Loan	5 5 4	
,, Bonus on 5% War Loan on Conversion	1 1 0	
,, Donations to Publication Fund	25 8 0	
		216 15 9
		£227 5 9

Cr.	£ s. d.	£ s. d.
By Printing Transactions	165 7 3	
,, Reprints President's Address	22 5 0	
,, Postages	12 1 0	
,, Stationery	5 5 6	
,, Library Rent	6 6 0	
,, Expenses Teas at Meetings	3 10 6	
,, Donations Attendants at Castle Museum ...	1 0 0	
,, Fire Insurance	13 6	
,, Hire of Stuart Hall	4 4 0	
,, Year Book of Societies	8 6	
,, Clerical Assistance to Hon. Secretary	5 0 0	
		226 1 3
,, Balance in Hand		1 4 6
		£227 5 9

Examined and found Correct,
(Signed) C. R. A. HAMMOND,
17th May, 1933.

II. LIFE MEMBERSHIP FUND

1932-33	£	s.	d.	1933	£	s.	d.
To Balance from 1932	6	16	3	By Balance in Savings Bank	17	19	7
„ 1 Life Member's Subscription	8	0	0				
„ Bank Interest		3	4				
„ Interest on War Loan	2	10	0				
„ Bonus on War Loan Converted		10	0				
	£17	19	7		£17	19	7

III. DEPOSIT ACCOUNT

1932-33	£	s.	d.	1933	£	s.	d.
To Balance from 1932	20	10	5	April 30. By Balance at Barclays Bank	21	0	0
„ Interest		9	7				
	£21	0	0		£21	0	0

IV. SPECIAL PUBLICATION FUND

1932-33.	£	s.	d.		£	s.	d.
To Donations				Transferred to General Account	25	8	0
Professor E. J. Salisbury	5	5	0				
Professor E. J. Salisbury	9	8	0				
C. J. Blackburne		10	0				
Dr. Robert Gurney	5	0	0				
P. M. Brydone	5	5	0				
	£25	8	0		£25	8	0

List of Investments and Assets

	£	s.	d.
£155 6s. 10d. 3½ per cent. War Stock at cost	150	18	1
£300 0s. 0d. 4 per cent. Consolidated Stock at cost	270	10	4
Balance in Savings Bank	17	19	7
On Deposit at Barclays Bank	21	0	0
On Current Account at Barclays Bank	1	4	6
	£461	12	6

I have checked the Books of the Society with the Bank Books and Receipts. I have not seen the Stock receipts of the Investments but

11th May, 1933.


BRITISH MUSEUM
NATURAL HISTORY

HARRIERS

By Major Anthony Buxton, D.S.O.

Perhaps because of a taste for sport handed down to me from my ancestors on either side, I have always had a fellow feeling for those creatures, whether bird or beast, which get their living by the chase. I like a fox better than a hare, a stoat better than a rabbit, an owl better than a mouse, a hawk better than a dove. Most people's sympathies are probably directed in the opposite direction (they certainly are in East Norfolk); my feelings are stated as an excuse for giving the marsh hunting hawks an article all to themselves. During the last two summers I have spent more time on and gained more information about the harriers than about any other bird, and if the question were put to me, "What provides the best sport at Horsey?" the answer would be, "Harriers in the summer and Pochard in the winter," while my terrier would murmur, "Stoats all the year round."

In addition to their peculiar habits and methods of life harriers acquire merit in my estimation by the fact that they are in most cases difficult creatures to deal with, remarkably keen of eyesight, and suspicious of human beings; also because they are comparatively easy to recognise as individuals owing to their variations in plumage. Moreover, there are not many places in this country where they are allowed to exist, so that residence at Horsey gives an almost unique opportunity of watching all the three species which visit England:—Hen-Harriers in the winter, Marsh- and Montagu's in the summer.

The two latter have probably been saved from extinction and certainly owe their present position in East Norfolk to the foresight and care of the late Lord Grey, the late Mr. Edwin Montagu, the late Lord Lucas, Lord Desborough and to Mr. Jim Vincent his head keeper, who probably knows more about them than anyone, with the possible exception of the late Mr. Henning Weis of Denmark. Apart from Mr. Weis' excellent book "Life of the Harrier in Denmark" and that

delightful account of the Harriers in Delamain's "Pourquoi les Oiseaux Chantent"* literature on Harriers usually consists of a diatribe against their predatory habits (they were not given those eyes or claws for nothing), or of an account of how specimens were acquired and their nests robbed. No wonder that the survivors have learnt to regard man as a destructive brute to be given as wide a berth as possible. It must indeed be confessed that most, though not quite all, the individual harriers of my acquaintance regard me, if not as a murderer or a thief, at least as a highly objectionable busybody, immodestly interested in their domestic affairs.

Hen-Harrier

It is impossible to get on terms of real intimacy with a bird which merely winters and does not nest in the district, as is the case with the hen-harrier, and my information about it is therefore very meagre, for I have never visited its breeding haunts in the north. Probably for this reason it arouses less affection in me than do the Marsh- and the Montagu and strikes me as a not very successful mixture of the two. An old cock Hen-Harrier is a great bird, but he just misses that perfect finish of a cock Montagu given by the pink streaks on the latter's breast and the thin black line down his secondaries. His likeness to a Montagu leads to the expectation of an equal gracefulness in flight, but he falls short in this respect of his smaller cousin, and yet in the opposite direction he misses that look of an out and out stage ruffian which is so characteristic of a Marsh-Harrier.

In this district, judging by two years' experience, the Hen-Harrier never coincides with the Montagu but he overlaps the Marsh both in Spring and Autumn. In 1932, for instance, a male Hen-Harrier and a Marsh-Harrier were both seen on March 25th, and a Hen-Harrier was still here on April 5th. In 1933 the first Marsh-Harrier was seen on April 1st and a female Hen-Harrier which had spent the whole winter in the neighbourhood was still here on April 13th. During last autumn and this a Hen-Harrier was seen at the end of September and the beginning of October, when at least two Marsh-Harriers

* Delamain's book has been translated into English by Ruth and Anna Sarason under the title "Why Birds Sing." Publisher, Victor Gollancz, Limited.—Editor.


BRITISH MUSEUM
NATURAL HISTORY

Montagu's Harrier

were still roosting on these marshes. It is believed that at one time there were five Hen-Harriers, two cocks and three hens, in the Hickling-Horsey area during the winter of 1932-33. They appear to start hunting very early in the morning, for we often saw one when duck flighting before sunrise, and probably they catch as much ground game as birds. They appear to hunt over the drier ground, like Montagu, and not to stick so closely to water as does the Marsh-Harrier.

Montagu's Harrier

More is probably known by British naturalists about Montagu's Harrier than about either of the other two. It is my favourite Harrier and indeed one of my favourite birds. For grace and beauty I would hand the apple to an old cock Montagu competing with any other British bird. But there are Montagu's and Montagu's, both ladies and gentlemen, and one specimen of each sex that attempted to nest here last year and were apparently driven off by short-eared owls, were hardly worth a look through a telescope. In contrast, there nested in 1932 and I believe also in 1933 a pair that were real stars even in that select company. Their portraits are shown, but no photograph can give any idea of the palest of pale grey set off by the typical black points of that grand old cock, or of the soft shades of brown and grey of his comely and charming hen. They were the best looking pair that ever came my way, and they knew how to rear a healthy family. Judging by specimens in captivity it takes at least three years for a cock Montagu to attain a complete grey livery, and much longer than that for him to reach that paleness, which gives him real distinction. The hens seem also to become paler and greyer as they age, and to lose the rather spectacled appearance given by the dark markings on the cheeks in early life. The two hens whose portraits appear illustrate the difference.

In 1932 the older pair and their family of five were watched at a range of 7-ft. from the moment when the young were a week old to the moment when they flew. In 1933, although this pale cock was seen throughout the summer, and his hen was recognized almost for certain on one occasion, attention was concentrated on the younger pair with a family of two, which were watched mainly from a hide situated at

thirty yards. In 1932 therefore we studied the behaviour o Montagu's mainly on the nest itself, while in 1933 with a wide and more general view we watched and recorded their behaviou not on, but in the vicinity of, the nest. The individuality o birds, which no close observer can fail to notice, was wel illustrated by these four creatures. The older pair were idea parents ; the pale cock, an indefatigable hunter, who returne at regular intervals with his prey, passed it to his hen usually i about the same spot, saw her safely down to the nest, and the at once departed on a fresh hunt. His mouse grey hen, calm i disposition, quickly recognizing us as friends but regarding al strangers with suspicion, divided the food with absolut impartiality among her family and maintained the strictes discipline on the nest.

The younger pair were much more fickle. The cock, althoug he could catch prey quickly enough when he liked, was alway taking unauthorized half-holidays. For hours at a time h would be " lost," having apparently forgotten all about hi wife and family, so that the former was forced to leave he charges and go off in desperation to fend for herself. At th end of one of these long periods of waiting, she would, when th cock eventually arrived, dash at him with a scream and almos snatch the food from his claws. He seemed in every way a casual bird, and showed himself strangely tolerant of a youn male visitor who, on several occasions, accompanied him home hung about round the nest, and endeavoured to make up t his wife. Even that caused only the mildest of demonstrations

The hen was not so calm in disposition as the older bird and was always prone to sudden fits of temper and fuss. Thi may have been due to disaster to an earlier nest, for she settle in very late in the summer and laid only three eggs. Probabl because of her uncertainty as to when the cock would turn up she was much more prone to wander away from the nest on a hunt of her own, than was the case with the mouse-grey hen When on such occasions the cock failed to find her, h brought in the food himself.

So much for comparisons. At the risk of some repetition o previous notes an account shall now be given first of the pal cock and the mouse-grey hen, and then of the younger pair.

BRITISH MUSEUM
NATURAL HISTORY

Quite early in our acquaintance in 1932, the pale cock whose main hunting grounds were my marshes, shewed himself to be a bird that demanded respect. While sauntering along his habitual beat he was ordered off the ground in our presence by a white-shouldered Marsh-Harrier (her history is given later), a far heavier bird than he. Without a moment's hesitation he drove straight for the larger bird, which just ducked in time to avoid him, and in response to a second attack dived to ground in the rushes. The Montagu tilted up to some forty feet, shut his wings and came down " plunk " like a peregrine on his antagonist, and it was only the timely arrival of the Marsh-Harrier's mate which drove off the Montagu, that averted a disaster. That old cock Montagu held right of way for the rest of the season. Despite his pugilistic qualities, this bird tolerated within a few hundred yards of his nest a young pair of Montagu's which reared two young birds, but the two cocks apparently respected each other's hunting countries, which lay in opposite directions.

Between 10.30 a.m. and 5.20 p.m., the pale cock brought in on an average about sixteen kills for his family of five, and within that time he occasionally reached the total of twenty-five kills. Not much hunting was done very early or very late and twenty kills per day was probably about the average. The kills were nearly always very small stuff, consisting mainly of larks and meadow-pipits, varied by a few young partridges, mice and other things. After the hen had ceased to brood, the prey was usually passed to her several hundred yards from the nest and when she had finished the plucking the cock escorted her back and hung in the air over her, until he saw that she was happily engaged in doling out the food to the young, when he would waft himself away in a series of long planes back to his hunting ground. There was usually a quiet period between 2 p.m. and 4 p.m. during which the young enjoyed a siesta and sprawled about in the nest like a litter of puppies. In very hot weather when the young were still in down, their mother spread her wings and tail over them to act as a parasol, and when all the family except the youngest had begun to grow feathers she made a sort of shelter in the rushes for them, by plucking the grass and opening out a hollow from the edge of the nest, into which she carried

what appeared to be a cushion of dry grass. For about a week before they flew the young birds ran about along paths which either we or they had made, and were fed at considerable distances from the nest. Both the young birds and their mother took readily to sandwiches (egg, ham, sardine, or cheese) which we placed on the nest, but we never persuaded the cock, who seldom visited the nest, to try one. Within a very few days after photography began, we had the satisfaction of feeling that she was completely at ease, and that everything we saw was natural and unaffected by our presence. Her alarm cry was no longer uttered at our approach, although she always used it if a stranger appeared, and she came quietly over our heads to inspect us, subsequently showing no signs of fuss. She had a ring on her foot, which had probably been placed there by Mr. Jim Vincent, but we were never able to read its number. Round and sleek are the adjectives which I should give to her appearance, and she was certainly the greyest and most beautiful hen Montagu I have ever seen. Her mate was unique in my experience, for the grey of his back was almost as pale as that of a common gull.

The finest exhibition of aerobatics was given by this pair one morning, when, after a number of kills had been brought in, work was interrupted and they gave themselves up for half-an-hour to sheer enjoyment of the art of flying. Their antics were centred on the manœuvre of the " pass," but no food was in their claws : it was all pure fun. Screaming and chattering they swept past each other in the air at every angle, sometimes on their sides, sometimes on their backs, and as they met their claws went through the motions of the " pass." Then the game ended and serious work was resumed. All the family of five left the nest in magnificent feather for their first flight.

Owing to a desire to obtain records of the " pass," we never attained the same degree of intimacy with the younger pair in 1933, for in order to give a wide field of view, the hide we mainly used was placed on a grass wall of short turf some thirty yards from the nest.

Unfortunately this pair laid only three eggs and reared two young, so that the number of passes was less than in the case of a large family. We had, however, the advantage of dealing with an amazingly casual cock, who never objected to hides or


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I. The Cock about to drop the prey.

II. The Prey dropping.

III. The Hen on her back catching the prey

IV. Another catch


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the noises and sights attendant upon photography. During the sitting and brooding period the pass was generally made comparatively near to the nest. The cock would come over, making his particular call, which sounds like a rather short, rather wet, double kiss. On hearing this call up would come the hen from the nest, often with a scream to meet him in the air. In a high wind he would frequently manœuvre for a considerable period in order to get their respective positions exactly correct. Then out would shoot his claw holding the prey for a moment with every leg muscle stiff, and finally dropping it to be caught by his wife in the air. She was an amazingly good field. Never did we see her miss a catch, and never did she make a catch look anything but perfectly simple. Sometimes she would tilt up so as to be almost on her back in the air, and indeed the film record in one case shows that she turned a complete somersault; but often she would scarcely tilt at all and, without apparently even looking at the cock, lazily put out a hand, back uppermost, and take the prey in her claws as it dropped in front of her nose. I found it very difficult not to stand up in our little pavilion and clap at some of the catches she made. On other days, particularly in hot weather, she would point with her claw imperiously to earth. This gesture would be obeyed by the cock who then deposited the prey on a bare space on the ground, whence she retrieved it from his hand: when it was too hot she could not, I suppose, be bothered to go up in the air and 'field.' When brooding ceased and the hen might be anywhere in the neighbourhood on the return of the cock, the pass occurred just where they happened to meet. If the cock could not find her, he brought the food in himself and threw it to the young, but made no attempt to parcel it out. Judging by what we saw and in particular by the film record an extract of which is reproduced, I gather that the main advice given to young Montagu's engaged in fielding practice is, " Stay well down wind of your man when taking a pass, for it is easier to run in than to run back while keeping your eye on the ball."

Those interested in photography may care to know that we made a wide opening in the hide which ran practically all along its front and we also opened two holes left and right for side

shots. The moment the cock appeared a guess was made at the position and distance of the spot where we thought the pass would take place. The focussing screw was at once adjusted and the camera then aimed to place the cock in the up-wind top corner of the camera's finder. As soon as his foot was thrust out, the film was run and the appearance of the hen in the centre of the finder was eagerly awaited. It was a great moment when she duly appeared, but of course in many cases the birds had drifted far away from the point of focus before the pass took place, and in others they had flown out of sight over the top of the hide. It was the most exciting form of photography in which I have yet engaged.

Marsh-Harrier

This, the largest of the three Harriers, is still in the initial stages of re-establishment as a breeding species on the broads, and for that reason is regarded at Horsey with a veneration which his rather untidy rascally appearance perhaps hardly merits. I do not feel quite the same affection for him as for a Montagu, but his habits are, to me at least, intensely interesting. In two years we have been at grips with four pairs, two in each year, and have also had a passing acquaintance with others. In order to make them distinguishable to the reader they shall each be given a title. First, then there is the "streaky cock," father of two families, three in 1932 and four in 1933 (portrait attached). Second, there is the "devil" (the mildest thing we ever called her), married to the streaky cock in 1932, divorced that July, and we all hope dead. Third, the "white-shouldered hen" (once known erroneously as the white-shouldered cock) the largest and most recognizable harrier in the district married to a miserable looking specimen in 1932, nesting place and history in that year unknown; married to the streaky cock in 1933, mother of four and still going strong (portrait attached). Those three made up a pair in both 1932 and 1933 with the same cock each year. Fourth, there is "the Murderer," who killed a young rival in 1932 and married—Fifth, the "nondescript hen." Owing partly to our stupidity and partly to her bad temper they deserted in 1932, and it is not known if they later reared a brood that year. They remained all the summer. Sixth, the "prize cock," who


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may possibly have been " the Murderer " but if so was completely transformed in 1933 into the most beautiful specimen I have yet seen. He married in 1933—Seventh, " the red-tailed hen " who reared, after his disappearance and presumable death at the time of hatching, a family of three. Her portrait is attached. Nos. 6 and 7 nested in 1933 in practically the spot where Nos. 4 and 5 had nested in 1932. Those are the main characters in the drama, and the others are, in comparison, of such minor importance that they do not warrant a title.

The story of " the streaky cock " and " the devil " has been told before and shall merely be summarised. The lady possessed an ungovernable temper and when, after endless difficulties and delays, and after the stalking and capture of two egg clutchers the hide reached a point within 15-ft. of the nest a fortnight after the hatch, she sulked, did less and less work, and finally left the district a fortnight before her family left the nest. The cock continued to bring in food regularly to a larder near the nest, and we took it thence to the young until they could fly and find the larder. All three flew in excellent health. Their mother has never been seen again.

That was in 1932, and early in April, 1933, ' the streaky cock ' returned to the same place, where a few days before had appeared a bird we had called in 1932 ' the white-shouldered cock.' This was the bird attacked by the old pale cock Montagu. Her sex had been wrongly diagnosed in 1932, partly owing to her own remarkable appearance, and partly owing to the dinginess of her consort of that year, which made us mistake him for a hen. They thought of nesting in the neighbourhood that year but changed their minds, and nothing more was seen of them until September, 1932, when the white-shouldered hen was recognized on several occasions.

For a few days in 1933 we mistook the antics of ' the streaky cock ' and ' the white-shouldered hen ' for rivalry between two cocks. Then one day both were seen building in places about 600 yards apart, and shortly afterwards it was obvious that their antics were caused, not by rivalry, but by mutual affection. The cock was building his own particular cubby-hole at the same time as the hen was building the nest proper. A description is given later of the courting habits and their connection with the cock's nest. Across their territory there wandered occasionally

a dark and ugly cock which lived across the boundary. The moment he appeared our cock was after him, but the darker bird never had the pluck to give battle on his adversary's ground: on one occasion his retreat was nearly cut off, and he only just got home with a spurt. Six eggs were laid by this pair, all of which were hatched, but one of the young was considerably smaller than the other five; these killed and ate him when about a fortnight old. Not content with that the big four two days later killed and ate No. 5, who was slightly less powerful than themselves. Further disaster was averted only because of the evenness in size of the big four, all of which took to the air in excellent health. Their mother, "the white-shouldered hen," though a distinct improvement on her predecessor, who had deserted her husband and family, was evil tempered and fussy in the extreme. So much so that we never risked placing a hide nearer than 25-ft. from the nest. She gave us endless trouble throughout the summer, and would no doubt assert exactly the same thing about us. She gained, if not our affection, at least our respect for her remarkable eyesight, and she can at any rate claim that she reared a healthy family, and is even now (Oct. 6th), still roosting on her old marshes, but has apparently packed her husband and children off to the south.

I shall not dwell on the tragedy of 1932 which, has already been confessed, whereby 'the nondescript hen,' owing to suspicion of the hide at its last move of only 3 feet, delayed too long her return to the nest and allowed the newly hatched young and eggs to get cold. Early that spring, there was found beneath the post on which her mate "the Murderer" was wont to sit, the corpse of a young cock floating in the dyke. We subsequently saw other demonstrations of this untidy looking bird's pugilistic qualities. In 1933, either the same bird improved out of all knowledge in appearance, or, more likely, an older individual ('the prize cock') took over this part of the marshes, together with a slim handsome creature known as 'the red-tailed hen.' The prize cock was the finest specimen I have seen in Norfolk, and indeed anywhere, easily surpassing in appearance each of the several cocks I saw this year on the Naadermeer in Holland. His shoulders and tail feathers were light grey, the top of his head very pale, and he carried a distinguishing white ring round his rump. Seven eggs were laid


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Marsh Harrier

in the nest belonging to this pair, of which the first three hatched successfully, but at that moment 'the prize cock' disappeared and has never been seen again. 'The red-tailed hen' had of course to go off on the hunt, against all rules of harrier conduct which prescribe these duties to the cock, and this at the very moment when her presence was required continuously for brooding the young. None of the other eggs were successfully hatched, but, to her great credit she reared the three chicks unaided, and a more cheery, healthy family it would be difficult to find. Unlike 'the white shouldered hen' who left carcases and all sorts of debris about in the nest, this bird kept the home scrupulously clean and removed by air all bones, etc. to a distance after each feed.

Mainly from this pair some knowledge was gained of the courting habits of Marsh-Harriers. However heavy in flight a Marsh-Harrier may appear at ordinary times, the cock, when on the court, becomes a real aerial acrobat. Appearing as a speck in the sky, he descends in a series of great swoops with closed wings, each swoop being followed by a check and an upward jerk with a few strong beats of his pinions. At each check and upward jerk he gives out a loud scream, not unlike that of a pee-wit but with the accent on the second instead of the first syllable. As he nears the ground the hen joins him and after a second or two together the cock alights on his own particular nest, which in the case of both pairs in 1933 was situated at a considerable distance from the hen's nest. After remaining a moment or two on the nest the cock rises to give place to the hen, but immediately rejoins her on the nest, where the two birds remain for perhaps a minute. Then the cock rises and flies to a bare piece of ground, followed by the hen who then receives the prey he has carried all the time in his claw. This procedure was perfectly regular till incubation began; then it ceased, but on fine days, when presumably the cock was feeling above himself, he would sometimes resort to his screaming and acrobatics, even after the young had flown. Owing to high sedge, it was impossible to see the birds in the cock's nest but the above evidence points in my opinion to its use in day time for pairing purposes.

In 1932 we were puzzled by the streaky cock's use of a larder

twenty yards from the nest, after his hen had deserted him. In 1933, for about ten days before the young flew, both the white-shouldered hen and the red-tailed hen moved them a certain distance each day by the following method. The hen would come in with food to just behind the nest, but instead of giving it to the young, she retreated through the rushes on foot carrying the prey, and deposited it at a short distance from the nest. She then took flight, and after a certain amount of petulant squealing the young would scramble and crawl through the rushes and find the prey. The hen would then make them comfortable in their new position by bringing in material and flattening out the rushes. We now believe that the cock's larder of 1932 was an amateur effort to move the young, but that he was ignorant of his children's walking capacity and indeed of the whole business, which properly appertained to his absent wife. He knew he had to do something, but he got it all wrong, and we helped him out by carrying the prey from the larder to the nest. This year the streaky cock hardly ever visited the nest, but passed to his hen, who did all the feeding and moving of the young herself. When they flew both parents would pass direct to the young, either on the ground or in the air, but they made them work for their money by refusing to deliver the goods, until the young had exercised their wings in chasing their parents across the marsh.

Since three nests, one in 1932 and two in 1933, were kept under close observation for two to three weeks, and someone was often in the hide all day, we acquired a fairly accurate knowledge of the prey brought to the young. On an average the prey of Marsh-Harriers is much bigger stuff than that of Montagu's, and there are therefore less feeds in the day. Thanks to " the streaky cock's " larder of 1932 we could read his game book complete for a considerable period, and his kills were duly entered in the hide diary which was kept by each of its occupants. The following is an extract from the diary :—

Contents of Larder.

July 13th, 1932. 3 hindquarters of 3 fairly large young waterhens.
1 young reed-bunting.


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Young Marsh-Harriers


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1 young blackbird (beheaded).
1 young partridge.

July 14th, 1932. 1 young starling added to larder in morning.

July 15th, 1932. Hindquarters of two fairly large young waterhens.
1 young bunting (head attached).
1 young partridge.
Hindquarters of a frog.

July 16th, 1932. By 11 a.m. the following had been added to larder :—
1 young pheasant (beheaded).
1 small waterhen.

Judging by what we saw at all three nests the main prey was waterhen with leveret and young pheasant about equal second. Before the young were hatched we occasionally saw a cock harrier catch young mallard and teal, but no young duck were ever brought to the nest in our presence. The " streaky cock " was once seen at close quarters attacking a brood of waterhens. He flopped and bounced about from one side of the dyke to the other, like a clumsy retriever, and it was only after a number of ineffective grabs that he succeeded in catching one of the brood. The average number of kills brought in daily for a family of four, from a fortnight to three weeks old, appears to be about eight, but this of course varies with the size of the prey. The only parent which kept any discipline in the nest was " the red-tailed hen." She doled out the food evenly and fairly and there was very little squabbling. The behaviour at the other two nests was appalling and there was a row between the young at every meal. The strongest or most hungry member of the brood would, on spotting its parent in the air, secure a central position in the nest and, when the parent arrived, seize the food. It would hold the prey until it choked or became absent-minded, when one of its brethren would waddle across the nest with an air of complete abstraction, and then suddenly shoot out a claw and seize the food : the same process would continue with the next young bird. As soon as they could walk about, the young made seats in the rushes and tunnels leading away from the nest : the bird securing the prey would spread its wings and hold the entrances to these tunnels in order to prevent the others getting out, while it ate its fill.

Any attempt to photograph or even to observe Marsh Harriers at close range without long, slow, and careful prepara tion, is, I feel sure, certain to end in disaster. In no instanc have I secured a single photograph without six weeks' pre liminary work, during which the hide has been graduall advanced from about three hundred yards towards the nes Subterranean hides have been dug at dead of night by perchin posts and feeding places, but never yet has the quarry failed t spot the new heap of rushes or the aperture for the lens. Wha ever may be said against the Marsh-Harrier, he provides for th photographer that supreme difficulty of achievement, whic constitutes real sport.

There appears to be an idea that harriers are gettir too numerous, and even that nothing else can exist in the neighbourhood. The wealth of bird life around them is th best answer to that. The occupant of the hides by their nes was never out of sound of other birds, sedge-warblers, gras hopper-warblers, reed-buntings, water-rails, bitterns, snip plover, redshank, duck, and others. Moreover, judging by th many encounters witnessed, they themselves will see to it th there is no overcrowding from others of their kind. Apa from the risk, real or imaginary, of disturbance by inquisitiv bipeds, who may or may not be kindly disposed towards th birds, it is no easy job for a cock harrier to seize and hold property against his rivals, find and keep a wife and with h rear a family.

II

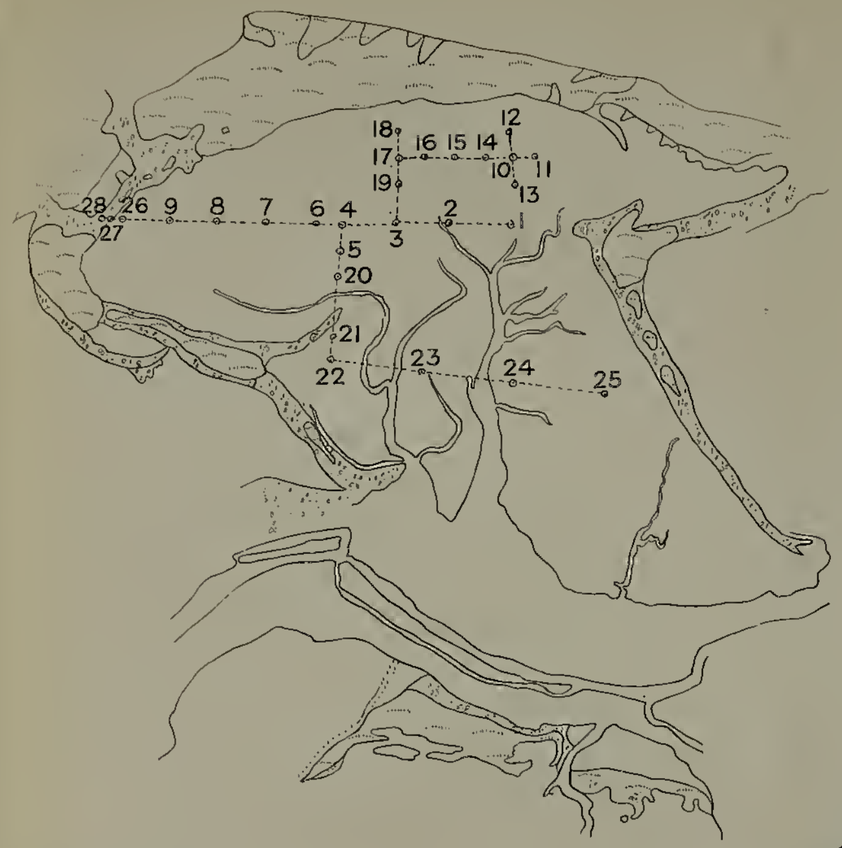
SCOLT HEAD ISLAND

Report for 1933

By J. A. Steers

During the whole of the past year the botanical and ecologic investigations of the island have been proceeding. Mr. V. Chapman has now more or less completed his field work, an hopes to summarize his main results in the forthcoming Han book on the island.

In June and July a fairly intensive investigation on the su structure of the marshes was carried out. A boring tool w



SAND

SURFACE MUD

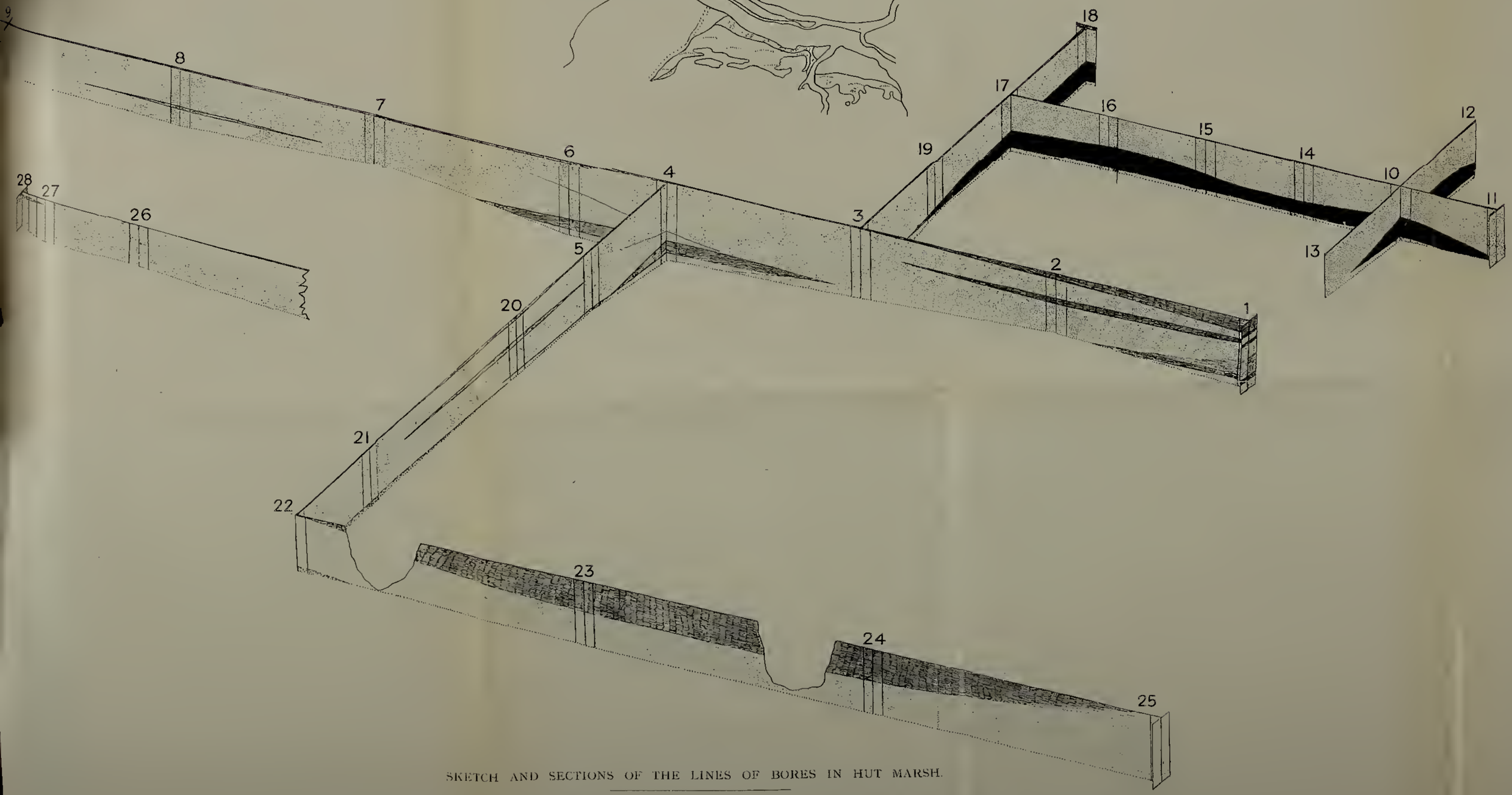
'HOLE' MUD

SHINGLE

APPROXIMATE SCALES:

HORIZ. 1 CM. = 20 YARDS.

VERT. 1 CM. = 4 FEET.



SKETCH AND SECTIONS OF THE LINES OF BORES IN HUT MARSH.

The upper sketch gives the positions of the bore-holes. The Hut is shewn as a small rectangle about half-an-inch above the figure 8 The line 22–25 will be seen to cross three creeks in the sketch: only two are indicated in the section. No attempt in either figure is made to shew the numerous small creeks which intersect the marshes.

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it by the Department of Botany at Cambridge, and after a od deal of hard labour a fair picture of the strata composing e island was obtained. The two main features which call comment in this place are, first, that sand, sometimes black colour, is the essential substratum of the island, and secondly, it in certain places there are holes, or pockets, of sticky ck mud resting on the sandy substratum, but often covered newer deposits of sand and mud. These are in their main ects very similar to the area of soft mud in the North Cockle ght Marsh. The exact significance of the pockets is not own. They appear to fill scour holes, but under what ditions the holes were scoured out it is at present impossible say. Plate 1 shews, in stereogram form, the main charac-istics of the sub-structure of the Hut Marsh. A shallow, t widely extended, pocket of mud in seen in bores numbered to 17. This mud is coloured solid black. The small tch above indicates the positions of the lines of bore es. The presence of shingle in holes numbered 21 and 22 presumably to be explained as the thinning out of the shingle m the small recurved ridge running north-eastwards from tcher's Beach. The positions of the two main creeks ining Hut Marsh are shewn on the section; it will be iced that their apparently pure mud banks are largely de up of sand with some mud.

A number of other marshes were similarly explored. e borings put down on the Great Aster Marsh gave in mselves no indication of rejuvenation, and there are now sons for believing that the "break-through" hypothesis Burnham Harbour which was supposed to have led to the ivenation of Aster Marsh is no longer tenable. In other ds, it is not improbable that the island has always been an nd. The reasons for this change of view will be discussed where, but it has been thought worth while to call attention he matter in this place.

The Far Point and Ternery have been re-mapped again by R. F. Peel, whose map (Plate 2) accompanies this report. very important changes have taken place during the past r, but the small dune, marked beyond the gap shewn on the 2 map, has now disappeared, as has also a certain amount of dune system of the Ternery proper. Other changes will be

more obvious if this year's map (1933) is compared with t published a year ago.

Further investigations have been undertaken in conne with beach-drifting and tidal currents along the main bea the island. Plate 3 shews the direction and strength o tidal currents just off Scolt Head as observed during complete periods of 25 hours. The division of the cu into an east- and a west-flowing part is clear, and the velc shewn on the curve for 8–9 July, a period of spring are rather greater than are those on the other curve, w was compiled from observations made during neap tides. observations were all made from an anchored boat w was well outside the breakers. Hence, the curves repr fairly accurately the general nature of the currents ac working upon the beach. Further observations were closer inshore with drift-bottles ; these agree with and co the boat observations which were made with a tide-pol the resulting curves are more irregular. This was only expected, even in calm or moderate weather.

The Submerged Forest Bed off the main beach at Bran has received some attention, as have the outcrops in Bran Harbour Channel. There is also an outcrop of peat at Hard*; the peat here, as revealed by boring, is about feet thick. It is hoped to be able to print a short acco the forest beds later.

Several enquiries (in likely places) have been made to find old maps of the Scolt Head area. There are many N county maps, but for the present purpose, as pointe below, they are of but little value. A certain amou interesting information has been gathered together, a described in the following paragraphs.

The Evidence of Old Maps

The recent changes in the configuration of the islan known fairly well, at any rate, since 1886, the first edit the six-inch map. The earlier history of the island, m obtained mainly from a study of its physiography. Old of the area are scarce, and county maps of Norfolk a this purpose useless, because either they conventionali

*A landing place used at low water and situated about 300 a north and east of the Staithe proper.

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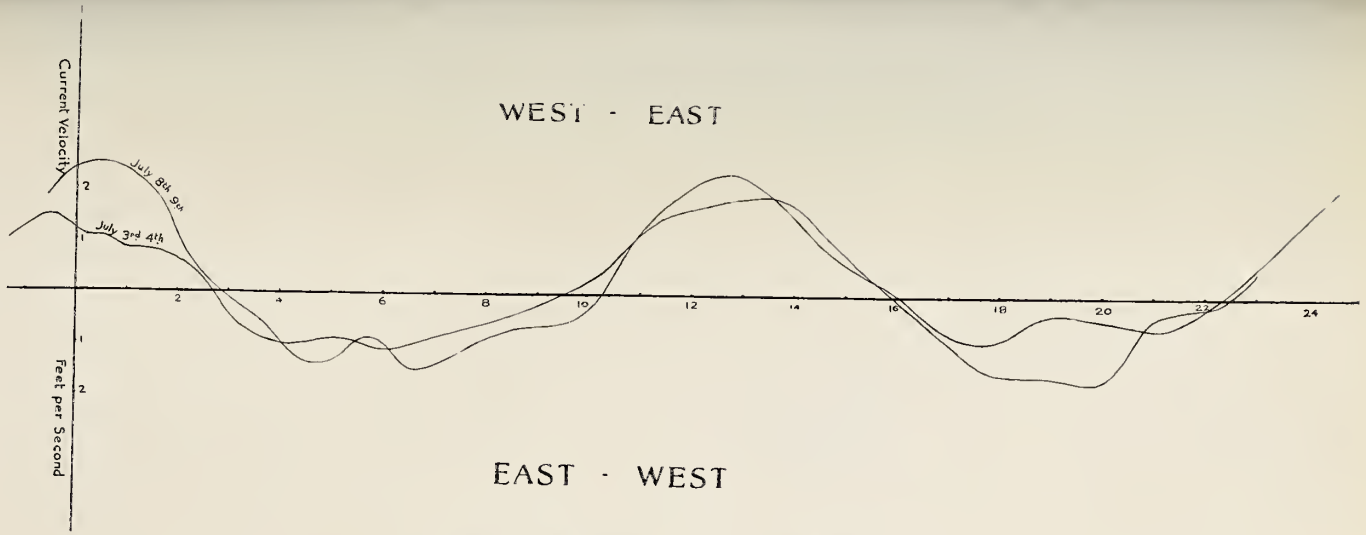
THE TERNERY AND FAR POINT -- JUNE 1933

[From a plane-table map by R. F. Peel



Tide Curves obtained from an anchored boat

The curves are plotted in such a way that high water on 3 and on 8 July correspond on the vertical line. Time is measured in hours along the horizontal line. When the curves are above the line the current is flowing to the east, and when they are below the line the direction of flow is to the west.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sland too much, or they miss it out altogether. Further, the cale in practically every case is so small that it does not help he present problem.

There may yet be some maps in private collections which hew this part of the coast on a large scale and in detail. But considerable number of enquiries have so far been unuccessful in finding them. If any one who reads these pages ıould know of such a map, it is greatly to be hoped that he ·ill communicate with the writer.

The first map here reproduced is from the atlas of Lucas anssen Waghenaer of Enklingven, and is dated 1585. The hotograph is not taken from the original, but from a copy which in the Central Public Library at Norwich, and it is slightly naller than the original. The map is mainly of historical terest. The Burn (Creake) River is shewn, and a spit of land ıd sand banks running westwards from it indicate the position, ıt not the form, of Scolt Head Island. Blakeney Point is ewn in a very similar way. It is useless to try to draw any ferences from the map, but as it is the earliest map to shew is part of the coast in any detail, it has been considered ›rth while to reproduce it. (Plate 4.)

We must jump about two hundred years to the next map. ıis is the map published by William Faden in 1797, and was ıde by Thomas Milne and Thomas Donald with other sistants. The photograph here reproduced is rather smaller an the original. The island is clearly shewn though appartly rather conventional in form. Norton Creek is called East eek, and the bank which now encloses Deepdale and Norton ırsh is not marked. Sandhills are indicated throughout the ıgth of the island, which is unbroken by any important gap. this way it differs a good deal from Bryant's map. The ›uths of Brancaster and Burnham Harbours are shewn in the ıd flats much in the same positions as those they now occupy. e western end of the island is in a position such as would be umed on physiographic evidence, and corresponds fairly ll with the maps which follow. (Plate 5.)

n 1824 appeared the first edition of the one-inch Ordnance vey map of the area. This differs a good deal from Faden's p. The island is shewn in rather " fragmentary " form, l two distinct breaks occur in the main line of dunes. It is

very difficult to establish the true meaning of these gaps. Th fact that a creek runs through each suggests definite brea in the shingle bar, but they may not be of any very materi significance. The eastern end of the island is definitely near (about a quarter of a mile) to Holkham than it is now. The also seems to be a distinct gap between House Hills and th dunes on the foreshore. Even to-day, the dunes are narro in this place, and the gap could easily have been filled by san The Wire Hills-Long Hills ridge is shewn as three separa "islands." It might easily have begun to form in this wa Brancaster and Burnham Harbours agree with Faden's and th succeeding map in essentials. One can scarcely suppo inaccuracy to characterize the Ordnance Survey, but th surveyors would probably not attach so much importance to sand island as to the mainland, and so we may perhaps assum that the breaks in the main ridge are more pronounced tha was actually the case. When the dunes were lower and possibl much more discontinuous than now, storms could easily brea through these gaps and form temporary channels, even thoug the main shingle bank remained virtually intact. It is certainl not necessary from the evidence of this and Bryant's map t assume that the island, regarded as a complex of *shingle* ridge irrespective of covering dunes, was in three or more parts. Th argument is strengthened when "Dugmore's" map is studied (Plate 6.)

Bryant's map of 1826 is very similar indeed to the first editio of the Ordnance Survey. The creek system, especially nea Brancaster Harbour, is less detailed, and two new name appear—Marram Hills and Ramsgate Hills. It seems mor than probable that it is based on the Ordnance Survey, and s it need not be discussed in detail here. (Plate 7.)

In the previous year, 1825, a detailed and large-scale surve of the island was made at the direction of J. Dugmore i connection with the Burnham Enclosure Award. This map i of much greater interest than any of the preceding. The mai ridge is shewn as continuous ; there are no gaps. House Hill meet the main ridge much as they do now. Privet Hill an ridge are marked, and Butcher's Beach and an early stage i the development of the Long Hills are clearly shewn Brancaster and Norton Channels, allowing for the swinging t


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Map of the Coast of Norfolk from the Atlas of Lucas Janssen Waghenaer, of Enkh
dated 1585

This plate is reproduced from the authentic copy in the Central Public Library, Nor
and is smaller than the original atlas map.

Part of the "Topographical Map of the County of Norfolk" .... by Thomas Donald, Thomas Milne, and assistants
Published by Wm. Faden, 1797

This photograph, taken from the copy in the Central Public Library, Norwich, is rather smaller than the original.


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eproduction of the One-inch Ordnance Survey Map of 1824. The tograph is taken from the electrotype map dated 1878, but in respect the coastline is identical with the First Edition copy kept in the versity Library, Cambridge.


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ich they are subject, agree with their general positions t day. Norton Creek is misnamed Thro'Land Creek, and by ro'Land creek is presumably meant Trowland Creek which narked but not named. (Plate 8.)

Considering that the map was made for a special purpose, l was a survey carried out of a particular area, it is reasonable attribute to it greater accuracy than that of the other maps. e surveyor was concerned with local problems, and so uld delineate the adjacent coast with as much care as sible. As with both the editions of the six-inch map, no ication of lateral ridges which are not dune covered is given. se would not interest the pure surveyor; they have a siographical significance only. The map, together with associated deeds, is preserved in the Shirehall at Norwich.

The next map, in which complete trust may be placed, is the edition of the six-inch Ordnance Survey. There is a close mblance between it and the 1825 map, but it shews much e detail. This map was described briefly by the Author in ort paper published in the *Transactions of the Norfolk and wich Naturalists' Society*, Part I, Vol. XII, 1924-25, p. 84. changes since 1886 were described there also, and the maps the Ternery which have been published during recent s give a far better indication of the recent changes than any written description. (Plate 9.)

beginning has also been made this year with an entomological stigation of the area. Mr. P. Brodie has collected a large ber of species and hopes to be able to continue his work in re years. His collection is being referred to experts, and it ped to be able to draw up a preliminary list of identifications, necessarily for publication at this stage, but for reference. list, when made, will be available should anyone wish to ult it if application is made to the writer.

ne selection of stations for stereophotographs has been nded, and Mr. S. Dicks has taken stereo-pairs from several em.' There is little point in publishing any of these photo- hs at this stage, but if the work can be carried on in future s by a competent person, some interesting comparative ographs should be available. Two photos of the Spiral h were printed in Part II. Vol. XIII, and will serve as specimens for the time being.

BOTANY

By V. J. Chapman

Several new additions to the island flora have been record during the year 1932-33. In the following list species mark with an asterisk must, for the time being, be regarded as distin from the true flora until further records have been obtain showing that they really have been established. Those mark E.A.E. were found by Mr. Ellis of the Norwich Castle Museu

Phanerogams.		Place found.
Ranunculaceæ	Ranunculus bulbosus, L.	House Hills
(E.A.E.)	Ranunculus sceleratus, L.	Norton Hills Pi
Cruciferæ	Cardamine hirsuta, L.	House Hills
Violaceæ	Viola canina, L.	Old Dunes
*Caryophyllaceæ	Silene cucubalus, Wibel.	Ternery
	Lychnis vespertina, Sibth.	Ternery and Norton Hills
Geraniaceæ	Erodium moschatum, L'Herit.	Old Dunes
Aquifoliaceæ	Ilex aquifolium, L.	Norton Hills Pi
Leguminosæ (E.A.E.)	Vicia hirsuta, Koch.	Norton Hills Pi
(E.A.E.)	Vicia sativa, L.	Norton Hills Pi
(E.A.E.)	Vicia tetrasperma, Mœnch.	Norton Hills Pi
	Vicia lathyroides, L.	Hut Dunes ar House Hills
Rosaceæ	Rosa canina, L.	Hut Dunes
(E.A.E.)	Agrimonia eupatoria, L.	Long Hills
Onagraceæ	Epilobium hirsutum, L.	Norton Hills Pi
Compositæ	Taraxacum lævigatum, D.C.	Old Dunes
*Gentianaceæ	Erythræa centaurium, Pers.	Ternery
*Scrophulariaceæ (E.A.E.)	Veronica officinalis, L.	Long Hills
*Labiatæ	Calamintha acinos, Clairv.	Ternery
*Boraginaceæ (E.A.E.)	Lycopsis arvensis, L.	Long Hills
Gramineæ	Agrostis stolonifera var. subrepens, Bab.	Old Shingle
	Cynosurus cristatus, L.	West Steps to H
	Dactylis glomerata, L.	Hut and Hou Hills
	Poa pratensis var. subcœrulea, Sm.	Old Shingle ar House Hills
	Bromus sterilis, L.	Hut Dunes
	Lolium perenne, L.	Norton Hills
	Agropyrum acutum, R. and S.	House Hills
	Hordeum murinum, L.	Hut Dunes

BRITISH MUSEUM
NATURAL HISTORY

Part of A. Bryant's "Map of the County of Norfolk"
published December 1st, 1826

This photograph, taken from the copy in the Central Public Library, Norwich, is rather smaller than the original.

PLAN
of the
MARSHES
(Embanked *and* Unembanked,)
within the Parishes of
Burnham Norton and Burnham Deepdale,
in the County of
NORFOLK,
to which the annexed Copy of
Award refers
1825.
P. Bigmore.

GERMAN OCEAN
HORN BURN
Plantation Channel
BRANCASTER
STERR
Parish
BURNHAM NORTON
Parish
BURNHAM DEEPDALE
Parish
BURNHAM OVERY
Parish
The Sea Beach
Dowsy Blyth Esqr
HENRY BLYTH, ESQR
HENRY BLYTH, ESQR
Allotments
Old Mill Plant
Scale of Chains

SCOLT HEAD ISLAND, 1825

This photograph is taken from the original map which is preserved in the Shirehall, Norwich.

BRITISH MUSEUM
NATURAL HISTORY

BRITISH MUSEUM
NATURAL HIST

A certain number of fungi have been recorded including (1) *Puccinia tripolii*, Wallr. on *Aster tripolium*. (2) *Puccinia cirsii* Lasch on *Cnicus arvensis*. (3) Four species of Uromyces were found ; *Uromyces scirpi*, Burr, the aecidia only, on *Glaux maritima* ; *Uromyces salicorniæ*, De Bary (Teleutospores and Uredospores) on *Salicornia herbacea* ; *Uromyces chenopodii* on *Suæda maritima var. flexilis* (This is a rare species and only a few infected plants were found) ; *Uromyces sparsus*, Lev., Aecidia Uredo and Teleutospores on *Spergularia media*. The Uredospore stage is very rare in England and the record of Aecidia is the first to be made in this country. There are only two further records of Aecidia on the Continent. This species was the most important addition to this flora made during the year. Many infected plants were found. (4) *Cystopus lepigoni* was found on *Spergularia media* in fair quantity, especially in the early summer. (5) The larger fungi have not yet been investigated, but *Gyromitra esculenta*, Pers. and *Tulostoma mammosum*, Fr. are recorded, the identifications being those of Mr. Ellis of the Norwich Museum.

Further work on the algæ has been carried out, but it is not proposed to publish any results yet as their distribution over the area has not yet been completed, and there are also difficulties, which still remain to be settled, regarding the marsh forms of *Enteromorpha* spp. It may be said that the area is quite rich in algæ, the total number of species being about 100.

Two new galls are recorded from the island, both on grasses. Nematoda : *Tylenchus tritici*, Bastian, on *Agrostis alba* ; Diptera : *Chlorops tæniopus*, Meigen, on *Agropyrum pungens*.

In the summer of 1933 quadrating of the marshes was commenced, valuable help being given by Mr. I. Morrison. When this work is complete it will help greatly in determining the plant succession.

Two tide-gauges were in use throughout the year ; it is proposed to let them record for another year, during which time wind observations will also be made. Both the tide-gauges and the anemometer are in the charge of Mr. Chestney, the watcher.

In the report for last year the attack of the cinnabar moth caterpillars on *Senecio jacobæa* was commented on, and it

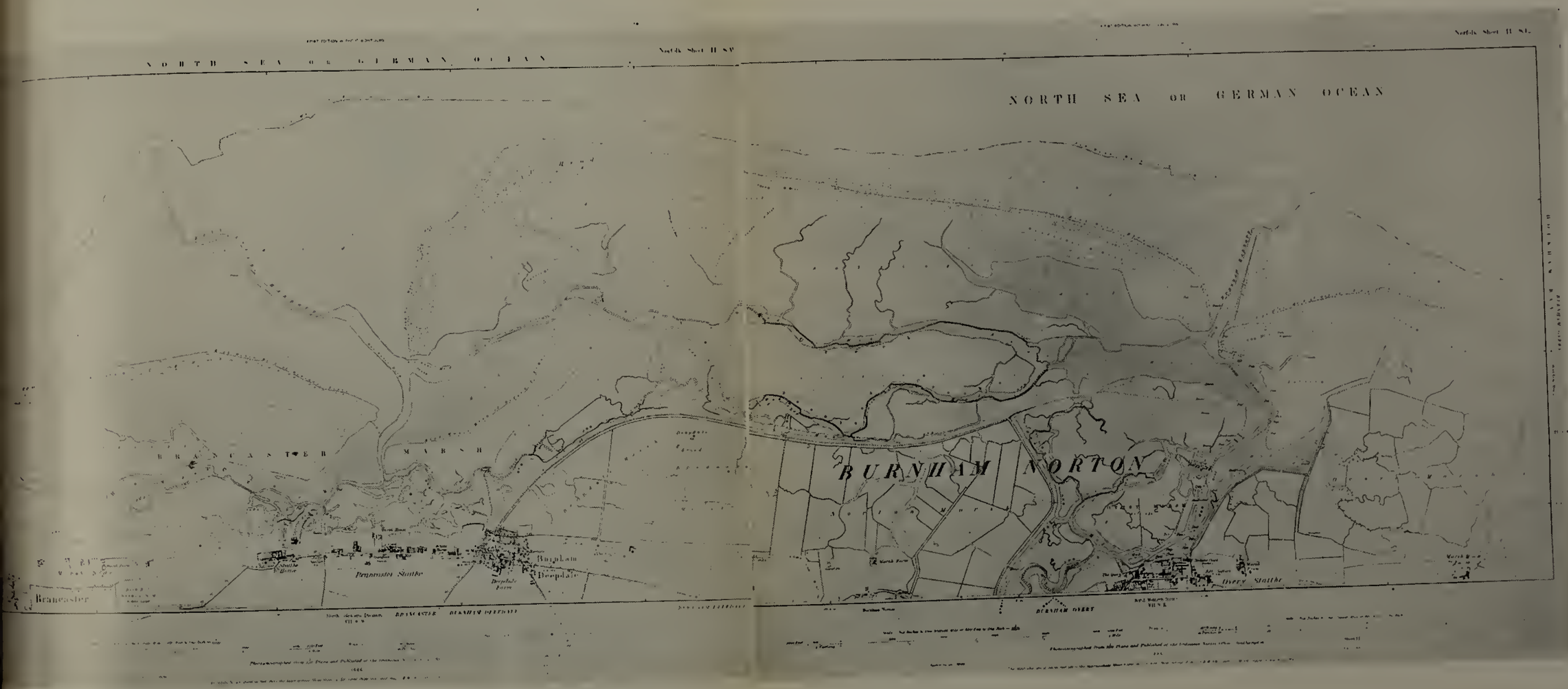
was suggested that this was one means of biological control. This view was further strengthened this year. There were very few plants of *Senecio jacobæa* on House Hills and they were eaten down almost as soon as they appeared. The result was the entire absence of this species at the flowering season from House Hills this year. On the other dunes there have been plenty of flowers as the moth is not nearly so abundant outside House Hills. It therefore seems that in two years the attack of the cinnabar moth is sufficient to wipe out the ragwort.

