THE WAVENEY-OUSE VALLEY FENS OF THE SUFFOLK-NORFOLK BORDER.

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Introduction.

The Fenlands of East Anglia have long been famous among naturalists and ecologists, and much has been written on them; in particular, there are the classic papers of Godwin (1929, 1931, 1932, 1936) on Wicken Fen, and those of Lambert and her co-workers on the Norfolk Broads (1948, 1951). It is, however, less generally realised that these fens fall into two clearly recognisable types on a basis of both vegetation and topography: the wide, flat fens of the main Fen basin (the "Great Level") between the city of Cambridge and the silt lands south of the Wash, of which Wicken Fen is the most important remaining fragment; and the smaller, usually concave, fens associated with the spring-lines of valleys cut in the glacial sands and clays of Norfolk and Suffolk. It is with examples of the second, hitherto little-studied type of fen that this paper is concerned.

Small, usually highly calcareous valley-fens are still very numerous and widespread in Norfolk, not only in valleys fringing the Broads region, but widely elsewhere in the county. The Black Bog-rush *Schoenus nigricans*, forms the dominant species over those parts of them where the influence of a calcareous spring-line is strongly felt, usually where there is marked water movement as on the slopes of the valley sides. The Norfolk valley-fens are to be the subject of a further paper, published by us elsewhere. In the present paper we are concerned with the still quite extensive remnants of valley-fen which exist about the headwaters of the Little Ouse and Waveney rivers, along the Norfolk-Suffolk border. Since nothing has been published hitherto about the present-day vegetation or ecology of this area, which contains the best examples of actively-growing fen vegetation remaining

in Suffolk, no apology is offered for presenting this account, It is the result of numerous visits to the area by both of us over a number of years and of much more intensive work over some weeks during the summers of 1958, 1959 and 1960. We wish to acknowledge the most valuable help, particularly during August, 1958, of Mrs. R. Bellamy, Miss P. A. Hitch, Mr. P. Holland and Mr. O. Davis ; Mr. Davis in particular supplied the photographs. The greater part of the vegetational analyses, levelling and stratigraphical work was carried out by D. J. Bellamy.

Topography.

The Ouse-Waveney valley of the Norfolk-Suffolk border displays some remarkable topographic features which must be described if we are to understand the structure of the fens of this region.

The headwaters of the Little Ouse and the Waveney are separated today by a low ridge of sand only 84 ft. above O.D., which is about 5 ft. above water level on either side and about 230 yds. wide at the narrowest point. This ridge is traversed by the road from Redgrave to South Lopham. Peat cutting and ditching are so extensive, that today, the causeway, on which this road runs, is the only effective watershed between the two river systems, the Little Ouse flowing west to the Great Ouse and ultimately the Wash, and the Waveney flowing east to enter the Yare, and then the sea at Great Yarmouth. It is clear that this valley, cutting at right angles across the main watershed of East Anglia, must once have been continuous.

Geological opinion appears to be divided on the question of how and when this valley was formed. It has been suggested that it was a glacial overflow channel, while other geologists consider that the valley may have been formed in a pre-glacial or inter-glacial period, subsequently being " filled with boulder clay, which has since been denuded and altered by ice and water action, the cutting back of the glacial deposits having reduced what was at one time an appreciable watershed to its present insignificant proportions ". (W. H. Burrell in Flora of Norfolk, 1914.)

To the east of the watershed, a large valley fen lies astride the county boundary. The Norfolk part is known as South Lopham Fen, the Suffolk part, Redgrave Fen. On South Lopham, stratigraphical studies by Tallantire (1953) have revealed the former presence of a lake dating from late glacial times, which has since been filled in, firstly with lake muds and later with fen peat. In this area we are clearly dealing with a hydroseral succession that has continued over a very long period of time, but much modified as we shall see below, by the activities of man.

West of the watershed the existing fens take the form of small fragments, along the main Little Ouse river valley. (Thelnetham, Hinderclay, Blo Norton, Hopton) or in a valley lateral to it (Weston). In all cases, spring-lines feeding the fens occur at the junction of the pervious glacial sands with the underlying chalky boulder clay.

The Possible Origin of the Extant Fens and Fen Deposits of the Area.

The extensive fen deposits of this flat water parting region may all be considered to have originated in much the same way, in shallow valleys, some broad, some very narrow, but all receiving base-rich waters from spring and seepage lines along their margins.

The movement of this water, slowly draining down the slight declivities of these valleys, being further impeded by the growth of aquatic fen plants, brought about a rise in the water level. " Such a rise in water level, creating the necessary hydrologic protection for the constantly accumulating plant remains, gave the essential growth impulse to the peat-mass. Thus the growth of these fen deposits was accomplished in relation to, and in consequence of, a gradual rise in water level actively effected by the fen flora ". (Kulczynski, 1949.)

This growth could continue upwards and outwards until the peat surface reached the upper limits of the seepage lines, when peat growth would stop and the normal (Tansley, 1953) fen succession to damp alder wood could be expected. This process could only have continued as long as the natural drainage systems of the valleys remained unaltered.

From the evidence to hand, we cannot say at which stage this process was arrested by man's intervention, but arrested it was ! Man in his attempts to drain these fens and surrounding wet soils, straightened, cleared and dredged the natural channels and cut new ones, bringing to an end the natural fen regime of the area as a whole.

Thus some of the areas were converted to agricultural land, others, probably because they were common land, were (apart from a certain amount of peat cutting) just left. To maintain the newly claimed land, constant dredging of the main drainage arteries was necessary, the dredging being deposited along the banks thus forming raised embankments. In some of the uncultivated areas, the embankments were not breached, or, if they were, breaches were repaired, thus these embankments formed more or less effective barriers to the drainage of these areas, causing a rise in water level and giving a new impulse to fen growth. (Thelnetham Old Fen and Hinderclay.) In others no reflooding occurred, but for one reason or another they remained in a partially drained state, still supporting a fen flora. (Redgrave and Weston.)

CONSIDERATION OF THE INDIVIDUAL FENS.

