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Heaths, woods and hedges: some historical perspectives on Norfolk's 'natural' landscapes

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The study of landscape history, and natural history, have long been connected, in the county of Norfolk perhaps more than anywhere else in England. From the early years of the twentieth century W.G.Clarke was fully aware that, in order to understand the character of the natural environment, some knowledge of past forms of land use and management were essential. Indeed, Clarke seems to have made little distinction between the study of human settlement, and the study of the natural environment. His most famous work, *In Breckland Wilds*, breaks conventional disciplinary divisions with gusto: the particular characteristics of Breckland, a region which was itself Clarke's own invention, are explained through a wide-ranging consideration of both natural and human influences, the latter including – in his description of rabbit farming especially – contemporary modes of exploitation.

Although people like Clarke were, in effect, doing what we would today describe as landscape history, the latter did not really emerge as a distinct and recognised discipline until the work of W.G.Hoskins, Maurice Beresford and others in the 1950s and 60s. The subject developed steadily in scope and sophistication thereafter, however, and today there are two national journals devoted to the subject (*Landscape History* and *Landscapes*) and numerous undergraduate and postgraduate courses at British universities, while each year innumerable books with the term 'landscape' in their title are published. Initially, the new subject developed out of historical geography and field archaeology, but historical ecology has also become an important influence, especially through the work of Oliver Rackham, whose monumental *History of the Countryside* was published in 1986.

Today, landscape historians usually feel some need to understand the basics of historical ecology, at least in so far as this relates to such characteristic components of the landscape as woods or hedges; while ecologists are usually keen to comprehend the land use and management history of particular habitats. Connections between the two disciplines are further encouraged by the fact that, among amateur practitioners in particular, as with Clarke, an enthusiasm for the countryside embraces both. Moreover, cooperation and interplay between the two is increasingly entrenched in agro-environmental policies which recognise the close interconnections between the cultural and the natural landscape.

But not everything about the relationship between landscape historians, and those interested in the natural environment, is rosy. To a significant extent members of the two groups come from different intellectual traditions and, while they make increasing use of each other's work, they can remain conceptually divided by the 'two cultures'. Historians and archaeologists often treat biological and botanical methods, theory and data in a naïve way. Conversely, those primarily involved in natural history often have a strangely simplistic view of the social and economic processes that have shaped landscapes and habitats, a view which – to those on the other side of the cultural divide – often seems to be derived largely from the childhood reading of Ladybird Books. In particular, while fully aware of the complexity of the natural processes shaping the character of landscapes, natural scientists seem often to view the past influence of human societies in a rather simpler way, in terms of 'rational' economic activity following straightforward, 'common sense' strategies of survival. Historians and archaeologists, in contrast, view human societies, and thus their relationship with the environment, in more complex terms. Questions of status and ideology also moulded the landscape and its exploitation; economic 'rationality' changed its character over time; and much about the environment was created less by 'rational' patterns of exploitation, maximising outputs on the basis of the available technology, than by the struggles between different interest groups within society – lords and peasants, landlords and farmers, farmers and workers, or whatever. But above all, historians and natural scientists perhaps differ in the emphasis they each place on the respective influences of 'natural' and 'social' processes in the formation of habitats and landscape features: and, as a landscape historian, I would perhaps place more emphasis than many readers on the human contribution, especially when studying a long-settled and intensively cultivated region like Norfolk.

HEDGES

I want briefly to examine some of these issues, in a Norfolk context, and will begin by looking at the work of Max Hooper and Ernest Pollard on the historical significance of the species composition of hedges (Pollard *et al.* 1974). As will be well known to most readers, Hooper's study of hedges in the 1960s and 70s culminated in the suggestion that they tend to acquire new species at a relatively standard rate and can, in consequence, be roughly dated by counting the number of different shrubs which they presently contain in a standard length of c.30 yards, on the basis of the rough equation 'one species = one century' (Pollard *et al.* 1974, p.78-84). Hooper was cautious in this suggestion, emphasising the importance of local variations in colonisation rates and stressing that the method only provided a very approximate guide to a hedge's antiquity. But, when embraced by landscape and local historians, eager to use a method which would provide dates for field boundaries (especially in places lacking early maps), such caution was usually thrown to the winds. Numerous studies were produced which confidently dated hedges to specific periods, even to particular centuries (e.g. Hewett 1974).

Pollard's research was less eagerly embraced by students of landscape. He reached conclusions which, although aired in the same volume as those of Hooper, differed from his in a number of important ways. In particular, Pollard drew attention to a type of very mixed hedge, characterised by large amounts of Hazel (*Corylus avellana*), Dogwood (*Cornus sanguinea*) and other woodland shrubs, and containing a range of woodland plants in the herb layer (Pollard *et al.* 1974, p.86-90; Pollard 1973). Pollard believed that these 'woodland relict hedges' had been created by managing lines of woodland vegetation around assarts cut from woodland early in the medieval period. Such very mixed hedges had been species-rich from the start: unlike Hooper's species-rich hedges, which had acquired their character through colonisation over time (Cameron 1984, p.204).

A substantial body of research, in Norfolk and elsewhere, has cast doubt on many of these old suggestions, and in particular has questioned the validity of 'Hooper's rule' – although it retains support in some influential quarters (e.g. Rackham 1986, 1976). As already noted, Hooper himself made clear that variations in seed supply, and in the character of soils, could have a major influence on the speed with which hedges acquired additional species. He nevertheless seems to have underestimated the full extent to which such things could, in practice, affect colonisation rates. In Norfolk, for example, the kind of ruler-straight hedges established in the eighteenth and nineteenth

centuries, and mostly in the period 1780 – 1830, are still dominated by the hawthorn or blackthorn with which they were first planted, and ought everywhere to contain the same approximate numbers of adventitious colonists. But they do not. Those established on moist clays contain on average significantly more shrubs (4.3 per 30 metres on Beccles Association soils, 4.2 on Burlingham soils) than those growing on light, well-drained soils (2.6 per 30 metres on Wick 2 and 3 soils, 2.4 on those of the Newmarket Association). The relationship between soils, and species diversity, is in part an indirect one, relating to factors of seed supply. In Norfolk, the districts of clay soils retained significant amounts of woodland throughout history, and already had some hedges in the middle ages, whereas lighter soils generally remained open and largely treeless from very early until relatively recent times. But in part the relationship is probably direct: new species simply became established at a faster rate in hedges growing on moist, fertile soils than in those growing in leached, dry contexts (Barnes and Williamson 2006, p.77-8).

A far more important problem with the 'Hooper hypothesis', as a series of researchers have suggested, is that it underestimates the extent to which early hedges may have been planted with a range of different shrubs. To some extent, that is, older hedges contain more shrub species than younger ones not simply because they have had more time to acquire colonists, but also because they started off with more. Careful analysis of a substantial number of Norfolk hedges has revealed that while those of eighteenth-century and later date appear significantly different in composition from those planted in the sixteenth and seventeenth centuries, the latter display few obvious differences from those of probable medieval or earlier origins: they are simply mixed, rather randomly, in character (Barnes and Williamson 2006, p.74). This mirrors closely the conclusions of Willmott (1980) in Derbyshire and Hall (1982) in Yorkshire, the latter memorably noting how pre- eighteenth-century hedges simply formed a 'statistically indistinguishable group'. In part at least this is probably due to the fact that whereas eighteenth and nineteenth-century hedges were normally planted with Hawthorn, Blackthorn, or a mixture of these species, earlier ones were initially planted with a rather greater range of plants, a practice which – as Wendy Johnson demonstrated many years ago – is clearly indicated in the documentary evidence (Johnson 1978). Planting practice, in other words, changed over time, and for a number of reasons. Early hedges, generally planted by small farmers in a peasant economy, were not merely intended to serve as stock-proof barriers. They were also established to supply a range of resources – fuel mainly, but also perhaps

fodder and fruit. Even in the eighteenth century, in the words of William Marshall, the entire supply of wood and timber in an area like north east Norfolk '*may be said, with little latitude, to be from hedge-rows'* (Marshall 1787, p.96). Eighteenth- and nineteenth-century hedges, in contrast, were mainly planted by large landowners, men who obtained their firewood from coppiced woodland or plantations, or used coal on their fires; and who had little use for the other resources which hedges might provide. They viewed hedges simply as boundaries, and as barriers to stock, and may also have had an ideological hostility to 'peasanty' mixed hedges, and an aesthetic preference for low, neatly trimmed, single-species ones. The early planting of multi-species hedges was also, of course, encouraged by the difficulty of obtaining large quantities of hedging thorn in the period before the development of large commercial nurseries, something which, in a local context, only seems to have occurred from the middle decades of the eighteenth century. All this, if correct, obviously makes nonsense of Hooper's 'rule'. If hedges in the past were planted with an unknown number of species – but with more than one - then even if they acquired new colonists at a standard rate we could never estimate their age, even approximately, from the number of different shrubs which they contain today.

The ideas about hedges put forward by Ernest Pollard in the 1960s and 70s have perhaps stood up to scrutiny rather better than those of his colleague Hooper. In Norfolk, certainly, the majority of hedges which he would have characterised as being of 'woodland relict' type do seem to occur on boundaries which we might suspect are among the oldest in the landscape: on old lanes, former common edges, parish boundaries (Barnes and Williamson 2006, p.84-96). They were presumably established in the early medieval period in a landscape in which woodland was relatively abundant, even on the lighter soils of the county, thus providing an abundant source both of hedging plants, and of seeds for colonisation. For we should not perhaps follow Pollard all the way, and see such hedges as having been cut directly out of woodland. Indeed, some hedges of 'relict' type surround fields which, to judge from their shape, were created by informal 'piecemeal' enclosure from the open fields. Most such hedges are probably characterised by a predominance of 'woodland' shrubs – including in a few cases such relative rarities as Wild service-tree (*Sorbus torminalis*) and Small-leaved Lime (*Tilia cordata*) – simply because they were planted with material gathered from the local woodland. And once again, we must be careful not to underestimate the direct influences of soils on hedge vegetation. The distribution of 'woodland indicator' herb species like Dogs Mercury (*Mercurialis perennis*) or Primrose (*Primula vulgaris*)

seems, on the Norfolk evidence, to be much more closely related to soil type than to the age or antiquity of the hedge in question, with such plants being particularly abundant in hedges growing on moist and fertile clays. Indeed, both of these species can be found on occasions in hedges of eighteenth or even nineteenth-century origin in parts of south and central Norfolk.

Landscape historians can certainly learn something about the history of clearance, settlement and enclosure from the study of hedges: we should not, that is, throw the baby out with the proverbial bathwater. But Hooper's simple 'rule' is incorrect and misleading not only because it oversimplifies the complex ecology of hedges, but also because it interprets variations in their botany almost entirely in terms of natural factors, rather than as the outcome of the complex interplay of natural and human influences.

HEATHS

Heaths are another good example of the way that social and environmental factors combined in the making of Norfolk's landscape. Until the end of the eighteenth century Norfolk probably had more heathland than any other county in England. As William Faden's county map (surveyed in the 1790s) makes clear, the largest concentration was in Breckland, in the south-west of the county, where aeolian sands were laid down during the Devensian glaciation over boulder clay or chalk (Boulton *et al.* 1984). To the north, a second cluster of heaths extended northwards along the edge of the Wash from Mintlyn to Snettisham, associated with the Greensand and related formations of Cretaceous date. In earlier times there had also been extensive areas of heath on the higher ground to the east of this belt, in the 'Good Sands' region of north-west Norfolk, but most of these had been reclaimed during the half-century or so before Faden's map was made. The geology of the area was broadly similar to that of Breckland, but here the layers of sandy drift were thinner, and the soils more easily marled and cultivated (Wade Martins and Williamson 1999, p34-43). Further areas of heathland could, however, be found on the outwash gravels to the north of Norwich, and along the north Norfolk coast, on the moraine ridge between Holt and Cromer. In addition, a scatter of heaths existed, until the parliamentary enclosures of the early nineteenth century, across the boulder clay plateau in the centre of the county, associated with small areas of glacial sands or gravels. Some Norfolk heaths, especially in Breckland, were grass heaths: but most were dominated by Heather (*Calluna vulgaris*), with subsidiary populations of Gorse (*Ulex*

europaeus) and Bracken (*Pteridium aquilinum*).

