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Late Pleistocene Deposits at Wretton, Norfolk. I. Ipswichian Interglacial Deposits

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LATE PLEISTOCENE DEPOSITS AT WRETTON, NORFOLK

I. IPSWICHIAN INTERGLACIAL DEPOSITS

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CONTENTS

Interglacial deposits found in the low terrace at Wretton, Norfolk, were formed in the zones II and III of the Ipswichian interglacial. The variety of sediments found is associated with the fluviatile environments of a meandering river. During zone II there was a regional mixed oak forest, with the local development of alder carr, fen, reedswamp and open water communities. During zone III the regional vegetation was more open and *Carpinus* became an important woodland tree. Locally, fen, reedswamp and open-water communities persisted, but alder carr was absent.

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The plants give some indication that the climate may have been more continental than at present, a number of species occurring which are not native to the British post-glacial flora but which have a wide distribution on the Continent. A brief comparison of the vegetational history is made with that of other Ipswichian interglacial sites in England and with the correlative Eemian interglacial on the Continent.

The interglacial sections at Wretton form one of the richest Ipswichian sites for non-marine Mollusca so far found in England. The presence of a few more southern or more continental species, not now living in England, confirms that the climate was probably slightly warmer than at present, at least in summer. Numbers are large enough for satisfactory analysis in almost all sections, so that the environmental conclusion they suggest can be checked against those deduced from the plants. In general, these conclusions match and indicate a series of deposits laid down by a plant-rich Fenland river, a true ancestor of the present river Wissey, in its channel and neighbouring parts of its floodplain.

The occurrence of brackish water species of Mollusca allows levels of marine influence to be clearly integrated with the vegetational history. Brackish horizons occur between −1.95 m and +0.45 m O.D. in zone II *b* deposits, giving an indication of sea-level at this stage. The zone III deposits, although at a lower level, show no trace of brackish influences and a possible oscillation of sea-level is inferred.

1. INTRODUCTION

In the summer of 1961 Dr G. P. Larwood brought to our notice Pleistocene organic deposits which had been found under terrace sands and gravels at Wretton in west Norfolk during excavations to make a new cut-off channel around the eastern edge of the Fenland (figure 1), a part of the Great Ouse River Board's flood protection scheme. Samples for analysis were

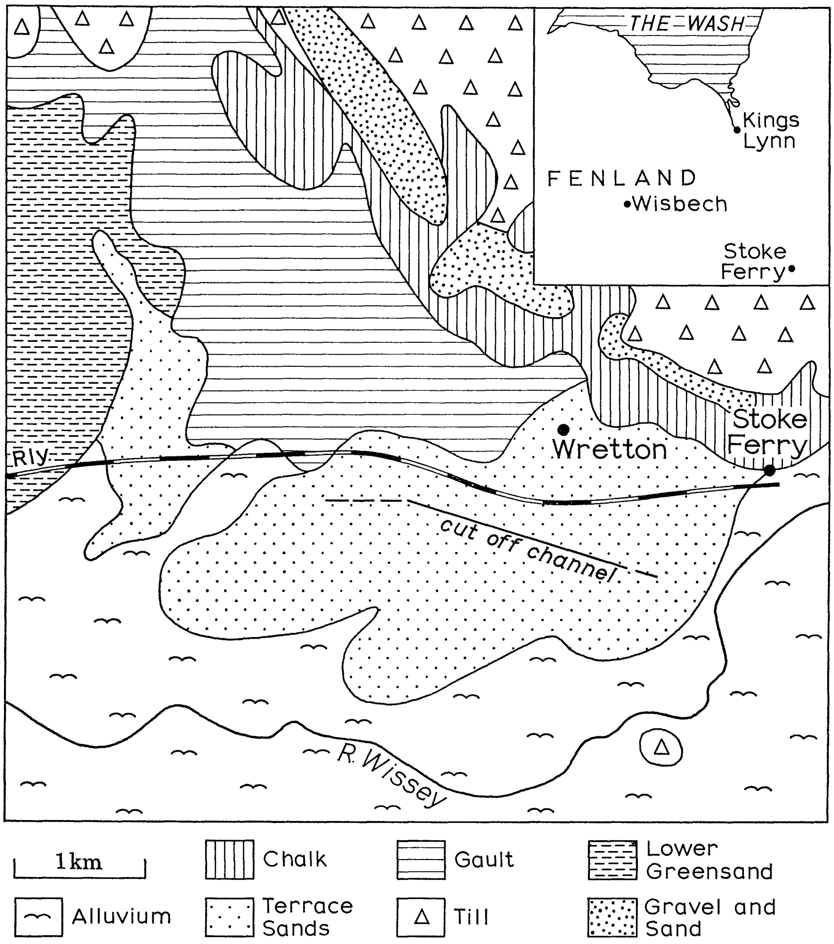

FIGURE 1. Location of the Wretton terrace deposits.

collected in July 1961, and it was found that the deposits were of Ipswichian (last) interglacial age.

In February 1962 excavations were continued a few hundred metres to the west and in the new sections so exposed the terrace sands and gravels were found to contain many horizons of organic sediment rich in plant remains, Mollusca and bones and associated with casts of ice wedges and involutions. During the rest of 1962, and on later occasions, samples from this series were collected and were found to be of Weichselian (last) glacial age.

The geological record at these sites covers a large part of Ipswichian interglacial time and an early part of the Weichselian glacial. It is convenient to divide the account of the deposits into two parts, this part dealing with the interglacial deposits, and a subsequent part with the Weichselian deposits.

2. Stratigraphy

The length of the cut-off channel where interglacial deposits were exposed is shown in figure 2. They occupy channels in the Gault Clay, as shown in figure 2, and are covered by a few metres of terrace sands and gravels, the level of the terrace surface being 4 m (13 ft.) o.d. The two main areas of exposure of the interglacial deposits were near Wretton Fen Bridge, and 500 m to the east, near culvert 24 by Joe's Plantation. The stratigraphy of the organic deposits in these two areas is shown in figures 3 and 4.

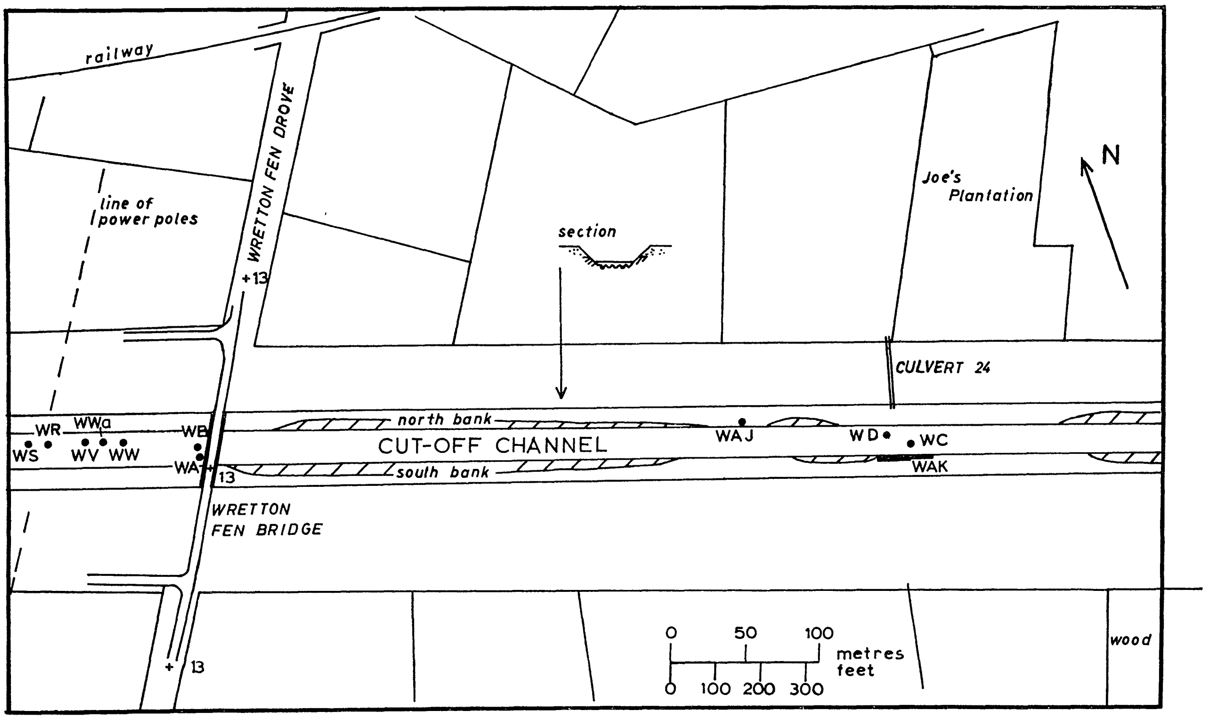

Figure 2. Location of sites along the cut-off channel (east end). Gault Clay shown by cross-hatching.

The terrace deposits cut across both the Gault and the interglacial deposits which lie in channels in the Gault. The great variety of interglacial sediments, silt, sand, gravel, detritus mud, clay-mud and marl, results from deposition in a fluviatile environment, in contrast to the simpler sediment series of enclosed lake basins. It is evident that we are dealing with the sediments of a small river or stream meandering through a valley. The interrelations of these sediments are complicated and details in all parts of the channel fillings are by no means clear. Thus there is no simple sequence of sedimentation or vegetational history such as is seen in some interglacial and Flandrian sequences of organic deposits, and a synthesis from the different sections has to be made. The details of the sections to be discussed are given in Appendix I.

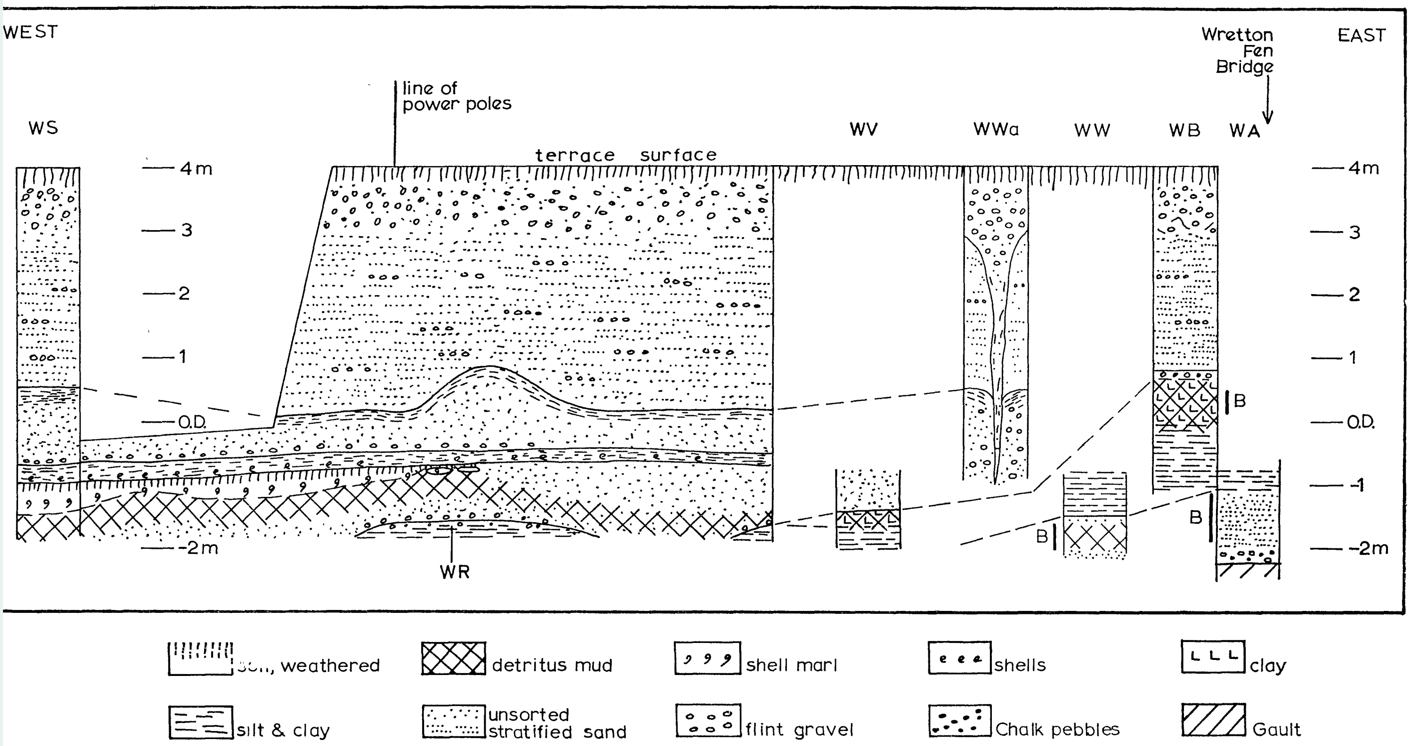

Figure 3. Sections near Wretton Fen Bridge. B, evidence for brackish water conditions.

(*a*) *The Wretton Fen Bridge section*

The sections lie in the area within 100 m west of the bridge (figure 2); details are shown in figure 3. The following sequence of deposition was seen.

The grey shelly sands and clays at the base of WA were deposited at the edge of a channel in the Gault; the east margin of this channel is shown just east of Wretton Fen Bridge in figure 1. A more organic sediment of the same period of deposition is seen in section WW. A grey silty clay was then deposited conformably on these lower deposits; it is seen in sections WA, WB, WV, WW and further to the west at WR, and represents a silting-up phase in the channel. At WB and WV a more organic deposit succeeds this clay-mud conformably and is the latest preserved part of the channel filling. It is probable that the change from the silts to the more organic clay-mud resulted from cessation of stream flow in the channel, perhaps associated with the cutting-off of a meander.

The next series of fossiliferous freshwater deposits is separated from the channel filling by a period of downcutting to the west of WV. This is seen in the sharp junction between the silty clay at WR and the overlying flint gravel. Above this gravel there is a sequence of fluviatile and pond deposits, seen in the length of section between WS and WR. Overlying the basal gravel and pale sand is a sandy mud with abundant plant remains. Conformable above this is a shell marl; then a weathered mud. Overlying this weathered horizon is a grey shelly clay, then a grey silt which overlaps eastwards on to a sand, as seen in figure 2. This sand was evidently deposited in a channel cut in the sandy muds, at a time later than the deposition of the shell marl, but before the deposition of the shelly clay. It will be shown later that the unconformity between the marl and the shelly clay is a very considerable one, the marl and underlying sandy mud being interglacial and the clay Weichselian. Thus the sediments below the weathering horizon form part of the further filling of a channel during the interglacial, first with fluviatile deposits then with still water muds and marls.

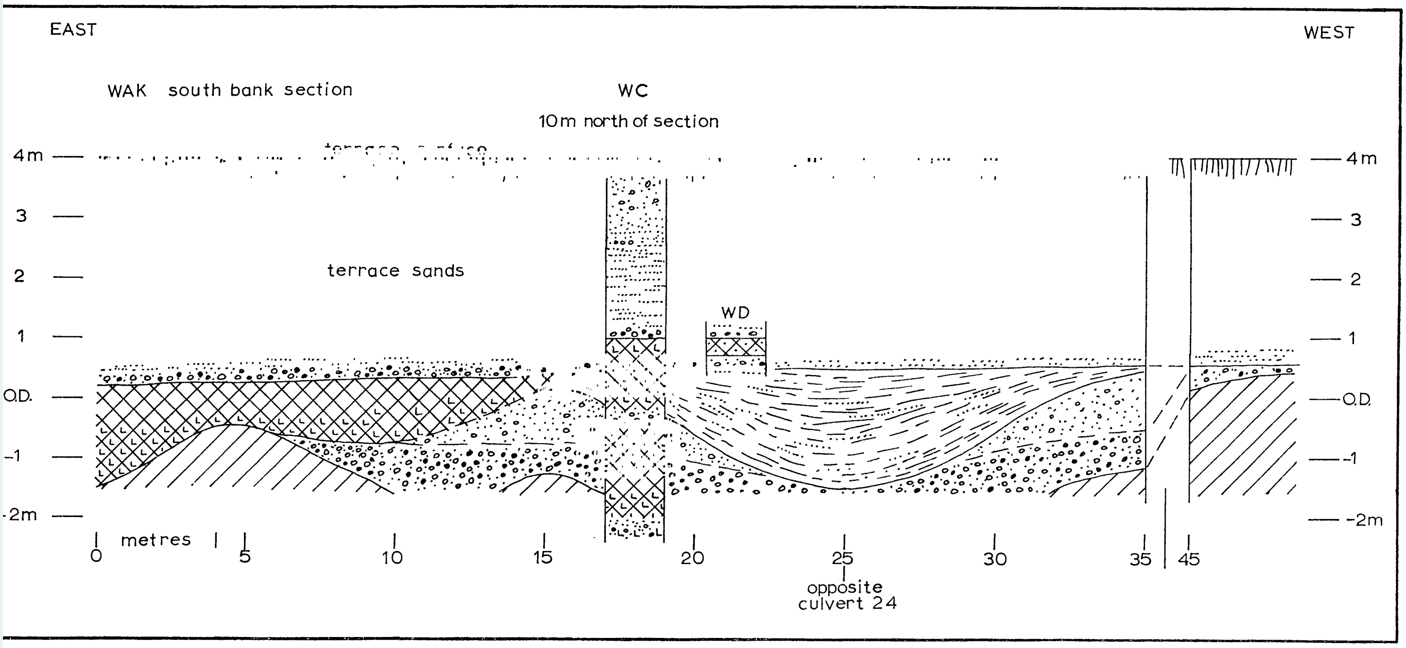

FIGURE 4. Sections near culvert 24.