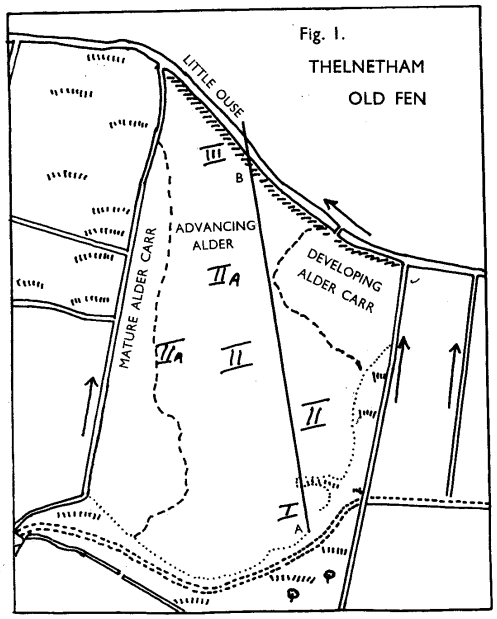
THELNETHAM OLD FEN.

Grid reference S.E. corner TM020786.

This is the site which may be taken to represent the whole of the above-described sequence.

The re-flooded area consists of three distinct regions.

1. A narrow upper terrace flanked by the dry mineral south-eastern rim of the fen.
2. A shallow central basin covering the greater part of the area.
3. An area of consolidated deep peat lying just behind the river embankment.



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Although the boundaries are not clear-cut and all degrees of gradation and admixture are seen, three distinct fen communities are recognisable, corresponding to these three regions.

The upper terrace supports a short herb community rich in species dominated by *Schoenus nigricans* (Table I E) ; this region, although rarely if ever completely dry, would be the first to be affected by a long summer drought.

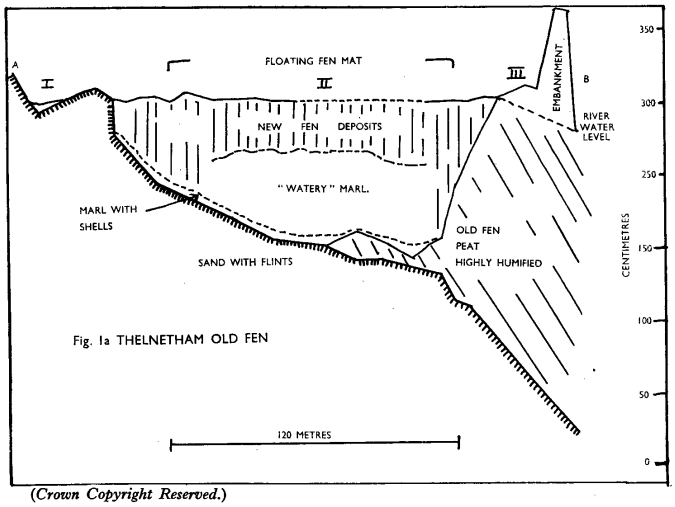


Fig. 1a THELNETHAM OLD FEN

(Crown Copyright Reserved.)

The shallow water-filled basin which comprises the major part of the fen is covered by a mat which, in the deeper parts, floats like a wet sponge at the surface of the water. This mat consists of the root systems, (together with a little slightly decomposed marly peat), of a medium tall herb community (Table I F), dominated by *Cladium mariscus* with *Typha angustifolia* locally abundant (Table I G).

The consolidated deep peat region supports a dense tall-herb community dominated by *Phragmites* (Table I H).

These three open communities are being invaded by Alder from all sides, but predominantly from the western margin and north-eastern corner of the fen. In the former a more or less

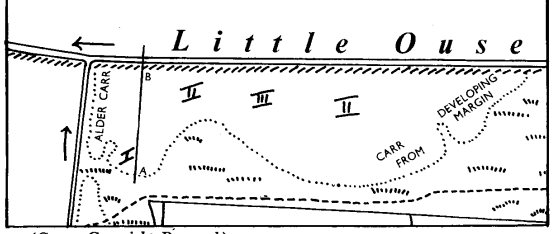
mature Alder carr (Table I J) fringes the fen, in the latter a dense carr is developing. It is interesting to note that both areas of Alder-dominated peat are in direct contact with low-banked drains that are regularly maintained to keep the flanking agricultural land drained, and have therefore possibly escaped complete re-inundation. These carrs may in fact represent the truncated succession initiated when the main drain was first cut.

HINDERCLAY FEN.

Grid reference S.W. corner TM038787.

Here again we find a very similar picture. Mature Alder carr is developed on the better drained peats which fringe the western dyke.

Fig. 2 HINDERCLAY FEN

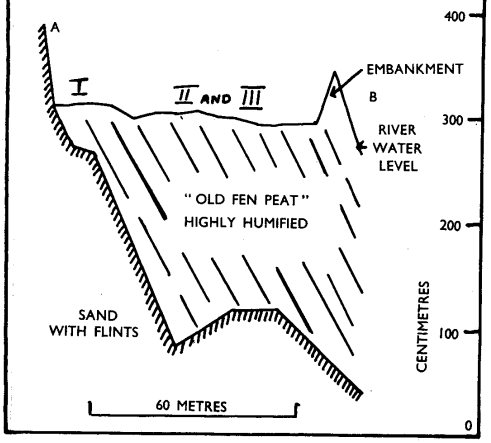


A mixed short and medium-tall herb association (Table I J) with some *Schoenus* occupies a very restricted upper terrace at the broad western end of the fen.

The bulk of the area supports a very dense tall-herb community dominated by *Phragmites* (Table I K), giving place locally to a more open medium-tall-herb community, with *Typha latifolia* (Table I L), and *Menyanthes trifoliata*. Both these communities are for the most part rooted in a solid, highly humified peat, questionably the old fen peat (*see below) which shows no tendency to flotation ; but some of the borings have shown that the same communities are present as floating mats over very local depressions.

*The presence of a number of blocked drainage clefts in the main river embankment points to the possibility of a gradual rise in water level as these clefts filled up. Such a gradual rise in water table would allow a slow deposition of new peat over the old fen deposit, probably showing no marked boundary.

Fig. 2a HINDERCLAY FEN
TRANSECT A.B.



REDGRAVE FEN.