Some heaths, especially in Breckland, may have remained as open ground since the last glaciation but most were once covered in trees. These were removed, by felling and overgrazing, by early farmers: the characteristic heathland vegetation then developed and was subsequently maintained by systematic exploitation. Heaths were intensively grazed, by sheep and other livestock. But they were also regularly cut, for a range of materials: ling or heather was used as fuel, and perhaps as thatch; gorse or furze for fuel and fencing; and bracken as cattle bedding and fuel. In addition, 'flag' (the matted roots of the heather) and turf were cut by the very poor, for firing. Many of these forms of exploitation were in potential conflict, not least because they were often enjoyed by different groups of people.

Sheep grazing was probably the most important use of the heaths. Nutrients were rapidly leached from the poor, light soils of these districts and fertility could only be maintained by grazing flocks on the heaths by day, and closely folding them on the nearby arable by night, when it lay fallow or before the spring sowing, where they dunged or 'tathed' it (Allison 1957). The heaths were thus systematically depleted of nutrients, something perhaps not always fully appreciated today when schemes for heathland restoration are formulated. Such 'sheep-corn' systems could be found in many areas of England but across much of medieval Norfolk they took a distinctive form. The manure was considered a manorial monopoly and while the tenants might benefit from the dung dropped as the sheep roamed over the fallows they had to pay to enjoy the intensive night-folding (Allison 1957; Postgate 1962). The sheep were organised into flocks dominated by the stock of the manorial lord, and each manor had its defined 'fold course' which included both heath and arable. There are signs that the fold course system may have become more formalised, and more rigid, in late medieval times. In the twelfth and thirteenth centuries some peasants may have had the right to erect folds, although even then the system had been dominated by manorial lords (Bailey 1989, p.43-5).

The fold course system persisted in many places into the nineteenth century but its character changed. From late medieval times it was increasingly used as a way of maximising the income from commercial sheep-farming. The tenants' sheep were now excluded from the fold-course flocks: the grazing on the heaths and the fallows was restricted to the lord's sheep, and the system became a way of running livestock over other people's land. Nevertheless, where – as was often the case - heaths were common land, 'great cattle' (horses, cows and bullocks) were pastured there by commoners, who were

often involved in disputes with fold course owners over grazing rights. Robert Buxton typically complained in 1595 that '*The fold courses about Thetford be 100 markes by year worse than of late they were, for where the township were wont to keep but twenty milch neat and three or four horse, they have now above one hundred of the one and four score of the other, and daily spoil the ling and furze*' (Clarke 1908, p.558).

Rabbits were also grazed on many Norfolk heaths. They were introduced into Norfolk early in the middle ages but both the size and the number of warrens increased considerably during the fifteenth and sixteenth centuries. Warrens were most numerous and extensive in Breckland but were also common in the other heathland districts (Bailey 1988; Sheail 1971). By the sixteenth century many were enclosed, but the rabbits still often escaped into adjacent areas, again leading to disputes and legal cases.

Heaths were cut with a similar intensity to that with which they were grazed, and their exploitation had to be managed accordingly. Even the cutting of bracken might be closely regulated, as at Thetford in the 1590s (Clarke 1908, 558), and portions of heath were often 'doled' – that is, allocated in strips to particular individuals for cutting, but opened for communal grazing at certain times of the year. As a result of all these pressures heaths were clearly often rather bare landscapes. Some sixteenth-century references even suggest that areas of gorse needed to be carefully preserved from grazing, so that the plants could grow high enough to provide winter shelter for the flocks. A witness in a court case concerning Kilverstone in the 1590s, for example, described how *'he hathe knowne twoe or three places of furres usually p[re]served for the layer and succar of the shepe as he thinketh in and upon the said heath grownds'* (TNAPRO E134/35Eliz/East24). Where rabbits were abundant they stripped the turf, leading to the development of mobile dunes. William Gilpin, visiting Breckland in the 1760s, famously described the scene as one of '*sand, and scattered gravel, without the least vegetation; a mere African desert'* (Gilpin 1809, p.28-9). But it was not only in Breckland that the activities of rabbits and warreners – compounded by the intensive grazing of other stock and the digging of turf for fuel – could lead to the removal of almost all vegetation. During an extended dispute in the late sixteenth century concerning the exploitation of Cawston Heath, for example, one witness described how:

> *Sand and gravell is cast upp in such great heapes uppon the playne grownd by reason of the digging therof that ther will noe grasse growe upon the said grownde in a verie long tyme and...the...digging now*

lately used is a great hindrance to the inhabitants of Cawston as well in the fede of the cattell as in dangering ther said cattell (TNAPRO E134/43&44Eliz/Mich7).

Many Norfolk heaths were also subject to periodic cultivation, often in the form of outfield 'brecks' which were ploughed for a while as part of the neighbouring open fields and then allowed to revert to rough grazing for several years. This was an ancient practice but, once again, seems to have become more systematic in the post-medieval period (Bailey 1989; Postgate 1962). More *ad hoc* cultivation of heathland also frequently occurred at times of rising prices and the area under cultivation in heathland districts certainly fluctuated over time. In a late sixteenth-century dispute concerning the alleged encroachment of Castle Rising Warren onto surrounding land one witness typically stated that:

The most pt of the groundes of the said mannor in Southwotton wherin the said farmors of Rysinge clayme warrenne hathe benne in tilthe as yt maie appeare apparanntly by Rigge and furrowes' (TNAPRO E134/35&36Eliz/Mich16).

Heaths were thus, for much of their history, very intensively exploited as a central part of the agrarian economy. As a result they were different in appearance from the rather wilder and rougher environments which were first recorded by naturalists in the late nineteenth century, when traditional practices, including grazing, were already in decline. This reduction in the intensity of exploitation had a major affect on the vegetation. Bracken increased in importance, no longer kept in check by a combination of regular cutting and the trampling of the young plants by livestock. In 1908 Clarke described how it was *'certainly the dominant plant of the "breck" district, and on several heaths has usurped the position which heather occupied some 20 years ago. Bracken lacks its former economic importance'* (Clarke 1908, p.567). By 1918 it was said to be dominant on other heaths in the county (Clarke 1918, p.306). Gorse also seems to have become more prominent, Bird in 1909 reporting how on East Ruston Common 'The best parts of the common for grazing purposes are now being much encroached upon by the spreading of furze … there are not enough Donkeys to nibble down the gorse bushes' (Bird 1909, p.645). On Barnham Common near Thetford, similarly, Clarke noted in 1918 that 'the original steppe flora has been greatly reduced by the encroachments of furze' (Clarke 1918, p.308). Indeed, many heaths – especially those in north Norfolk – were by this stage becoming colonised by scrub, and by woodland of birch, oak and pine (Clarke 1918, p.305). By the

inter-War period, some heaths were even being managed by regular burning (Rider Haggard and Williamson 1933, p.129), a practice unrecorded in earlier times.

WOOD-PASTURE HEATHS

Not all Norfolk heaths had traditionally been completely open, treeless environments, however. Somewhat surprisingly, given the intensity with which they were grazed and cut, recent research suggests that many carried a significant degree of managed tree-cover in the middle ages and, indeed, well into the post-medieval period: wood-pasture heaths were a fairly common element of the Norfolk landscape and are frequently referred to in early documents.

In 1482, for example, Hugh Donne leased the lands owned by Mount Joye Priory in Haveringland and Felthorpe *'except all the woods of the place'*. The lease agreement includes the clause: '*the said Hugh shall have from the Prior 200 good faggots yearly and sufficient thorns and underwood for fencing the closes ... and all the old wood, boughs, sticks and windfall wood that fortune to fall within the said lands except great trees'* (NRO NRS 21788 361X2). In 1239 Robert de Hauteyn granted lands to William Lincoln in Taverham, along with *'common of pasture for 8 sheep, 6 beasts, in the woods, except in the park of the said Robert'* (Blomefield, 1805, Vol. II, p.247). As late as the sixteenth century the inhabitants of nearby Marsham asserted that James Brampton had *'felleth downe woode growinge uppon the common contrarye to the custome of the mannor'* (Smith *et al.* 1982, p.242-3). By the eighteenth century all of these parishes were devoid of woodland, their landscapes consisting entirely of arable and heath.

There were, moreover, private as well as common wood-pastures, for medieval deer parks are recorded in the Patent Rolls, Charter Rolls, and Close Rolls in many heathland parishes, including Baconsthorpe, Castle Rising, Cawston, Costessey, Gaywood, Hevingham, Holt, Horsham, Horsford and Roydon. In 1309 the pale at Costessey was repaired using *'twenty fallen oaks within the park'*; in 1324 Robert de Morley and others were accused of having set up tents *'in warlike fashion in the park at Costeseye, and felled trees in the said park';* while in the 1350s trees were cut down in, and timber carried away from, the Bishop of Norwich's park at Gaywood, Hevingham, Thornage, and Thorpe. In c.1560 John Gray, leasing Costessey park, reserved the right '*to remove loads of wood ... at all convenient times'* (NRO NRS 10381 25.A.6).

A number of early maps show wooded heaths, including a survey of New Buckenham made in 1597 (NRO MC 22/11); a map of Haveringland of 1600 (NRO MS4521); an undated 16th-century map of Castle Rising; and a survey of Appleton of 1596 (NRO BL71; NRO BRA 2524/6). Indeed, close examination indicates that a number of residual fragments of wood-pastures are actually shown on Faden's 1797 map of Norfolk, within areas denoted 'heath'. But what is perhaps even more striking is that remnants of these heathland wood-pastures still survive in a number of places. On the Bayfield estate in north Norfolk, for example, over 30 pollarded oaks – some Pedunculate (*Quercus robur*), some Sessile (*Q. petraea*) – grow on dry, leached soils of the Newport 4 and Barrow Associations. The youngest may be less than 300 years old but the largest, the so-called 'Bayfield Oak', is probably around 700 years old. Most are to be found within estate woodland which was already in place by the late eighteenth century, but some are growing in areas still described as heathland on the Tithe Award map of 1838 and, in one case, on the OS 6″ Second Edition of 1906. Further examples of relict heathland wood pasture occur on the Letheringsett estate, some 1.5 kilometres to the east, where more than eighty oak pollards are again hidden away within an eighteenth-century plantation ('Pereer's Hills'); and at Holt Hall, less than a kilometre further to the east.

Similar evidence comes from the Goodsand ridge to the north of Kings Lynn. Buried within the eighteenth and nineteenth-century woodland around Ken Hill House (centred on TF679349), surrounding a small area of surviving heath, are a number of oak pollards with girths of between c.4.5 and 5.5 metres. The area is shown as 'Caen Wood' on Faden's map of 1797 but appears to have been heathland in the early seventeenth century, and by the time of enclosure in 1766 had partly been enclosed for use as a rabbit warren (NRO Le Strange OB2; NRO BO1) (something which may explain the low pollarding height of some of the trees). Once again there are other, more fragmentary survivals in the vicinity, most notably the scatter of oak pollards within Refley Wood, immediately to the west of Kings Lynn.

Further examples of relict wood-pastures can be found, although perhaps less surprisingly, on the areas of former heathland scattered across the clay plateau of mid-Norfolk. Ancient oak pollards thus exist within Thursford Wood, the nature reserve managed by the Norfolk Wildlife Trust (TF978332) which partly overlies sands and gravels: and in Little Heath Plantation, some c.2 kilometres to the north east (TF993346), which lies entirely on sandy soils. Before enclosure in the early nineteenth century the latter formed the

northern section of an extensive tract of common called *Stock Heath*, which was shared by a number of parishes in the area.