(*b*) *The culvert* 24 *section*

The deposits here fill a further channel in the Gault, as shown in figure 2. Figure 4 shows the detail of the west end of the channel filling. The following sequence of deposition was seen.

A deep channel in the Gault was filled with sand and gravel with flints and chalk pebbles. A grey sandy silt filled a further channel within this sand and gravel; it is very sparsely fossiliferous. To the east this series of channel fillings has been subject to downcutting, and in the further channel so formed a series of sands, highly fossiliferous interglacial clay-muds and mud was deposited: they are seen in the south bank section WAK and in the baulk section WC, studied in detail for its fauna and flora. The section WD, just to the north-west of WC, showed the channel floor rising to the north, with a thin organic deposit lying on the sand and gravel.

The age of these fossiliferous deposits, indicated by the contained pollen, is younger than the age of the channel fillings near Wretton Fen Bridge. But the age of the older channel filling of grey sandy silt at WAK is probably older than any of the other channel fillings. It contains much derived pollen and spores, as well as very scarce but better-preserved pollen of *Betula*, *Pinus*, *Armeria* and *Lycopodium*. This cold-tolerant assemblage may be of early interglacial or late-glacial age, and thus belong to an earlier period than the richly fossiliferous interglacial deposits in the other channel fillings.

(c) *Conclusion*

It is clear that the stratigraphy of these sections at Wretton Fen Bridge and culvert 24 represent the deposits of a series of channels cut at different times in basal Gault. The changes in lithology follow from the same lateral movement of the main stream or river which successively cut the channels. The analyses of the fauna and plant remains from these sections reveal more of the environmental changes which accompanied the river development.

3. PALAEOBOTANY

Samples from the following sections were analysed for pollen and macroscopic plant remains: WA, WB, WR, WS and WW at Wretton Fen Bridge and WC and WD at culvert 24. The resulting pollen diagrams are given in figures 5 and 6, and the macroscopic analysis in table 1, with figure 7 giving the percentage macro representation of different ecological groups at successive horizons.

(a) *Zonation of pollen diagrams*

Two principal pollen zones are apparent in the diagrams. The older is seen in the diagrams from the Wretton Fen Bridge section, and is a zone characterized by the presence of *Quercus*, *Pinus*, *Corylus* and *Alnus*. This zone is to be correlated with zone II *b* of the Ipswichian temperate stage (West 1968), and is the mixed oak forest zone of this interglacial.

The second zone is seen in the diagram from section WC at the culvert 24 section, and in the nearby section WD. This zone is characterized by the presence of *Carpinus*, *Quercus*, *Pinus* and *Corylus*. It is to be correlated with the *Carpinus* zone, zone III, of the Ipswichian temperate stage.

The boundary between these zones is seen towards the base of section WC at 240 cm; it is placed at the level where *Carpinus* pollen equals in frequency the pollen of other trees. The two zones represented in the pollen diagrams cover a major middle part of the interglacial. There is no evidence for those earlier zones which show the development of the mixed oak forest at Bobbitshole, Ipswich (West 1957) or the later zone showing *Pinus* dominance at Histon Road, Cambridge (Sparks & West 1959).

Although the overall zonation is clear, there is considerable diversity in the pollen spectra in zone II, which is associated with lithological variation, and thus with the changing local conditions in the environs of the river. No useful purpose is served by subzoning the diagrams on the basis of these local variations in the pollen spectra. Rather it will be most convenient to describe the vegetational history and environmental history in sequential order of deposition.

(b) *Environmental and vegetational history*

(i) *WA* 41–152 cm

The fluviatile fine shelly sediments below the grey silty clay show a predominance of tree and shrub pollen, particularly high frequencies of *Corylus* pollen being seen at the base. *Betula, Pinus*, *Ulmus*, *Quercus*, *Alnus*, *Fraxinus* and *Hedera* are represented by pollen and their relative frequency indicates the regional presence of forest with *Pinus*, *Quercus* and *Corylus*, though probably the high frequencies of the last are associated with local development of hazel-dominated communities. The high frequency of *Alnus* pollen at 110 cm is at the same level as the occurrence of abundant fruits of *Alnus glutinosa*. At other horizons where pollen analyses were made both pollen and macroscopic remains of *Alnus* are much scarcer. Evidently, even though alder was a

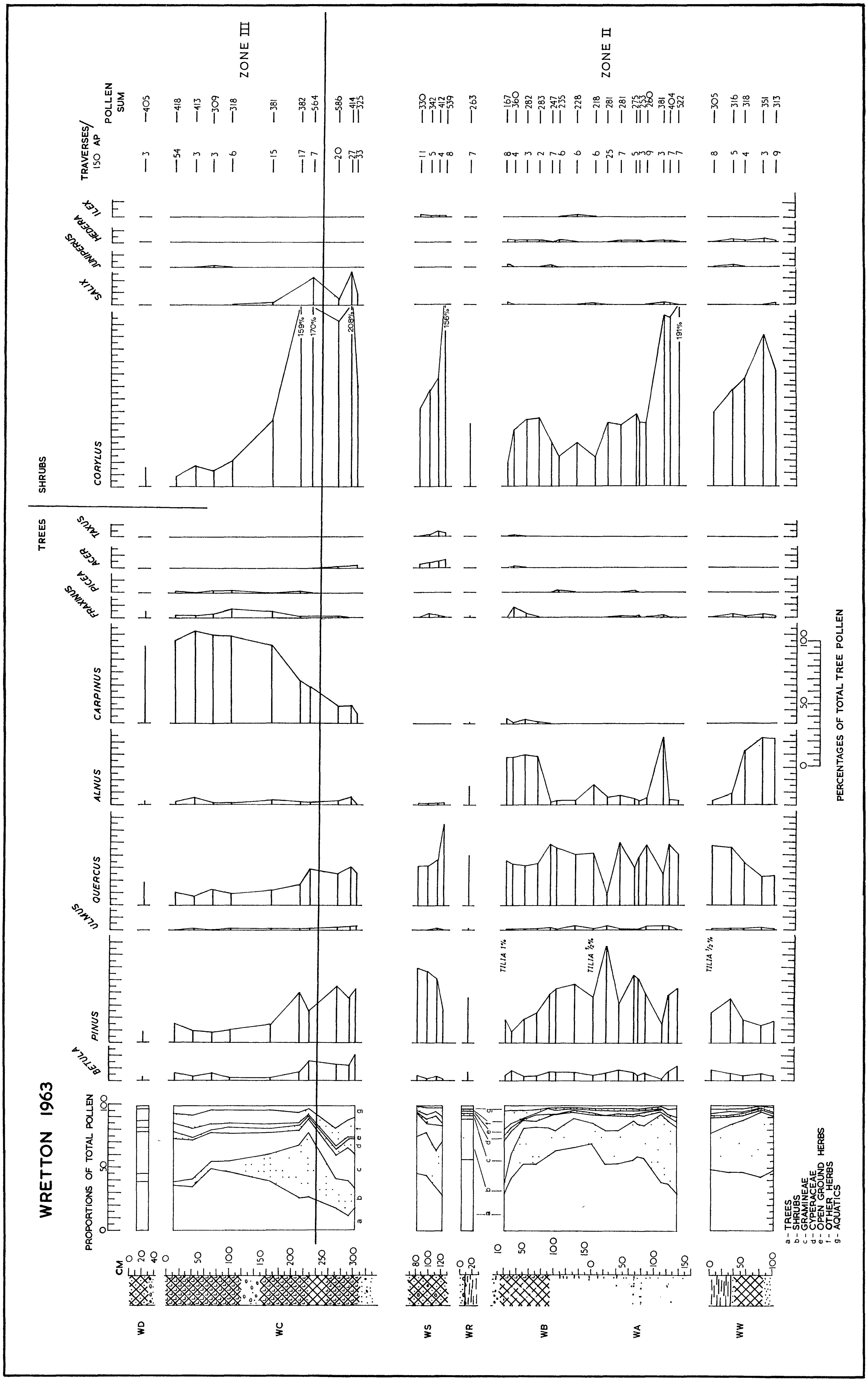

FIGURE 5. Tree and shrub pollen diagram.

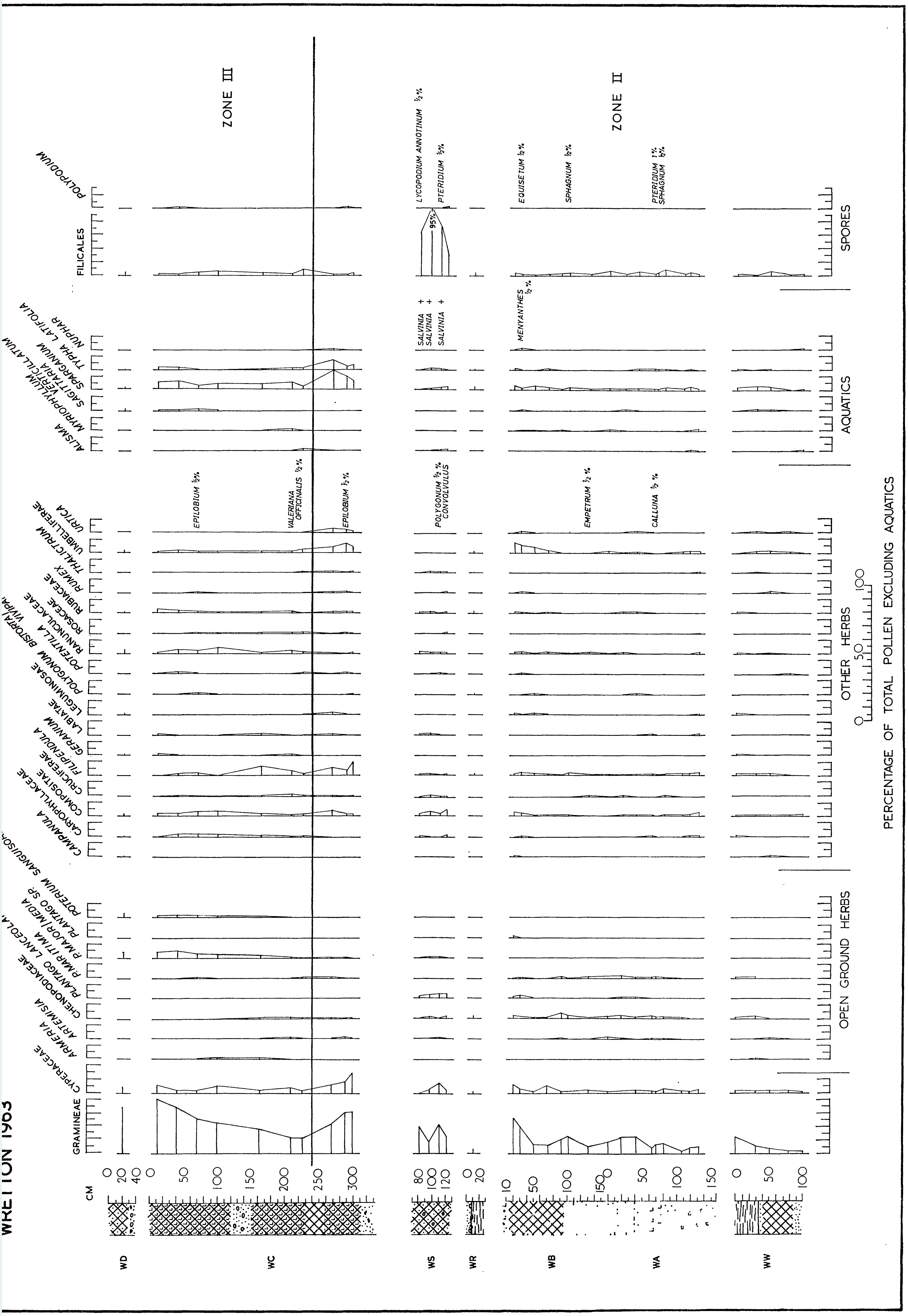

FIGURE 6. Non-tree pollen diagram.

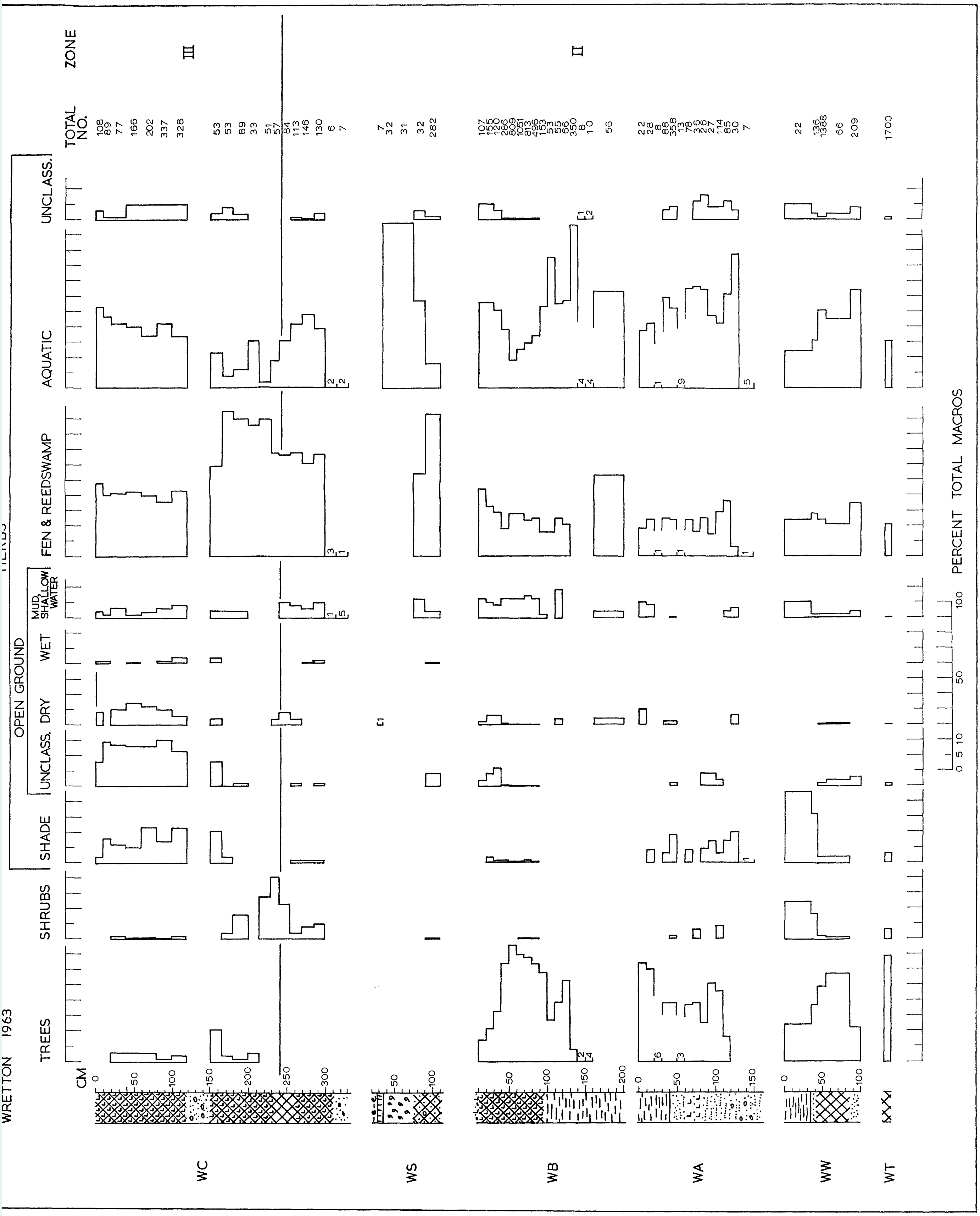

Figure 7. Frequency diagram of macroscopic plant remains. Where the total number of remains is too low for a percentage calculation, figures give the number found.

tree of local wet land, its pollen contribution was not high except where the contributory source was very near.