Earlier in the report it has been suggested that the hypothesis of Burnham Harbour originating as a break-through is incorrect. The botanical evidence for and against this view has been carefully investigated and it is concluded that this evidence is not in favour of the rejuvenation of the Great Aster Marsh, but strongly in favour of the island always having been an island.

The collection of typical island plants which is being kept at Dial House is now practically complete, and it has been checked by Dr. W. B. Turrill of Kew, to whom we are very grateful.

As some of the levelling-stations established in 1928 were found to be unsatisfactory and in some cases liable to be displaced by waves, some new lines of level were made this year. Hence the figures printed on p. 466 of the *Transactions* in Vol. XII, Part IV, should be discarded.

Plates 6 and 9 in this Report have been reproduced by permission of the Director-General of the Ordnance Survey.



Scolt Head Island in 1886

This plate is a photographic reproduction of the two sheets of the Six-inch Ordnance Survey Map (1886), First Edition, kept in the University Library, Cambridge.

Reduced from the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office.

BRITISH MUSEUM
NATURAL HISTORY

III

ON THE DAY TEMPERATURES OF SAND DUNES IN RELATION TO THE VEGETATION AT BLAKENEY POINT, NORFOLK

By Prof. E. J. Salisbury, D.Sc., F.R.S.

The two chief adverse factors affecting plant life upon dune habitats are the high mobility of the soil and the low water retaining capacity of the sand consequent upon the relatively small surface which the coarse sand grains present and the deficient organic component, at least in the earlier phases of the dune succession. Both the high mobility and the low water content tend to be accentuated with increase of temperature. The increased evaporation, consequent upon a higher temperature, not only accelerates the transpiration from the surface of the plant but also water loss from the surface of the soil so that the drier sand-grains are more easily moved by air currents. It is evident therefore that a knowledge of soil temperatures in dunes is essential if we are to assess the rigours of the conditions with which the colonising species have to contend.

In July, 1931, during a period of two weeks, students of the Botanical Department of University College, London made a large number of simultaneous temperature observations, in several hundred stations, and a number more observations were similarly made in April, 1932. The limited periods of the year over which these records extend would render the observations of very restricted value were it not that their chief importance lies, not in the actual temperatures observed, but in the relations which they bear to one another. The actual temperatures attained must necessarily depend on the weather conditions at the time of the observations and, though fine sunny weather and cloudy conditions, both with and without wind, were experienced during each of the periods mentioned, it is evident that, though a fair sample, they do not represent the complete range of conditions which may be experienced during the growing season. Nevertheless the assistance of a considerable number of helpers made possible a comparative study of which the value is dependent on the large number of stations utilised and the number of simultaneous readings obtained.

Fig.

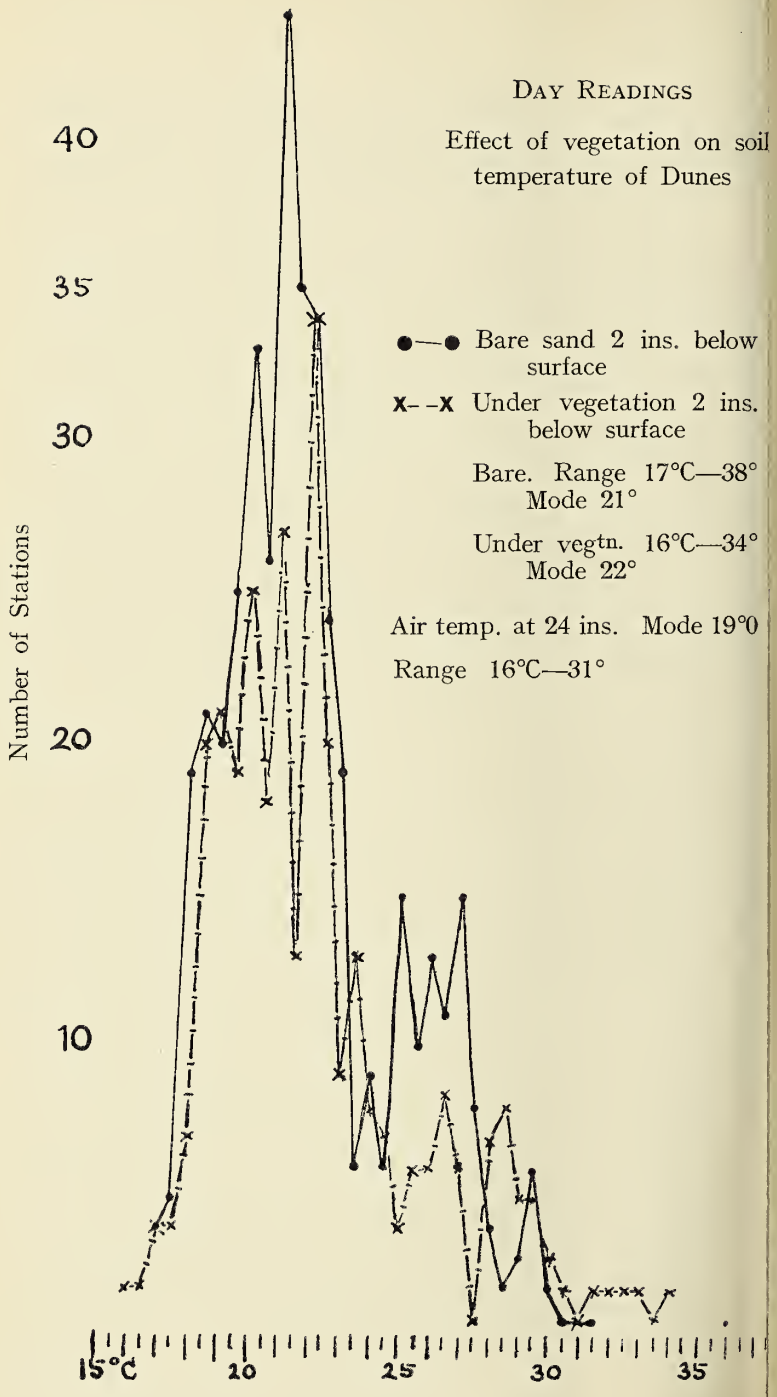
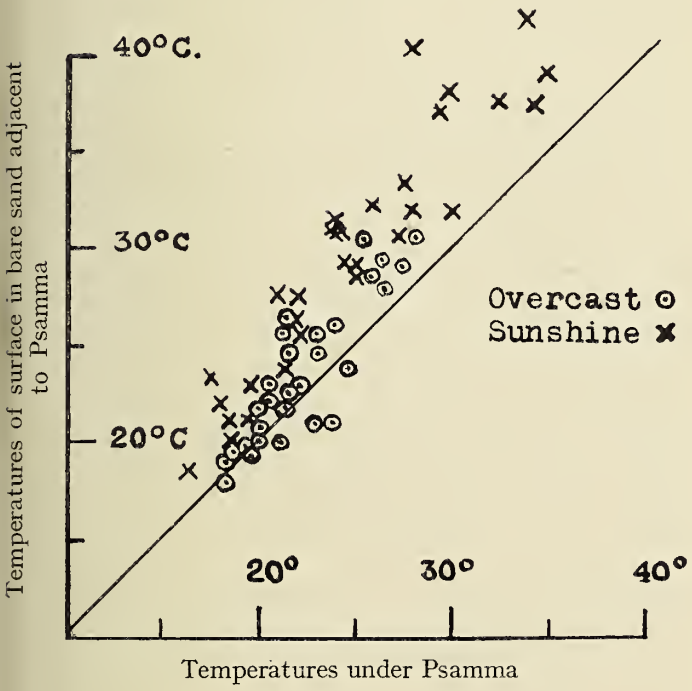

Day Readings
Effect of vegetation on soil temperature of Dunes
●—● Bare sand 2 ins. below surface
x--x Under vegetation 2 ins. below surface
Bare. Range 17°C—38° Mode 21°
Under vegtn. 16°C—34° Mode 22°
Air temp. at 24 ins. Mode 19°0
Range 16°C—31°
Number of Stations
40
35
30
20
10
15°C
20
25
30
35

Fig. 2


40°C.
30°C
20°C
Overcast ⊙
Sunshine ✖
20°
30°
40°
Temperatures of surface in bare sand adjacent to Psamma
Temperatures under Psamma

The procedure, at each station, was to take temperatures at four different levels simultaneously. The levels selected were :—2-ins. below the surface of the sand ; the surface (with the bulb of the thermometer just covered) ; the air at 2-ins. above the surface ; the air at 2-ft. above the surface.

The author would wish to express his indebtedness to the numerous helpers and in particular to Dr. Barbara Russell-Wells who not only assisted in the organisation of the field work but also in the arduous task of classifying the very large mass of data obtained.

(*a*) The Effects of Vegetation.

If we compare the surface temperatures of bare areas in dunes with those under various types of vegetation (c.f. Fig. 1), it is at once clear that the effect of the plant covering is, in general, to reduce the temperature of the surface sand by from one to four degrees centigrade. Actually the average temperature of the surface sand under vegetation is a trifle higher than that under bare sand viz. 22.18°C for the former as compared with 22.02°C for the latter. This, in view of the shading effect, might appear surprising were it not for the fact that, in high winds, the bare sand may be cooled considerably at the surface and, moreover, the sand amongst vegetation is often darker than the bare sand owing to the presence of more humus and thus, together with the vegetation itself, absorbs heat more readily than the lighter coloured bare areas. But, owing to the differential influence of the diverse vegetation types, such a generalisation is misleading. A more satisfactory comparison can be made if we compare the surface temperatures of bare sand and sand occupied by vegetation of particular types. It should be emphasised that for this purpose readings were taken simultaneously in pairs of stations, one on bare sand and the other on a comparable adjacent area occupied by the selected vegetation.

A comparison of surface temperatures in bare areas and in clumps of *Psamma arenaria* illustrates the shelter effect very clearly. The data from sixty pairs of stations are represented in Fig. 2. Here each surface temperature of the bare sand is plotted as an ordinate, and the surface temperature of the

comparable area under *Psamma* is plotted as an abscissa. If there were no difference between the temperatures in the two types of station the data would, of course, all be situated on the diagonal line representing $x = y$. In the figure the dots represent readings during overcast or cloudy conditions whilst the crosses represent readings during sunshine. Considering the latter first, we note, as was to be expected, that the readings under *Psamma* are invariably lower than in bare sand, due to the shading effect which is seen to become more pronounced as the temperature rises. If we divide the readings into groups, differing by five degrees with respect to the bare-sand temperature, and average the differences of temperature under *Psamma* we find that between 15°C. and 20° C. the average difference is 3°C.; between 20°C. and 25°C. the average difference is 4.5°C., and between 25°C. and 30° C. the average difference is 6°C. The data in each category are too few to be conclusive, but the fact that for each rise of five degrees the difference augments by the same amount, namely 1.5°C., suggests that the data may actually represent a close approximation to the real trend of the temperature curve. Under conditions when the temperature of the bare sand is between 30°C. and 35°C. the temperature of the surface shaded by *Psamma* might be expected therefore to be about seven and a half degrees lower. Only three readings under such conditions are actually available and these give an average difference of only 5.2°C. But little if any importance can be attached to this figure. When we turn to the data obtained under overcast or cloudy conditions we find the same tendency for the divergence in the readings to become more marked as the temperature rises, but with the striking distinction that an appreciable number of the lower readings shew a higher temperature under *Psamma* than for exposed sand. This is doubtless a consequence of the protection which the grass affords against air currents, thus retarding the removal of the warm air from above the sand surface. The *Psamma* thus has a stabilising effect upon the surface temperature, but undoubtedly, the most significant feature, as it affects vegetation, is the markedly lower maximum temperatures attained in the shelter of the grass which is probably not only beneficial to the *Psamma* itself but is of even more importance for the incoming ephemerals. Since temperatures of over 42°C. may be attained

Fig. 3

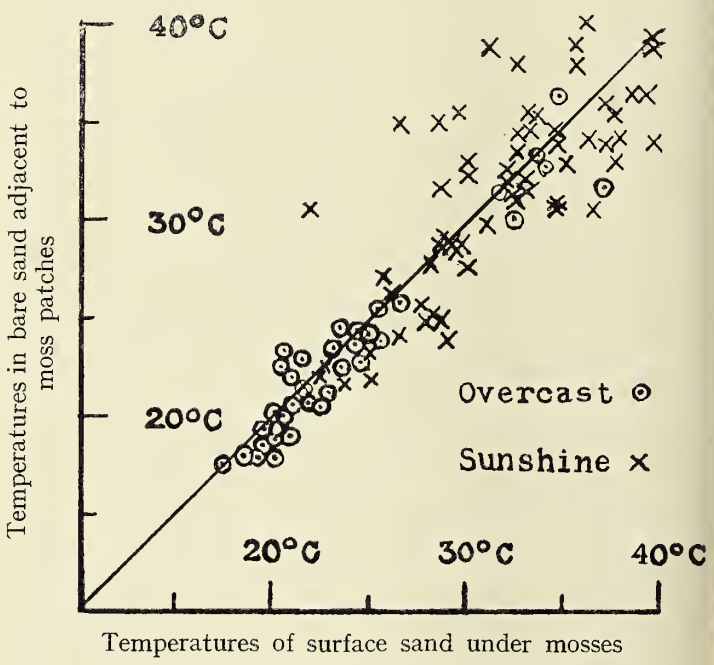
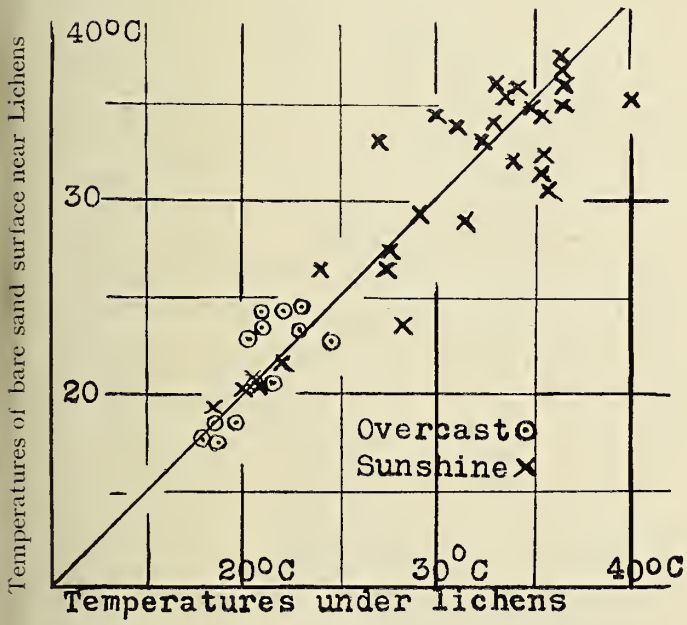

40°C
30°C
20°C
Overcast ⊙
Sunshine ×
20°C
30°C
40°C
Temperatures in bare sand adjacent to moss patches
Temperatures of surface sand under mosses

Fig. 4


40°C
30
20
Overcast ⊙
Sunshine ×
20°C
30°C
40°C
Temperatures under lichens
Temperatures of bare sand surface near Lichens

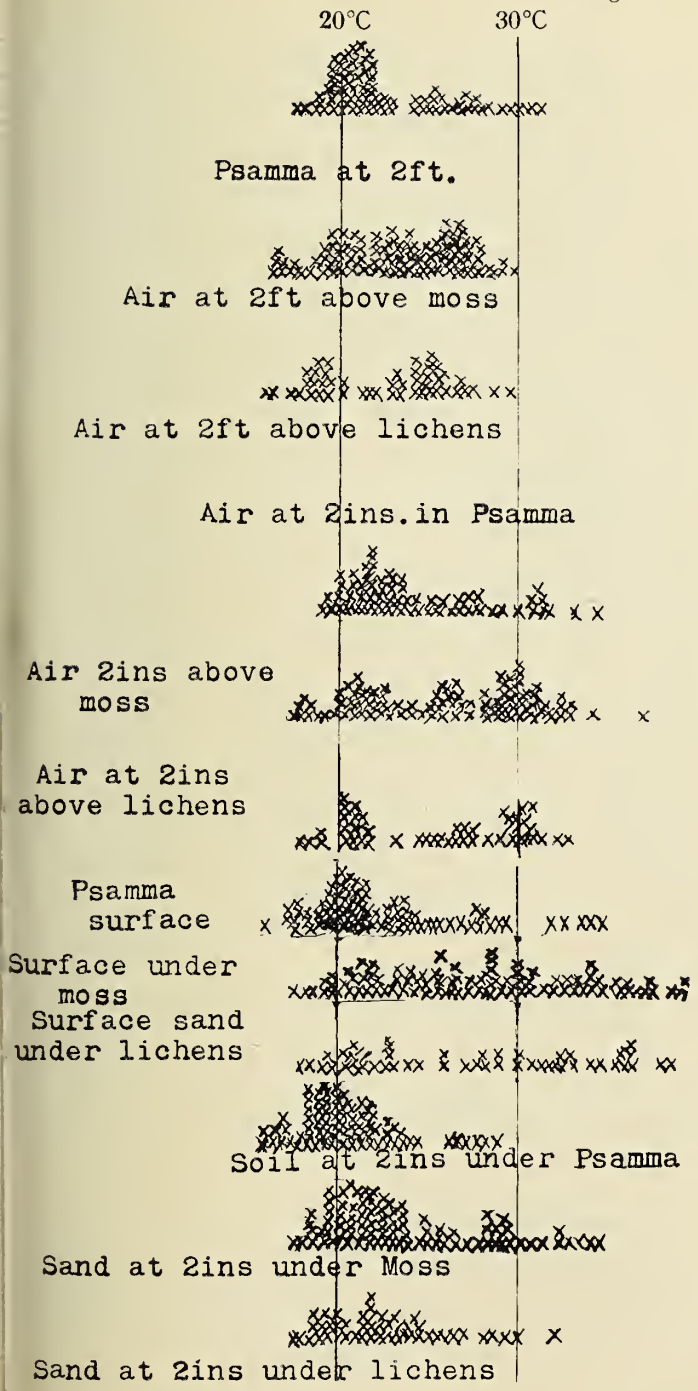
at the surface of the bare sand this factor may obviously b important in the early phases of the succession.

When we turn to the vegetation of the later dune phases, th shading effect is of a different character. The *Psamma* itsel has become sparse, but the sand surface is more completel covered with mosses and lichens though usually interspers with numerous small bare areas. Even where the carpet o vegetation is more or less continuous the condition is, in reality a mosaic of exposed and shaded surfaces, so that the temperatur at any one spot is an average of the conditions immediatel around.

Comparison of the surface temperatures in bare areas an under mosses (*Tortula*, *Brachythecium*, etc.) from the olde dune phases (c.f. Fig. 3) shews that the temperatures attaine under the moss covering can attain as high temperatures a the corresponding bare areas. The sand under a moss ma has an appreciably higher organic content than the bare area in general and, usually, a higher water content. Despite th increased heat conduction, resulting in the main from the bette contact between the soil particles, which naturally tends t lower the temperature which the surface attains, we find tha no less than fifty-eight, out of a total of ninety-eight pairs o stations, shewed a higher temperature under the moss covering Furthermore, though the percentage is greater under overcas conditions the proportion is high in bright sunshine. Fa then from producing a shading effect, the moss covering tend to accentuate the high temperatures; an effect that mus be attributed to the dark colouring of the moss covering actin like a black-bulb thermometer. The influence of a liche covering (Fig. 4) is similar, the temperatures, here too, bein frequently higher than on adjacent bare sand. In severa instances the sand under the lichen mat was five degrees highe than that of the uncovered sand, and under a covering of mosse a difference of as much as six degrees has been recorded. It should, however, be noted that differences of even greate magnitude in the other direction have been recorded, particu- larly where the bare sand was appreciably darkened through admixture of humus.

The temperature gradient in the three types of vegetation studied is shewn in Fig. 5. For each of the four levels investi-

Fig. 5


20°C
30°C
Psamma at 2ft.
Air at 2ft above moss
Air at 2ft above lichens
Air at 2ins.in Psamma
Air 2ins above moss
Air at 2ins above lichens
Psamma surface
Surface under moss
Surface sand under lichens
Soil at 2ins under Psamma
Sand at 2ins under Moss
Sand at 2ins under lichens

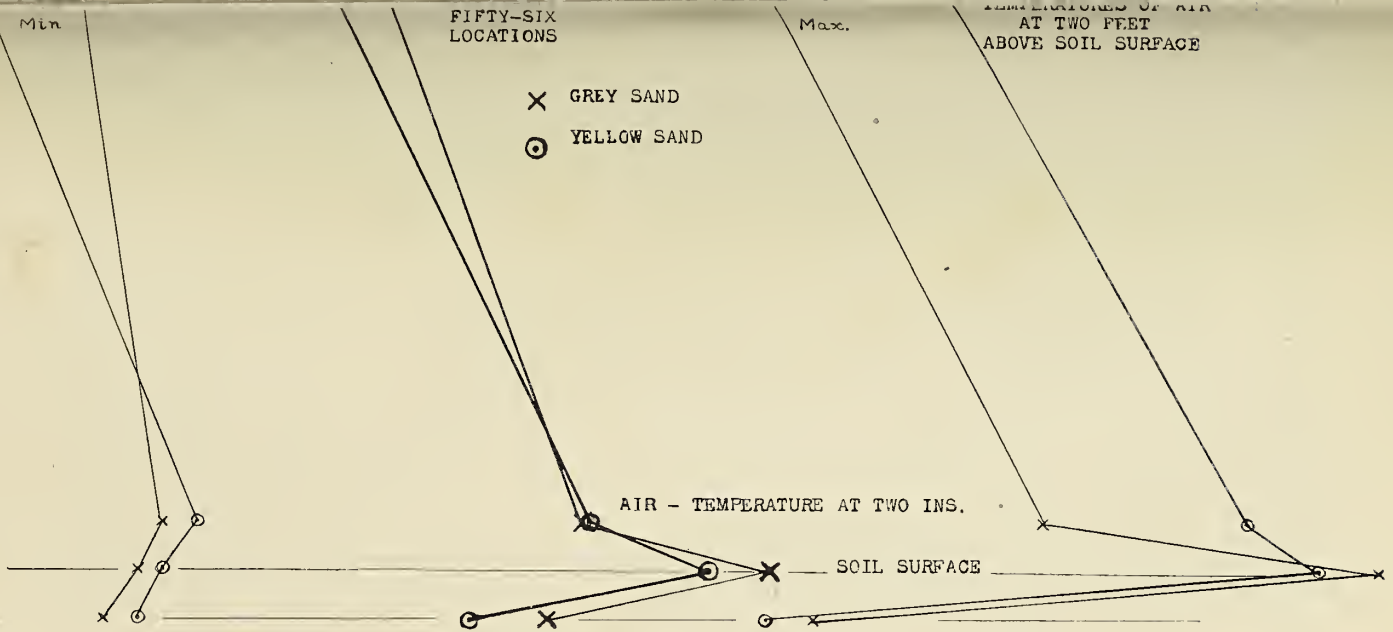
gated the data are plotted as a histogram. It is evident tha at the two foot level the air temperatures tend to attain highe values over the moss and lichen areas. Most of the data fo *Psamma* cluster around 20°C. whereas over moss the majorit of the readings are between 20°C. and 28°C. Over lichens th air temperatures tend to form two groups around 19°C. an 25°C. respectively. Similar features are shewn when the ai temperatures at the two inch level are compared. In *Psamm* the modal value is about 22°C. whereas, during the sam period, the majority of the readings over moss are in the regio of 30°C. Over lichens the air, at this level also, exhibits bimodal grouping of the temperatures.

The surface sand under *Psamma* again shews a mode at 20°C with a range from 16.1°C. to 35.2°C. whilst at two inches belo the surface the sand shews a mode at 19°C. and a range fro 16°C. to 29°C. Under mosses, the surface shews a wide rang from 17.5°C. to 39.8°C. with no definite mode but a majo grouping between 20°C. and 30°C. At two inches below th moss covering the temperature range is from18.5 to 25°C. an there is here a definite mode in the region of 21°C. with a slightly assymetrical grouping, mainly towards the higher readings. Under lichens, the sand temperatures shew a similar grouping to those under moss, and there is no indication of the bimodal grouping shown by the corresponding air temperatures. This latter feature is, therefore, probably due to the fact that though the lichens, like the mosses, tend to increase the amount of radiant heat absorbed and so raise the temperature, they never form so effective a covering and hence the exposure effect is more pronounced.

We have already noted that the average temperature of the bare sand is 22°C. which is above the modal value for sand under *Psamma* but below the mean temperatures and modes for sand under moss or lichens, hence the average for sand under vegetation treated collectively is almost the same as that for bare sand, as mentioned above.

(*b*) Effect of Sand Colour.

The effect of the colour of the surface upon the temperature has already been referred to and, in order to estimate the degree of importance of this factor, simultaneous temperature



Soil-Temperature at depth of 2 ins.

Comparison of Air-Temperature and Soil-Temperature Gradients in Areas of Yellow Sand and Grey Sand (Sand with Humus) Day Temperature in August

Fig. 6

readings were obtained from pairs of adjacent areas, the one where the sand was yellow, the other where the sand was grey owing to the presence of humus. Fifty-six pairs of stations were examined in this way and it was found that where the sand was yellow in colour the surface temperature had a mean value of 22.13°C. as compared with a mean temperature of 22.6°C, for grey sand. At a depth of two inches the mean value for yellow sand was 20.3°C. and for grey sand 20.°C. (c.f. Fig. 6). In bright sunshine differences of three or four degrees may occur at the surface but, owing to the greater heat conductivity of the darker sand (even in the dry condition this is the case as the humus particles help to fill the gaps between the sand grains), the temperature differences are not a complete measure of the difference in amount of radiant heat absorbed. In dull or cloudy weather the differences are small and the grey sand may, actually, show a lower temperature at the surface than adjacent yellow sand, but, usually, in such circumstances the subsurface beneath the grey sand will be found to have a higher temperature than the subsurface beneath the yellow. In other words the heat absorbed by the latter tends to be retained near the surface, whilst in sand richer in organic matter the heat absorbed is passed on more rapidly to the region where the ephemeral vegetation has most of its roots.

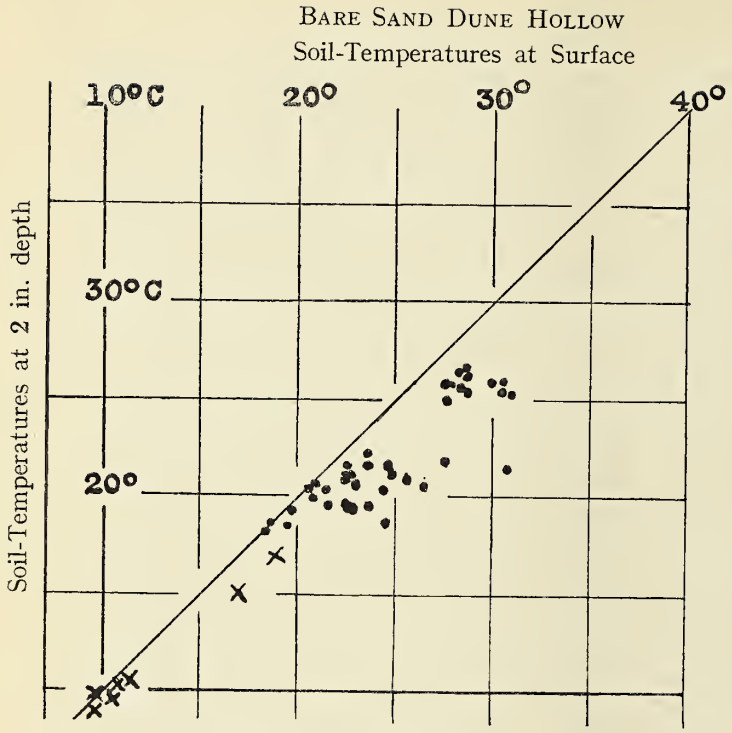
(c) Temperature in Relation to Topography.

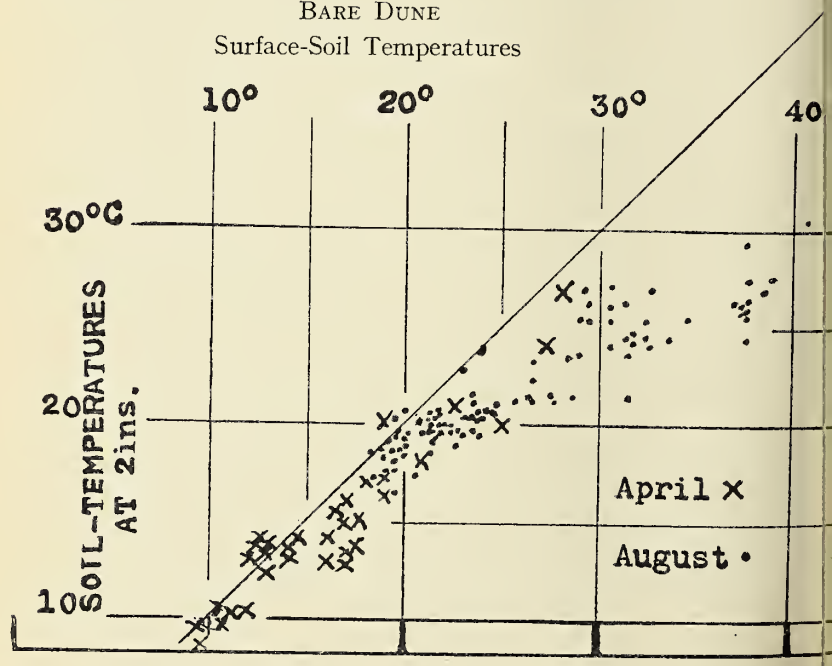
The relatively high temperatures of the surface of bare sand which may attain over 42°C. in the sun (ca. 108°F.) is, of course, in large measure due to the low rate of heat conduction which sand exhibits. With the increase of organic content which accompanies the edaphic succession (c.f. E. J. Salisbury. The soils of Blakeney Point. Ann. Bot., Vol. XXXVI, pp. 391-431, 1922) the water content increases and, mainly from the better contacts thus established, the conductivity improves. So that, though as we have seen, the resulting darker colour brings about an augmented heat absorbtion, the increased rate at which this heat is transmitted to the subsurface layers, and to some extent the increased heat requisite to raise an equivalent volume of moister sand to the same temperature, may even more than compensate for the colour effect just considered. If, indeed,

we compare the sand temperatures on the landward slopes of successive dune ridges, from the youngest to the oldest, we find that the bare sand has, on the average, a very similar temperature on all three ridges, despite the increasing organic content and accompanying darkening of the surface. But, comparing the temperatures two inches below the surface, the average is about half a degree higher on the second ridge than on the first (23.6°C. as compared with 23.08°C. for ridge 1). This, despite the fact that the corresponding surface temperature is in fact a trifle lower (27.4°C. as compared with 27.63°C. for ridge 1). The temperature of the third ridge at two inches below the surface averages 23.3°C. as compared with 27.6°C. at the surface. It is evident then, that with comparable mean surface temperatures on both the first (youngest) and third (oldest) ridges the average temperatures at two inches depth approximate more closely to the surface temperature on the third ridge than on the first, thus bearing witness to the higher heat conductivity of the older dune soil which may well account for the fact that the mean surface temperature is, in fact, a trifle lower, despite the darker colour of the dune soil. This conductivity effect is further illustrated by the difference between the surface and subsurface layers of the crests of the second and third ridges. This difference for the younger crest (mean of 44 stations) is 4.75°C. whereas for the older ridge it is only 3.5°C. (mean of 57 stations). A further example is furnished by comparing moss-covered areas on the crests of the second and third dune ridges. The similar vegetation ensures an approximate uniformity of colour in the heat-absorbing surface. Actually, the surface temperatures of twenty-five moss patches average the same for the two ridges namely 27.03°C. But, whereas on the younger dune the temperatures at two inches depth averaged 23.1°C., a difference of 3.93°C., on the older ridge the subsurface gave a mean value of 23.8°C. or a difference of only 3.23°C.

It will then be apparent that, in general, the shallow roots of plants on the older dunes will be at a slightly higher temperature than those of plants on the younger phases, but that, particularly where the sand is relatively bare, the air temperature just above the soil surface will tend to be as high on the younger as on the older dunes, or even higher.

The lag in transference of heat through the soil, due to the low

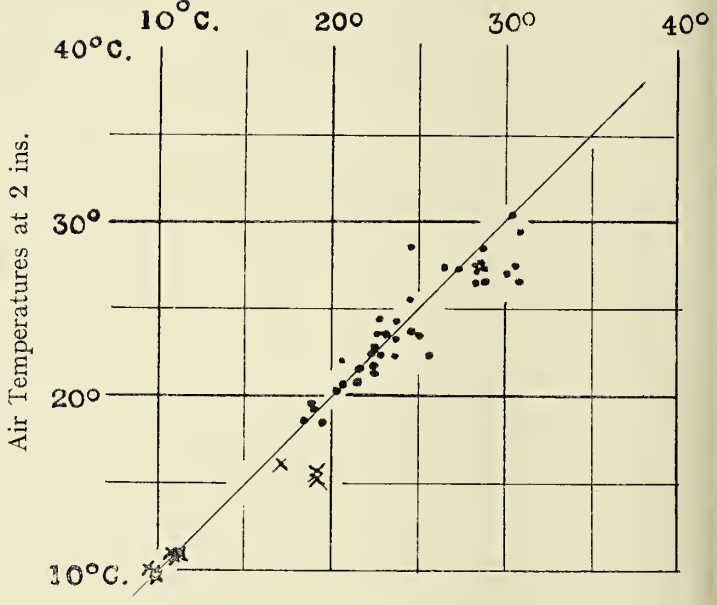

Bare Sand Dune Hollow
Soil-Temperatures at Surface
10°C
20°
30°
40°
30°C
20°
Soil-Temperatures at 2 in. depth


Bare Dune
Surface-Soil Temperatures
10°
20°
30°
40
30°C
20
10
SOIL-TEMPERATURES AT 2ins.
April ×
August •

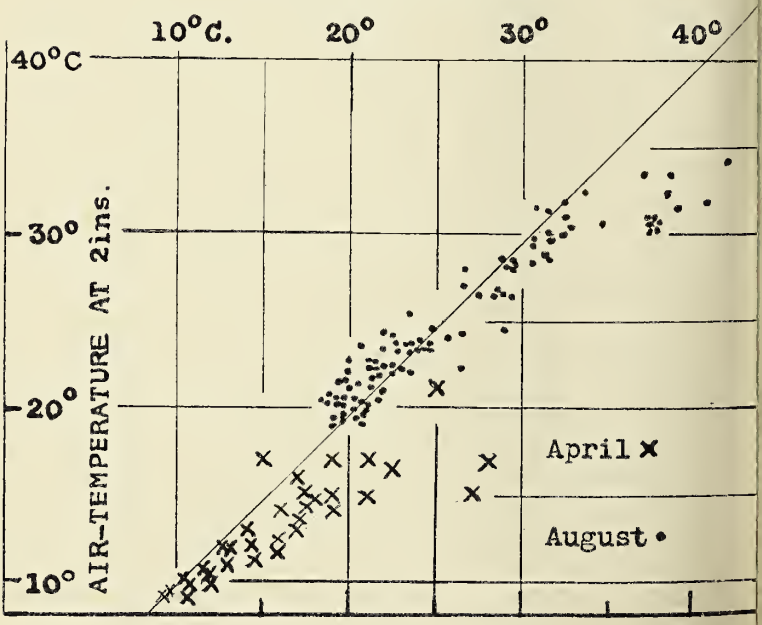
heat conductivity of the sand grains interspersed by air gaps, is well shewn if we compare the temperatures of surface and subsurface taken simultaneously in ninety-seven distinct stations on bare sand. Plotting the soil temperature at two inches as ordinates (x) and the temperatures of the corresponding subsurfaces as abscissæ (y) we note that the observations are grouped along a diagonal line which diverges more and more from the line $x = y$ as the temperature of the surface rises (c.f. Fig. 7 below). In a dune hollow the same feature is exemplified (Fig. 7 above,) but the surface temperatures do not attain such high values and the general trend of the readings shews a slightly less marked divergence from the line $x = y$. This closer approximation between surface and subsurface temperature is clearly to be correlated with the higher average water-content in a dune hollow, involving greater specific heat and higher conductivity for heat.

The relations between the surface temperature of the sand and the air temperature just above the sand surface are more complex. It will be noted that, when the one is plotted against the other (Fig. 8 below), the observations constitute a diagonal grouping the general direction of which crosses the line $x = y$ at about 25°C. Here too, the difference between the temperatures at the two levels increases with extremes of temperature, but in both directions. At surface temperatures below 25°C. about eighty per cent. of the day readings in the air at two inches are higher than those of the sand surface immediately below. Comparison of readings taken when the sun was shining and when obscured by clouds, or in still air and in wind, reveal no correlation (of the inversion of the normal temperature gradient just described) with such changes. It is, however, true that rather more of these apparently aberrant readings have been recorded between 10 a.m. and 2 p.m. than later in the day. If, however, we investigate these instances, when the air temperature at 2-ins. is higher than that of the surface sand, in relation to topography, we find an interesting and suggestive correlation of their frequency with the position of the recording station on the dune system. In the following table are enumerated the percentage frequency of such occurrences in the different parts of the dune system, together with the average difference between the two readings.

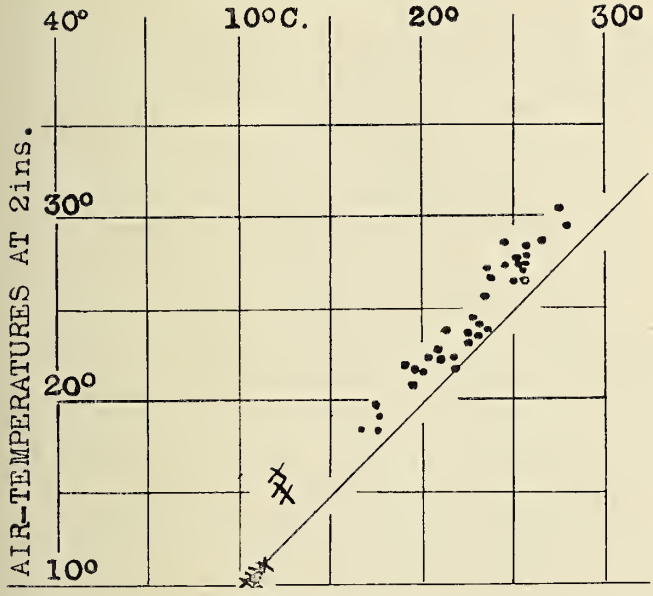
Bare Sand Dune Hollow
Soil-Temperatures Surface



Bare Dune
Surface-Soil Temperatures



BARE SAND DUNE HOLLOW
Air-Temperatures at 2 ft.



BARE DUNE
Air-Temperatures at 2 ft.

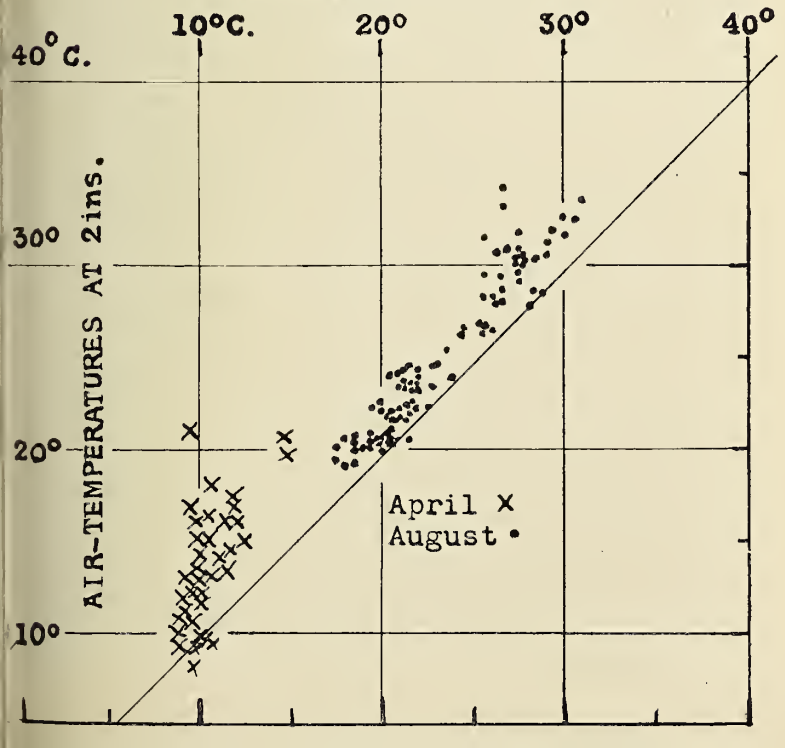


TABLE OF OCCURRENCES WHERE THE AIR TEMPERATURE AT TWO INCHES ABOVE BARE SAND EXCEEDED THE SURFACE TEMPERATURE OF THE SAND BELOW

Dune Ridge I.			Dune Ridge II			Dune Ridge III		
Seaward face	Crest	Landward face	Seaward face	Crest	Landward face	Seaward face	Crest	Landward face
53%	—	16%	35%	18%	11%	22%	8%	4%
Average differences between surface temperature and air temperature—								
1.1°C	—	0.7°C.	1.59°C.	0.9°C.	0.6°C.	0.6°C.	0.6°C.	

These figures are so consistent that there would appear to be little doubt that the factor involved, responsible for the cooling of the sand surface below the temperature of the air, is the convection currents set up within the sand surface itself bringing about internal dew formation. (c.f. Hill, T. G. & Hanley, J. A. The Structure and Water Content of Shingle Beaches. J. of Ecology Vol. II pp. 23-38, 1914 and literature there cited). The rising air from between the sand particles is replaced by cooler air from over the sea. This moisture-laden air though cooler than the heated air which it replaces is nevertheless warmer than the particles of the subsurface sand into which it is drawn and upon which it consequently deposits moisture. The increased capacity for heat conduction, due to the more effective contact which results, brings about a warming of the subsurface at the expense of the surface sand grains so that the temperature falls below that of the overlying air. Such an explanation appears to satisfy the conditions and is in harmony with the greater frequency and magnitude of the phenomenon, on the seaward faces as compared with the landward faces, and, on the younger as compared with the older dune ridges.

The uniformly lower temperature at 2 feet than at 2 inches above the surface is a striking feature, both in summer and spring, and doubtless accounts for the habit of dune mollusca to crowd to the top of the *Psamma* leaves in hot weather (c.f. Fig. 9).

An important feature of the relation between soil temperature and topography is the effect of the dune slope upon the amount of radiation which the surface receives per unit area. At Blakeney Point the general trend of the dune ridges is approximately in a N.E. to S.W. direction, with the sea on the northern face. As a consequence the landward slope receives

an appreciably greater amount of radiation per unit area than the seaward. But for the irregularities of the surface the difference would be much greater than it actually is. The effect of the direction of slope is naturally greatest when the altitude of the sun is lowest, so that this effect is of especial interest in the spring when the temperature is most likely to be a limiting factor to the assimilation of the winter annuals. The following data based on the averages for April determinations furnish an example of this topographic effect.

Average Day Temperatures on dune ridges in April with ranges observed :—

RST RIDGE.

	Seaward face	Middle of Ridge	Landward face
Air at 2-ft.	9.6 (9—10)	9.6 (9.2—10.5)	11.9 (9.5—16.5)
Air at 2-ins.	10.6 (9—13)	11.3 (9.1—14)	15.1 (9.8—25.3)
Soil Surface	10.7 (8—16)	11.8 (7—16.5)	16.1 (9.6—24.5)
Soil at 2-ins.	10.1 (7.2—13)	10.9 (7—16.5)	15.0 (8.9—21.3)

SECOND RIDGE

	Seaward face	Middle of Ridge	Landward face
Air at 2-ft.	10.0 (9.3—11.5)	9.8 (9.0—10.7)	10.1 (9.0—10.5)
Air at 2-ins.	11.0 (9.7—14.5)	11.8 (10.0—17.0)	13.2 (10.2—22.5)
Soil Surface	10.6 (7.0—17)	13.77 (9.2—28)	14.9 (10.1—25.0)
Soil at 2-ins.	9.9 (8—14)	13.3 (8.3—27)	13.6 (9.4—20)

THIRD RIDGE

Air at 2-ft.	10.1 (9.2—10.5)	10.1 (9.—10.5)	10.5 (9—12)
Air at 2-ins.	13.0 (10.0—21)	11.6 (10.2—13.2)	11.9 (10.0—15)
Soil Surface	14.4 (10.5—25)	12.2 (10.0—15.5)	13.1 (10.2—17.5)
Soil at 2-ins.	12.8 (9.5—20)	12.1 (10.0—17.5)	12.9 (9.5—18)

It will be seen that for ridges I and II the means and maxima, at all levels, are consistently higher on the landward than on the seaward slopes. This is not true for the third ridge, where the landward face is very exposed to wind action, and it is probably the cooling effect of the wind which is responsible for this discrepancy. If, however, we consider Ridge II only, as being equally protected from, or exposed to, wind on both faces, we find that the mean difference amounts to 4.3°C. for the sand surface and 2.2°C. for the air at 2-ins. whilst the respective maxima differ by eight degrees at both levels. It is perhaps not a mere coincidence that the maxima on the two faces of Ridge I differ at these levels by the same amount. The

difference of the means for the two faces of Ridge I are greater than for Ridge II, probably owing to the greater exposure to wind of the seaward face of Ridge I which, in this respect, is comparable with the landward face of Ridge III. It is evident from these data that the winter annuals gain a definite temperature advantage on the southern slopes in general, though local inequalities of surface may enable situations on the seaward slope of the dunes to possess an aspect almost equally favourable.

If we compare the temperature at the surface of successive dune ridges in August we find, as was to be expected, that the difference between the landward and seaward faces is not so great; this corresponding to the increased altitude of the sun. It will be noted that there is the same decrease in magnitude of the difference on the landward face of the third dune ridge, and indeed, under vegetation, the seaward face of the third ridge actually has a higher temperature than the landward face.

SURFACE TEMPERATURES (AVERAGES) IN AUGUST ON DIFFERENT PARTS OF THE DUNE SYSTEM.

Bare Sand	Landward face	Number of obs.	Seaward face	Number of obs.
RIDGE I	27.63	38	24.2	38
	Difference L-S 3.43°C.			
RIDGE II	27.4	44	26.17	40
	Difference L-S 1.23°C			
RIDGE III	27.6	47	25.9	54
	Difference L-S 1.70°C.			
With vegetation				
RIDGE I	24.6	37	21.35	37
	Difference L-S 3.25°C.			
Ridge II	27.92	38	25.74	38
	Difference L-S 2.18°C.			
RIDGE III	26.18	37	27.07	37
	Difference L-S 0.89°C.			

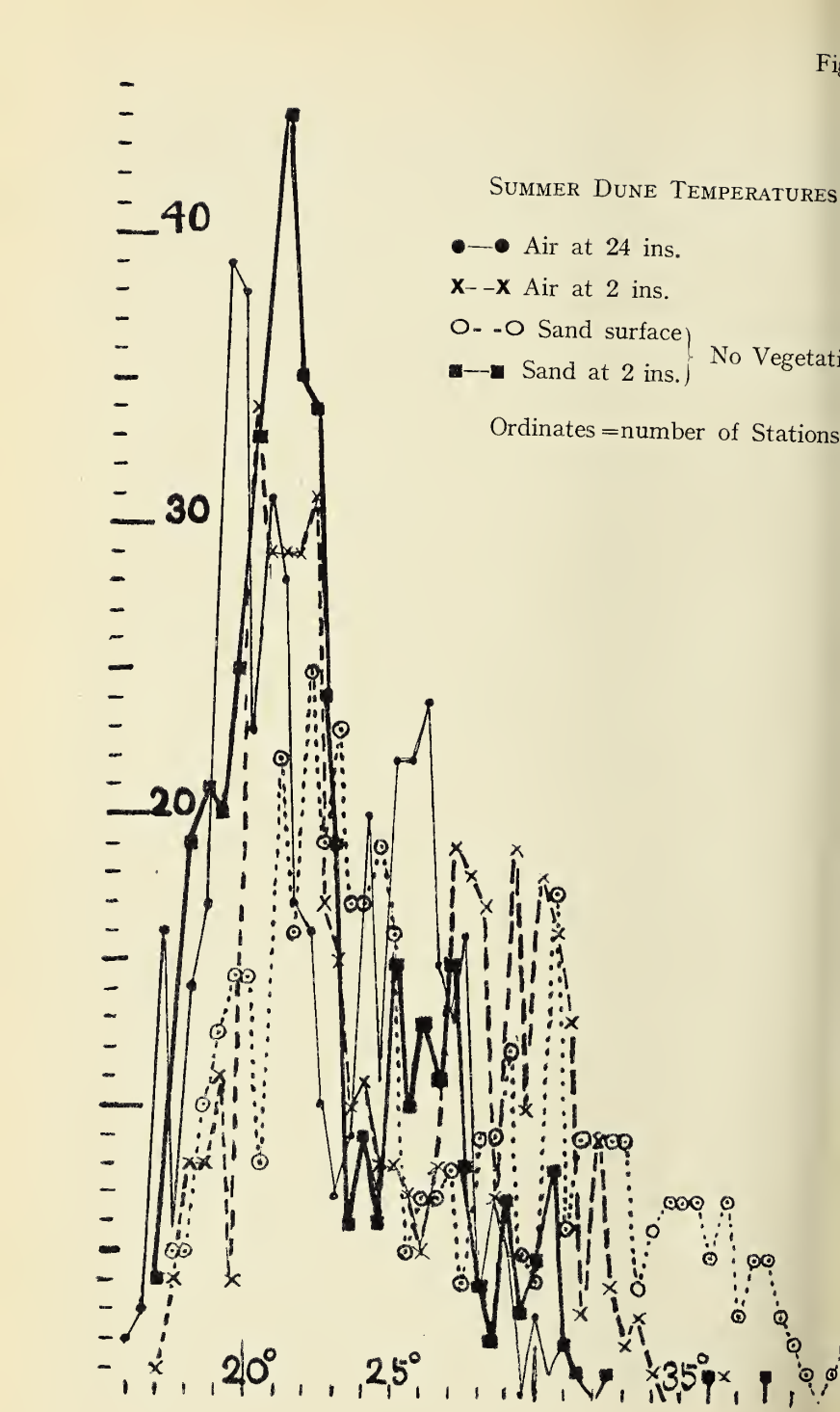
AVERAGE LANDWARD (241 Stations) 26.9°C.

AVERAGE SEAWARD (244 Stations) 25.0°C. Average Difference 1.9°C.

Actually, the mean difference, for over two hundred and forty stations on both the landward and seaward faces, during August was 1.9°C. as compared with a mean difference for the

surface of the seaward and landward face during April of 2.8°C. But, in comparing these figures, it must be born in mind that the sand in the Spring is as a rule moister than in August and in consequence the conductivity is greater. Actually, therefore, the difference in Spring is probably greater in comparison with that in summer than the figures cited would suggest.

The heating of the air layers immediately over the sand surface above the temperature of the air generally is a matter of considerable importance since, as the data for April show, the phenomenon may be very marked in sunny weather at a period of the year when the prevailing air temperatures are quite commonly the limiting factor for assimilation. The stratum between the surface and two inches above the surface represents approximately the zone occupied by the vegetative organs of the annual species which are at the height of their activity at this period of the year. Individual readings show that, even when the air temperature at two feet above the ground is only just over 9°C., the temperature at two inches above the surface may in sunshine be from seven and a half to eleven and a half degrees higher, whilst the sand-surface itself, occupied by ephemerals interpersed with bare sand, was at a temperature of from 25°-28°C., which implies a difference of from 15.5° to 18.5°C. higher than the air at two feet above the ground. Therefore, on a conservative estimate, the assimilating organs of the ephemerals would be surrounded by air at a temperature at least 10°C. higher than that of the air generally, whilst a difference of over 15° might well be experienced. Having regard to the fact that the so-called ephemeral vegetation of the dunes consists of " winter annuals " which germinate in the autumn and must carry on their assimilation during a period of the year when the air temperature will often be at, or below, the limiting condition for photosynthesis, it will be at once evident how important this microclimatic factor may be. It must in fact often enable the annual species of the dune to carry on assimilation when the physiological processes of the species of other habitats are at a standstill. As already pointed out, the data shew that this effect is most marked on the landward slopes of the medium-aged dunes and it is just these situations which are richest in winter annuals. It is, perhaps, not unreasonable to suppose that the reduction in temperature of the


Summer Dune Temperatures
●—● Air at 24 ins.
X--X Air at 2 ins.
O- -O Sand surface
■—■ Sand at 2 ins.
No Vegetati
Ordinates = number of Stations
40
30
20
20°
25°
35°

ower layers of the air which accompanies the diminution of helter on the older more flattened ridges is an additional dverse factor which, combined with the pressure of competi- ion, is responsible for the decrease in the annual flora of the lder phases of the dune succession.

The high air temperatures attained, together with the revalence of wind, must tend to accelerate markedly the rate f transpiration, and the pronounced transpiration checks xhibited by the leaves of most dune annuals have their chief ignificance not so much in relation to excessive dryness of the and during the winter months as to the necessity for reducing he rate of water loss to a speed commensurate with the area f absorbtion of the root system and the translocatory efficiency f the plant's anatomical organisation.

The microclimatic feature just considered, so beneficial in the older months, tends to become inimical as the season advances lthough, with the general amelioration of climatic conditions, he difference between the temperature of the surface of the nd and that of the air diminishes. Yet the actual tempera- ures attained may be considerably greater than in spring. hus the maximum temperature recorded at the two-inch level the air in April on a sunny day with no wind was 28°C. where- s during August under similar conditions a temperature of 34°C. as recorded.

But these high temperatures which at the surface sometimes ttain over 42°C. and which would be so inimical to the dwarf sette annuals are indirectly beneficial to the perennial species, nce upon this depends the internal dew formation already ferred to. As a consequence it not infrequently happens that ough the surface of the dune is hot and dry the interior is both ol and moist.

IV

PRESERVATION OF KETT'S OAK

By Sydney H. Long, M.D.