The age of surviving pollards makes it clear that new trees must have been established on some heaths well into the post-medieval period. New species may sometimes have been used. The pollarded beeches within Felbrigg Great Wood in north Norfolk have been discussed on a number of occasions. The trees lie immediately to the north of Felbrigg Park: a sketch map of 1777 shows that many at this time grew in an area described as 'heath' (NRO C/ Sce 2 Road Order Box no.21). It has been suggested that they are among the most northerly indigenous examples of this species to be found in England (Rackham 1986, p.141; Rackham 1976, p.27). But even the largest of the trees have girths of only a little over seven metres, many are considerably smaller: when compared with the size of beeches of known date in the county it is hard to believe that any of the Felbrigg trees were planted before the late 17th century. William Windham began a sustained campaign of tree-planting in and around Felbrigg Park in c.1676 and it is probable that the beeches represent estate planting using plants brought in from elsewhere, rather than relics of the local natural vegetation. Heathland wood-pastures probably existed in the locality in the middle ages, and perhaps later. In the 1490s William Hamund of Felbrigg was granted the right to take *'all the underwood and lop all the trees that grow on the land of the said cottage and upon the separate common (*communam separalem*) opposite'* (NRO WKC2/115). But the Felbrigg beeches seem, on present evidence, to be relatively recent additions to the landscape.

What is particularly intriguing is the fact that wood pastures were not equally common in all heathland areas of Norfolk. There is, in particular, little evidence for significant tree cover surviving far into the middle ages in Breckland, or in the 'Goodsands' district of north west Norfolk. Major and minor place names suggest the presence of some woodland in both of these districts in the early middle ages but no maps or documents refer to or show existing woodland or wood-pasture. The reasons for this broad difference between Breckland and the Good Sands on the one hand, and the other heathland areas in Norfolk on the other, are probably in the last analysis related to soils and geology. In the former districts, chalk or boulder clay underlies acid sands at depths which vary from a few centimetres to around three metres. Where the sands lay less than c.0.3 metres deep they could be cultivated as outfield 'brecks' and this would obviously have militated against the survival of trees. Moreover, where the sands lay thicker extensive warrens were widely established from

an early date. While rabbit grazing would not have affected mature trees it would have helped prevent the successful establishment of new ones. In addition, the poor heathy soils in these areas were interspersed with ribbons of rather better, more calcareous land on which settlement was relatively extensive in prehistoric and again in Saxon times, presumably ensuring considerable pressure on the adjacent areas.

Rabbit warrens, and sporadic outfield cultivation, were also features of the other heathland districts in the county: of the areas of glacial sands and gravel to the north of Norwich and on the Holt-Cromer ridge, and of the Greensand ridge north of Kings Lynn. But they were here rather less prominent. In these areas there were often hard pans of gravel, as well as sand; while in places there was a high water table. Above all, these areas lacked underlying deposits of chalk, or boulder clay, which might be dug out and spread on the surface to neutralise soil acidity, a precondition for successful long-term cultivation. Such areas were thus less attractive both to agriculturalists and to warreners. The sands and gravels in these areas are, moreover, generally less interspersed with ribbons of more amenable soils than is the case in Breckland or north-west Norfolk. In most periods these districts had relatively low population densities, something which would presumably have meant lower pressures on the surrounding heaths.

CONCLUSION

Not only were heaths thus created, and maintained, by human agency. Their varied character was as much the consequence of varied forms of management and exploitation as it was of direct 'natural' influences. All this is doubtless true of other 'semi-natural' habitats and environments in the county, although I do not have the space to discuss any of them in detail here. The various forms of ancient woodland, in particular, raise similar questions about the relative balance of human and natural influences: and also, once again, of how far present character is the consequence of relatively recent social and economic developments. The distribution of Hornbeam (*Carpinus betulus*) woodland, for example, in south east Norfolk and north east Suffolk, is only in part a consequence of the fact that this plant grows well on the moist Beccles Association soils characteristic of these areas. On similar soils in mid-Norfolk hornbeam is a minor component of ancient woods and often, as at Wayland, seems to have been deliberately planted, at a relatively late date. The marked western boundary of the distribution of Hornbeam woods, roughly along the Tas valley, suggests that economic as much as 'natural'

factors may have been at work. But why was hornbeam favoured, or encouraged, as an understorey plant in some areas rather than in others? The issue is complicated by the fact that the present predominance of hornbeam in these woods is almost certainly, in part at least, a consequence of quite recent changes. Even woods (such as East Wood, Denton) where Hornbeam is today overwhelmingly dominant were, before the mid nineteenth century, probably much more mixed in character. Decline of management, and the consequent growth of the coppice stools to canopy level, has served to suppress other understorey shrubs. Similar issues, and questions, are raised by other types of woodland in the county. Hockering wood is thus dominated by outgrown and singled coppice of Small-leaved Lime (*Tilia cordata*). Lime was doubtless a significant element of the natural vegetation here but why was it encouraged by medieval woodland managers? The long strings of ponds within the wood – perhaps used for retting the bast – together with the associated moated site hint that in medieval times the wood may have functioned, in effect, as a rope factory. But once again we need to ask how the present overwhelming dominance of lime is, in fact, the result of developments since the mid nineteenth century – the neglect of 'traditional' management, and the deliberate encouragement of lime as a single species.

Questions like these will only be answered by further research, carried out by natural scientists and landscape historians working together. The 'semi-natural' environments of Norfolk are precisely that – *semi-* natural. Establishing which aspects of their character are the result of social and economic factors, which the result of natural influences; and unravelling the complex interplay of natural and human agency in their development; will be fascinating tasks, but not easy ones.

Abbreviations

NRO	Norfolk Records Office
TNAPRO	The National Archive: Public Records Office.

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An annotated list of plants of Blakeney Point, Norfolk, with selected distribution maps

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INTRODUCTION

The topography and vegetation of Blakeney Point was first described by Oliver & Salisbury (1913a). A revised list of the flowering plants of Blakeney Point was published by White (1960). This list was updated together with the inclusion of the ferns (White 1967a, b), and further additions to the flora were made by White (1972) and White & Taylor (1984). A revised account of the flora and plant ecology was produced by White (1989). Recording has continued over the past decade and the distribution of some of the rarer and critical elements of the flora have been mapped. In addition, the perception is that some scarce or very localised species on the Point have recently begun to spread e.g. Sea-holly *Eryngium maritimum,* Sea Spurge *Euphorbia paralias,* Sea-heath *Frankenia laevis* and Curved Hard-grass *Parapholis incurva.* Whether this can be attributed to climate change, an increase in air pollution (nitrogen), or rabbit decline is uncertain, but it is hoped that the selected distribution maps will provide useful information for future botanical investigations on Blakeney Point. An opportunity has now arisen to update the list to include the new records and to take account of changes in the nomenclature and classification of the flora.

The names and synonyms used in this list and their sequence follow as far as possible that of the *New Flora of the British Isles* (Stace, 1997). An attempt has been made to include every plant which has ever been recorded for the Point. In such a habitat there are inevitably some transient species. Propagules

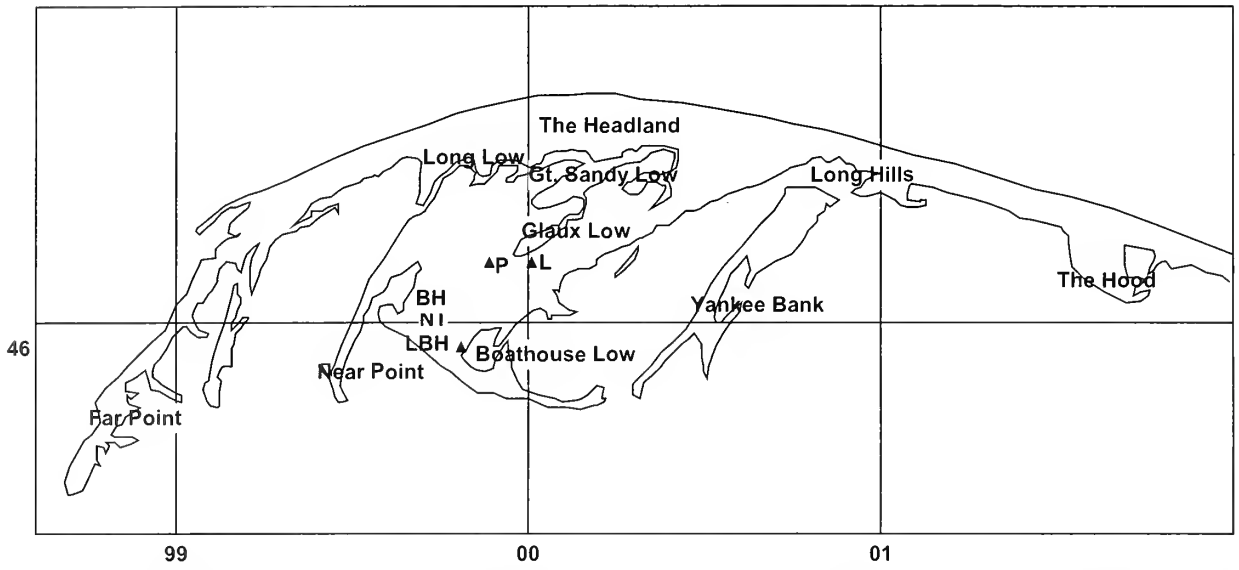
arrive by sea, are carried by the wind and dispersed by birds. The resulting plants may survive for some years and then die out. Where known the dates of arrival and of disappearance of a species are given since in some cases these may be of biological interest.

The original list of Oliver & Salisbury (1913a) contained about 120 species, while the present list records over 300 species of flowering plants, of which 36 are grasses. There are seven species of ferns.

METHODS

Recording of species over the last ten years has taken place on visits to the Point every June and again in August/September of each year with an occasional visit in April. Access to the western end of Blakeney Point is restricted between April and August, due to nesting birds. For this reason more detailed mapping and surveying of selected species took place in late August to early September between 2000 and 2004. The whole of Blakeney Point above the high water mark, from the Hood to Far Point, was surveyed in squares *c* 25m x 25 m simply by pacing out the distances. Because of the difficult nature of the terrain and the impossible task of pacing out perfect squares, an accurate grid reference for the centre of each square was obtained from a GPS positioner. Mapping of plant distributions was carried out using hand-held GPS positioners (Garmin eTrex) set to UK OS grid reference mode (OSGB36) and grid north. The maps in this paper have been produced using Dr Alan Morton's DMAPW software (www.dmap.co.uk). The recent (2000) outline for Blakeney Point was produced by walking all of the extreme high spring-tide line and logging this using the GPS trail facility. The trail was then downloaded to a computer for transfer to DMAPW and subsequent digitization to produce the base outline. For details of the Watch House bank and the Marams beyond the Hood refer to the 1961 map (White 1989).

The time series of westerly extensions to the headland, the laterals, each the result of a shingle spur built out from the end of the Point, was catalogued by Salisbury (1922). The terminal hook of 1921, Far Point (now named Near Point), has survived despite tidal flooding, changes in shape, size and orientation. In 1966 a new terminal lateral (now named Far Point) appeared to seaward of Near Point and by 1979 had become consolidated to provide a range of new habitats (Barfoot & Tucker 1980). To clarify any possible confusion with references to locations in some of the older species lists some of the important locations mentioned in the present text are indicated on Map 1.



Map 1 Blakeney Point from the Hood to Far Point: (▲LBH) Life Boat Houses; (P) Plantation; (L) Laboratory; (NT) National Trust exclosure; (BH) Beacon Hills.

PLANT LIST

Ophioglossaceae

Ophioglossum vulgatum L. - Adder's Tongue.

In June, 1970, a patch of this fern was found on the Hood. In 1971 there were fewer plants, but those present were sporing. Not now present.

Polypodiaceae

Polypodium vulgare agg. - Polypody.

This aggregate species was recorded in Oliver & Salisbury (1913a), for the Long Hills. Nine clumps, each of some considerable size and all aggregated together in fairly close proximity, occurred in the central area of the Long Hills. Only a remnant of the Long Hills now remains since much of this dune system was blown away in the late nineteen-thirties, and no *Polypodium* has been seen in this region since the war. It was recorded for the Old Grey (*Carex*) dunes in 1947 and has since spread vigorously.