The non-tree pollen percentages are low. Pollen of grasses, *Artemisia*, Chenopodiaceae, and *Plantago maritima* occurs. The last is of interest in view of the brackish conditions indicated by the Mollusca at the same horizons. Pollen of aquatic species is also scarce.

There are abundant plant macroscopic remains from these fluviatile sediments. There are records of trees and shrubs; *Alnus glutinosa*, *Betula* (tree) sp., *Quercus*, *Corylus avellana*, *Sambucus nigra*, *Thelycrania sanguinea* and *Viburnum lantana*, the last two calcicolous shrubs being characteristic of the present Chalk soils in the area. There are several herbs of open ground and of the local woodland, including *Ajuga reptans*, *Stellaria holostea*, *S. neglecta* and *Valeriana offinalis*, and a long list of helophytes and aquatic species.

Table 1 lists the species found according to their ecological category and the percentage representation of these categories is shown in figure 7. The list and diagram indicate the local presence of fen carr, fen, reedswamp and open-water communities, with little evidence of open ground.

(ii) *WW* 36–100 cm *and WT*

The WW sediments below the grey silty clay are fluviatile inorganic and quiet water sandy muds. The pollen spectra are similar to those already discussed from WA 41–152 cm, except that the *Alnus* pollen frequency is high throughout, and again correlated with this is the high abundance of fruits and cones of *Alnus glutinosa*. The site of deposition was evidently near alder carr. The list of species recorded macroscopically is greater, with a greater variety of helophytes and aquatics. The high frequency of *Zannichellia* achenes relates to a brackish episode established on the basis of the mollusc analyses. The woodland species *Mercurialis perennis* and *Pyracantha coccinea* are also recorded. Other species are much more common than in WA, including the woodland element: *Ajuga reptans*, *Corylus avellana* (though the pollen percentages are about the same as in WA), *Sambucus nigra* and *Stachys* cf. *sylvatica*. At the site WT (figure 3, south of WS) a wood peat was found of similar age to the basal muds of WW. This represents a further lateral sediment variation, at the site of fen carr. Here a rich macroscopic flora was found (table 1), similar but richer again than WW. In addition to the species recorded in these previous sites, *Crataegus monogyna*, *Rosa*, *Rubus*, *Salix*, *Iris pseudacorus* and *Marrubium vulgare* are also present.

(iii) *WA* 0–41 cm; *WB* 95–160 cm; *WW* 0–36 cm; *WR*

The grey silty clay in these sections overlies the lower fluviatile series and demonstrates a silting phase of the channel. The pollen flora of the clay is uniform and similar to the older spectra. Tree and shrub pollen is dominant. *Quercus*, *Pinus* and *Corylus* are the most frequent genera, *Alnus* being represented by low frequencies. The influence of local vegetation appears to be less than in the lower sediments, but there is no reason to believe that there was much change in the regional forest composition. The flora of macroscopic plant remains is much poorer than that of the lower sediments, both in number and kind. *Typha* sp. is most abundant macroscopically, and is characteristic of silting areas. *Alnus glutinosa* is the only tree represented; there are a few species of woodland herbs, and the largest element is of helophytes and aquatics. Apart from this the proportions of the macroscopic remains of the different ecological groups (figure 7) show no consistent differences from those seen in the lower inorganic and organic deposits.

(iv) *WB* 10–95 cm

Deposition of organic clay-mud, conformably on the grey silty clay, marks the final preserved stage of the channel infilling. The ratio of tree to non-tree pollen decreases sharply towards the top of the diagram, as a result of the increase in the pollen frequency of grasses, sedges and Umbelliferae. This change may be related to the final filling stage of the channel with a consequent spread of herbs, and is also expressed by the increase of macroscopic remains of open ground herbs at the same level (figure 7). The tree-pollen frequencies remain much the same as in the basal part of the section in WW, except that there are low frequencies of *Carpinus* and *Salix* pollen and frequency of *Alnus* pollen remains high throughout, as does the frequency of macroscopic remains of *Alnus glutinosa*. The abundance of *Alnus* remains, together with the records of *Betula* fruits and *Frangula alnus* seeds, is a clear indication of neighbouring fen carr communities. The shade species *Moehringia trinervia*, *Stellaria neglecta*, *S. holostea* are also present, but they decrease in frequency towards the top, where they are replaced by species of more open ground, especially *Ranunculus* spp. There are sporadic records of species of dry open ground, but the most abundantly represented group are the remains of helophytes and aquatics. The most abundant species are *Alisma plantago-aquatica*, *Caltha palustris*, *Carex*, *Mentha aquatica/arvensis*, *Solanum dulcamara* and *Urtica dioica*, amongst fen plants, and *Hydrocharis morsus-ranae*, several species of *Potamogeton*, *Ranunculus-Batrachium*. *Scirpus lacustris*, *Sagittaria sagittifolia*, *Sparganium* species, *Stratiotes aloides*, and *Zannichellia palustris* amongst the aquatics. Again, then, there is clear evidence for fen, reedswamp and open water communities from the macroscopic plant remains (figure 7).

Throughout the time of deposition of the zone II*b* deposits so far considered, then, we have a time of high water levels with a diversity of plant communities represented, most notably alder carr and its associated herbaceous species. This high water level must be related to a high and perhaps rising sea-level, evidence of which is seen in the occurrence of brackish-water levels (figure 3). There is a strong contrast between this period and the subsequent period represented by sections WS, WC and WD, particularly in the lower frequency of tree remains, and the consequent greater frequency of herb remains in the later deposits, a difference illustrated in figure 7.

(v) *WS* 75–120 cm

Although considerable changes of river environment occurred in the interval between the deposition of the sediments of WB and WS, as described in the previous section, the tree pollen spectra in the basal sandy muds of this section show the dominance of *Pinus*, *Quercus* and *Corylus*, as in the older sediments. But the values of *Alnus* are considerably lower, *Carpinus* pollen is absent, and there are increased frequencies of pollen of *Acer* and *Taxus*, both found sparingly at the top of WB, and of pollen of *Ilex*. The tree-pollen frequency is lower than that of the non-tree pollen, and this, together with the occurrence of pollen of such open ground indicators as *Artemisia*, *Plantago lanceolata*, and *P. major/media*, indicates the more open nature of the local vegetation than in the earlier part of the interglacial. Perhaps the presence of *Acer* and *Taxus* can also be related to the openness of the vegetation, for both these genera are now characteristic of open woodland on calcareous soils, such as would have been present in the area during the interglacial. High frequencies of Filicales spores are also found in the sandy muds. In the absence of specific determination it is difficult to comment on this increased frequency. Possibly it derives from local marsh species.

The macroscopic remains from this section are less varied than in WB, but they are of considerable interest. No tree remains are present; *Corylus avellana* and *Rubus* cf. *idaeus* are found. *Ajuga* cf. *reptans* is abundant and there are a few open-ground herbs. Helophytes are the most abundant group, and there is a small group of shallow-water aquatics, including *Lemna* cf. *minor*, *Ceratophyllum demersum*, *Naias minor* and *Salvinia natans*. The last three are not recorded in any other interglacial section at Wretton.

Above the sandy mud of WS 75–120 cm is a shell marl with *Chara*, but this sediment contained no recognizable pollen and very few macroscopic plant remains apart from oospores of Characeae. Under shallowing water conditions, the marl replaced the more organic muds, but the associated vegetational changes are not known.

The macroscopic remains diagram for WS (figure 7) shows a great contrast with that from the earlier deposits. The remains are predominantly those of open ground, fen, reedswamp and aquatic communities, with no evidence for fen carr conditions.

(vi) *WC and WD*

These sections in the later channel filling at the culvert 24 site show variations in sediment type which again suggest a changing fluviatile environment. Clay-mud predominates, but there is also sand and detritus mud.

As already explained, the boundary between zone II*b* and zone III is placed at 240 cm near the base of this section, where the frequencies of *Carpinus* pollen rise to substantial values. Below this level the tree-pollen frequencies resemble those of the older sediments already considered, with a dominance of *Pinus*, *Quercus* and *Corylus*, but with the differences that low frequencies of *Carpinus* pollen are present. The frequency of *Betula* is also higher. There are low frequencies of *Acer* and an absence of *Taxus*. Above 240 cm the *Carpinus* frequencies rise to 70 % of the total tree pollen, and the frequencies of *Fraxinus* also rise slightly. Except for *Alnus* which remains at consistently low values, the other tree genera fall in frequency, as does *Corylus*. In general, these changes imply the replacement of *Quercus* by *Carpinus* in the regional woodland, a replacement accompanied by the reduced importance of *Corylus*. The significance of the high frequency of *Carpinus* is discussed further in the next section.

The low frequencies of tree pollen in the lowest part of the section may be related to local open vegetation near the meandering channel. In the lower half of the section the total tree-pollen values are depressed by the high frequency of *Corylus* and *Salix* pollen, as well as by the high frequency of grasses. Higher in the section, the shrub pollen sharply decreases, though the grass pollen continues to rise. The density of the regional woodland with *Carpinus* is not clear; the high non-tree pollen frequencies certainly indicate the abundance of open ground locally and perhaps regionally. The considerable frequencies of pollen of *Plantago major/media* and *Poterium sanguisorba* suggest the presence of openings on the base-rich soils of the region. The macroscopic plant remains discussed later lend support to this conclusion.

Other herb pollen taxa, such as *Filipendula*, are derived from local fen communities, for which there is abundant evidence from the macroscopic remains. Pollen of aquatics is well represented throughout the section, more so than in the lower parts of the interglacial.

The only macroscopic tree remains from this section are fruits of *Carpinus*, most abundant between 40 and 165 cm, corresponding to the high frequencies of *Carpinus* pollen. There are no remains of *Alnus*, and we may note the corresponding low values of *Alnus* pollen. There are more species of shrubs represented. *Rubus caesius*, *R.* cf. *fruticosa*, *Salix* sp., *Sambucus migra*, *Thelycrania sanguinea* and *Viburnum opulus* are found. The finds of *Salix* occur at the same level as the high frequencies of *Salix* pollen at the base of the section, and indicate the local presence of this genus, probably in local carr, especially in the lower half of the section. The other species are indicative of local damp soils and open calcareous habitats. There is a short list of herbs of shady habitats and of general open ground, *Stellaria neglecta* being prominent in the former group and *Ranunculus* species in the latter. Dry ground herbs are well represented (figure 7), more so than in the earlier sediments of the interglacial. Their frequency must be correlated with the open conditions of vegetation implied by the pollen spectra. The most abundant are *Scabiosa columbaria* and *Rumex acetosella* s.l. *Valerianella carinata* fruits occurred at three levels. This annual species is now a local plant of open ground in southern England.

The fen and reedswamp plants and aquatics are again abundant in this section, despite the lack of *Alnus* macroscopic remains and the increase in dry land open ground species. The assemblages are generally similar to those of the earlier sediments, except that the aquatic flora is distinctly poorer than in section WB, and the fen and reed-swamp flora richer (figure 7).

The loss of alder carr in this zone, even though conditions were evidently suitable for fen and reedswamp, is notable. A carr stage, with *Salix* rather than *Alnus*, occurs in the lower half of WC, and this carr stage is associated with a rich fen and reedswamp flora and a reduced aquatic flora. The loss of *Alnus* may be associated with either a different water-level regime related perhaps to a falling base-level occurring in the latter half of the interglacial or with a widely fluctuating summer and winter water-level, such as occurs in the north Armagh fens (White 1932) and which may hinder bush colonization. In this respect the occurrence of species of wet open ground (table 1) is confined to the later part of the interglacial and may be evidence of such fluctuating conditions.

Alternatively, there may be a climatic cause associated with the changed distribution of *Alnus*, such as lower rainfall, or increased spring droughts (McVean 1953). A convincing explanation of the scarcity of *Alnus* in zone III has yet to be found; it may be merely a local deficiency, such as occurs now at Wicken Fen, with no regional significance.

In summary, the section WC reveals the persistence of the fen and aquatic communities, the loss of alder carr in the area, the development of woodland with abundant *Carpinus* and of open habitats with basic soils.

(vii) *The* Carpinus *zone*

Noting the relative pollen frequencies of *Carpinus* and *Quercus* in zone III, and allowing for the relatively greater pollen production of *Carpinus* compared with *Quercus* (Pohl 1937), it is clear that *Carpinus* became an important woodland tree in zone III. At present *Carpinus betulus* is generally distributed in south-east England, forming oak-hornbeam woodland. On the Continent, in northern and central Europe, the tree is widespread in a variety of habitats, from the higher parts of river flood plains to the uplands, in mixed oak forest on both wetter gleyed mineral soils and dryer brown-earths, particularly in areas where too dry or wet conditions prevent the thriving of beech (Ellenberg 1963; Oberdorfer 1957; Neuhäuslova-Novotna 1965; Neuhäusl & Neuhäuslova-Novotna 1968). The abundance of the fruits in zone III indicates the local growth of the tree and from the evidence of pollen and fruits, it appears that *Carpinus betulus* occurred both in the lowland in the vicinity of the site and the neighbouring uplands, together with *Quercus*. The association tables of the various *Carpinus* communities in central Europe (Oberdorfer 1957; Neuhäusl & Neuhäuslova-Novotna 1968) which show closest similarity to the fossil record are those from the lowland flood-plain (Querco-Ulmetum carpinetosum (Pass.

1953) Mezera & Samek 1954) and from the higher parts of flood plains and uplands (Carpinion: Stellario-Carpinetum Oberdorfer 1957). In both these groups of communities *Alnus glutinosa* is generally absent, a comparable situation to the zone III fossil lists, in which *Alnus* pollen is rare and macroscopic remains absent.

Regarding the rôle of *Carpinus* in the mixed oak forest, it is significant that *Carpinus* casts dense shade, more so than *Quercus*, and it may be considered a tree of climax mixed oak forest in the absence of beech. It is probable that the progress to a *Carpinus* climax is associated with the character of the changes in pollen frequency from zone II to III. There is no need to suppose a significant climatic change to produce this development, but the presence of such a climax forest perhaps does indicate a slightly greater continentality of climate than in the area today.

(viii) *Analysis of vegetational history in a fluviatile environment*

From the point of view of investigations of vegetational history, lake sediments or bog sequences are usually taken as offering the clearest evidence of the kind required. This is especially so in the Flandrian, where a wide choice of possible sediments is available. Few sediment series of the type found at Wretton have been investigated. The alluvial deposits at Shustoke, Warwickshire, studied by Kelly & Osborne (1964) are an exception, and show, as does the present study, that such deposits can be very rewarding in terms of unravelling the local and regional vegetational history if both microscopic and macroscopic remains are analysed. Two points are apparent. First, the examination of synchronous deposits at different places in the valley with different sediments, containing contrasting pollen and macro assemblage (as in WW and WA), reveal local vegetational differences and enable explanations to be made of particular changes in the pollen curves. Secondly, variation in sediment types over a period of time can be correlated with differences in pollen and macroscopic fossil content which give some indication of the derivation of the pollen.