By the courtesy of the Chairman of the Norfolk County Council, Mr. Russell J. Colman, I am able to give the following particulars with regard to the preservation of that ancient oak on the right of the Norwich-Wymondham road, in the parish of Hethersett, which is commonly known as, and is labelled "Kett's Oak." Tradition says that under this tree the followers of Robert Kett, the rebellious tanner of Wymondham, used to meet to take an oath to reform the abuses of church and state, in the year 1549, the year that Kett was hanged on the tower of Wymondham church. The work of preservation was undertaken in the summer of 1933 by the Norfolk County Council, which deputed Mr. H. Goude, the Horticultural Superintendent, to carry it out. The following is Mr. Goude's report to the chairman of the council :—

All the loose and rotten wood was scraped from the cavity. The entire trunk was hollow, without any base ; the cavity had split to two-and-a-half feet in width on the south-east side and extended over the trunk to the north-west side. The tree was dividing into two separate individuals. A steel rope was made taut by attachment to the main branches, and the tendency to separate arrested.

The cleaned cavity was painted twice with plastic bitumen. We had proved by trials that this bitumen was innocuous to living plant tissue, and it destroyed, by smothering the wood, mining larvæ of moths that were present.

As the leaves developed in Spring, the foliage was sprayed with arsenate of lead to kill the leaf-eating caterpillars, and the leaves grew greener and larger than in the previous season. Leaves were preserved for comparison, and the improved appearance of the growth indicated that the tree had responded satisfactorily to the treatment.

The base soil in the trunk was removed to a depth of two-and-a-half feet and the hole filled with strong concrete to above the ground level, buffered from the tree with pieces of sound oak wood. In this base of concrete was fixed an upright piece of

Kett's Oak, 1933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angle iron extending into the two main branches to reinforce the filling material.

When the base of concrete was set, the whole of the cavity was filled with a light breeze concrete ; five parts breeze, one part cement. About eight feet from the ground we found iron stays hanging loose inside the trunk from previous attempts to preserve the tree. Firmer concrete was placed in a layer to utilise these iron stays as cross ties. The breeze concrete left a rough surface. On examining the tree for the final surfacing we found that several people had cut their initials in the concrete before it had set.

The breeze surface was finally covered with plastic bitumen and cement. A good cap was made to prevent water from leaching into the trunk, and the surface left corrugated to imitate the natural bark. The whole was then covered with a sheet of uralite until the cement set, this precaution being taken to prevent disfiguration by the public.

Mr. Goude goes on to say that he had been told by the late Mr. Back of Hethersett, who was, he believed, responsible for the protecting rails round Kett's Oak, that the tree had been struck by lightning. The splitting is compatible with injury of this character, but it must have been caused many years ago. Both sides of the wide split on the south-east side were folding inwards with new wood growth. This growth cannot fold in now, and will tend to spread over the surface of the filling material, and reduce the size of the opening. It will be advisable to control leaf-eating caterpillars each Spring, and some slight repairs may be necessary occasionally to the filling concrete and bitumen. The wire will probably require tightening.

I understand that Mr. Goude is germinating a few of the acorns from the oak at the Horticultural Station at Burlingham.

V

HELIGOLAND, 1933

By Miss M. Barclay

The island of Heligoland is forty miles from the nearest mainland, the coast of Germany. It is one and a quarter miles long, and half a mile wide, with a present circumference of only three miles; but in 800 A.D. it was 120 miles in circumference, and has been reduced by erosion to its present size. It was captured by Britain from Denmark in 1807, ceded to Germany in 1890 in return for Germany's recognition of the supremacy of British interests in Zanzibar. By the Treaty of Versailles, it was demilitarized but retained by Germany.

On September 18th, 1933, accompanied by some ornithological friends, I paid my first visit to the island and our stay was extended to October 4th. Our first impression on approaching Heligoland was of a large red rock, with a bright green top to it, rising sheer out of the sea. The cliffs are about 100 feet high, and are composed of Bunter's sandstone. The top of the island, which is absolutely flat and without any trees or shrubs, is always spoken of as the "Oberland." The lower portion, which consists of houses, harbour and waste land, is known as the "Unterland." The town is partly built on the Oberland and partly on the Unterland. There is a lighthouse, a good museum and a very fine aquarium. The fish looked wonderfully healthy, especially the mackerel, which are very difficult to keep in tanks. We were told that the condition of the fish was due to the fact that no water is allowed to pass into the tanks except through celluloid pipes, because water passing through metal was apt to injure the health of the fish.

The islanders are happy, good-natured, easy-going people. They subsist chiefly on the fish they catch, and on young herring-gulls which they shoot. During the autumnal migration of woodcock, golden plover, etc., a heavy toll is taken upon these birds also, but the shooting of passerines is forbidden. The whole population, young and old, are keen and knowledgeable about birds, and many keep traps of their own, taking any interesting captures for registration to those in charge of the bird station.

They have a good fishing fleet and catch lobsters, crabs, soles, etc., most of which are sent to Hamburg.

During the season many tourists come over for the bathing, which is very good. Most of the houses have small gardens with trees and shrubs in them, which are very attractive to the migrant birds. Along one side of the island are the allotment gardens, growing chiefly potatoes and cabbages ; the rest of the island is covered with rough grass, on which a few sheep are tethered and regularly milked by their owners. There are no cows, goats, or horses. The only cart used is a small four-wheeled waggon, which is dragged by the men or women while they are working in their allotments. There are no roads ; only paths or tracks.

One of our objects in visiting Heligoland was to see the German system of tracking and ringing the birds, and also to study migration. We were made very welcome and received great hospitality from Professor Drost and his co-workers. They made us members of the Vögel Warte, the Bird Watching Station, where all the ornithological research is done, and where several students are always at work. The organisation is very complete. One room is full of skins and contains a specimen of every bird killed on the island ; another is entirely given up to the taxidermist's work, and another for the correspondence in connection with ringing. There is a splendid library which contains nearly all our bird books and magazines.

The Fang Garten, where all the trapping and ringing is done, consists of a thick shrubbery with high banks on each side, surrounded by a green iron fence ; the tops of some of the trees just rising above it. The garden is planted with elder, wild rose, silver poplar and all kinds of berry-bearing shrubs that attract birds. There is a small pool in the middle with rushes and overhanging willows. The garden is about 150 yards long by 40 wide. Three huge traps of green wire-netting are hidden among the shrubs, made on much the same principle as a pipe of a duck decoy, a large opening into a big cage with a swing door in the middle, which is closed as soon as a number of birds fly in. The birds are then driven into the narrow part of the trap, through a small door into a large box with a talc back which makes the birds imagine that in that direction lies freedom. The small door is then dropped by means of a string,

and the birds are caught. The bushes are then beaten with sticks towards Number 2 trap (made on the same system, but in rather a different shape) and so on to Number 3 trap, which is generally the most effective and catches the birds that have flown over the other two traps. The captives are placed in the collecting boxes and brought to the ringing room, which is at the entrance to the Garden. This room is wonderfully equipped—all the rings in sizes on wires, easy to reach with special pliers to fit each size. The rings never overlap. There is a weighing machine with celluloid cubes of different sizes, into which the birds are slipped for weighing. The ringed birds are registered on printed forms and are then liberated through a hole in the wall. As members of the Vögel Warte we had the right to operate the traps ourselves.

There is only one species of resident bird on the island, the House sparrow, of which there are about 100. The only birds that regularly breed on the island are Ray's yellow wagtail, guillimots, and razorbills and a few starlings. On Düne, a small uninhabited island which lies two miles away, white wagtails, whitethroat, and skylark have been known very occasionally to breed.

It was a wonderful experience to watch a migration in progress on the island. I give a description of a typical day. The wind was light from the S.W. The gardens were full of redstarts, chiffchaffs, willow-warblers and garden-warblers. Flocks of chaffinches kept getting up under our feet, with a few bramblings among them. Sparrow-hawks and kestrels kept flying overhead, also a peregrine falcon and a merlin. We had a close view of a dotterel resting with some golden plovers. At 7.45 a.m. a heavy shower came on, and it seemed to rain small birds. Gold-crests were on the cliffs, in the gardens and everywhere. We had a wonderful morning with the traps, catching many redstarts, song thrushes and garden-warblers, a few chaffinches, a whitethroat, a pied fly-catcher, some chiffchaffs, two ring-ousels, and the biggest prize of all—a red-breasted flycatcher, a male, in perfect breeding plumage. The whole island was swarming with birds, redstarts all over the place, and small flocks of siskins, and a blue-throat. Every day we added two or three new birds to our list, and kept an approximate account of each species seen on each day on

Ready for "Ringing"

Entering the Trap


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Heligoland and Düne. On some days one species swarmed, the next day they had nearly all disappeared, to be replaced by something fresh.

On another good day with the wind E. to N.E., we saw fifty-six different species during the day on both islands. All the Waders were seen on Düne. During the early hours of the morning a constant stream of song-thrushes, skylarks, golden plovers, and ring-ousels kept passing over, calling as they went. All that day the island was swarming with thrushes. On the Unterland we saw some shore-larks in full plumage. On the island of Düne the " Bushes " were " flicking " with robins, hedge-sparrows, wrens, chiffchaffs and thrushes and two blue-throats. A goshawk flew over the island, a bird very seldom seen there. In one of the gardens was another red-breasted flycatcher, a female.

The migration of the grey crows was an impressive sight. They continued to pass over the island in hundreds, throughout the morning, all going in one direction, from E. to W. Some circled round, but none actually landed.

During the seventeen days that we were on the island we saw 101 different species.

The general meteorological conditions would seem to influence the landing of the birds on the island, even more than the direction of the wind. For instance, on a morning when the sky was clear, we saw but few birds, though when clouds came up and it began to rain, birds appeared from everywhere. A large section of the autumn migrants travel over Heligoland from east to west ; others take a north to south line. A great many birds that pass over during the autumn migration are never seen again during the spring. It is usually the birds that winter in Great Britain that return via Heligoland ; those that migrate further south travel on their return journey east via Holland and North Germany.

VI

PROGRESS OF THE NORFOLK ROOM AT THE NORWICH CASTLE MUSEUM

By Frank Leney, Curator

The grant of one hundred guineas from the accumulated funds of the Norfolk and Norwich Naturalists' Society towards the cost of the installation of dioramas illustrative of the fauna and flora of the County of Norfolk was noticed in this Society's Transactions for 1930-31. The accompanying illustration of "Breydon in October" gives a pleasing impression of one of these large plate glass cases measuring 13 feet in width by 6-ft. 6-ins. in height. Elimination of reflections is always a great difficulty in Museum cases and the gratifying outcome of many experiments is that visitors do not realise with these cases that they are looking through glass. The "Breydon" case is an unqualified success and that result is due to the artistic skill and remarkable ability of Mr. Ernest Whatley of the Imperial Institute Studios, London. Mr. B. B. Riviere, F.R.C.S., M.B.O.U., was untiring in his efforts to get the birds arranged in natural positions; the Wigeon just alighting is an instance of his knowledge of birds and desire to get a true representation of attitudes which are characteristic although perhaps not familiar to casual observers. The group of Dunlin washing their catches in the runnels is very good and their foot marks together with body outline shadows on the mud are just the requisite touches which made the case so attractive. Then too there is the Great Black-backed Gull perched on an old skep left with other flotsam and jetsam by the tide. The Heron, or to give it the local name Harnser, stands on one leg in pensive mood, suggestive of contentment after finding his food in the quickly draining mud flats. A marvel of perspective is seen in the treatment of the flint sea wall on the right of the case; an actual flint from the wall is succeeded by cardboard and painted reproductions gradually fading into what appears to be miles of distance. The mooring posts are reminiscent of the days when huge baulks of timber from warmer climes floated on the placid waters of Breydon and were moored to posts awaiting a purchaser. In the background are the posts marking the channel available for shipping. By means of an

"Breydon in October"


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electric light switch visitors are able in a moment to bring before their vision a characteristic scene of wild life within twenty miles of Norwich. A second switch illuminates a map of Norfolk showing the position of Breydon as the estuary of the River Yare and another equally interesting map of the district. In the centre is a key plan to the exhibits in the case giving the names of the birds, etc. On the right is displayed a series of enlarged and illuminated photographs depicting aspects of Breydon at different seasons of the year. This method of showing photographs is rather expensive as it entails making a transparency on ground glass from the ordinary negative. The result is particularly good as may be seen in the other cases ; for instance, a Beech wood, a Swan rising from the water, Montagu's Harrier on nest and other nesting groups. By means of electric light it has also been found possible to show in an attractive manner, giving full colour values to the subjects, such exhibits as the Estuarine Prawn, Wigeon Grass, Peringia ulvae and other mollusca, Ragworms and other forms of life on Breydon.

Another large case measuring 13-ft. by 6-ft. 6-ins. illustrates a Norfolk Loke or Lane. The season is that of Autumn and instead of paint work the effect has been produced by actual bushes on which the foliage, etc., has been preserved and the flowers and berries modelled by Mr. E. A. Ellis of the Museum staff. The background of a beech tree and the glimpse of fields beyond the stile have been slightly indicated in crayons by Mr. Horace Tuck of the Norwich School of Art. On the actual tree trunk may be seen a Tree Creeper and Ivy in flower with Peacock and Holly Blue Butterfles visiting it. It is interesting to hear the exclamations of visitors as they discover for themselves the Hedgehog, the tiny Field-vole, the Blackberries and the various hedgerow birds with the Blackbird in its usual dominant place. The baby Rabbit against the stile gives the secret of the cases, for a fully grown animal in that position would have spoiled the whole perspective of the group. The rich hues of Autumn as shown in the foliage and fungi make this case particularly bright in colour and attractive to the eye of the visitor.

To describe the Broadland Case is almost impossible for the size of the case is double that of the others, viz., 26-ft. long.

This attempt to visualise our world-famous Broads for the benefit of visitors was probably too ambitious and resulted in several failures. However, Mr. Owen P. Smyth of the Maddermarket Theatre, Norwich, with great enthusiasm, tried and tried again and the scenic effect fully justifies the immense amount of work and patience expended on giving us this wonderful visualisation of a glorious June day on the Broads. The hidden electric lights combined with the warmth of colour certainly create the atmosphere of the land of the Lotus eater. It needs little imagination to hear the rustling of the reeds and as we gaze they part and we see the Bittern, still and stately, protected by his colouration which resembles the brown stems of last year's reeds. Again the reeds move and the Coot emerges followed by her black fluffy chicks with their red faces. The eye is again arrested by a nest containing a clumsy baby Cuckoo being fed by its foster parents the Reed Warblers. A dominant feature is a Great-crested Grebe in all the glory of his summer plumage and nearby his hard-working partner bringing along their progeny in their curious striped down. To the right of the case an endeavour has been made to give some idea of the country frequented by Harriers. On a submerged stump is a Montagu's Harrier, but not perhaps so well marked a bird as might be desired. The dioramic effect is of no particular Broad, although it will be evident to many that Lord Desborough's bird sanctuary at Hickling has formed the basis of the scene. In this case too it is interesting to overhear visitors' remarks such as " Oh here's a Bearded Tit " or again " Look at the Forget-me-nots." The Yellow Flag which paints the Broadland landscape in such a vivid shade is also in evidence. It was tempting to put in many other characteristic Broadland Birds but the Committee adhered to their scheme of having a few objects well shown instead of, as in the old days, exhibiting a crowd of birds with little or no resemblance to nature.

Four large cases are now ready on the other side of the Norfolk Room and as money becomes available through the Norfolk Room Fund, of which the Lord Lieutenant of Norfolk (Mr. Russell J. Colman) is Hon. Treasurer, it will be possible to illustrate the salient features of Breckland, Salt Marshes, Sea Shore and Underwater. The former generous response to an

appeal for funds to carry out this work has enabled the Castle Museum Committee to complete three cases which were the outstanding feature of interest at the conference of the Museums Association in July, 1933. It is not an exaggeration to say that there is nothing like these cases to be seen in this country and although the idea was largely borrowed from the Museums of the United States of America, it is more than gratifying to realise that Norwich leads the way in visualising the features of the country in a manner which will attract the notice and arouse the interest of the most casual visitor.

These cases are of course only the beacon lights of the complete scheme as it is the desire of the Committee that every form of life in the county should be illustrated in this Norfolk Room. To carry out such an ideal needs the active co-operation of members of the Norfolk and Norwich Naturalists' Society who have knowledge of particular groups. The upper floor of the Norfolk Room will be fitted with cases and cabinets to contain the flora and fauna of Norfolk. Many collections formed by members of our Society who are no longer with us have found a permanent home in the Museum and therefore form a basis for the series of Norfolk specimens. This more particularly applies to the Lepidoptera, Coleoptera and kindred groups, to which the late Mr. H. J. Thouless devoted the greater part of his leisure. The late Mr. F. Long bequeathed his collection of Norfolk Plants ; the J. B. Bridgman Collection of Norfolk Mollusca, too, is a valuable asset and lastly, but by no means of least importance, is the very complete collection of skins of Norfolk Birds, from nestling to adult plumage formed by the late Mr. J. H. Gurney of Keswick and presented by his son Mr. Gerard Gurney. It is, however, in the lower forms of the Animal Kingdom that the help of our fellow members is required ; to mention just a few :—Echinoderms, Crustaceans, Rotifers, Annelids, Nematodes, Mycetozoa and other forms of Protozoa.

The early volumes of Transactions of the Norfolk and Norwich Naturalists' Society contain Members' Records of the Flora and Fauna of Norfolk upon which we build our present day knowledge. The Committee realises that without the help of the present generation of workers in natural science it will be impossible to carry out this scheme. Such men as the Gurneys,

Southwell, Geldart and the Woodwards studied a far wider field than the present-day worker who in most instances specialises on one group or subject but yet it must be possible to carry on their work and publish the results of recent investigations in our Transactions.

The Yarmouth Naturalists' Society whose membership includes some young and enthusiastic workers is desirous of marking the centenary of the publication of Paget's "Natural History of Yarmouth" by presenting a Naturalists' table or desk for the gallery of the Norfolk Room. The desk will incorporate a data guide to the Flora and Fauna of the County, topical exhibits, and local Natural History News, making the desk a focal point of interest to all workers in natural science.

The visitors to the Castle Museum in 1932 as registered by the turnstiles was 163,282. A large proportion of this remarkable attendance must with reluctance be classed as ordinary visitors who take only a general interest in the collections. There is little doubt that in the near future everyone will have more leisure than in the past and it is not too much to hope that Museums will be a means of leading an ever increasing number of people to the study of Natural Science in its many and varied forms.

VII

THE SOCIETY'S PROCEEDINGS, 1932-33

By The Editor

Two excursions took place during the summer of 1932. On May 12th between forty and fifty members of the Society assembled at Horsey Hall by invitation of the President and Mrs. Buxton. A fine view of the marshes surrounding Horsey Mere was obtained from the observation platform situated in a tree above the reeds. The boom of a bittern was heard, and nests of the bearded-tit, water-rail, sedge-warbler, reed-bunting and great crested grebe were visited.

On June 23rd a large party embarked on a steamer near Thorpe Station for a trip down the river to Surlingham and thence by narrow waterways to Rockland Broad. Colonel Chamberlin conducted a ramble over the marshes. A picnic tea was provided by the kindness of Mr. and Mrs. R. T. E. Gilbert.

In place of the ordinary September meeting, a meeting was held in December.

The session began with a meeting held on October 18th at the Norwich Castle Museum. Mr. Russell J. Colman was in the chair, and about one hundred members and others were present. Research work now being carried out at Scolt Head was detailed by Professor F. Debenham of the Geographical Department of Cambridge University, and Mr. J. A. Steers described the physiographical and other features which had been examined recently. Many lantern slides were used as illustrations. Professor Debenham expressed the appreciation of his department for the use of part of Dial House at Brancaster Staithe as a residence with laboratory for students of the special problems of the estuary and the island.

The November meeting was occupied by Mr. H. E. Hurrell's account of the Polyzoa of the Norfolk rivers and broads with special mention of Sir Sydney Harmer's work on the group.

On December 20th the meeting included an exhibition of specimens found by members ; also Mr. Frank Leney (curator) showed recent additions to the collections at the Castle Museum. The late Dr. Donald Hutchinson's photographs of the life history of the garden spider which had been presented by Mrs. Hutchinson were exhibited ; also his series of microphotographs

of Protozoa. Mr. R. J. Colman showed a flint scraper which he had found recently at Crown Point. Mr. G. J. Cook exhibited specimens of rare fungi with illustrative drawings. Mr. H. J. Howard showed a series of bee-boards which he had brought from Yugoslavia.

On January 17th at Stuart Hall, Major Anthony Buxton delivered a lecture illustrated by slides and cinematograph films on some of the birds found on his Horsey Hall estate—the bearded-tit, great crested grebe, the Montagu's harrier and the marsh-harrier. The bittern's use of its powder-puff was illustrated in actual progress.

Dr. H. Muir Evans of Lowestoft gave a lantern lecture on the weapons of the early-North Sea Fishermen, the chief exhibit of interest at the meeting being a harpoon of stag's horn dredged during the Autumn of 1931 from the Leman and Ower Sands off the Norfolk coast. The weapon, which has been presented by Dr. Muir Evans to the Castle Museum, is of Maglemose culture of about 7000 B.C. and is only the third of the type recorded for this country. The lecturer dealt with the habits of the Maglemose fishermen and by the aid of maps traced the homes of these people on the Continent at a time when the Dogger Bank was the northern limit of the land surface uniting England to the Continent. The result of the pollen and other analyses of the "moorlog" in which the Norfolk harpoon was found were of considerable interest yielding conclusive evidence of the presence of birch and pine forests.

On March 21st Mr. A. Holte Macpherson gave an account of the Bird Life of the Orkneys and Shetlands as the result of two visits he had made recently to these northern islands, and showed a fine series of slides lent by the Royal Society for the Protection of Birds.

The 64th Annual Meeting of the Society was held at the Norwich Castle Museum on Tuesday, April 18th, 1933. Major Anthony Buxton, D.S.O., was re-elected President; Dr. S. H. Long continues as Honorary Secretary, and Mr. H. J. Thouless as Hon. Treasurer. On the recommendation of the Committee the meeting agreed that in future the duties of the Norfolk Wild Birds Protection Committee shall be transferred to the Norfolk Naturalists' Trust which shall administer the fund collected for the payment of watchers, etc.

The subject of Major Buxton's Presidential Address was "The Confessions of a Sportsman Naturalist." The following account is based upon the report in the *Eastern Daily Press* (April 21st, 1933). Major Buxton started by asking how it was that anyone, like himself, who took a keen interest in the domestic affairs of wild creatures, could spend part of his time in trying to kill them; he believed it was first and foremost, for excitement. For real excitement there must be difficulty in doing what you set out to do, and there should be just a spice of success in the midst of much failure, failure which whets the appetite. He himself had indulged in many forms of "sport," by which he meant dealings with wild creatures that had caused him excitement, irrespective of whether or not those creatures had suffered at his hands. Our hunting tastes had been handed down to us by our far-off ancestors, the harpooners of the North Sea, the hunters of the Irish elk and the English red-deer.

Are we people who have sporting tastes less brutal than were our ancestors? In some ways he thought we were. During the last fifty years this country, the United States, Holland, Switzerland, Germany, and, quite recently, Italy, had established reserves where wild beasts and birds could live either all the year round, or at least in the reproductive season, preserved from any destruction by man. In Tanganyika recent legislation has reserved for the observation and photography of wild animals a large tract of country where much destruction would otherwise have taken place by shooting from motor cars. It was said that the lions now came out to meet the motors, which usually brought them supper as a bait for photography.

Major Buxton vividly described several hunting incidents in which he had taken part during the War and in various parts of the world.

In discussing the question of a shorter shooting season Major Buxton strongly advocated that wild fowl shooting in Norfolk, at any rate, should be limited to the period of September 1st to February 1st, instead of as now, from August 1st to February 10th.

VIII

THE JUNIOR BRANCH OF THE NORFOLK AND NORWICH NATURALIST'S SOCIETY

Annual Report, 1933

The Junior Branch is primarily intended for those young people who, being at school or college, are unable to attend the meetings of the Senior Society, but others interested are eligible. The annual subscription is 2s. 6d.

The present membership numbers about 50.

A Nature Log is circulated among the members and it is hoped each will contribute something to it.

Three meetings were held in 1933, viz. :—

January 7th.—Mr. Jim Vincent gave a most interesting lantern lecture on the Birds of Hickling.

April 24th.—An excursion to Horsey Mere by kind invitation of Major Anthony Buxton who personally conducted the members round and showed them many interesting birds.

September 8th.—An excursion to Salthouse and Cley, where Mr. R. M. Garnett very kindly took the members round.

The Hon. Sec. will welcome suggestions as to future excursions from senior members or their friends who would be willing to invite the members of this Branch to visit any suitable place; also offers from any who would be willing to give a talk on a suitable subject during the Christmas holidays.

A copy of the Annual Report and statement of accounts is sent to each member.

Judith M. Ferrier, F.Z.S., M.B.O.U.,
(*Hon. Sec.*)


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IX

WILD BIRD PROTECTION IN NORFOLK IN 1933

Report of the Committee

The Committee has pleasure in submitting to its subscribers the following report for the year 1933. Since the last report was issued the responsibility for raising a fund annually for bird protection work in Norfolk has, by mutual consent, been transferred from the Norfolk and Norwich Naturalists' Society to The Norfolk Naturalists Trust. The latter body is gradually acquiring properties in the county where protection is needed, and under the new arrangement the accounts will be simplified. During the year the fund has lost, by death, some valuable supporters, so that it is hoped that those who are interested in the work of the committee will do their best to add new subscribers. Four watchers have been maintained, namely, one for the five summer months on Breydon Water, and an all-the-year watcher at Cley, Blakeney Point and Scolt Head Island. There has been no change in the personnel of these men. Intending visitors to Blakeney Point are advised to communicate with the watcher, William Eales, Blakeney Point, Morston, who will arrange for their transport; and those desirous of visiting Scolt Head Island will often save themselves disappointment if they write first to Charles Chestney, Dial House, Brancaster Staithe, the watcher, who will advise as to tides, etc.

Scolt Head Island

When one recalls the very high mortality that occurred amongst the common tern chicks at Scolt Head in 1932—it was estimated that not more than 10 per cent. survived—it is rather remarkable that there appeared to be no decrease in the size of the colony in 1933. The nests were spread over such a large area in the dunes, though concentrated mostly at the west end of the island, that it was impossible to make an accurate census of their number; on a conservative estimate this might be put at between 500 and 600 nests. The birds began to arrive about their usual date, April 12th, and were preceded by one day by the Sandwich terns. The first little terns were seen on April 13th.

As mentioned in our last Report, during the last two years, owing to high tides and gales, great changes have been effected at the Far Point: 175 yards of young dunes have been swept away and the terminal shingle ridge lengthened and raised by accretion. Hitherto, both common and Sandwich terns have nested mostly in these dunes, but this year the Sandwich selected a small, raised area at the extreme western end of the new shingle ridge, some 500 yards from the common terns' colony. On the intervening shingle were dotted nests of both common and little terns.

It was a matter for speculation as to whether any Sandwich terns would nest on the island this year; they came and went, sometimes in large numbers, and on the evening of May 6th the watcher estimated that there were about 400 on the ternery. However, only 38 pairs remained to nest, and these birds all successfully hatched their eggs. The first egg was hatched on June 24th, several days later than at Salthouse.

With the exception of a cold week at the end of June when several dead chicks of common terns were found, the season was ideal for the birds. The "whitebait" in-shored early so that there was a plentiful food supply, and the mortality amongst the young birds was negligible. A roseate tern was seen on May 19th, and on the 27th a pair. This pair nested in the dunes in the midst of nests of common terns, and their nest was well made of marram grass bents. On June 11th their first egg was laid and incubation started; on the 13th the female was found sitting on two eggs. The first of these eggs hatched on July 5th, and the second on the 7th, giving an incubation period of twenty-four days. The chicks remained in the region of the nest for about a week, and were afterwards seen in the dunes on several occasions. Although the nest this year was very near to the site of last year's nest it is suggested that the female of the pair was a new-comer, because the two eggs this year were identical in their markings, whereas for the two previous years they were dissimilar.

The little terns' nests were widely distributed on the shingle, though they were found in greatest numbers at Smugglers' Gap. Eighty-seven nests were found, and the last hatched out on July 20th.

Ringed plovers' nests were everywhere, as usual. The first,


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Charles Chestney, watcher of Scolt Head Island, with family of Stoats killed on the Ternery

vith eggs, was found on April 6th, and as late as August 23rd hree young chicks, about a day old, were seen on the ternery.)ne very unusually-placed nest was found with four eggs. It vas concealed in the marram roots in the over-hung sand cliff on he north side of the ternery. As is well known, these birds ıave second and third, clutches. There are usually about a lozen redshanks' nests, and the first was found this year on \pril 17th, near House Hills.

Since the island has been under protection nesting oyster- catchers have markedly increased in number ; this year there were thirty-eight nests, the first being found on May 8th, and the last to hatch was on July 25th. These nests—merely shell-lined depressions—are usually placed on the shingle ridges in the open, where the sitting bird is often disturbed, and so wary s she that she will leave the nest as soon as an intruder is in ight, and very cautiously return to it. It is worth noting that, n spite of these frequent uncoverings, every clutch on the sland hatched.

There are certain winged raiders of a tern colony that are very difficult to control. On Scolt Head these are large gulls ; kuas, both great and arctic, arriving about the middle of July, ınd short-eared owls. Throughout the past season one of these)wls paid evening visits to the ternery, though there is no evidence hat it was one of a pair nesting on the island. Rats and stoats ure a further menace to the birds and their eggs. These are, as ar as possible, controlled by the watcher during the winter nonths, but during the past nesting season he watched a family)arty of stoats march across the Cockle Bight to the ternery ; ıe waited until he could cut them off and then secured them all. We publish a photograph of this incident.

When August comes the terns begin to move off, and by September most have gone, though small parties—probably birds from farther north—are to be seen over the sea and resting on the sands at night, up to October.

About thirty pairs of black-headed gulls again nested on the saltings towards the east end of the island.

Migration Notes.—From September 2nd to 18th the writer stayed on the island. For the first ten days the wind was fresh from east or north-east, with brilliant sunshine. On the evening of the 13th the great drought broke with a thunder

storm and heavy rain, which was succeeded by a northerly gal lasting twenty-four hours. After this, warmth and sunshin returned with light winds veering from south to north, throug west.

On arrival there was a very large number of waders on th island ; at the top of the spring tides one could get an idea o these numbers. There was, for example, a flock of 450 curlew which were usually to be found resting on the west sands in th evening. There were a few whimbrel, which left at the end o the first week. There were several bar-tailed godwits ; n black-tailed were seen, though one or two of these were note by observers at Blakeney. Redshanks were numerous—large flocks ; and on the 5th six greenshanks rested at high-water on the base of a dune in front of the hut ; they soon passed on. There were large additions to home-bred ringed plovers ; flocks of from 50 to 200 were seen on the shingle ridges at high-water. There must have been at least 1000 on the island. There was a flock of sixty-two grey plovers, in all stages of plumage ; a few golden plover, in ones and twos. Dunlins were numerous. There were busy little flocks of sanderlings and turnstones on the shore-line, and on the 3rd several flocks of sanderlings were noted migrating west along the line of breakers. Several great and arctic skuas were seen and, when the sea was rough, gannets were noted passing east, near the shore-line. One oiled guillemot, still alive, was found on the beach, but no other oiled birds were seen. A hen-harrier was seen quartering the island on several occasions.

Of passerine migrants there were but few ; the weather was too fine for them to descend. There were several common redstarts and one black redstart, a few spotted and pied flycatchers and one bluethroat. There was a good number of wheatears on the island for a few days, and some of these were of the larger, northern, race. On the 13th a continental robin was found in the white poplar at House Hills and remained for two days. During the visit sixty-three different species were seen.

On the rest of the coast line of Norfolk there are small, scattered colonies of little terns, that at Horsey being still maintained at from fifteen to twenty pairs. A visit was made to the old nesting grounds at Wells on June 25th, when only

two common terns and one pair of little terns (with nest and eggs) were seen.

Major Anthony Buxton has supplied us with the following notes from the Horsey area of the Broads :—

From the naturalist's point of view the main feature of the broads in 1933 was the plague of short-tailed field mice, which brought with it, as I understand it normally does, an invasion of short-eared owls. In 1932 there was one pair of these birds in the neighbourhood, whereas in 1933 there were nine pairs nesting within a mile-and-a-half of my house. They left in August, but owls reappeared in the autumn.

The presence of these owls made the marshes a very lively bit of country, for some of them could generally be seen at any hour of the day either hunting or squabbling with the harriers and other hawks. Their main sport was however concentrated in the early mornings and in the evenings, and a capital season they must all have had. On one occasion a cock owl which started hunting about 6 p.m. brought in to his spouse sitting on her brood 25 feet in front of my hide, six field mice in twenty minutes. She accepted the first five but merely turned her back on the sixth, and, looking rather annoyed, her husband carried it off and ate it himself. The ceremonial of handing in the mice was very entertaining. The cock would arrive carrying his prey in his claws and alight about twenty yards from the nest. In the conversation which followed between the cock and the hen some of the sounds he emitted were like a distant cow and after a considerable amount of low murmuring between the two birds the hen made a noise like a cat, when the cock instantly transferred the mouse from his claws to his beak (from which it hung like a drooping moustache with an extra droop on the tail side), flew straight to the nest and handed in the mouse. He then flew off for the next draw, hunting very low over the marshes and flopping suddenly down whenever he spied a mouse. He seemed as a rule to make about five misses to one kill. On making a kill he flew straight back home, instead of continuing his ranging flight, and it was possible to determine by the straightness or crookedness of an owl's flight whether he was hunting or bound for home with his prey. Once an owl clearly bound for home had the mouse snatched from his claws in mid-air by another owl who darted up from the ground to intercept him. He turned and at once gave chase, but failed to recover his bag.

The owls seemed to prefer for nesting purposes a rush marsh that had been burnt in early spring, probably because it was easier for their young to run about over the burnt ground when they left the nest, which they do at an early age, than would have been the case in thicker covert. The owls had no hesitation in attacking a harrier that crossed their particular property but none of the many encounters that I witnessed ended seriously. In my belief, however, the owls drove away at least one pair of Montagu's harrier that intended to nest. It is almost true to say that no harrier, in the early morning or in the late evening, ever got home with his prey without a brush with an owl.

Some of the owls were very aggressive, when their nests were approached. On only one occasion was anyone actually struck, but they charged very close and often performed all sorts of absurd antics on the ground within 20 yards. The young when picked up did not attempt to scratch but made quaint little snappings of their bills. The birds of prey, whether hawks or owls, took no notice and had no fear of anything on the road, but the moment anyone transgressed from the highways on to the marshes suspicion was aroused.

There were two pairs of barn owls in the neighbourhood, one of which nested close to my house and reared a brood. The cock of this pair persisted in roosting in an old dovecote, which properly belongs to a pair of kestrels. This was very annoying since I had repaired the dovecote specially for the kestrels.

Apart from owls it was quite a good season for other birds of prey and in particular for harriers. Since the harriers are dealt with in an article all to themselves nothing more shall be said of them here.

Ducks.—One ferruginous duck was shot at morning flight and not recognized until it was picked up. Two or three more were seen a few days later.

There were a lot of pochard and tufted from December to February, and some scoters and scaup in October and February. During the hard weather enormous quantities of mallard visited the east coast and the broads. They were very tired and hungry. Teal were plentiful up to the end of October, but we never saw really large quantities again until the spring when they began to come in to breed.

A fair number of garganey came in at the usual time, but for some reason they nearly all moved on elsewhere to breed. There was a very good show of shoveller, but where they and their broods go after they hatch is a mystery. One pair of tufted were seen very late in the summer, and it is practically certain that they nested, for what appeared to be a large brood was seen in September. Although numbers of geese passed in the winter they did not seem to think that feeding on these marshes was good enough for them.

Finches.—There were a good many goldfinches, and several pairs bred in the neighbourhood.

A few bramblings appeared in the winter.

Horsey garden swarmed with greenfinches, and there were too many bullfinches for my gardener's tastes. We spared them, however, and let the fruit take its chance.

Tits.—Great companies of long-tailed tits passed the winter at Horsey and spread all over the marshes, but not a single pair remained to breed.

There were great quantities of blue tits and great tits both in winter and summer. The pair of marsh-tits that nested last year were not seen.

Bearded Tits.—The hard spell in January probably reduced their numbers, for in the spring there were certainly less than last year. They all seemed to rear at least two families and it is hoped that they will have made up for casualties. In the winter they concentrate in and north of Starch Grass.

Woodpeckers.—Both green and great spotted woodpeckers were seen for a few days in the spring, but always disappeared again.

A pair of great spotted spent the winter near Horsey Mere, and fed on the short turf of the Meadow dyke wall. What they found there is a mystery, and the place seems quite unsuitable for these tree-climbing birds. They came into the garden in the spring and the cock "rattled" continuously for ten days, so that we were confident they would nest. They departed, however, and their nesting place was not found, but they brought their family into the garden in July.

Water-Rails.—These were extremely numerous and the broods I saw were large. The parents seemed to be very clever at manœuvring their infants about and getting them round,

over, or under, every obstacle. Their conversation and antics including tail-flirting, on these occasions were most entertaining.

TERNS.—A few pairs of little terns as usual frequented the most populous part of the beach at Horsey Gap, but by great luck some at least escaped the human foot and reared their broods.

A single black tern was seen on June 3rd, but none were seen at the end of April, when they appeared in 1932.

WADERS.—Two or three reeves were seen for a few days. Several greenshank, green sandpipers, and Jack snipe, stayed for a time. Greenshank in large numbers came at the end of July. Owing to the dry summer snipe and redshank used a flooded marsh in great numbers, and it was a ticklish business walking about on it with nests in all directions. We put up a hide in a barrel in the middle of it, and with shoveller, teal, mallard, garganey, redshank, plover, snipe, herons, a spoonbill, harriers, and other odd visitors, it was a most amusing spot. Provided that a companion was available to walk ostentatiously away, the company re-appeared and the fun began in the first five minutes after the hide was occupied.

Between June 10th and June 25th curlews in large numbers were passing constantly, but never seemed to alight; whether they were nesting birds or immature is not known. On October 7th a wader with a note like a redshank but sharper and higher pitched flew high over my head. It was not a note that I know and I presumed it to have been a spotted redshank.

HERONS.—One spoonbill was seen on most days for a month in the summer on a piece of flooded marsh. It and the herons seemed to be friendly and it clearly found a good supply of food, probably fresh-water shrimps.

The number of bitterns seemed to be at least up to last year's figures. At one nest a good illustration was given of the callousness of a bittern for its young. All the young had left the nest except the youngest which sprawled miserably about. One of its elder brethren returned and kicked it out into the water. It laboriously clambered back, but the elder bird heard its mother arrive and, in scrambling away to meet her, again kicked the youngster overboard. After feeding all the others out of sight and never visiting the nest, the old bird climbed the

reeds to within sight of her unfortunate infant, slowly went through her toilette aloft and then sailed away, without paying the smallest attention to the baby which died in the night. This bittern gave its nest away in the following manner. I was standing with my keeper upright on a piece of flood water, when the bird sailed across us, shied off with a series of loud squawks and flopped down into a reed bed 50 yards from us. It seemed a poor chance, but the keeper entered the reed bed, while I gave him the line from outside. When he reached the spot where the bird had alighted, he found the nest practically at his feet. Nothing surely but a bittern would have been such an ass, first to squawk, and then to sit down in the right place.

Waxwing.—One bird was seen about Christmas time eating hips and haws, by Horsey Staithe.

Ring-Ouzels.—Two ring-ouzels were seen about a mile from the coast at the end of September and beginning of October.

Shrikes.—The little colony of three pairs of red-backed shrikes seen last year did not return to their old haunts. A great grey shrike was seen near Horsey mill in October.

Wagtails.—I am practically certain that I saw white wagtails late in March and in October. There were very few yellow wagtails.

Warblers.—The first cock black-cap arrived in my garden on May 5th, and he and another cock both found hens. One pair certainly nested and the other presumably. Not a single chiffchaff appeared this spring or autumn.

There were plenty of willow-wrens, but fewer common and lesser whitethroats than last year. There were not such vast numbers of sedge-warblers as last year, but many more reed-warblers. Grasshopper-warblers, common and lesser whitethroats appeared to me to be rather less. A pair of goldcrests stayed in the garden for several days in the spring but finally chose other quarters. A few other single birds were seen on the spring migration, and in September the garden was hardly ever without one.

In October I found near the coast, obviously just after they had landed, the greatest host of goldcrests that I had ever seen. In every tree and bush, up all the reed-fringed dykes, in every beet field they swarmed. They were moving quietly along westwards, feeding as they went.

After a visit to Holland the chief mystery to me is th absence of icterine warblers and great reed-warblers from ou Eastern Counties and the rarity of snipe in Holland. An homestead with a few bushes seems good enough for an icterin in Holland, and any broad with a reed bed for great reed warblers. Why do not both of them swarm with us, and wh are there so few snipe breeding in Holland on what appears t be suitable ground ?

Egg-Clutchers.—During the summer there were variou excursions and alarms concerning possible egg-clutchers, and fo one week in particular we hardly got to bed at all. As a matter of fact we never found, far less killed, one, and my pack are complaining for want of blood. There is no doub a lot to be said against the egg-clutcher, but he does a least introduce into the business of bird preservation a element of excitement, and we all live in hopes that on day we may catch him in the act, his fingers stained wit yolk. This year, at least, all the evidence goes to show that we did not suffer at his hands. It is satisfactory to find that many of those who take their holidays afloat on the broads are keenly interested in birds, particularly in the species which they are unlikely to see elsewhere. To many of them the sight of bearded tit, bittern, or harrier, is one of the attractions of this part of the world. Such people can be of great assistance in giving information concerning anyone whose actions have aroused suspicion.

We are indebted to Mr. R. M. Garnett, M.B.O.U., for the following notes from the Salthouse and Cley area.

January

The year opened with very mild weather ; common partridges were pairing off on the 1st, and lesser celandine was in bloom on January 9th. The severe frost from the 19th to 27th brought scaup duck and brent geese to the coast. A bar-tailed godwit was seen on the 21st, an unusual bird here at this season. When the marshes became frozen the herons moved elsewhere, and the coot flock, which normally winters on the Broad, took to the sea.

February

An unusual number of sheld-duck remained to winter; fifty-eight were counted on the Broad on February 1st, during

a south-west gale. Knots were numerous, and with them on February 2nd were four bar-tailed godwits. The heavy snowfalls between the 10th and 25th did not bring in any particularly rare birds.

March

Seven brent geese on the 1st and 7th, and wigeon were increasing in numbers on spring passage day by day. Meadow pipits and pied wagtails in bright spring dress began to arrive. On March 8th six Bewick's swans came in from the east and after resting for half an hour went off in the direction from which they came. The same day a green sandpiper was seen at Weybourne.

An adult little gull turned up on March 10th and was watched feeding with other gulls on a newly-ploughed field. A slavonian grebe was seen offshore at Cley the same day. On March 12th two black-tailed godwits were seen to leave the Broad and go off east over the sea. Lapwings were also moving east the same morning. One or two dead fulmars were found on the beach ; it is curious that their corpses appear each year in March. I have only one record here (also in March) of the living bird. A single grey-lag goose was seen on the 19th and on the same date the wheatear appeared upon the heath. Lesser black-backed gulls were passing on the 23rd, and on the 24th a female black redstart was seen. There were no less than ten black-tailed godwits on the Broad on March 30th, surely a record for these marshes.

April

Sandwich terns began to arrive during the first week, and summer visitors, chiffchaffs and willow-wrens, white and yellow wagtails, swallows and house-martins, the second week. A black tern was on Cley marsh on April 12th, an early date. Three black-tailed godwits, an adult little gull and the first common terns were also seen that day. The nightingale arrived at Kelling on the 17th. On April 25th a ring-ousel was seen on "Little Eye," and the first whimbrel the day following, when many swallows were passing west along the coast. The cuckoo was calling at Kelling the same day.

May

A woodcock's nest was found this month by a keeper at Weybourne, but unfortunately the eggs were destroyed, probably by a jay.

A ruff or reeve was seen on the 15th. Several wood-warblers were heard singing in a wood in the district during the month but no nest was found. A spoonbill arrived on the 28th, an adult bird.

Seven hundred and thirty-eight nests of Sandwich terns were counted on Salthouse broad on the 31st ; only one clutch of three was seen.

June

A quail was heard calling in young corn near the East Bank on June 3rd. A ruff was seen on the 4th, and on the 6th a most interesting little party of waders was seen, including a reeve, four sanderling (two in summer plumage), three curlew-sandpipers (of which one was red), and two little stints in breeding dress, and on the next day a broad-billed sandpiper had joined them. Two greenshanks arrived on June 14th. A spoonbill was present again on June 18th.

July

The long drought was temporarily broken during the second week, and following the rain the first signs of the autumn passage of waders were seen, a common sandpiper being noted on July 12th. A grey plover in breeding dress, a knot, a fair number of dunlin, and several curlew and whimbrel were passing west on the 17th. A greenshank arrived on the 20th. Several black-tailed godwits, turnstones, a red knot, and more curlew and whimbrel were noted on the 31st, while snipe were far more numerous. I saw a great black-backed gull kill and devour a young sheld-duck.

August

On the 13th a marsh-harrier passed east across the marshes ; the herons rose in alarm and flew overhead at some height. With their necks stretched out looking down at the harrier they presented a curious sight, resembling so many cranes. A young cuckoo migrating passed east over the Broad on the 15th. Several black terns appeared between the 15th and 22nd ; all were either juveniles or moulted adults. A passage of wheatears occurred on August 21st. Some gannets also passed east at the end of the month, and kittiwakes and skuas were seen. Nearly all the local breeding common and Sandwich terns left about this time. There was little to be seen of small passerine


BRITISH MUSEUM
NATURAL HISTORY

Photo] [*H. G. Wagstaff*

Black-tailed Godwit at nest, in Holland. It is hoped that this bird, which visits the county every year, will some day return to its former nesting haunts in Norfolk

migration during the month, but there was a good show of waders and twenty-three species were noted including a few curlew-sandpipers, ruffs and reeves, and a spotted redshank. Some more black-tailed godwits arrived and as many as eight were seen on August 18th and 19th.

September

A juvenile snow goose, an escape from Woburn (" British Birds," Vol. xxvii, p. 212), was shot on Salthouse Broad on September 8th and was sent to me for identification. It is now in Norwich museum. Passage of waders continued and three red-n cked phalaropes spent some days on a pool near " Great Eye."

A remarkable " hold-up " of small passerines occurred on September 27th when conditions were suitable, *i.e.*, with the wind N.E. and heavy wet mist. The outstanding feature was the amazing number of robins which came down all along the coast. Curiously enough at " Little Eye " the birds arrived sometime between noon and 2 p.m. as a friend spent the morning there without seeing more than a single willow-wren, whereas when we went down together after luncheon we found the hill alive with birds. We estimated that there were 60-80 robins, and in addition we found a red-breasted flycatcher, several common redstarts, a number of chiffchaffs and willow-wrens, a sedge-warbler, two or three goldcrests and a reed-bunting. I also watched a bluethroat running in the open, whence it was driven off by a wheatear. We noticed that the flycatcher frequently flicked its black and white tail, a character which we had never noticed in either the spotted or the pied, neither of which have so distinctive a tail pattern.

October

I was away from home during the earlier part of the month, and on my return, on October 17th, I was shewn a grey phalarope which had then been on the Broad for several days. On that date skylarks, starlings and lapwings were passing along the coast westwards in some numbers, but it was not until the 20th that I saw the first grey crows, when there was a strong east wind blowing. I also saw two shore-larks and an immature peregrine falcon.

Blakeney Point

The tern population on Blakeney Point would seem to be still on the increase, and in 1933 there were about 100 more nests of the common tern than in the previous year. The following is the result of a census taken by the watcher, William Eales, towards the end of June.

	Nests.
Sandwich tern	none
Common tern	1,543
Little tern	34
Oyster-catcher	19
Ringed Plover	148
Redshank	7
Sheld-duck	40 (about)

A number of additional layings took place after the census had been taken. The birds had a very successful hatching and at no time was there a shortage of food. The mortality was negligible.

On April 14th, one or two Sandwich terns were seen off the Point, and these preceded the arrival of the common and little terns by ten days. The Sandwich all concentrated this year on Salthouse Broad, where there were over 700 nests. There were probably a few arctic terns nesting in the Blakeney colony, and the writer thought he identified one or two of this species, but, with such a large number of birds always screaming overhead, it is extremely difficult to pick out the call of this tern. The only roseate terns that nested in Norfolk in 1933 were the pair on Scolt Head Island.

During the first week of April a waxwing frequented the garden of Dr. Maidment, at Harleston. Food was supplied to it by Dr. Maidment in the shape of currants and sultanas which he impaled upon thorn twigs. The bird became exceedingly tame, and on the 5th, from a distance of only a few feet, the writer watched it pick off and swallow sixteen sultanas as a meal. Doubtless this artificial food supply explained its unusually prolonged stay. No reports were received of any general immigration of these birds into the county, as occurred in the winter of 1931 to 1932.

An osprey visited Seamere, Hingham, during the last week in April, where it was seen several times by Mr. George; the

writer missed it by twenty-four hours when he visited the mere on April 29th. Another of these birds frequented one of the Gunton ponds for several days during the early days of July, where it was seen by several observers.

On September 28th, in misty weather with north-east wind, a very large immigration of robins took place on the north Norfolk coast, extending from Kelling to Brancaster—perhaps further. The marshes and hedgerows were full of these birds, which must have totalled several thousands. On Scolt Head Island they were equally numerous, where, Mr. Douglas Carruthers wrote, " every tussock contained a robin." Many were picked up dead from exhaustion, and one, from Scolt Head which was sent to the British Museum, was described as being of the Continental race. By the next day those that had survived had moved on and, from the unusual number of robins that have been noticed in the hedgerows and woods of Norfolk during the late autumn, these birds would seem to have spread themselves over the county.