It is now known that two species of the aggregate occur on the Point:

P. vulgare sensu stricta L.

Found on the Old Grey (*Carex*) dunes; on the main ridge and on the eroded dunes bordering Boathouse Low.

P. interjectum Shivas

Found with *P. vulgare* on the Old Grey (*Carex*) dunes and on the eroded dunes bordering Boathouse Low. It is also found on the Lichen Heath and on the Hood. The large patch of *Polypodium* opposite the Laboratory is

a pure stand of *P. interjectum*. These two species may occur together and appear to occupy similar types of habitats. They are now very widespread across the grey dunes. A fuller account of these two species on Blakeney Point is published by White, White & Peterken (1970).

Aspleniaceae

Asplenium adiantum-nigrum L. - Black Spleenwort.

Found in 1970 growing on the headland dunes (identification determined by A.C. Jermy). The plant was growing mingled with a patch of *Polypodium vulgare*. It had three fertile, current year's fronds. There were also several dead fronds from the previous year so that the plant was certainly two years old. From its size this plant may well have been several years old. Not seen recently.

Woodsiaceae

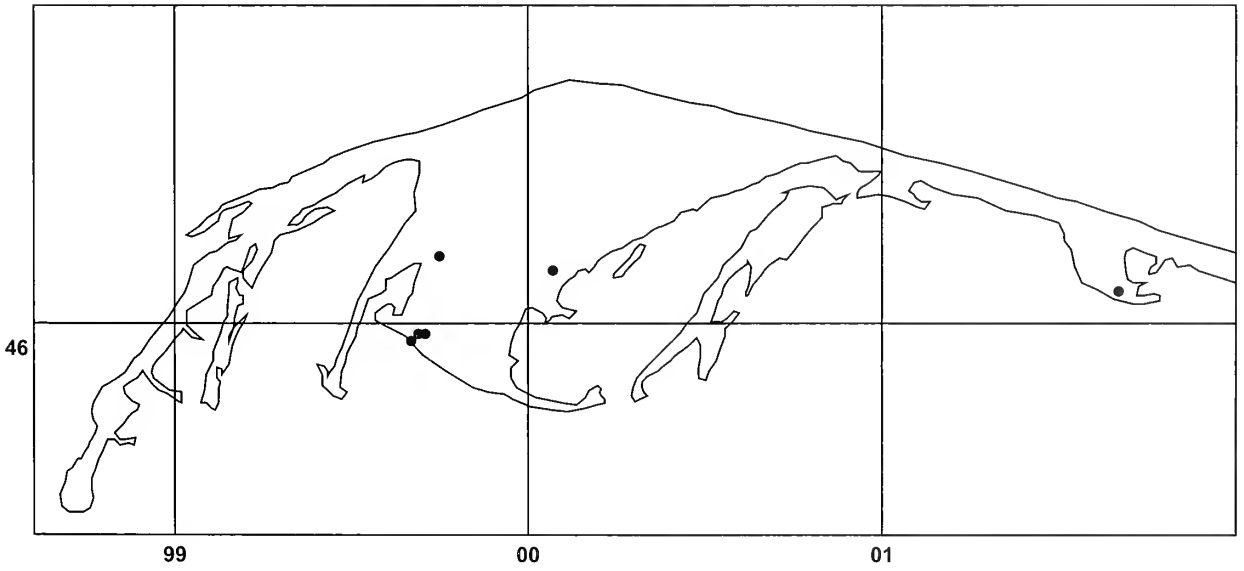
Athyrium filix-femina (L.) Roth (*Aspidium filix feomina*) - Lady-fern.

Described in Oliver & Salisbury (1913a) as being the rarest plant on the Point. A single plant occurred on the Hood, growing in a disused rabbit hole. The plant has not been seen for many years.

Dryopteridaceae

Dryopteris filix-mas (L.) Schott - Male-fern.

Found on the Hood where there were about ten plants in 1967. Only a single crown was observed on the Hood in 2003. In 2000 four clumps were seen at the top end of the NT enclosure (see Map 2).

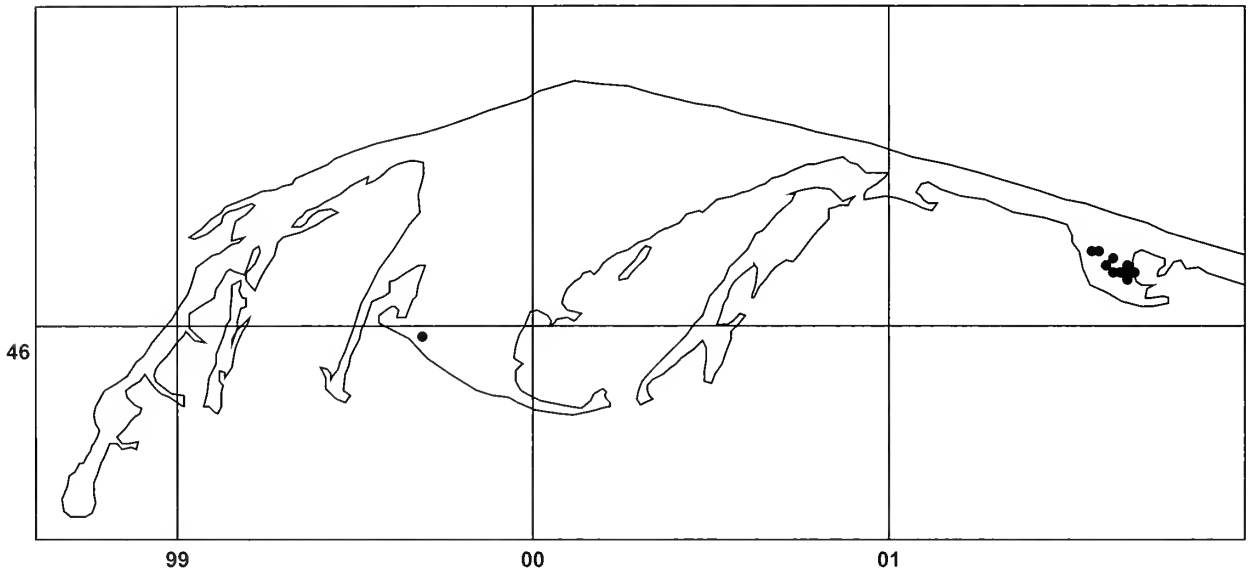


Map 2 *Dryopteris filix-mas*

Dryopteris dilatata (Hoffm.). A. Gray - Broad Buckler-fern.

Found in small amount on the Hood. One very young plant was found in

1964 on the slope of the dunes adjoining Great Sandy Low. In 1970 it was found growing in a small depression on the dune forming the 'outlier' of the Long Hills. In 2002 two to three crowns seen at the westerly end of the NT enclosure. In 2003 also occurring in patches across the Hood (see Map 3).



Map 3 *Dryopteris dilatata*

Pinacea

Pinus nigra L. – Corsican Pine.

Planted in the plantation by Professor Oliver in 1916-17.

Ranunculaceae

Ranunculus repens L. - Creeping Buttercup.

A rare casual, occasionally recorded for the main shingle bank.

Ranunculus bulbosus L. - Bulbous Buttercup.

Two plants were found on the main dune ridge in June, 1964.

Thalictrum minus L. - Lesser Meadow-rue.

First observed on the dunes in 1957. It was still there in 1959. Seen in 2006 in dunes fringing south side of Great Sandy Low.

Papaveraceae

Papaver rhoeas L. – Common Poppy.

A rare casual. Flowering in the main ternery on Near Point in 1999.

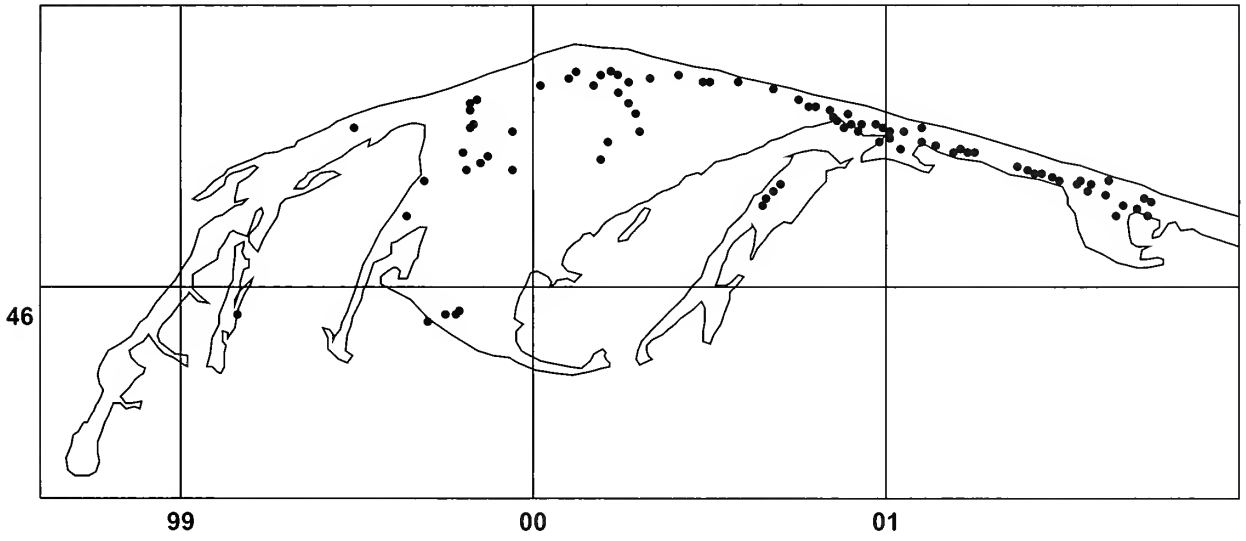
Papaver somniferum L. – Opium Poppy.

Accidental. Seen in local abundance on the main shingle bank towards the Hood and on the Watch House bank.

Glaucium flavum Crantz - Yellow Horned-poppy.

A biennial, sometimes perennial, plant of the shingle. Especially abundant

on the main shingle ridge between the Hood and the Marams. It produces many seeds. According to Salisbury (1952) a single plant may produce up to 60,000 seeds. Germination is good; a crop of seedling rosettes can often be seen surrounding a parent plant. There was hardly a plant to be found on the main ridge in the summer of 1953 following the great flood of the previous February. It was there in fair numbers in 1954, and by 1957 was again abundant. During recent years this plant has become more abundant on the shingle between the Hood and The Headland (see Map 4).



Map 4 *Glaucium flavum*

Urticaceae

Urtica dioica L. - Common Nettle.

Recorded as a casual on the Long Hills by Oliver & Salisbury (1913a). Also recorded for the Hood where it is still present, and now around parts of the NT enclosure.

Urtica urens L. - Small Nettle.

Several flowering plants of this annual were found in 1961 in disturbed ground among the lupins near the Old Lifeboat House. It probably occurs most years. Still present in 2004.

Betulaceae

Betula pubescens Ehr. - Downy Birch.

Already present in the NT enclosure in 2004.

Chenopodiaceae

Chenopodium album L. - Fat-hen.

An occasional plant of the shingle. Found in the main ternery on Near Point in 1998.

Atriplex prostrata L. (*A. hastate* auct. non L.) - Spear-leaved Orache

Atriplex prostrata x *A. littoralis* = *A. hulmeana* .

A fertile hybrid.

Atriplex littoralis L. - Grass-leaved Orache.

Abundant on the upper limit of the drift line on the marsh side of the main bank, and on both drift lines of the lateral banks.

Atriplex laciniata L. - Frosted Orache.

Common on the strandline in 2004.

A*triplex patula* L. - Common Orache .

All the above species of *Atriplex* are found on the strandlines and on the Main Shingle Ridge.

Atriplex portulacoides L. [*Halimione portulacoides* (L.) Aellen] - Sea Purslane

A perennial plant found at all levels of the marsh. In the lowest marshes the plant occurs along the sides of the creeks, i.e. in the better drained areas.

Beta vulgaris L. ssp. *maritima* (L.) Arcang. (*Beta maritima* L.) - Sea Beet.

A characteristic plant of the shingle. It is found on the main shingle bank towards and beyond the Watch House, and on parts of Yankee Bank.