The first of these points is clear from the discussion already made of the interpretation of sections WA and WW. The second is well-illustrated by the behaviour of *Alnus* in these interglacial deposits. There is a strong correlation between low pollen frequencies and low numbers or absence of *Alnus* macroscopic remains. Such low values occur in the fluviatile sediments of WA (except at two restricted levels where high frequencies of fruits and cones occur) and in the silty clay, also associated with fluviatile conditions, at the top of WA, base of WB and top of WW. Most of the pollen here will have been transported in the stream and may be partly derived by run-off from soil as well as by sedimentation on to water. It is probable that the spectra have a regional significance, and this view is strengthened by the much higher values of *Alnus* found associated with abundant macroscopic remains, both in the fluviatile strongly inorganic sediments at the base of WA and in the clay-muds. We therefore conclude that *Alnus* played a minor part in the regional upland vegetation, but that it was an important tree of local fen carr in the Wissey valley in interglacial time during zone II*b*. This behaviour of *Alnus* in the interglacial is consistent with the low pollen frequencies of the tree found in other Ipswichian deposits in southern England: Bobbitshole, Ipswich (West 1957); Selsey, Sussex (West & Sparks 1960); Histon Road, Cambridge (Sparks & West 1959).

Clearly this approach to the differentiation between local and regional vegetation is a useful one, but one which requires a varied sedimentary environment.

(ix) *Climatic indications*

The Wretton interglacial sediments cover the middle part of the Ipswichian interglacial and the time of the climatic optimum of the interglacial. The amelioration at the beginning of the interglacial and the deterioration at the end, known from other sites in southern England, are not seen. There are no clear indications of a climate very different from the present climate in the area. But, as at other Ipswichian sites in England, there are species of water plants which suggests that the climate was more continental, with warmer summers than at present, or indeed than during the Flandrian climatic optimum, as the species concerned are not known from British Flandrian deposits. Such species at Wretton are *Naias minor* and *Salvinia natans*. The presence of *Pyracantha coccinea*, a native of southern Europe, also suggests a warmer climate. The abundance of *Carpinus betulus* in zone III gives similar indications, as already discussed.

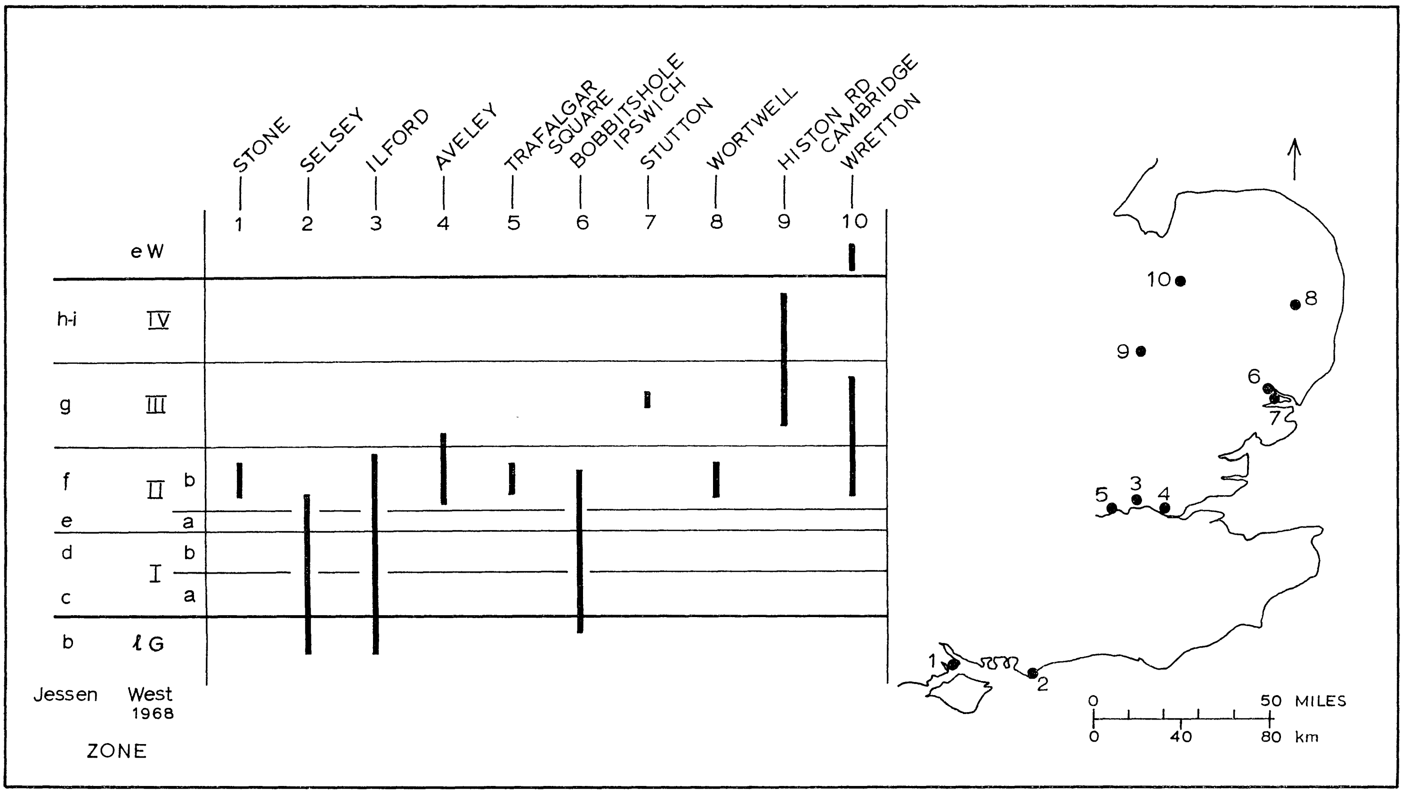

FIGURE 8. Ipswichian interglacial sites and pollen zones represented at each site.

(*c*) *Comparison with other interglacial sites of Ipswichian age*

Although on the continent in north-west Europe there are sequences of interglacial deposits in old lake basins, often kettle-holes of the Saale glaciation, such a complete sequence has not yet been found in Britain, probably because the mode of retreat of the ice of the previous glaciation did not favour the production of kettle-holes. Ipswichian interglacial deposits so far described have been found in terrace and marine transgression sequences. Figure 8 shows the occurrence of various pollen zones at the various sites. It will be seen that the *Carpinus* zone is also known from the site at Histon Road, Cambridge, where it precedes a *Pinus* zone, and from the sites at Aveley and Stutton, while the mixed oak forest zone II is known from many other sites, where it is preceded by the earlier zone of the interglacial and by the preceding late-glacial episode. The Wretton site is the first where a well-developed *Carpinus* zone follows the mixed oak forest zone, though this has already been presumed on the basis of the sequence known from north-west Europe (Jessen & Milthers 1928).

Thus the sequence of major pollen zones in East Anglia in the Ipswichian interglacial may now be considered fairly clear, and it is of interest to compare it with the sequence known for the correlative Eemian interglacial in north-west Europe. There are very considerable differences. First, there is a general lack of *Tilia* pollen in the late part of the mixed oak forest zone II, except at Aveley where a low pollen frequencies occur (West 1969). It is uncertain whether these low frequencies imply local presence of *Tilia* or distant transport. On the continent *Tilia* shows considerable pollen frequencies in the late part of Jessen's zone *f* (the correlation of Jessen's scheme with the zonation system used here is given in figure 8). Secondly, there is a lack of a *Picea* zone (Jessen's zone *h*) between the *Carpinus* and the *Pinus* zones. This latter difference may be caused by barriers to migration caused by the early rise in sea-level and the formation of an English Channel in the interglacial or by unsatisfactory ecological conditions. It is not possible to discern which alternative is correct, though the former would perhaps seem more likely in view of the fact that *Picea* occurs in the earlier interglacial periods. The absence of *Picea* may be a contributory cause to the much higher frequencies of *Carpinus* in England than are seen on the Continent, for the reason that the soil-changing effect of *Picea*, tending to work against the success of *Carpinus* by podsolisation, would be absent in this country.

4. NON-MARINE MOLLUSCA

The last interglacial deposits at Wretton are among the richest in Britain in non-marine Mollusca. The species have already been listed elsewhere, but merely in broad categories of frequency for the deposit as a whole (Sparks 1964). The precise numbers, horizon by horizon, from the various sections are listed herein (tables 2 to 5 inclusive). A total of 85 species are recorded from zones II *b* and III (*f* and *g* on the older notation used in the previous list referred to above): this may be compared with 105 species from all the Cambridge gravel deposits known or suspected to belong to this interglacial. It must be remembered that included in the latter are four major deposits as well as a number of minor deposits and that they were studied over decades and cover a wider segment of the interglacial than do the Wretton deposits.

(*a*) *General nature of the fauna*

(i) *Climate*

Like most interglacial deposits in this country the bulk of the fauna, both with regard to number of species and number of individuals, consists of wide-ranging species, tolerant of a great variety of climates, many of them still characteristic of the British fauna. In this respect the Mollusca very much resemble the plants. As these sections cover mainly the warmer parts of the interglacial, little or no climate variation can be detected from variations in frequency of the species.

However, in addition to elements of the present British fauna, there are certain species now characteristic of more southern or more continental climates. The most important of these are:

Belgrandia marginata. This small snail, now found in certain clear-water springs in the south of France, is found through most of section WA (table 2) though never very abundantly,

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			WW					WA									
	type of remains	WT	85 to 100	55 to 85	42 to 55	36 to 42	0 to 36	130 to 152	120 to 130	110 to 120	100 to 110	90 to 100	80 to 90	70 to 80	60 to 70	50 to 60
us glutinosa (L.) Gaertn.	f	∞	25	312	539	37	3	.	.	7	41	11	4	10	20	3
	c	∞	13	66	45	3	3	.	.	3	7	4	3	6	10	1
ula L. (tree sp.)	f	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rpinus betulus L.	f	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
us sylvestris L.	s	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ercus L.	cu	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
rylus avellana L.	f	10	1	5	2	.	.	.	.	.	2	.	.	.	.	.
ataegus monogyna Jacq.	s	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
angula alnus Mill.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
racantha coccinea M. J. Roem.	s	3	1	.	.	1	.	.	.	.	.	.	.	.	.	.
sa L.	s	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
saceae	th	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
bus caesius L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. *fruticosa* L. s.l.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
cf. *idaeus* L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
bus L. sp.	s	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ix L. sp.	b	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
nbucus nigra L.	s	11	1	5	8	2	.	.	.	.	1	.	.	.	.	.
elycrania sanguinea (L.) Fourr.	s	13	.	5	1	.	.	.	.	.	1	.	.	1	.	.
urnum lantana L.	s	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.
opulus L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
uga cf. *reptans* L.	n	36	15	27	22	6	.	1	3	3	2	.	.	.	3	.
rcurialis perennis L.	s	8	.	.	1	.	.	.	.	.	.	.	.	.	.	.
ehringia trinervia (L.) Clairv.	s	2	.	.	5	1	.	.	.	1	1	2	1	.	.	.
ne dioica (L.) Clairv.	s	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
chys cf. *sylvatica* L.	s	7	1	2	.	.	.	.	.	.	.	.	.	.	.	.
llaria holostea L.	s	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.
neglecta Weihe	s	1	.	.	.	1	.	.	.	1	.	.	.	.	.	.
rimonia eupatoria L.	f	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
lygonum lapathifolium L. or *P. nodosum* ers.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
nunculus acris L.	a	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.
repens L.	a	4	2	5	4	.	.	.	.	.	1	.	1	.	.	.
L. subg. *Ranunculus*	a	11	3	6	7	.	.	.	.	.	1	.	.	.	.	.
raxacum Weber	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
leriana officinalis L.	n	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
agallis arvensis L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
iplex patula L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rduus L.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rastium holosteoides Fr.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
elidonium majus L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
album L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
bonus-henricus L.	s	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
enopodium L. sp.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
sium vulgare (Savi) Ten	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
nopodium vulgare L.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
anthus L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
nium purpureum L.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
bsana communis L.	a	.	.	3	3	.	.	.	1	.	.	.	.	.	.	.
arrubium vulgare L.	n	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ris hieracioides L.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
mex acetosella L. s.l.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
biosa columbaria L.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ne nutans L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ne cf. *vulgaris* (Moench) Garcke	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
lerianella carinata Lois.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rbarea vulgaris R. Br.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
chnis flos-cuculi L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ntia fontana L. subsp. *chondrosperma* Frenzl) Walters	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
sma plantago-aquatica L.	fr	3	4	5	16	2	1	.	1	1	.	.	.	.	.	.
ocharis palustris (L.) Roem. & Schult.	n	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
mex maritimus	n+p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rula erecta (Huds.) Coville	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ltha palustris L.	s	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.

Table 1. Analysis of macroscopic plant remains

						WB																
50 to 60	40 to 50	30 to 40	20 to 30	10 to 20	0 to 10	160 to 200	150 to 160	140 to 150	130 to 140	120 to 130	110 to 120	100 to 110	90 to 100	80 to 90	70 to 80	60 to 70	50 to 60	40 to 50	30 to 40	20 to 30	10 to 20	90 to 110
3	99	25	6	14	10	.	4	2	15	28	16	9	74	270	470	634	558	154	27	19	8	.
1	28	.	.	.	.	.	.	.	.	.	.	.	7	10	16	29	9	1	2	1	.	.
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.	10	1	.	.	.	.	.	1	.	4	8	2	.	4	2	5	7	.	.	.	.	.

WS				WC																		
75 to 90	50 to 75	35 to 50	28 to 35	315 to 330	300 to 315	285 to 300	270 to 285	255 to 270	240 to 255	230 to 240	215 to 230	200 to 215	180 to 200	165 to 180	150 to 165	100 to 120	80 to 100	60 to 80	40 to 60	20 to 40	10 to 20	0 to 10
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mex maritimus	n+p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rula erecta (Huds.) Coville	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ltha palustris L.	s	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.
rex pseudo-cyperus L.	n+u	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rex cf. *pseudo-cyperus* L.	n+u	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
rex riparia Curt.	n+u	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
rex L. sp.	n	130	31	29	55	6	.	.	1	5	15	1	.	2	7	.
dium mariscus (L.) Pohl	n	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.
ilobium parviflorum Schreb.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
patorium cannabinum L.	a	10	.	10	23	2	.	.	.	3	1	1	1	.	.	.
ipendula ulmaria (L.) Maxim.	s	2	.	.	3	.	.	.	.	.	.	.	.	1	2	.
pericum tetrapterum Fr.*	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
pseudacorus L.	s	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
copus europaeus L.	n	4	.	3	3	1	.	.	.	3	3	.	.	.	1	.
ntha aquatica L. or *M. arvensis* L.	n	20	18	13	41	8	.	1	.	4	1	.	1	.	.	.
osoton aquaticum (L.) Moench	s	.	.	.	2	.	.	.	.	2	.	.	.	.	.	.
nunculus lingua L.	a	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.
sceleratus L.	a	1	.	2	5	1	.	.	.	.	1	.	.	.	.	.
rippa microphylla (Boenn.) Hyland.	s	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.
m latifolium L.	fr	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
anum dulcamara L.	s	4	1	2	3	.	.	.	.	.	1	.	.	.	.	.
tica dioica L.	a	18	1	8	57	4	1	.	.	3	.	.	2	.	.	1
ium inundatum (L.) Reichb. f.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
atophyllum demersum L.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
tine hydropiper L.	s	.	.	.	15	.	.	.	.	.	.	.	.	.	.	.
enlandia densa (L.) Fourr.	s	.	.	2	14	.	.	.	.	.	1	1	.	.	.	.
ppuris vulgaris L.	s	6	3	5	2	.	.	.	.	.	.	.	.	.	.	.
drocharis morsus-ranae L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
nna cf. *minor* L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
riophyllum spicatum L. or *. vertillatum* L.	s	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
ias minor All.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
phar lutea (L.) Sm.	s	9	.	4	.	.	.	.	.	1	.	.	.	.	.	.
mphaea alba L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
anthe aquatica (L.) Poir.	fr	.	.	2	1	.	.	.	.	1	.	.	.	.	.	.
amogeton L. sp.	s	17	2	3	3	.	.	.	.	1	1	.	.	2	.	.
alpinus Balb.	s	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
coloratus Hornem.	s	7	4	3	5	.	.	.	.	.	.	.	.	.	.	.
crispus L.	s	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.
cf. *filiformis* Pers.	s	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
natans L.	s	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.
obtusifolius Mert. & Koch	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
pectinatus L.	s	4	.	2	.	.	.	.	.	.	.	.	.	.	.	.
trichoides Cham. & Schlecht.	s	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
trichoides Cham. & Schlecht. or *. acutifolius* Link	s	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.
nunculus subg. *Batrachium*	a	39	34	30	35	5	.	1	1	15	2	.	1	.	1	.
ittaria sagittifolia L.	fr	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.
rpus lacustris L.	n	215	61	57	25	4	1	2	6	8	10	2	1	3	15	1
rganium angustifolium Michx.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
erectum L.	s	52	5	12	16	.	.	1	1	2	1	.	.	1	3	.
minimum Wallr.	s	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
atiotes aloides L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
pha L. sp.*	s	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.
nnichellia palustris L.	a	.	.	107	435	13	1	.	.	11	20	5	2	2	.	.
vinia natans (L.) All.	m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
araceae	o	4	3	1	7	7	.	1	5	3	1	2	9	12	24	8
ryophyllaceae	s	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.
pericum pulchrum L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
biatae	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
entilla L. sp.	a	4	4	1	2	.	.	.	1	1	.	.	.	.	.	.
mex L. sp.	n	3	.	3	9	2	1	.	.	2	4	.	1	2	.	.
la L. subg. *Viola*	s	4	3	1	1	.	.	.	.	.	.	.	.	.	.	.
la L. sp.	s	6	2	4	3	1	.	.	.	2	1	1	1	.	.	.