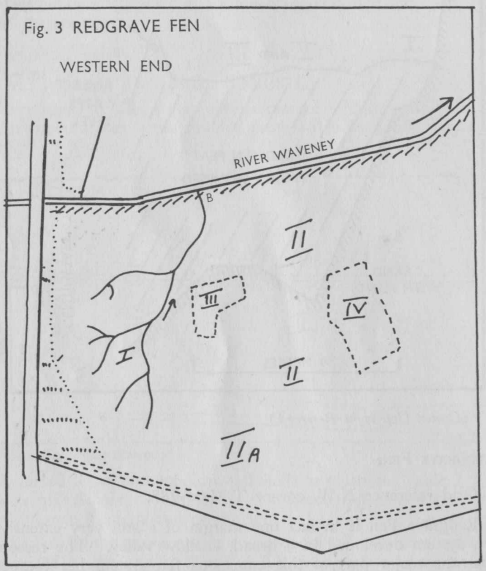
Grid reference N.W. corner T.M.049788.

Redgrave Fen is in fact one margin of a still very extensive fen system developed in a broad, shallow valley. The reasons that the major part of this enormous fen system has escaped cultivation are in all probability its extreme flatness, which makes efficient drainage almost impossible and the fact of its being unenclosed common-land.

However, dykes have been cut and embankments of dredging thrown up, the partially drained areas of fen behind them having been extensively cut for peat.

Redgrave Fen is in just this state, an area of old peat cuts which, due to lack of marked declivities, (even in this marginal region), has never drained completely and which, due to regularly maintained drainage clefts in the dyke embankment, has not been permanently re-flooded.

This account deals only with the wider western end of the Fen where, however dull a picture the above description may appear to paint, an extremely interesting diversity of vegetational types is found.



The floors of the shallow peat cuts close to the road have been colonised by an open short-herb community dominated by *Schoenus nigricans* (Table I M), the ridges left between them being crowned with *Molinia caerulea* and, occasionally *Calluna vulgaris*. These cuttings receiving water from the marginal seepage lines, are drained by a complex of sinuous channels eventually joining a lateral streamlet which discharges into the Waveney at point B. This miniature cruciate drainage system allows better drainage of this region, which may be regarded as the driest area that still maintains a " fen " flora.

Photos—Owen Davis

Redgrave Fen : General view across fen, looking east ; the small birch trees in middle distance to right mark the position of one of the areas of wet heath on sandy soil ; another is in right foreground.

Drosera rotundifolia on *Sphagnum plumulosum* in wet heath, Redgrave Fen.

The area of the fen not served by this cruciate drainage system is therefore " wetter " and supports a medium-tall-herb community dominated in part by *Cladium mariscus* (Table I O) and in part by *Phragmites communis* (Table I N).

Apart from the man-made undulations of the peat surface, natural undulations of the mineral substrate are manifest as two sandy islands or ridges which bear a markedly different flora. Owing to the tendency of the ground waters to flow around these obstacles on the slight gradient, their apices are free from the effects of the moving base-rich waters except in a period of abnormally great inundation. We find here a mixed association (Table I P, Q, R) of species typical of wet acid heathland (*Calluna vulgaris ; Erica tetralix ; Drosera rotundifolia*), those typical of rich fen (*Juncus subnodulosus*) and others of intermediate requirement (*Sphagnum russowii ; S. fimbriatum*, etc.). It is of interest to note that even these sandy islands show signs of peat cutting, proving that the peat deposits of the past and thus the fen water table must have at one time stood much higher that at present.

A similar type of mixed flora is found on the sand margins just above the seepage lines of all the fens, where not destroyed by cultivation.

Weston Fen.

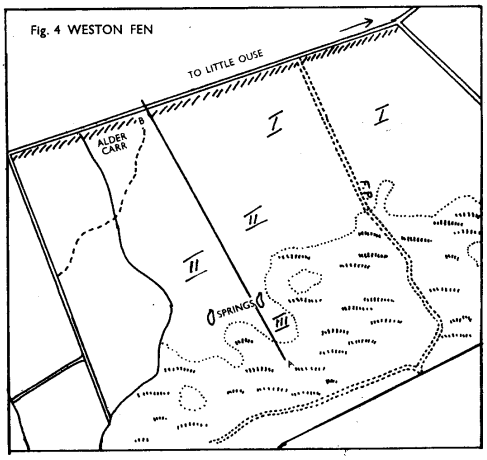
Grid reference N.E. corner T.L.984789.

Both the south-western and north-eastern ends of the fen have been much altered by draining and soil dumping ; only the central part has escaped and this is grazed by cattle.

The embankment of the shallow, dredged stream is a low broad structure and, well supplied as it is with more or less open drainage clefts, cannot be considered as a very effective barrier to drainage from the fen as a whole. Added to this, another factor aiding drainage is an appreciable declivity of the peat surface, the total drop between spring line and river being more than one metre. This slope is occupied by a complex system of soaks, which support a patchy medium-tall-herb community dominated in part by *Cladium mariscus* (Table I S) and in part by *Juncus subnodulosus* (Table I T). The presence of a thriving fen community, rich in species, on a readily draining(?) slope such as this, can only be explained by one factor, a large and permanent water income. This is supplied from a number of springs arising on the lip of of the slope, two of which are very large and prominent, being surrounded by enormous tussocks of *Carex paniculata* and dense stands of *Phragmites communis* (neither of these dried up completely even in the exceptionally dry summer of 1959).

The presence of a complementary system of ridges among the wet soaks must help, in effectively slowing down the drainage.