Sarcocornia perennis (Mill) A.J. Scott (*Salicornia perennis* Mill) – Perennial Glasswort.

A somewhat woody perennial plant found at the upper levels of the marshes and, restricted to the sides of the drainage channels, in the lower marshes. Some of the shoots possess a fine coppery-bronze colour.

Salicornia europaea L. agg. - Glasswort, Samphire.

The following annual diploid (2n = 18) species have been recognized on the marshes (Beckett & Bull 1999; Davy *et al.*, 2001):

S. ramosissima Woods.

Widespread in the upper levels of the marshes.

S. europaea L.

Frequent in the upper levels of the marshes.

S. obscura P.W. Ball & Tutin.

Found only on the marshes at Blakeney and Scolt Head Island.

Salicornia procumbens Sm. agg.

Includes the following annual tetraploid (2n = 36) species recognised on the marshes (Beckett & Bull 1999; Davy *et al.*, 2001):

S. nitens P.W. Ball & Tutin.

Found only once at Blakeney.

S. fragilis P.W. Ball & Tutin.

Has a restricted distribution on the north coast marshes between Blakeney and Wells-next-the-Sea

S. dolichostachya Moss.

Tetraploid variant (Ingrouille *et al.,* 1990) found at the lowest levels of the marshes.

Species of the annual Salicornias are among the earliest colonists of mud, leading to marsh formation.

Suaeda vera Forssk. Ex J.F. Gmel. (*S. fruticosa* sensu Coste non Forssk.) – Shrubby Sea-blite.

A woody shrub of the shingle. It grows on the marsh side of the main ridge and on both flanks of the lateral ridges. When partially buried by shingle the plants are stimulated into vigorous growth. They help to stabilise the shingle and since during moderate movement of the shingle the plants will accumulate it around their stems they will tend to increase the height of the shingle bank, in their immediate neighbourhood (Oliver & Salisbury 1913b).

Under natural conditions *S. vera* establishes itself by seed dispersed with tidal drift. Abundant in the main ternery on Near Point in 1998. By 1999 it had. spread so much that the terns stopped using this area for nesting and have now moved on to Far Point. *Suaeda vera* is a mediterranean species and is here nearing the northern limit of its range.

Suaeda maritima (L.) Dum. - Annual Sea-blite.

An annual salt-marsh plant occurring usually well below the high tide level but also always abundant along the high tide mark behind the main ridge.

Salsola kali L. ssp. *kali* - Prickly Saltwort.

An annual plant of the strandline and, less abundantly, of the drift line on the marsh side. The plants have a very deep root system, and a tiny seedling will have a main root going down for twelve inches or more. Saltwort is tolerant of sea water. It was formerly collected and burnt (like *Salicornia*) to provide soda for glass-making.

Caryophyllaceae

Arenaria serpyllifolia L. - Thyme-leaved Sandwort.

An annual, sometimes perennial, plant found regularly on the stabilised shingle of the lateral banks.

Honckenya peploides (L.) Ehrh. - Sea Sandwort.

A shingle plant with an extensive underground system. Its leaves die back in winter, growth taking place the following spring from subterranean buds. It can tolerate some shingle movement but seems to prefer shingle

in which there is plenty of sand. It can tolerate a high concentration of salt and is often found on the strand line where it will accumulate sand and form miniature dunes in advance of the dune system proper. Seedlings are rarely seen although *Honckenya* is one of the commonest plants of the shingle and produces a very large number of seed capsules.

Stellaria pallida (Dum.) Piré (S. *apetala* auct.). - Lesser Chickweed.

An annual plant of the dunes. Seed germinates mainly in the spring.

Cerastium fontanum ssp. *vulgare* (Hartm.) Greuter & Burdet - Common Mouse-ear

This plant, which is normally a perennial, probably behaves as an annual in the dunes. Its distribution is similar to the two following species.

Stellaria pallida (Dum.) Piré (S. *apetala* auct.). - Lesser Chickweed.

Cerastium diffusum Pers. (*C. atrovirens* Bab.) - Sea Mouse-ear.

A winter annual distributed like *C. semidecandrum,* but probably not so abundant. It comes into flower later than *C. semidecandrum.*

Cerastium semidecandrum L. - Little Mouse-ear.

A very abundant winter annual occurring on the fixed dunes, stabilised shingle and in the shingly-sandy lows.

Sagina nodosa (L.) Frenzl. - Knotted Pearlwort.

No recent records.

Sagina procumbens L. - Procumbent Pearlwort.

On the Watch House Bank near the house in 1956. Also among the stones near the Laboratory.

Sagina apetala Ard. - Annual Pearlwort

No recent records

Sagina maritima Don. - Sea Pearlwort.

No recent records.

Spergularia media (L.) C. Presl. (S. *marginata* Kitt. nom. illeg.) – Greater Sea-spurrey.

A perennial plant of the upper salt-marshes.

Spergularia marina (L.) Griseb. (S. *salina* J. & C. Presl.) - Lesser Sea-spurrey.

An annual plant of upper and drier margins of the salt-marshes.

Silene uniflora Roth (*S. maritima* With.) - Sea Campion.

A deep-rooted plant with an extensive underground system. It can tolerate some movement of shingle when growing on the main bank. Salisbury has described it as an *'Ammophila* of the shingle.' Also grows on sand. It was abundant on the eroded dunes of the Long Hills. Its leaves remain green throughout the winter, but the buds from which the following year's

growth will occur are subterranean. *Silene* appears to have become very much less abundant these last few years. This may be due to competition from grasses. The Yankee Bank is developing a closed carpet of vegetation and this appears to have been paralleled by the decrease in *Silene.* The absence of rabbits with its effect upon the grasses may be tied up with the decrease. The flowers of *S. uniflora* are very variable. They have been investigated by Salisbury (1912), who recognised several different forms.

Silene latifolia Poir. [*S. alba* (Mill.) E. H. L. Krause] - White Campion.

A casual. This cornfield plant was recorded on the Hood by Oliver & Salisbury (1913a).

Polygonaceae

Polygonum oxyspermum C.A. Mey. & Bunge ex Ledeb. (*P. raii* Bab.) – Ray's Knotgrass

First recorded in 1955 growing among *P. aviculare* on the main shingle ridge. The identity of this plant was confirmed by Professor T. G. Tutin. (Jane 1958). In 1985 many plants found on Near Point in front of the big Hide and in 2004 several plants found at the end of Far Point.

Polygonurn aviculare - Knotgrass.

On the main shingle ridge.

Fallopia convolvulus (L.) Á. Löve (*Polygonum convolvulus* L.) – Black-bindweed.

Two shoots found in 2004 at the end of Far Point and one plant on Near Point.

Rumex acetosella L. - Sheep's Sorrel.

A common plant, occurring in patches on the lateral shingle banks, the Lichen heaths, and on the older dunes where the marram is deteriorating. Flowers freely. An indicator plant of somewhat acid conditions.

Rumex acetosa L. - Common Sorrel.

Recorded by Oliver & Salisbury (1913a) for the main shingle bank. Very rare. Not seen recently.

R*umex crispus* L. ssp. *littoreus* (*R. crispus* var. *trigranulatus*) - Curled Dock

A perennial plant, growing on the main shingle ridge and, less abundantly, on the lateral ridge.

Plumbaginaceae

Limonium vulgare Mill. (*Statice limonium* L.) - Common Sea-lavender.

A widespread plant of the salt-marshes. A lax-flowered variant of *L. vulgare* which is very variable in this respect, having a panicle intermediate

between *L. vulgare* and *L. humile* (possibly as a result of introgression, but not recently) also occurs. The lax flowered plants in Norfolk are in other respects unlike real *L. humile*, they are much more robust and spread vegetatively (M.J. Ingrouille personal communication). These variants are most probably those described by Choudhuri (1942) as hybrids (*L* x. *neumanii* C.E. Salmon) between *L. vulgare* and *L. humile* in the Blakeney Point populations.

Limonium humile. Mill. (*Statice rariflora* Drejer) – Lax-flowered Sea-lavender.

A rare perennial found at lower levels of the salt-marshes in deep mud. Seen recently in 1991 in Blakeney Harbour, K. Ferrousat (Beckett & Bull 1999).

Limonium bellidifolium (Gouan) Dumort (*Statice reticulate* auct. angl. Non L.) - Matted Sea-lavender.

Occurs on the shingle where there is a good deposit of mud, e.g. on the edges of the lateral shingle banks, and in the shingly lows such as Boathouse Low. It appears always to occur in places which are flooded occasionally by the higher tides. In 2004 abundant at the edges of Great Sandy Low. It is often associated with *Frankenia laevis* (q.v.). This plant is a mediterranean species and is here near the northern limit of its range.

Limonium binervosum (G.E.Sm.) C. E. Salmon ssp. *anglicum* (*Statice binervosum* G. E. Smith) - Rock Sea-lavender.

On Blakeney Point this is the sea lavender of the shingle. It is especially abundant on the shingle plateau on the N.W. side of the upper *Pelvetia* marsh, where it approaches the main shingle beach. It first became abundant in this region about 1914. Occasional plants occur on the main shingle bank, but it appears to prefer areas where there is much sand mixed with the shingle. It often forms a distinctive zone on the flanks of the lateral banks, e.g. on the Marams and, in places, on the Yankee Bank. Now also found in the Lows. The sea-lavenders provide one of the three main flowering 'seasons' on the Point. Their flowering usually extends from the third week of July until the middle of August.

Armeria maritima Willd. ssp. *maritima* - Thrift.

On Blakeney Point this is essentially a plant of the shingle and drier parts of the lows. It is often one of the dominants on the crests of the lateral shingle banks *e.g.* on Watch House Bank. It occurs, less abundantly, on the upper edges of the older marshes of the Marams.

Malvaceae

Lavatera arborea L. - Tree-mallow.

A single plant found on the seaward side of Far Point in 2003, not present in 2004.

Violaceae

Viola canina L. - Heath Dog-violet.

Large clumps and spreading patches over an area of about $10m^2$ just outside the NT enclosure, near the fence and the last hut, in 2002. Still locally abundant in 2004 and also found in the grey dunes.

Viola arvensis Murray - Field Pansy.

First recorded in June, 1998. About 24 plants just above the strandline in an area near the bird hide on Near Point. Still present in 2002 and 2003, but not seen in 2004. Found again in numbers at a separate location, the dune crest in Beacon Hills some 100m eastwards.

Tamaricaceae

Tamarix gallica L. (*T. anglica* Webb) - Tamarisk.

Clump by the laboratory planted in 1912 by Professor F. W. Oliver where it still occurs. More plants were put in the edge of the plantation and on the paths behind the main dunes in January, 1956, but these have failed to survive.

Frankeniaceae

Frankenia laevis L. - Sea Heath.

A mediterranean plant almost at the limit of its northern range. It grows in the *Suaeda vera* zone on the flanks of the older laterals, where the shingle is stabilised and there is a good mixture of sand. It is a constant associate of *Limonium bellidifolium* (q.v.) in muddy shingly lows which are regularly flooded by the higher tides, e.g. in Boathouse Low and in the small low at the side of the Yankee Bank. *Frankenia laevis* appears to be spreading on the Point, although it is said to produce a few fertile seeds in its Norfolk stations (see Map 5).

Cucurbitaceae

Bryonia dioica Jacq. - White Bryony.

Growing near Tamarisk bushes next to the Laboratory in 1987, but not seen recently.