1, Trees; 2, Shrubs; 3, Herbs—shade; 4, Herbs—ope

a, achene; b, budscale; c, cone; cu, cupule; fr, frui

* Small seeds, many more of which were found in

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pen ground; 5, Herbs—open ground, dry; 6, Herbs—open ground, wet; 7, Herbs—open ground, wet or shallow water; 8, Fen and ree
uit; m, megaspore; n, nut or nutlet; o, oospore; p, perianth; s, seed or fruitstone; th, thorn; u, utricle; ∞, very many examples.
n the 'less than ½ mm' fraction.

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edswamp helophytes; 9, Aquatics; 10, Unclassified.

(*Facing p.* 16)

Table 2. Analysis of Mollusca from section WA

	WA SAMPLES	152–130	130–120	120–110	110–100	100–90	90–80	80–70	70–60	60–50	50–40	40–30	30–20	20–10	10–0	TOTAL
3	*Valvata cristata*			11	8	3	4	5	4	1	64	3			1	104
3	*Valvata* cf. *macrostoma*				10					1						11
4	*Valvata piscinalis*	4	10	194	122	20	62	123	184	95	1665	85	1	1	46	2612
	Hydrobia ventrosa			10	210	132	20	8	13	2						395
	Hydrobia ulvae					1										1
	Pseudamnicola confusa			19	13	8	1	2		1	2					46
3	*Belgrandia marginata*		3	62	110	3	6	7	15	5	97	3			13	324
4	*Bithynia tentaculata*	24	30	255	624	86	122	373	168	97	227	34	1	1	10	2052
4	*Bithynia inflata*						3				3					6
	Carychium minimum			38	21	2	2	1	5	1	15	6				91
	Carychium tridentatum			15	24	6	7	10	24		59	5				150
1	*Lymnaea truncatula*			11	18	17	7	23	38	7	98					219
2	*Lymnaea palustris*			38	62	19	25	38	32	12	88					314
4	*Lymnaea stagnalis*			2				1								3
2	*Lymnaea peregra*			13	26	19	10	8	21	4	18					119
	Lymnaea sp.	1														1
4	*Physa fontinalis*			4	1											5
3	*Planorbis carinatus*			8	?1		?2		2	2	3					18
3	*Planorbis planorbis*		2	15	17	1	2	5	4	1	1					48
	Planorbis (Planorbis) sp.			14	2						5					21
3	*Planorbis vorticulus*			12	17	1					1				1	32
3	*Planorbis vortex*			16	34		2	1	1		11					65
1	*Planorbis leucostoma*			12	8	2	1	4	9	2	15	2				55
2	*Planorbis crista*			1	2	1		1	1	2	9	3				20
2	*Planorbis contortus*				6	1			1		4					12
2	*Segmentina complanata*	1		1												2
3	*Segmentina nitida*						?1									1
	Succinea putris				4				?8	?1	?14					27
	Succinea pfeifferi			11	5	5	5	12	14	6	21					79
	Succinea sp.			12	15	5	3	18	13	4	60	6				136
	Cochlicopa lubrica			3	3		6	13	15	3	20	1				64
	Cochlicopa sp.		1	19	17	2	22	50	27	6	34	1				179
	Columella edentula			1												1
	Vertigo pusilla										1					1
	Vertigo antivertigo			?1	4			5	5	2	11					28
	Vertigo substriata							1	1		1					3
	Vertigo pygmaea	?1		1	1	1	2		2	1	10					19
	Vertigo moulinsiana							1			4					5
	Vertigo angustior			14	19	2	6	14	16	3	43	3				120
	Pupilla muscorum			3	4		5	12	8	2	11					45
	Acanthinula aculeata			1	1						2					4
	Acanthinula lamellata				2			1			5					8
	Vallonia costata		1	14	24	2	16	17	31	8	103	3				219
	Vallonia pulchella			3	10	2	5	17	31	9	71	5			1	154
	Vallonia sp.			9	10	6	3	8	10	3	55	5				109
	Clausilia bidentata	?2	1	11	11	1	8	32	16	6	8	1				97
	Arianta arbustorum			1	1		1	2	2	1	1					9
	Helix (Cepaea) sp.			1	1	1	1	2	1	1	2					10
	Hygromia hispida			5	4	1	4	8	10	2	22	2				58
	Punctum pygmaeum			10	16	2		5	8	3	56	3				103
	Discus ruderatus			?1						1						2
	Discus rotundatus							1	1		5					7
	Euconulus fulvus			9	4			6	3	2	14					38
	Vitrea contracta			10	3	2	1	?2	8	2	15					43
	Oxychilus cellarius		?1													1
	Retinella radiatula			4	7	1	1	2	4	4	12	1				36
	Retinella pura				2	1		1	1		3					8
	Retinella nitidula			3	7	2	4	4	10	5	3					38
	Zonitoides nitidus			17	14	1	4	8	18	3	83				1	149
	Vitrina pellucida			1												1
	cf. *Limax* sp.						2									2
	Agriolimax cf. *agrestis*		3	10	8		10	35	5	13		2			1	87
	Agriolimax cf. *reticulatus*	6	5	3	6	1	3	18	7	10						59
	Agriolimax cf. *laveis*	1	1	8	10		6	20	6	6						58
	Agriolimax sp.	3	1	4	2		2	7	6	3	7					35
4	'*Unio*' sp.					1	1									2
4	*Corbicula fluminalis*		1	5	62	472	313	274	199	216	485	9			2	2038
2	*Sphaerium corneum*	2	3	24	53	10	7		4		10					113
1	*Sphaerium lacustre*				11	5										16
4	*Pisidium amnicum*	1	1	16	11	12	13	25	31	41	156	4				311
1	*Pisidium casertanum*			14	11	24	6	6	14	21	36	4				136
4	*P. casertanum* var. *ponderosa*									?2						2
1	*Pisidium obtusale*				3					1	19	4				27
2	*Pisidium milium*			2	1		1	1	1	1						7
2	*Pisidium subtruncatum*			15	26	4	11	1	7							64
4	*Pisidium supinum*				32			5	3	17	30					87
4	*Pisidium henslowanum*		3	141	609	103	57	91	156	298	6356	291	2	1	33	8141
2	*Pisidium nitidum*	1	1	159	206	49	28	27	66	14	120	11				682
4	*Pisidium moitessierianum*	1			12	35	12	26	43	22	391	42				584
	TOTAL	48	68	1317	2588	1075	846	1388	1333	976	10685	539	4	3	109	20979

Table 3. Analysis of Mollusca from section WB

	WB SAMPLES	170 - 180	120 - 130	100 - 110	90 - 100	80 - 90	70 - 80	60 - 70	50 - 60	40 - 50	30 - 40	20 - 30	10 - 20	TOTAL
3	*Valvata cristata*				17	83	63	139	79	29	29	42	15	496
4	*Valvata piscinalis*				28	162	184	263	267	175	513	1764	228	3584
	Pseudamnicola confusa							8	3	2				13
3	*Belgrandia marginata*									1		1	1	3
4	*Bithynia tentaculata*				113	511	270	301	218	185	170	176	85	2029
4	*Bithynia inflata*					1	3	8	22	21	74	208	118	455
	Carychium minimum				1	11	13	48	41	6	1	? 1		122
	Carychium tridentatum					1			1				1	3
1	*Lymnaea truncatula*							3	4		3			10
2	*Lymnaea palustris*				9	26	19	48	32	7	3	? 1	3	148
4	*Lymnaea stagnalis*							1	? 1		3	3		8
2	*Lymnaea peregra*						2	6	2	2		2	3	17
3	*Lymnaea glutinosa*											? 1		1
	Lymnaea sp.		1	1	10									12
3	*Planorbis carinatus*				? 1	6	9	18	25	6	17	38		120
3	*Planorbis planorbis*					4		3	2					9
3	*Planorbis vorticulus*				8	49	64	121	90	83	152	133	5	705
3	*Planorbis vortex*				1	4		16	14	5		1	1	42
1	*Planorbis leucostoma*					6	9	11	5	1		1		33
2	*Planorbis crista*					1			1	1	9	10	2	24
2	*Planorbis contortus*					5	4	21	15	2	8	5	2	62
2	*Segmentina complanata*				2	13	14	59	46	37	74	182	14	441
3	*Acroloxus lacustris*					4	6	14	5	7	8	27	12	83
	Succinea sp.		1	1	5	20	10	30	24	3		1	2	97
	Cochlicopa lubrica									1				1
	Cochlicopa sp.				1	1	1	3						6
	Vertigo antivertigo					1	1	1						3
	Vertigo angustior					1		1						2
	Pupilla muscorum												1	1
	Vallonia costata						2	1				3		6
	Vallonia pulchella					11	5	12	7					35
	Vallonia sp.					5	4	34	17		1			61
	Clausilia bidentata					1								1
	Clausilia sp.						1							1
	Helix (Cepaea) sp.					1		1						2
	Hygromia hispida						1	? 1						2
	Punctum pygmaeum						1		1			1		3
	Zonitoides nitidus	1			? 1	16	6	15	10					49
	Agriolimax cf. *agrestis*				3	7	3		8					21
	Agriolimax cf. *reticulatus*					2	3	4	2					11
	Agriolimax sp.				2								2	4
2	*Sphaerium corneum*							? 1			1	1	1	4
1	*Sphaerium lacustre*										2	17	4	23
4	*Pisidium amnicum*				1	3	1	4	6	1		1	3	20
1	*Pisidium casertanum*					25	5	19	11	8	19	77	13	177
2	*Pisidium milium*				1	8		23	13	12	43	69	6	175
2	*Pisidium subtruncatum*					14	18	67	57	24	69	166	41	456
4	*Pisidium henslowanum*			1		1	1	7	5			1		16
2	*Pisidium hibernicum*								12	2	4			18
2	*Pisidium nitidum*				3	72	69	294	165	83	137	442	128	1393
3	*Pisidium pulchellum*								4	2	16	28	6	56
4	*Pisidium moitessierianum*											20	6	26
	TOTAL	1	2	3	207	1076	792	1606	1215	706	1356	3423	703	11090

Table 4. Analysis of Mollusca from sections WR, WS, WT, WV and WW

	SECTION	WV	WW	WW	WW	WW	WW	WT	WR	WS	WS	WS	WS	WS	WS	WS	TOTAL exc. WS 0-35
	SAMPLE		85-100	55-85	42-55	36-42	0-36			90-110	75-90	50-75	35-50	28-35	20-28	0-20	
3	*Valvata cristata*	31	1	8	18	6		5		3	2	483	1917	2	11		2474
4	*Valvata piscinalis*	3	24	359	956	105		61	2	3		96	114	1	147		1723
	Hydrobia ventrosa				10	5											15
	Pseudamnicola confusa			1	7	3											11
3	*Belgrandia marginata*		4	9	88	89		2		4	1	396	1215				1808
4	*Bithynia tentaculata*	53	3	108	1337	2320	1	24		3	5	988	1241	11	19	2	6083
4	*Bithynia inflata*	32	3	34	232	82											383
	Carychium minimum		7	14	24	13		34				3	7				102
	Carychium tridentatum		7	2	30	22		1									62
	Lymnaea truncatula														8		
2	*Lymnaea palustris*	19	3	6	28	11		9				2	15	? 1	269		93
4	*Lymnaea stagnalis*												4		6		4
2	*Lymnaea peregra*	1		7	39	4		1			1	9	19		3		81
3	*Lymnaea glutinosa*											2	21				23
1	*Aplexa hypnorum*				1												1
4	*Physa fontinalis*				4	? 2							2				8
3	*Planorbis carinatus*											30	142				172
3	*Planorbis planorbis*	? 2		4	17	3		2							43	1	28
	Planorbis (Planorbis) sp.									1				1			1
3	*Planorbis vorticulus*			67	182	15		6		1		61	168				500
3	*Planorbis vortex*	2		11	57	4		3			1	2	10				90
1	*Planorbis leucostoma*	1	2	4	13	4		5				2	1	3	953	1	32
	Planorbis laevis											3					3
2	*Planorbis crista*		2	1	4			1				13	23		17		44
2	*Planorbis contortus*			2		1											3
2	*Segmentina complanata*				2			1				18	54				75
3	*Segmentina nitida*												6				6
3	*Acroloxus lacustris*				1			2				37	154				194
	Succinea pfeifferi							? 2				? 4	6		8		12
	Succinea sp.	3		3	7	14							13		27		40
	Cochlicopa lubrica			3		1		3							1		7
	Cochlicopa sp.		1		5	7											13
	Vertigo antivertigo				1	7						2	5				15
	Vertigo pygmaea				1	2											3
	Vertigo moulinsiana				1												1
	Vertigo angustior		8	7	15	29		3									62
	Pupilla muscorum									2			1	5	34		3
	Acanthinula lamellata			2	3			2									7
	Vallonia costata		2	11	16	22		21									72
	Vallonia pulchella			9	7	4		8							? 4		28
	Vallonia enniensis		? 1										3				4
	Vallonia sp.		2	14	19	12		17						1			64
	Clausilia bidentata		? 1	2	2	1		? 1									7
	Arianta arbustorum					1											1
	Helix (Cepaea) sp.				1												1
	Hygromia hispida		1	3	3	11		5							2		23
	Punctum pygmaeum		9	6	23	38		11									87
	Discus ruderatus					1											1
	Discus rotundatus							1									1
	Euconulus fulvus		1	2	? 2	? 2		4									11
	Vitrea contracta		? 1		? 4	? 9		5									19
	Retinella radiatula				3	3											6
	Retinella nitidula							2									2
	Zonitoides nitidus		1	? 2	13	12		6				1	3				38
	Agriolimax cf. *agrestis*	4											2		3		6
	Agriolimax cf. *reticulatus*	1		1									2		4		4
	Agriolimax sp.				4	22		1				2				1	29
4	*Corbicula fluminalis*				9	26											35
2	*Sphaerium corneum*		3	2	30	12		2				1	10				60
1	*Sphaerium lacustre*			3	7	9						17	37		2		73
4	*Pisidium amnicum*	1	2	3	13	6											25
1	*Pisidium casertanum*	2	6	16	155	30		13					4		22		226
1	*Pisidium personatum*			1	1			1									3
1	*Pisidium obtusale*												1		146	? 1	1
2	*Pisidium milium*			6	22	1		7				7	30				73
2	*Pisidium subtruncatum*		2	35	116	25		126				7	23				334
4	*Pisidium supinum*					1											1
4	*Pisidium henslowanum*			5	104	341		1				1					452
2	*Pisidium hibernicum*				18	10						1	1				30
2	*Pisidium nitidum*	1	10	100	419	189		178				18	24				939
4	*Pisidium moitessierianum*			5	63	36		14	1								119
	TOTAL	156	107	878	4137	3573	1	591	3	17	10	2206	5278				16957