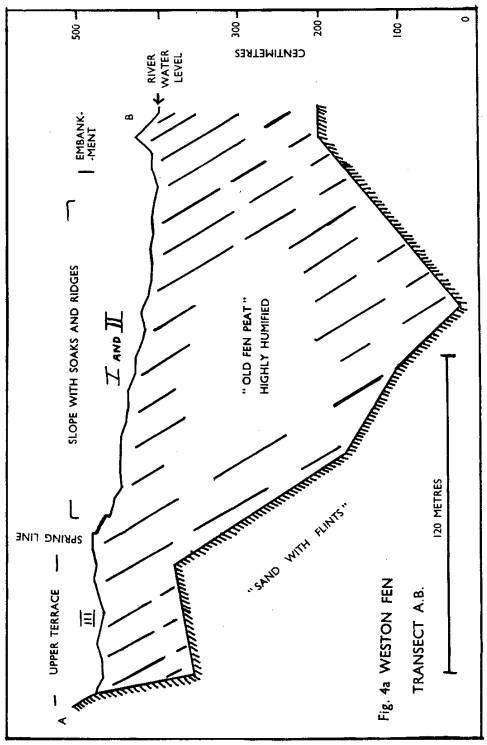
The origin of these soaks and ridges is not at all clear. Within the Alder carr at the north-west corner of the fen there are some pools too regular in outline to be considered natural and probably represent old peat cuts. It is therefore conceivable that the soak system is the remains of more extensive cuttings, the distinct boundaries of which, having been subject to the trampling of cattle, are now evident only as low ridges. The low, broad form of the river embankment may also be due to this factor.



Above the slope at the western end of the fen, is a flat terrace which, although lying behind, is on the same level as the springs and therefore receives a certain amount of water (backwash) from them, as well as water from the seepage lines along its landward margin.

Here, a medium-tall-herb community (Table I U) has developed rooted in a shallow peat. This is being invaded by *Sphagnum plumulosum* (Table I V) which already covers quite a large area, the larger species of the swamped fen association protruding through the *Sphagnum* carpet.

It must be noted that this flat terrace is at the head of a marked drainage slope and can therefore never be subject to deep inundation, a rise in water table being compensated immediately by an increased outflow. Thus the *Sphagnum* growing on top of the fen peat is never wholly subject to moving base-rich waters.



The Presence of Oxyphilous Species as Indicators of Change to an Oligotrophic (Bog) Succession.

The presence on the fens of species more typical of acid bogs and heaths (Table I.P.Q.R. and Table II) poses the question, could the change to an oligotrophic succession take place here? The answer is definitely no, so long as the supply of base-rich water continues. The oxyphilous communities in question have all developed in positions which are rarely, if ever, subject to the moving base-rich ground waters. They are thus very restricted and cannot therefore be looked upon as the initiation of an overall change. Nevertheless, their presence, and the marked pH. gradient between the apices and bases of the *Sphagnum* hummocks, shows that if the base-rich water supply were replaced by one poor in bases, the change could quickly take place.

Table II.

OXYPHILOUS SPECIES PRESENT.

Fen & Position	Species
Redgrave :—	
Fen margin	Calluna vulgaris Drosera rotundifolia Erica tetralix Genista anglica Potentilla erecta Sphagnum papillosum Sphagnum plumulosum
Peat ridges	Calluna vulgaris Drosera anglica Drosera rotundifolia Potentilla erecta Sphagnum plumulosum Sieglingia decumbens
Mineral Islands	See Table I P.Q.R.
Thelnetham :—	
Fen margin	Drosera anglica Genista anglica Potentilla erecta Sphagnum plumulosum
Weston :—	See Table I V.

Liparis loeselii in the Waveney Valley fens.

Redgrave Fen : *Cladium mariscus Eupatorium cannabinum.*

TABLE III. ANALYSIS OF FEN WATERS.

FEN AND NUMBER OF SAMPLES ANALYSED	ALL RESULTS (EXCEPT PH) GIVEN AS MILLI./EQUIVALENTS/LITRE.										
	PH	HCO_3^-	Cl^-	SO_4^-	NO_3^-	Ca^{++}	Na^+	Mg^{++}	K^+	Total Anions	Total Cations
THELNETHAM	7.13	5.12	0.50	0.89		6.13	0.70	0.01	0.06	7.26	7.26
	7.31	5.69	0.66	1.49	<.004	6.81	0.78	0.14	0.10	7.86	7.83
14	7.53	6.69	0.88	2.15		7.50	0.90	0.26	0.13	8.50	8.47
REDGRAVE	6.79	1.96	0.80	5.48		7.73	0.62	0.00	0.04	8.63	8.56
	7.14	2.69	1.45	8.93	<.004	11.89	1.03	0.20	0.06	13.06	13.17
12	7.48	4.93	2.29	15.20		17.51	1.61	0.62	0.10	19.49	19.49
HINDERCLAY	7.33	5.56	0.89	0.81		6.30	0.71	0.00	0.06	7.15	7.14
	7.46	5.97	0.88	1.30	<.004	6.97	0.83	0.24	0.08	8.15	8.13
10	7.57	6.49	1.05	2.04		7.61	0.96	0.48	0.12	9.10	9.08
WESTON	7.26	5.66	0.76	1.83		7.32	0.82	0.15	0.04	8.66	8.68
	7.51	5.94	0.97	2.22	<.004	7.72	0.92	0.45	0.06	9.13	9.14
16	8.19	6.14	1.40	2.66		8.26	1.01	0.79	0.10	9.58	9.62

WATER ANALYSIS.

The relationship between mire vegetation and the base status of mire waters has been the subject of numerous papers which may be summed up very crudely by the statement :

" Rich Fens only develop in base-rich waters, bogs in base-poor waters."

The analysis (Table III) shows that over the whole of each fen studied the ground waters are very rich in bases, the cation content of these waters bringing them all well within the range of Extreme Rich Fen. (M. Witting, Data in Gorham, 1955).

It was found impossible (without completely destroying the *Sphagnum* hummocks) to express enough water for complete analysis. The scanty results do however show marked differences between the water squeezed from the *Sphagna* (Table IV) and the fen water in which they are " rooted ".

For Analysis methods, see Gorham (1956).

All pH. measurements were made in the field, using a portable meter, with spear type electrodes.

All results in Table III are given as the means and the extreme values for each fen.

TABLE IV.

ANALYSIS OF WATER EXPRESSED FROM SPHAGNA.

FEN AND SPECIES OF SPAHGNUM	All Results (Except PH) M. Equivs./Litre.			
	PH	Ca^{++}	Mg^{++}	HCO_3^-
REDGRAVE : S. russowii	3.8	0.2	0	0
REDGRAVE : S. palustre	3.9	0.11	0.09	0
REDGRAVE : S. plumulosum	4.15	0.30	0.05	0
THELNETHAM S. plumulosum	4.4	0.90	0.21	0
WESTON S. plumulosum	4.2	0.81	0.13	0

METHOD OF VEGETATION ANALYSIS.