Salicaceae

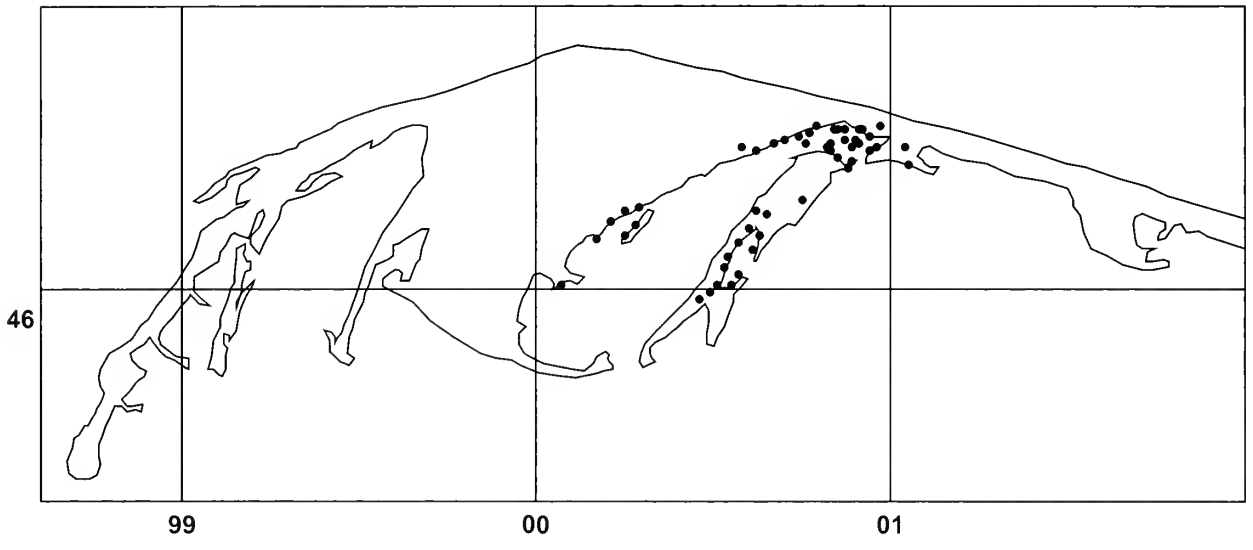
Populus alba L. - White Poplar.

The original trees in the plantation planted by Professor F. W. Oliver in 1916-17 are now dead. Since 1955 they suckered very freely on the slopes about the plantation and these shoots are now forming quite a dense

thicket. Perhaps the absence of rabbits has encouraged the regrowth.

Populus balsamifera L. - Eastern Balsam Poplar.

Planted in the plantation by Professor F. W. Oliver in 1916-17. The original tree has gradually been dying back since the floods of 1953 but several suckers survived. Not seen recently.



Map 5. *Frankenia laevis*

Brassicaceae (Cruciferae)

Sisymbrium officinale (L.) Scop. - Hedge Mustard.

Localised patches found on Far Point in 2004. Occasional on the Watch House bank.

Descurainia sophia (L.) Webb ex Prantl. (*Sisymbrium sophia* L.) – Flixweed.

Found in disturbed ground near the Old Lifeboat House in 1960.

Armoracia rusticana P. Gaertn., B. Mey & Scherb. - Horse-radish.

One plant occurred on the dunes in front of the New Lifeboat House.

Cardamine pratensis L. - Cuckooflower.

In 2004 six plants found in the dunes near Glaux Low.

Erophila verna (L) DC - Common Whitlowgrass.

A very short-lived spring-flowering dune annual. Abundant on the fixed dunes and lichen heaths. By early summer only the dried remains of this plant will be found.

Cochlearia officinalis L. - Common Scurvygrass.

A perennial plant, a member of the so-called 'general salt-marsh community.' Comes into flower very early in the season.

Cochlearia anglica L. - English Scurvygrass.

Rather rare, mainly confined to the *Suaeda vera* zones on the flanks of the older lateral shingle banks.

Cochlearia danica L. - Danish Scurvygrass.

A biennial plant. Recorded on the Yankee Bank , parts of the grey dune near the Lifeboat houses and from the upper edges of the marsh.

Capsella bursa-pastoris (L.) Medik. - Shepherd's-purse.

In disturbed ground near the Lifeboat Houses. Recorded in 1998 in the main ternery on Near Point.

Cakile maritima Scop. - Sea Rocket.

An annual plant of the strand line. Plants will also be found on and behind the seaward face of the main dune ridge, where seed has been carried by the high tides during winter storms.

Crambe maritima L. - Seakale.

A single specimen of this plant occurred on the main shingle ridge beyond the Watch House towards Cley. This established itself from seed (derived from the Calshot Shingle Spit) sown on the selfsame spot in January 1912, by Professor F. W. Oliver. It was destroyed in the floods of 1953. However, by 1968 there were three plants on the main shingle bank between Cley beach and the Hood. The largest plant growing on the seaward edge of the shingle bank, east of the Hood and about one-third of the way along towards the Watch House, flowers annually. Have these plants come from long-buried seed derived from the original plant which was destroyed in the storm-surge of 1953?

Resedaceae

Reseda luteola L. - Dyer's Rocket, Weld.

A casual in disturbed ground by the Lifeboat Houses where it may be found in most years. More widespread in 2004.

Primulaceae

Anagallis arvensis L. *ssp. arvensis* - Scarlet Pimpernel.

Found occasionally on the shingle banks, shingly lows and on the 'older' dunes.

Glaux maritima L. - Sea-milkwort.

Salisbury (1932) described this plant as a pseudo-annual, it perennates and spreads by means of fleshy stolons, while its aerial shoots are annual. It grows in places where there is some deposition of mud or sand, usually as a result of flooding by high tides. The plant gives its name to Glaux Low, over which it eventually formed a more or less complete carpet. This colonization began to take place in 1910 and by about 1917 it had occupied more than half the Low. However, by 2003 and 2004 the plant was in decline in Glaux Low where it is being out-competed by *Agrostis*

stolonifera It is now abundant in parts of Great Sandy Low, and it also occurs in Boathouse Low.

Crassulaceae

Sedum acre L. - Biting Stonecrop.

An abundant plant on the fixed dunes and shingle.

Sedum anglicum Huds. - English Stonecrop.

A beautiful plant with pink and white flowers found on the shingle. Locally abundant on Yankee and Watch House Banks. Not so widespread nor so abundant as *S. acre.* There was a particularly good show of this plant on Yankee Bank in 1966.

Rosaceae

Filipendula ulmaria (L.) Maxim. - Meadowsweet.

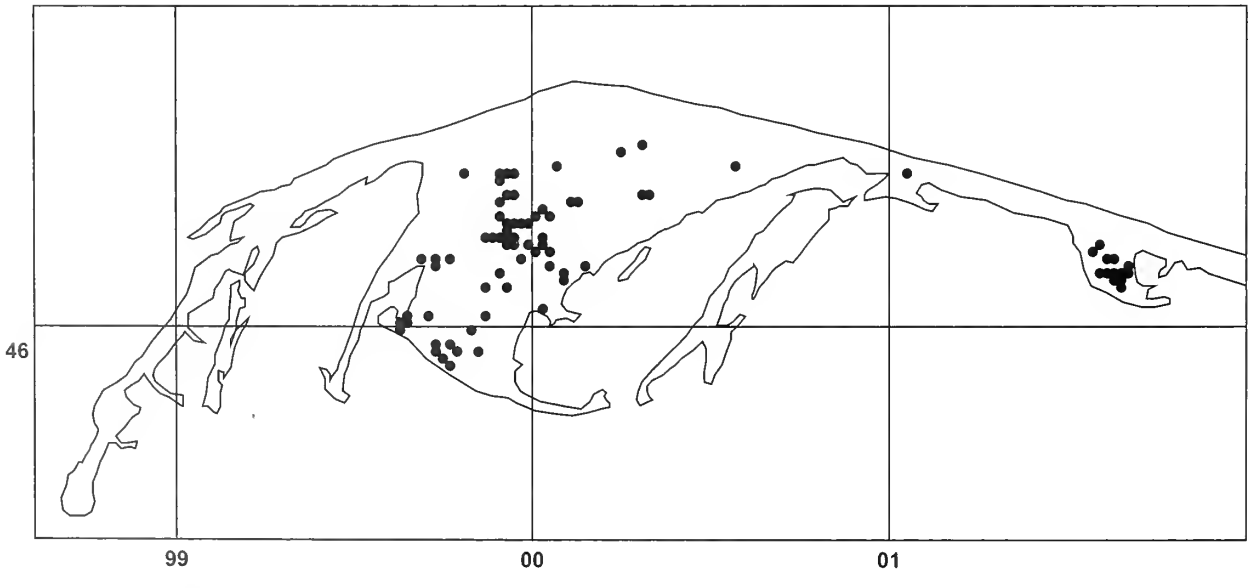
A plant was found growing with a patch of *Scutellaria* in a hollow on the main dunes in 1956. It was still there in 1959, but has not been seen recently.

Rubus idaeus L. - Raspberry.

A single bush present for many years on the fixed dunes next to the Yucca, between the laboratory and the plantation. Found in fruit in 1986 and in 2004. Four shrubs have become established at the same site.

Rubus fruticosus agg. - Bramble, Blackberry.

Known for some years as an occasional plant on the dunes (see Map 6). Samples of the following species (in *Rubus* L. subgenus *Rubus* section *Glandulosus* (*R. fruticosus* L. agg.)) were collected in the summer of 1980, and kindly identified by the late E.S.Edees:



Map 6 *Rubus fruticosus* agg.

R. ulmifolius Schott.

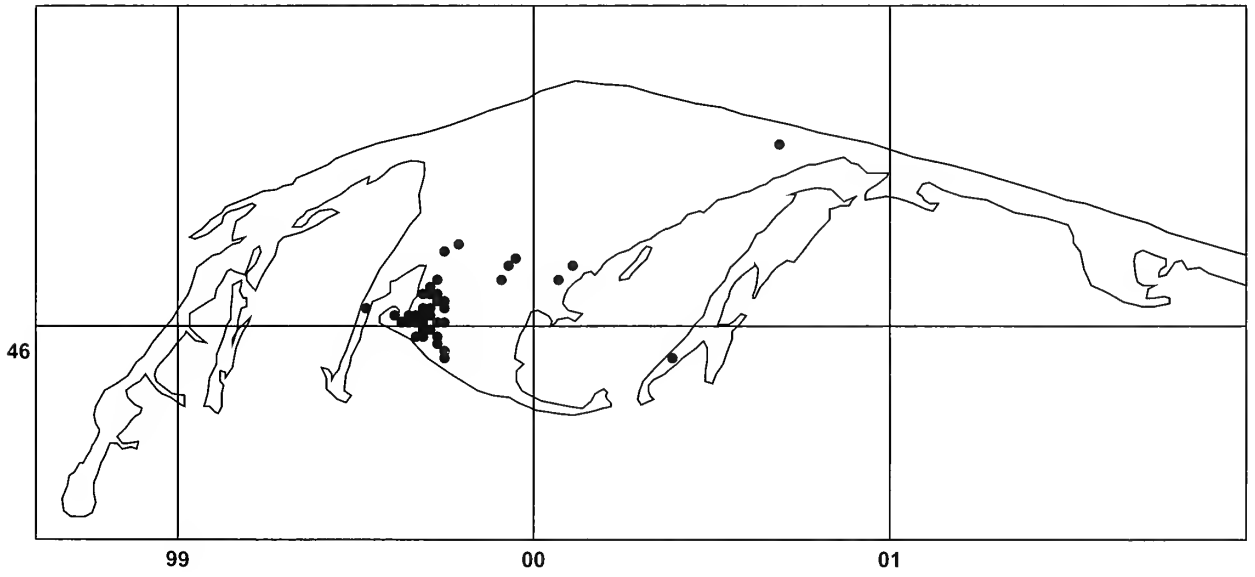
Vigorous specimens occur on the Hood, the Long Hills and on the dunes at the head of Great Sandy Low. In 1986 occurring near the Old Lifeboat House and at the head of the Lagoon near an old stand of *Leymus arenarius*.

R. boraeanus Genev.

Found growing with *R. ulmifolius* on the Hood. A local and rather variable species in Norfolk.

Rubus caesius L. - Dewberry.

Samples collected for identification from the Beacon Hills at the same time as the bramble samples above. A few plants present for some years and now spreading (see Map 7).



Map 7 *Rubus caesius*

Potentilla anserina L. - Silverweed.

Occurs around the margin of Glaux Low, where it is spreading, on the Hood, and in odd places on the seaward side of the dunes where flotsam gets washed up. Present in Glaux Low in 2002.