Signed (on behalf of the Norfolk W.B.P. Committee),

SYDNEY H. LONG, *Hon. Sec.*

LIST OF SUBSCRIPTIONS AND DONATIONS TO THE NORFOLK WILD BIRDS PROTECTION FUND FOR 1933

	£	s.	d.
H.M. THE KING	3	3	0
H.R.H. THE PRINCE OF WALES, K.G. ...	2	2	0
Adam Miss M. E. ...	1	1	0
Ainslie Mrs. & Miss ...		5	0
Aldridge P. H. ...		5	0
Allars R. W. E. ...	3	3	0
Allen J. W. ...	2	2	0
Allen T. H.		10	0
Anderson Edward ...		10	0
Attenborough, Col. J. C.M.G.	1	1	0
Back H. W.		10	0
Baker K. E.		10	0
Baker Miss M. E. ...		10	0
Baker S. E.	1	0	0
Barclay F. H. ...	2	0	0
Barclay H. G. ...	2	2	0
Barclay Miss M. ...	1	0	0
Barnard Mrs. ...	1	1	0
Barne Mrs.	1	0	0
Carried forward ..	£23	15	0

	£	s.	d.
Brought forward ...	23	15	0
Barrow Miss		5	0
Barry W. J.	1	1	0
Barton S. J., M.D. ...	1	1	0
Barton Claud ...		10	6
Beevor Sir Hugh, Bart.	2	0	0
Benn Sir Ion Hamilton Bart., C.B., D.S.O.	1	1	0
Blackburn C. J. ...	1	0	0
Blake H.	2	2	0
Bland Miss R. ...		10	0
Blatch Edward ...	1	0	0
Boardman E. T. ...	1	0	0
Boileau Sir Maurice, Bart.	1	1	0
Brash T.	2	2	0
Briscoe Capt. F. M. Eliot-Drake ..		10	0
Brooks J. R.... ...	1	1	0
Brown E.		10	6
Brown H.	1	1	0
Carried forward ...	£41	11	0

	£	s.	d.
Brought forward ...	41	11	0
Buckle Lt.-Col. D. W.	1	1	0
Bullard Ernest ...	1	1	0
Bulwer Col. E. A. ...		10	0
Burrowes R. B. ...	1	0	0
Burrows Mrs. ...	2	0	0
Burton G. Murray ...	1	1	0
Butler R. Fawsett ...		10	0
Butler Richard W. ...	1	1	0
Buxton Aubrey ...		5	0
Buxton Major Anthony	2	2	0
Byers J.		10	0
Caffyn D. E. ...		10	0
Calder Sir James C., C.B.E.	1	1	0
Capron J. T.		10	0
Capron Miss J. ...		2	6
Carroll H. D. ...		10	0
Carruthers D. ...	1	1	0
Cassie R. L.		10	0
Cator John		11	0
Chadwick Dr. Morley	2	2	0
Churchill Mrs. Arnold		5	0
Clarke Mrs. Frank ...	1	1	0
Cleminson H. M. ...	1	0	0
"Cley"		2	6
Clogstoun H. P. S., M.B.E.	1	1	0
Clutton Brian ...	3	3	0
Coe Mrs. A. E. ...		10	0
Cole I. V.		2	6
Collar Arthur ...		5	0
Colman Miss E. M. ...	1	1	0
Colman Miss H. C. ...	1	1	0
Colman R. J. ...	1	1	0
Cooke G. J.		10	0
Cox Major General Sir Percy, G.C.M.G.		10	0
Cozens-Hardy A. ...	1	1	0
Cresswell C. A. ...	2	0	0
Cresswell Mrs. George	1	1	0
Dalgety Christopher T.	1	1	0
Dallas C. C.	1	0	0
Davis H. L. N. and P.	1	1	0
Deacon Dr. G. E. ...		10	0
Drury G. L.		10	6
Duncanson T. J. G. (the late)	3	3	0
Eccles James R. ...	1	1	0
Eddison C. R. ...	1	1	0
Edwards G. C. ...		5	0
Edwards Michael ...		5	0
Elphick Dr. G. ...	2	2	0
Elton D.		10	0
Ennion Dr. & Mrs. E. F. R.	1	1	0
Everitt W. G. ...	1	1	0
Carried forward ...	£89	16	0

	£	s.	d.
Brought forward ...	89	16	0
Ewing Miss J. Orr ...		5	0
Ferrier Miss Judith ...		10	0
Finch Alfred		10	0
Finch F. R.	1	1	0
Fisher H. H., F.R.C.S.		10	0
Fletcher Miss R. ...	1	1	0
Flowers John, K.C. ...	1	1	0
Forbes Lt.-Col. A. M. H., D.S.O. ...	1	1	0
Forbes H.	1	1	0
Foster, Capt. T. H., R.N.		10	0
Fox F. Douglas ...	1	1	0
French Miss E. M. ...		12	6
Friedlein W. ...	1	1	0
"Friend"		5	0
Garnett R. M. ...		10	0
Garrod F. W.... ...		10	6
Gay Miss C. E. ...	1	1	0
Gay Miss Ellen ...		10	0
Gayner Dr. J. S. ...	1	1	0
Giles C. C. T. ...		10	0
Giles Rev. A. Linzee		10	6
Gilman Randon ...		10	6
Goddard W. N. ...	1	11	0
Gowen H. P.... ...	1	1	0
Graves Mrs.	1	1	0
Green Lt.-Col. E. A. Lycett	1	0	0
Gresham School Nat. Hist. Soc.	1	1	0
Gurney G. H. ...	2	2	0
Gurney Q. E. ...	1	1	0
Gurney R., D.Sc. ...	2	2	0
Haig Mrs. Donald M.		5	0
Hamilton Miss M. E.		5	0
Hannaford G. ...	2	2	0
Hardy Mrs. H. F. H.		5	0
Hardyman Miss F. N.	1	0	0
Harker W.	1	1	0
Hastings Thomas ...	1	1	0
Haydon W.		5	0
Heywood R.	1	1	0
Hill Nettleship ...		10	6
Hill T. A. M. ...	1	1	0
Holland C. B. ...	1	1	0
Home Miss M. Logan		2	6
Homere Miss (*In Memoriam*, J. W. C.)	1	1	0
Hopwood Miss M. ...		5	0
Horsley Miss S. ...		10	0
Hulse Mrs. M. W. ...		10	0
Hulse Miss E. M. ...		10	0
Jago Cyril		10	0
Jenkins Rev. T. L. ...	1	10	0
Carried forward ...	£131	4	0

	£	s.	d.
Brought forward ...	131	4	0
Jones Commander B. E., R.N.		10	0
Jones Sir L., Bart. ...	1	1	0
Jones Lawrence E. ...	2	2	0
Keith E. C	1	10	0
Kerr Mrs. H. M. Rait	1	1	0
Kolle H. W.	2	2	0
Lance Capt. H. W. ...	2	0	0
Lang Gordon L. ...	1	1	0
Larking R. C. ...	1	1	0
Lawson Harry ...	1	1	0
Lee-Elliott Rev. D. L.	1	1	0
Lees M. Mackenzie ...	1	1	0
Lendrum Mrs. T. J. ...	1	0	0
Lister S. R., M.D. ...		11	0
Lewis J. Spedan ...	2	2	0
Long S. H., M.D. ...	2	2	0
Low G. Carmichael, M.D.	2	2	0
McHardy Maj.-Gen. A. A., D.S.O. ...	1	0	0
Macdonald Malcolm, M.P.		10	0
Mackay Dr. Helen M.		10	0
Macpherson A. Holte	1	1	0
Madoc Col. H. W. ...	1	0	0
Maidment Dr. F. W. H.	1	1	0
Marples George ...	1	1	0
Marshall E. H. ...	1	0	0
Marshall W. K. ...		11	0
Marshall J. M., J.P....	1	1	0
Matthews T. G. ...	1	1	0
McIlquham Miss M. ...		5	0
McKenzie Miss G. ...		10	0
McKittrick T. H., Jun.	1	1	0
McLaren Mrs. ...		10	0
McLaren Miss Sheila		2	6
McLean C.	1	1	0
Meade-Waldo E. G. B.	1	1	0
Meadows Mrs. A. H....		10	0
Medlicott Miss ...		5	0
Mennell E.		10	0
Micholl Mrs.	1	1	0
Milne Mrs. Findlay ...	1	1	0
Milnes G. A.		5	0
Mitchell Arthur ...	1	1	0
Molteno D. J. ...	1	1	0
Mortimer Gilbert ...		5	0
Murton Mrs. ...	1	0	0
National Trust, The...	10	0	0
Naylor W. S. ...	1	1	0
Newman Miss F. B. ...		10	0
Noble E.		10	0
Noel-Buxton Lord ...	2	0	0
North Mrs.		10	0
Carried forward ...	£190	8	6

	£	s.	d.
Brought forward ...	190	8	6
Oliver Prof. F. W., F.R.S.	1	0	0
Pagan Miss E. L. ...	1	1	0
Palmer A. J.		5	0
Partridge Miss M. ...		5	0
Pearson S. V., M.D. ...		10	0
Penrose Mrs. F. ...	1	1	0
Perry Miss M. ...	1	1	0
Phelps Mrs. B. ...		10	0
Pilkington Mrs. Hubert	1	1	0
Plowright Dr. C. T. ...	2	2	0
Poole Miss D. Lane ...		5	0
Powell A. M.... ...		5	0
Pratt Alfred	1	1	0
Preston Sir E., Bart., D.S.O.		10	6
Previté A. W. ...		5	0
Purdy T. W.... ...	1	1	0
Ransome Mrs. ...	1	1	0
Raikes Miss D. T. ...	1	1	0
Reeves D. L.	3	0	0
Reid Dr. E. S. ...		10	0
Richmond H. W., F.R.S.	5	0	0
Ringrose B. J. ...	1	1	0
Rippingall Neal F. ...	1	1	0
Riviere B. B., F.R.C.S.	1	1	0
Rogers Rev. H. ...	1	0	0
Ross Miss W. M. ...	1	1	0
Royal Society for the Protection of Birds	2	2	0
Rushton Miss... ...		10	6
St. Quintin W. H. (the late)	1	1	0
Savill Harry	2	2	0
Savin A. C.		10	0
Savory Mrs.		10	0
Sewell P. E.	2	2	0
Sheldon W. G. ...		10	6
Smith Col. H. F. ...	2	2	0
Soman A. E. & Co., Ltd.	1	1	0
Spalding G.		10	0
Sparrow Col. R. ..		10	6
Southwell E. B. (the late)	1	1	0
Stimpson E. ...		10	0
Sumpter Dr. B. G. ...	1	1	0
Tate Mrs.	1	0	0
Taylor Commander Mark, R.N. ...		10	0
Taylor Dr. Mark ...	1	1	0
Tennant Bernard V. A.	1	1	0
Thompson Hugh ...	2	2	0
Thouless H. J. (the late)		10	0
Times W. O.	1	1	0
Carried forward ...	£241	16	6

	£	s.	d.
Brought forward ...	241	16	6
Tracy N.		10	0
Trafford Maj. E. B. ...	1	1	0
Tuke Anthony W. ...	2	2	0
Upcher H. E. S. ...	1	0	0
Upcher Miss L. ...	2	2	0
Vincent Miss. G. H. M. M.	2	2	0
Waddy Mrs.		5	0
Walter C. H. ...	1	1	0
Walters Lewis ...	1	1	0
Watson-Kennedy Mrs.	1	1	0
Wemyss Major G. ...	1	0	0
Carried forward ...	£255	1	6

	£	s.	d.
Brought forward ...	255	1	6
Whittaker W. I. ...	1	1	0
Whitehead G. K. ...		5	0
Wilkinson H. J. ...	1	1	0
Winch Major S. B. ...	2	2	0
Wing J. Sladen ...	1	1	0
Winter Gordon ...		10	0
Wolley-Dod Mrs. ...		10	0
Wright T. J.		10	0
Wyllys H. J. M. ...		10	0
Wyllys W.		10	0
Yelf C. W.	1	0	0
Young Rev. Belton ...		5	0
Total ...	£264	6	6

NORFOLK WILD BIRDS PROTECTION FUND

Year ended 31st December, 1933

RECEIPTS

	£	s.	d.
Balance brought forward from 1932	31	14	11
Subscriptions and Donations, 1933	264	6	6
Blakeney Point Collecting Box	1	7	6
Scolt Head Collecting Box ...	1	2	0
Sales of Report	1	10	6
	£300	1	5

PAYMENTS

	£	s.	d.
Breydon Watcher's Wages and Insurance	42	5	6
Oil, Coal, etc., for Breydon House Boat	1	9	6
Scolt Head Watcher's Wage and Insurance	137	3	8
Blakeney Point—Contribution to Watcher's Wages	30	0	0
Cley Marshes—Watcher's Wages	65	4	0
Workmen's Compensation Insurance Premium	1	0	0
Yarmouth Port and Haven Commissioners—Registration fees for boats		10	0
Printing of Annual Report ...	14	7	0
Hon. Secretary—Stationery and Postages	7	3	0
Cheque Books		5	0
Balance		13	9
	£300	1	5

Examined and found correct,
FRANK INCH

Norfolk & Norwich Hospital
Norwich, 15th Jan., 1934

X

THE GREAT YARMOUTH HERRING FISHERY 1932

By Sydney H. Long, M.D., F.Z.S.

Since the War, and especially during the last few years, the condition of the Yarmouth herring fishery has been one of a declining fleet, dwindling catches and shrinking exports.

The prosperity of this trade has always depended upon the foreign demand, the home market having absorbed no more than five per cent. of the output. Of late Continental markets have been steadily contracting, and Russia, once our largest customer, has severely curtailed purchases, while other European countries, by the operation of tariffs and a quota system, have further harassed and dislocated trade.

With the object of trying to increase the popularity of the herring as an article of food amongst our own people the experiment was made of salting and cooking the fish before putting it on the market, but to what extent a widespread organisation for its distribution on a large scale can be effected remains to be seen. An endeavour was made in 1932 of controlling the market by regulating supplies, and towards this end all boats were ordered to be in port on Saturday nights. A fixed price was placed upon the herrings until a certain quantity had been dealt with, when the restrictions were removed. This scheme did not meet with much enthusiasm by the fishermen, who maintained that the price fixed had been placed too low. It was estimated that the average earnings of each Yarmouth boat was about £400, and as the average expenses of the voyage amounted to £300, the fisherman's share in many cases amounted to little more than the cost of his food.

It occasionally happens that a boat will catch more fish than she is capable of bringing into port, as occurred with a Lowestoft drifter on September 29th, when she caught 287 crans ; she brought in 172 crans and handed over the balance of her nets, 115 crans, to a Yarmouth boat.

The fleet comprised 531 Scotch boats compared with 612 last year and 634 in 1930, and 111 Yarmouth boats which is twelve

less than in 1931. About 20 Lowestoft boats also worked from Yarmouth throughout the season. The weekly landings in October and November were :—

	1932 crans	1931 crans	1930 crans
Oct. 8	6,329	14,379	53,783
,, 15	32,862	68,611	79,344
,, 22	35,086	69,617	98,730
,, 29	25,382	92,664	60,011
Nov. 5	57,840	44,609	106,882
,, 12	45,680	25,651	60,240
,, 19	42,731	10,946	18,763
,, 26	6,437	18,160	7,680
	252,347	344,637	485,433

Curing commenced on October 12th and ended on November 16th, so far as the Scotch operations were concerned. Of the total cure Yarmouth's share was 230,864 barrels against 288,470 barrels in 1931 and 524,994 in 1930. Up to November 27th the quantity shipped was 137,513 barrels compared with 168,278 last year. They were sent to Danzig, Stettin, Memel, Konigsberg, Riga, Libau, Rotterdam, Hamburg, and Duisburg. The shipments of fresh herrings to Wesermunde were estimated at 11,200 crans.

XI

METEOROLOGICAL NOTES, 1932

(From Observations taken at Norwich)

By Richard J. Preston

JANUARY

1932 opened with every prospect of a long spell of wintry weather, the ground being covered with snow, and the minimum readings at 9 a.m. on January 1st being 19.4 in the screen and 4.9 on the grass respectively. Nevertheless a period of exceptionally mild weather immediately set in, and by the early morning of the 2nd, the thermometer had jumped to 50 degrees, and the mean temperature from the 2nd to the 20th was almost as high as that for April. The last week was colder, and the mean for the whole month was 42.7 degrees. It was the driest January for 30 years, rainfall being 1.09 inches below the average. There was no snow. Sunshine was in excess of the average. The first part of the month was very unsettled, and there were almost daily gales or strong winds. During the latter part there were some exceptionally high barometer readings, the glass reaching 30.95 ins. during the 26th, which equalled the reading of January, 1882, then said to have been the highest reading since 1825.

Vegetation made a very early start, and many of the early spring flowers made their appearance long before the usual time.

FEBRUARY

Temperature was in close agreement with the average, and the thermometer only once reached 50 degrees. Between the 9th and the 13th there was a brief wintry spell, and on the 10th there were frequent blizzards of fine snow accompanied by violent squalls, and there were deep drifts in some parts of the county. A minimum of 13 degrees on the grass was recorded on the 11th.

Rainfall was again deficient, the total (.87 ins.) being the same as that for January. Sunshine was 11 hours below the average. The high barometer readings continued, and the mean pressure (30.41 ins.) was the highest for any month since February, 1891.

MARCH

Temperature was again about normal, the first three weeks being cold, and the rest of the month mild. The lowest readings were 23.4 in the screen and 16.5 on the grass on the 12th. A little snow fell on the 10th and 11th. The dry weather continued until the 22nd, but on that night there was a heavy fall of .83 ins. Sunshine was 8 hours above normal. Thunder occurred on the 28th, 30th, and 31st.

APRIL

Although the mean temperature was approximately normal, this was due to the absence of cold nights, and day temperatures were abnormally low. 60 degrees was not reached until the 29th, which is unusually late for the first "60" of the year. Rainfall was 1.29 ins. above the average, and sunshine was deficient. Hail and sleet fell on several days, and a little snow on the 12th. Thunder was heard on two days. Vegetation was backward at the end of the month.

MAY

After two warm days there was a change to winterly conditions, and the mean temperature of the week ending May 8th was actually lower than that for the corresponding period in January. From the 14th to the 21st maxima were in the neighbourhood of 70 degrees, but another cold spell followed. This was the third successive wet May, and rain fell almost daily, the total being 1.60 ins. above the average. There were only 118 hours of sunshine, this being easily the lowest total for May since Mr. Willis started his readings in 1911. Thunder occurred on the 16th, 21st, 23rd, and 30th. In the early hours of the 21st three severe storms passed in succession over or near the city, and there was much vivid lightning, though little damage was done.

Vegetation was extraordinarily backward up to the 12th, but thereafter made rapid progress.

JUNE

This month was notable for great variations of temperature. After reaching 71 degrees on the 2nd, the maximum dropped to 54 degrees on the 3rd; and several unseasonably cold days followed. Seventy-eight degrees and 80 degrees were reached

on the 11th and 13th respectively, but there was another drop of 20 degrees on the 13th. Except for a cold spell from the 18th to the 21st, the rest of the month was fairly warm, and 80 degrees was again reached on the 27th. It was the driest June since these records were commenced, and the total of 0.44 in. included 0.31 ins., which actually fell during the early hours of the 1st July. The previous driest Junes were 1884, 0.52 in.; 1886, 0.50 in.; 1887, 0.48 in.; and 1921, 0.55 in. Sunshine was over 20 hours below the average, but apart from the chilly periods above referred to, it was a very fine summer month, and the heavy rains of the previous months, and the lack of sunshine prevented the drought from becoming disastrous.

JULY

There was a short heat wave from the 9th to the 12th inclusive, the thermometer reaching 80 degrees or over on each of those four days. The mean temperature of the first fortnight was 5½ degrees above the July average. The most remarkable feature was the warm night of the 9th-10th, when the minimum was 66.9 degrees, the warmest night on these records. The remainder of the month was unsettled and cooler, but the mean temperature for the month was 1.7 degrees above normal. Once again the weather broke down round about the date of "St. Swithin's," and the rainfall was nearly an inch above the average. Sunshine was 56½ hours below the average. Thunder was heard on several days, and there was a very heavy storm on the evening of the 20th, frequent vivid flashes of lightning being accompanied by almost incessant thunder.

AUGUST

This month will long be remembered for the great heat which occurred on the 19th, when the thermometer reached 96.4 degrees. This was the hottest day in these records, and probably the hottest day ever recorded in East Anglia. The previous hottest days since these records were commenced were 93.5 degrees on August 9th, 1911, 93 degrees on September 3rd, 1906, and 92.9 degrees on 11th July, 1923. Mr. J. H. Willis' reading at Ipswich Road was 95.5 degrees. An almost equally remarkable feature was the extraordinarily high mean temperature of the same day (the 19th) the great heat being preceded by a very warm night, with a minimum of 65 degrees,

so that the mean for the day was 80.7 degrees, and it was therefore also the warmest 24 hours in these records. The month generally was very warm, the mean temperature working out at 65.9 degrees, nearly 5 degrees above the average. There have only been two warmer months in the past 50 years, namely, August, 1884, and August, 1911. A heat wave set in on the 8th, lasting until the 13th, and returning on the 17th. Eighty-seven degrees was reached on the 18th. The showery weather of the last half of July continued until the 4th, after which it was fine and dry, except for a fall of .42 in. on the 12th during a thunderstorm. Rainfall was half an inch below the average, and sunshine 20 hours deficient. Thunderstorms occurred on the 4th, 12th, and 30th, and thunder was heard on the 1st and 21st.

SEPTEMBER

There was no repetition of the August hot weather, the warmest day being the 2nd, with a maximum of 77 degrees. Mean temperature closely approximated to the average. The night of the 21st-22nd was the coldest September night since 1919, the screen thermometer falling to 34 degrees. Rainfall was frequent, but there were few heavy falls, and the total was little above the normal. Sunshine was again deficient. The showery weather hampered harvest operations, which were not generally completed until nearly the end of the month.

OCTOBER

This was a rather cold month, the mean temperature being 1.2 degree below the average. This was accounted for by the absence of warm days, the maximum being only 61.8 degrees, which is remarkably low for October. The nights were not particularly cold. Rain fell almost daily, and the total (exactly 4 ins.) was .88 ins. above normal. There was a great absence of sunshine, the total being only 69 hours, or little more than the average for November. Thunder was heard on the 2nd and 13th. Garden flowers continued in full bloom to the end of the month.

NOVEMBER

After a mild first week, day temperatures were about normal, but again there was practically no frost, and the mean was 1.4 degree above the average. Rainfall was 1.11 inch deficient,

and the sun shone for 39.9 hours only, as compared with the average of 63.2 hours, and it was the dullest November for 20 years. As some compensation for the gloomy weather we were spared the thick fogs usually associated with this month. Thunder was heard on the 23rd. Roses, dahlias, and various summer annuals were flowering in the open up to the close of the month.

DECEMBER

This was on the whole a mild and open month, with a mean temperature 3 degrees above the average. It was the driest December on these records, the total rainfall being only .66 in. Up to and including Christmas Day there was plenty of sunshine, and the dry, sunny weather in the middle of the month was reminiscent of summer. The last six days were practically sunless. The barometer reached 30.72 ins. on Christmas Day, which was brilliantly fine. As a result of the absence of screen frosts many varieties of flowers continued to flower in the open, and roses could be picked out of doors up to the end of the month.

THE YEAR

The weather readings begun by my father on January 1st, 1883, are now, with the close of this year, complete for a period of half a century.

It is rather remarkable that it should have been left to the fiftieth year to provide the highest readings of both thermometer and barometer during the whole of that period, and also the warmest night, the warmest day (i.e., 24 hours), and the driest June and December.

The year's mean temperature was 1.3 degree above the average. The warmest month was August, and the coldest February.

Rainfall was 2.11 ins. below normal. The total from January 1st to March 22nd was only just over 2 ins.

Sunshine was much below the average, and we have to go back to 1916 for a year with a lower total. Mr. J. H. Willis has again very kindly supplied the sunshine readings.

Barometer readings during the earlier part of the year were extraordinarily high, and the mean pressure (9 a.m.) for the period, 18th January to 29th February, was 30.47 ins.

MR. PRESTON'S METEOROLOGICAL RECORDS FOR 1932

1932 Month	BAROMETER					THERMOMETER					HYGROMETER	SUNSHINE	RAINFALL		WIND								
															Direction and Days								
	Highest	Date	Lowest	Date	Mean	Highest	Date	Lowest	Date	Mean	Mean Relative Humidity 9 a.m	Hours	Inches	No. of Days	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
	in.		in.		in.	°F		°F		°F	%											
JAN.	30.92	26	29.32	6	30.14	56.0	3	19.4	1	42.7	90.0	63	.87	11	0	0	1	2	5	12	11	0
FEB.	30.68	18	29.98	24	30.14	50 0	3	23.9	7	38.0	89.1	68	.87	14	8	7	6	1	0	0	5	2
MARCH	30.33	21	29.28	30	29.93	56.3	31	23.4	12	41.0	78.0	132	1.93	14	4	2	5	4	3	3	5	5
APRIL	30.41	13	29.07	2	29.70	65.0	30	32.5	9	45.7	80.0	137	3.00	23	3	2	2	2	6	3	7	5
MAY	30.16	18	29.53	9	29.80	74.5	19	34.7	26	53.1	85.0	118	3.53	27	7	3	2	1	4	5	7	2
JUNE	30 26	23	29.69	28	30.03	80.0	12 27	41.8	7	58.3	73.2	185	.44	6	8	6	2	0	1	3	7	3
JULY	30.19	9	29.44	1	29.84	84.0	12	45.1	19	63.3	77.6	154	3.50	17	6	1	1	1	6	5	10	1
AUG.	30.37	24	29.78	30	30.05	96.4	19	48.4	23	65.9	80.3	164	1.77	10	4	2	5	0	3	4	12	1
SEPT.	30.38	15	29.41	11	29.87	77.0	2	34.0	22	57.7	86.0	119	2.34	18	5	1	2	2	3	6	9	2
OCT.	30.14	19	29.12	9	29.62	61.8	7	35.0	6 29	48.7	85.2	69	4.00	24	2	0	1	0	4	5	15	4
NOV.	30.59	13	29.49	23	30.04	58.0	26	31.8	1	44.8	87.7	40	1.46	16	2	2	8	1	2	5	10	0
DEC.	30.72	25	29.41	3	30.06	55.4	20	30.8	2	41.9	90.4	50	.66	16	0	2	5	1	15	3	5	0
MEANS					29.93					50.1	83.5											
EXTREMES & TOTALS.	30.92	Jan. 26	29.07	Apl. 2		96.4	Aug. 19	19.4	Jan. 1			1298	24.37	196	49	28	40	15	52	54	103	25

XII

MISCELLANEOUS NOTES AND OBSERVATIONS

Death's Head Moth.—In the first week of September, 1933, the chrysallis of a Death's Head Moth (*Acherontia atropos*) was brought to me by a village lad who had dug it up in his potato patch. I put it into a breeding-cage and covered it with mould. On the next morning I found it on the surface, so I covered it again. It once more dug itself out, and as the authorities on the subject hold that this chrysallis is particularly delicate when the shell which the caterpillar constructs is broken I covered it with the lid of a cardboard box. On October 2nd the moth emerged about 9 p.m. and is a very fine specimen. I put these facts on record because the Death's Head moth has become somewhat uncommon in East Norfolk; it emerged in October, whereas its correct month is July; and, so far from being delicate to rear, it stood up to treatment worthy of the stoutest of the lepidoptera. (A. A. McHardy, Major-General, Hickling, Norfolk).

XIII
H. J. THOULESS
1864—1933

Henry James Thouless belonged to a family whose sons for many generations have been freemen of the city of Norwich. A son of Henry Thouless, he was born on December 5th, 1864. Apprenticed at the age of fifteen to Messrs. Barnard, Bishop and Barnard he spent two years in their well-known ironmonger's shop on the Walk opposite the Norwich Guildhall. Later he joined the clerical staff of Norfolk Ironworks (now Barnards Limited) in St. Miles Parish, the Managing Director, Mr. J. G. Bower being his uncle. Mr. Thouless became secretary to the firm, and for thirty years he was a director of the Company with which he had been associated for fifty-three years.

He was actuated by a keen sense of duty and rendered devoted service to all that he undertook, but his real hobby was natural science. An ardent student of entomology, he collected butterflies and became an acknowledged authority on beetles of which his collection was one of the largest in the possession of any private collector. This valuable collection and his library are now in the possession of the Norwich Castle Museum where for the last three years he had been a co-opted member of the sub-committee entrusted with the formation of the Norfolk Room. He was also a member of the Prehistoric Society of East Anglia, of the Egyptian Society, and the Norfolk and Norwich Archæological Society.

In 1886 Mr Thouless joined the Norfolk and Norwich Naturalists' Society of which he was President in 1915-16. The subject of his Presidential Address was " Insects in their relation to Mankind." At the time of his death he was Hon. Treasurer of this Society.

Mr. Thouless owned a bungalow on the bank of the River Bure near Wroxham Broad. Here he did research work among not only the insects but also the native plants of an untouched piece of ancient marshland and its waterways.

He was always ready to impart knowledge to any student, his quiet reserved manner adding emphasis to the clearness of his description.

He died in June 1933, leaving a widow, a son (Dr. R. H. Thouless), and two daughters. He was interred in Wroxham Churchyard.

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H. J. Thouless
1864—1933


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OF THE

Norfolk and Norwich

NATURALISTS' SOCIETY

PRESENTED TO MEMBERS FOR

1933—34

VOL. XIII.—PART V

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2.—MSS. OF PAPERS.—As soon as any paper is ready for publication, whether it has been read before the Society or not, it must be sent to the Hon. Editor for the consideration of the Committee.

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The Norfolk and Norwich Naturalists' Society has for its objects—

1. The practical study of Natural Science.

2. The protection, by its influence with landowners and others, of indigenous species requiring protection, and the circulation of information which may dispel prejudices leading to their destruction.

3. The discouragement of the practice of destroying the rarer species of birds that occasionally visit the County, and of exterminating rare plants in their native localities.

4. The record of facts and traditions connected with the habits, distribution, and former abundance or otherwise of animals and plants which have become extinct in the County ; and the use of all legitimate means to prevent the extermination of existing species, more especially those known to be diminishing in numbers.

5. The publication of Papers on Natural History contributed to the Society, especially such as relate to the County of Norfolk.

6. The facilitating of a friendly intercourse between local Naturalists by means of Meetings for the reading and discussion of papers and for the exhibition of specimens, supplemented by Field-meetings and Excursions, with a view of extending the study of Natural Science on a sound and systematic basis.

7. Any Member who, in the opinion of the Commttee, contravenes the objects of the Society is liable to have his name erased from the List of Members.

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D

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1911 Spurrell J. T., Manor House, Newton St. Faiths, Norwich
1923 Spurrell Miss M., Manor House, Newton St. Faith's, Norwich
1923 Spurrell Miss P., Manor House, Newton St. Faith's, Norwich
1925 Steers J. A., M.A., St. Catharine's College, Cambridge
1921 Stimpson Edward, Sall Moor Hall, Reepham, Norfolk
1932 Stone Miss I., 42, Sandringham Road, Norwich
1922 Sumpter Dr. B. G., Brancaster Staithe, King's Lynn
1896 Sutton W. Lincolne, F.I.C., Framingham Pigot, Norwich

T

1931 Talbot Sir Gerald, K.C.V.O., C.M.G., O.B.E., Burnley Hall, Somerton, Norfolk
1931 Tate Mrs., Lenwade House, Near Norwich
1921 Taylor Dr. Mark R., 338, Winchester Road, Southampton
1878 Taylor Shephard T., M.B., The Mount, Edgefield, Melton Constable
1933 Taylor Commander M., R.N., 50, Queen's Gate Terrace, London, S.W.7
1921 Thain D., West Somerton, Norfolk
1931 Thomas J. F., Bowden House, Seaford, Sussex
1929 Tillett Miss I., "Sunnymead," Buxton, Norwich
1896 Tillett Wilfrid S., "Sunnymead," Buxton, Norwich
1933 Tindall Miss E., Kettleby Lodge, Sheringham
1920 Todd Lt.-Col. Eardley, Mundham House, Brooke
1902 Todd R. A., B.Sc., The Retreat, Elburton, Plymouth
1932 Todd Mrs., Mundham House, Brooke, Norfolk
1910 Tracy N 3. King Street, King s Lynn
1925 Tucker B. W., 9, Marston Ferry Road, Oxford
1906 Turner Miss E. L., F.L.S., H.M B.O.U., *Hon. Mem.*, 13, Storey's Way, Cambridge
1927 Turner Edgar, "Kuruman," Walberswick

U

1923 Upcher Rev. E. C. S., Weybourne Rectory, Norfolk
1921 Upcher H. E. S., The Gables, Upper Sheringham
1930 Upcher Mrs. H. E. S., The Gables, Upper Sheringham

V

1917 Vincent James, Hickling, Norfolk

Elected

W

1923 Walter Mrs. Cyril, Old House, Drayton, Norwich
1923 Waterfield Mrs., Attlebridge, Norfolk
1926 Wemyss Major, Bryn House, Wroxham
1927 Wemyss Mrs. ,, ,,
1931 Wheeler G., Tatterford Rectory, Fakenham, Norfolk
1932 Wheeler Engineer-Capt. S. G., R.N., Lower Hellesdon, Norwich
1922 Willett W. L., Paddock Wood, Kent
1929 Wilson Mrs. Gerald, Saxlingham Nethergate, Norwich
1934 Winter C. H., Abbot's Manor, Kirby Cane, Norfolk
1909 Witherby H. F., M.B.E., F.Z.S., 326, High Holborn, W.C.
1931 Wontner Rev. T. S., Ashby St. Mary Rectory, Norwich
1931 Woolley Miss, B.Sc., Blyth Secondary School, Norwich
1923 Woolsey G. E. W., Old Catton, Norwich
1907 Wormald Hugh, M.B.O.U., Heathfield, East Dereham
1922 Wortley Francis, Half-Year, West Runton, Norfolk

Y

1915 Yarmouth Free Library, The, Great Yarmouth

TOTAL

Honorary Members	... ...	5
Life ,,	... ...	27
Ordinary ,,	... ...	344
		376

The Treasurer in Account with the Norfolk and Norwich Naturalists' Society, Year Ending 30th April, 1934

I. GENERAL ACCOUNT

1933-34. Dr.	£ s. d.	£ s. d.
To Balance from 1933		1 4 6
„ Subscriptions		159 6 0
„ Investments, 4% Consolidated Stock	12 0 0	
3½% War Loan	3 13 8	
		15 13 8
„ Publication Fund—		
Major A. Buxton	3 5 0	
Professor Salisbury	2 2 0	
J. Cator	10 0	
H. Upcher	10 0	
Sir R. Neville	10 0	
Mrs. Butler	10 0	
E. B. Hinde	10 0	
Small Sums	1 0 0	
		8 17 0
„ Sales of Transactions		1 4 0
„ Sales of East Anglian Flora		14 17 0
„ Balance		56 7 1
		£257 9 3

CR.	£ s. d.	£ s. d.
By Printing Transactions		155 18 6
„ Reprints of East Anglian Flora		29 3 4
„ Expenses Secretary	6 7 1	
„ „ Editor	5 13 3	
„ „ Treasurer	8 0	
		12 8 4
„ Library Rent		6 6 0
„ Binding		10 1 10
„ Printing and Stationery		4 0 6
„ Expenses of Meetings		9 13 3
„ Contribution to "Scolt Head," 1st Instalment		25 0 0
„ Insurance		13 6
„ Cheque Book		5 0
„ Subscriptions: Museum Conference	2 2 0	
Year Book	8 6	
East Anglian Scientific Association	7 6	
S.P.R.E.	1 1 0	
		3 19 0
		£257 9 3

II. DEPOSIT ACCOUNT

1933-34	£	s.	d.	1934	£	s.	d.
To Balance from 1933	21	0	0	By Balance at Barclays Bank	21	7	3
„ Interest		11	4				
	£21	11	4		£21	7	3

III. LIFE MEMBERSHIP ACCOUNT

1933-34	£	s.	d.	1934	£	s.	d.
To Balance from 1933	17	19	7	By Balance at Savings Bank	20	1	6
„ Interest on War Loan	1	15	0				
„ Bank Interest		6	11				
	£20	1	6		£20	1	6

I have audited the above three accounts and found them correct.

18*th May*, 1934.

C. R. A. HAMMOND.

BRITISH MUSEUM
PRESENTED
2 APR 1935

ADDRESS

Read by the President, MAJOR ANTHONY BUXTON, D.S.O., *to the Members of the Norfolk and Norwich Naturalists' Society, at their Sixty-Fifth Annual Meeting, held at the Castle Museum, Norwich, on April 17th,* 1934.

PROTECTION OF WILD LIFE

The invention of modern weapons, like the shot gun and the rifle, the ease and rapidity of travel, and the spread of civilization have brought about an enormous destruction of wild life, and it is only comparatively recently that man has begun to think that he has gone too far and that wild animals, birds and flowers are worth preserving for his own entertainment. With this change of attitude there has been a great output of literature on natural history subjects, some of it of a very high standard and, helped by photography and more recently by the film, an interest in wild life has been aroused in a much wider public than was ever the case before. Moreover the facilities for travel, which at first led to destruction by the few, have brought wild places and wild creatures within reach of the many, who are beginning to demand that nature shall be left alone for their enjoyment.

In taking stock of what has been done to limit destruction of wild life it seems worth while to say a word or two about international action, for although little has yet been achieved by this method, and indeed has only recently become possible, it may well be that international action will in the future produce more far reaching results than national, for protection of creatures which move vast distances and ignore all frontiers can only be really effective, if it is in force wherever they go. To give only one instance, it is of little value to stop the netting of quail as they land in Europe, if they are still to be decimated before they leave the African coast. The advantages of international action are not confined to the protection of birds and fish. In 1900 the African Powers, realising that something was required to prevent the smuggling of ivory and other destructive processes in that continent, attended a Conference in London and

signed a Convention to prevent unrestricted slaughter of African Fauna. Although that Convention was never ratified, sanctuaries were constituted in many of the British possessions, an example which was followed in other Territories, and further protective measures were taken by individual countries, so that the position when a second Conference was called in 1933, also in London, was much more hopeful.

At this second Conference all the African Powers except Abyssinnia signed a Convention containing the following provisions :—

1. The establishment of Permanent National Parks under definite regulations.
2. The provision of Game Reserves, preliminary and secondary to National Parks.
3. The protection of certain species in danger of extinction, and regulation of the trade in trophies.
4. Prohibition of specially deadly methods of destruction, such as the use of poison, nets, pits, etc., and of shooting from motor cars.

Signature of an International Convention is always a more easy matter than ratification, but even in the unlikely event of non-ratification, it has been decided in any case to hold periodical conferences to consider international measures to prevent the destruction of flora and fauna, and the subject has become so popular that Governments will hardly be allowed in future to ignore it.

Attempts have also been made, so far with little success, to draw up international regulations for the protection of marine animals, whales, seals, etc., but if Governments learn that such measures are economically profitable common action may well follow. The economic argument carries more force than any other with Governments. Perhaps because they have not yet seen how it can be made to pay, so far no international action has been taken in relation to birds, the creatures for which such action has the most obvious advantages. Although Governments have not moved there have been several unofficial conferences on Bird Protection intended to lead up to Government action. About ten years ago such an unofficial Conference met in Geneva and reached general agreement, hedged about unfortunately with too many national exceptions, for

the fixing of an annual period during which destruction should cease, and birds should be allowed to reach their breeding areas and rear their families unmolested. In the northern hemisphere, from March 1st to some date in the autumn, with a corresponding period in the southern hemisphere was to be constituted a close season. Unluckily no Government took action along the lines of these recommendations and the British Government poured rather more cold water on the scheme than the others, perhaps because of the false theory—held strongly in this country but no less strongly in other countries about themselves—that "we shall keep this Convention, but none of those other dirty dagoes will." That idea has been fatal to many a Convention, and in this case nothing was done. As a typical instance of the need for international action. paired mallard travelling across France to breed in these islands still run the gauntlet on the continent in March and, in return, we polish off the flappers in August, lest somebody else should get them when they can fly further afield.

Another international Conference has just met in Oxford, which was one of the most successful ever held. As at the previous Congress held in Amsterdam, in 1930, the question of oil pollution of sea birds was again under discussion and the following resolution was passed :—

"The VIII International Ornithological Congress approves the intention of the British Government to raise the question of oil pollution of the sea at the next meeting of the Assembly of the League of Nations ; urges that all possible steps be taken, both in relation to that meeting and also by influencing public opinion in all maritime countries of the world, to bring the evil to an end ; and, as a practical means of effecting this purpose, stresses the need for legislation requiring the installation of oil separators in all oil driven and oil carrying ships under all flags."

This resolution to be forwarded to the British Foreign Secretary, the British Board of Trade, and the appropriate authorities in all the maritime countries of the world.

The British Government last September proposed at the League Assembly that international action should be taken to deal with oil pollution and the proposal was welcomed by delegates of European and North and South American

countries. A technical committee of the League has accordingly been asked to report fully on the question to the next Assembly.

In addition, the Congress recommended " that the study of the form of birds should take a part in the teaching programme in schools, as leading to the development of the sense of observation, and in consequence to the development of the spirit of protection of birds."

Whatever the chances of official international action in the future, the best hope will lie in something very simple and extremely moderate ; otherwise there is certain to arise a demand for exceptions from particular Governments, which will ruin the efficacy of any Convention. A comparatively short time ago, even if a number of Governments happened to wish to do the same thing, it was difficult for them to get together and see that it was done. Now it is quite easy ; the machinery is there, but the old trouble persists that different Governments so seldom wish to do the same thing, and even if they do, much public pressure is required before any one of them can be persuaded to start the ball rolling.

However small the results of international action, individual countries have done a great deal in the last fifty years to check or repair the destruction previously wrought. The United States after perhaps the swiftest of all slaughters of wild animals, set the fashion in reserves. When it was almost too late, they suddenly awoke to the position and in the nick of time constituted the first national reserve—the Yellowstone Park. That example was followed in other parts of the States, in Canada and, later, in other countries. If the United States were once the worst offenders, they were the first to adopt a change of policy, and there is now I suppose more public feeling and more legislation, whether Federal or State, on the subject of protection of wild life in the United States than in any other country. Apart from reserves, protection is effected mainly by the prohibition of the sale of game, by a short open season, and a strict limit both of the daily bag and of the hours of shooting. No shooting is allowed for instance before sunrise and after sunset, a restriction which some of us in this country who have a taste for flighting would find difficult to accept. At this moment there is a perfect flood of literature

containing demands for still stricter protective measures, and suggestions for increasing the stock of wild creatures, put forward partly in the interests of sport and partly in the interests of natural history.

There has been a parallel movement in Africa where reserves have been established, both in territories belonging to the British Empire and in those of other countries. Most famous of all these reserves and most interesting in its manner of development is the Kruger National Park in South Africa. A game reserve of about 1500 square miles was first established between the Sabi and Crocodile rivers in 1898, but the South African war practically destroyed this first attempt and when the reserve was re-proclaimed in 1902 the head of game contained in it was comparatively small. Between that date and 1926, when the National Park, covering an area rather larger than Wales, was finally constituted, many difficulties had to be overcome, and the final success was achieved by enlisting public interest in the scheme. Trains were stopped in the Park and the visitors returned with glowing accounts of what they had seen. Motor roads were made, the volume of tourist traffic increased, and the Reserve became a great holiday resort. In 1929 eight hundred cars visited the Park, in 1930, two thousand cars, in 1931, three thousand cars. I have no figures for cars for the later years, but in 1933, in addition to South Africans, several thousand Europeans visited the Park, and the revenue from the public is now almost equal to the recurrent expenditure. The Park has become a great national possession of which South Africans are justly proud.

The Dominions are ahead of the British Government in the matter of reserves for, so far, none of our Colonial possessions contains a reserve constituted on a permanent basis like the Kruger National Park. The Game Wardens who have done such excellent work in these territories hold the view that permanent parks are the only safe form of reserve and that areas which can be opened or closed by order of the Governor, though of great value as preliminary measures, should be eventually turned into National Parks. They also insist that it is useless to attempt to form a reserve in country suitable for economic development.

It is of course of more immediate interest to us to consider

what is being done nearer home on the Continent of Europe. An Englishman is apt to feel something of a shock on discovering when he crosses the channel that however democratic his own country may be in certain directions, it has no idea what the word democratic means in relation to sport and freedom of movement in the country. He is unaccustomed to seeing two sets of sportsmen converge on one covey of partridges on land over which none of them have any special right, or to finding several other fishermen hurling a variety of baits at the particular trout on which he has set his heart and cast his fly ; both are a shock to his insular notions of sport. Sport, and with it a certain knowledge of wild life, is far more widely spread abroad than here and a Continental Government has to legislate in these matters not for a comparatively small number or for a particular class, but for a large proportion of its able-bodied population. Therefore its legislation has to be general and simple—an open season when everything must take its chance, and a close season when any shot fired means a poacher.

There is another great difference. In these islands we have specialised in the preservation of what we call game, and employ a great number of people to destroy anything that destroys or looks as if it might destroy these sacred and priviledged creatures. The result has been terrific destruction of what we call vermin. On the continent gamekeepers are rare, and birds of prey are for that reason far more common. Plenty of arguments could be given in favour of either system ; my point is that the two systems, the democratic and our own, are very different, and it may well be that both of us would benefit by a greater knowledge of the other.

Some attempt shall now be made to pass on a few impressions of what is being done in certain individual European countries, beginning with those nearest to our shores. In Holland bird protection is probably more advanced and has become more popular than in any other country ; indeed it has become so popular that the bird-man and the bird both have to give up any notions of solitude and get accustomed to company. Holland is the only country in which I have seen a string of motor buses drawn up opposite a colony of sea birds, while the crowd were escorted by a guard to view from a neighbouring

gate the occupants of the colony. Birds which seem to insist elsewhere on absolute solitude have learnt to live and nest in Holland cheek by jowl with human neighbours in country the reverse of wild—Ruffs displaying on a road passable for motors, and an Oyster-catcher sitting precariously on its eggs on the roof of a barn by a public thoroughfare. Bird Protection has become a public business, but it was started by private initiative now well backed by the authorities. In any event the success of the venture is an example to every country.

There is a general impression in England that a Frenchman with a gun shoots any little bird he sees at all times of the year. That is a false impression, at any rate in those parts of France with which I am familiar Partly owing to the scarcity of game and partly owing to the migratory habits of certain birds in France which are more stationary or more constantly present with us, a French sportsman hunts certain creatures which we ignore and cares and probably knows more than we do which are the best to eat. He is limited by a perfectly definite and well kept close season, but both he and others, including ourselves, would I think benefit if that close season began on the first of March instead of on the first of April. If we are to obtain such a concession from France and other countries concerning the spring closing, we must be ready in return to open the shooting season, as they already do, later in the autumn.

My experience of Belgium has been too limited to justify serious comment. My impression is that the Belgians are less democratic than the French, but more democratic than us in their dealings with wild creatures. I remember that they set great store by the spring migration of woodcock in March, and no doubt the temptation is great, for woodcock do not stay with them as with us throughout the winter ; nevertheless I hope that one day Belgium will, together with France, agree to end the shooting season for everything, woodcock included, one month earlier.

Anyone visiting the Scandinavian countries must be struck by the kindness to animals there displayed. They stand at the top of the tree in that respect and are therefore certain to take a progressive view in matters of protection. Both Norway and Sweden can boast of a recent increase in their larger animals,

thanks to the measures they have adopted. The open season for elk for instance is everywhere short and its length varies in different districts and different years according to the actual stock. I understand that while the authorities can keep down poaching in the more central and accessible districts, they find it difficult to do so in the remote areas, with the result that elk are more abundant in the centre of Sweden than in the north. There has, it is said, been a very large increase of Roe in the last few years. particularly in the south of Norway, and a certain increase in Reindeer in the west of that country after a period during which the stock got very low, mainly owing to the use of magazine rifles, which are now forbidden. The Ryper of Scandinavia is to all intents and purposes our Grouse, however much we may boast that our bird has no white feathers and is therefore our special perquisite. There is just as much excitement over the opening of the Ryper season with them as there is over the 12th of August with us, but the excitement is felt by a much larger proportion of their population, who have moreover to take a longer uphill walk over steeper ground to reach the haunts of their quarry. Whatever may be the minor differences, a Scandinavian's outlook on wild life, on its destruction and on its protection, as on most other subjects, is extremely like our own ; and no wonder, for there is scarcely more difference between us than between their ryper and our grouse—a lighter plumage and that is about all.

My experience of Germany, Poland, Austria, Hungary and Czechoslovakia has been too limited to form an opinion of any value, but in all those countries there is a strong and widespread taste for natural history. I once listened to an international dispute between Poland and Czechoslovakia, the reasons for which were at first very obscure. It came out at last that the origins of the dispute were certain sporting rights, and thanks largely to the present Lord Halifax, who was the British representative and in the chair, an excellent solution was found in the constitution of a Game Reserve on the frontier between the two countries. There has been no trouble since, and I understand that the reserve and its inhabitants are thriving.

During a recent visit to Rome I heard a good deal and saw something of a real move towards better protection of wild

life. Dr. Axel Munthe's establishment of a bird reserve at Capri has aroused public opinion, and other steps have followed. Signor Mussolini has shown great interest in the subject, and with a stroke of the pen quail shooting and netting has been stopped for the first time this year, the shooting of Honey Buzzards as they passed between Sicily and Italy has been prohibited, and all sorts of measures are in contemplation to encourage the study and prevent the undue destruction of wild creatures. At this moment the Italian Government is the foremost in its desire to call an International Conference on bird protection. Italy can also boast that she has provided the last refuge of the Alpine Ibex and has saved that animal from extinction.

In Switzerland the knowledge of natural history is probably greater and more widespread than anywhere else in Europe. In so democratic a country where such a large proportion of the population shoots, fishes and collects flowers, legislation has to be on very simple lines. Indeed some creatures, such as the pheasant and the partridge which lead a sedentary life in accessible country, can hardly exist at all. They are practically wiped out each year and fresh stock is turned out to take their place. The government and the local authorities must find it no easy matter to hit the happy mean between the demand for sport and the need for protection. Let it be said at once that they have done very well, and that if life be somewhat precarious for wild creatures during a short period, they enjoy real and complete immunity from destruction by human hands for the rest of the year. Switzerland owns an excellent National Park, where its larger game is thriving, in addition to a number of small reserves, mainly for the purpose of protecting particular species. If I have a criticism it is that in Switzerland, as in this country, enthusiasm has in some cases led to a waste of money over reserves which are too small in area to be of any lasting value. Moreover in Switzerland the people, young and old alike, are so well educated and so well disposed to wild life that the whole country is a natural reserve in the summer. During twelve years at Geneva I never saw a single instance of a bird's nest wantonly destroyed, and never felt any anxiety lest a hide or some other evidence of a nest left by me would lead to damage. I am glad to record that over the frontier in

France my experience was exactly the same. They knew much they were anxious to learn more, and they did no harm.

Of recent years I have neither seen nor heard sufficient news of what is happening in Spain to venture any opinion. The Spanish Ibex, that greatest of European climbers, was, and I hope still is, carefully preserved in the Sierra de Gredos and in certain amazing valleys of the Pyrennees where it alone can find a foothold. There is still plenty of " Wild life in Spain " but in the last years the government can have had little chance of giving attention to its protection.

After this cursory review of other countries I shall be expected to say something in conclusion of where we stand and of what in my opinion we ought to do. The great successes in other parts of the world in the matter of protection have been attained by enlisting the interest of the public, therefore publicity is the best weapon, even though at first it may appear dangerous. If the public can get some fun and interest out of wild creatures it will insist on their protection. In planning protective measures the interest of the sportsman as well as of the naturalist must be borne in mind. In most cases their respective interests are by no means antagonistic, and the two qualities are often combined in the same individual. Close and open seasons ought to conform to some general rule which will insure that destruction shall cease before courting begins, and shall only begin again, when the young are capable of looking after themselves. If such a principle were adopted a number of our opening and closing dates would have to be revised ; for instance we should have to stop shooting mallard inland by February 1st and not begin again as early as August 1st. The 'twelfth' would no doubt be a difficult date to change, but although it may be suitable enough in certain districts, it is too early for the grouse in others. The last man whose interests ought to be ignored is he who cannot afford to pay for his sport, and obtains it only with energy and resource mainly on the foreshore. In the matter of reserves, we have I think in some cases wasted money and energy on areas that are too small to be effective. Except for the protection of colonies of certain birds on limited areas, small reserves are I believe bad policy and despite the difficulties inherent in letting in the general

public, the reserves of the future ought to be on a large scale and mainly in the hands of some such organization as the National Trust. The mania for collecting is being curbed already and will eventually I believe be destroyed, through unpopularity. The most effective weapon against that too is publicity.

II

PEDDARS WAY

By H. C. Davies.

In revising, for the Journal of the Society, a report which presented to the County Council in February, 1934, I shoul make it clear that I was reporting as a lawyer and not as ar archæologist. I lay no claim to the latter title, nor have sufficient imagination to qualify for it! My enquiries wer chiefly directed to advising the Council as to the rights of the Public over so much of the way as is still in evidence.

The most important source of information available to m is the Parish Enclosure Award, which generally provides a complete list of the public and private roads. These Award were made after a very thorough survey and local enquiry an put on record all facts that could be so ascertained. Th majority of them were made in the last quarter of the 18t Century and the first quarter of the 19th Century and wher accompanied by a map are invaluable as a guide to loca History. Unfortunately our collection at the Shirehall i not complete. Three copies were made as a rule, one bein deposited with the Clerk of the Peace.

Before 1888 this office was held by gentlemen whose private offices were often used for County business and County record were not kept so carefully as now. From time to time, I hear news of an Award in the custody, quite properly, of a Recto or Lord of a Manor, and by the courtesy of the owner, I am allowed to make a copy to augment our records, or to have th custody of the original on loan. In some cases, an Award is discovered in a strong room with family deeds. I hope I may be allowed to hint that the strong room at the Shirehall is the best resting place for all such interesting and valuable documents!

Although my investigation was begun before the operation, on January 1st, 1934, of the Rights of Way Act, 1932, this Act makes it very desirable that any doubtful public rights should be settled as soon as possible, and the District Councils concerned are, I understand, making the necessary enquiries.

In addition to the Awards, I have searched our Quarter

Sessions Records for enrolment of orders diverting or stopping up highways, and find no reference to any part of Peddars Way. Except under the Authority of Statute (e.g., Enclosure Awards frequently stopped up or diverted roads) no road, once public, can be stopped up (since 1835) except by an order of Magistrates, enrolled at Quarter Sessions. To this rule the only exception is a negligible one, i.e., by a long disused form of legal procedure. The legal position as stated refers to the period during which some approach to the adoption of fixed legal principles has prevailed.

An axiom often quoted in connection with highway law is " once a highway always a highway " and so far as roads of any kind have been used as public highways since English law and customs became crystallised in their present form, the axiom generally holds true, and for a very great number of years a highway could not be abolished as such except with certain legal formalities. Sir Edward Coke, writing in the year 1628 says, " there be three kind of ways whereof you shall read in our English Books " and it may be clearly assumed that modern highway law is based upon the Common Law of England, which, with regard to highways, had reached some degree of finality very many years before Coke wrote, but I am definitely of opinion that the above quoted statement regarding the permanency of a highway does not necessarily extend to the preservation of a highway which was such in prehistoric times, but had been abandoned as such, possibly during the Roman, Saxon or Early Norman occupation of Britain. To hold the contrary would be to contend that every disused road, the foundations or traces of which could be discovered, was a public highway. It is quite clearly laid down that whether a way is or is not a highway is a question of usage, and, therefore, disuse over a *very* long period would still, I suggest, have the effect of an abandonment of the public right.

A question has also been raised as to the power or duty of the Highway Authority to repair any part of Peddars Way which is admitted or discovered to be a public highway. As to this there is authority to the effect that where a track has run through meadows and has never been metalled or paved, a Highway Authority would have no right, without the land-

owners' sanction, to metal or pave it, and in the case of an ancient trackway across a moor it was held by the High Court that a Highway Authority was not justified in making bridges retaining walls, laying stones in a bog, erecting signposts and placing stone pillars to mark the way, and in another case decided in 1704, but still looked upon as good legal authority it was held that the parish (which was then the Highway Authority) was not bound to put a common footway in better condition than it had been time out of mind.

For a physical description of Peddars Way, so far as it can be identified, reference should be made to W. G. Clarke's book " In Breckland Wilds."

The oldest Map which I have been able to make use of is Faden's Map of 1797, and Mr. Warren, the County Surveyor has provided me with a strip tracing showing, the course of the Way according to Faden, and according to the Ordnance Survey. Faden's Map shows a road which, from Tottington Southwards is called " Peddars Way " but its continuation south of the Norwich-Thetford Road is labelled " Roman Road." From its southern end it leaves the county boundary at " Blackwater Ford " (Little Ouse) one and three-quarter miles west of Gasthorpe Gate, runs north for a mile to join what is now a county road (Garboldisham to Shadwell). In a quarter mile the road joins the Thetford-East Harling road. From this point Faden's Map shows the " Roman Road " crossing (nearly due north) West Harling Common Field, crossing the River Thet by a ford called the " Drove Way Ford " and then over Bridgham Heath to the Norwich-Thetford Road. E. M. Beloe in 1896 suggested that the country was too " Fenny " for a ford, and wondered how the road crossed the two rivers. Faden marks the two fords quite clearly.

The Ordnance Map shows this road for about half a mile South of the Norwich-Thetford road, and then a continuation south-west to the cross-roads near Brettenham Manor. Faden also shows this road, with no name to it, ending at the same point on the south, but joining the Thetford main road on the north at a point to the westward of the junction of the Roman Road (Faden) with Peddars Way, with a cross track joining Peddars Way at a point half a mile south of the main road.

There is no award among the County Council records for the

arishes of Rushford, West Harling or Brettenham, but there s an Award for the parish of Bridgham, dated 1806, where the hird public road was called the Shadwell and Wretham road, nd the map on the Award, I assume, refers to the road in Bridgham which we know as Peddars Way. Shadwell is a amlet lying to the east of, and now forming part of, the parish f Rushford, and the fact that the road was called the Shadwell nd Wretham road makes it fair to assume that from Shadwell o Wretham the road was at that date a public highway. The eneral description, however, would apply to either of the two oads shown on Faden's Map—as one ends north of Shadwell ourt, the other, the " Roman Road " passes between and orms the boundary of Shadwell and West Harling.

North of Bridgham the track runs through the Parish of Roudham and we have an enclosure Award (without map), ated 1773, which sets out as Public Highways both the oad to Brandon across " Roudham Great Heath " (The Drove Road) and " one other road leading from Bridgham aforesaid o Wretham aforesaid across the Turnpike Road and Great Heath called the Ridge Road or Pilgrims Road." The latter is, without much doubt, the Peddars Way.

North of Roudham the track (Faden's Map) forms the oundary between East Wretham and Illington. We have no ward for either Parish, but the public road set out in the Roudham Award describes it as leading " to Wretham " which akes us at least as far as that village and the next Award deals with its continuation.

We have an Award (and Map) for Hockham, where the Way orms the western boundary of the Parish and is set out as the 0th Public Road. There is no Award for the Parish of Breckles. North of Breckles and East Wretham the line of he road is the boundary between Stow Bedon and Thompson n the east and Tottington on the west. We have an Award or Stow Bedon, dated 1816, and a map, which however, does ot show Peddars Way.