Areas, as large as possible, well within the boundaries of each distinct, (easily recognisable by eye) plant community were staked out.

Full plant lists for each area were first compiled.

The plant communities within the marked areas were then sampled by half metre square random quadrats ; estimation of cover in each quadrat being made on the following scale :—

\+ Sparsely present, cover very small.

1. +—20%.
2. 20%—40%.
3. 40%—60%.
4. 60%—80%.
5. 80%—100%.

The sum of the means for each figure recorded (e.g. 1=10%, 2=20%, etc., + being taken to equal 1%) for each species was divided by the total number of quadrats used for sampling.

The result in each case is the upper figure recorded against the species in the columns of Table I and may be taken as a measure of cover of the species in the community.

The lower figure recorded in each case is the % number of quadrats in which the species occurred ; a measure of frequency of occurrence in the community.

The cover figure is given correct to the nearest whole number except where the result is less than unity, when it is given correct to two places of decimals. The frequency figure is in all cases given correct to the nearest whole number.

Where a species occurred within the marked out area, but not in any of the quadrats, its presence is show by a + in Table I.

This is not the place to argue the merits, if any, of this method, but let it suffice that as all the results were treated in the same way and all the estimations were made by the same observer during one week in August, 1958, the results give at least some basis for comparison of the seventeen communities thus studied.

TABLE I. A, B, C, D are species lists for the areas bounded by the upper limits of the spring or seepage lines which mark the boundaries of the fen proper.

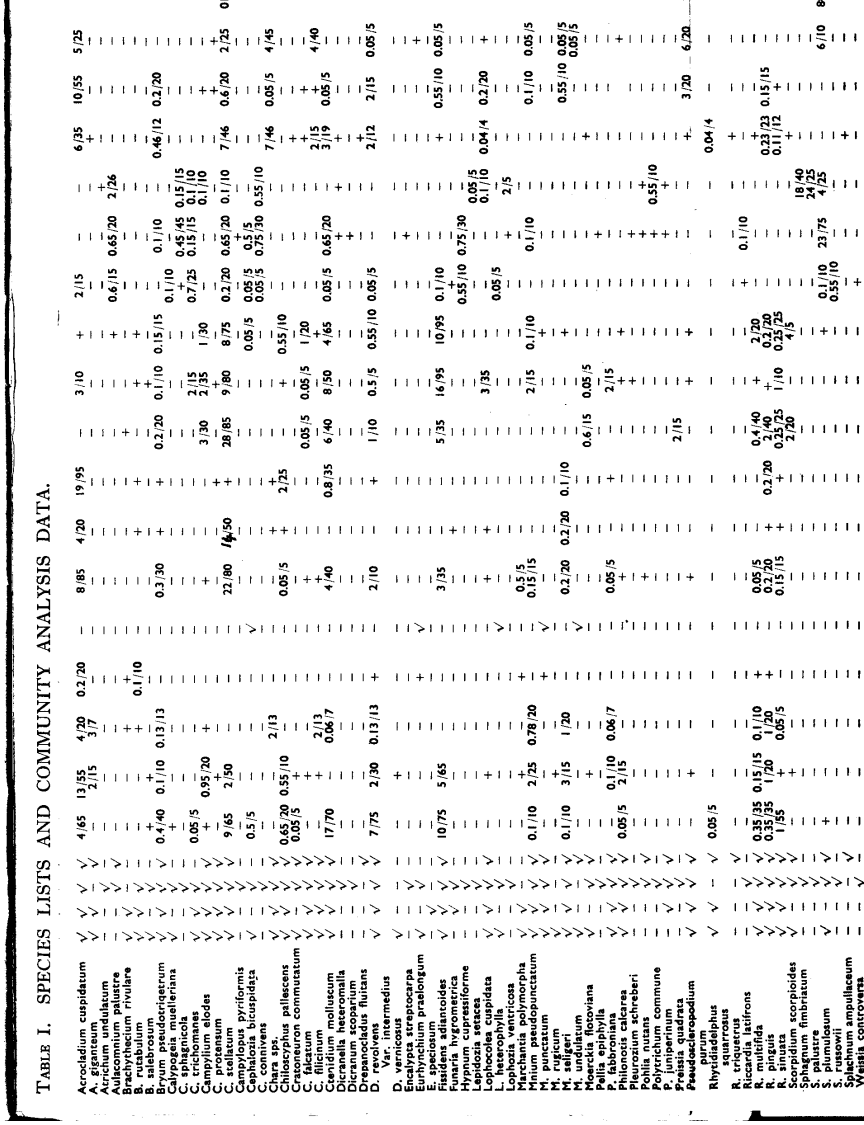
A. Thelnetham Old Fen.
B. Hinderclay Fen.
C. Redgrave Fen.
D. Weston Fen.

Table I	*Fen*	*Approximate positions of the communities shown on fig. I-4*
E.	Thelnetham Old Fen.	I.
F.	Thelnetham Old Fen.	II.
G.	Thelnetham Old Fen.	IIA.
H.	Thelnetham Old Fen.	III.
I.	Thelnetham Old Fen.	(*Plant list only*) Mature Alder Carr.
J.	Hinderclay Fen.	I.
K.	Hinderclay Fen.	II.
L.	Hinderclay Fen.	III.
M.	Redgrave Fen.	I.
N.	Redgrave Fen.	II.
O.	Redgrave Fen.	IIA.
P.	Redgrave Fen.	III.
Q.	Redgrave Fen.	IV.
R.	Redgrave Fen.	IV. (*Betula Scrub*).
S.	Weston Fen.	I.
T.	Weston Fen.	II.
U.	Weston Fen.	III.
V.	Weston Fen.	III.

NOTES ON THE MORE INTERESTING SPECIES OF THE AREA.

As will be apparent from the species lists and the vegetational analyses, the Waveney-Ouse fens have a rich flora. Many species such as *Schoenus nigricans*, *Drosera anglica*, *Parnassia palustris* and *Epipactis palustris* are today virtually confined to this area in Suffolk. The calcareous fen communities, however tend to have remarkably constant species lists when we compare one site with another; variety is mostly supplied by the wet heath areas, best developed at Redgrave, where numerous calcifuge species appear. Formerly a good wet heath existed adjacent to Hinderlcay Fen, but repeated burning has greatly reduced the number of species present, and has eliminated the Sphagna.