Aphanes arvensis L. - Parsley-piert.

Occurs sparsely on the older shingle laterals. Recorded on the Yankee Bank in 1956.

Rosa pimpinellifolia L. - Burnet Rose.

A plant has been known for some years on the main dunes.

Rosa canina L. - Dog-rose.

Found at the top end of the Beacon Hills enclosure near the fence of the NT exclosure and a single plant in the grey dunes in 2000.

Rosa rugosa Thunb. ex Murray - Japanese Rose.

Several plants found in 2002 around Glaux Low, but removed by the wardens.

Prunus domestica L. - Wild Plum.

Four saplings found on the Hood in 2003. In 2004 a single sapling was found in the Grey dune near the Laboratory and another near the boardwalk.

Crataegus monogyna Jacq. - Hawthorn.

A single small (ca. 30cm), stunted plant was found in the dune on the Hood and also a single plant in the Main Dunes near the boardwalk in 2003.

Mimosaceae

Acacia dealbata Link– Silver wattle.

An accidental. A native of S.E. Australia and Tasmania. Widely naturalized in S. Europe. Seedling by the side of the boardwalk found in 2004. Still surviving in 2005 and 2006.

Fabaceae (Leguminosae)

Anthyllis vulneraria L. - Kidney Vetch.

Ten plants found near the bird hide on Near Point in 2004.

Lotus corniculatus L. - Common Bird's-foot-trefoil.

This plant grows on the crest of some of the lateral shingle banks, e.g. Watch House and Yankee Banks. It is quite common on the Hood., where it was recorded as locally abundant in lower shingle depressions in 2003.

Vicia sativa ssp. *nigra* L. (ssp. *angustifolia* (L.) Gaudin) - Common Vetch.

Oliver & Salisbury (1913a) recorded it as an occasional plant on the Watch House Bank and on two of the Marams. More recently it has appeared on Yankee Bank, and in 1965 it was recorded for the first time on the Hood.

Vicia lathyroides L. - Spring Vetch.

A single plant found on the Watch House Bank in 1985.

Lathyrus japonicus Willd. (*Lathyrus maritimus* (L.) Bigelow) - Sea Pea.

Probably introduced to Blakeney Point; in 1954 E. A. Ellis sowed 100 seeds in the shingle at Cley Beach over a distance of about 300 yards running west from where the road comes down to the beach. The seed was collected in 1953 from Shingle Street in Suffolk. Several plants were found in flower on the shingle near East Point in 1959. In 1970 several plants were found on the main shingle bank east of Watch House. Still to be found in 1996, but after the main shingle ridge was overrun by the sea in spring storms in 1997 it could not be found (Beckett & Bull 1999).

Present in 2006 (P. Lambley pers. com.).

Trifolium repens L. - White Clover.

There is a small patch of this plant persisting on the Headland dunes. Still present in 2004.

Trifolium campestre Schreb. - Hop Trefoil.

Occurs on some of the older lateral shingle banks.

Trifolium dubium Sibth. - Lesser Trefoil.

On some of the lateral shingle banks and in some dry shingle lows (e.g. Long Low).

Trifolium striatum L. - Knotted Clover.

Occurs on some of the older shingle laterals.

Trifolium scabrum L. - Rough Clover.

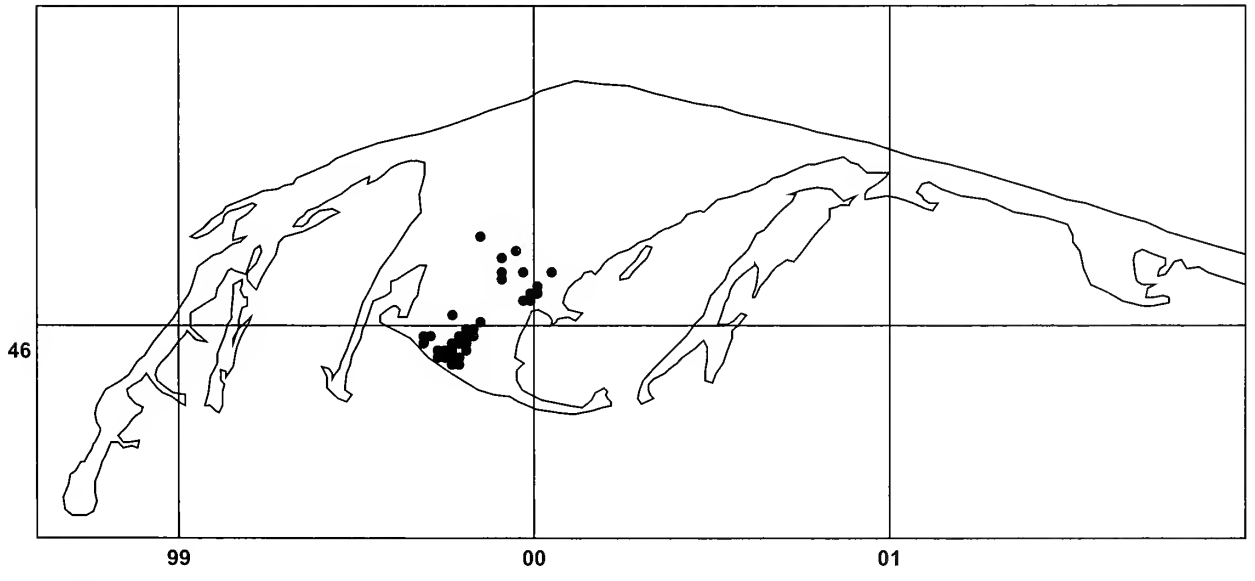
Has been recorded for the Watch House Bank.

Trifoljum arvense L. - Hare's-foot Clover. On the Marams,

Watch House and Yankee Banks. In 2003 it was locally abundant in lower shingle depressions on the Hood.

Lupinus arboreus Sims - Tree Lupin.

Originally planted near the Lifeboat Houses and the Laboratory. It appears to be spreading particularly in the shingle of Long Low. Still present but many dead older plants found in 2003 and lots of seedlings in 2004 (see Map 8)



Map 8 *Lupinus arboreus*

Elaeagnaceae

Hippophae rhamnoides L. - Sea Buckthorn.

Several plants on the trackways behind the main dune ridge where they were planted in January, 1956. Two of the plants were going ahead nicely

and producing suckers by 1959. One had a long row of sucker shoots forming. But neither these plants nor the three or four plants on the Hood which were planted in 1956 or 1957 have survived.

Onagraceae

Epilobium hirsutum L. - Great Willow-herb.

Very rare. Was first recorded for the main shingle bank by Oliver & Salisbury (1913a). Now much more widespread.

Epilobium montanum L. - Broad-leaved Willowherb.

Several plants around the edges of Glaux Low in 2002 and 2003, and on the Yankee Bank in 2004.

Epilobium ciliatum Raf. (*E. adenocaulon* Hausskn.) - American Willowherb.

A plant was found on the Yankee Bank in 1967. Another plant was found on the main dunes in 1970. Found on the Hood in 2004 in the shingle interface and on the dunes locally frequent.

Chamerion angustifolium (L.) Holub (*Epilobium angustifolium* L.) – Rosebay Willowherb.

A casual originally found occasionally on the main shingle ridge but now found more frequently. In 2003 forming extensive localized patches around the higher parts of the Grey Dune and in the dunes on the Hood.

Celastraceae

Euonymus europaeus L. - Spindle.

Two plants behind the plantation, possibly from bird-sown seed or possibly planted. The plants are flourishing, sending up suckers and fruiting. Also now occurs in the NT enclosure and elsewhere.

Euphorbiaceae

Mercurialis annua L. - Annual Mercury.

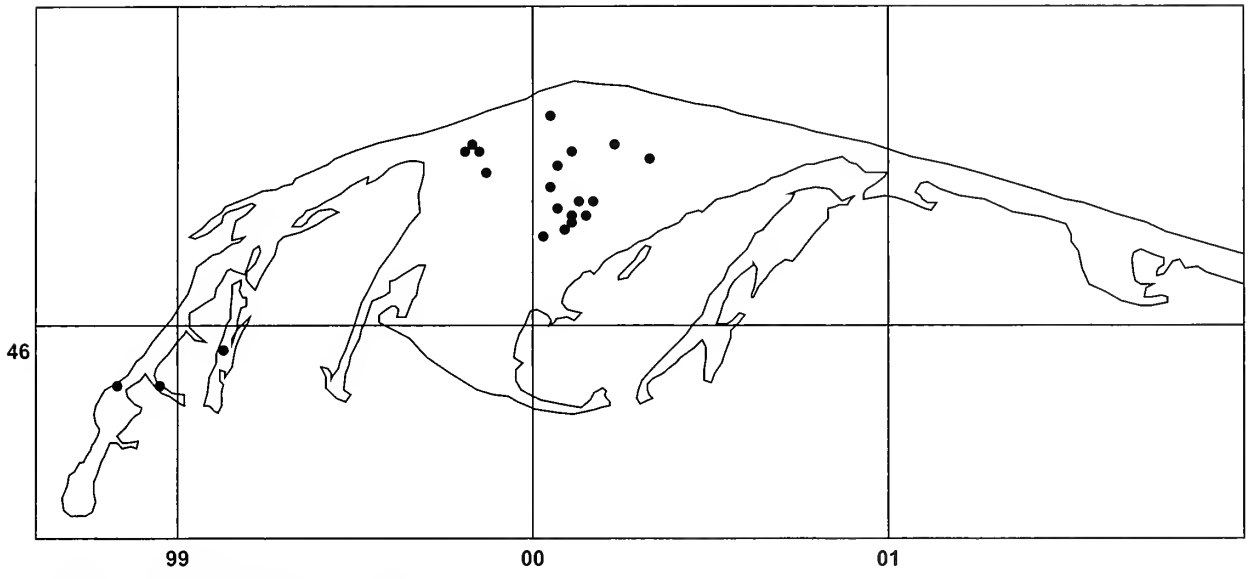
Three plants (one male, two female) were found growing near the New Lifeboat House in 1934, but not seen recently.

Euphorbia lathyris L. – Caper Spurge.

A biennial, casual or naturalized alien. First occurred in 1964 inside the NT fenced area near the Lifeboat Houses. By 2000 had spread to 30-40 plants.

Euphorbia paralias L. - Sea Spurge.

Found in 1959, on the dunes near the neck of Glaux Low. Still present and flowering in 1960. In 2001 two mature plants and 20-30 young shoots found in the neck of Glaux Low, and several plants around Great Sandy Low. Now more widespread (see Map 9).



Map 9 *Euphorbia paralias*

Aceraceae

Acer pseudoplatanus L. - Sycamore.

Several trees in the plantation present in 2004. It was probably planted about 1916 or 1917.

Geraniaceae

Geranium molle L. - Dove's-foot Crane's-bill.

Occasional plants occur on the stabilised shingle banks and on the older grey dunes. In 2004 good colonies forming on Yankee Bank, Far Point and Near Point.