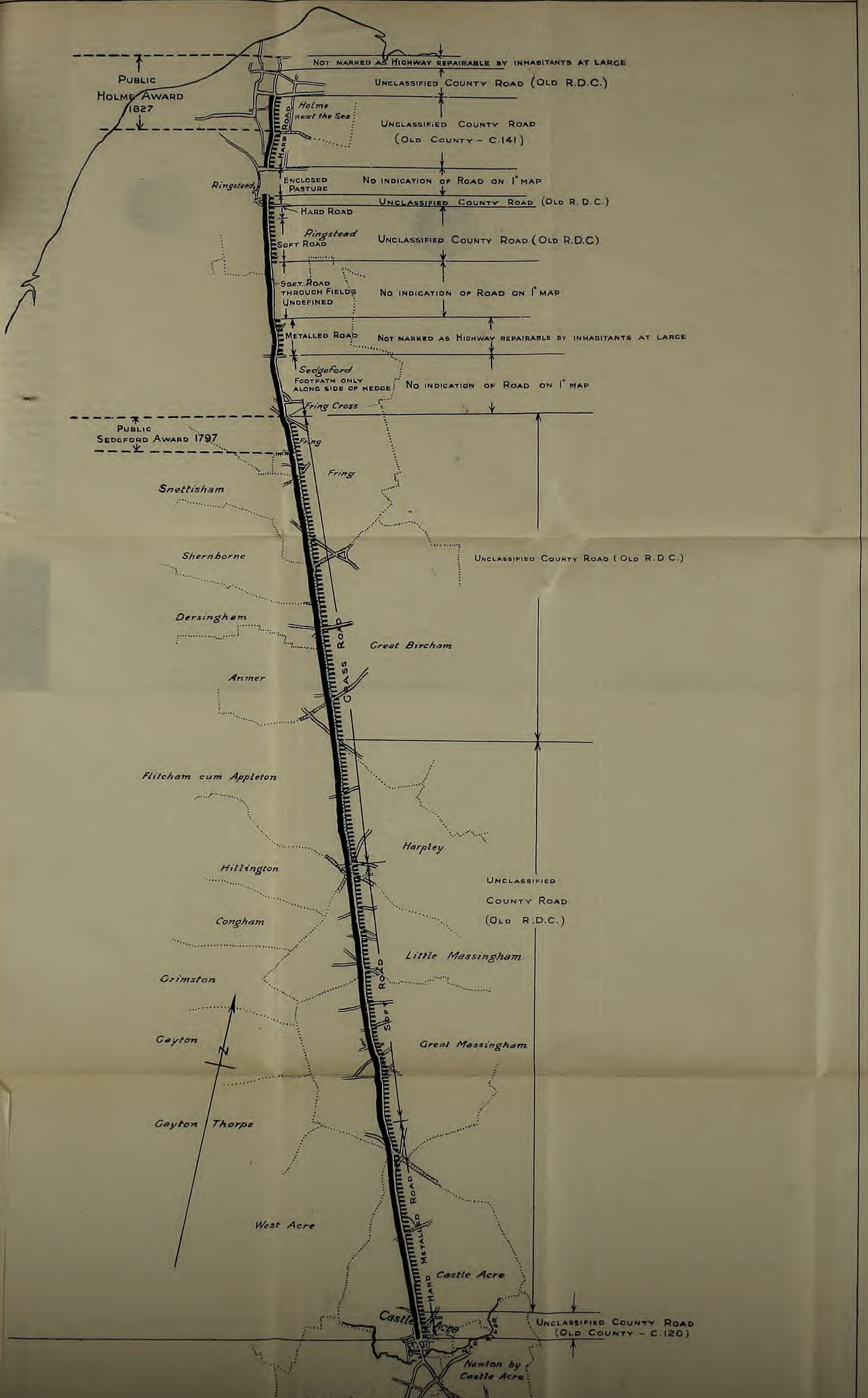
We have an Award for Tottington (1774) but no map. One f the Public roads described runs from " Cherry Row Corner t the Parish boundary leading from thence to the bounds of reat Wretham being the present Road from Watton to Harling." I can find no record to show which Parish is meant

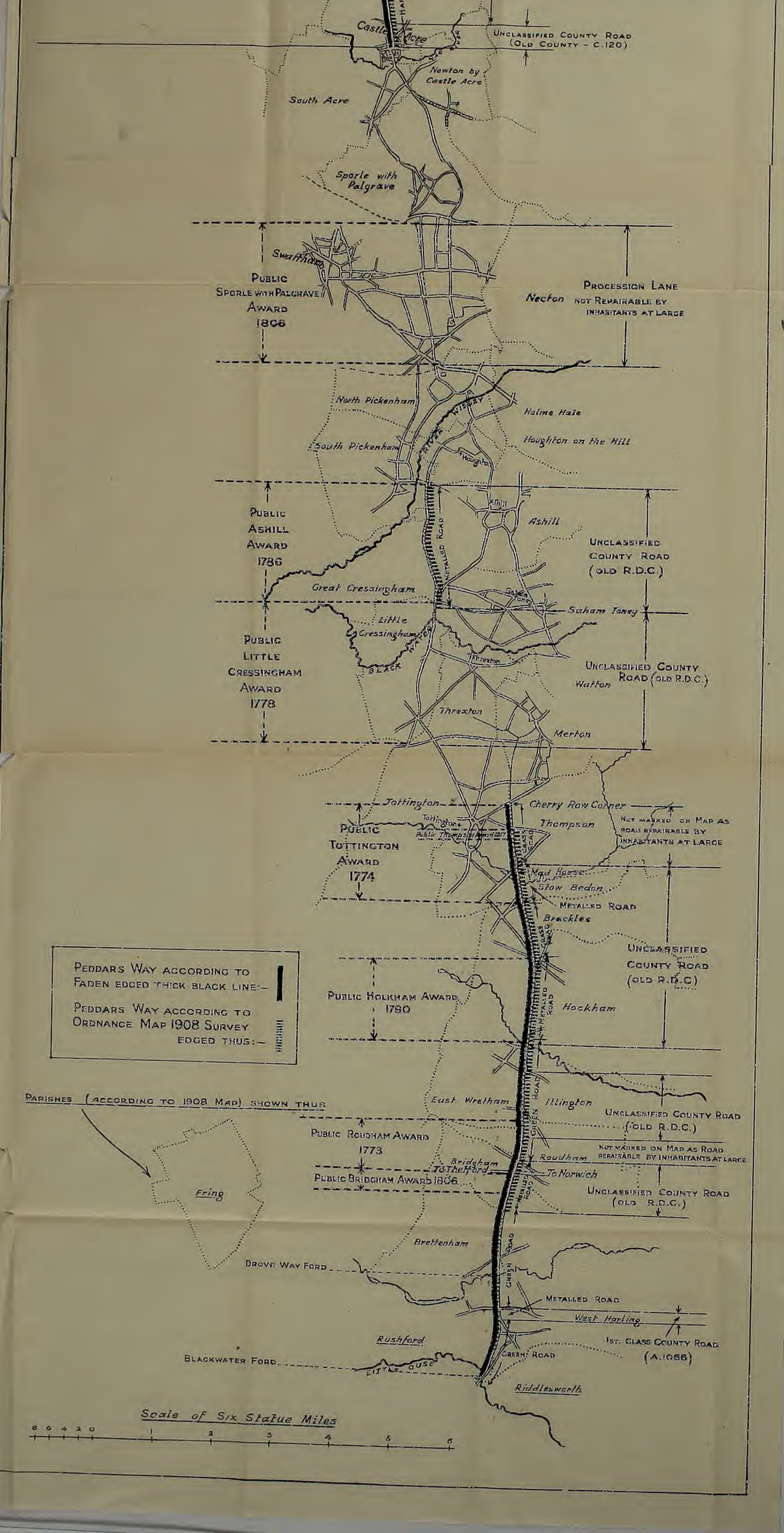
by " Great " Wretham. On Faden's Map " Cherry Row Gate " is marked where the line of Peddars Way reaches the Main Tottington-Watton road, just south of Sparrow Hill and Tumuli as marked on the 1" Ordnance Map. In the Thompson Award of 1817, with map, the 7th Public Road is clearly on the line of Peddars Way for a distance of about 100 yards. From Cherry Row Gate, Faden's Map shows no trace of a road on the line of Peddars Way (with one exception) till Castleacre is reached.

Between those points there is nothing definite to be gathered from Awards. There are no Awards for Merton or Threxton. Clarke suggests its site can be traced where it follows the boundary between Merton and Threxton.

In an Award of 1778 for the parish of Little Cressingham, a public highway is laid out leading " from the Parish of South Pickenham by Sturston to Thetford called Walsingham Way Road beginning at the North East Corner of a Shortland field where the Parishes of Saham Toney, Great and Little Cressingham join, then proceeding southwards across the River at Hills Common on the East side of the said Whitehorse Alehouse in a straight line to the North West Corner of Well Close then on the West side of the fence of the same Close and of the said Earl of Clements new Inclosure to the South West corner thereof thence in a straight line over the said heath and to the point of the Heath where the bounds of the parishes of Tottington and Little Cressingham join." There is no reference to the Way in the Saham Toney Award of 1800, and although there is an Award for Great Cressingham dated 1803, there are no extracts which give any help, but in the case of Ashill the 6th and 7th roads, which are to-day unclassified county roads, are set out as public roads from north to south of the parish and these roads were stated in the Award of 1786 to be called Walsingham Way. This length is a county road and metalled. Part of the Pickenham-Little Cressingham Road is marked Peddars Way on the Ordnance Map, which is my reason for setting out the above extract in full. These two roads " Walsingham Way " are not on the general line of the Peddars Way.

There are no Awards for the Parishes of South Pickenham or Houghton ; there was an Award in 1807 for North Pickenham, but no reference to Peddars Way. For Swaffham there were


Not marked as Highway repairable by inhabitants at large
Unclassified County Road (Old R.D.C.)
Public
Holme Award
1827
Holme next the Sea
Road
Hard
Unclassified County Road
(Old County - C.141)
Ringstead
Enclosed Pasture
No indication of Road on 1" map
Unclassified County Road (Old R. D. C.)
Hard Road
Ringstead
Soft Road
Unclassified County Road (Old R.D.C)
Soft Road through Field's Undefined
No indication of Road on 1" map
Metalled Road
Not marked as Highway repairable by inhabitants at large
Sedgeford
Footpath only along side of hedge
No indication of Road on 1" map
Fring Cross
Public
Sedgford Award 1797
Fring
Fring
Snettisham
Shernborne
Unclassified County Road (Old R.D.C.)
Dersingham
Road
Great Bircham
Grass
Anmer
Flitcham cum Appleton
Harpley
Hillington
Congham
Unclassified
County Road
(Old R.D.C.)
Little Massingham
Grimston
Great Massingham
Gayton
Gayton Thorpe
West Acre
Hard Metalled Road
Castle Acre
Castle Acre
Unclassified County Road
(Old County - C.120)
Newton by
Castle Acre
South Acre


Castle Acre
Unclassified County Road (Old County - C.120)
Newton by Castle Acre
South Acre
Sporle with Palgrave
Swaffham
Public Sporle with Palgrave Award 1806
Procession Lane
Necton
not Repairable by Inhabitants at Large
North Pickenham
Wissey
Holme Hale
South Pickenham
Houghton on the Hill
Houghton
Ashill
Public Ashill Award 1786
Unclassified County Road (Old R.D.C.)
Great Cressingham
Saham Toney
Little Cressingham
Public Little Cressingham Award 1778
Threxton
Watton
Merton
Tottington
Cherry Row Corner
Thompson
Not marked on Map as road repairable by Inhabitants at Large
Public Tottington Award 1774
Mad Horse
Stow Bedon
Metalled Road
Breckles
Unclassified County Road (Old R.D.C.)
Public Holkham Award 1790
Hockham
Peddars Way according to Faden edged thick black line:-
Peddars Way according to Ordnance Map 1908 Survey edged thus:-
Parishes (according to 1908 Map) shown thus
East Wretham
Illington
Unclassified County Road (Old R.D.C.)
Public Roudham Award 1773
Not marked on Map as Road repairable by Inhabitants at Large
Roudham
Bridgham
To Thetford
To Norwich
Public Bridgham Award 1806
Unclassified County Road (Old R.D.C.)
Fring
Brettenham
Drove Way Ford
Metalled Road
West Harling
1st. Class County Road (A.1066)
Rushford
Blackwater Ford
Green Road
Riddlesworth
Scale of Six Statue Miles
8 6 4 2 0 1 2 3 4 5 6

an Award and map of 1869, and although a road is shown on the map it is not mentioned in the Award. Where it forms the boundary between Swaffham and Sporle with Palgrave, it is referred to in the Sporle Award of 1806, shown on the Award map and clearly shown as a Public Road known as Procession Lane. The parish boundary appears to run down the middle of the Way because the Sporle Award sets out as a public road " one moiety in width of another road against the said Parish of Swaffham beginning at the Falgate south corner of Home Common and proceeding along Procession Lane and over the Heath to the road leading from Swaffham to North Pickenham." The latter point is clearly just to the south of the Swaffham and Watton Railway near " Manor Ho " (Ordnance 1"). The north point of Procession Lane appears to end when it meets the Swaffham-Dereham railway. Faden's Map shows no continuation beyond that point, and incidentally shows this lane (which to-day crosses the main road in a straight line) making a distinct turn on reaching the main road, before continuing north.

We have no Awards for Southacre, Newton-by-Castleacre, Castleacre, Westacre, or Great Massingham, Little Massingham, Harpley, Hillington, Flitcham, Great Bircham, or Anmer. Through these parishes, however, the reputed Way is clearly indicated.

For a short distance north of Castleacre it follows the course of the Castleacre–King's Lynn main road, and from there northward to just north of the Harpley boundary it is an unclassified county road, metalled to " Shepherd's Bush " (1 mile south of Great Massingham village). From that point to the King's Lynn–Fakenham road, short stretches of green road alternate with short stretches of unmetalled track. Three-quarters of a mile north of the Lynn–Fakenham road is a stretch of 200 yards overgrown with brambles.

We have an enclosure Award for Dersingham, but no apparent reference to Peddars Way, and the same observation applies to Snettisham.

We have no Award for Fring but the Sedgeford Award with map), of 1797, shows as the " 4th " Public " Road," a length of the Peddars Way called Podders Road beginning at the bounds of Fring and proceeding nearly in a Northward

Direction as far as the Common Rivulet near a place called Fring Cross."

Between the Dersingham—Great Bircham road and the Snettisham–Great Bircham road, a length of about a quarter of a mile is raised above the level of the adjoining fields.

We have an Award for Ringstead but no reference to Peddars Way. The Holme Award of 1827 (with map) shows the Way as the 3rd, 4th and 5th Public Roads.

In conclusion the following is a general summary of available evidence :—

Faden's Map shows the Way as continuous (whether road or track) from the Holme Marshes to Castleacre, except for a gap at Ringstead.

The Ordnance Map shows the same gap in Ringstead, and a mile south of Ringstead another gap occurs till one mile north of the Sedgeford–Docking Road. From that point the Ordnance Map shows a track or road continuous to Castleacre.

North of Holme the track is probably a public highway not repaired by the public, from Holme southward to the gap at Ringstead it follows a public county road. South of the gap for a mile it is a county road, and again from Fring Cross southward to Castleacre.

I leave to others the decision whether Procession Lane in Sporle is part of the way, or whether the Ordnance Map is correct in naming as Peddars Way the present county road from Holme Hale via Houghton to Little Cressingham.

Faden's Map shows the Way again at a point he calls Cherry Row Gate and thence without a break to Black Water Ford at Riddlesworth.

The Ordnance Map shows no road quite so far north as Cherry Row Gate (which on Faden's Map is on the main road at the south-west corner of Sparrow Hill, south of Merton Park), and shows a track or road ceasing at three quarters of a mile south of the main Thetford road, where the present track turns south-west. Between that point and the Ouse the track is, however, evident on the ground in many places.

It is a Public County Road from North of Thompson Water to the Hockham–Illington boundary, and again for a short length between Illington and East Wretham, and when it runs through Bridgham and again for a quarter-of-a-mile in West

Harling. From this latter point, it appears southwards as a narrow planted and raised strip and northward as a low causeway with trees and scrub, although not marked as a road on the Ordnance Map, and though I am told it disappears near the river, it appears again as a planted and enclosed strip south of the Brettenham–Bridgham road. Between that point and the southern termination (on the Ordnance Map) on Brettenham Heath, the apparent course runs through a plantation and is enclosed. I hope a more detailed examination can be made on the ground by someone interested in this matter.

I have yet to see a convincing explanation of why the Way (in parts) is raised above the level of the Heathland, and that on the highest and driest part of its course. Actually on Brettenham Heath the present track runs *beside* the raised part.

The annexed strip map illustrates the text. This is a composite map taken from Faden's with approximate parish boundaries added.

III

SCOLT HEAD ISLAND REPORT, 1933-34

By J. A. Steers

For reasons of economy this report must be reduced to minimum space, so only a brief resumé of the year's work will be given. It is hoped to report more fully every fifth year.

1. Mr. R. F. Peel has remapped the Ternery and Far Point. The Ternery dunes are still suffering erosion, but it seems possible that a new clump of dunes will develop at the Far Point. Sandwich Terns nested there this year in considerable numbers.

2. Mr. B. C. Gibbs has made a detailed map of the western part of Missel Marsh. Creek development there is interesting, and valuable comparative data should be available in a few years.

3. Lines of Alum Bay sand have been put down on Missel Marsh and Salicornia Marsh in order to obtain information of the rate and nature of sedimentation on these marshes. These lines are only experimental and may have to be revised next year before definite measurements can be started.

4. The new " island," just west of Thornham Harbour, has been mapped by Mr. B. C. Gibbs, and its plants investigated by Mr. V. J. Chapman. The development of this " island " is well worth watching and should throw a good deal of light on the evolution of Scolt.

5. Mr. J. W. Loxton has continued and extended the stereo-photography of significant parts of the island.

6. A specimen of Rhomb Porphyry was found on the 18th September, 1934. This rock type was not recorded in the list given in the book " Scolt Head Island " recently published.

7. Mr. Chapman records the following new species :—

Phanerogams :—*Alchemilla arvensis* Lamk. (found by P. N. Hartley and M. H. Rogers.)
Papaver rhœas L.
Sinapis arvensis L.

Algæ :— *Calothrix consociata* Born. et Flah.
Dermocarpa prasina Born.
Pilinia rimosa Kütz.

Orchis pyramidalis was seen by Mrs. Bovill.

Investigation of *Obione portulacoides* suggests that there are two distinct varieties on the island :—

O. portulacoides var. *latifolia*, a large, bushy form ;

O. portulacoides var *parvifolia*, a dwarf form (See Moss, Cambridge Flora).

8. Mr. P. N. Hartley and Miss M. H. Rogers have begun to investigate the Lows on the island and adjacent coastline. Lows may be defined as areas enclosed between laterals or other shingle ridges, which may or may not bear dunes, and are characterized by the fact that they are flooded only by the highest spring tides. The water left by these tides remains in the lows for some time. On the island they occur in House Hills (2), Wire Hills (1), and the Ternery (3). There are others on the mainland marshes. The Ternery lows, as distinct from enclosing ridges, are characterized by the following species :—*Suæda fruticosa*, *S. maritima* var. *macrocarpa*, *Obione portulacoides*, *Statice reticulata*, *Glyceria maritima*, and *Salicornia annua* (in two lows only). All these three lows have probably been formed in less than forty years. The Hut Low (Wire Hills) and the two in House Hills possess the following plants in addition to those mentioned above :—*Spergularia media* and *Frankenia lævis*, but *O. portulacoides* is absent from one of the lows on House Hills. In a general way, the vegetation is more " closed " in the older lows.

Further work on these lows, and comparison with those at Blakeney, Wells, and elsewhere, is to be undertaken.

9. Mr. E. A. Ellis records the following additional species of Uredinales from the island :—*Puccinia punctata* Link on *Galium verum* near the Hut, *P. absinthii* DC. on *Artemisia maritima* in several places, *P. cirsii-lanceolati* Schröt on *Cirsium lanceolatum* in the damp hollows in Norton Hills, and *Uromyces armeriæ* (Schlecht) Lev. on *A. maritima*, on the shingle between Wire Hills and the Hut.

10. Mr. P. Brodie sends the following preliminary list of Lepidoptera found on the island :—

(Nomenclature based on R. South, Butterflies and Moths of the British Isles, 2nd Edition ; E. Meyrick, Revised Handbook of British Lepidoptera, 1927.)

PAPILIONIDÆ.
(*Papilio machaon* L. Believed seen in 1927 by C. Chestney, the Watcher.)
Pieris brassicæ L.
Pieris rapæ L.
Pieris napi L. (E. A. Ellis)

NYMPHALIDÆ.
Vanessa urticæ L.
Pyrameis cardui L.
Pyrameis atalanta L.
Argynnis aglaia L.
Hipparchia semele L.
Pararge megæra L.
Epinephele jurtina L.
Epinephele tithonus L.
Cœnonymphus pamphilus L.

LYCÆNIDÆ
Chrysophanus phlæas L.
Lycæna astrarche Bgstr. (E. A. Ellis)
Lycæna icarus Rott.

SPHINGIDÆ.
Smerinthus populi L.
Sphinx ligustri L. (C. Chestney)
Macroglossa stellatarum L.

NOTODONTIDÆ.
Dicranura vinula L.

THYATIRIDÆ.
Habrosyne derasa L.

LYMANTRIIDÆ.
Porthesia similis Fuesl.
Stilpnotia salicis L.

LASIOCAMPIDÆ.
Cosmotriche potatoria L.

ARCTIIDÆ.
Spilosoma lubricepeda L.
Phragmatobia fuliginosa L. (E. A. Ellis)
Arctia caja L.
Hipocrita jacobææ L.
Lithosia lurideola Zk.
Lithosia complana L.

NOCTUIDÆ.
Agrotis segetum Schiff.
Agrotis vestigialis Rott.
Agrotis corticea Hb.
Agrotis puta Hb. (F. Sowels)
Agrotis cursoria Hufn.
Agrotis nictitans L. (F. Sowels)
Agrotis tritici L.
Agrotis exclamationis L.
Agrotis ripæ Hb.
Noctua c-nigrum L.
Noctua xanthographa F. (F. Sowels)

NOCTUIDÆ, *continued*
Triphæna comes Hb.
Triphæna pronuba L.
Triphæna interjecta Hb.
Mamestra albicolon Hb.
Mamestra dissimilis Kn.
Mamestra trifolii Rott.
Cerigo matura Hufn. (C. Q. Parsons, *Ent. Rec. & Journ. of Var.*, May, 1934)
Hama abjecta Hb. (F. Sowels)
Apamea gemina Hb.
Apamea basilinea F.
Apamea secalis L.
Miana fasciuncula Hw.
Miana strigilis Cl.
Miana literosa Hw. (F. Sowels)
Xylophasia monoglypha Hufn.
Phlogophora meticulosa L.
Tapinostola elymi Tr.
Leucania impura Hb.
Leucania straminea Tr. (F. Sowels)
Leucania impudens Hb.
Leucania littoralis Curt.
Caradrina taraxaci Curt.
Plusia gamma L.
Euclidia mi Cl.

GEOMETRIDÆ.
Acidalia interjectaria B.
Acidalia aversata L.
Acidalia dimidiata Hufn.
Acidalia emutaria Hb.
Lobophora carpinata Bkh.
Xanthorhœ sociata Bkh.
Camptogramma bilineata L. with *ab. infuscata* Gump.
Eupithecia oblongata Thnb.
Eupithecia absinthiata Cl.
Selenia bilunaria Esp.
Hygrochroa syringaria L. (C. Q. Parsons *loc. cit*)
Opisthograptis luteolata L.
Aspilates ochrearia Ross.

ZYGÆNIDÆ.
Zygæna trifolii Esp. (E. A. Ellis)
Zygæna filipendulæ L.

HEPIALIDÆ.
Hepialus lupulinus L.

PYRALIDINA

PHYCITIDÆ.
Anerastia lotella Hb.
Homœosoma cretacella Rsl.
Homœosoma nebulella Hb.

CRAMBIDÆ.
Crambus pascuellus L.
Crambus pratellus L.
Crambus culmellus L.
Crambus hortuellus Hb.
Crambus perlellus Sc.
Crambus fascelinellus Hb.
Crambus inquinatellus Schiff.
Crambus geniculeus Hw.
Crambus salinellus Tutt
Crambus tristellus F.
Platytes alpinella Hb.

PYRAUSTIDÆ.
Phlyctænia fuscalis Sch.
Scoparia lineola Curt.
Scoparia cratægella Hb.
Scoparia pallida Stph.
Scoparia dubitalis Hb.

PTEROPHORIDÆ.
Agdistis bennetii Curt.

TORTRICINA

PHALONIADÆ.
Phalonia tesserana Tr.
Phalonia atricapitana Stph.

TORTRICIDÆ.
Cacœcia podana Scop.
Pandemis heparana Schiff.
Tortrix viridana L.
Tortrix paleana Hb.
Tortrix unifasciana Dup.
Cnephasia incertana Tr.
Argyrotoxa bergmanniana L.
Peronea contaminana Hb.

EUCOSMIDÆ.
Evetria buoliana Schiff.
Eucosma diniana Guen.

EUCOSMIDÆ, *continued*
Eucosma cana Hw.
Eucosma trigeminana Stph.
Eucosma tripunctana Fabr.
Polychrosis littoralis Curt.
Argyroploce lacunana Dup.
Laspeyresia nigricana Stph.

TINEINA

GELECHIADÆ.
Aristotelia pictella Z. with var. *tarquiniella* Staint.
Gelechia desertella Dgl.
Phthorimæa suædella Rich.
Phthorimæa salicorniæ Hering
Phthorimæa marmorea Hw.

OECOPHORIDÆ.
Endrosis lactella Schiff.
Borkhausenia pseudospretella Staint.

ELACHISTIDÆ.
Elachista triatomea Hw.

COLEOPHORIDÆ.
Coleophora saturatella Staint.
Coleophora obtusella Staint.

EPERMENIADÆ.
Epermenia illigerella Hb.

PLUTELLIDÆ.
Plutella maculipennis Curt.

LYONETIADÆ.
Bucculatrix maritima Staint.

TINEIDÆ.
Trichophaga tapetiella L.
Tineola biselliella Hum.
Tinoa pellionella L.
Tinea lapella Hb.

11. Two other matters should be noted. First, the so-called " Danish Camp " in Holkham Marshes has been mapped by Messrs. J. S. Hobbs, B. C. Gibbs, and R. H. Greenwood. Secondly, on June 30th, 1934, a representative party of the Geologists' Association paid an interesting and strenuous visit to the island.

12. The high equinoctial tides of the 21st to 25th September, 1934, did considerable damage to the Ternery dunes. Fortunately these tides did not coincide with a storm, but if a severe storm occurs this winter, the dunes will be considerably foreshortened.

IV

WHEATFEN BROAD, SURLINGHAM

By E. A. Ellis

The area here dealt with in a preliminary fashion is the Yare Valley swamp covering some hundreds of acres to the north of Rockland Broad (see map). The owner, Mr. M. J. D. Cockle, possesses a land of fascinating desolation, known to few but the marsh folk.

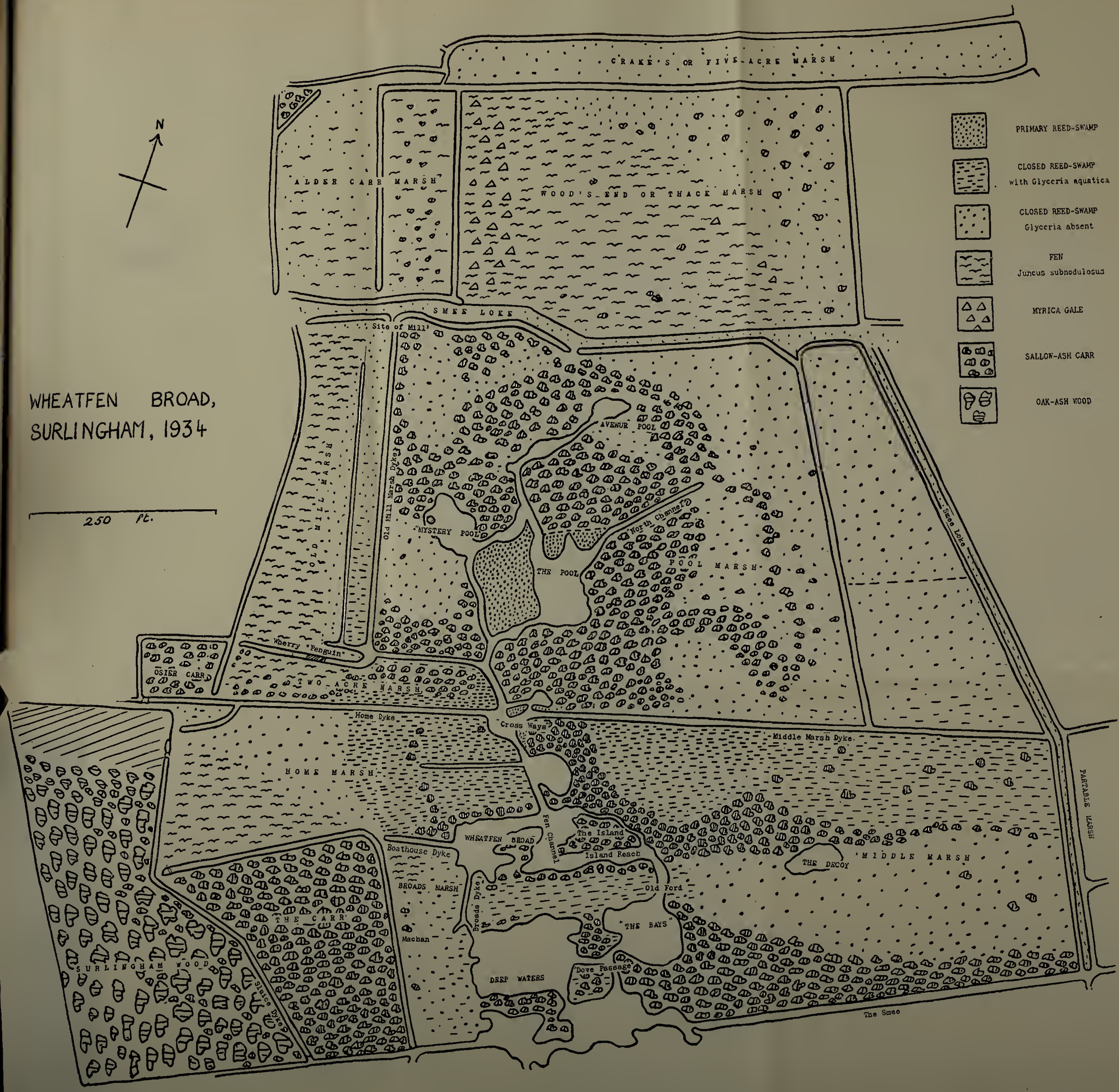
The plant communities of Surlingham and Rockland broads were investigated by Miss M. Pallis thirty years ago (Tansley's " Types of British Vegetation," 1911) and the present paper, in covering intermediate ground, brings out several fresh points for discussion by ecologists.

The " home " water is Wheatfen Broad, and this traditional name is given to the whole estate. The other waters and marshes have nearly all their local designations as shown on the map.

Physiography

Immediately underlying the marsh peat is the water-holding red gravel " pan " ; this is near the surface at Surlingham Wood, and forms slightly raised " hard-bottom " islands in the swamp. The peat ranges from a few inches to five feet or more in thickness. Tidal communication with the Yare through the Fen Channel, Rockland Broad and at times The Smee, is responsible for regular circulation of the water throughout the chain of broads ; there is a rise and fall of eight inches normally, which may be greatly exceeded when there are spring tides with a north-west wind, flooding the greater part of the marshes. The current through the main channels scours all fine silt, leaving, particularly in the narrow reaches and at bends, extensive deposits of shells. The water is of very low chloride content (.1 promille) and alkaline (pH 7.5—8.0) ; in consequence the shells are not eroded as in acid meres. Where the force of the tide is expended over a larger area, fine mud settles to form shoals ; fragments of " hover " (floating reed-bed) become detached and float into quiet backwaters to form islands, and tend to consolidate the whole.

WHEATFEN BROAD, SURLINGHAM, 1934




BRITISH MUSEUM
NATURAL HISTORY

Atmospheric humidity is greatest in the carrs, where lichens and mosses grow luxuriantly on the trees.

Plant Communities

In Open Water

Submerged :

Ranunculus circinatus : frequent.

Nymphæa lutea : in the broads and Fen Channel, not very plentiful.

Castalia alba : a few plants in Deep Waters.

Nasturtium officinale : in the smaller dykes.

Hippuris vulgaris : rare, in Fen Channel.

Myriophyllum spicatum : in the smaller dykes, but not abundant.

Callitriche stagnalis : frequent.

Hottonia palustris : in a few dykes.

Ceratophyllum submersum : dominant.

Stratiotes aloides : a little in Deep Waters ; abounds in Rockland Broad.

Elodea canadensis : frequent, especially in Fen Channel.

Alisma plantago-aquatica : not plentiful, but widely distributed.

Sagittaria sagittifolia : in the channels here and there.

Butomus umbellatus : used to grow in Fen Channel, but has disappeared.

Potamogeton lucens : not common, mainly in Fen Channel.

P. crispus : fairly frequent.

P. compressus : abundant.

P. pectinatus : forming dense beds in summer.

Floating :

Hydrocharis morsus-ranæ : locally frequent, especially in the shallower dykes.

Lemna minor : very abundant
L. polyrhiza : very abundant } dominant.

L. gibba : abundant.

L. trisulca : abundant.

The alga *Enteromorpha intestinalis* is sometimes present in large masses in the broads, but shows marked fluctuation in quantity. The toad-spawn alga, *Batrachospermum moniliforme* thrives on stones, wood and shells in channels (e.g. Broads Dyke) where the current is strong.

Most of the aquatics are hardly noticeable in winter ; but by August Ceratophyllum, P. pectinatus and P. compressus form dense beds swarming with mollusca and other animal life. The surface is then a sheet of duckweed, especially L. polyrhiza ; so that it becomes difficult to force a punt anywhere except in the deeper parts. The surface species are blown by the wind and taken by tidal eddies to corners, where their thick canopy must put submerged species in gloom. The annual disintegration of all these plants produces a significant amount of virgin peat-humus.

Reed-swamps, Fen, Carr and Oakwood succession

The great amount of detail accumulated in mapping the distribution of the land plants has proved too unwieldy for publication except in the form of a table showing comparative frequency of the species in thirteen picked areas. By using this in conjunction with the map a glimpse of the manifold changes that are taking place on these marshes may be obtained. There was not time to carry out investigations into pH values of the soil waters at Wheatfen while attempting to see all the flowering plants in one summer ; this work should be easy enough at some future date, now that the plant zones have been described. It is safe to suggest that nowhere is there any highly acid peat in the area : there are, however, portions of fen on Home Marsh, Old Mill Marsh and Thack Marsh that produce a few moorland species.

Table Showing Distribution of the Larger Plants

Succession = primary reed-swamp, closed reed-swamp, fen, sallow-ash carr, oak-ash wood.

TABLE HEADINGS

1. The Pool :
   a = open reed swamp to west.
   b = two patches ditto to north.
   c = east and south shores.
2. Middle Marsh :
   a = third near mid-marsh dyke.
   b = central marsh.
   c = the decoy.
   d = carr near and including island.
   e = sallow-ash carr by the Smee.
3. Carr South-East of The Pool.
4. Shores of Deep Waters.
5. Marsh, Deep Waters to Island Reach :
   a = northern margin.
   b = central Glyceria marsh.
   c = carr north of Dove Passage.
6. Broads Marsh :
   a = low-lying portion to east.
   b = north-west corner.
   c = path along west side.
7. Home Marsh :
   a = low-lying half to east.
   b = centre and to north.
   c = fen in south-west quarter.
   d = higher ground along west side.
8. Two-Acre Marsh and Osier Carr :
   a = Glyceria marsh to south-east.
   b = carr at east end.
   c = osier carr and near gate.
   d = fen with scattered sallows.
9. Old Mill Marsh :
   a = reed-bed along east side.
   b = low-lying marsh near grup.
   c = main fen.
   d = hollow at north-west corner.
   e = higher ground along west side.
10. Pool Marsh :
    a = shores of Mystery Pool.
    b = swamp near Avenue Pool and channel.
    c = carr on " islands " in marsh.
    d = marsh at north-east corner.
11. Thack Marsh :
    a = reed-swamp.
    b = main fen.
    c = Myrica—Cladium fen to west.
12. The Carr
13. Surlingham Wood.

[In the following table * denotes great abundance ; where no sign is given the species is common or moderately frequent ; ' implies that it is local or rare.]

ANGIOSPERMÆ	1	2	3	4	5	6	7	8	9	10	11	12	13
Thalictrum flavum ...	– – –	– b – – e′	3	–	– b c	a′ b c	a b c –	– b′ c d	a b c′ – e′	– – – –	a b c′	–	–
Anemone nemorosa ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Ranunculus repens ...	– – –	– – – – e	3	–	– – –	– – –	a b c d	– – – d	– – – d –	– b′ – –	a b –	–	13
R. acer	– – –	– – – – –	–	–	– b –	– b c	a b c –	– – c d	– b c*d e	– – – –	– b c	–	–
R. bulbosus	– – –	– – – – –	Distribution not described			fully	– – – d	– – – d	– – – – e	– – – –	– – –	–	–
R. lingua	a′ – –	– – c – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
R. flammula	– – –	– – c – –	–	–	– – –	– – –	– – c –	– – – d′	– – c′ d –	– – – –	– b –	–	–
R. sceleratus	– – –	– – c – e′	3′	–	– – –	– – –	– b – –	– – – –	– – – – –	– – – –	– – –	–	–
R. ficaria	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – –	– – – –	– – –	12	13
Caltha palustris ...	– – –	a – c′ – e	3	–	– – –	a′ – –	– b c –	– b′ – d	– – c – –	– – – –	a b –	–	–
Nasturtium amphibium	– – –	– – – – –	–	4′	– b′ –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
N. islandicum ...	– – –	– – – – e′	–	4′	– b′ –	– – –	– – – –	– – – d′	– – – – –	– – – –	– – –	–	–
Cardamine pratensis ...	– – –	– – – – –	3	–	– – –	– – –	– b c –	– – c d	– – c – –	– – – –	– b –	–	–
C. amara	– – –	– – – – –	–	–	– – –	– – –	– – – –	a′ – – –	– – – – –	– – – –	– – –	–	–
C. flexuosa	– – –	– – – – e′	3	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
C. hirsuta	– – –	– – – d e	3	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Sisymbrium alliaria ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – –	– – – –	– – –	–	13
Viola riviniana						c′		c				12	13

Polygala vulgare ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – c′ – –	– – – –	– – –	–	–
Lychnis flos-cuculi ...	– – –	– – – – –	–	–	– b –	– b c	– b c –	– – c d*	– b*c*d*e	– – – –	a b*c	–	–
L. dioica	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Cerastium vulgatum ...	– – –	– – – – –	–	–	– – –	– b c	a′b – –	– – – d	– – – – e	– – – –	– – –	–	–
Stellaria uliginosa ...	– – –	– – – – –	3′	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
S. dilleniana var. *palustris*	– – –	– – – – –	–	–	– – –	– – –	– b′– –	– – – –	– – c′– –	– – – –	– – –	–	–
S. graminea	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d′	– – – – –	– – – –	– – –	–	–
Arenaria trinervia ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c –	– – – – –	– – – –	– – –	12	13
Sagina apetala ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
Hypericum quadrangulum	– – –	– – – – –	3′	–	– – –	– – c′	a′b′– –	– – c′–	– – c′– –	– – – –	– b –	–	–
Geranium robertianum	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c′–	– – – – –	– – – –	– – –	12	13
Ilex aquifolium ...	– – –	– – – – –	–	–	– – c	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′
Euonymus europæus...	– – –	– – – d e	3	–	a – –	– – –	– – – –	– – – –	– – – – –	– – c –	– – –	12	–
Rhamnus frangula ...	distribution as *R. catharticus*, but much less abundant.												
R. catharticus... ...	– – c	– b′– d e	3*	4′	– – c	– – –	– – – –	– b c′d′	– – – – ..	a b c –	– – c	12	–
Acer pseudoplatanus	– – –	– – – d′e′	3′	4′	– – c	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Ulex europæus ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – e	– – – –	– – –	–	13

ANGIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
Trifolium pratense ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d	– – c d e	– – – –	– – –	–	–
T. fragiferum ...	– – –	– – – – –	–	–	– – –	– – –	– – c′ –	– – – –	– – – – –	– – – –	– – –	–	–
T. repens	– – –	– – – – –	–	–	– – –	– – –	½ – b′ – d	– – c d	– – – d –	– – – –	– – –	–	–
Lotus uliginosus ...	– – –	– b′ c – –	–	–	– – –	– b c	– b*c –	– – c d	– b c – –	– – – –	– – c′	–	–
Vicia cracca	– – –	– b*c – –	–	–	– – c′	a b*c	a b c –	– b′ c d	a b c – e	a – – d	a b c	–	–
Lathyrus palustris ...	– – –	– b – – –	–	–	– – –	– b′ –	– – – –	– – – –	– b′ – –	– – – –	a′ b′ c	–	–
L. pratensis	– – –	– b′ – – –	–	–	– – –	– b′ –	– b′ – –	– – c′ d′	– b′ c – e	– – – –	– b′ –	–	–
Prunus spinosa ...	– – –	– – – d e	3	4′	– – –	– – –	– – – –	– – – –	– – – – –	– – c –	– – –	12′	13′
Spiræa ulmaria ...	– – c	a b*– d e	3′	4′	– b* c	a* b*c	a b′ c′–	a b c d	a*b*c′ d′ e	a b c d*	a b c	–	–
Rubus fruticosus agg.	– – –	– – – d e	3	–	– – –	– – c′	– – – –	– – c d′	– – – – e	– – c –	– – –	12	13
Geum urbanum ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c′ –	– – – – –	– – – –	– – –	12	13
Fragaria vesca ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c –	– – – – –	– – – –	– – –	12′	13
Potentilla anserina ...	– – –	– – – – –	–	–	– – –	– b′ –	– – c d	– – – –	– – – d e	– – – –	– – –	12	–
P. reptans	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
P. erecta	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – d	– – – – –	– – – –	– b c	–	–
P. sterilis	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
P. palustris	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – c′ – –	– – – –	– b′ –	–	–
Agrimonia eupatoria...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – – –	– – – – –	– – – –	– – –	–	–

Rosa canina agg. ...	– – –	– – – d e	3	4′	– – c′	– – c′	– – – –	– b′ – –	– – – – c′	– – – –	– – –	12	–
Pyrus malus ...	– – –	– – – – –	3′	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
P. aucuparia	– – –	– – – d′ –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Cratægus oxyacantha...	– – –	– – – d e	3	4′	– – c	– – –	– b′ – –	– b c d′	– – – – –	– – c –	– – –	12	–
Saxifraga granulata ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d′	– – – – –	– – – –	– – –	–	–
Parnassia palustris ...	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – –	– – – – –	– – – –	– b′ –	–	–
Ribes uva-crispa ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – c –	– – –	–	13
R. nigrum	– – –	– – – d e	3	–	– – –	– – –	– – – –	– b c –	– – – – –	a b c –	– – –	12	13
R. rubrum	– – –	– – – – c	3	–	– – c	– – –	– – – –	– b – –	– – – – –	– – – –	– – –	12	13
Lythrum salicaria ...	– – c	– b c d e	3	4	– – –	– b c	a′ b c′ –	a b c′ –	– b′ c′ – –	a b – –	a b′ c′	–	–
Epilobium hirsutum...	a b c	a b – d e	3	4	– b c	a – c	a – – –	– b c –	a b′ – – –	a b – –	– – –	–	–
E. parviflorum ...	– – –	– – – – e	3′	–	– – –	– – –	– b c –	– – – d	– – – d –	– b – –	a b –	–	–
E. tetragonum ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c′ –	– – – – –	– – – –	– – –	–	–
E. montanum ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c′ –	– – – – –	– – – –	– – –	–	–
E. palustre	– – –	– – – – –	3′	–	– – –	– – –	– b c –	– – c d	– – – – –	– – – –	a b –	–	–
Circæa lutetiana ...	– – –	– – – – –	–	–	– – c	– – c′	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Bryonia dioica ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	–
Hydrocotyle vulgaris ...	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – d	– – – d e	– – – –	– b –	–	–

ANGIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
Sanicula europæa ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Cicuta virosa ...	– – c	– – – – e′	3′	4	– b′ c	– – –	a′ – – –	a′ – – –	– – – – –	– – – –	– – –	–	–
Sium erectum ...	– – –	– – – – e′	3′	4′	– – c′	– – –	a – – –	– b′ c′ –	– – – – –	– b′ – –	a′ – –	–	–
Chærefolium sylvestre	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c –	– – – – –	– – – –	– – –	–	13
Œnanthe lachenalii ...	– – –	– b′ c – –	–	–	– – –	– – –	– – c* –	– – – –	– – – – –	– – – –	a b′ –	–	–
Œ. fistulosa	– – –	– b′ – – –	–	–	– – –	– – –	– b′ c –	– – – –	a b c′ – –	– – – –	– – –	–	–
Angelica sylvestris ...	– – –	– b′ – – e	3	4′	– b c	a b c	a b c –	a b c d	a b c* – e	– b – –	a b c	–	13′
Peucedanum palustre...	a – c	– b c* – e	3*	4	– b c	a′ – –	a′ – c –	a′ b – d	a′ – c′ – –	a b c d*	a* b′ c	–	–
Heracleum sphondylium	– – –	– – – – –	–	–	– – –	– b′ –	– – – –	– – c –	– – – – –	– – – –	– – –	–	–
Daucus carota	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d′	– – – – –	– – – –	– – –	–	–
Hedera helix	– – –	– – – d e	3	–	– – c	– – –	– – – –	– b c –	– – – – –	– – c –	– – –	12	13
Sambucus nigra ...	– – –	– – – – –	–	–	– – c	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Viburnum opulus ...	– – –	a′ b′ – d e	3*	–	a – c	– – c′	– b′ – –	– b c d	– – – – e′	a b c –	a′ b′ c′	12	–
Lonicera caprifolium...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Galium uliginosum ...	– – –	– b – – –	–	–	– – –	– b c	– – c –	– – c –	– b c d –	– – – –	a b*c	–	–
G. palustre	a – c	– b – d e	3	–	– b c	a b c	a b c –	– b c d	a b c′ – –	– b – –	a b c	–	–
G. aparine	– – c	– – – – –	3*	4	– b c	a – c	– – – –	– b c –	– – – – e	– – c –	– – –	12	13
Valeriana officinalis	– – –	– b* – – e	3	4	– b c	a*b c	a b – –	a b c′ –	a b*c′ d –	– – – d	a b c′	–	–

	1	2	3	4	5	6	7	8	9	10	11	12	13
V. dioica	– – –	– – – – –	–	–	– – –	– – –	– b*c*–	– – – d*	– – c*d*e	– – – –	a b*c	–	–
Scabiosa succisa ...	– – –	– – – – –	–	–	– – –	– b c	– b c –	– – – d	a b c d e	– – – –	– b c′	–	–
Eupatorium cannabinum	a – –	– b*– d e	3	4′	– b c	a b c	a b c –	a b c d	a b c – –	a b c d*	a b′ c′	12′	13
Bellis perennis ...	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – c d	– – – – –	– – – –	– – –	–	–
Gnaphalium uliginosum	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – – –	– – – – –	– – – –	– – –	–	–
Pulicaria dysenterica...	– – –	– – – – –	–	–	– – –	– – c*	– b′– d′	– – – –	– – – – e′	– – – –	– – –	–	–
Bidens cernua ...	– – –	– – – – –	3′	–	– – –	– – –	– – – –	– – – d′	– – – – –	a′– – –	– – –	–	–
Chrysanthemum leucanthemum	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – –	– – – –	– – –	–	–
Tussilago farfara ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d	– – – – –	– – – –	– – –	–	13
Senecio aquaticus ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – d –	– – – –	– – –	–	–
Arctium lappa ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Cirsium lanceolatum...	– – –	– – – d′–	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
C. pratense	– – –	– – – – –	–	–	– – –	– b′–	– – c –	– – – –	– – – – –	– – – –	– b c′	–	–
C arvense	– – –	– – – – e	–	–	– – –	– – c	– b – –	– – c –	– – – – –	– b′– –	– – –	–	–
C. palustre	a′– –	– b – – –	3	–	– – –	– b c	– b – d	– b c d	– – c – e	– b′ c –	a*– –	–	–
Centaurea nigra ...	– – –	– b′– – –	–	–	– – –	– b′ c	– b′ c –	– – c d	– – c – e	– – – –	– – –	–	–
Lapsana communis ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Hypochæris radicata...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – e	– – – –	– – –	–	–

ANGIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
Leontodon autumnalis	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – e	– – – –	– – –	–	–
Taraxacum sp. ...	– – –	– – – – –	–	–	– – –	– b –	– b c′ –	– – c′ d	– – c – e	– – – –	– b –	–	–
Sonchus arvensis ...	– – –	– – – – e′	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
S. asper	– – –	– – – – –	3′	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
Campanula rotundifolia	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′
Primula vulgaris ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Lysimachia vulgaris ...	– – –	a b c – e	3	–	– b –	– b c′	– b′ – –	a′ – c –	a′ b – – –	a – – d′	a b c′	–	–
L. nummularia ...	– – –	– – – – e′	3′	–	– – –	– b′ c	– b′ – –	– – – d′	– – – – –	– – – –	– – –	–	–
Anagallis tenella ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d′	– – – – –	– – – –	– – –	–	–
Fraxinus excelsior ...	– – –	a′ b′ – d e*	3*	4	a b c	– – c′	a′ b′ – –	– b c –	– – – – –	a b c d′	– – –	12*	13
Ligustrum vulgare ...	– – –	– – – d e	3	–	– – c	– – –	– – – –	– b c d′	– – – – –	– – c –	– – –	12	13
Menyanthes trifoliata...	– – –	– – c′ – –	–	–	– – –	– – –	– – c –	– – – –	– – c′ – –	– – – –	– b′ –	–	–
Myosotis palustris ...	a – –	a b c – e	3	–	– b –	a′ – –	a b – –	a b c′ –	a b c′ – –	a b – –	– – –	–	–
Calystegia sepium ...	– b –	a b – d*e	3	4	a b c	a b c′	a – – ·	– b c –	a – – – –	a b c –	– – –	–	–
Solanum dulcamara ...	– – –	– b – – e	3	4	– b c	– – –	a – – –	– b – d	– – – – –	a b c –	– – –	–	–
Scrophularia aquatica	a – –	– – – d e	3′	4	– – –	– – c	a′ b – –	– b′ c′ –	a b′ – – –	– b – –	– – –	–	–
Veronica chamædrys	– – –	– – – – –	–	–	– – –	– b′ –	– b′ – –	– – – –	– – – – –	– – – –	– – –	–	–
V. beccabunga ...	– – –	– – – – –	3′	–	– – –	– – –	– b – –	– – – –	– – – – –	– – – –	– – –	–	–

Scrophulariaceæ, contd.	1	2	3	4	5	6	7	8	9	10	11	12	13
V. anagallis-aquatica	– – –	– – – – –	3′	4′	– – –	– – –	– b – –	– – – –	– – – – –	– – – –	– – –	–	–
V. serpyllifolia ...	– – –	– – – – –	–	–	– – –	– – c′	– – – –	– – c′ –	– – – – –	– – – –	– –	–	–
Euphrasia sp. ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – c′	–	–
Bartsia odontites ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d	– – – – –	– – – –	– – –	–	–
Pedicularis palustris...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– b′ – – –	– – – –	– b′ –	–	–
Rhinanthus crista-galli	– – –	– – – – –	–	–	– – –	– – –	a b c –	– – c d	– b c*d e	– – – –	– b c′	–	–
Mentha aquatica ...	– – –	– – c – e	3	–	– – c	– – c	a*b*c*–	– – c′ d	– b*c d* –	– – – d	a b*–	–	–
Lycopus europæus ...	– – c	– – – – e	3	4	– – –	– – –	– b c –	– – – –	– – – – –	– b – –	– – –	–	13
Glechoma hederacea ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Scutellaria galericulata	– – c	– – – – e′	–	–	– b –	a′ – c	– b c –	– – – –	– b – – –	a – – –	– – –	–	–
Prunella vulgaris ...	– – –	– – – – –	–	–	– – –	– – –	– b′ c –	– – c′ d	– – – d e	– – – –	– – –	–	13
Stachys sylvatica ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c d	– – – – –	– – – –	– – –	–	–
S. palustris	– – c	– b′ – – e′	3′	4′	– b c′	– – –	a b – –	a′ – – d	a′ – – – –	– – – –	– – –	–	–
Teucrium scorodonia...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Ajuga reptans ...	– – –	– – – – –	–	–	– – –	– b′ c	– b – –	– – – –	– – – – –	– – – –	– – –	12	13
Plantago lanceolata ...	– – –	– – – – –	–	–	– – –	– b –	a b c –	– – c d	– b′ c d e	– – – –	– b ..	–	–
P. major	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – c –	– – – – –	– – – –	– – –	–	–
Polygonum persicaria	– – –	– – – – –	–	–	– – –	– – c	– – – d	– – c –	– – c d*e	– – – –	– – –	–	13

ANGIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
P. hydropiper ...	– – –	a – – – e	3	4	– b c	a – –	– – – –	– b – –	a – – – –	– b – –	– – –	–	–
Rumex hydrolapathum	a – c	a – – d e	3	4	– – –	– – –	a – – –	a – c –	– – – – –	a b – –	a – –	–	–
R. crispus	– – –	– – – – –	–	4′	– – –	– – –	– – – –	– – c –	– – – – –	– – – –	– – –	–	–
R. conglomeratus ...	– – –	– – – d –	3	–	– – –	a b c	a b – –	– – c –	a b c – –	– – – –	a b –	–	–
R. acetosa	– – –	– – – – –	–	–	– b –	a′– c	– b – –	– – c d	a′b c*– e	– – – –	a b –	–	–
Euphorbia amygdaloides	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Ulmus montana ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Humulus lupulus ...	a′– –	– – – – –	3′	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
Urtica dioica	a′– c	a′ b′– d e	3*	–	– b c	a′– c′	a′b′– –	– b*c –	– – – – e	– b c –	– – –	12*	13
Myrica gale	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– b′c*	–	–
Betula alba	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c′ –	– – – – –	– – – –	– – –	12′	13′
Alnus glutinosa ...	– – –	– – – d e	3	4	– – c*	– – –	– – – –	– – – –	– – – – –	a b c –	– – c*	12	13
Corylus avellana ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Quercus robur ...	– – –	– – – d′e′	3′	–	– – –	– – c′	– – – –	– – c d′	– – c′– –	– – – d′	– – c	12*	13
Fagus sylvatica ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′
Salix purpurea ...	– – –	– b′– – –	–	–	– – –	– – –	a′– – –	– – – –	– – – – –	– – – –	– – –	–	–
S. alba	– – –	– – – – e′	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– b′– –	– – –	–	–
S. triandra	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – –	– – – –	– – –	–	–

ANGIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
S. caprea	– – –	a b – d*e*	3*	4	a b c	– b′c′	a b′c′ –	– b* c* –	a – – – –	a b*c d	a b′c′	12	–
S. aurita	– – –	– b′ – – e	3	–	– – –	– – –	– – – –	– b – –	– – – – –	– – – –	– – c	–	–
S. repens	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– b′c′	–	–
Populus tremula ...	– – –	– – – – –	3′	4′	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12′	–
Listera ovata ...	– – –	– – – – –	–	–	– – –	– – c	– b c –	– – c –	– – c – –	– – – –	– – –	–	13
Epipactis palustris ...	– – –	– – – – –	–	–	– – –	– – –	– – c′ –	– – – –	– – – – –	– – – –	– – –	–	–
Orchis latifolia ...	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – –	a′b′c d –	– – – –	– b c	–	–
O. incarnata	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– b′–	–	–
O. prætermissa ...	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – c –	– b c – –	– – – –	– b c	–	–
O. maculata	– – –	– – – – –	–	–	– – –	– – c	– – c –	– – – –	– – c – –	– – – –	– – –	–	–
Gymnadenia conopsea	– – –	– – – – –	–	–	– – –	– – –	– – c′ –	– – – –	– – – – –	– – – –	– – –	–	–
Iris pseudacorus ...	– – –	a b c – e	3	4	– b*c	a b c	– b′– –	– b c d	a b c – –	a – – –	a b c	12′	13
Tamus communis ...	– – –	– – – – e	–	–	– – c	– – –	– – – –	– b c –	– – – – –	– – – –	– – –	12	–
Scilla non-scripta ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Juncus conglomeratus	– – –	– b′– – –	–	–	– – –	– b′c′	– b′ – d	– – c′ –	– – – d –	– – – –	– – –	–	–
J. effusus	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
J. inflexus	– – –	– – – – –	–	–	– – –	– – –	a′– – d	– – – –	– – – – e	– – – –	– – –	–	–
J. subnodulosus ...	– – –	– b c* – –	–	–	– – –	– b′–	a b c*–	– – c′ –	a′b c* d e	– b′– –	a b*c*	–	–

ANOIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
J. articulatus ...	– – –	– – c – –	–	–	– – –	– – –	– – – –	– – c′d	– – – d′e	– – – –	– b′ –	–	–
J. bufonius	– – –	– – – – –	–	–	– – –	– – –	– – – d′	– – – d′	– – – – –	– – – –	– – –	–	–
Luzula campestris ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c –	– – – – –	– – – –	– – –	–	–
Typha latifolia ...	– – c′	– – – – e	–	–	– – c′	– – –	– – – –	– – – –	– – – – –	a – – –	– – –	–	–
T. angustifolia ...	a*b′c	– – c′d e	–	4	a – c′	– – –	a – – –	– – – –	– – – – –	a b – –	– – –	–	–
Sparganium ramosum	a′– –	– – c′d –	3	4′	– – c′	– – –	a – – –	– – c –	– – – – –	– b′– –	– – –	–	–
Arum maculatum ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
Acorus calamus ...	a′– –	– – – – –	–	4′	– – –	a′– –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
Scirpus cæspitosus ...	– – –	– – – – –	–	–	– – –	– – –	– b′– –	– – – –	– – – – –	– – – –	– – –	–	–
Eriophorum angustifolium	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – c′– –	– – – –	– – –	–	–
Schœnus nigricans ...	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – –	– – – – –	– – – –	– b –	–	–
Cladium mariscus ...	– – c′	– b′c′d e′	–	4	a – c	– – –	a′b′– –	– – – –	– – – – –	a b*c –	– b′c*	–	–
Carex pulicaris ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – c′– –	– – – –	– – –	–	–
C. paniculata ...	a – –	a – – d e	3*	4*	– – c	a b –	a b*c –	– – c –	a b c – –	a*b*c –	a b*c*	–	–
C. remota	– – –	– – – – –	3*	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	–
C. hudsonii	position not recorded.												
C. gracilis	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– b – –	– – –	–	–
C. goodenowii ...	– – –	– – c – –	–	–	– – –	– – –	– b c –	– – – –	– – c d –	– – – –	– b –	–	–

	1	2	3	4	5	6	7	8	9	10	11	12	13
C. panicea	– – –	– – – – –	–	–	– – –	– b –	– – – –	– – – –	– – – d –	– – – –	– b′ –	–	–
C. pseudo-cyperus ...	a′ – c′	– – – d′ e′	–	4′	– – –	– – –	– – – –	– – c′ –	– – – – –	a′ b – –	– – –	–	–
C. rostrata	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – c′ – –	– – – –	– – –	–	–
C. acutiformis ...	a – –	a b c d e	3	4	– – –	– – –	a – – –	– b c –	– – – – –	– b* – –	a b –	–	–
C. riparia	a – –	a b c d e	3	4	– – c	a – c	a b – –	– b c –	– – – – –	– b* – –	a b –	–	–
Phalaris arundinacea...	– – –	a*b – – –	3′	4′	– b′ c	a b′ –	a b′ – –	a*b – –	a b – – –	– – – –	– – –	–	–
Anthoxanthum odoratum	– – –	– – – – –	–	–	– – –	– – –	– b – –	– – – d	– – – d e	– – – –	– – –	–	–
Phleum pratense ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – d	– – c – –	– – – –	– – –	–	–
Agrostis alba ...	– – –	– b c – –	–	–	– b –	– b –	– b c –	– b c d	a b – – –	– – – –	– – –	–	–
A. canina	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – – –	– – – – e*	– – – –	– – –	–	–
Calamagrostis canescens	– b –	– b* – – –	3	–	– – –	– b* –	a – – –	– b c d	– – – – –	– b′ – –	– – –	–	–
Deschampsia cæspitosa	– – –	– – – – –	–	–	– – –	– – –	– b – –	– – – –	– – – – –	– – – –	– – –	–	–
Holcus lanatus ...	– – –	– – – – –	–	–	– – –	– b c	a b c d*	– b – d	a b c d e	– – – –	a b –	–	–
Arrhenatherum elatius	– – –	– – – – –	–	–	– – –	a b c	a b – –	– – c d	a b – – –	– – – –	– – –	–	–
Phragmites communis	a*b*c	a*b*c d e*	3	4*	– b*c*	a*b c	a*b – –	– b*c –	a*– – – –	a b*c′ d	a*– –	–	–
Cynosurus cristatus ...	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – c –	– – – – e	– – – –	– – –	–	–
Molinia cærulea ...	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – –	– – – – –	– – – –	– b*c	–	–
Dactylis glomerata ...	– – –	– – – – –	–	–	– – –	– – –	a b – –	– – c d	– b c – –	– – – –	– – –	–	–

ANGIOSPERMÆ, *contd.*	1	2	3	4	5	6	7	8	9	10	11	12	13
Briza media	– – –	– – – – –	–	–	– – –	– – –	– b′ c′–	– – – –	– – c* – e	– – – –	– b –	–	–
Poa trivialis	– – –	a b c – –	3	–	– b –	a b –	– b c –	a b c –	a b – – –	– b – –	– – –	–	–
P. annua	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – – –	– – – – –	– – – –	– – –	–	–
Glyceria aquatica ...	– – –	a*b – d e	3	4*	– b*c*	a – –	a*– – –	a*b – –	a*b – – –	– – – –	– – –	–	–
Festuca elatior ...	– – –	– – – – –	–	–	– – –	– – –	a b c′–	– – – –	a b – d –	– – – –	a b –	–	–
Brachypodium sylvaticum	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12′	13
Lolium perenne ...	– – –	– – – – –	–	–	– – –	– – –	– – – d	– – – –	– – – – –	– – – –	– – –	–	–
Agropyron repens ...	– – –	– – – – –	–	–	– – –	– – –	a′– – –	– – c –	– – – – e	– – – –	– – –	–	–
GYMNOSPERMÆ													
Pinus sylvestris ...	– – –	– – – – –	–	–	– – –	– – –	– – – d′	– – – –	– – – – –	– – – –	– – –	12′	13′
Abies excelsa ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
PTERIDOPHYTA													
Equisetum palustre ...	– – –	– b – – –	–	–	– b*–	a*b*c	a b* c –	– – c d*	– b c*d* e	– – – –	a b –	–	–
Eupteris aquilina ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Blechnum spicant ...	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′
Phyllitis scolopendrium	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′

Asplenium adiantum-nigrum	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′
Athyrium filix-fœmina	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – c′ –	– – – – –	– – – –	– – –	–	13
Dryopteris filix-mas ...	– – –	– – – – –	3′	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
D. aristata	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	12	13
D. spinulosa	– – –	– – – – –	–	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13′
D. thelypteris ...	– – –	– b′ c′ – e	3*	–	a – –	– – –	a′ – – –	– b – –	– – – – –	a b c –	– – c*	–	–
Polypodium vulgare ...	– – –	– – – – –	3′	–	– – –	– – –	– – – –	– – – –	– – – – –	– – – –	– – –	–	13
Ophioglossum vulgatum	– – –	– – – – –	–	–	– – –	– – –	– – c –	– – – d*	– – c – –	– – – –	– – –	–	–

The nomenclature used in the above list is that of the British Plant List see Bibliography and Rust Fungi Paper.

TABULATED AREAS

1. The Pool—This is a shallow broad which would grow up rapidly if left alone. While the channel is kept clear of hover a good deal of mud passes down-stream with the ebb tide, especially when the bottom is stirred by the passing of a boat.

(a) Newly formed reed-swamp on west side; abundance of Phragmites and Typha angustifolia, encroaching on Pool.

(b) Much as (a) but almost entirely Phragmites; one small patch of T. angustifolia and a mass of Epilobium hirsutum near the entrance to North Channel. Bearded tits frequent this spot.

(c) Shore south and east, with "mixed" tussock species typical of the carr outliers near water.

2. Middle Marsh—The whole of this area is subject to frequent flooding.

(a) The third portion near Middle Marsh Dyke is low-lying reed-bed with much Glyceria and Phalaris, and occasional sallow, ash, etc.

(b) Central marsh: a fine example of closed reed-swamp never mown or burnt. There is a small belt of purple willows running east from the Decoy. It was in the heart of this marsh that the bittern nested in 1934. The reeds grow to 7 feet high.

(c) The Decoy lies a foot below the surrounding marsh, and forms a shallow pool under normal conditions, almost drying up in summers like 1933 and -34. The mud is smothered with small snails, Limnæa pereger, and a charophyte (Nitella sp.) bleaches white when the surface dries. The plants indicate a tendency for slightly acid peat-water to stand here.

(d) Sallow-ash carr near and including the Island and the shore running north to Middle Marsh Dyke.

(e) Sallow-ash carr on the north bank of The Smee.

3. Carr South-East of The Pool, rounded off by Fen Channel and Middle Marsh Dyke. Usually a lot of water stands in hollows among the trees, and is carpeted with a Cladophora-like alga. The wilderness of fallen branches is rich in moss and lichen, and tussocks and stumps rise from an emerald fretwork of marsh fern. In May nettles

[*Photo. by H. J. Howard*

Swallowtails: Norfolk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NATURAL HISTORY

growing here among the sedges are gorgeous with orange cluster-cups of Puccinia caricis, finer than in any other locality I have visited. This carr is notable for the abundance of Carex remota. It bears also the solitary apple, not a wild crab, but a self-sown wanderer from an orchard ; Mr. Cockle was interested in an apple that would grow on such unpromising ground, and Messrs. Bunyard and Co., to whom a sample was submitted, suggested that it was probably the variety known to horticulture as Winter Majestin. Ivy, which shuns acid soils and thrives among deciduous trees, climbs ash, sallow, alder and hawthorn in this area, despite its swampy nature.

4. Shores of Deep Waters—" Tussock " species.

5. Marsh Between Deep Waters and Island Reach—

(a) Northern margin, with some carr and a fair amount of Cladium.

(b) Central portion, east to west ; Glyceria marsh, regularly mown.

(c) Carr north of Dove Passage. This is on rather higher ground than any carr on the riverward side of it ; though quite small, it is distinctive in possessing several elder bushes and patches of enchanter's nightshade.

6. Broads Marsh—(occasionally mown ; or burnt in March).

(a) Low-lying reed-swamp covering most of eastward half.

(b) North-west corner, with a few fen species indicating lower pH.

(c) Slightly raised path along western border, bounded by a dyke beyond which is The Carr. This is the best locality for observing the encroachment of carr on high-level marsh ; many seedlings of ash, oak and guelder rose.

7. Home Marsh—The generally low level of this area makes it suitable for skating when frost follows a winter flood. Goats and a few pigs have been allowed free range over it for many years, but they do not appear to have modified it to any great extent, save that the former have almost eradicated meadowsweet and the latter have been seen to root up something which may have been Iris rhizomes.

(a) Eastern half ; Phragmites—Glyceria marsh, usually burnt in March.

(b) Central and north-western marsh, intermediate in character between (a) and (c).

(c) Fen in south-west quarter : the distinctive species is Œnanthe lachenalii ; the solitary examples of Epipactis palustris and Gymnadenia conopsea are remarkable in being the only ones found in the whole of Wheatfen.

(d) Higher ground along western margin. A fine Scots pine stands here.

8. Two-Acre Marsh and Osier Carr—

(a) Glyceria marsh in south-east corner (near Home Dyke).

(b) Carr in north-east corner.

(c) Osier Carr and clump of trees on raised ground near gate leading to Old Mill Marsh.

(d) Fen (mown for the last few years) with scattered sallows.

9. Old Mill Marsh—

(a) Reed-bed along east side.

(b) Low-lying marsh near grup. There is a small community peculiar to the wetter hollows just outside the reed-swamp : Œnanthe fistulosa (dominant), Juncus subnodulosus, Galium palustre and Stellaria dilleniana var. palustris (rare at Wheatfen, and always a species of restricted habitat-range).

(c) Main fen, dominated by Juncus subnodulosus : regularly mown.

(d) Depression at north-west corner, indicative of pH slightly lower than that of the main fen. A flock of 30 or 40 geese was penned here during 1929 (only).

(e) Higher ground sloping from " brow " of dyke along west side. Meadow rue grows in association with Agropyron repens here, and bears aecidia of their joint rust Puccinia persistens, unnoticed elsewhere in the neighbourhood.

10. Pool Marsh—

(a) Shore of Mystery Pool. The vegetation is of the greatest variety, including open and closed reed-swamp types, carr, and " tussock " with patches of Cladium and Cicuta. In clearing away " hover " a few years ago Mr. Cockle noticed a little bog myrtle (Myrica gale).

(b) Swamp encircling Avenue Pool and by the channel approaching it.

(c) Alder, sallow, ash, guelder rose, etc., forming patches of carr on raised "islands" in the marsh, where there is "hard bottom."

(d) Reed-swamp at north-east corner (burnt a few years ago, but not regularly).

11. THACK MARSH—

(a) Reed-swamp with scattered sallows.

(b) Main fen (subject to mowing).

(c) Myrica and Cladium fen (not mown).

12. THE CARR—Sallow, ash and oak abundant, hazel appearing.

13. SURLINGHAM WOOD—on higher ground than The Carr, with more oak, ash and hazel; slight clearings with bracken to the west near the footpath to Rockland.

MISCELLANEOUS NOTES ON THE FLOWERING PLANTS

Atriplex hastata, Sonchus asper, Solanum nigrum, Sisymbrium alliaria and *Senecio vulgaris* obtain temporary foothold on newly thrown-up mud along the channel banks. *Cirsium arvense* sometimes occurs on these banks, and being perennial it establishes somewhat limited colonies in the midst of fen otherwise alien to it.

Calystegia sepium flourishes best along the south margins of the carrs, where its clusters of white trumpets are arrestingly beautiful in early August; in a few places, e.g., Pool Marsh, the flowers are pink.

Cirsium palustre with white flowers has been noticed on Home Marsh and Old Mill Marsh.

The absence of the bulrush, *Scirpus lacustris*, from the open reed-swamp, is noteworthy, and the lack of *Glyceria aquatica* in the Pools and their channels interesting when it is so abundant in most other parts of Wheatfen.

Juncus inflexus and *Bartsia odontites* (parasitic on Trifolium repens) are confined to slightly raised paths, and flourish in Smee Loke near Thack Marsh.

Trifolium fragiferum was introduced experimentally on Home Marsh about five years ago. One plant was found in 1934 and the species seems to be dying out.

LICHENES

The branches of sallow, buckthorn, guelder rose, ash, privet, etc., in the carrs are covered with some of the commoner arboreal species. The air is so moist that lichens grow well and spread even over young green shoots, especially where these dip towards the water.

Parmelia physodes Willd.
P. caperata Ach.
P. sulcata Tayl.
P. fuliginosa Nyl.
Evernia prunastri Ach.
Ramalina farinacea Ach.
Usnea florida Web., var hirta Ach.

BRYOPHYTA

OF THE CARRS AND WOOD

MUSCI

Catharinea undulata Web. & Mohr.
Polytrichum aloides Neck.
Dicranella heteromalla Schp.
Fissidens bryoides Hedw.
Tortula muralis Hedw.
Barbula convoluta Hedw.
Weisia viridula Hedw.
Zygodon viridissimus R. Brown
Orthotrichum affine Schrad.
O. tenellum Bruch.
Funaria hygrometrica Sibth.
Aulacomnium androgynyum Schwæg.
Bryum capillare L.
B. argentium L.
Mnium affine Bland.
M. undulatum L.
M. hornum L.
M. punctatum L.
M. subglobosum B. & S. (on 2-acre marsh)
Leskea polycarpa Ehrh. (in carrs only)
Thuidium tamariscinum B. & S. (Surlingham Wood)
Brachythecium rutabulum B. & S. (very abundant)
B. velutinum B. & S.
B. purum Dixon.
Eurhynchium prælongum Hobk.
Plagiothecium denticulatum B. & S.
Amblystegium serpens B. & S.
A. varium Lindb.
A. filicinum De Not.
Hypnum riparium L.
H. cupressiforme L. (very abundant) and var. *filiforme* Brid.
H. cuspidatum L.
Hylacomium squarrosum B. & S. (on fen)

HEPATICÆ

Conocephalum conicum (L.) Dum.—In wood near Sluice Dyke.
Marchantia polymorpha L.—abundant

Pellia epiphylla (L.) Corda—on the damp "floor" in carrs.
Lophocolea bidentata (L.) Dum.—widespread under trees.
L. heterophylla (Schrad.) Dum.
Radula complanata (L.) Dum.
Frullania dilatata (L.) Dum.

MYCETOZOA

IN THE CARR AND SURLINGHAM WOOD

Badhamia capsulifera (Bull.) Berk.
B. utricularis (Bull.) Berk.
Physarum psittacinum Ditm.
P. viride Pers.
P. nutans Pers.
Fuligo septica (L.) Gmel.
Craterium minutum (Leers.) Fr.
Leocarpus fragilis (Dicks.) Rost.
Didymium difforme (Pers.) Duby.
D. squamulosum (Alb. & Schw.) Fr.
Stemonitis fusca Roth.
S. hyperopta Meylan.
Comatricha nigra (Pers.) Schrot.
C. typhoides (Bull.) Rost.
Cribraria argillacea Pers.
C. vulgaris Schrad.
Dictydium cancellatum (Batsch.) Macbr.
Tubifera ferruginosa Gmel.
Enteridium olivaceum Ehrenb.
Lycogala epidendrum Fr.
Trichia affinis De Bary.
T. persimilis Karst.
T. varia Pers.
T. decipiens (Pers.) Macbr.
Hemitrichia vesparium (Batsch.) Macbr.
Arcyria cinerea (Bull.) Pers.
A. pomiformis (Leers) Rost.
A. denudata Wettst.
A. incarnata Pers.
A. nutans (Bull.) Grev.

FUNGI

About 150 species of fungi have been identified at Wheatfen Broad, exclusive of the Uredinales (see "Rust Fungi of Norfolk" in this Part). A few of the more noteworthy are given here. *Cyathus striatus* (Huds.) Pers.; *Pholiota erinacea* (Fr.) Quél.; *P. radicosa* (Bull.) Fr.; *Mycena sanguinolenta* (A. & S.); *Marasmius conigenus* (Pers.) Karst. on fallen pine cones; *Trametes rubescens* (A. & S.) Fr. on old sallow boughs; *Hydnum auriscalpium* (L.) Fr. on pine cones; *H. repandum* (L.) Fr.; *Phylacteria terrestris* (Ehrh.) Big. & Guill. in Surlingham Wood; *Clavaria cristata* (Holmsk.) Fr.; *C. fusiformis* (Sow.) Fr.; *Tremellodon gelatinosum* (Scop.) Pers. on a dead pine stump in The Carr; *Morchella semilibera* DC. in carr (3) and Two-acre marsh, April; *Peziza aurantia* Oed. on fallen leaves in the

wood; *Ciboria pseudo-tuberosa* (Rehm.) Fuck. abundant on rotting acorns; *C. amentacea* (Balb.) Fuck. on fallen male catkins of alder, coming up on those of the previous year in February, when the new catkins are opening to shed their pollen; *Cordyceps militaris* Fr. (perithecial and conidial stages on larvæ and pupæ of moths, under trees); *C. ophioglossoides* Link parasitic on *Elaphomyces muricatus* in Surlingham Wood; *Ustilago longissima* (Schlecht) Meyers on Glyceria aquatica; *U. coronariæ* Liro on Lychnis flos-cuculi; *U. utriculosa* (Nees.) Tud., on Polygonum hydropiper; *Sphærotheca humuli* Burr. on Humulus lupulus in September; *Napicladium arundinaceum* (Corda) Sacc. blackening the leaves of Phragmites communis; *Plasmopara dense* Schröt. on Rhinanthus crista-galli; *Synchytrium taraxaci* De Bary on Taraxacum and radical leaves of Cirsium palustre; *Rebentischia typhæ* Faure on Typha angustifolia; and *Cytospora myricæ-gales* Bres. on Myrica gale.

THE MOLLUSCA

Shells of most of the following occur in great numbers in the deposits of Fen Channel. The aquatic species thrive in the Ceratophyllum-filled broads, and it will be noticed that the prosobranchiate snails, which require freely coursing water, are well represented (e.g., all species of Valvata). There is a definite association of small gastropods in the carr mosses near water-level; one of the slugs (Limax arborum) abounds on the lichen-covered sallows, etc. and another (Arion ater) occurs, though not very plentifully, on the open marshes.

In the following list (a) = living in the broads and channels, commonly where not otherwise stated; (b) =shells found in the deposits; (c) =living in the carr mosses; (d) =in reed-beds near the water; (e) =in Surlingham Wood; special cases are mentioned in the text.

GASTROPODA:

PROSOBRANCHIA

Viviparus viviparus (L.)
a, b.

V. fasciatus (Mull.)
a, b.

Bithynia tentaculata (L.)
a, b.

B. leachi (Shepp.)
a, b.

Valvata piscinalis (Mull.)
a, b.

V. macrostoma (Stnbch MS.)
Morch. a, b (a fair sprinkling)

V. cristata Mull.
a, b.

PULMONATA

Carychium minimum Mull.
c.

Limnæa stagnalis (L.)
a, b. (rather rare).

L. auricularia L.)
a, b (rather rare).

L. peregeer (Mull.)
a, b (see note below).

L. palustris (Mull.)
a, b (variable in form).

L. truncatula (Mull.)
c, b.

Planorbis planorbis (L.)
a, b.

P. carinatus Mull.
a, b.

P. corneus (L.)
a, b.

P. albus Mull.
a, b (moderately common).

P. vortex (L.)
a, b.

P. contortus (L.)
a, b.

Segmentina nitida (Mull.)
a, b.

Ancylus lacustris (L.)
a, b (especially on water-lilies)

Physa fontinalis (L.)
a, b (not frequent).

Pupilla muscorum (L.)
marshes, probably occurs in c.

Vertigo substriata (Jeff.)
c.

Columella edentula (Drap.)
c. (rather rare ?)

Vallonia pulchella (Mull.)
c.

Cochlicopa lubrica (Mull.)
c, b.

Goniodiscus rotundatus (Mull.)
e (under mossy logs).

Arion ater (L.)
marshes, hardly abundant.

A. hortensis Feruss.
c, e.

Petasina fulva (Mull.)
c.

Helicella nitidula (Drap.)
c.

Vitrea crystallina (Mull.)
c.

Vitrina pellucida (Mull.)
c.

Limax arborum Bouch.—Chant.
in the carrs and wood.

Agriolimax agrestis (L.)
2-acre marsh.

Fruticicola hispida (L.)
c (shells in marsh debris).

F. striolata (C. Pfeiff).
on marsh banks.

Arianta arbustorum (L.)
shells rarely in b.

(the garden snail, *Helix aspersa* Mull. was not found anywhere in the area).

Cepæa nemoralis (L.)
e.

Clausilia rugosa Drap.
e.

Succinea putris (L.)
d.

S. elegans Risso.
d.

LAMELLIBRANCHIA

Sphærium corneum (L.)
a, b (very abundant).
S. lacustre (Mull.)
a, b.
Pisidium amnicum (Mull.)
a, b (fairly frequent).
P. cinereum Alder
a, b.
Anodonta cygnea (L.)
a, b (not plentiful).

THE FISHES OF WHEATFEN BROAD

PERCH : frequent.
RUFFE : occasional.
THREE-SPINED STICKLEBACK : occasional.
FLOUNDER : rather rare (sometimes very small).
PIKE : frequent, especially in Deep Waters.
EEL : numerous.
CARP : several in Deep Waters.
TENCH : common.
ROACH : plentiful.
RUDD : fairly numerous.
BREAM : a few normally.
LAMPERN : Two have been caught in the dykes.

Somewhere about the 25th of May each year great numbers of roach, rudd, bream, perch, carp, etc., swim up from Rockland Broad for the rouding in Wheatfen ; these shoals form a remarkable sight as they pass along the clear waters of Fen Channel.

THE INVERTEBRATES :

MISCELLANEOUS

The following notes are given as a " taster " of good things in store for naturalists who wish to work in special directions, helped by Mr. Cockle, in years to come.

Two specimens of the turbellarian *Mesostoma tetragonum* (Mull.) were noticed in water taken from one of the broads, 15-6-1934.

The earthworms of such a specialised tract as this call for investigation ; so far only *Eiseniella tetrædra* Savig. has been identified (from Carr 3)—it is an abundant species in similar habitats at Wicken Fen.

We have seen a few dragonflies: *Platetrum depressa* (L.), in May and June; *Sympetrum striolatum* (Charp.) during August; *Lestes sponsa* (Hans.) apparently rather rare, July—August; *Ischnura elegans* (Lind.) common in May and June (frequently carrying Hydrachnids); *Agrion pulchellum* Lind. and *A. puella* (L.) common, May to July; *Pyrrhosoma nymphula* (Sulz.) especially in May; *Enallagma cyathigerum* (Charp.) in July.

The butterflies and moths are numerous; outstanding among the former are the brimstone (*Gonopteryx rhamni* L.) which flies in March and again in August—its food-plants the buckthorns being abundant in the carrs; the swallowtail (*Papilio machaon* L.) which has increased during the last few years and whose larvæ were frequent on milk parsley in the fens during July 1934; the vanessids: peacock (*Nymphalis*) (*io* L.), red admiral (*Vanessa atalanta* L.) tortoiseshell (*Aglais urticæ* L.) which crowd on to the hemp-agrimony blossom in early August; and the green-veined white (*Pieris napi* L.) which was seen visiting flowers of water forget-me-not in some numbers during July, 1934.

A few beetles have been identified: *Chilocorus similis* Rossi. like a black shining lady-bird with two red spots may be seen sunning itself on flowering alder branches in March; *Cyphon padi* L. occurred in moss from carr (3); *Adalia 10-punctata* L.; *Coccidula rufa* Hb.; *Malachius bipustulatus* L. on Home Marsh; *Anthocomus terminatus* Me.; *Clytus arietis* L. (a zebra-striped longicorn frequent in the old sallow-carrs); *Plateumaris sericea* L.; *P. discolor* Pz.; *Gastroidea viridula* D.G. on a marsh dock (Rumex conglomeratus L.); *Hydrothassa marginella* L.; *Haltica lythri* Ab. abundant on willow-herb especially in June; *Pyrochroa serraticornis* Sp. frequent on the fen in June; *Chrysomela polita* L.; *Melasoma populi* L. numerous on the few creeping willows (Salix repens) on Thack Marsh in July; *Erirrhinus nereis* Pk. on Cladium mariscus, 7-6-1934; the weevils *Cionus scrophulariæ* L., *C. alauda* Hb. and *C. pulchellus* Hb. (the two former most commonly) on water figwort in June. These are sufficient to indicate the country a visiting coleopterist may expect. The staphylinid *Oxyporus rufus* L. was present in a Boletus near Surlingham Wood, 9-7-1933.

Honey-bees (*Apis mellifica* L.) visit the flowers of cowbane (Cicuta virosa) near the broads; they have been seen to collect

the pollen of this plant both at Wheatfen and Hockham Mere in Norfolk.

Mr. H. E. Hurrell found masses of the Polyzoon *Fredericella sultana* (Blb.) among submerged roots and branches of sallow in Dove Passage, together with *Plumatella fungosa* (Pall.), var. *coralloides* (Allman) Harmer, July 19th, 1934.

THE PLANT GALLS

Wheatfen is remarkable for the variety of galls occurring on its flowering plants. Diptera : *Rhabdophaga saliciperda* Duf. on sallow ; *Dasyneura persicariæ* L. on Polygonum persicaria ; *D. ulmariæ* Brem. very abundant on meadowsweet ; *D. urticæ* Perr. on nettles ; *Oligotrophus bursarius* Brem. on ground-ivy ; *O. capreæ* Winn. on sallow ; *Clinodiplosis thalictricola* Rubs. abundant on meadow-rue ; *Lipara lucens* Mg. not very frequent on reeds (fen-burning may have been responsible for this). Hymenoptera : *Pontania bella* Lad. common on sallow ; *Rhodites rosæ* L. forming robin's pin-cushions on dog rose. Hemiptera : *Trioza galii* Fst. on Galium palustre ; *Livia juncorum* Latr. on Juncus articulatus (Old Mill Marsh) ; *Rhopalosiphum ribis* L. causing " billowy " distortions of black-currant leaves in the carrs ; *Trichopsylla walkeri* responsible for the galls on leaves of buckthorn ; *Chermes abietis* L. on spruce. The beetle *Gymnetron villosulum* Gy. causes the flowers of Veronica anagallis to swell. Acarina : *Eriophyes axillaris* (Schl.) and *E. lævis* Nal. are frequent on alder leaves ; *E. cratægi* Canest. on hawthorn (possibly this or something near it on spindle) ; *E. tetanothrix* Nal. on sallow ; *E. pustulatum* on aspen ; and *Phyllocoptes fraxini* Nal. on ash.

ANIMAL ECOLOGY :

Short Notes

It has been found that moles store quantities of earthworms slightly bitten at one end in their large winter mounds in Surlingham Wood. Twelve of these mounds were opened by Mr. Cockle on April 14th, 1934, when such stores had been exhausted ; in these were seventeen nests made of dry oak leaves. One heap of large size against the foot of an oak contained three nests and three others had two.

Water shrews bite open the shells of small *Limnæa pereger* round the margins of the broads, leaving them empty on the banks. Fifty-six specimens of *L. pereger* were taken from the crop of a mallard, 10-8-1932.

Numbers of frogs assemble in the Decoy for spawning purposes.

Mr. M. J. D. Cockle and the writer tender thanks to Mr. H. J. Howard, F.L.S., for help with the mycetozoa, Mr. G. J. Cooke with the larger fungi and to Mr. A. Mayfield, F.L.S. and Dr. P. G. M. Rhodes, F.L.S., for identifying most of the mosses, hepatics and lichens. All students of natural history are invited to visit Wheatfen Broad for scientific purposes.

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V

LAND SNAILS OF BLAKENEY POINT

By Charles Oldham, F.L.S., F.Z.S.

In a recently published account of the snail fauna of Scolt Head Island,[1] it was suggested that a survey of the snails of Blakeney Point might provide an interesting comparison. An opportunity for, at any rate, a cursory examination of the *locus* at Blakeney, which a short visit (September 29th to October 1st, 1934) afforded, yielded unexpected results. No member of the Blakeney fauna was absent from Scolt, but there were twice as many species at Scolt as at Blakeney, and some of these were large snails that could hardly have escaped notice. Scolt, it may be recalled, has a richer flora than Blakeney, although some plants occur at Blakeney which are absent from Scolt.

The physiography of Blakeney Point and Scolt has been described at length, in these *Transactions* and elsewhere,[2] and it must suffice to say here that, whilst the conditions are similar —blown sand piled up on a bar or spit of shingle, with lateral hooks that have been more or less denuded of sand—at Blakeney the main beach is in places no longer masked by dunes but is a high pebble-bank, where in storms shingle is thrown over the crest and scattered down the leeward slope.

The area worked at Blakeney was from the new dunes at the Far Point to the most easterly of the lateral hooks known as the Marrams. As at Scolt, there is no permanent fresh-water and, in consequence, no fresh-water snail. No slug was found at Blakeney ; there are two species at Scolt. Two or three shells of *Cernuella virgata*, picked up on the tide-line near the Life-boat House, were obviously sea-borne, and had no more claim to a place in the Blakeney fauna than had shells of *Planorbis spirorbis* in the jetsam on the tide-line at the Hood.

On the dunes at the Far Point no snail was seen, but *Vitrina pellucida* was plentiful on driftwood, pieces of paper, etc., on the dunes, even those near the sea, N. of the Lifeboat House ;

[1] *Scolt Head Island* (1934) pp. 214–220.

[2] *E.g.* Oliver and Salisbury; *Blakeney Point, Norfolk*, Topography and Vegetation, Vol. IX, pp. 485-542; Oliver; *Scolt Head and Blakeney Point*, Vol. XI, pp. 565-578 : Steers; *Scolt Head Island.*

there were twenty-three examples on one strawboard box-lid. *Pupilla muscorum* was not seen on the newer dunes of the Headland, but, associated with *V. pellucida*, it occurred on the older, degraded dunes 200 yards E. of the Lifeboat House. These two were the only species seen W. of the Long Hills. In mats of *Silene maritima* on the bare shingle at the S.W. end of the Long Hills, however, another species, *Vallonia excentrica*, occurred, associated with the *Vitrina* and *Pupilla*. These three were found in association in suitable places, *e.g.*, under driftwood, in silene-mats, and in the sparse turf of the lateral hooks, thence all the way to the eastern end of the Marrams.

In the neighbourhood of the Marrams two other species, *Candidula caperata* and *Clausilia rugosa*, appeared, the latter in great abundance in the short turf on the lateral hooks and in silene-mats on the lower slopes of the landward face of the pebble-bank, but the other three species of the association, *P. muscorum*, *V. pellucida* and *C. caperata*, were found in the silene-mats right up to the crest of the bank, where the coincidence of an onshore gale and a high tide implies not only drenching with salt water but the risk of being overwhelmed by the shifting shingle. The austere nature of this habitat is reflected in the vegetation, which, apart from the silene-mats, consists of scattered plants of *Glaucium flavum*, *Arenaria peploides*, *Rumex triangulatus* and *Suæda fruticosa*. The pebble-bank was formerly covered by dunes, of which indeed there are scanty remains here and there, and the question arises whether the snails now living in the silene-mats of the pebble bank constitute a relict fauna or are pioneers. That the silene-mats not only provide shelter for the snails but conserve the moisture long after the bare shingle that surrounds them is dry is shown by the presence, often in considerable numbers and on the lateral hooks as well as on the crest and landward slope of the bank, of a sand-hopper *Orchestia gammarellus*.

Helix aspersa and *Cepæa nemoralis* occur on the dunes of the Hood, but not elsewhere. The broken shells around the numerous thrushes' anvils testify to their abundance. The absence of *C. caperata* from these dunes and indeed from the whole of the area W. of the Marrams is puzzling, seeing that at Scolt it is associated with the other pioneer species, *P. muscorum* and *V. pellucida*, on even the newer dunes.

Several examples of *Fruticicola hispida*, associated with *P. muscorum*, *V. excentrica* and *V. pellucida* were found under bricks and in a heap of rubble at the Watch-house, where at one time there was a patch of cultivated ground, the explanation probably of their presence there.

The snails found at Scolt, but not at Blakeney, are :— *Vallonia costata*, *Cochlicopa lubrica*, *Arion intermedius*, *Helicella alliaria*, *Agriolimax agrestis*, *Cernuella virgata*, *Xerophila itala* and *Theba cantiana*.

Blakeney Point is believed to be older than Scolt Head Island, and its chances for colonization have been, one would suppose, greater; but even if the view be rejected that Scolt has been piled up as an island and independently of any direct connection with land to the E. of it, the paucity of the Blakeney Point fauna, eight species or just one half of the Scolt fauna, is remarkable.

In this note I have set out the facts as I know them, but an explanation of the wide difference between the two faunas is still to seek.

VI

THE SOCIETY'S PROCEEDINGS, 1933—34

By The Editor

On May 18th, 1933, Members visited Breckland. Starting from Roudham on the Norwich—Thetford Road the party, led by the Excursion Secretary, proceeded along the Old Drove Road. By kind permission of Mr. Percy Musker members wandered over the heathland and saw nests and eggs of the Norfolk Plover, plants characteristic of the district, and quantities of cinnabar moths. Langmere, Fowlmere and the Devil's Punchbowl were inspected.

On June 8th, by permission of the Earl of Leicester, the heronry at Holkham was visited, waterfowl were observed on the lake, and hybrid fir seedlings were examined on the sandhills.

On June 22nd there was a half-day excursion to Buxton Heath and Swannington Common.

On July 14th a whole day excursion to Scolt Head Island was of much interest to botanists as well as to ornithologists.

The first meeting of the Winter Session was held at the Norwich Castle Museum on October 17th, the President in the chair, when it was unanimously resolved that a Handbook on Scolt Head Island, edited by J. A. Steers, M.A., of St. Catharine's College, Cambridge, be published by this Society, and the sum of £100 was voted from its funds towards the cost, it being understood that the repayment of this sum would be the first call upon the sale receipts of the book.

Mr. G. J. Bedford showed a series of beautifully hand-coloured photographic lantern slides of English wild flowers.

On November 21st a discussion on Bird Migration was introduced by Miss M. Barclay who described the autumnal migration on Heligoland.

At the December meeting the Curator exhibited recent additions to the Norwich Castle Museum especially the lately acquired collection of insects made by the late H. J. Thouless, and the books he had used.

The proposed general plan of the Norfolk Room having been explained by his assistant Mr. E. A. Ellis, Mr. Leney asked

for the help of this Society in working out the Norfolk Study Scheme, and a Committee was appointed to advise the Curator as to personnel.

On January 16th, 1934, it was unanimously resolved that this Society shall become an Affiliated Organisation to the Norfolk Branch of the "Council for the Preservation of Rural England," and that Dr. S. H. Long shall be the representative of this Society on the General Council.

A demonstration of the art and craft of Flint Knapping was given by two knappers from Brandon, Messrs. Edwards and Field, and the various processes were explained. The Brandon stone is the best obtainable, and the industry is carried on now as it has been by many generations of knappers.

On February 20th many Norfolk specimens, animal and vegetable, were exhibited and discussed. The President spoke of Bearded Tits attending on reed-cutters and snatching insects or other food in the newly cleared spaces. Mr. Ellis showed specimens illustrating the life history of *Lipara lucens* the reed gall-fly, the larvæ of which are said to be attacked by the Bearded Tit. Mr. Cockle showed *Mycetozoa* from Surlingham and samples of an extensive deposit of freshwater shells at Wheatfen Broad.

On March 20th Mr. J. E. Sainty gave an extremely interesting address on Norfolk Geology illustrated by a series of beautiful lantern slides.

At the Annual Meeting on April 17th Major Buxton delivered his Presidential Address on "The Preservation of Wild Life at Home and Abroad."

Mr. W. P. Pycraft, A.L.S., F.Z.S. was appointed President for the ensuing year, and Dr. S. H. Long was elected Secretary and Treasurer.

VII

THE JUNIOR BRANCH OF THE NORFOLK AND NORWICH NATURALISTS SOCIETY

Annual Report, 1934

The Junior Branch is primarily intended for those young people who being at school or college, are unable to attend the meetings of the Senior Society, but others interested are eligible.

The annual subscription is 2s. 6d.

The present membership numbers about 50.

A Nature Log is circulated among the members, and it is hoped each will contribute something to it.

Three meetings were held in 1934, viz. :—

January 8th.—An interesting lecture was given by Mr. R. Gaze on " Butterflies, Birds and Flowers to be seen in Norfolk," illustrated by many beautiful slides.

April 16th.—A delightful afternoon was spent when the late Mr. Gerard Gurney took Members round his aviaries, and afterwards gave them tea at Keswick Hall.

September 10th.—An excursion was made to several of the finest broads. A halt being made at Ranworth, where the Church was visited.

The Hon. Secretary finds it difficult to arrange new excursions and ventures to appeal urgently to Members of the Senior Society and their friends who possess places of Natural History Interest, kindly to allow the Junior Branch to visit them, bringing their own picnic teas.

Judith M. Ferrier, F.Z.S., M.B.O.U.,
(Hon. Sec.)

BALANCE SHEET, 1934

Receipts.	£	s.	d.
Balance for 1933	4	19	6
35 Members' subscriptions ...	4	5	0
Members' payments for teas ...		10	0
Members towards excursion, September 10th	3	5	6
	£13	0	0

Payments.	£	s	d.
Postage		11	6
Fee to Lecturer	1	1	0
Tips on Excursion		10	0
September Excursion, Hire of Launch, etc.	5	7	0
Balance	5	10	6
	£13	0	0

Note.—35 Members paid. 24 Members not paid. 59 Members in all.

Judith M. Ferrier, F.Z.S., M.B.O.U.,
(Hon. Secretary).

VIII

WILD BIRD PROTECTION IN NORFOLK IN 1934

Report of the Committee

In presenting its report for 1934 to its subscribers the Norfolk Wild Birds' Protection Committee would like to express its thanks to all those who continue their support. The principal breeding grounds of terns and other sea birds in Norfolk, which have now an almost world-wide reputation, are so isolated that it is impossible to protect them during the nesting season, except through the agency of some voluntary organisation, such as the committee represents. To encourage interest, the nesting grounds are available for inspection, under the supervision of the watchers, at all reasonable times. Unfortunately the egg-collector is still a menace that has to be reckoned with, though, as past experience has taught him, it is unlikely that he will receive a more cordial welcome in the future than has been meted out to him in the past if he visits the nesting grounds of Norfolk. The compiler of these reports is always pleased to receive notes of ornithological interest, and he thanks those who have assisted him in this way during the past year.

Scolt Head Island

On almost every day of the year there is something of interest to note in the bird life of Scolt Head Island; it is on a line of migration of many species, and since it has been under protection during the breeding season the number of nesting birds has considerably increased. Its ranges of dunes and shingle beaches provide suitable nesting sites for four species of terns and a few waders, and the rabbit burrows are, most of them, occupied by sheld-ducks. The following notes with regard to the bird life in 1934 have been extracted either from the watcher's diary or from our own note-book.

A female Bittern tamed at the nest, at Catfield, by Lord William Percy, where she was hand-fed with fish and eels for 85 days. In the photograph, taken when part of her brood was hatched, she was in the stage of mixed defiance and friendliness at the approach of the human hand.


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During January there was an unusual number of shore-larks and snow-buntings, and throughout the winter large flocks of linnets. These, the buntings and linnets, formed an easy prey for a female hen-harrier which had been on the island since the previous September. On April 6th she was joined by a male, and the pair left during the third week of the month. In early September wandering harriers which had probably been summer residents on the Broads were seen about the island, both marsh- and Montagu's (S.H.L.). Kestrels are common visitors to the dunes, and occasionally one sees a peregrine come in from the sea, as did the writer on the early morning of September 11th. During February a pair of merlins spent several days on the island, they also having been attracted by the linnets and snow-buntings. (S.H.L.)

It remains a problem as to what happens to the large number of sheld-ducks that nest on the island. By the end of August all of them, old and young, have left. It may be that they spend the autumn months on the shallow seas of the Wash, for the watcher has noticed that in bad weather they will return to the island for shelter. It is not, however, until January that they return in numbers.

On February 1st a green woodpecker was flushed in the dunes, and on April 6th a woodcock was found resting on the island.

The first wheatear was seen on April 6th, and on the same day the first swallow. The wheatear nearly always arrives on the inland heaths of south-west Norfolk before it does on the coast, and this year the writer found a male in Breckland on March 17th, a day of blizzards.

The Sandwich terns usually arrive ahead of the other terns, and this year the first was seen on April 6th, five days earlier than last year. Others came, and on May 12th six eggs were found on some miniature dunes now beginning to form on the extreme Far Point at the west end of the island. On the evening of the 14th, when there were seventeen nests, each with one egg, the watcher estimated that there were about 400 of these birds round about the ternery. On this night there was a strong N.N.W. wind with a high tide, which washed out all the terns' eggs, and, in addition, five oyster-catchers' nests, four redshanks' and many ringed plovers'. On the night of the

16th there was a bad sandstorm, followed by hail and snow the next day, and all the Sandwich terns left the island. By May 25th there were four new nests with eggs on the old site ; these increased later to sixty-four nests containing ninety-two eggs, all of which hatched.

Common and little terns were both first seen on April 12th and their ultimate numbers were about the same as last year, that is to say, from 400 to 500 nests of the common and about 100 of the little. Unless some system is resorted to of marking each nest, which it is hoped to adopt next year, it is impossible to give anything like an exact figure for the number of nests of these two species. Their principal food, " whitebait," inshored early and the old birds brought in from the sea thousands of fish in excess of the requirements of their chicks. These lay about the ternery and well manured the young dunes. With the exception of one bad sand-storm, on June 24th, when a number of eggs were smothered, the birds had an ideal nesting season.

One pair of roseate terns again nested, within two yards of last year's nest. The first was seen on May 13th, and the pair on the 23rd. The first egg was laid on June 1st and the second two days later. The first hatched on June 24th and the second on the 26th. Both young reached the stage of flight, after which they became indistinguishable from the numerous young common terns.

There were thirty-eight oyster-catchers' nests, all of which hatched off, though in a few cases a second clutch was laid owing to the first having been destroyed by storm. There were three nests on the ternery, two being placed within ten yards of each other ; the other nests were mostly on the shingle ridges.

During the first eighteen days of September, a period of continued fine, sunny weather, the writer stayed on the island. During this time, as is usual, there was a large number of waders passing through. There was an unusual number of bar-tailed godwits this year, as was noticed, also, at Blakeney and Salthouse. On the island these birds were generally to be found feeding on the shore, in the company of many sanderlings. Greenshanks and whimbrel were passing through on most days. The majority of the common and little terns had

left, but Sandwich terns were still present in numbers. As is generally the case at this season, great and arctic skuas were seen daily chasing these birds.

On September 12th, with a perfectly calm sea, a trip was made into the Wash by motor boat, and when about four miles from the island a male smew in almost adult plumage was found resting on the sea and allowed of a close approach—an early date for this species to be so far south.

A migration of small birds is to be seen only when the wind is from the east or north-east, and on two days only did it blow from this direction, namely, on the 6th and 13th. On both days common redstarts and pied flycatchers were to be found in the bushes. On the 13th no small migrants were noticed in the morning, but by 4 p.m. both of the species mentioned were generally distributed in the bushes. A blue-throat was found by the Cockle Bight, and there were a few whinchats, willow-wrens and numerous wheatears. A spotted flycatcher spent the afternoon catching flies from the roof of the hut, but moved on during the night.

Blakeney Point

As on Scolt Head Island, the nesting birds on Blakeney Point had an ideal season ; a good hatching, a plentiful food supply and a low mortality amongst the chicks. The results of a census taken by the watcher, William Eales, gave the following results :—

Common terns	... ...	1962	nests
Little terns	... ...	29	,,
Oyster-catchers	... ...	18	,,
Ringed plover	... ...	123	,,
Redshanks	... ...	16	,,
Sheld-ducks	... ...	40	,, (estimated)

No Sandwich terns nested at Blakeney this year.

From the above figures it will be seen that Blakeney Point still contains the largest nesting colony of common terns in Norfolk, but there are more little terns and oyster-catchers nesting on Scolt Head Island.

Notes from the Kelling-Salthouse-Cley Area, 1933-1934

by Ronald M. Garnett

Notes published in the last Protection Report were compiled up to October 20th 1933: the following cover a period from that date to October 31st 1934.

1933

October

During the last week some wild weather was experienced, with westerly gales, heavy rain, and some snow. These conditions brought in some interesting birds, including a pomathorine skua, two whooper swans, two red-necked grebes, and an Iceland gull.

November

A wet month with little sunshine and no frost. A little auk was diving for food on Salthouse Broad on the 2nd, a grey phalarope was seen on the 4th, and a ruff or reeve on the 5th. On November 8th, one of the few really fine days, a passage westwards of lapwings, rooks and grey crows occurred when the wind was from the west. Next day eleven grey-lag geese passed inland from Salthouse, Miss M. Barclay, who was with me at the time, recognized them at once by their call.

An "oiled" guillemot, found alive on the beach on the 22nd, was the "ringed" variety. Forty-nine sheld-ducks were counted on Salthouse on November 26th. This species has become more numerous here in winter, especially during rough weather, and the reason is, in my opinion, that there is now little or no shooting on the Council drift which crosses the middle of the marsh, this ground being now in the hands of Mr. Pope.

December

A cold month with frost on most nights, though not very severe. A woodcock was walking about in broad daylight on the Kelling-Salthouse road on the 1st. The coot flock on Salthouse Broad, always large in winter, exceeded all previous records in my experience, for by the end of the month there must have been 400-500 birds. Brent geese began to come in about December 14th following an easterly gale the day

previous. A single Bewick's swan appeared on the 21st, and there were eighteen present on the 24th.

1934

January

A feature of the month's weather was the abnormally low barometer on the 14th during a westerly gale, and equally abnormal high readings from the 21st to 24th during severe frosts.

A peregrine was seen several times during the first week over Salthouse marsh, but I never saw it make a kill, though on one occasion it made several stoops at a rock-pipit. A blue-tit roosted nightly in an empty cocoanut shell hanging by a string from a tree in my garden.

On the 12th, a spring-like day, skylarks were singing high in air along the coast towards Blakeney Point. Snow-buntings were scarce this winter, only small parties were seen. A dead eider duck was found on the Hood on January 12th. A grey wagtail again wintered in Kelling village on the beck which runs between the cottages, where it became exceedingly tame.

February

A dry month ending with snowfalls. Two glaucous gulls frequented the beach from February 4th to 21st feeding upon the carcase of a seal washed up. Both were shot by collectors. A very large flock of bramblings was feeding on seeds of sea aster in the middle of Cley marsh the whole month. I estimated the numbers at about 400 birds. Perched on the dead reed stems they were a beautiful sight. By the 17th sheld-ducks in pairs were moving east along the marshes towards Kelling, whence, later, they fly up to the heath in search of nesting sites. A pure-white stoat, black only in nose, eyes and tail-tip, was trapped near Salthouse heath and is now in Norwich Museum. An immature little gull was seen passing along Salthouse beach on the 20th.

March

The grey wagtail left Kelling about the 8th, by which date it had assumed the black throat of breeding dress. Wigeon increased in numbers during this month, as they usually do. The spring passage of waders commenced on the 23rd, when two black-tailed godwits and a greenshank were seen. The

former species increased in numbers, thirteen being present on the 26th and fifteen on the 28th. Last year ten were the most seen together, on March 30th. The first wheatear was seen at Kelling on the 26th, a week later than in 1933. A female hen-harrier appeared on Cley beach on the 31st.

April

Nine Sandwich terns, the first seen, had reached Salthouse on April 5th. Another hen-harrier, this time I think a young male, was hunting on Kelling heath on the 8th. A few warm days from 14th to 16th brought many summer migrants, including numerous swallows, yellow wagtails and a male blue-headed wagtail. Black tern and little terns were seen on the 12th, an early date for either. Some lapwings were moving east on the same date. There were still thirteen black-tailed godwits on the marsh on the 13th. A passage of white wagtails occurred during the latter half of the month, and they were much more numerous than usual. Sixteen pintails were counted on Salthouse on the 24th, and the first common terns were seen on the 25th. Many siskins were passing through the inland woods on the 26th.

May

A long period of drought began with the advent of May. A passage of ring-ousels took place between the 2nd and 5th; unlike most passage migrants, they seem to be more numerous in spring than in autumn. The Sandwich tern colony was even larger than in the year previous. The birds began laying in the first week, and two young had hatched on the 30th, on which date 827 nests were counted with strings. Only one clutch of three was seen, of which one egg was unlike the other two. An immature spoonbill arrived on the 28th and remained on Salthouse for several days. An oyster-catcher's nest, found this month at Salthouse, contained five eggs, and these were almost certainly the product of two hens, as three birds were usually to be seen close by, and there was no other nest within a considerable distance. All the eggs hatched off safely.

June

There were no less than eleven black terns feeding on Salthouse marsh on the 1st; all were in breeding plumage. A little stint

Photo] [*R. M. Garnett*

Dotterel on Kelling Heath, Norfolk, 1934

(This photograph was taken without the aid of a hide)


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was seen on the 3rd ; this species is much more commonly seen in the autumn. The event of the month was the occurrence on Salthouse on June 10th of an adult white-winged black tern. The jet-black under-wing coverts contrasted very noticeably with the white upper surface of the wings and the pure white tail and rump. Unfortunately it only remained for a few hours. Holman, the keeper on the marsh, spotted it first, and later it was seen by several other observers. An avocet also spent some hours on the same marsh on the 13th, when a party of naturalists from Warham were lucky enough to see it. Many butterflies were seen on the coast on the 17th, a very hot day, mostly large and small whites, though a brimstone, a red admiral and a common blue were also seen.

July

A break in the long drought occurred on the 18th, and a very large movement of waders followed, when turnstones, green sandpipers, ruffs, a black-tailed godwit and many dunlins came along. The fresh marshes were full of snipe, and many other species of waders followed during the remainder of the month.

August

The migration of waders increased in volume, for the rain had flooded portions of the marsh which had been dry for many weeks, and these pools proved most attractive to the birds. By the end of the month twenty-one species of waders had been noted since the passage began, of which only five breed locally.

September

A further large increase in the number of waders was noticed on the 3rd, when ruffs and curlew-sandpipers were especially numerous. A dotterel was seen on the beach on the 5th, and another was found on the heath on the same date, where it remained for several days, and a photograph (here reproduced) was taken of it without the use of a " hide." Three more were found at the same place on the 17th by Col. Madoc.