TABLE I. SPECIES LISTS AND COMMUNITY ANALYSIS DATA.



ABLE I. SPECIES LISTS AND COMMUNITY ANALYSIS DATA.

	A	B	C	D	E	F	G	H		J	K	L	M	N	O	P	Q	R	S	T	U	V
ostis canina	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	0.1/10	–
Var stolonifera																						
us glutinosa	√	√	√	√	0.15/15	5/15	5/40	+	√	2/65	–	–	–	–	–	–	–	–	–	0.05/5	–	–
gallis tenella	√	√	√	√	0.30/30	+	0.66/7	–	–	0.05/5	–	+	+	+	–	0.55/10	–	–	0.04/4	–	–	–
elica sylvestris	√	√	√	√	0.35/35	–	0.06/7	+	√	0.2/20	+	0.65/20	–	–	+	–	–	–	0.04/4	–	–	–
noxanthum odoratum	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	0.05/5	0.1/10
um nodiflorum	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	–
ula erecta	√	√	–	√	–	–	0.26/26	1/40	–	–	+	0.35/35	–	–	–	–	–	–	–	0.1/10	5/25	–
ula pubescens	–	–	√	√	–	–	+	–	–	–	–	–	–	–	–	5/15	–	14/55	–	–	–	–
errucosa	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–
mus compressus	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1/10
a media	√	√	√	√	0.1/10	–	–	–	–	+	–	–	–	–	–	0.25/25	0.8/35	–	0.04/4	–	–	–
magrostis canescens	√	–	√	–	–	+	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
epigeios	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
itriche stagnalis	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
una vulgaris	√	√	√	√	–	–	–	–	–	–	–	–	–	–	–	23/90	11/70	0.25/25	–	–	–	–
ha palustris	√	√	√	√	–	0.1/10	0.46/46	–	√	–	1/20	0.65/20	–	–	+	–	–	–	–	–	0.5/5	–
damine pratensis	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.05/5	–	0.1/10	–
ex acutiformis	√	√	–	√	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
ppropinquata	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0.5/5	–
liandra	√	√	–	√	0.05/5	+	–	–	–	–	0.1/10	–	–	–	–	–	–	–	–	–	0.05/5	–
lioica	–	–	√	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
elata	√	√	√	√	–	+	0.06/7	0.6/60	√	–	0.3/30	2/65	–	+	+	–	–	–	+	–	–	–
lacca	√	√	–	√	–	–	0.26/26	–	–	–	–	–	–	–	–	–	0.1/10	–	+	+	–	–
epidocarpa	√	√	√	√	+	0.1/10	+	–	–	+	–	–	–	+	+	–	–	–	0.85/15	0.5/5	0.1/10	–
nigra	√	√	–	–	–	–	0.06/7	0.1/10	–	–	0.3/30	+	–	+	–	–	–	–	–	–	–	–
panicea	√	√	√	√	0.2/20	0.2/20	0.06/7	–	–	0.3/30	+	–	+	+	+	0.2/20	–	+	2/50	4/65	2/45	0.2/20
paniculata	√	√	–	√	–	–	–	–	√	–	–	–	–	–	–	–	+	–	–	–	+	–
pulicaris	√	–	√	√	–	+	–	–	–	–	–	–	–	–	–	0.25/25	+	–	–	0.10/10	–	+
remota	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
ium arvense	√	–	√	√	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
lissectum	√	–	√	√	0.5/5	–	–	–	–	–	–	–	–	2/20	–	–	0.1/10	+	–	0.05/5	–	0.0/10
palustre	√	√	√	√	–	+	+	1/10	√	–	0.05/5	–	–	0.1/10	0.6/15	0.05/5	–	–	0.4/4	+	0.55/10	–
lium mariscus	√	√	√	√	3/80	16/100	2/73	0.3/30	√	3/65	1/30	0.2/20	3/70	3/35	34/100	0.25/25	–	–	28/96	3/65	28/85	0.8/70
tylorchis incarnata	√	–	√	–	–	+	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–
praetermissa	√	–	√	√	+	0.05/5	0.06/7	–	–	–	–	–	+	+	+	–	+	–	+	0.05/5	–	–
traunsteineri	√	–	√	√	–	–	–	–	–	–	–	–	+	+	–	–	–	–	+	–	–	–
sera anglica	√	–	√	–	+	–	–	–	–	–	–	–	+	–	+	–	–	–	–	–	–	–
rotundifolia	√	–	√	√	–	–	–	–	–	–	–	–	–	+	–	0.35/35	2/70	0.55/10	–	–	–	0.3/30
obium palustre	√	√	–	√	–	–	0.13/13	–	–	–	–	–	–	–	–	–	–	–	0.08/8	–	–	–
bactis palustris	√	√	√	√	+	+	0.13/13	–	–	+	0.1/10	+	+	+	+	0.1/10	1/30	–	+	0.05/5	–	0.1/10
isetum arvense	√	–	√	–	–	–	–	–	√	–	–	–	–	–	+	–	–	–	+	–	–	–
luviatile	√	√	–	–	–	+	–	–	–	–	–	0.1/10	–	–	–	–	–	–	–	–	–	–
palustre	√	√	√	√	0.15/15	0.15/15	0.39/40	–	–	0.2/20	0.1/10	0.05/5	+	–	0.3/30	–	–	–	+	0.05/5	0.2/20	–
a tetralix	√	–	√	–	–	–	–	–	–	–	–	–	–	–	–	4/25	12/40	0.6/15	–	–	–	–
atorium cannabinum	√	√	√	√	0.15/15	1/55	0.83/26	4/60	√	2/70	3/50	1/70	–	8/85	10/75	0.05/5	–	–	0.46/8	0.2/20	0.15/15	0.1/10
hrasia sp.	√	–	–	–	0.05/5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
cuca ovina	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	0.15/15	6/70	0.3/30	–	–	–	–
endula ulmaria	√	√	√	√	0.1/10	–	1/13	8/60	√	0.05/5	5/10	3/40	–	–	–	–	–	–	–	–	–	–
gula alnus	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
um hercyincum	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1/10	–	–	–	–	–
palustre	√	√	√	√	–	0.15/15	0.06/7	–	–	0.1/10	2/10	0.2/20	–	–	–	–	–	–	–	+	+	–
uliginosum	√	√	√	√	0.1/10	0.15/15	0.13/13	–	√	0.1/10	+	0.1/10	–	+	1/55	–	–	–	0.07/8	0.25/25	0.2/20	0.3/30
nista anglica	√	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	0.2/20	–	–	–	–	–
choma hederacea	√	–	√	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