Table 5. Analysis of Mollusca from sections WC and WF

	WC SAMPLES	330 – 315	315 – 300	300 – 285	285 – 270	270 – 255	255 – 240	240 – 230	230 – 215	215 – 200	200 – 180	180 – 165	165 – 150	120 – 100	100 – 80	80 – 60	60 – 40	40 – 20	20 – 10	10 – 0	WF	TOTAL
3	*Valvata cristata*		1	75	127	77	35	56	5	8	25	? 1		10	13	5	1	3	15	12	159	628
4	*Valvata piscinalis*			32	45	34	7	15						49	52	44	30	35	91	51	41	526
3	*Belgrandia marginata*								4		2			3	4						10	23
4	*Bithynia tentaculata*	2	16	196	186	134	67	80	2	14	64	14	19	71	52	28	19	11	48	97	501	1621
4	*Bithynia inflata*		? 2	? 8	14	15	3	7			1			? 4	3	? 2		2	1	4		66
	Carychium minimum				? 2					4	5			1							2	14
	Carychium tridentatum							? 2														2
1	*Lymnaea truncatula*																				1	1
2	*Lymnaea palustris*			? 2		? 3	? 5	? 14	18	? 5	? 5										1	53
2	*Lymnaea peregra*				? 5				1					? 1					1			8
2	*Lymnaea* sp.																				27	27
4	*Physa fontinalis*																		2	1		3
4	*Planorbarius corneus*			1		1									1			1				4
3	*Planorbis carinatus*																		7	1		8
3	*Planorbis planorbis*			3	2	1	1	5												1	1	14
3	*Planorbis (Planorbis)* sp.																1					1
3	*Planorbis vorticulus*													1	2	3			1	1	6	14
3	*Planorbis vortex*			? 1		1		3			1				1				1			8
1	*Planorbis leucostoma*			7	10	3	1	3		1												25
2	*Planorbis crista*													1							3	4
2	*Planorbis contortus*				1						4											5
2	*Segmentina complanata*								1					4	1	2		2	16	12	3	41
3	*Acroloxus lacustris*			21	43	7		9						1	5	7	3	1	6	12	52	167
4	*Ancylus fluviatilis*																				1	1
	Succinea pfeifferi					1											1					2
	Succinea sp.	3	1	2	10	2	4	19	5	1	5	3	4	1							28	88
	Cochlicopa lubrica																				3	3
	Cochlicopa sp.			3		1								1	1					1		7
	Vertigo antivertigo					2		1			1										7	11
	Vertigo substriata								1							1						2
	Vertigo pygmaea					1																1
	Vertigo moulinsiana							1														1
	Vertigo angustior													1	1							2
	Pupilla muscorum			2										2							1	5
	Vallonia pulchella			4	1			2				1		2					2		3	15
	Vallonia sp.	1	1	11	6	2		4			2				1	2					17	47
	Clausilia bidentata			? 1				1						1								3
	Clausilia pumila										1	? 1	? 1		? 1						1	5
	Arianta arbustorum			1																		1
	Helix (Cepaea) sp.			1				3	2			? 1										7
	Hygromia hispida	2						1	? 1												1	5
	Punctum pygmaeum			3			1															4
	Euconulus fulvus	1		2		1		2													? 1	7
	Retinella radiatula			4		1					3										1	9
	Retinella pura													1								1
	Zonitoides nitidus				1			2		1	7	1	? 2				? 1				2	17
	Vitrina pellucida					1																1
	Agriolimax cf. *agrestis*																				20	20
	Agriolimax cf. *reticulatus*																				8	8
	Agriolimax sp.			4	1	4	1	1	1	2	2	2	7	1		1					1	28
2	*Sphaerium corneum*								7		3	1	2	8	5	5	7	6	6	6		56
1	*Sphaerium lacustre*													4	11	67	76	73	70	27	3	331
4	*Pisidium amnicum*										1			28	27	17	7	5	14	19	5	123
1	*Pisidium casertanum*							3		? 1			? 2	150	91	68	45	14	21	15	6	416
4	*P. casertanum* var. *ponderosa*													10	6	4	3				4	27
1	*Pisidium personatum*							3	1													4
1	*Pisidium obtusale*				2			2													3	7
2	*Pisidium milium*							1	8					2	1	1	3	2	29	25	7	79
2	*Pisidium subtruncatum*				3			4	21					58	26	49	30	18	64	71	12	356
4	*Pisidium henslowanum*	1												36	57	102	52	43	52	21	7	371
2	*Pisidium nitidum*			2	7	4	3	5	79	1	7	1	4	101	73	89	46	79	216	210	71	998
3	*Pisidium pulchellum*																1		2	4	2	9
4	*Pisidium moitessierianum*												3									3
	TOTAL	10	21	386	466	296	128	249	157	38	139	26	44	553	435	497	326	295	665	591	1022	6344

sparsely in section WB (table 3), commonly in section WW (table 4) and very abundantly in WS 75–35 (table 4). Occasional specimens occur in sections WC and WF (table 5). The very great abundance in WS is in that part of the section composed of *Chara* marl and is probably a response to local pure water conditions. *Belgrandia marginata* is known from many deposits dating from the last interglacial and occurs usually and most commonly in zone II*b*, though it apparently survived till late in the interglacial in small numbers in some localities (Sparks 1964).

Planorbis vorticulus. Although this snail still lives in Britain today, it is rather rare and local. It must have been very much more common in the last interglacial, in which the cleaner, vegetated streams probably suited it better than the more muddy streams associated with human modification of the landscape. It is common in the warmer parts of the last interglacial, zones II*a*, II*b* and III, at a number of sites (Sparks 1964).

Vallonia enniensis. This species is a typical British interglacial species, though one not confined to the last interglacial. It is very rare at Wretton, being found only in WW and WS (table 4).

Clausilia pumila. This Central European species is quite characteristic of the last interglacial deposits of the Cambridge area and Stutton, near Ipswich (Sparks & West 1964). At Wretton it occurs only in sections WC and WF in zone III (table 5) a distribution consonant with its presence elsewhere. Perhaps somewhat more continental climatic conditions in this zone suited it.

Discus ruderatus is found very occasionally in WA (table 2) and WW (table 4). It occurs in more than one British interglacial and also in the warm part of the Flandrian, always in very small numbers, a fact which may reflect real scarcity or the poor chances it has of being transported from its dry land habitat into fluvial deposits. From its history in the British Quaternary it would seem to indicate rather warm conditions, though its present distribution—it is extinct in Britain—is Arctic–Alpine and may not be entirely climatically determined.

Corbicula fluminalis is, of course, the classic interglacial species. It is common in WA (table 2), where the coarser sediments are more indicative of the stream conditions favoured by this bivalve, and rarer in section WW (table 4), where it occurs in sand, the coarsest sediment present.

The presence of these species, some of them fairly common, indicates the probability, as do the plants, of a somewhat more southern and continental climate, though the extent of the difference between the last interglacial climate and the present British climate must not be exaggerated. Summer temperatures 2 °C higher would probably suffice to explain the differences.

(ii) *General Environment*

Although there are variations in detail between the various sections, which are discussed below, certain general features characterize these Wretton interglacial deposits.

In the first place the proportion of freshwater to land snails (figures 9 and 10) is very high, particularly in sections WB, WS and WC. These sections consist generally of fine sediments and are associated with plant remains suggesting fen, reedswamp and aquatic communities.

Secondly, the proportion of marsh species among the land snails is very high (figure 9)—it is also high in WC but the total numbers of land snails here are too small to allow a significant histogram to be drawn.

Thirdly, the freshwater Mollusca, which are divided into four ecological groups in figures 9 and 10, show certain recurrent features. The grouping, which we have used on a number of occasions since it was instituted (Sparks & West 1959), consists of:

(1) Slum species, i.e. tolerating very poor conditions of poor oxygenation and periodic drought.

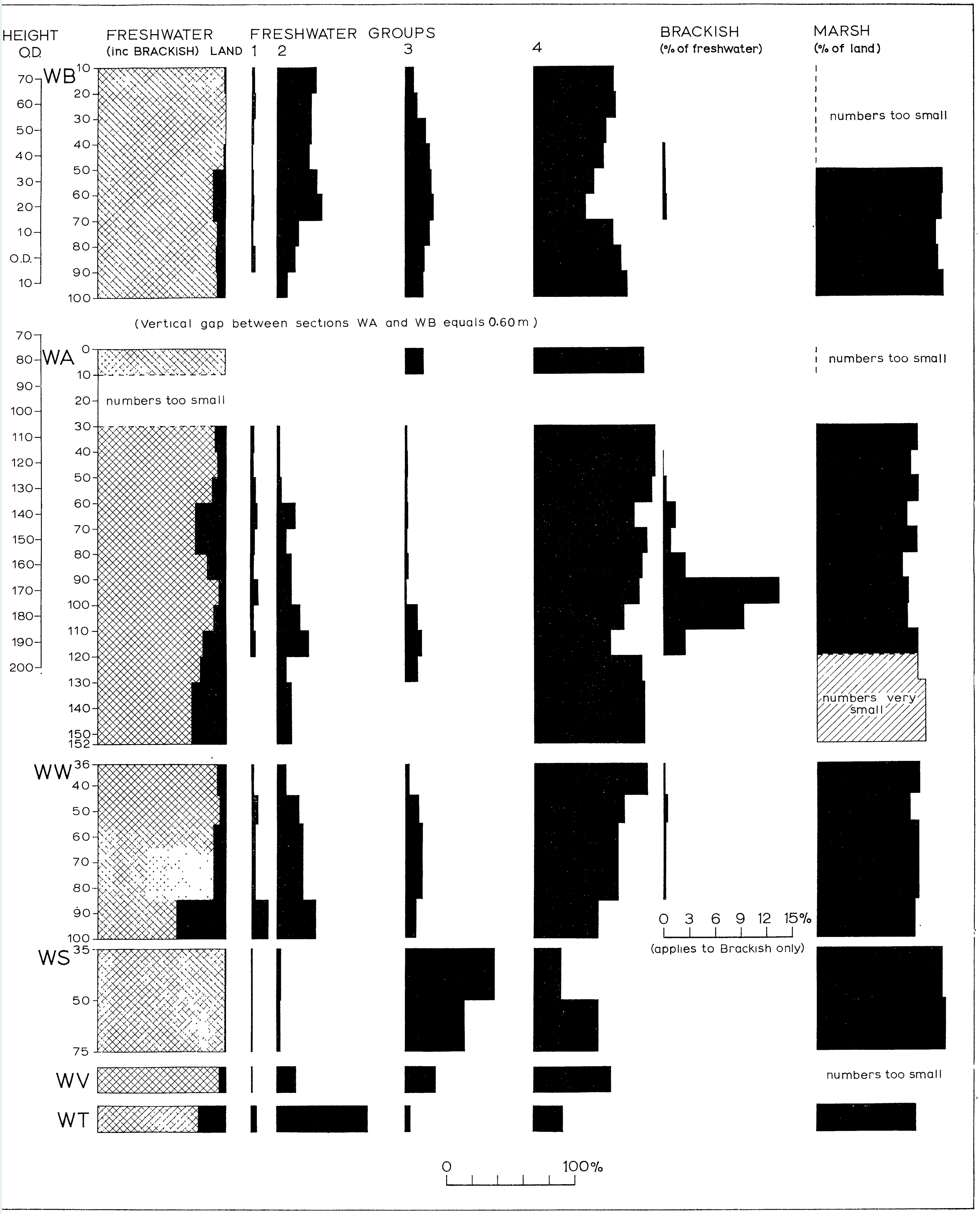

FIGURE 9. Relative frequencies of certain ecological groups of Mollusca in zone II*b* sections. Height scales in cm.

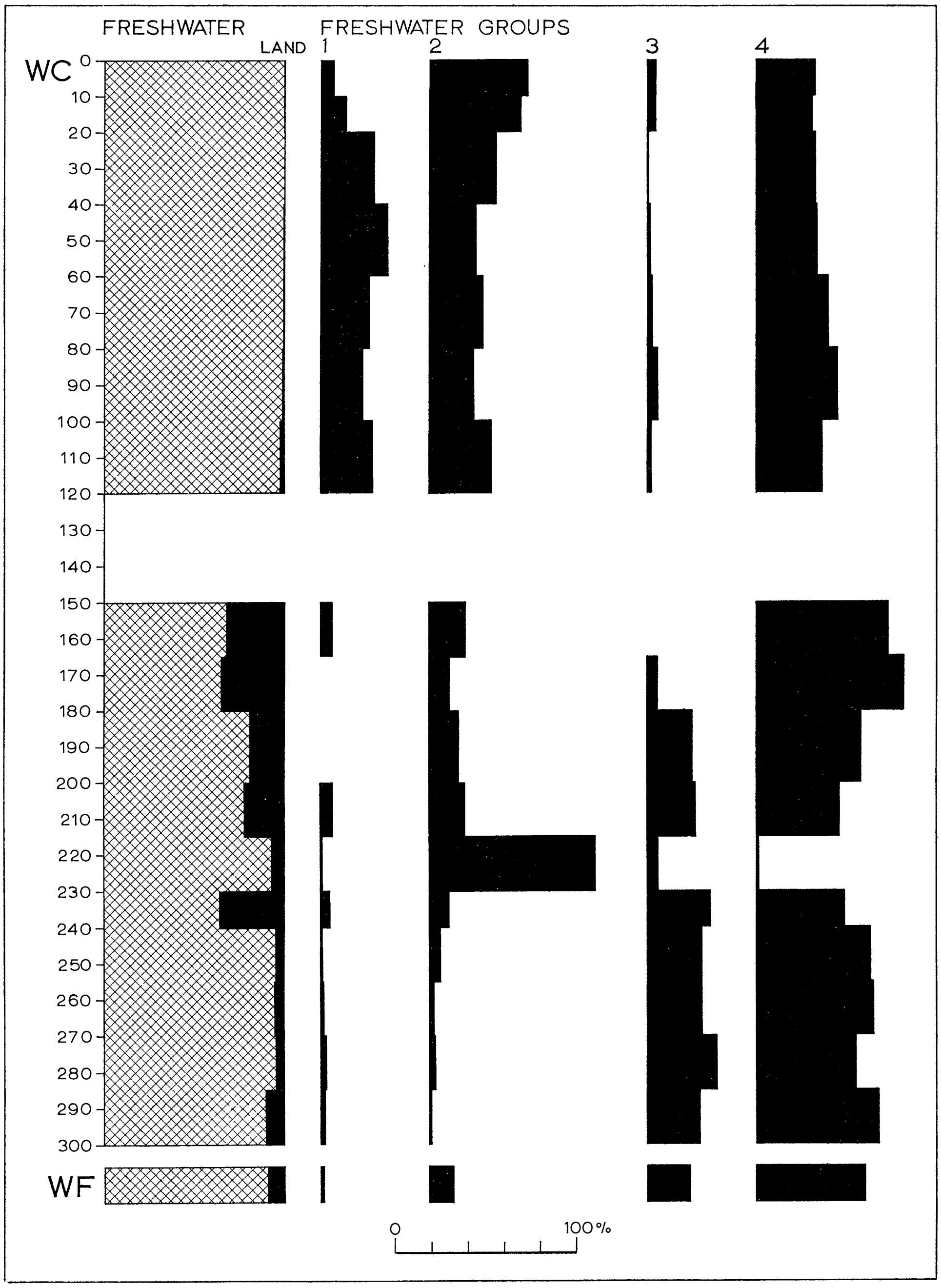

Figure 10. Relative frequencies of certain ecological groups of Mollusca in sections WC and WF. Height scale in cm.

(2) Catholic species, i.e. tolerating a wide range of conditions, but excluding conditions tolerated by slum species.

(3) Ditch species, i.e. mainly characteristic of slow-moving, plant-rich streams.

(4) Moving water species, i.e. found in large streams and ponds where currents or wind effect water movement.

Throughout the Wretton deposits there is a general scarcity of group 1 freshwater Mollusca. There is a fairly high frequency in the upper parts of WC (figure 10) though the species involved here are those that will tolerate such conditions rather than those which are confined to them. Generally group 4 dominates with subordinate group 2 and occasionally important group 3, especially in WS (figure 9).