The first red-necked phalarope arrived on September 7th, and on the 8th two wood-sandpipers were seen by several observers at Little Eye. Little stints increased in numbers until, on the 16th, sixteen were counted on two small pools at the same place. A feature of the month was a flock of bar-tailed godwits, curlew-

sandpipers and ruffs, which could be seen feeding day after day on a dry pasture on the edge of Salthouse marsh beside the road. It was not until the 20th that it became clear what it was that attracted them, but on that date an extraordinary hatch of crane-flies took place, and it was doubtless upon the pupæ of these that the birds had been feeding. Three days later the weather became suddenly cold, and it was a sight to watch the birds gorging upon these insects. House-martins were taking them from the walls of the wooden buildings on the marsh, and swallows from the thistle-tops where they rested, while starlings and black-headed gulls gathered in large numbers to the feast. A spotted redshank was seen on the 29th.

October

Some swifts remained unsually late this autumn, for birds were seen on October 1st, October 4th (two) and on October 6th.

A red-necked phalarope, seen on September 28th, by Mr. Sladen Wing, remained until October 5th. On the 14th, during a severe westerly gale, gannets were passing east offshore in hundreds, and many arctic skuas with them, while at 4.30 p.m. a single short-eared owl beat slowly in from the sea and dropped like a stone upon the beach.

Two Bewick's swans (both adults) arrived at Salthouse on the 19th, an early date, and on the 21st a red-necked and a grey phalarope were swimming side by side on the same marsh. Both were using a typical method of obtaining food, by spinning round and round as on a pivot, and churning up some form of life from the mud below.

A purple sandpiper on October 21st brought the number of wader species seen this autumn up to twenty-seven.

Notes from Horsey
by Major A. Buxton

Birds seldom enjoy two such breeding seasons as were those of 1933 and 1934. They have made the most of their good fortune. Bearded Tits, for instance, all seem to have had three broods in 1934 instead of two, and when only the first broods were out, my keeper who, in exercising his dogs round Horsey Mere, disturbed a flock of these youngsters in the reeds, counted forty-five flying cross an opening, and that was

by no means the whole of the flock. Recently I saw a flock of at least fifty sunning themselves on the tops of the reeds in the early morning sun, — one of the prettiest sights I ever saw on the Broads. This year, while just as thick as usual in their normal breeding grounds, they have spread to fresh sites. In the winter they congregated round the reed-cutters, with whom they were on terms of great familiarity. One of them which was ferreting about in a reed bundle omitted to get out of the way when the reed cutter flattened out the bundle with his foot, and the bird was accordingly stamped on. I watched them flocking from all corners of the reed bed to the sound of the scythe, which meant more grubs laid bare in the reed stalks for their benefit. In a district where some one is always turning up to look at birds, bearded tits are the greatest comfort, for they can be depended upon to show themselves and, moreover, do not at all resent being examined at close quarters.

That is not the case with the bitterns ; there is no difficulty about hearing them during the booming period, but at that time it is hard to obtain a good view of them. When they were in full boom I counted ten cocks on the property, or within a few yards of the boundary, which indicates a slight increase. Probably we have reached high-water mark in bitterns on the broads and, apparently, colonization elsewhere has started, for this year at a certain locality in Suffolk, there were (apparently) three cocks booming, as against one or two previously. I shall be much surprised if some of these birds do not nest in such valleys as the Test and the Frome before many years are past. Bitterns and bearded tits have ceased to be in any sense rare birds on the Broads.

A certain cock marsh-harrier, incidentally the best looking male I ever saw, which, with his spouse, nested in the neighbourhood, spent all his spare time bullying bitterns. For long we were at a loss to account for his peculiar antics ; he would dash down repeatedly over a certain spot in the reeds, rising again just before he touched the ground ; then, after a time, he would pretend to go away, but presently came slinking back low and repeated his series of plunges and upward jerks. One day I heard a boom from the place at which he had made his attack, and soon afterwards he was twice seen

to pursue a flying bittern, drive it to earth and then go through the above performance. Apparently it was all for fun, for he never seemed to do the bittern any harm or drive it away.

I only saw one other harrier do the same thing, and then only once. The old white-shouldered hen marsh-harrier, now universally known as 'the Old Gal' was seen to make the same movements presumably at a bittern whose young had recently left the nest, situated only about sixty yards from that of the harrier. Since she is easily the greatest character at Horsey and I have related her family history up to this year, her story of 1934 shall be told. She turned up to date with the "streaky" cock, who was so greatly improved in appearance that he deserves a new title, and they again took over the same beat, which extends beyond my boundary. The cock built his nest near the spot where they reared their family in 1933, but to our disgust the hen selected a site a few hundred yards over the march and nearly a mile from her husband's nest. She had begun to sit, when something, I know not what, disturbed her, and one day we witnessed the peculiar spectacle of the cock trying to force her back to the nest, even striking at her in the air. It was no good; she deserted, but luckily for us returned after much hesitation to her old marsh on my land. For the next ten days she was fed repeatedly by the cock, which returned again and again with prey. The result was excellent—six eggs from which emerged in due course six young harriers. As usual, the larger four killed and ate the smaller two, and worse might have befallen had not the first born, which was a week older than the rest, been a bird of placid temperament compared with most young marsh-harriers. Number two was a perfect little devil, but it was not quite big enough to manage number three and number four. My last view of the family was of all four sitting on the top of my hide, a sight which must have shocked their fond mamma to distraction, for that good dame loaths a hide almost as much as she loaths me. It took us seven weeks to get two shots at her with a camera and those were the only two we got, because the next day she moved the young six feet back behind the reeds. The cock proved himself once more to be a right good sort; when she had a fit of the tantrums he carried gaily on and brought the food straight into the nest with a cheery chuckle. She

Photo]

Marsh-Harriers [*A. Buxton*


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looked rather in need of a wash-and-brush-up when she arrived in the spring, but after the moult, during her sitting period, she emerged in splendid feather and instead of merely a white head and white shoulders she now has white blotches on her chest. If she goes on at the present rate, she might be a complete albino by about 1950. Black or white, I wish I knew how to get on the right side of her. She is without exception the most cunning old bird I have ever met, but despite all the trouble she gives us, I would never exchange her for another.

The same pair of Montagu's which were photographed doing the " pass " last year, returned and nested in the same place, rearing four splendid young birds out of four eggs. After some hesitation I left them alone and turned my attention to a new pair, which settled down about half a mile away from them. I did so chiefly because I preferred the looks of the new cock and on a closer acquaintance both he and his beautiful yellow hen proved to be a delightful pair. The cock was much more domestic than most others of his kind. He showed intense excitement over the arrival of each of his four young, fluttering over the nest and examining each new infant as it emerged from the egg. On one occasion he was allowed by the hen to feed the new arrival himself after he had called the hen off the nest, with the food displayed in his claw. I naturally expected her to return with it to the nest, but instead he came back leading and—still holding the food. She fluttered over him as he dropped on the nest, then circled back and gave him about five minutes all to himself, returning to watch him from the air and finally pushing him quietly off.

When the young had grown feathers and the hen no longer considered it necessary to be always in the vicinity of the nest, the cock made almost as many visits to the young as the hen. As a rule he merely tossed down the prey and was off again without ever closing his wings, but occasionally he parcelled out the food just like the hen. It was always her business to remove bones at the end of a feed whether given by him or by her. He was a big-game hunter, and preferred leveret and pheasant to lark and meadow-pipit, which form the commonest Montagu fare.

The method of inducing the young to leave the nest was interesting. As in the case of honey buzzards, each

young bird was drawn out by semi-starvation when it could first use its wings. There was a week between the hatching of egg number one and egg number four, and the young birds maintained the respective intervals throughout, the younger never in any way catching up the older. When the correct moment arrived the oldest was therefore starved, while the others were well fed, until in its impatience it fluttered away and was then rewarded at a distance from the nest by the hen. She appeared to take over the feeding of this particular bird, which was just ripe for flight, while the cock attended to those still not ready to leave the nest. All went well with them from beginning to end, and I shall be very disappointed if they do not return next year. We nearly had a third pair in between the other two, but on the arrival of these fresh birds, the other four with one accord agreed that that was too much of a good thing, and promptly drove them off. The old gal was the pet aversion of the Montagus ; they were at her in a trice whenever she wandered into their vicinity, which she did three or four times a day.

There was a fair number of short-eared owls in the winter and a great influx at the beginning of April, but since the field mice had disappeared they all passed on, with the exception of two pairs which nested in the neighbourhood. We were, however, well represented in the owl line, with barn, brown, long-eared, short-eared, and little owls.

An osprey turned up as usual, in the spring, and on the day of its departure there was a second in the air with it.

A Rough-legged Buzzard also made a rather prolonged stay in the spring.

To turn from large things to small it was, like 1932, a bumper year for sedge-warblers and probably owing to an increase in reed there was a very large increase in reed-warblers, who have spread to fresh ground. Grasshopper-Warblers were very numerous. There seemed to be less common whitethroats than usual but more lesser whitethroats. My two pairs of blackcaps, the only ones on the place, again nested in the garden. Not a single chiffchaff was seen or heard.

The year was remarkable for the number of what might be called funnies. Here is the bare list :—Spoonbill, ruffs and reeves, wood-sandpiper, little stint, black-tailed godwit, little

Photo] [*A. Buxton*

Hen Montagu Harrier, parasoling her young


BRITISH MUSEUM
NATURAL HISTORY

egret, white-winged black tern, golden oriole. My millman saw the little egret at a range of twenty yards on Horsey Staithe. He had never seen one before, but his description was so accurate that I have no doubt about it myself. The white-winged black tern was seen at close range by my keeper, who without the smallest hestitation pounced on the portrait of the bird, in Dresser's " Birds of Europe." The golden oriole, a cock which only stayed half an hour, arrived on June 29th, most suitably at the keeper's house at the same moment as the keeper, who is very familiar with the bird, and he heard it whistling as it approached from the S.E. He saw it flash over the road, summoned his wife who comes from oriole country, in time to hear one of her own birds, and then walked about with it while it whistled its way all round the garden out into the floating meadow wood and thence, alas, away. I missed it by about ten minutes.

The wood-sandpipers, of which there were at least six, arrived on May 6th and stayed over a week. At that moment my flood-grounds were full of life, for apart from the duck and the nesting red-shank, snipe and plover, there were ten reeves and a rather untidy, but very ardent, ruff; two little stints; occasionally two black-tailed godwits; some greenshanks, dunlins and ringed plovers, with whimbrel passing over. A spoonbill, possibly the bird that stayed a month in 1933, arrived on April 21st and remained for a fortnight. I understand that two more were seen in the district later in the season.

A single pintail duck was seen on July 21st, but I do not know whether or not there was a nest in the neighbourhood. One pair of tufted ducks have probably nested. It has been a good season, without any known disasters, and any year we may, I believe, be honoured by some new species, e.g., reeve, godwit, spoonbill, or black tern breeding again in East Norfolk.

Breydon Water

For many years the committee has put a watcher in its house-boat on Breydon Water during the summer months with the object of preventing the shooting of rare visitors during the closed season. On the other hand, the demand for stuffed specimens has now practically died out, and in view of the expense of maintaining such a watcher and the increased

expenditure that has arisen for providing watchers on other parts of the coast-line of Norfolk which are important nesting areas, the question of continuing the Breydon watcher will have to be carefully considered by the committee before next year. It is hoped that an increase in the subscription list will allow the Committee not to make this change. The present watcher is Walter Bulldeath, who has been employed for the past five years and from his diary for 1934 we have extracted the following notes. He was on duty from the 1st April to the 31st August.

An early spoonbill arrived on April 18th and stayed for two days. Five more of these birds came on June 8th and stayed for two days ; and two more were seen on the estuary on July 16th and 17th. On July 14th a flamingo arrived and remained for nine days : the bird was probably an " escape." Two avocets arrived on August 2nd and remained for a few days. The only birds that nest on the area are sheld-ducks, which have their nests in the cliffs of Burgh Castle at the south-west corner of the estuary. Of late years these birds have increased, as in other parts of Norfolk, and on July 3rd the watcher estimated that there were 100, old and young, on the water. By the beginning of September they have all left for some unknown destination.

Mr. N. Tracy has supplied the following notes of bird life in his wood sanctuary at South Wootton, near King's Lynn, during the year.

Crossbills were absent all the year and he does not think that any stayed to nest in the Castle Rising district. Even in the Thetford district, he says, they were very scarce and he found only two nests after a long search. One of these was, later, destroyed by a squirrel. Though cones were plentiful, they were very hard and small and contained but few undersized seeds. The great spotted woodpecker that lives in his wood, after breaking up sixty-two fir cones, relinquished these as food and was often absent for weeks on end, whereas last year it ate the seeds of over 6000 cones.

Common redstarts returned to the wood on April 18th and two pairs hatched off successfully. On May 12th he found the female of the third pair dead and scalped in one of the bird

boxes. This he thinks was the work of a great tit, which was nesting in a box in the next tree.

Four pairs of wood-wrens were located by him in his district. A male pied flycatcher was singing in his wood for several hours on May 15th, but on the next day Mr. Tracy left for his holiday. He saw and heard the bird again on June 23rd, when it left and was not seen again. A green sandpiper visited the almost dried-up pond in his wood on August 9th.

Miscellaneous Notes

On January 14th the writer found two greylag geese on the cricket ground in Holkham park, which had apparently mated with two of the Egyptian geese : Lord Leicester said that they had been there for some weeks. One of them was still there on the 28th October. From their unusual tameness they were probably two of the full-winged birds which Captain Cator had imported from the Outer Hebrides to his broad at Ranworth.

The winter of 1933-4 was a great woodcock year, and at Holkham the total bag was 354—a record for Holkham (D. McEwan, head keeper).

The annual coot shoot at Hickling took place on February 10th, when the following bag was made :—

Coots	1213
Moorhen	2
Mallard	10
Pochard	14
Tufted duck ...	7
Shoveller	1
Scaup	1
Swans	27
	1275

The swan total will probably be a surprise to the reader, but it has to be remembered that these birds have increased very largely in number of late years on the Broads and have become a serious menace to the smaller nesting water fowl, for which reason they have to be kept in check.

Swallows and martins were late in arriving this year ; the first house-martin was not seen until May 2nd. Swifts arrived

in Norwich on May 11th, a week late, and most of them left on the night of August 10th. Mr. Henry Upcher reports that a swift was flying round when the Sheringham lifeboat was launched for practice on September 27th.

During the week ending May 14th, a snow-bunting was seen daily on the Brancaster golf links (Capt. H. W. Lance).

A pair of hobbies again occupied their old nest of last year and were several times seen at the nest, the last time on July 26th, when it was thought that the eggs were near hatching. However, they were not seen again and it is uncertain as to what was their fate.

As an evidence of the number of sheld-duck that are hatched now-a-days on the north coast of Norfolk, Miss C. E. Gay reports that she counted 108 young, on July 16th, on a small piece of water on Salthouse Broad.

A honey-buzzard, a bird of the year, was seen at Catfield by Lord William Percy on September 29th. He reports that, after a few hours' stay in his wood, it was driven away by a flock of rooks and jackdaws, which persistently mobbed it.

Signed (on behalf of the Norfolk W.B.P. Committee),

SYDNEY H. LONG, *Hon. Sec.*

LIST OF SUBSCRIPTIONS AND DONATIONS TO THE NORFOLK WILD BIRDS PROTECTION FUND FOR 1934

	£	s.	d.
H.M. THE KING	3	3	0
H.R.H. THE PRINCE OF WALES, K.G. ...	2	2	0
Adam Miss M. E. ...	1	1	0
Ainslie Mrs. & Miss ...		5	0
Aldridge P. H. ...		5	0
Allars R. W. E. ...	3	3	0
Allen J. W. ...	2	2	0
Allen T. H.		10	0
Anderson Edward ...	1	1	0
Anonymous	1	1	0
Attenborough, Col. J. C.M.G.	1	1	0
Back H. W.		10	0
Baille Miss I.		2	6
Baker K. E.		10	0
Baker S. E.	1	0	0
Barclay F. H. ...	1	0	0
Carried forward ..	£18	16	6

	£	s.	d.
Brought forward ...	18	16	6
Barclay H. G. ...	2	2	0
Barclay Miss M. ...	1	0	0
Barlow J. Alan, C.B., C.B.E.	2	2	0
Barnard Mrs. ...	1	1	0
Barne Mrs.	1	1	0
Barry W. J.	1	1	0
Barton S. J., M.D. ...	1	1	0
Barton Claud ...		10	6
Bedford W. D., F.R.C.S.	1	1	0
Beevor Sir Hugh, Bart.	2	0	0
Benn Sir Ion Hamilton Bart., C.B., D.S.O.	1	1	0
Blackburne C. I. ...	1	0	0
Blake H.	2	2	0
Bland Miss R. ...		10	0
Blatch Edward ...	1	0	0
Carried forward ...	£37	9	0

	£	s.	d.
Brought forward ...	37	9	0
Boardman E. T. ...	1	0	0
Boileau Sir Maurice, Bart.	1	1	0
Brash T.	2	2	0
Briscoe Capt. F. M. Eliot-Drake ,,		10	0
British Empire Naturalists' Association ...		10	0
Bristow W. R., F.R.C.S.	1	1	0
Brooks, Mrs. A. Basil	1	1	0
Brooks J. R.... ...	1	1	0
Brown Arthur ...	1	1	0
Brown E.		10	6
Brown H.	1	1	0
Bruce Mrs.		5	0
Buckle Lt.-Col. D. W.	1	0	0
Bullard Ernest ...	1	1	0
Bulwer Col. E. A. (the late)		10	0
Burrowes R. B. ...	1	0	0
Burrows Mrs. ...	2	0	0
Burton G. Murray ...	1	1	0
Burton Mrs. Murray		10	6
Butler R. Fawsett ...	1	0	0
Butler Richard W. ...	1	1	0
Buxton W. L. ...	1	1	0
Buxton Major Anthony	2	2	0
Byers J.		10	0
Caffyn D. E. ...		10	0
Calder Sir James C., C.B.E.	2	2	0
Calley Miss J. M. ...	2	2	0
Capron J. T.		10	6
Capron Miss J. ...		2	6
Carroll H. D. ...		10	0
Carruthers D. ...	1	1	0
Carter R. G.	1	1	0
Cassie R. L.		10	0
Cator Capt. H. J. ...		10	0
Cator John		11	0
Chadwick Dr. Morley	2	2	0
Churchill Mrs. Arnold		5	0
Cleminson H. M. ...	1	0	0
Clogstoun H. P. S., M.B.E.	1	1	0
Clutton Brian ...	3	3	0
Coe Mrs. A. E. ...		10	0
Cole I. V.		2	6
Collar Arthur ...		5	0
Colman Miss E. M. ...	1	1	0
Colman Miss H. C. ...	1	1	0
Colman R. J. ...	1	1	0
Cooke G. J.		10	0
Cox Major General Sir Percy, G.C.M.G.	1	10	0
Carried forward ...	£84	10	6

	£	s.	d.
Brought forward ...	84	10	6
Cozens-Hardy A. ...	1	1	0
Cresswell C. A. ...	2	0	0
Cresswell Mrs. George	1	1	0
Dalgety Christopher T.	1	1	0
Dallas C. C.	1	0	0
Davis P.	1	1	0
Drury G. L.		10	6
Dunkerley Rev. C. L.		5	0
Eccles James R. ...	1	1	0
Eddison C. R. ...	1	1	0
Edmundson Miss K. M.		10	0
Edwards G. C. ...		5	0
Edwards Michael ...		5	0
Ellis A. E.		5	0
Elphick Dr. G. ...	2	2	0
Elton Lady		10	0
Ennion Dr. & Mrs. E. F. R.	1	1	0
Enock A. G.	1	1	0
Everitt W. G. ...	1	1	0
Ewing Miss J. Orr ...		10	0
Ferrier Miss Judith ...		12	6
Finch F. R.	1	1	0
Fisher H. H., F.R.C.S.		10	0
Fletcher Miss R. ...	1	1	0
Flowers John, K.C. ...	1	1	0
Forbes Lt.-Col. A. M. H., D.S.O. ...	1	1	0
Forbes H.	1	1	0
Foster, Capt. T. H., R.N.		10	0
Fox F. Douglas ...	1	1	0
French Miss E. M. ...		12	6
Friedlein W. ...	1	1	0
" Friend "		5	0
Garnett R. M. ...		10	0
Garrod F. W.... ...		10	6
Gay Miss C. E. ...	1	1	0
Gay Miss Ellen ...		10	0
Gayner Dr. J. S. ...	1	1	0
Giles C. C. T. ...		10	0
Giles Rev. A. Linzee		10	6
Gilman Randon ...		10	6
Glover Miss E. R. ...		5	0
Goddard W. N. ...		10	0
Gowen H. P.... ...	1	1	0
Graves Mrs.	1	1	0
Green Lt.-Col. E. A. Lycett	1	0	0
Gresham School Nat. Hist. Soc.	1	1	0
Griggs H. R.	1	0	0
Gurney G. H. (the late)	2	2	0
Gurney Q. E. ...	1	1	0
Gurney R., D.Sc. ...	2	2	0
Hadley Mrs.		5	0
Carried forward ...	£128	10	6

	£	s.	d.
Brought forward ...	128	10	6
Haig Mrs. Donald M.		5	0
Hanly B. J. ...	1	1	0
Hannaford G. ...	2	2	0
Hardy Mrs. H. F. H.		5	0
Hardyman Miss F. N.	1	0	0
Harker W.	1	1	0
Hastings Thomas ...	1	1	0
Haydon W.		5	0
Henniker Miss A. M.		10	0
Heywood R.	1	1	0
Hill Nettleship ...	1	1	0
Hill T. A. M. ...	1	1	0
Hogg Charles ...		10	6
Holland C. B. ...	1	1	0
Homere Miss (*In Memoriam*, J. W. C.)	1	1	0
Hopwood Miss M. ...		5	0
Horne Major J. S., I.M.S.		5	0
Hulse Mrs. M. W. ...		10	0
Hulse Miss E. M. ...		10	0
Jeffreys Miss G. H. ...		10	0
Jenkins Rev. T. L. ...		10	0
Jones Commander B. E., R.N.		10	0
Jones Sir L., Bart. ...	1	1	0
Jones Lawrence E. ...	2	2	0
Jones W. R.		10	0
Keith E. C.	1	10	0
Kennedy Lt.-Col. J. W., R.A.	1	10	0
Kerr Mrs. H. M. Rait	1	1	0
Kolle H. W.	2	2	0
Lance Capt. H. W. ...	2	0	0
Landon Mrs. ...		10	0
Landon Miss ...		5	0
Lang Gordon L. ...	1	1	0
Larking R. C. ...	1	1	0
Lawson Harry ...	1	1	0
Lee-Elliott Rev. D. L.	1	1	0
Lees M. Mackenzie ...	1	1	0
Lendrum Mrs. T. J. ...	1	0	0
Lewis J. Spedan ...	2	2	0
Littlewood Miss ...	1	0	0
Long S. H., M.D. ...	2	2	0
Long Miss ...		5	0
Low G. Carmichael, M.D.	2	2	0
McHardy Maj.-Gen. A. A., D.S.O. ...	1	1	0
Macdonald Malcolm, M.P.		10	0
Mackay Dr. Helen M.	1	0	0
Macpherson A. Holte	1	1	0
Madoc Col. H. W. ...	1	0	0
Carried forward ...	£175	15	0

	£	s.	d.
Brought forward ...	175	15	0
Maidment Dr. F. W. H.	1	1	0
Marples George ...	1	1	0
Marshall E. H. ...	1	0	0
Marshall W. K. ...	2	2	0
Matthews T. G. ...	2	2	0
McIlquham Miss M. ...		5	0
McKenzie Miss G. ...		10	0
McKittrick T. H., Jun.	1	1	0
McLaren Mrs. ...		10	0
McLaren Miss Sheila		2	6
McLean C.	2	2	0
Meadows Mrs. A. H....		10	0
Medlicott Miss ...		5	0
Mennell E.		10	0
Metcalfe Dr. G. A. ...		10	0
Micholl Mrs.	1	1	0
Middleton Miss M. E.		2	6
Milne Mrs. Findlay ...	1	1	0
Milnes G. A.		5	0
Mitchell Arthur ...	1	1	0
Molteno D. J. ...	1	1	0
Moyle S. H. L. ...	1	1	0
Murton Mrs. ...	1	0	0
National Trust, The...	10	0	0
Naylor W. S. ...	1	1	0
Newman Miss F. B. ...		10	0
Noble E.		5	0
Noel-Buxton Lord ...	2	0	0
North The Hon. Mrs.		11	0
Oliver Prof. F. W., F.R.S.	2	0	0
Pagan Miss E. L. ...	1	1	0
Palmer A. J.		5	0
Pearson S. V., M.D. ...		10	0
Penrose Mrs. F. ...	1	1	0
Perry Miss M. ...	1	1	0
Phelps Mrs. B. ...		10	0
Pilkington Mrs. Hubert	1	1	0
Plowright Dr. C. T. ...	2	2	0
Poole Miss D. Lane ...		5	0
Powell A. M.... ...		5	0
Pratt Alfred	1	1	0
Preston Sir E., Bart., D.S.O.		10	6
Previté A. W. ...		10	0
Purdy T. W.... ...	1	1	0
Ransome Mrs. ...	1	1	0
Raikes Miss D. T. ...	1	0	0
Reid Dr. E. S. ...		10	0
Richmond H. W., F.R.S.	5	0	0
Ringrose B. J. ...	1	1	0
Rippingall Neal F. ...	1	1	0
Riviere B. B., F.R.C.S.	2	2	0
Robinson B.	1	1	0
Carried forward ...	£236	5	6

	£	s.	d.
Brought forward ...	236	5	6
Rogers Rev. H. ...	1	0	0
Royal Society for the Protection of Birds	2	2	0
Rushton Miss... ...		10	6
Ryan Miss J. M. N. ...		10	0
Savill Harry	2	2	0
Savin A. C.		5	0
Savory Mrs.		10	0
Sewell P. E.	2	2	0
Sheldon W. G. ...		10	6
Shoubridge Mrs. ...		10	6
Smith Col. H. F. ...	1	1	0
Soman A. E. & Co., Ltd.	1	1	0
Spalding G.		10	0
Sparrow Col. R. ...		10	6
Stimpson E. ...		10	0
Sumpter Dr. B. G. ...	1	1	0
Tate Mrs.	1	0	0
Taylor Commander Mark, R.N. ...	1	1	0
Tennant Bernard V. A.	1	1	0
Thompson Harry ...	1	1	0
Times W. O.	1	1	0
Todd Miss H. C. ...		10	6
Tomlinson J. R. ...	1	1	0
Carried forward ...	£257	17	0

	£	s.	d.
Brought forward ...	257	17	0
Tracy N.	1	0	0
Trafford Maj. E. B. ...	1	1	0
Tuke Anthony W. ...	1	1	0
Upcher H. E. S. ...	1	0	0
Upcher Miss L. ...	4	4	0
Vincent Miss. G. H. M. M.	2	2	0
Waddy Mrs.		2	6
Walter C. H. ...	1	1	0
Walters Lewis ...	1	1	0
Watson-Kennedy Mrs.	1	1	0
Wells C. H.	1	1	0
Wemyss Major G. ...	1	0	0
Whittaker W. I. ...	1	1	0
Whitehead G. K. ...		7	6
Wilkinson H. J. ..	1	1	0
Winch Major S. B. ...	2	2	0
Wing J. Sladen ..	1	1	0
Winter Gordon ...		10	0
Wolley-Dod Mrs. ...		10	0
Wright T. J., F.R.C.S.E.		10	6
Wright W. A. ...		10	6
Wyllys H., F.R.C.S.E.		10	0
Wyllys W. ... ,,,		10	0
Young Rev. Belton ...		5	0
Total ..	£282	10	0

NORFOLK WILD BIRDS PROTECTION FUND

Year ended 24th November, 1934

RECEIPTS

	£	s.	d.
Balance brought forward from 1933		13	9
Subscriptions and Donations, 1934	282	10	
Blakeney Point Collecting Box		10	0
Scolt Head Collecting Box ...	2	9	0
Sales of Report	1	8	3
Balance	12	18	9
	£300	9	9

PAYMENTS

	£	s.	d.
Breydon Watcher's Wages and Insurance	42	0	6
Oil, Coal, etc., for Breydon House Boat		17	8
Scolt Head Watcher's Wage and Insurance	123	9	0
Upkeep of Scolt Head Boat ...	1	0	0
Blakeney Point—Contribution to Watcher's Wages	30	0	0
Cley Marshes—Watcher's Wages	86	3	1
Workmen's Compensation Insurance Premium	1	0	0
Printing of Annual Report ...	11	17	0
Hon. Secretary—Stationery and Postages	3	17	6
Cheque Books		5	0
	£300	9	9

Examined and found correct,

FRANK INCH

Norfolk & Norwich Hospital
Norwich, 26th Nov., 1934

IX

FAUNA AND FLORA OF NORFOLK

Additions to Part XI.—Birds (Tenth List)*

1929—1933

By Sydney H. Long, M.D., F.Z.S., M.B.O.U. and
B. B. Riviere, F.R.C.S., F.Z.S., M.B.O.U.

That there should not be any break in the records of the occurrences of the rarer birds that have occurred in Norfolk during the five years ending December 31st, 1933, we have made an attempt in the following list, such as we have previously published, to bring together all the information at our disposal. We have also endeavoured to give the status of certain of the rarer birds that nest in the county. References have been given only when the importance of the record seemed to justify it.

Raven (*Corvus corax*).—On December 27th, 1931, one was seen at close quarters by Mr. H. E. S. Upcher, at Sheringham. On January 13th, 1933, one was seen at Morston by Major P. Hamond. On March the 8th and 9th, 1933, one was again seen by Mr. Upcher at Sheringham, and on March 10th one—probably the same—by Miss Barclay at Salthouse. These are the first records of this species in the county since the seventies of last century.

Nutcracker (*Nucifraga caryocatactes*).—One was seen by G. Davey, at Letheringsett, on October 6th, 1930 ("British Birds," Vol. XXIV, p. 312).

Golden Oriole (*Oriolus oriolus oriolus*).—Single specimens of this species were recorded in May, 1931, and April, 1932.

Crossbill (*Loxia curvirostra curvirostra*).—There was evidence of a considerable immigration of crossbills to the Norfolk coast in the late summer of 1929 and 1930. In 1931 unusually large numbers were found to be nesting within their accustomed

* For previous Lists see Vols. IV., 259 and 397; V., 642; VI., 501: VII., 733; VIII., 847; IX., 784; X., 499; XI., 586; XII., 713.

area in S-W Norfolk, whilst two small colonies were found by Mr. Garnett to be breeding in fir woods a few miles apart near the northern coast-line.

Ortolan Bunting (*Emberiza hortulana*).—Two were recorded in the period under review ; one being identified, by Col. W. A. Payn, at Cley, on September 11th, 1930, and another in the same locality, by Mr. E. C. Bird, in September, 1933.

Blue-Headed Wagtail (*Motacilla flava flava*).—A pair of Blue-headed wagtails nested and successfully reared broods in the county in 1931 and 1932 ("British Birds," Vol. XXV, p. 346). They did not return to the locality in the following year.

Grey-Headed Wagtail (*Motacilla flava thunbergi*.—A male of this northern form of the yellow wagtail was obtained at Salthouse on September 12th, 1932 ("British Birds," Vol. XXVI, p. 322). The only other Norfolk specimen was killed at Sheringham in May, 1842.

Grey Wagtail (*Motacilla cinerea cinerea*).—Two pairs nested in Norfolk in 1932 ; one at Hellesdon, the other at Bolwick. This is the first time that more than one breeding pair has been reported in the county.

Fire-Crested Wren (*Regulus ignicapillus ignicapillus*).—In 1931 one was identified by Mr. R. M. Garnett near the coast on March 31st. In 1933 one was seen by Miss Ferrier at Hemsby on January 23rd. Another, a male in perfect condition, was picked up dead at Great Yarmouth on March 17th, and a third was seen by Mrs. Hood at Sidestrand on October 29th.

Bearded Tit (*Panurus biarmicus biarmicus*).—Chiefly owing to a succession of mild winters and also, possibly, to more efficient protection, the stock of bearded tits is probably higher at the present time than at any time during the past decade. In 1932 Major Buxton estimated the number of pairs

breeding at Horsey at about ten, and Mr. J. Vincent, within his area at Hickling, at between twenty-five and thirty.

Waxwing (*Bombycilla garrulus*).—A few waxwings were reported in the early part of 1929. In November, 1931, a considerable arrival took place, many being recorded during the winter of 1931-32, the last on April 11th. A fresh arrival occurred in Novembzr, 1932, but on a smaller scale.

Red-Breasted Flycatcher (*Muscicapa parva parva*).—During a "rush" of small migrants at Salthouse on September, 1933, a red-breasted flycatcher was seen at close quarters by Mr. R. M. Garnett and Colonel Madoc ("British Birds," Vol. XXVII, p. 315).

Barred Warbler (*Sylvia nisoria nisoria*).—On September 5th, 1929, one was identified by Mr. E. C. Arnold at Cley. In 1931 one was seen at Blakeney by Miss Barclay on August 25th, and on September 24th and 25th one by Mr. E. C. Arnold and others at Cley.

White-spotted Bluethroat (*Luscinia suecica cyanecula*).—A male, the first to be recorded in Norfolk, was watched at close quarters and identified by Mr. R. M. Garnett at Salthouse on April 7th and 8th, 1930 ("British Birds," Vol. XXIII, p. 339).

Alpine Swift (*Apus melba melba*).—An alpine swift was seen near Hunstanton on September 25th, 1930 (D. H. Ball, "Field," November 8th, 1930).

Hoopoe (*Upupa epops epops*).—Single hoopoes were reported as seen at Hunstanton on September 20th, 1929; at Hickling from September 13th to 21st; at Thornham in October, 1931; at Salthouse on June 5th, 1932, and at Billingford on March 17th, 1933.

Northern Great Spotted Woodpecker (*Dryobates major major*).—A considerable immigration of great spotted woodpeckers seems to have occurred in the autumn of 1929, and unusual numbers were noted near Great Yarmouth during the winter

(A. H. Patterson). A female sent to one of us (B. B. R.), killed at Horsey on January 6th, 1930, proved to be a typical example of the northern form.

Short-Eared Owl (*Asio flammeus flammeus*).—Attracted no doubt by the plague of field voles, an unprecedented number of short-eared owls bred in the county in 1933. In the Broads district some eighteen pairs were reported as nesting within the Hickling-Horsey area alone, while two pairs, at least, bred in Breckland on the Norfolk side of the boundary.

Hobby (*Falco subbuteo subbuteo*).—It is satisfactory to be able to record that a pair of hobbies successfully reared a brood in the county in 1933. This appears to be the first authentic breeding record since the eighties and nineties of last century.

Red-Footed Falcon (*Falco verspertinus vespertinus*).—On September 21st, 1931, one was seen by Mr. J. Vincent at Hickling ("British Birds," Vol. XXV, p. 349.)

Marsh-Harrier (*Circus æruginosus æruginosus*) : Montagu's Harrier (*Circus pyargus*).—A few pairs of both species of harrier now rear their broods yearly within a protected area of Broadland, as do a pair or two of Montagu's harriers, in some years, in Breckland. All ornithologists, and all "Norfolkers" who take an interest in their county's fauna, owe a deep debt of gratitude to Lord Desborough and to Major Anthony Buxton for the protection which they continue to afford these grand birds, one of which—the marsh-harrier—nests nowhere else in the British Isles. Is it too much to hope that other Norfolk landowners will eventually adopt the same enlightened view towards these and other of our rarer raptorial birds ?

Spoonbill (*Platalea leucorodia leucorodia*).—Spoonbills, either singly or in small parties, continue to visit the Norfolk coast annually during the summer

months, and why they should do so in their breeding season remains a mystery. The earliest and latest dates of occurrence recorded during the period under review were March 22nd and September 20th in 1929.

Little Bittern (*Ixobrychus minutus minutus*).—In 1929 one was flushed at Hickling on March 27th (J. Vincent), and another was picked up dead at Holme-next-the-sea in December (C. R. H. Ball).

Bittern (*Botaurus stellaris stellaris*.)—The bittern is now well established as a breeding species in the county, nesting in all suitable localities along the Bure valley, with its tributary rivers and chains of broads, and also in more than one locality in the valley of the Yare.

Garganey (*Anas querquedula*).—In 1928 a marked increase was noted in the number of garganeys nesting in the county. This increase was maintained during the next three years, but in 1932 and 1933 there was a falling off, Ranworth becoming almost deserted, while only three pairs nested at Hickling in 1932 (J. Vincent). In this year, however, a pair reared a brood in the Wensum valley, a new locality (L. Lloyd).

Pintail (*Anas acuta acuta*).—Two pairs, one of which successfully hatched six ducklings, bred in S-W Norfolk in 1929, this being the first authentic record of this species nesting in England ("British Birds," Vol. XXIII, p. 191. "Ibis," 1930, p. 130).

"Paget's Pochard" (*Nyroca ferina* x *N. nyroca*).—A drake hybrid common pochard x white-eyed duck was shot at Hickling on October 23rd, 1929, making the 7th or 8th recorded for the county.

Buffel-Headed Duck (*Bucephala albeola*).—For several days during February, 1932, a female was watched through glasses and telescope by Dr. C. T. M. Plowright on the sea off Hunstanton, where it was also seen by Mr. N. Tracy. The only authentic Norfolk specimen of this American

species is a drake in the Norwich museum, which was killed near Great Yarmouth about 1830 (" British Birds," Vol. XXVI, p. 326).

Madeiran Little Shearwater (*Puffinus assimilis baroli*).—On May 11th, 1929, a female, now in the Norwich museum, and the second for Norfolk, was picked up dead at high-water mark on Blakeney Point (" British Birds," Vol. XXIII, p. 41).

Black-Necked Grebe (*Podiceps nigricollis nigricollis*).—On August 27th, on one of the W. Norfolk meres, Miss M. Barclay and Mr. W. B. Alexander watched a pair of black-necked grebes accompanied by what appeared to be a full-grown young one. On August 30th, one of us (B. B. R.) saw on the same mere a black-necked grebe diving and feeding two young ones as large as itself. These appeared to be of an almost uniform golden-brown in colour, with somewhat darker mantles. This plumage does not tally with that of the juvenile black-necked grebe, but is, of course, characteristic of the young dabchick ; so that it is possible that a pair of migrant black-necks had temporarily adopted and were feeding a brood of the former. In any case as a record of the breeding of the black-necked grebe in Norfolk, we feel that the verdict must be " non-proven."

Kentish Plover (*Charadrius a. alexandrinus*).—On June 20th, 1932, one was identified by Mr. J. Vincent, at Hickling.

Northern Golden Plover (*Charadrius a. apricarius*).—One of this race of golden plover, ringed in Iceland on July 4th, 1928, was recovered near King's Lynn on February 3rd, 1930 (" British Birds," Vol. XXIV, p. 72).

Broad-Billed Sandpiper (*Limicola f. falcinellus*).—One was identified by Miss M. Barclay, Mr. R. M. Garnett and others at Salthouse on June 7th, 1933 (" British Birds," Vol. XXVII, p. 52).

Ruff (*Philomachus pugnax*).—Considerable numbers continue

to visit Norfolk at both the spring and autumn migration seasons.

Avocet (*Recurvirostra avosetta*).—An occasional visitant, mostly single birds, but occasionally two or three together, during the spring and autumn migration. Late dates of occurrence recorded during the period under review are December 5th, 1930 and November 19th, 1932.

Black-Tailed Godwit (*Limosa l. limosa*).—Is a regular spring and autumn passage migrant and, we believe, in increasing numbers. We have not given up hope that this species and the ruff may one day, like the bittern, re-establish themselves as breeding species in the county.

Black-Winged Stilt (*Himantopus h. himantopus*).—Two were seen by Mr. J. Vincent at Hickling on May 24th, 1929 (" British Birds," Vol. XXIII, p. 287).

Whiskered Tern (*Chlidonias l. leucopareius.*)—One was identified by Mr. J. Vincent at Hickling on July 7th, 1933 (" British Birds," Vol. XXVII, p. 319).

Gull-Billed Tern (*Gelochelidon n. nilotica*).—On June 30th, 1932, one was seen by Mr. J. Vincent at Salthouse (" British Birds," Vol. XXVI, p. 328).

Sandwich Tern (*Sterna s. sandivensis*).—Distributed in varying numbers from year to year between the three colonies at Scolt Head Island, Blakeney Point and Salthouse broad. The numbers breeding annually in the county may be estimated at between 500 and 1000 pairs.

Roseate Tern (*Sterna d. dougallii*).—Two pairs nested in 1929 and 1930 ; one pair in 1931 ; none in 1932 ; and one pair in 1933.

Great Black-Headed Gull (*Larus Ichthyætus*).—Between March 2nd and 9th, 1932, a great black-headed gull was watched almost daily, by Mr. H. Cole, feeding with common black-headed gulls on the shore-line at Cromer. This is a new species to the Norfolk list (" British Birds," Vol. XXVI, p. 329).

Iceland Gull (*Larus leucopterus*).—Iceland gulls were recorded at Horsey on November 26th, 1930; at Wey bourne on November 25th, 1931, and at Salthouse between October 29th and November 3rd, 1931 All were single birds.

FLORA AND FAUNA OF NORFOLK

Additions to Part IV.—Fishes (Tenth List)

By Arthur H. Patterson

Since the last list appeared in Vol. XII, Part V, I have been fortunate in adding four new species of Fishes to the Norfolk List. Some of these were obtained at the intake pipe of the Electricity Works riverside pumping station at Yarmouth, about half a mile from the Harbour Mouth.

Norway Haddock (*Sebastes marinus* L.).—For the first time the Norway Haddock made its appearance a certainty when, on Februray 11th, 1933, a fresh example, still violently red in colour, was stranded on Bacton beach. It measured barely 20 inches and weighed a goodly 3 pounds. Pennant (B. Zool.: 1770) mentions this species as taken near Scarborough. I know of no other record south of Bacton.

Red Band Fish (*Cepola rubescens* L.).—The first specimen to come to my notice was netted with shrimps in January, 1930. When I saw it, it was freshly dead fading from gorgeous red to creamy white. A second example, 22 inches long, was taken at the Electricity Works, and a few days later two others were brought into Lowestoft. Undoubtedly a small shoal had strayed into the neighbourhood.

Baillon's Wrasse (*Crenilabrus melops* L.).—In June, 1930, one of these fishes came up the suction pipe. The spaces between the vertical black bands were pewter colour.

Golden Mullet (*Mugil auratus* Risso).—Three grey mullets from the river at Yarmouth in January, 1934, were distinguished by Dr. Norman as the above species, which is believed to be rare in British waters.

Golden Tench (*Tinca vulgaris* L.).—Whilst not recording this fish as indigenous to Norfolk, it appears to have become

acclimatised in this country. At Woburn Abbey, Buckland assures us, this species has bred freely, and he thought it had become established in the Norfolk Broads. Two tenches given by him to Higford Burr bred much faster than if mixed with other fish. Some must have survived that " acclimatisation " in Upton Broad. One was caught there in August, 1916, weight 4 pounds ; and a fine 3½ pound Golden Tench was taken out of this water at Upton, adjoining Acle, in May, 1930. Sir Herbert Maxwell (British Freshwater Fishes) mentions " A variety known as the golden tench, said to have originated in Germany, and to have been introduced into Britain during the last century . . . . is of a rich orange colour, irregularly blotched with (brown) the normal colour of the species. This change of colour must be attributed to incipient albinism, such as gives distinction to the goldfish."

NORFOLK MYCETOZOA*

By H. J. Howard, F.L.S.

Badhamia lilacina (Fries) Rost.—Three patches of bright yellow plasmodium which afterwards matured, and one of ripe sporangia, were found on turf and sphagnum on boggy ground at Buxton Heath, Hevingham, on September 15th, 1932, by Mr. E. A. Ellis. The only other records of this somewhat rare species in England have been made from Bedfordshire, Yorkshire and Shropshire, although Professor Macbride describes it as common in the eastern U.S.A.

Physarum javanicum Racib.—The first British record of this species, determined by Miss Lister, was made during the British Mycological Society's Norfolk foray, October 1934, when Miss Cayley collected sporangia on a piece of dead wood. Owing to its great resemblance to the very common P. nutans, it was not at once recognised and the exact locality not registered, though Westwick is probable. The only other gatherings are from Cape Province, Uganda, Java, Florida, and if P. discoidale proves the same, California.

Physarum mutabile (Rost.) Lister.—A considerable quantity was found on an old straw heap at Costessey on May 30th, 1930.

Physarum conglomeratum Rost.—A single gathering of the pale yellow crowded sporangia was found on a dead holly leaf in a plantation at Costessey Hall in August, 1930.

Lamproderma echinulatum Rost.—A small patch of this rare species was found on an old stump and twigs at Middleton near King's Lynn on April 3rd, 1930, by Mr. T. Petch.

Oligonema nitens Rost.—A considerable quantity of this interesting species was found in Costessey Hall woods on May 3rd, 1930. A cartwheel had passed over the remains of an old beech saw-dust heap and an inch below the surface on the side of the rut the shining yellow sporangia were detected. On digging into the heap thousands of sporangia were found over a large area ; in no case could they be seen on the surface. In August of the same year Mr. R. Gaze found an extremely large gathering of well-formed sporangia maturing after rain on the surface of another beech sawdust heap at some distance from where it occurred previously.

Hemitrichia Karstenii Lister.—Mr. T. Petch found this on dead wood at North Wootton, King's Lynn, on April 6th, 1930.

Other Records of Interest

Badhamia capsulifera (Bull.) Berk.—The second Norfolk gathering of this species was made at Surlingham Wood, April 19th, 1934, by Mr. M. J. D. Cockle.

Physarum psittacinum Ditm.—A patch of somewhat weathered sporangia was seen on dead wood lying at the edge of a ditch in Surlingham Wood, July 9th, 1933.

Physarum compressum Alb. and Schw.—A colony appeared in 1931 and again in May, 1932, on old sacking at Wroxham : a somewhat unusual habitat.

Physarum gyrosum Rost.—This rare species has re-appeared in great abundance in a cucumber house at Eaton ; on September 28th, 1932, it was found swarming on red Salvia, and on October 5th. 1934, in several cucumber houses in the same locality.

Physarum virescens Ditmar.—West Runton woods, October 6th, 1932.

Diachea subsessilis Peck.—In August, 1930, Messrs. Gaze and Torbell noted a large number of sporangia maturing on grass,

dead sticks and leaves in an alder carr on the Costessey Hall Estate. From the quantity it was assumed to be a common species, but a few days later the sporangia were recognised as those of the above ; meanwhile many had been destroyed by weather conditions. The writer visited the spot on September 6th and found a number of mature sporangia. There is only one other Norfolk record for this species (see Trans. N. & N. Nat. Soc., vi, 451).

Didymium vaccinum Buchet had previously been recorded only from an old strawheap at Swainsthorpe ; it was found in quantity in a similar situation at Costessey, May 31st, 1930.

Brefeldia maxima (Fr.) Rost.—Mr. H. Edwards found a mass at the foot of an old birch on Ringland Hills, November 20th, 1932.

Cribraria rufa (Roth). Rost.—An unusually large colony was found on dead pine wood at Whitlingham Woods, September 10th, 1932.

Tubifera ferruginosa Gmel.—64 separate groups of sporangia were found on a decaying pine log at Stratton Strawless, September 17th, 1932. A week previously five groups were forming at 21 feet up a dead standing pine in Whitlingham Woods.

Liceopsis lobata Torrend.—The second Norfolk gathering was made on an old stump in Costessey Hall woods, June 25th, 1930.

Lycogala epidendrum Fries.—163 æthalia appeared in a space of 18 by 4 inches on a rotting baulk at West Caister (Yarmouth), April 29th, 1934.

Prototrichia metallica Mass.—A great many sporangia were found on a dead elder branch several inches from the ground at Stratton Strawless, February 15th, 1930. It is interesting to note that this species seems to prefer dead elder. A similar case was met with at Dunston, May 3rd, 1934, by Mr. E. A. Ellis.

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*For previous accounts of Norfolk Mycetozoa see Vol. XII, Part IV, pp. 383-413 and references included therein.

FLORA OF NORFOLK

Rust Fungi (Uredinales)

By E. A. Ellis

Since the days of Norfolk's two great mycologists, M. C. Cooke and C. B. Plowright, little attention has been paid to micro-fungi in this county. Meanwhile the system of classification has evolved so far that it is now difficult to recognise species named in the early lists published in these "Transactions." Concerning rusts, Plowright worked out many of their life-histories for the first time, connecting up various spore-forms, often on two quite different host plants, that had been looked upon as separate species or even belonging to distinct genera! The results of his experiments were brought together in 1889 in a "Monograph of the British Uredineæ and Ustilagineæ" which was greatly welcomed. It remains a classic for original work, while W. B. Grove's "British Rust Fungi" has been the standard manual since 1913.

The present list of Norfolk rusts includes those given in the old accounts 1—7 (see bibliography) interpreted mainly by reference to 8, 14 and 15, and amplified by a few local records given in 7, 9, 17, 18-21; more than forty fresh species have been noticed during the past three years. The general classification is that of Fragoso's "Uredales" in Flora Iberica (14, 15), but the species within each genus have been arranged with their hosts in the familiar order of the British Flora (16, amended). All specific names are commenced with a small letter, for the same reason given by most zoologists and many botanists for discarding capitals: impatience of the anomalies engendered and waste of attention in indexing.

The writer is especially grateful to Mr. A. Mayfield for his guidance and encouragement: Mr. W. B. Grove, the late Dr. P. G. M. Rhodes and Dr. G. E. Deacon for much practical inspiration; Messrs. R. Burn, V. J. Chapman, M. J. D. Cockle, G. J. Cooke, E. T. Daniels, M. B. Ellis, H. Goude, H. J. Howard, A. E. Mahood, P. E. Rumbelow, F. W. Simpson and W. H. Watson for their interest and help in adding to our knowledge of these fungi in East Anglia.

Life History

The Uredinales are micro-fungi parasitic on flowering plants, conifers and ferns, and are highly specialised. As many as five stages may be passed through in the life-cycle. Primary infection of a leaf takes place when the contents of a germinating basidiospore enter one of its stomata. A localised mycelium develops at the expense of the surrounding cells, and pycnidia (O) producing nectar and pycnidiospores appear as yellowish pustules usually on the upper surface of the leaf. J. H. Craigie in a letter to " Nature " in 1927 showed that pycnidia arising from separate basidiospores bore *haploid* " a " or " b " pycnidiospores, and that those of two pustules had in most cases to be intermixed to bring about the *diploid* condition resulting from the fusion of " a " spores with " b " mycelium and vice versa. Flies were found to be potent spore-carriers. The same result was effected by two pustules developing close together so that direct mycelial contact took place. The *zygote* may now produce successively the three following kinds of spore :—

I æcidiospore, developing in æcidia (clustercups) or cæomata (pulvinate masses without a peridium) ;

II uredospore, thin-walled, usually spiny for wind dispersal, developing in sori (cushion-like bunches) ;

III teleutospore, thick-walled, with one, two or more cells ; produced in separate sori or with the uredospores, and carrying the species over winter. Typically four basidio-spores (haploid) appear from each germinating teleuto-cell.

One or more of the above stages may be left out. All may occur on a single host species (autœcism) or pycnidia and æcidia on one, and the later stages on another kind of plant (heterœcism).

In this list the symbols O, I, II and III denote the spore-forms found. Square brackets are used for species that are doubtfully Norfolk and for spore-forms not yet recorded here.

A collection of Norfolk rust-fungi is available to students at Norwich Castle Museum.

UREDINALES OF NORFOLK

Pucciniaceæ

Pucciniæ :

Genus *Puccinia*

thalictri Chev.—III on Thalictrum flavum : Wheatfen Broad, Surlingham, 9–7–1933 and plentifully during July, 1934 ; one of the rarest British species.

fusca (Pers.) Wint.—O, III on Anemone nemorosa : Wayford and North Wootton (2) ; the Grove, Aldeby, in April and May.

calthæcola Schröt—O, I, II, III on Caltha palustris : Beeston Common, Sheringham ; Brumstead ; West Caister ; Eaton near Norwich ; Flordon Common ; Buxton Heath, Hevingham ; Horsford ; Ranworth ; Roydon Fen near Diss ; Shotesham Common ; Stratton Strawless ; Surlingham ; Swannington ; Wroxham. I from mid-May to early July ; II and III from mid-June to September.

calthæ Link.—O, I, II, III on Caltha palustris : Roydon Fen near Diss, 27-7-1933. Plowright (2) recorded a rust on Caltha in Norfolk, but it is now doubtful which.

mirabilissima Peck.—II, III on Mahonia aquifolium : this North American species has appeared in many parts of Britain since Malcolm Wilson discovered it at the Edinburgh Botanic Gardens in 1923 (13). Mr. A. Mayfield noticed it in Suffolk in May, 1932 and the late Mr. H. J. Thouless brought it to me from a Mahonia in his garden at Wroxham on June 18th of that year. Since then it has proved not uncommon in shrubberies : Norwich, Thetford, Gt. Yarmouth and Geldeston near Beccles.

violæ (Schum.) DC.—O, I, II, III on Viola canina, sylvestris and odorata : dunes, hedgerows and woods; common ; I in April.