nnadenia conopsea	√	–	√	–	+	–	–	–	–	0.05/5	+	0.05/5	+	–	+	–	0.6/15	–	–	0.05/5	0.05/5	0.3/30
Var. densiflora																						
dera helix	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	+	0.2/20
cus lanatus	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
mulus lupulus	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
drocotyle vulgaris	√	√	√	√	0.05/5	3/25	0.19/20	–	√	1/35	2/20	1/55	–	0.05/5	0.55/10	–	–	–	–	0.05/5	–	–
bericum tetrapterum	√	√	–	–	–	–	019/20 .	–	–	–	+	0.2/20	–	–	–	–	–	–	–	–	–	–
pseudacorus	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
cus subodulosus	√	√	√	√	4/100	9/80	25/92	+	√	11/90	23/80	17/100	4/70	9/80	7/80	1/80	8/80	0.95/50	8/92	39/100	16/80	14/100
nna minor	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	–	–
nna trisulca	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–
ntodon hispidus	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	1/55	0.35/35	–	–	–	–	–
leysseri	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–
ustrum vulgare	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
nicera periclymenum	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
us uliginosus	√	√	√	√	+	+	0.06/7	–	–	0.05/5	0.1/10	3/85	–	–	+	–	2/30	–	0.04/4	0.15/20	0.75/30	3/30
cula multiflora	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	0.05/5	0.3/30	–	–	–	–	–
hnis flos-cuculi	√	–	√	–	–	–	0.06/7	–	–	–	–	0.05/5	–	–	–	–	–	–	+	0.05/5	0.05/5	–
opus europaeus	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
hrum salicaria	√	√	–	√	–	0.1/10	–	+	√	–	+	0.5/5	–	–	+	–	–	–	+	–	–	–
ntha aquatica	√	√	√	√	+	0.35/35	0.39/40	0.6/60	√	0.35/35	0.1/10	0.3/30	+	0.6/15	0.1/10	–	–	–	0.27/27	0.6/60	0.55/55	0.3/30
nyanthes trifoliata	√	√	–	–	–	–	–	–	–	–	0.2/20	1/20	–	–	–	–	–	–	–	–	–	–
linia caerulea	√	√	√	√	11/95	15/85	0.26/26	–	–	6/75	–	2/50	11/65	11/70	6/50	16/95	9/85	23/95	0.07/8	9/45	1/30	5/80
nanthe fistulosa	–	–	–	–	–	–	0.06/7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
lachenalii	√	√	√	–	0.35/35	1/65	0.39/40	+	–	0.35/35	–	1/55	–	–	–	–	–	–	–	–	–	–
nassia palustris	√	√	√	√	0.45/45	0.35/35	+	–	–	0.4/40	–	–	+	–	–	0.05/5	0.1/10	0.2/20	+	+	+	–
dicularis palustris	√	–	–	–	–	+	0.13/13	–	–	–	–	+	–	–	–	0.05/5	0.25/25	–	0.04/4	–	–	–
ragmites communis	√	√	√	√	0.55/55	11/85	16/79	75/100	√	1/55	68/100	11/90	0.8/35	43/100	1/35	0.5/50	0.15/15	7/75	0.46/46	1/75	2/60	0.5/50
guicula vulgaris	√	–	√	√	–	+	+	–	–	–	–	–	+	–	+	–	1/10	–	0.04/4	0.6/15	–	–
ygala serpyllifolia	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1/10	0.05/1	–	–	–	–
entilla erecta	√	√	√	√	2/50	–	–	–	–	0.4/40	–	+	–	0.2/20	+	4/80	3/75	0.95/50	0.11/12	0.85/40	0.15/15	3/100
palustris	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
nunculus flammula	√	√	–	–	–	–	0.06/7	–	√	–	+	+	–	–	–	–	–	–	–	–	–	–
lingua	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
bus fruticosus	–	–	–	√	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	+	–	–
ix cinerea	√	√	–	√	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
guisorba officinalis	√	√	–	–	0.25/25	0.15/15	–	–	√	0.65/20	–	–	–	–	–	–	–	–	–	–	–	–
noenus nigricans	√	√	√	√	18/100	13/65	–	–	–	5/90	+	–	57/100	0.7/20	0.65/20	0.35/35	0.7/25	–	6/31	14/35	4/35	0.2/20
rophularia aquatica	–	√	–	–	–	–	–	–	–	–	–	0.1/10	–	–	–	–	–	–	–	–	–	–
utellaria galericulata	√	√	–	–	–	–	–	–	–	–	–	01/40	–	–	–	–	–	–	–	–	–	–
glingia decumbens	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
anum dulcamara	√	√	–	–	–	–	–	0.4/40	√	–	+	–	–	–	–	–	–	–	–	–	–	–
ccisa pratensis	√	√	√	√	4/75	0.85/40	0.26/26	–	–	0.75/75	–	–	0.2/20	0.1/10	+	7/90	7/80	–	0.54/19	0.8/35	0.25/25	3/80
raxacum officinale	–	√	√	–	–	–	–	–	–	0.05/5	–	–	–	–	–	–	–	–	–	–	–	–
paludosum	√	–	√	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
alictrum flavum	–	–	√	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–
elypteris palustris	√	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
iglochin palustris	√	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
pha angustifolia	√	√	–	–	–	1/15	7/40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
latifolia	√	√	–	–	–	–	0.13/13	–	√	–	0.1/10	0.05/5	–	–	–	–	–	–	–	–	–	–
ex europaeus	√	√	√	√	–	–	–	–	–	–	–	–	–	–	–	0.05/5	0.1/10	–	–	–	–	–
tica dioica	√	–	–	–	–	–	–	–	√	–	–	–	–	–	–	–	–	–	–	–	–	–
leriana dioica	√	√	√	√	3/95	3/70	0.39/40	0.1/10	–	2/80	0.1/10	2/55	+	8/100	–	0.4/40	2/30	–	0.42/42	1/55	0.9/45	1/50
officinalis	√	√	√	√	–	–	0.13/13	–	√	0.1/10	–	–	–	–	0.65/20	–	–	–	–	–	0.05/5	–