If these three aspects are taken together it may be concluded that the Wretton interglacial deposits were laid down by a stream which was slow-running but never stagnant, and which at times was rich with aquatic plant life. There is no evidence of very rapid water flow: the larger bivalves are missing, *Ancylus fluviatilis* is represented by one specimen only (in WF), while *Corbicula fluminalis*, although often associated with coarser deposits, has been found elsewhere, e.g. Selsey (West & Sparks 1960), in fine deposits. At Wretton it occurs in WA in some of the coarser sediments present. These conclusions, largely based on the freshwater molluscs, are reinforced by the details of the distribution of land molluscs. Land molluscs are most rare in the deposits of large ponds and lakes, and next to these must rank fenland rivers with low-lying banks and marginal marsh environments. In these cases there is little gradient on the valley sides to feed in slope sediments and associated Mollusca as there would be in a normal river valley. Thus the proportion of land molluscs is small and the representation of marsh snails in that proportion is very high, as is the case at Wretton. The more clearly defined the valley and the smaller the stream the higher the representation of land snails and the higher the proportion among these of 'dry land' species. The extreme is met in the case of the deposits caused by flash floods in desert wadis, where no freshwater species can live in the normally dry valley bottoms and the deposits therefore contain only the xerophilous land species washed in off valley sides. Presumably, then, the Wretton interglacial deposits were laid down by a meandering fenland river, in most aspects a true-to-type ancestor of the present river Wissey.

(iii) *Brackish horizons*

At three horizons (figure 9) there are indications of brackish conditions. The clearest of these is in section WA and reaches a peak between −1.65 and −1.85 m O.D. The species concerned is mainly *Hydrobia ventrosa*, and only one specimen of *Hydrobia ulvae*, which is present by the million on modern Norfolk salt marshes, was found. Thus it seems likely that the deposits were only just reached by traces of sea water and a reasonable assumption would be that this was about or a little above high water springs of the time.

There is another indication, much more slight, of brackish conditions in section WW at about the same level (figure 3).

Finally, in section WB there is the slightest trace of brackish conditions between 0.15 and 0.45 m O.D. The only species concerned is *Pseudamnicola confusa*, which usually behaves as though it is the brackish species least tolerant of high salinity.

Thus it seems that during the deposition of the sediments in the sections WA, WB and WW a rising sea-level provoked extensive river aggradation and that only occasionally did the sea-level rise slightly faster than the land built up. The actual shoreline could have been a considerable distance away from the Wretton area as the gradients were slight then as they are at the present time.

(*b*) *Analysis of faunal changes through the sections*

The sediments have already been described and a correlation suggested for them (figures 3 and 4). To a considerable degree, these divisions correspond with changes in the plants and also, as will be shown below, in the Mollusca.

(i) *WA* 41–152 cm

The sediments are grey sands with clay streaks and with appreciable gravel content below 82 cm. They have been considered as stream channel deposits. A number of features of the histogram of Mollusca (figure 9) supports this view. In WA as a whole, group 4, the freshwater Mollusca requiring running water, is at a maximum and group 3, those often found in plant-rich, slow-running streams, is at a minimum. Further, land species are generally higher in this section, another characteristic of stream deposits rather than fen or pond deposits, while the proportion of land snails which are marsh species is somewhat lower than normal for the Wretton sections. This is the zone of dominant *Corbicula fluminalis*, normally a true stream species, which drops dramatically in frequency at WA 40 cm with the change in deposition; so too does *Pisidium amnicum*, another pointer in the same direction. The majority of the *Corbicula* are adult shells, or broken pieces, and not juveniles, which might have been born but not survived in poor conditions. Several of the land species must have been washed into the river from environments other than riverside marsh, e.g. *Carychium tridentatum* which is the less hygrophilous of the two British species and the more common here; *Pupilla muscorum*, usually xerophilous, and *Vallonia costata*, also dry-loving; *Clausilia bidentata*, *Acanthinula aculeata* and *A. lamellata* are scrub or woodland species, so too are *Discus rotundatus* and *Retinella nitidula*.

(ii) *WW* 36–100 cm *and WT*

In many respects there are similarities between these sections and WA 41–152 cm. On the whole WW (figure 9) shows rather fewer group 4 freshwater molluscs and more of group 3 while the proportion of land molluscs is somewhat lower and the proportion of marsh species in the land total higher. Yet this section has *Corbicula fluminalis*, which was only found in WA and WW: it has practically equal numbers of *Carychium tridentatum* and *Carychium minimum*; *Vallonia costata* is quite common and *Acanthinula lamellata* occurs. It would seem that the stream had access to this site without it forming part of the main channel for the whole time as seems to be the case in WA. WT, a wood peat representing a fen carr, shows far more group 2 freshwater species, the catholic group, but there are still a number of non-marshland species, e.g. *Vallonia costata* and *Acanthinula lamellata*, as though the stream occasionally affected it.

(iii) *WA* 0–41 cm, *WB* 95–160 cm, *WW* 0–36 cm *and WR*

Little can be said about these from the point of view of Mollusca, which are almost completely absent in WR (table 4), WW 0–36 cm (table 4), and WB below 100 cm (table 3). In the upper parts of WA they occur only at 0–10 cm and 30–40 cm, but it is difficult to draw conclusions from so small numbers. It may be significant that the Mollusca are so rare. So too were the macroscopic plant remains. This could mean a fairly rapid silting of the channel.

(iv) *WB* 10–95 cm

The fine sedimentation and the plants have indicated that this represents the final silting-up of the channel. The Mollusca indicate quieter water conditions and less contribution from the banks, which seem to have been marshier. Compared with WA (figure 9) the percentage of group 4 freshwater molluscs drops, while groups 2 and 3 rise. It must not be thought that this indicates a really stagnant cut-off body of water, but rather a slow, well-vegetated, well-aerated stream, perhaps like a natural fen drain. The land snails are fewer and almost totally marsh species. *Carychium minimum* dominates *Carychium tridentatum*, whereas in WA and WW the reverse was true though the domination was not so absolute. Similarly, *Vallonia costata* is much scarcer than *Vallonia pulchella*, again the reverse of the conditions, in WA and WW. All this agrees very closely with the plants, where there are sporadic records of open dry ground species but a dominance of helophytes and aquatics.

(v) *WS* 35–120 cm

No comment can be made on the section from 75–120 cm as there are very few Mollusca (table 4). It is a pity that no pollen and few macroscopic plant remains were found in the sediment from 35–75 cm, as it is extremely rich in Mollusca. Obviously this *Chara* marl was deposited in a cut-off pool or something of the sort, for group 4 freshwater molluscs are almost as low as anywhere in these sections, land molluscs are very rare and almost all hygrophiles apart from one specimen of *Pupilla muscorum*, while group 3 freshwater molluscs, those liking pure water rich in plants, are abundant. This is mainly due to the very great frequency of *Belgrandia marginata* and *Valvata cristata*.

At WS 35 cm there is a major break in sedimentation and the upper part of WS is Weichselian, not interglacial. The complete break in species and in the representation of the freshwater mollusc groups is shown in figure 11, the two horizons being separated by only 7 cm of what seems to be a weathered soil horizon. At this level the more southern species, e.g. *Belgrandia marginata*, *Planorbis vorticulus*, *Segmentina nitida* and *Acroloxus lacustris*, disappear.

(vi) *WC and WF*

These sections consist generally of fine clay-muds and detritus muds, the horizon of sand with flints, i.e. WC 120–150 cm, having no molluscs. These sections on the whole must represent quiet stream conditions: in WC 160–300 cm the proportion of group 3 freshwater molluscs is high, while in the upper part, WC 0–120 cm, the high proportion of groups 1 and 2 of freshwater molluscs, together with the very low percentage of land snails, would seem to indicate shallower, poorer water conditions with perhaps local periodic drying out. This conclusion seems compatible with that derived from the macroscopic plant remains (figure 7), where fen, reedswamp and aquatic plants combined bulk higher in WC 160–300 cm than in WC 0–120 cm, which has a higher proportion of open ground and shade plants.

5. Relative land/sea-level changes

The discussion of the meaning of brackish horizons is beset by the fact that whether the sea invades a particular area depends partly upon the height of sea-level and partly upon the induced rate of aggradation of rivers draining into that area. It is in this light that we must review the fact that an important brackish horizon occurs at −1.95 to −1.20 m O.D. and that further indications occur as high as +0.15 to +0.45 m O.D. at Wretton.

The first striking fact is that the main brackish horizon indicated above is almost identical in elevation with the marine transgression at Selsey (West & Sparks 1960), which occurs at −1.76 m O.D. As both of these occur fairly early in zone II*b*, it seems that the evidence for sea-level changes is very similar in both places. One cannot be absolutely certain of this, because precise correlations within pollen zones is not at all easy, especially when sedimentation is rapid.

However, there is no evidence whatever at Wretton for true marine conditions succeeding

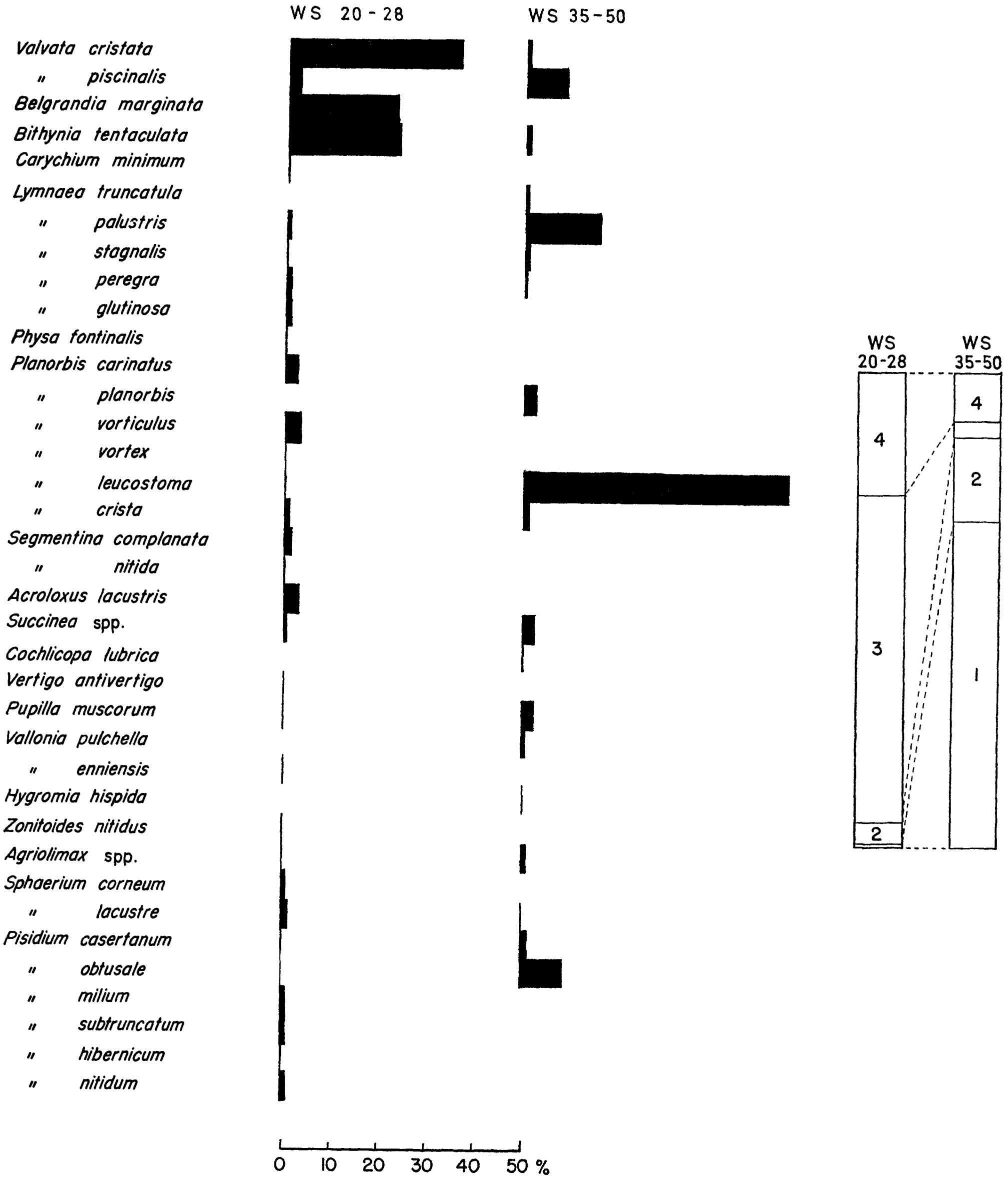

Figure 11. Changes in individual species and ecological groups of Mollusca across the unconformity in section WS.

the brackish conditions, unlike Selsey and the Sussex area in general where marine gravels, extending up to some 12 m o.d., lie above the Selsey deposit, although only a small thickness can be proved to be in contact with that deposit. On the other hand, the March gravels (Baden-Powell 1934), which are widespread in the central Fenland, range up to 10–12 m o.d., very much the same as the highest elevations reached by the Sussex gravels. They have a rich marine fauna, associated with *Corbicula fluminalis* and other freshwater Mollusca, and are generally considered to be last interglacial in age. In this respect they agree very well with what might have been expected from the height of last interglacial aggradation in the Cam valley (Sparks & West 1959) to about 12–13 m or a little above in the Histon Road deposits. It may be that the March gravels are not true marine gravels but marine gravels pushed up or reworked by the ice and meltwater of the Weichselian ice sheet, thought to be represented in this area by the Hunstanton Till. They would then be similar to the *Corbicula* gravels associated with Weichselian hummocky moraine in east Lincolnshire and Holderness. On the other hand, they do fit well with the Cam valley aggradation, which is much nearer the meridian of the March gravels than the Wretton deposits, and it might seem better to recognize them as last interglacial deposits *in situ*.

If the March gravels are glacially reworked, then there is no problem of explaining the relative attitude of the Wretton deposits. If they are not reworked, we must assume either that the Wretton area, which is some 25 km east of the March gravel area, is downwarped, or that the evidence for higher aggradation at Wretton has been eroded away. There is an important though not very visible unconformity, only clearly shown in WS, between zone II*b* and III deposits and the succeeding Weichselian deposits of the terrace. It is possible that either marine sediments or the fluvial sediments associated with the aggradation caused by a rising sea-level, as in the Histon Road deposits, were deposited and then eroded away, the truncated remains of the section (the various interglacial sections described herein) being later covered with Weichselian sediments. In this connexion it must be stated that we know of no higher terrace remnants representing this conjectured phase in the Wretton area.

There is possibly another way out of this dilemma. Zone II*b*, as interpreted in this account of Wretton, was a phase of aggradation in which a rising sea-level was offset by induced fluvial sedimentation. These sediments in WB run up to about 0.75 m O.D. still in zone II*b*. On the other hand WC starts at about -2.0 m O.D. late in zone II*b* and changes into zone III at about -1.5 m O.D. On the face of it this looks very much like an oscillation of base level high in zone II*b*. It is possible to get sedimentation of a later age at a lower level by assuming that the later sedimentation was river channel sedimentation and that the earlier was flood-plain sedimentation, but the reverse seems to be more likely if one compares the interpretation of sections WA and WC given above. Furthermore, an oscillation of base-level of a similar type and age has already been suggested by us (Sparks & West 1963) to explain the relative attitudes of the Bobbitshole zone II*b* deposits and the Stutton zone III deposits near Ipswich.

Somewhere in East Anglia there must have been a hinge line or hinge zone separating the downwarped from the non-affected areas. The March gravels and the Cam river gravels seem to be on the non-affected side of this line. On the basis of the interglacial evidence alone it is difficult to decide what the position of Wretton was, because deposits may have been eroded away. However, the Weichselian deposits, lying in the same terrace above the interglacial deposits, are at very much the same elevation as the Intermediate Terrace of the Cam valley (Sparks & West 1965) and the Great Ouse terrace immediately north of Earith, so that little differential downwarping occurred around the Fens since that date. But in the Cam valley the Weichselian deposits lie in a terrace below that in which the Ipswichian interglacial deposits are found, whereas at Wretton they lie above the interglacial deposits in the same terrace. This may suggest relative downwarping at Wretton after zone III and before the Weichselian deposition, with little differential movement since; if so, the marine transgressions at comparable heights at Selsey and Wretton cannot be contemporaneous.