ægra Grove.—I, II, III on Viola cornuta and various cultivated hybrids : Castle courtyard, Norwich, 1932-33 ; in gardens at Surlingham, Sprowston and Framingham, 1934. Probably not uncommon.

arenariæ (Schum.) Wing., form *lychnidearum* (Link).—III on Lychnis dioica : Neatishead and North Wootton (2) ; Castle Rising and Mintlynn (4) ; Blackdale Wood, Earlham ; Bluestone Wood, Heydon ; Haveringland, Hoveton. Form *dianthi* (DC.) on Dianthus barbatus : Brundall, Coltishall, Eaton (G.E.D.), Earlham.

malvacearum Mont.—III on Malva sylvestris, M. rotundifolia and Althæa rosea (hollyhock) : Plowright found this at King's Lynn in 1873 ; it had been first discovered twenty years before in Chile, and had spread meanwhile to Australia, Africa and Europe, becoming so abundant as to menace the cultivation of hollyhocks, and attacking numerous host species in the order Malvaceæ. It is now a common rust in Norfolk, but apparently not so virulent here as in more southern counties.

pruni-spinosæ Pers.—O, I on Anemone coronaria and A. nemorosa ; II, III on Prunus domestica and P. spinosa ; I at King's Lynn (2) ; II, III common (2) ; abundant on plums in east Norfolk, 1933-34 (G.E.D.)

epilobii-tetragoni (DC.) Wint.—O, I, II, III on Epilobium hirsutum and E. tetragonum : common on the former host (2) ; still so. Earliest I at Gt. Yarmouth, 23-4-1933. I and III at the same time on E. tetragonum, Scolt Head (18) and on Horsey Dunes, 20-8-1933.

circææ Pers.—III on Circæa lutetiana : " Norfolk ' (4).

hydrocotyles (Link) Cooke.—[O, I], II, III on Hydrocotyle vulgaris : this is a rare rust on a common host-plant ; Irstead (2) ; II in damp hollows of the dunes between Winterton and Horsey, 20-8-1933, II and III at Calthorpe Broad, 6-9-1934 ; Westwick (Miss E. M. Wakefield) 3-10-1934.

saniculæ Grev.—O, I, II, III on Sanicula europæa : III in The Grove, Aldeby, 13-4-1933 ; I at Shotesham St. Mary, 31-5-1934.

conii (Str.) Fckl.—II, III on Conium maculatum : Ditchingham (2) ; II abundant at Flordon Common, 27-7-1932 and on the Breydon wall at Yarmouth, 9-6-1934 ; III at Eaton, 31-8-1933.

smyrnii-olusatri (DC.) Lindr.—O, I, III on Smyrnium olusatrum : " Norfolk " (4) ; this rust follows the distribution of its host on hedge-banks all round the coast from Hunstanton to Yarmouth ; in the Fleggs ; both sides of the Yare valley, e.g. at Intwood, Postwick and Heckingham ; and following the Waveney by Haddiscoe, Gillingham, Geldeston and Ditchingham up to Brockdish. Aecidia are produced from October to mid-June ; teleutospores may be found at all times, but more particularly from June to August.

apii Desm.—O, I, II, III on Apium graveolens : abundant at King's Lynn (2) ; Heacham (5). A. graveolens at Yarmouth appears to be free from this rust.

cicutæ Lasch.—O, I, II, III on Cicuta virosa : II locally abundant at Barton Broad, 22-8-1933 ; I on the north shore of Deep Waters Broad next Wheatfen Broad, Surlingham, 3-6-1934, II appearing there 20-6-1934, and III, mainly on the stems, 10-8-1934 ; Surlingham Broad, September, 1934. Cicuta is more abundant at Hockham Mere than in any other Norfolk station, but a lengthy search in July, 1934, revealed no rust on it. It is likely that Plowright included this species as British on the strength of Norfolk material (see Trans. Brit. Myc. Soc., ii, 26), though it is not in his published county lists. Apart from a Suffolk habitat at the Blocka Lane end of Fritton Lake (M. B. E. and E. A. E., 1934), P. cicutæ appears to be unknown elsewhere in Britain. We found it attacked by numbers of fungus-midge larvæ, especially at Barton.

ægopodii (Schum.) Mart.—III on Aegopodium podagraria : " Norfolk " (4) ; Bramerton, Geldeston and Earlham Park.

pimpinellæ (Str.) Mart.—O, I, II, III on Pimpinella saxifraga : " Norfolk " (4).

tumida Grev.—III on Conopodium majus : North Wootton (2) ; The Grove, Aldeby, 13-4-1933.

chærophylli Purt.—O, I, II, III on Chærefolium sylvestre : II and III at Fishley near Acle, 31-7-1932, and Burntfen, 6-9-1934.

petroselini (DC.) Lindr.—O, II, III on Aethusa cynapium : II and III at Gt. Melton, 1930 (G.E.D.) and Wroxham, 23-8-1933.

angelicæ (Schum.) Fckl.—O, II, III on Angelica sylvestris : II at Horsford, 22-6-1932 and subsequently at Saxlingham Nethergate, Surlingham, Burntfen Broad and West Caister.

bullata (Pers.) Wint.—O, II, III on Peucedanum palustre. Grove (8) assigns this rust, found on the above host at Shapwick Bog, Somerset in 1883 (H. B. Waterfall) to the aggregate P. bullata Wint. and gives P. silai Fckl. on Silaus flavescens separately. Fragoso (14) includes silai in bullata. In Norfolk we have found the rust on Peucedanum palustre : III at Irstead, 22-8-1933 ; II at Calthorpe Broad, 24-6-1934 and locally plentiful at Hockham Mere, 11-7-1934 ; these comprise the only British stations known, for it on this host. Mr. Mayfield finds the rust on Silaus in east Suffolk.

adoxæ Hedw. f.—III on Adoxa moschatellina : " Norfolk " (4) ; Mintlynn, Castle Rising (5) ; Keswick Woods ; Mundesley (W.H.W.).

albescens (Grev.) Plowr.—O, I, II, III on Adoxa moschatellina : Mintlynn (5) ; Drayton ; Dunston.

valantiæ Pers.—III on Galium hercynicum and G. cruciata : this is a common species in Suffolk and surely occurs here, though so far overlooked.

punctata Link.—O, I, II, III on Galium palustre, G. uliginosum and G. verum : North Wootton (2) ; on G. verum at Scolt Head, West Runton, denes at Caister and Yarmouth, and Skeet's hill Shotesham ; on G. palustre at Buxton Heath, Eaton, Earlham, Hockham Mere and Surlingham ; on G. uliginosum at South Walsham ; I from mid-May ; earliest II, 19-5-1934.

ambigua (Alb. et Schw.) Lagh.—O, I, III on Galium aparine : I in the Road Belt, Costessey Park, 26-6-1934 ; I and III plentiful in a sunnier situation at Horstead two days later.

celakovskyana Bub.—O, II, III on Galium cruciata : a few II and many III at West Runton, 6-10-1932.

asteris Duby.—III on Aster tripolium : north coast of Norfolk (4) ; rond on north shore of Breydon ; Scolt Head ; Wells and Cley ; May to October.

millefolii Fckl.—III on Achillea millefolium : King's Lynn (5) ; Hellesdon, 2-7-1934 (M.B.E.).

chrysanthemi Roze.—II, III on Chrysanthemum chinense ; first found in 1898 (Plowright) ; not uncommon ; especially prevalent in 1933.

tanaceti DC.—II, III on Tanacetum vulgare : Irstead 1868, M. C. Cooke (2).

absinthii D.C.—II, III on Artemisia maritima : II on several plants by House Hills and Aster Marsh, Scolt Head, 19-5-1934 ; later on the north wall of Breydon and south beach, Heacham.

glomerata Grev.—III on Senecio jacobæa : North Wootton (2) ; Sandringham (5).

carduorum Jacky.—O, II, III on Carduus nutans : Gt. Yarmouth, 1933.

cardui-pycnocephali Syd.—II, III on Carduus pycnocephalus, form tenuiflorus : north and south denes, Gt. Yarmouth, 1932-34.

cirsii-lanceolati Schröt.—O, I, II, III on Cirsium lanceolatum : I in Norfolk, 1931 (21) ; II on Scolt Head, 4–6–1933 ; O, I and II there in a marshy hollow of Norton Hills (sand-dunes), 19–5–1934. Uredospores are frequent on C. lanceolatum in Norfolk, but until æcidia of P. cirsii lanceolati were discovered in Britain in 1931 all other stages had been assigned (in some doubt) to P. cirsii.

cirsii Lasch.—O, II, III on Cirsium pratense and C. palustre : Swannington Common ; Buxton Heath ; Horsford and Burntfen Broad, and on C. acaule at Holt, 16–8–1934.

obtegens (Link.) Tul.—O, II, III on Cirsium arvense : very common (2) and still so. It was found heavily parasitised by *Tuberculina persicina* (Ditm.) Sacc. on Trimingham cliffs, 12–7–1934. The pycnidia give forth a sweet odour which, as Mr. Grove points out, exactly resembles that of the Cirsium flowers.

le-monneriana Maire.—III on Cirsium palustre : Reffley Wood (2) , King's Lynn (5) ; Hickling, Beeston Common, Wroxham, Horning,

South Walsham, Shotesham Common, Surlingham, and Hockham Mere ; May to October.

centaureæ DC.—O, II, III on Centaurea nigra aggr. : Mintlynn (5) ; very common. Form *scabiosæ* Hasl. on Centaurea scabiosa at Beeston Hill, Sheringham, 21–8–1933.

lapsanæ (Schultz) Fckl.—O, I, II, III on Lapsana communis : King's Lynn (2) ; Gt. Massingham, Castle Rising and Bawsey (5) ; Neatishead, Waxham, Surlingham, Coltishall and in Norwich Castle gardens. Aecidia appear on seedlings in April and May.

crepidis Schröt.—[O, I], II, III on Crepis capillaris : Bluebell Road, Eaton, II and III, 31–8–1933 ; II near the Mill Stream, Mundesley, 12–7–1934.

hieracii (Schum.) Mart.—O, II, III on Hieracium umbellatum : North Denes, Gt. Yarmouth and Caister.

piloselloidearum Probst.—O, II, III on Hieracium pilosella : Hemsby Dunes ; Mundesley cliff ; Shotesham Common ; probably widespread. We have failed to discover it on the denes at Caister where its host grows in the midst of heavily rusted H. umbellatum.

hypochæridis Oud.—O, II, III on Hypochæris radicata: II at Scolt Head (18) ; II and III at West Runton, 6–10–1932 (teleutospores were not found in Britain till 1916, near Epsom—Malcolm Wilson in Journ. Bot. for 1919, p. 161) ; Belaugh ; Yarmouth and Caister denes and by the Bure at Runham.

leontodontis Jacky.—O, II, III on Leontodon hispidus : Halvergate Bridge, 12–7–1932 ; Mundesley, 1934. Form *thrinciæ* Kleb. on L. nudicaulis : Stratton Strawless, 14–7–1932.

variabilis Grev.—O, I, II, III on Taraxacum vulgare and T. paludosum : Watlington (5) ; Horsford, 1932-33.

taraxaci (Reb.) Plowr.—O, II, III on Taraxacum vulgare : King's Lynn (5) ; frequent, especially on dry chalky or sandy ground, e.g. at Eaton, Haveringland, Earlham, Sheringham, Scolt Head and Yarmouth Denes ; only twice noticed in damp situations, at Horning and Wroxham.

chondrillæ Cda.—I, II, III on Lactuca muralis : I by the main Norwich-Aylsham road at Stratton Strawless, 14–7–1932.

sonchi Rob.—O, II, III on Sonchus palustris, S. arvensis, S. asper and S. oleraceus : widespread on the last three hosts ; on the first by the river Bure at Acle, 1–8–1932.

tragopogonis (Pers.) Cda.—O, I, III on Tragopogon pratensis : Terrington (2) ; King's Lynn, May 1874 (C.B.P.) ; I and III at Aldeby, 26–6–1932.

primulæ (DC.) Duby.—I, II, III on Primula vulgaris : Beeston (2).

vincæ (DC.) Berk.—O, II, III on Vinca major and V. minor : Ashwicken (5) ; II and III on the former host at Little Ormesby, 27–5–1933 (P.E.R.).

antirrhini Diet. et Hol.—II, III on Antirrhinum majus (cultivated) : This North American rust was first officially recognised in Britain in 1933, when its discovery in Hants. was quickly followed by others in Norfolk, Suffolk, Essex, Herts., Kent, Surrey, Sussex, Oxon and Devon (Pethybridge : Trans. Brit. Myc. Soc., XVIII, Pt. IV), see also (22) ; Correspondence in horticultural journals has since shown that it had appeared in this country twenty years previously, and here and there in the intervening time. Dr. G. E. Deacon found it at Coltishall, Norfolk, in July, 1933. In the same month of 1934 Mr. H. Goude

reported it from Fakenham, Wells, Brundall, Norwich, Wymondham, etc., and it became evident that the rust was widespread in the county. During September and October, there was marked acceleration in its growth, with virulent epidemic effect, not only in Norfolk, but over a great part of England. The uredo-sori were attacked by the hyphomycete Tuberculina persicina in Norwich Castle gardens, September, 1934.

menthæ Pers.—O, I, II, III on (*a*) Mentha spicata, (*b*) M. aquatica, and (*c*) Clinopodium vulgare : on (*a*) at Framingham Pigot and (*b*) at Norwich and Reffley (2) ; common on (*b*), e.g. at Blakeney, Sheringham, Wroxham, Horsford, Eaton, Surlingham, Yarmouth ; on (*c*) at Beeston near Sheringham, 22–9–1932.

glechomatis DC.—III on Glechoma hederacea : " Norfolk " (4) ; West Runton woods ; Blackdale Wood, Earlham ; Haveringland.

annularis (Strauss) Schlecht.—III on Teucrium scorodonia : Irstead and Reffley Wood (2) ; Costessey Park, 26–6–1934 ; Northrepps, Westwick and Buxton Heath, October, 1934.

polygoni-amphibii Pers.—[O, I], II, III on (*a*) Polygonum amphibium, (*b*) P. persicaria and (*c*) P. convolvulus : " common (2) " ; on (*a*) at Acle, Upton, Halvergate, Roydon Fen (Diss), Flordon Common, Wroxham and South Walsham Broad ; on (*b*) at Sheringham ; on (*c*) at Hoveton St. John and Hevingham.

acetosæ (Schum.) Körn.—II, [III] on Rumex acetosa : Hingham churchyard, 25–5–1933 ; Wroxham, Shotesham Common, Buxton Heath, Burntfen Broad. The spiny uredospores in small scattered sori are distinct from those of Uromyces acetosæ, which are smoother and in pulverulent masses.

buxi DC.—III on Buxus sempervirens : " Norfolk " (4) ; Costessey Park, Northrepps.

iridis (DC.) Wallr.—II, III on Iris spp. (cultivated) and on I. pseudacorus ? : " Norfolk " (4) ; not uncommon on the former, but we have never found it on the wild species here.

asparagi DC.—O, I, II, III on Asparagus officinalis : Norfolk, 1895 (Abbey) ; Brundall, Lakenham, Cringleford, Coltishall, Hethersett, Marlingford, Framingham (G.E.D.), Woodbastwick, Emneth and Stoke Ferry, 1933 (Pethybridge in Trans. Brit. Myc. Soc., XVIII, Pt. IV) ; especially prevalent in 1933. Mr. H. Goude found it fairly common, with centres in both east and west Norfolk, 1934.

oblongata (Link.) Wint.—II, III on Luzula campestris : " Norfolk " (4) ; Horsford, Hemsby, Winterton, Horsey, etc., frequent.

obscura Schröt.—O, II on Bellis perennis ; II, III on Luzula campestris : " Norfolk " (4) ; æcidia in September and October.

scirpi DC.—O, I on Limnanthemum nymphoides ; II, III on Scirpus lacustris. Plowright found the teleutospores on S. lacustris floating down the Ouse at King's Lynn, 17–11–1877 ; the æcidia were found on the Old Bedford Level at Earith, Huntingdonshire in July 1895 (see 4, 6 and 11).

caricis (Schum.) Reb.—O, I on Urtica dioica ; II, III on Carex spp. : Irstead and North Wootton (2) ; I appearing from mid-April to the end of June, at Hemsby, Winterton, Calthorpe, Hickling, Barton Broad, Horning, Wroxham, Stratton Strawless, Drayton, Costessey, Keswick, Dunston, Surlingham (very abundant) and Thompson Water. The æcidia were peculiarly scattered in small spots, mainly on the leaves, of Urtica growing near the river at Horning (the same patch was remarked upon 19–6–1932 and 27–5–1934). II and III have been

found on Carex paniculata, goodenowii, pseudocyperus, acutiformis, riparia and hirta in this county. Forms with æcidia on Ribes spp. have been studied by Klebahn and Eriksson, who have isolated several biological races. It would be unsafe to name those found in Norfolk till culture experiments have been devised with local material. Such æcidia have been found on (*a*) Ribes uva-crispa ; Neatishead (2) and in many places in Norfolk since Plowright's record ; they were present on the *fruit* of gooseberry at Geldeston, 24–5–1933 (abundant in several places, 1933, G.E.D.) and at Haynford in 1934 (A.E.M.) ; on (*b*) R. nigrum : Mr. H. Goude found æcidia on this host many years ago—they are well known here now, particularly in gardens near sedgy marshes or on the wild currant bushes in carrs ; Horning, Hoveton St. John, Geldeston and Surlingham ; on (*c*) R. rubrum in a carr at Surlingham ; on (*d*) R. sanguineum at Earlham Park, 7–6–1932. These æcidia are attacked by *Tuberculina persicina*.

extensicola Plowr.—O, I on Aster tripolium ; II, III on Carex extensa : Wells, west of the sea wall (5).

paludosa Plowr.—O, I on Pedicularis palustris ; II, III on Carex goodenowii : I at Dilham, May 1866 (M.C.C.) ; I at Horning (2) ; I, II and III at Stalham and Irstead (5) ; Irstead, 24–6–1934.

schœleriana Plowr. et Magn.—O, I on Senecio jacobæa ; II, III on Carex arenaria : Bawsey (2) ; North Wootton and Roydon Heaths (5) ; Scolt Head (18) ; Waxham, Horsey, Winterton and Hemsby dunes ; I from the first week in May till the end of June.

[*arenariicola* Plowr].—O, I on Centaurea nigra ; II, III on Carex arenaria : Canon Du Port and Plowright found æcidia on C. nigra near the beach at Hemsby, 1884, and connected them successfully with later stages on Carex arenaria (5, 6, 8). The rust has not been found elsewhere, nor again at Hemsby—the Centaurea is not a usual member of the Carex arenaria association there (we could not find a single plant of it on the dunes from Hemsby to Winterton in 1933). The æcidium on this host may have been a stray effort on the part of Puccinia schœleriana (21). See P. caricis-montanæ Ed. Fisch. (15).

dioicæ P. Magn.—O, I on Cirsium palustre, II, III on [Carex dioica] and C. inflata : æcidia abundant in June and July at Buxton Heath (first noticed in 1932) ; and at Saxlingham Nethergate, 14–6–1934. Teleutospores (of this?) were present on Carex dioica gathered at Flordon by Mr. W. H. Burrell ; a special search has been made but no æcidia found there. III on Carex inflata present with the Cirsium were found in 1934 by Dr. Rhodes and Dr. Alex Smith.

graminis Pers.—O, I on (*a*) Berberis vulgaris and (*b*) Mahonia aquifolium ; II, III on many grasses : I on (*a*) at North Wootton, II and III common (2) ; I on (*a*) at Geldeston and Haynford ; on (*b*) at Wroxham (H. J. Thouless).

coronata Cda.—O, I on Rhamnus frangula ; II, III on several grasses, including Holcus and Agrostis spp. : I at North Wootton (2) ; Hoveton, Costessey, Surlingham, etc. ; II and III common on Holcus lanatus.

coronifera Kleb.—O, I on Rhamnus catharticus ; II, III on Lolium perenne, Holcus lanatus, Avena fatua, Arrenatherum elatius etc. : I at Hoveton and Wheatfen Broad (attacked by Tuberculina persicina) ; II, III especially common on Lolium.

glumarum (Schum.) Erikss. et Henn.—II, III on Agropyron repens, Hordeum vulgare (barley) and Triticum æstivum (wheat) ; common on the first and very prevalent on wheat and barley (G.E.D.).

dispersa Erikss. et Henn.—O, I on Lycopsis arvensis ; II, III on Secale cereale (rye) and possibly also on Triticum æstivum (wheat) :

I at Roydon near Lynn (2) ; æcidia appeared on Lycopsis in Plowright's garden in September, 1885, about a month after he had placed a bundle of rusted wheat straw near the plants.

orchidearum-phalaridis Kleb.—O, I on (*a*) Listera ovata, (*b*) Orchis latifolia, (*c*) O. incarnata, (*d*) O. prætermissa, (*e*) O. maculata and (*f*) Gymnadenia conopsea ; II, III on Phalaris arundinacea : Dilham (2) ; on (*a*) at Surlingham in abundance, and Horning ; on (*b*) Surlingham; on (*c*) at Ludham, Alderfen Broad (R. Blockey) and Surlingham ; on (*d*) at Ranworth (E.T.D.), Surlingham, Flordon Common; on (*e*) at West Caister and Wheatfen Broad ; on (*f*) at West Caister, 4–7–1932 ; II, III common.

phalaridis Plowr.—O, I on Arum maculatum (particularly its form immaculatum) ; II, III on Phalaris arundinacea : I " in east Norfolk, Mr. Mundford " (2) ; I and II at Well Hall Lane, Gayton (5) ; O and I at Dunston, 3–5–1934 ; I in Dr. Mahood's garden at Haynford, 22–5–1934.

winteriana P. Magn.—O, I on Allium ursinum ; II. III on Phalaris arundinacea : " Norfolk " (4).

[*anthoxanthi* Fckl.—II, III on Anthoxanthum odoratum] : Plowright found uredospores " with a large number of capitate, hyaline paraphyses" on A. odoratum at King's Lynn in 1884 and ascribed them to this species (6). Grove points out (8) that no paraphyses were described by Fuckel or present in Sydow's typical specimen. Later (12) he suggests that Plowright's species is really Uredo anthoxanthina Bubak. Fragoso includes a description of paraphyses in P. anthoxanthi, and says that these appear to be an inconstant feature. They are very distinct and characteristic in U. anthoxanthina, however, and I shall follow Mr. Grove by placing Plowright's gathering in the latter, which has been found in Britain several times since.

perplexans Plowr.—O, I on Ranunculus acer ; II, III on Alopecurus pratensis : South Wootton (5).

phlei-pratensis Erikss. et Henn.—II, III on Phleum pratense : very abundant in the Yare marshes at Earlham, 31–8–1933.

holcina Erikss.—II, III on Holcus lanatus and H. mollis : widespread.

phragmitis (Schum.) Körn.—O, I on Rumex crispus, R. obtusifolius, R. conglomeratus, R. hydrolapathum and Rheum officinale ; II, III on Phragmites communis : I common, III North Wootton (2) ; abundant in all stages throughout the marshy districts of Norfolk ; I from mid-April to the end of June, II mainly in June-July, III forming July-August, but may be found on the dead leaves at all times ; we have seen I on rhubarb only at Surlingham (20–6–1934).

trailii Plowr.—O, I on Rumex acetosa ; II, III on Phragmites communis ; first noticed in Norfolk near Hickling Broad, 10–6–1932 ; later at Barton Broad, South Walsham, Horning, Burntfen, Wheatfen Broad (Old Mill Marsh), and Flordon Common. Earliest appearance of I, 17–4–1933, finest at the end of May ; earliest II, 28–6–1934. Morphologically, this rust is hardly to be distinguished from P. phragmitis ; æcidia appear on R. acetosa alone in some stations where other Rumices seem to be immune ; in others, e.g. at Hickling and Surlingham, R. crispus, R. conglomeratus and R. hydrolapathum bear æcidia close to affected R. acetosa. It must be admitted that Plowright's cultures took place rather late in the summer (teleutospores were applied July 29th and August 1st) to be naturally convincing. The clue may lie just as much with the varying powers of immunity in the host species, perhaps temporarily affected to some extent by environ-

ment, as with specific predilection on the part of the rust. Bio-chemists and cytologists could jointly improve their technique by investigating some of these delicate problems.

magnusiana Körn.—O, I on Ranunculus repens, R. bulbosus and probably R. lingua (see Aecidium ranunculacearum); II, III on Phragmites communis: " Norfolk " (4); frequent near the broads.

[*molinæ* Tul.—O, I on Melampyrum pratense; II, III on Molinia cærulea]: Plowright took æcidia on Orchis latifolia to be of this species, trusting to Rostrup's conclusions which are not now accepted.

poarum Niels.—O, I on Tussilago farfara; II, III on Poa spp.: first record, Terrington (2); very common, the æcidia forming in late April and again in July-October. I attacked by Tuberculina persicina at Stratton Strawless (Alex. Smith) and Hoveton, October, 1934.

festucæ Plowr.—O, I on Lonicera periclymenum; II, III on Festuca ovina: I abundant at North Wootton in July, 1871 (2); Hemsby dunes, 18–6–1933.

symphyti-bromorum Fr. Müll.—[O, I] on Symphytum officinale; II, III on Bromus sterilis: the later stages were abundant at Surlingham 1–7–1934.

baryi (Berk. et Br.) Wint.—II, III on Brachypodium sylvaticum: " Norfolk " (4); Horstead, Brundall and Surlingham, 1934.

simplex (Körn.) Erikss.—II, mesospores and III on Hordeum murinum; frequent.

agropyrina Erikss.—II, III on Agropyron repens: very common.

persistens Plowr.—O, I on Thalictrum flavum; II, III on Agropyron repens: I and III at Watlington (5); I at Ditchingham, 30–4–1933 and 21–6–1934, and on Old Mill Marsh, Wheatfen Broad, 1–7–1934.

elymi West.—[I on Thalictrum minus ?]; II, [III] on Elymus arenarius: Massee (9) states that he met with this species at Palling in August. Uredospores were plentiful on Elymus growing on the North Denes, Gt. Yarmouth, 11–6–1933 and at Palling and Yarmouth in September, 1934. No teleutospores were found, and Mr. W. B. Grove, who examined uredospores from Yarmouth, considered that they were much like those of P. agropyrina in the P. dispersa group; capitate paraphyses were present in some samples.

Uredinales imperfecti

The five following species are incompletely known, only one spore-form having been discovered in each case; all show affinities with Puccinia and are placed next the grass rusts in this list rather than at the end for that reason.

Aecidium ranunculacearum DC., var linguæ Grove—I on Ranunculus lingua: on the stems and leaves, Calthorpe and Barton Broads, 24–6–1934. Previously this had been found but once in Britain, viz., by Dr. Greville at Duddingston Loch (6, 8). Dr. Rhodes and the writer found II and III of P. magnusiana abundantly on reeds growing with the R. lingua at Calthorpe later in the year, and considered that the circumstances pointed to the æcidium belonging to this species; an experiment will be made to show whether this is the case.

Uredo anthoxanthina Bub.—II on Anthoxanthum odoratum: King's Lynn, 1884 (recorded as Puccinia anthoxanthi, q.v.).

U. ammophilina Kleb. et Lind.—II on Ammophila arenaria (marram grass): Scolt Head (20); dunes at Winterton, 1933; Yarmouth north denes and Hemsby, August 1934; see (12).

U. glyceriæ Lind.—II on Glyceria maritima (see Trans. Brit. Myc. Soc., Vol. xii, p. 115, and Lind's " Danish Fungi," 1913, tab. V, fig. 71). Uredospores were plentiful on G. maritima growing near the south beach at Heacham, 17–6–1934 ; there were numerous capitate paraphyses, and the rust was heavily parasitised by the sphæropsid fungus Darluca filum (Biv.) Cast.

U. agropyri Preuss.—II on Agropyron junceum : Scolt Head (20) ; near the Far Point, Blakeney, July 1934.

Genus *Uromyces*

ficariæ (Schum.) Lev.—III on Ranunculus ficaria : " Norfolk " (4) ; frequent.

caryophyllinus (Schrank.) Wint.—[O, I on Euphorbia gerardiana] ; II, III on Dianthus caryophyllus and D. barbatus : the later stages are sometimes abundant on carnations, and occasionally on sweet williams.

behenis (DC.) Unger—I, III on Silene maritima : I on a few plants at Scolt Head (18) ; plentiful at both ends of the island, 6–8–1933.

sparsus (Kze. et Schm) Lév.—O, I, II, III on Spergularia media : II and III of this rust had been found in a very few British localities and I not at all when Mr. V. J. Chapman noticed æcidia and uredospores on a plant of sea spurrey on the Hut Marsh, Scolt Head, in early June, 1933. These were described by Mr. Grove in Trans. Brit. Myc. Soc. (21). Later in the summer there were plenty of uredo—and a few teleuto-spores in the same locality, and the following spring (19–5–1934) I saw pycnidia and æcidia on hundreds of plants there, but could not find any in other parts of the island. On 2–6–1934 I found æcidia and a few uredospores on the south shore of Breydon at Gt. Yarmouth. There may be a climatic explanation for the occurrence of æcidia on the " drier side " of England, but on the other hand a little patient searching may reveal them in the other British stations.

geranii (DC.) Ott. et Wartm.—O, I, II, III on (*a*) Geranium dissectum and (*b*) G. pyrenaicum : I on (*a*) Runham marshes, Gt. Yarmouth, 9–6–1934 ; II, III on (*b*), Redenhall, 4–9–1932.

genistæ-tinctoriæ (Pers.) Wint.—[O, I on Euphorbia cyparissias], II, III on Cytisus scoparius and [Genista tinctoria] : found on wild broom at Haynford, 1–11–1934.

trifolii (Hedw. f.) Lév.—II, III on (*a*) Trifolium hybridum and (*b*) T. pratense : Plowright did not distinguish this from the next species, so we are not sure whether he found this at Lynn (2) ; II on (*a*), Eaton 1–9–1932.

[*trifolii-repentis* (Cast.) Liro]—O, I, II, III on Trifolium repens : ? King's Lynn (2), see above.

flectens Lagh.—III on (*a*) Trifolium repens and (*b*) T. fragiferum : very common on (*a*) ; on (*b*) by the river Bure at Runham Vauxhall, 9–6–1934.

anthyllidis (Grev.) Schröt.—II, III on Anthyllis vulneraria : II abundantly on Mundesley and Trimingham cliffs, 12–7–1934.

fabæ (Pers.) De Bary—O, I, II, III on (*a*) Faba vulgaris (*b*) Vicia cracca and (*c*) Lathyrus pratensis : Neatishead (2) ; common on (*a*) ; II on (*b*) at Buxton Heath and Surlingham and on (*c*) at Beeston Hill and Wheatfen Broad.

ervi (Wallr.) West.—I, II, III on Vicia hirsuta : South Wootton (5).

alchemillæ (Pers.) Lév.—II, III on Alchemilla vulgaris : " Norfolk " (4) ; the host plant is rather rare in this county (Nicholson, Fl. Nfk., p. 78).

valerianæ (Schum.) Fckl.—O, I, II, III on (*a*) Valeriana officinalis and (*b*) V. dioica : Honing and Dilham (2) ; common, especially on (*b*) ; I, April-June ; II from the end of May ; III from August.

limonii (DC.) Lév.—O, I, II, III on Statice limonium : " Norfolk " (4) ; Scolt Head (18) ; I forming in late May and June, II in July and III in mid-August at Scolt Head ; Heacham, Thornham, Brancaster, Wells, Cley and Blakeney Point, 1934.

armeriæ (Schlecht.) Lév.—O, I, II, III on Armeria maritima : this was included in U. limonii by Plowright ; I and II were abundant near the Wire Hills at Scolt Head, 19–5–1934.

betæ (Pers.) Lév.—O, I, II, III on (*a*) Beta vulgaris and (*b*) B. maritima : " common " (2) ; frequent on garden beet, mangolds and to some extent on sugar beet ; II and III on (*b*) at Scolt Head, Brancaster, Wells and Blakeney.

salicorniæ (DC.) De Bary.—I, II, III on Salicornia europæa (the bright green upright annual form) : " Norfolk " (4) ; II abundant on Butcher's Beach, Scolt Head, 19–8–1933 ; I there and on the Great Aster Marsh, 19–5–1934 ; II, III near Privet Hill, 16–8–1934 ; II at Blakeney Point, 5–7–1934.

chenopodii (DC.) Schröt.—I, II, III on Suæda maritima : Terrington Marsh (H. G. Ward) and North Wootton Marsh (Plowright)—the latter place has been reclaimed to such an extent since 1900 that when in 1934 Mr. Petch directed me to the scene of his early rambles with Dr. Plowright, I found most of the salt-marsh plants extinct. V. J. C. found the rust on S. maritima var. flexilis on the Hut Marsh, Scolt Head (19) ; I saw æcidia on the normal upright form at Blakeney Point, 5–7–1934, II and III on the same near Privet Hill, Scolt Head, 16–8–1934.

polygoni (Pers.) Fckl.—O, I, II, III on Polygonum aviculare : " Norfolk " (4) ; II and III are common ; the æcidia, which are seldom noticed in this country, were found with uredospores on the same leaves on Yarmouth South Denes, 1–6–1934 (M.B.E.).

rumicis (Schum.) Wint.—[O, I] on Ranunculus ficaria ; II, III on Rumex crispus, R. hydrolapathum, R. conglomeratus, etc. : Neatishead (2) ; Flordon Common, Ludham, Haveringland, Wheatfen Broad ; probably rather common.

acetosæ Schröt.—O, I, II, III on Rumex acetosa : this species appears to be less common, though more abundant where it occurs, than Puccinia acetosæ. The æcidia were first found in Britain by Mr. Grove and his daughter on Boniface Down in the Isle of Wight, 4–6–1933 (21) ; on 11–6–1934 they were found, in company with uredospores, on Ringland Hills, Norfolk (M.B.E.) and I saw the rust in all stages on Crostwick Common, 28–6–1934. Boniface Down and Ringland Hills have some aspects in common, but the Crostwick habitat is low-lying meadow a short distance from a river.

scillarum (Grev.) Wint.—II on (*a*) Scilla non-scripta and (*b*) S. campanulata (cultivated) : Castle Rising (2) ; on (*a*) Haynford and Geldeston ; but probably quite frequent ; on (*b*) in Norwich Castle gardens.

lilii (Link) Fckl.—O, I, III on Lilium candidum : teleutospores were found at Trowse by Mr. A. Adcock during a foray of the Brit. Myc. Soc., 4–6–1922.

junci (Desm.) Tul.—O, I on Pulicaria dysenterica ; II, III on Juncus subnodulosus : " Norfolk " (4) ; frequent, e.g. at Acle, Buxton Heath, Flordon Common, Horning, Surlingham (at the last place I is attacked by *Tuberculina persicina*).

scirpi (Cast.) Burr.—O, I on Glaux maritima ; II, III on Scirpus maritimus : plentiful on these hosts near Breydon, 1933-34 ; I at Scolt Head (19) ; all stages at Cley, 16–8–1934, where the æcidia were parasitised by *Tuberculina persicina*. In Britain the æcidia have been found also on Oenanthe crocata, and in other parts of the world on various Umbelliferæ and Hippuris ; a search on several of these in suitable places near Gt. Yarmouth in 1933 failed to reveal æcidia on any of them, see (21).

dactylidis Otth.—O, I, on Ranunculus acer, R. bulbosus and R. repens ; II, III on Dactylis glomerata : King's Lynn (2) ; widespread and abundant.

poæ Rabh.—O, I on Ranunculus ficaria, R. repens and R. bulbosus ; II, III on Poa pratensis, P. annua and P. trivialis : very common.

Phragmidiæ

Genus *Phragmidium*

rubi-idæi (Pers.) Karst.—O, I, II, III on Rubus idæus : " Norfolk " (4) ; fairly common on cultivated raspberries, but inconspicuous (G.E.D.).

rubi (Pers.) Wint.—O, I, II, III on Rubus fruticosus agg. : " Norfolk " (4) ; rather frequent.

violaceum (Schultz) Wint.—O, I, II, III on Rubus fruticosus agg. and R. laciniata (cultivated) ; common (2) ; abundant on most blackberries, though some forms are more susceptible than others ; cæomata are formed sometimes in September as well as normally in April-May ; uredospores in this county may be found from mid-June to September ; teleutospores appear at the beginning of August, and the leaves bearing them may remain on the plants till March.

tormentillæ Fckl.—O, I, II, III on (*a*) Potentilla reptans and (*b*) P. erecta : II, III on (*a*) at Westwick (Alex. Smith) and on (*b*) at Buxton Heath, October 1934.

fragariastri (DC.) Schröt.—O, I, II, III on Potentilla sterilis : Irstead (2) ; Shotesham St. Mary, Swannington, Costessey, Stratton Strawless, etc.

mucronatum (Pers.) Schlecht.—O, I, II, III on Rosa spp., both wild and cultivated : several biological forms have been isolated in cultures and certain rose stocks found to be immune. In Norfolk Dr. G. E. Deacon has experimented for some years with this rust and some account of his work would be welcomed in these Transactions.

Genus *Kuhneola*

albida (Kühn) P. Magn.—O, II, III on Rubus fruticosus, particularly of the corylifolius type : Blackdale Wood, Earlham ; Mousehold Heath ; Eaton ; Burlingham ; probably rather frequent in wooded districts.

Genus *Triphragmium*

ulmariæ (Schum.) Link.—O, II, III on Spiræa ulmaria : widespread ; III from mid-July.

Gymnosporangiæ :

Genus *Gymnosporangium*

clavariæforme (Jacq.) DC.—O, I on Cratægus oxyacantha and Pyrus communis ; III on Juniperus communis : West Newton, Lynn, Ashmanhaugh (2) ; I at Surlingham, 1–7–1934.

confusum Plowr.—O, I on Cratægus oxyacantha, Mespilus germanica and Pyrus vulgaris ; III on Juniperus sabina : Downham, King's Lynn, Clenchwarton, Wiggenhall St. Germain's and Terrington St. Clement's (5)

sabinæ (Dicks.) Wint.—O, I on Pyrus communis ; III on Juniperus sabina : East Norfolk, Ashwicken and King's Lynn (2).

juniperi Link.—O, I on Pyrus aucuparia ; III on Juniperus communis : North Wootton (2).

Melampsoraceæ

Melampsoriæ :

Genus *Melampsora*

hypericorum (DC.) Wint.—I, III on Hypericum perforatum, H. androsæmum and H. pulchrum : " Norfolk " (4).

lini (Pers.) Cast.—[O, I] II, III on Linum catharticum : North Wootton (2).

euphorbiæ (Schub.) Cast.—I, II, III on Euphorbia peplus and E. exigua : widespread (2), etc.

helioscopiæ (Pers.) W. Müll.—O, I, II, III on Euphorbia helioscopia : common (2), etc.

larici-epitea Kleb.—O, I on Larix decidua ; II, III on Salix spp.

larici-caprearum Kleb.—O, I on Larix decidua ; II, III on Salix spp.

Cæomata have been found on larch, and uredospores commonly on Salix aurita, caprea, fragilis, triandra, purpurea and repens in Norfolk ; the above two species have not been distinguished in many of these cases, as teleutospores have not been found at the time.

repentis Plowr.—O, I on (*a*) Orchis prætermissa (*b*) O. maculata and (*c*) Gymnadenia conopsea ; II, III on Salix aurita and S. repens : Honing (2) ; I on (*a*) at West Caister and Buxton Heath ; on (*b*) at Flordon Common and (*c*) at Roydon Fen near Diss.

larici-populina Kleb.—O, I on Larix decidua ; II, III on Populus tremula : Ringstead and North Wootton (2) ; on P. pyramidalis at Brundall (G.E.D.).

rostrupii G. Wagner.—O, I on Mercurialis perennis ; II, III on Populus alba, P. tremula, etc. : I, " Norfolk " (4) ; I in a wood at Dunston, 3–5–1934.

Pucciniastriæ :

Genus *Melampsoridium*

betulinum (Pers.) Kleb.—O, I on Larix decidua : II, III on Betula alba : " Norfolk " (4) ; widespread.

Genus *Melampsorella*

caryophyllacearum (Link) Schröt.—O, I on Abies pectinata ; II, III on Cerastium vulgatum (probably also on C. arvense, C. viscosum, Stellaria graminea, etc.) ; II at North Wootton (2). Mr. W. H. Burrell (7) gives a long account of " witches' brooms " caused by this fungus

(which has a perennial mycelium in both its hosts) on the silver fir in Norfolk ; Mr. F. G. G. Peake pointed out to me a good example in Earlham Park (1934). I have found the later stages on Cerastium vulgatum only, at Shotesham, Runham marshes near Yarmouth, and on Mundesley cliff. Dr. Deacon found II on Cerastium tomentosum at Brundall, 1934.

Genus *Pucciniastrum*

abieti-chamæneri Kleb.—[O, I] on Abies pectinata ; II, III on Epilobium angustifolium : II plentiful in the " Roman Camp " woods at West Runton, 8–9–1932 ; Ludham and Westwick, 1933 ; Stratton Strawless, 1934.

circææ (Schum.) Speg.—II, III on Circæa lutetiana : " Norfolk " (4) ; Surlingham Wood and at Haveringland, August, 1933.

agrimoniæ (Schw.) Tranzsch.—II, III on Agrimonia eupatoria : Ringstead (2) ; West Runton, Stratton Strawless, Wheatfen Broad, etc., not uncommon.

Genus *Thecopsora*

galii (Link) De Toni—II, III on Galium palustre and G. uliginosum at South Walsham, 1934.

Genus *Milesia*

blechni (Syd.) Arth.—II, III on Blechnum spicant : North Walsham Wood, 3–10–1934 (J. Ramsbottom).

Cronartiaceæ :

Cronartiæ

Genus *Endophyllum*

sempervivi (Alb. et Schw.) De Bary.—O, III on Sempervivum tectorum : Castleacre (5).

euphorbiæ-silvaticæ (DC.) Wint.—O, III on Euphorbia amygdaloides : Ashwicken, Dr. J. Lowe (2).

Genus *Cronartium*

flaccidum (Alb. et Schw.) Wint.—[O, I] on Pinus sylvestris ; II, III on Pæonia officinalis : North Wootton (5).

ribicola (Lasch.) Fisch. de Waldh.—O, I on Pinus cembra, P. monticola, P. strobus ; II, III on Ribes nigrum and R. rubrum : first discovered in Britain at King's Lynn by Dr. Plowright, on black, white and red currant bushes, 3–7–1892 ; soon afterwards he found the other stages on Weymouth pine (P. strobus) nearby (8). Mr. H. Goude (in a letter, 1934) describes it as generally distributed on black currants in Norfolk ; on one occasion he planted an acre of currants by the Wash, some miles from any pines, yet these were infested with the Cronartium each autumn.

quercuum (Brond.) Miyabe.—[O, I on Pinus spp.] ; II, [III] on Quercus pedunculata : " near Bungay," D. Stock ; Ditchingham, M. C. Cooke (2).

Coleosporiaceæ

Coleosporiæ:

Genus *Coleosporium*

tussilaginis (Pers.) Lév.—O, I on Pinus sylvestris ; II, III on Tussilago farfara, common (2) ; etc.

petasitis (DC.) Ed. Fisch.—O, I on Pinus sylvestris ; II, III on Petasites ovatus : Cantley, M. C. Cooke (2) ; Denton (Waveney Valley), 4–9–1932.

senecionis (Pers.) Fr.—O, I on Pinus sylvestris ; II, III on Senecio vulgaris and S. sylvaticus : I at Bawsey (2) ; one of our commonest rusts ; II may be found throughout the year ; earliest III on S. vulgaris growing on the north wall of Breydon, 9–6–1934. In May, 1933, æcidia were rife on many of the young pines near Fowlmere in the newly-afforested Breckland.

sonchi (Schum.) Lév.—O, I on Pinus sylvestris ; II, III on Sonchus palustris, S. arvensis, S. asper and S. oleraceus : common (2) ; abundant everywhere on the last three hosts and found on S. palustris at Acle, 1–8–1932.

campanulæ (Pers.) Lév.—O, I on Pinus sylvestris ; II, III on (*a*) Campanula rotundifolia (*b*) C. trachelium and (*c*) persicifolia (cultivated) : Ashmanhaugh (M.C.C.) and North Wootton (2) ; II on (*a*), Stratton Strawless, 20–10–1932 ; II, III on (*c*) at Thorpe Wood, 3–9–1934.

euphrasiæ (Schum.) Wint.—O, I on Pinus sylvestris ; II, III on Euphrasia spp., Bartsia odontites and Rhinanthus crista-galli : Irstead (2) ; fairly frequent.

Ochropsoriæ :

Genus *Ochropsora*

ariæ (Schleich.) Syd.—O, I on Anemone nemorosa ; [II, III] on Pyrus spp. : I, Wayford, M. C. Cooke (2).

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MISCELLANEOUS OBSERVATIONS

PLANTS

Algæ—*Nostoc commune* L. appears periodically in large masses on a gravel walk at Heydon, and dries up. It was luxuriant 18–5–1932.

Hepaticæ—*Riccioarpus natans* Corda was plentiful on the surface of a dyke about a quarter of a mile west of the Yarmouth road at Caister, 30–3–1934 (P. E. Rumbelow).

Angiospermæ—*Cardamine flexuosa* With. is very local in Norfolk; it was found in a damp shady spot at Clippesby, 20–5–1932 (M.B.E.) and later at Hoveton St. John and Surlingham.

Lepidium draba L. has spread, especially in coastal districts, since Nicholson's Flora was published. In June, 1934, it was seen at Wiggenhall St. Mary (O.P.), North Wootton, Heacham, Hunstanton, Thornham, Brancaster, Wells, Salthouse, Gt. Yarmouth (in plenty). It grows inland at Ditchingham, Lingwood and Cantley, by the railway.

Radiola linoides Roth. was frequent in damp hollows of Winterton-Horsey dunes, 20–8–1933.

Trigonella m. ornithopodioides DC. was found on Swannington Common by Dr. Salisbury during the S.E.U.S.S. excursion, 8–6–1933.

**Vicia bithynica* L. was flowering beside Lathyrus aphaca L. in Norwich, 25–5–1934, obviously a casual.

Geranium versicolor L. still abounds near Horsey Hall and is now known from two further Norfolk localities : Tunstead (G.J.C.) and near the river at Thorpe.

Inula helenium L. has been noticed occasionally at Brundall during the past five years ; a fine plant had just come into bloom not far from the river, 9–7–1933.

Inula squarrosa (L.) S. & T. was flowering abundantly on a hilly field near Eaton chalk-pit, 1–9–1932.

Centaurea solstitialis L. was seen flowering in a second crop of lucerne at Aldeby during September, 1932 (L. Lloyd).

Veronica scutellata L., var. *villosa* Schum. = *hirsuta* Weber, had not been noticed in this county for perhaps fifty years, when it was discovered growing with the type at Hockham Mere, 29–7–1934.

Orobanche purpurea Jacq. was very fine on Achillea millefolium at Trimingham (an old station), 12–7–1934.

Lamium galeobdolon (L.) Crantz. produced a peloric (regular) terminal flower at Framingham Pigot, 7–6–1932. All the petals were equal and showed the reddish honey-guides normally found on the centre " platform " petal.

**Orchis hircina* Crantz. : the first Norfolk lizard orchis was noticed by Dr. F. Maidment at Harleston in July 1932. He took measures for its protection and was successful in seeing it through the flowering period.

ANIMALS

PROTOZOA—**Ophrydium versatile* Muller, a colonial species which forms globular jelly-masses (green), was abundant in Fowlmere, 25–5–1933.

ACTINOZOA—*Diadumene luciæ* (Verrill), a brackish-water anemone, was observed on flint stones in Breydon, 1925 ; in a salt-marsh creek at Blakeney, 1932, and on mussel shells dredged from the Yare less than a mile from the harbour-mouth in 1933.

PLATYHELMINTHES—The small fish tapeworm **Ichthyotænia ambigua* (Duj.) was found encysted beneath the skin of three-spined sticklebacks from the Yare at Yarmouth, 25–2–1934. One which measured 3 mm. when taken from its host elongated to 12 mm. and became active when placed free in salt water.

MYRIAPODA—The luminous centipede **Geophilus carpophagus* Leach, was collected at Roydon near Diss by Mr. E. Hose in May, 1932, and later at the Grove, Aldeby.

ISOPODA—Numbers of tiny white woodlice, *Platyarthrus hoffmannseggi* Brandt. were seen in a nest of yellow ants (Lasius flavus De G.) at Costessey, 20–4–1933 ; some were present in a courtyard at Norwich Castle.

THYSANURA—**Thermobia domestica* (Packard). The space above a baker's oven, when the air is almost too dry to breathe and the bricks too hot to be handled, is the regular abode of these insects in Gt. Yarmouth (P. E. Rumbelow, 1932). Others were seen in Norwich the same year.

Lepisma saccharina L. A note on the longevity of this species seems worth recording. Five eggs laid circa July 21st, 1932, were left in a cardboard pill-box 1 in. in diameter and ½-in. deep ; they were mislaid till October 7th, 1933, when one Lepisma was found one-third grown in the box. It had been born and had lived in darkness and survived without food or moisture other than what was provided by the clean interior of the box and the remains of the other eggs. These conditions remained undisturbed save for a single inspection till October 21st, exactly 15 months. A few grains of sugar were then introduced, but this was all. The insect died during the first week of April, 1934, after growing a little more.

EPHEMEROPTERA—Clouds of mayflies *Ephemera vulgata* L. were rising at Taverham on the evening of 28–5–1932 and 22–5–1933 (H.J.H. and L.L.)

LEPIDOPTERA—*Limenitis sibilla* L. A white admiral was seen at Ellingham during the summer of 1933 (Mrs. C. Smith) ; another at East Carleton, 19–7–1934 (J. H. McInnes Skinner) ; one near Ketteringham, 27–7–1934 (P. S. Hovell) and three at Haynford, 4–8–1934 (G. B. Taylor). It may be that two warm summers have tempted this butterfly to extend its range farther north. F. C. Hinde.

Phragmatobia fuliginosa L. (ruby tiger moth) : many cocoons were noticed by Mr. E. N. Mennell on the dunes between Holkham and Burnham Overy, 1–5–1932, and eight days later the moths began to emerge ; on the 16th swarms were flying at Scolt Head towards sundown. The larvæ were numerous (full-fed) on ragwort at Burnham Overy in November, 1932. Since then, however, this species has been hardly noticed in that neighbourhood. One of the moths was seen at St. Faith's, 22–5–1934.

Mesotype virgata Rott. on Yarmouth North Denes : the spring brood was plentiful here in May and early June (to 16th), 1932. The second brood, from caterpillars which had fed on Galium verum, appeared on July 19th (E.A.E. and P.E.R.).

Semiothisa alternaria Hubn. : a most unusual place for this moth was Yarmouth South Denes, where one was captured 16–6–1932.

Papilio machaon L. : a melanistic swallowtail butterfly emerged from a Hickling caterpillar 13–5–1933 (R. I. Hook) ; the wings were not uniformly dark, the yellow markings being visible though suffused with black.

Pararge ægeria L. : the wood brown butterfly is rare in the Eastern Counties, so the appearance of one in an open glade in Holkham Park, 28–9–1932 was noteworthy (G. J. Cooke).

Vanessa antiopa L. : a Camberwell beauty in fresh condition was seen to alight on the road at Dene Side, near St. George's Park, Gt. Yarmouth, at 2.30 p.m., 18–8–1934. Mr. P. E. Rumbelow and several other persons had a clear view of it ; two men captured it, but happily it escaped and was last noticed flying over a house-top. Another rested on the Corton lightship, August 21st (S. G. Sharman).

Thecla w-album Knoch. : a white-letter hairstreak was recorded from Horsford by Mr. C. G. Doughty in August, 1930 ; another fluttered down on to the road opposite Carrow Works, Norwich, 7–7–1933.

COLEOPTERA—*Monochamus sutor* L. emerged from Russian timber in the Stalham district, July, 1933.

Cassida hemisphærica Hb. was feeding on ragged robin at Wroxham, 23–8–1933.

**Anthicus instabilis* Sdt. was taken for the first time in Norfolk at Scolt Head, by the late Mr. H. J. Thouless, 11–6–1923 ; others were seen in the same locality during May, 1934.

ARACHNIDA—**Chelifer cancroides* L. was abundant in a wood at Dunston, 1934.

GASTROPODA—**Assiminea grayana* (Leach) Fleming was abundant on salt-marsh " rond " by the river at King's Lynn, the mouth of the Bure at Gt. Yarmouth, and on the Norfolk bank of the Waveney at St. Olave's Bridge in the spring of 1929 ; in May, 1934, several of these molluscs were seen in the Cockle Bight and Great Aster Marsh on Scolt Head.

Buccinum undatum L. : within two days three sinistral (left-handed) whelks were taken in consignments from Wells, August, 1932 (I. Minns).

**Alderia modesta* (Lov.) Allm. and **Limapontia depressa* Ald. & Han. were numerous on Cladophora with its rich diatom-flora in a creek at Blakeney Point, 3–4–1932.

Physa fontinalis (L.) and *Bithynia tentaculata* (L.) with very pale yellow bodies were examined from Acle New Road dykes near Yarmouth in April, 1934 ; *Limnæa pereger* (Muller) had been found showing similar aberration at Gorleston a few days before.

Aplexa hypnorum (L.) : in a stream at Colney, 28–3–1933.

Cephalopoda—the small squid **Alloteuthis media* (L.) Wulker was taken from draw-netter's refuse on Yarmouth beach, 22–4–1934. The mantle was 2¾ inches long, the head with short tentacles 1 inch and the pair of long tentacles 2½ inches. (P. A. Rumbelow).

Pisces—A snake pipefish, *Nerophis æquoreus* L., 15⅛ inches long was caught in a net off Yarmouth, 15–4–1934 (P.A.R.) and another at Sheringham about the same time (J. Gillingwater).

Mammalia—A pigmy shrew, *Sorex minutus* L. was found dead in a nest of paper inside a beehive at Haynford, 28–4–1934. (A. E. Mahood).

Where not otherwise stated E. A. Ellis is responsible for the above records ; species " new " to Norfolk are marked *.

X

GERARD HUDSON GURNEY, F.Z.S., F.E.S., M.B.O.U.

1893—1934

It is with regret that we record the death, on 18 May, 1934, at the age of 54, of Gerard Hudson Gurney, of Keswick Hall, Norwich. He had been a member of the Norfolk and Norwich Nat. Soc. since 1893, and was elected President for the year, 1929-1930.

The subject of his Presidential Address was " The Mentality of Birds, with some Notes on Sexual Selection," (Trans. XIII, 1–13).

Gerard Gurney was the third in direct succession of a family devoted to Ornithology. His grandfather, J. H. Gurney, sen., was the great authority on Raptorial birds, and formed the well-known collection which is now in the Norwich Museum, whilst his father, J. H. Gurney, jun., who died in 1922, was an ornithologist of world-wide reputation. The love of Natural History was inherited by Gerard Gurney in full measure, but in his case included a wider field, for he was much interested in botany, and was an entomologist of some repute. While still in the twenties he undertook a shooting expedition to East Africa, from where, in addition to big-game trophies, he brought back a useful collection of birds, butterflies, and plants. An account of this expedition formed the subject of a paper read to the Norfolk and Norwich Naturalists' Society on November 24, 1908 (Trans. VIII, 696-726).

It is as an aviculturalist, however, that Gurney will be best remembered. The well-known aviaries at Keswick Hall, constructed and maintained by J. H. Gurney, jun., were extended and improved by his son upon his succession, and his collection of rare foreign birds was latterly one of the finest to be found in England. Probably owing to the limit set upon his activities through indifferent health, this collection of live birds became in recent years a more and more absorbing interest in his life, and he spared no pains to acquire new

rarities whenever the opportunity occurred. One of the successes of which he was most proud was the successful breeding in his aviaries of a pair of Australian Laughing Jackasses, and his most recent acquisition, in which he was intensely interested, was a consignment of Humming-Birds from Brazil.

Apart from natural history, Gerard Gurney was a man of wide interests and culture, with a keen appreciation and considerable knowledge of art, literature, and music.

He was unmarried, and lived at Keswick Hall with his mother, who survives him. He will be greatly missed by a wide circle of friends in Norfolk and elsewhere. (B. B. R.)

Adapted from the " Ibis," 1934.

PRESENTED
2 APR 1935

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