Approximate positions of the communities shown in fig. I-4

I.
IIA.
II.
Plant list only) Mature Alder Carr.
I.
III.
IIA.
III.
V. (Betula Scrub).

ESS OF THE AREA.

s and the vegetational ch flora. Many species Parnassia palustris and d to this area in Suffolk. end to have remarkably one site with another; h areas, best developed cies appear. Formerly ricay Fen, but repeated species present, and has

r the areas bounded by lines which mark the

ENS

The more remarkable species of higher plants occurring in the Waveney-Ouse valley fens include *Liparis loeselii*, and *Dactyorchis traunsteineri*. *Liparis* was much more abundant in the Thelnetham area twenty years ago ; it occurred in at least one spot as a colony of between 50 and 100 individuals. It appears to have been lost sight of for some years, but we are pleased to report that a number of plants still exist in this area on the Suffolk side of the Little Ouse, whilst another colony exists on the Norfolk side of the Waveney. Elsewhere in Britain, the type of the species only exists, today, as far as is known in five or six spots in the fens of the Norfolk broads, and very sparingly in two West Norfolk fens, though the *var. ovata* of Riddlesdell is locally plentiful in the dune slacks of South Wales.

Dactylorchis traunsteineri has only in recent years been definitely recognised in Britain. (It is widespread in fens in Central Europe, but owing to the taxonomic difficulty of these plants in Britain, it has been overlooked with us.) It occurs at Weston ; Thelnetham and Redgrave fens, and quite widely in the Norfolk valley fens. Characteristically it has few flowers in the spike, few very long narrow leaves, and flowers in May.

Peucedanum palustre is strangely rare in the Waveney-Ouse fens and has only been found so far at Bressingham fen on the Norfolk side, though common in the Broads. *Baldellia ranunculoides* appears confined to the Waveney ditch at Redgrave fen.

Certain fairly widespread fen species of East Anglia appear to be quite absent from our area, these include, *Lathyrus palustris ; Cicuta virosa ; Sium latifolium* and *Myrica gale.*

The Bryophyte flora of this fen system is rich in calcicole species characteristic of *Schoenus-Cladium* fens. The most noteworthy species present are *Preissia quadrata* (a long overlooked East Anglian species, now known to be also in at least 3 places in Norfolk valley fens) ; *Moerckia flotoviana ; Philonotis calcarea* and *Drepanocladus vernicosus.* These Bryophytes may well be relics here, of comparatively early post-glacial times, as they are characteristic of open fens at fairly high altitudes and latitudes. However, other more definintely Northern or Sub-Arctic species, such as *Camptothecium nitens* and *Cinclidium stygium*, which have old records in the Lark valley fens, and still exist in the Norfolk valley fens, have not been found in the Waveney-Ouse Fens.

Splachnum ampullaceum, which is frequent on the grazed area at Weston Fen, is a species of much interest. This coprophilous* moss is not known today elsewhere in East Anglia, and must be regarded as an interesting survival in an archaic land-management regime, namely, grazed but undrained fen ; the old records indicate that it was formerly much commoner in southern England than today.

* Found always growing on dung.

Man and the Natural Fen Succession.

The rapid increase of Alder at Thelnetham Old fen over the past few years has been very marked, seedlings appearing in their hundreds over the upper parts of the fen. This fact together with the presence of mature Alder carr on similar terraces in the vicinity poses the question, how have the fen communities described remained open, since their initiations on the terraces as we see them today ?

We have the plain evidence of grazing, and the consequent trampling, at Weston, which could easily account for the lack of Alder seedlings over much of the fen. Although no actual historical records of management have yet been obtained, local inquiry leaves little doubt that in the past, the fens have been mown to provide reeds for thatching and litter for animal bedding. Though this has not been a regular practice for many years it must have played an important rôle in the past. Probably with the dying out of this practice which rendered the fens communally useful, another, that of wilfully firing the fens has become more prevalent. The growth of this practice is manifest by the notice at Thelnetham warning would-be fire-raisers of prosecution, and the sorry sights that some of these fens often present in the early Summer, which appears to be the " open season " for this most harmful sport. Not only does it effectively check the spread of Alder but it has a disastrous effect on the fen flora as a whole. Fire is undoubtedly an unwanted factor if the already impoverished floras of these fens are to survive, and yet it is today the only widespread factor holding back the succession, which in any case spells doom for the open communities.

What of the future ? We cannot rely on the Coypu rat, already established at Weston, to keep the fens open ; conservation and a well-executed management plan is the only answer.

This brief account deals with only four small areas of the Waveney-Ouse Valley Fens. These four fens were chosen because they appear from our " brief " survey to be the best examples on the Suffolk side. More detailed search on the Norfolk side may reveal other areas as good or even better, and may bring to light factors at variance with the theories advanced in this paper.

However tenuous these theories concerning the origin of the fens are, and they must be regarded as extremely so, and however inadequate this description of the fen system is, it is hoped that it may stimulate interest in these fens before it is too late.

Only by continued study, especially by workers living near enough to make long term observations on water table fluctuations, vegetational change, effect of firing, spread of the Coypu, etc., can a clear understanding of the ecology of these fens be built up ; and only then can a sensible management plan, which is so necessary, for their continued existence, be formulated.

Notes on the Figs. 1-4.

Figs. 1-4 are based on the Ordance Survey 1/2500 sheets.

The " old fen peat " shown in figures IA-IVA is in no case a uniform layer, strata rich in Alder wood and others rich in sand being present.

It is hoped that the detailed stratigraphy of these deposits will form the basis of a further paper.

The position of the river embankments is shown on the maps by hatching.

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