We thank Dr G. P. Larwood for drawing our attention to the deposits, and Dr K. Rybnicek for discussion of the *Carpinus* problem. We gratefully acknowledge the help and co-operation given us by the engineers of the Great Ouse River Board's flood protection scheme, by the contractors, Sir Lindsay Parkinson, and by the consulting engineers, Sir M. Macdonald and partners.

Appendix. Stratigraphy of sections analysed for flora and fauna

WA

cm	
0–41	Grey silty clay
41–52	Grey sandy clayey silt with shells
52–64	Grey gravelly sand with *Corbicula*
64–66	Grey shelly clay
66–69	Grey shelly sand
69–70	Grey shelly clay
70–81	Grey sand with few shells
81–82	Grey clay with few shells
82–152	Grey sand with few shells, flint and wood fragments; at 80–100 cm large bivalves present and at 120–122 cm and at 135 cm light brown sandy silt layers
	Gault Clay

WB. Terrace sands. 2.3 m stratified sands, overlain by 1 m of rusty sandy gravel contorted by involutions

cm	
0–10	Grey clay with Chalk pebbles
10–15	Grey clay-mud
15–28	Light-brown clay-mud
28–87	Brown shelly clay-mud
87–95	Transition
95–200	Grey silty clay

160 cm depth at this section is level with the 0 cm level of WA.

WF. A bulk sample of material dredged out in the vicinity of section WC. Although not stratified it was full of *Carpinus* fruits and there can be no doubt that it belongs to zone III

WR. Muddy sand, as at 75–110 cm of WS

25 cm	Sand and coarse flint gravel with Chalk pebbles, forced into underlying clay
	Grey silty clay, as at base of WB

WS. 3 m of terrace sands, stratified, then

cm	
10	Clayey grey sand*
100	Grey sand, stony at base*
0–20	Grey-brown clayey silt with few Mollusca*
20–28	Grey-brown shelly clay*
28–35	Brown mud, weathered
35–75	Grey shell marl
75–120	Silty sandy mud with wood fragments and a few black flints

WV. Yellow unsorted sand

cm	
0–20	Brown clay-mud
20–25	Transition
25–60	Grey silty clay, as at base of WB

* Weichselian.

WC. Terrace sand with Chalk pebbles and flints at base, then:

cm	
0–5	Light brown clay-mud
5–120	Dark grey-brown clay-mud
120–150	Grey sand with flints
150–230	Brown-grey clay-mud
230–232	Transition
232–255	Brown detritus mud
255–300	Grey-brown sandy clayey mud
300–310	Grey muddy clay
310–315	Grey sand
315–330	Grey clayey sand and Chalk pebbles

WD. Terrace sand (base at same level as in WC), then

0–30 cm	Grey-brown sandy mud
	Grey sand with Chalk pebbles and flints, as at base of WC.

WW

cm	
0–36	Grey silty clay, as at top of WA
36–42	Grey sand with *Corbicula*
42–85	Brown-grey sandy detritus mud
85–100	Grey fine sand

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* Used in the construction of figure 8.

Table 1. Analysis of macroscopic plant remains

				WW					WA														WB																WS					WC																		
		type of remains	WC	85 to 100	56 to 85	42 to 56	36 to 42	0 to 36	130 to 162	120 to 130	110 to 120	100 to 110	90 to 100	80 to 90	70 to 80	60 to 70	50 to 60	40 to 50	30 to 40	20 to 30	10 to 20	0 to 10	180 to 200	160 to 180	140 to 160	130 to 140	120 to 130	110 to 120	100 to 110	90 to 100	80 to 90	70 to 80	60 to 70	50 to 60	40 to 50	30 to 40	20 to 30	10 to 20	90 to 110	75 to 90	50 to 75	35 to 50	26 to 35	315 to 330	300 to 315	285 to 300	270 to 285	255 to 270	240 to 255	230 to 240	215 to 230	200 to 215	180 to 200	165 to 180	150 to 165	100 to 120	80 to 100	60 to 80	40 to 60	20 to 40	10 to 20	0 to 10
1	*Alnus glutinosa* (L.) Gaertn.	f	∞	25	312	380	37	8	.	.	7	41	11	4	10	20	3	99	25	6	14	10	.	4	2	15	28	16	9	74	270	470	684	568	154	27	19	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		c	∞	13	60	16	3	5	.	.	3	7	4	3	6	10	1	28	.	.	.	.	.	.	.	.	.	.	.	7	10	18	29	9	1	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Betula L. (tree sp.)	f	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
	Carpinus betulus L.	f	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	6	7	2	7	5	2	.	.
	Pinus sylvestris L.	s	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Quercus L.	cu	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	*Clematis vitalba* L.	f	10	1	5	2	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Crataegus monogyna Jacq.	s	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Frangula alnus Mill.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Pyracantha coccinea M. J. Roem.	s	3	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Rosa L.	s	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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	Rubus caesius L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
	R. cf. *fruticosus* L. s.l.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.
	R. cf. *idaeus* L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Rubus L. sp.	s	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
	Salix L. sp.	b	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	9	6	.	.	.	.	.	.	.	.	.	.	.
	Sambucus nigra L.	s	11	1	5	8	2	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	6	2	1	9	1	.	3	.	.	1	.	1	1	.	.	.
	Thelycrania sanguinea (L.) Fourr.	s	13	.	6	1	.	.	.	.	.	1	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3	.	.	.	.	.	.	.	.	.
	Viburnum lantana L.	s	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	V. opulus L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
3	*Ajuga* cf. *reptans* L.	n	86	15	27	22	6	.	1	3	3	2	.	.	.	3	.	27	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	2	1	.	3	.
	Mercurialis perennis L.	s	3	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Moehringia trinervia (L.) Clairv.	s	2	.	.	5	1	.	.	.	1	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	2	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.
	Silene dioica (L.) Clairv.	s	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	1	.
	Stachys cf. *sylvatica* L.	s	7	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	2	.	.	1	.	.	.	.
	Stellaria holostea L.	s	2	.	.	.	.	.	.	.	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S. uliginosa Weihe	s	1	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	7	4	2	2	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	8	40	18	22	8	6	4	2
4	*Agrimonia eupatoria* L.	f	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Polygonum lapathifolium L. or *P. nodosum* Pers.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	1	.	.	.	.
	Ranunculus acris L.	a	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	3	2	.	1	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	R. repens L.	a	4	2	5	4	.	.	.	.	.	1	.	1	.	.	.	3	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	2	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	3	5	3	5	2	1
	R. L. subg. *Ranunculus*	a	11	3	9	7	.	.	.	.	.	3	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	1	7	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	8	30	60	27	23	8	15	8
	Taraxacum Weber	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Valeriana officinalis L.	a	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
5	*Anagallis arvensis* L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
	Atriplex patula L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Carduus L.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Cerastium holosteoides Fr.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
	Chenopodium rubrum L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	C. album L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	.	.	.	2	.	.	.	.	.	.
	C. bonus-henricus L.	s	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
	Chenopodium L. sp.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.
	Cirsium vulgare (Savi) Ten.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Clinopodium vulgare L.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.
	Dianthus L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
	Lamium purpureum L.	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
	Lapsana communis L.	a	.	.	3	3	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.	1	.	1
	Leucanthemum vulgare L.	a	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1
	Picris hieracioides L.	a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Rumex acetosella L. s.l.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	8	2	1	.	.
	Scabiosa columbaria L.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	10	5	4	1	.	1
	Silene nutans L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Silene cf. *vulgaris* (Moench) Garcke	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
	Valerianella carinata Lois.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.
	Barbarea vulgaris R. Br.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
	Lychnis flos-cuculi L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
	Montia fontana L. subsp. *chondrosperma* (Fenzl) Walters	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	3	6	.	1	.	1	1
	Alisma plantago-aquatica L.	fr	5	1	5	10	2	1	.	1	1	.	.	.	.	.	.	1	.	.	1	1	1	.	.	.	.	5	.	2	28	53	62	48	17	4	7	6	8	2	.	.	.	5	1	7	3	2	4	.	.	.	2	1	1	12	6	1	1	1	1	1
	Eleocharis palustris (L.) Roem. & Schult.	n	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	3	2	1	1	.	.
	Scirpus maritimus	n+p	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	2
	Berula erecta (Huds.) Coville	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	1	6	2	2	1	.	.	4	.	.	.	.	.	.	.	.	2	1	.	13	5	8	3	.	.	1	.	.	.	.	.
	Caltha palustris L.	s	1	1	2	.	.	.	.	.	.	.	.	.	.	.	.	10	1	.	.	.	.	.	1	.	4	4	2	.	4	2	6	7	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.	9	3	6	2	.	1	.	.	.	.	.	.
	Carex paniculata L.	n+u	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Carex cf. *pseudocyperus* L.	n+u	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Carex riparia Curt.	n+u	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	1	.	.	.	.	.	.	.	.	1	.	.
	Carex L. sp.	n	139	31	20	55	6	.	.	1	5	15	1	.	2	7	.	37	7	.	.	.	2	.	.	.	.	.	.	7	10	40	34	65	5	7	14	13	59	4	.	.	.	.	1	12	9	9	18	9	1	7	23	18	11	57	37	12	11	3	5	10
	Cladium mariscus (L.) Pohl	n	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Epilobium parviflorum Schreb.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
	Eupatorium cannabinum L.	a	10	.	10	23	3	.	.	.	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	2	3	8	3	1	.	.	1	5	6	.	.	.	.	.	.	.	.	.	.	.	.	1	.	3	1	.	.	.	.	.	.
	Filipendula ulmaria (L.) Maxim.	s	2	.	.	3	.	.	.	.	.	.	.	.	1	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	10	8	2	.	1	8	.	.	1	.
	Hypericum tetrapterum Fr.*	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Iris pseudacorus L.	s	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lycopus europaeus L.	n	1	.	3	3	1	.	.	.	3	3	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	3	6	9	.	2	1	1	9	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	3	6	10	1	2	.	2	.
	Mentha aquatica L. or *M. arvensis* L.	n	20	16	13	41	8	.	1	.	4	1	.	1	.	.	.	1	2	.	.	2	4	.	.	.	.	.	1	2	12	45	48	44	10	1	3	8	33	.	.	.	.	.	.	.	1	2	1	1	6	5	2	.	.	9	12	13	1	1	4	6
	Myosoton aquaticum (L.) Moench	s	.	.	.	2	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	4	.	3	.	.	.
	Ranunculus lingua L.	a	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3	1	.	.	.	.	.	.	1	6	6	10	5	.	.	.	.	.	.	.	.	3	1	1	.	.
	R. sceleratus L.	s	1	.	2	6	4	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	3	3	3	.	1	5	6	.	.	106	6	.	.	.	1	1	30	32	28	16	14	.	.	.	1	.	5	8	14	13	11	9	18
	Rorippa microphylla (Boenn.) Hyland.	s	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Sium latifolium L.	fr	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Solanum dulcamara L.	s	4	1	2	8	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	8	27	10	1	1	.	1	.	.	.	.	.	.	.	4	4	2	6	8	6	3	2	3	5	9	7	1	1	.	.	1
	Urtica dioica L.	a	12	1	8	57	4	1	.	.	3	.	.	3	.	.	1	1	.	1	1	.	13	.	.	.	.	.	.	.	1	11	10	2	2	6	13	10	7	.	.	.	.	.	.	18	24	14	1	5	.	1	10	14	2	16	10	13	15	7	7	6
	Apium inundatum (L.) Reichb. f.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Ceratophyllum demersum L.	fr	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Elatine hydropiper L.	s	.	.	.	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Groenlandia densa (L.) Fourr.	s	.	.	2	14	.	.	.	.	.	1	1	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Hippuris vulgaris L.	s	9	3	5	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Hydrocharis morsus-ranae L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	5	6	5	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Lemna cf. *minor* L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.
	Myriophyllum spicatum L. or *M. verticillatum* L.	s	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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	Nuphar lutea (L.) Sm.	s	9	.	4	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Nymphaea alba L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Oenanthe aquatica (L.) Poir.	fr	.	.	2	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	3	2	3	1	.	2	1	.	.	.	.	.	1	1	10	17	17	9	8	.	2	2	.	1	1	2	.	1	1	.	.
	Potamogeton L. sp.	s	37	2	3	3	.	.	.	.	1	1	.	.	2	.	.	2	1	.	.	.	.	.	.	.	.	.	.	4	3	10	15	4	8	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	1	1	3	5	.	1	.
	P. alpinus Balb.	s	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	5	12	7	8	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	P. coloratus Hornem.	s	7	4	3	6	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	P. crispus L.	s	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	6	1	.	12	7	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	P. cf. *filiformis* Pers.	s	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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	P. obtusifolius Mert. & Koch	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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	P. [illegible] Cham. & Schlecht.	s	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	P. trichoides Cham. & Schlecht. or *P. acutifolius* Link	s	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	.	.	.	.
	Ranunculus subg. *Batrachium*	a	39	34	30	35	5	.	1	1	16	3	.	1	.	1	.	10	4	.	1	.	.	.	.	.	3	.	.	1	11	13	41	23	30	19	22	9	3	1	.	.	.	.	.	2	1	.	.	.	.	.	.	.	1	6	3	.	.	1	1	2
	Sagittaria sagittifolia L.	fr	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	2	8	3	3	.	21	26	.	1	.	.	.	.	.	1	1	4	.	.	.	.	.	.	.	7	24	30	38	17	27	36
	Scirpus lacustris L.	n	215	61	57	26	4	1	2	6	8	10	2	1	3	13	1	81	23	.	.	.	4	.	.	.	.	.	18	41	48	33	44	7	13	11	7	.	3	1	.	.	.	.	.	1	4	1	3	.	.	.	1	.	.	42	30	7	4	3	3	1
	Sparganium angustifolium Michx.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	S. erectum L.	s	52	6	12	16	.	.	1	1	2	1	.	.	1	3	.	9	1	.	.	.	.	.	.	.	.	.	.	2	3	2	12	2	.	.	1	1	14	11	.	.	.	.	.	.	.	.	1	2	1	.	.	2	.	.	4	1	.	1	.	.
	S. minimum Wallr.	s	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
	Stratiotes aloides L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Typha L. sp.*	s	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	1	6	6	26	13	3	380	24	25	26	10	12	6	8	2	6	.	8	2	2	1	.	.	.	.	.	3	13	3	1	.	.	5	.	.	.	.	.	1	.	.	.	.
	Zannichellia palustris L.	a	.	.	107	485	18	1	.	.	11	30	3	2	2	.	.	.	1	.	.	.	.	1	1	6	7	.	1	2	5	4	4	2	.	1	1	.	.	.	.	.	.	.	.	10	12	13	4	.	.	.	2	.	5	20	22	4	4	3	3	5
	Salvinia natans (L.) All.	m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	∞	∞	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Characeae	o	4	3	1	5	7	.	1	5	3	1	2	3	12	24	3	10	12	.	1	.	1	.	.	.	.	.	.	1	3	4	1	3	.	1	.	.	.	.	31	32	.	1	.	.	4	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.
	Caryophyllaceae	s	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Hypericum pulchrum L.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
	Labiatae	n	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	1	.	.	.
	Potentilla L. sp.	a	1	4	1	2	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	1	1	1	.	.	2	7	4	.	1	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	7	9	5	8	1	1	8
	Rumex L. sp.	n	3	.	3	9	2	1	.	.	2	4	.	1	2	.	.	7	1	.	.	.	2	.	.	.	.	.	.	.	2	.	1	3	2	2	.	1	4	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.	5	8	1	1	.	.	.
	Viola L. subg. *Viola*	-	4	3	1	1	.	.	.	.	.	.	.	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Viola L. sp.	s	6	2	4	3	1	.	.	.	2	1	1	1	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	4	4	1	4	.	.	.

1, Trees; 2, Shrubs; 3, Herbs—shade; 4, Herbs—open ground; 5, Herbs—open ground, dry; 6, Herbs—open ground, wet; 7, Herbs—open ground, wet or shallow water; 8, Fen and reedswamp helophytes; 9, Aquatics; 10, Unclassified.

a, achene; b, budscale; c, cone; cu, cupule; fr, fruit; m, megaspore; n, nut or nutlet; o, oospore; p, perianth; s, seed or fruitstone; th, thorn; u, utricle; ∞, very many examples.

* See the text, many more of which were found in the 'less than ½ mm' fraction.

(Facing p. 10)