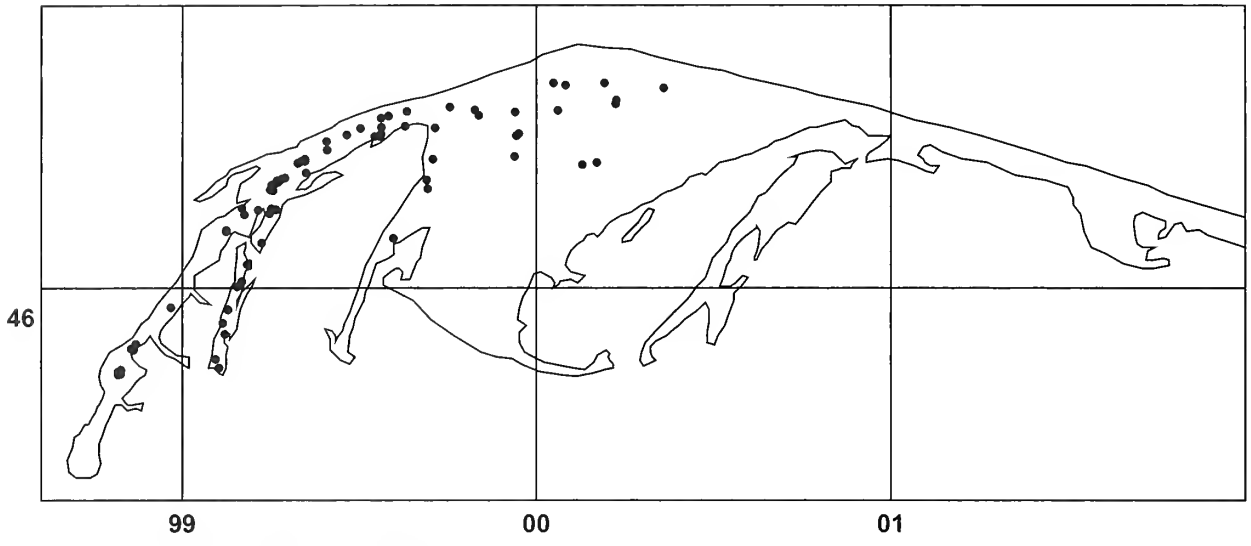
Erodium cicutarium (L.) L'Hérit. - Common Stork's-bill.

A common, somewhat variable plant of the fixed dunes and lichen heaths.

Apiaceae (Umbelliferae)

Eyngium maritimum L. - Sea Holly.

A perennial plant of mobile sand dunes and of shingle which contains a good deal of sand. Initially not a particularly common plant on Blakeney Point, but now spreading. It occurs mainly among the derelict small dunes at the eastern end of the main ternery where it is perhaps now rather more abundant than hitherto. One small plant found on the main shingle bank in 1992, not seen since. A single flowering specimen found in low yellow dune near the foreshore in 2002. Occasional in yellow dune on New Far Point and the main dune in 2002. Now spreading further (see Map 10).



Map 10 *Eryngium maritimum*

Anthriscus caucalis M. Bieb. - Bur Chervil.

In disturbed ground near the Lifeboat Houses where it still occurs. In 1968 several plants were also found flowering and fruiting on the Watch House Bank.

Heracleum sphondyllium L. - Hogweed.

Found on Far Point.

Solanaceae

Lycopersicon esculentum Mill - Tomato.

Four plants found towards the end of Far Point in 2004.

Solanum nigrum L. - Black Nightshade.

A casual that has been recorded from the Long Hills, and from the Beacon

Solanum dulcamara L. - Bittersweet.

A rare casual which has been recorded at the edge of the fence surrounding the NT enclosure near the Old Lifeboat House. In flower also inside the enclosure in 1994. A good shrub 1-1.5 m wide still present in 2003. Spreading in 2004

Solanum tuberosum L. - Potato.

Found in the NT enclosure and on the Hood in 2004

Convolvulaceae

Convolvulus arvensis L. - Field Bindweed.

An odd plant on the seaward edge of the dunes where detritus has been washed up.

Calystegia sepium (L.) R. Br. – Hedge Bindweed.

Several shoots in dune fringing the south side of Great Sandy Low and near the neck of Glaux Low.

Calystegia soldanella (L.) R.Br. (*Convolvulus soldanella* L.) – Sea Bindweed.

A small patch was growing on the mobile sand behind the big blow-outs in the Beacon Hills. Since the disappearance of rabbits this has spread extensively and flowering is profuse. The plant is now appearing in many other parts of the Point. Continuing to expand in parts of the grey dune and flowering profusely in 2003.

Boraginaceae

Echium vulgare L. - Viper's-bugloss.

One specimen of this plant was found in flower on the Hood in 1959. It had not previously been seen on the Point and it has not been seen since.

Anchusa arvensis (L.) M. Bieb. (*Lycopsis arvensis* L.) - Bugloss.

In 2004 three plants found in the NT enclosure.

Mertensia maritima (L.) S. F. Gray - Oysterplant.

First seen at Blakeney Point in 1905. In 1914 there were five plants. Last seen in 1921. This was the most southerly station on the east coast for this rare shingle plant.

Myosotis ramosissima Rochel (*Myosotis collina* Hoffn.) - Early Forget-me-not.

A very abundant, short-lived, dune annual. It is common on the fixed dunes and Lichen heaths, but less common in the shingly lows and on the stabilised lateral shingle banks.

Myosotis discolor Pers. - Changing Forget-me-not.

Was recorded by Oliver & Salisbury (1913a) as a rare plant on the Long Hills.

Cynoglossum officinale L. - Hound's-tongue.

A biennial plant with a stout fleshy taproot, found scattered in small groups mainly on the yellow dunes. The plant is said to have a "mouse-like odour which is unmistakeable." It has an efficient dispersal mechanism in the fruits with hooked spines. Now frequent in all parts of the grey dunes.

Lamiaceae (Labiatae)

Stachys palustris L. - Marsh Woundwort.

Nine plants, one in flower, found in 2000 near the bird hide. In 2004 more than 50 shoots present. Probably an accidental.

Lamium purpureum L. - Red Dead-nettle.

Several flowering plants of this annual were found in 1961 in disturbed ground among the lupins near the Old Lifeboat House. Several plants found in 2004 on Near Point.

Scutellaria galericulata L. - Skull-cap.

First noticed in 1955 on the seaward face of the main dunes, where detritus bad been washed up. In 1957 another patch of this plant was found elsewhere on the dunes. The plant has been gradually disappearing and in 1965 there were only two flowering shoots. Not seen recently.

Lycopus europaeus L. - Gipsy-wort.

A single plant was found on the dunes in 1956. Not seen recently.

Plantaginaceae

Plantago coronopus L. - Buck's-horn Plantain.

A very variable plant of the stabilised shingle and of the sandy-shingly lows. Normally biennial, but some of the plants are undoubtedly perennial (Oliver & Salisbury 1913a). It can tolerate a high salt concentration and will tolerate periods of submergence by high tides.

Plantago maritima L. - Sea Plantain.

Found as scattered plants about the mid-level of the *Salicornia* marshes. On the higher level marshes it is a component of the so-called 'general salt-marsh community and here it occurs in patches as, for example, on the marshes by the Marams. Occasional plants of *P. maritima* may be found in the lows (e.g. in Glaux and Boathouse Lows), among the embryo dunes and even on the strand line, due to tidal distribution.

Plantago lanceolata L. - Ribwort Plantain.

Found occasionally. Recorded on the Watch House Bank in 1956.

Oleaceae

Ligustrum vulgare L. - Wild Privet.

In 2004 one shrub found in NT enclosure and two large shrubs on the north side of the main dune ridge.

Scrophulariaceae

Digitalis purpurea L. - Foxglove.

One plant was found on the Watch House Bank in 1967. More plants were seen in 1968. In 1969 there were two patches growing on the shingle by the Laboratory; one patch had white flowers and the other pinkish. By 1971 they had spread further into Long Low. Not seen recently.

Veronica officinalis L. - Heath Speedwell.

Occurs regularly on the Hood although not in great quantity. Several patches of the plant were found in 1966.

Veronica arvensis L. - Wall Speedwell.

Reported by Oliver & Salisbury (1913a) as occurring on the Long Hills but rather rare. In 1969 several plants were in flower on the dunes near

Glaux Low.

Veronica persica Poir. - Common Field-speedwell.

A small localized patch found on Far Point in 2004.

Rubiaceae

Sherardia arvensis L. - Field Madder.

Recorded for the Hood. Very rare.

Galium verum L. - Lady's Bedstraw.

Found on the Hood, the Long Hills and on some of the older, lateral shingle banks. It was first recorded from the Yankee Bank in 1956. A good localised colony growing in the grey dunes in 2002. Locally frequent amongst the dune grasses (except *Ammophila*) on the Hood in 2003.

Galium saxatile L. - Heath Bedstraw.

Found on the older dunes near the Long Hills in 1957, and in 1964 it was found on the old dunes along Great Sandy Low.

Galium aparine L. - Cleavers.

In 1970 several plants were found in flower growing in the detritus which had accumulated among the *Suaeda vera* bushes on the shingle in the western angle between the Watch House Bank and the main ridge. In 1971 there were several plants in flower among the Tree Lupins surrounding the well in the NT enclosure. Many plants found in the semi-fixed dunes in the Beacon Hills near the Lifeboat houses in 1984 and still present in 2004.

Caprifoliaceae

Sambucus nigra L. - Elder.

Several specimens of this shrub are to be found on the Point, e.g. on the Hood, the Long Hills and the grey dunes. Probably the results of birds distributing the fruits (see Map 11).

Lonicera periclymenum L. - Honeysuckle. Several shoots found in the plantation in 2004.

Valerianaceae

Valerianella locusta (L.) Laterr. - Common Cornsalad

One time fairly common on the Long Hills but now rare. Has been reported occasionally on the seaward side of the main dunes in recent years.

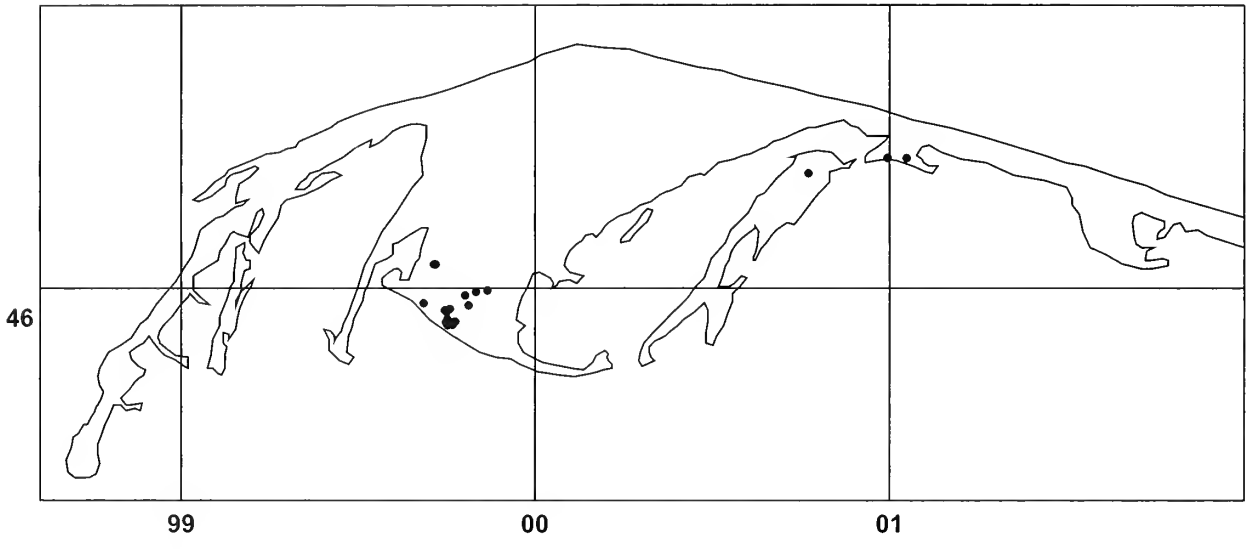
Dipsacaceae

Dipsacus fullonum L. - Teasel.

An occasional plant has occurred from time to time. In 1963 some 26 plants were found on the relict dune beyond the Long Hills. In 1964 there

were between two and three dozen plants (14 of which flowered) on the margin of the dune beside Great Sandy Low. In the following year there was an additional small patch of these plants near Great Sandy Low.

The number of these plants continues to increase and in September, 1966, there were 62 dead inflorescences and no fewer than 100 first-year rosettes (some growing on the shingle) at the Long Hills site, and 10 inflorescences and more than 20 rosettes at the Great Sandy Low sites.



Map 11 *Sambucus niger*

Asteraceae (Compositae)

Carduus nutans L. - Musk Thistle.

A single plant was found in 1971 on the ridge south-east of the Lifeboat House by E.A. Ellis. Now more widespread, locally frequent.

Cirsium vulgare (Savi) Ten. - Spear Thistle.

An occasional plant of the shingle and dunes.

Cirsium arvense (L.) Scop. - Creeping Thistle.

Found regularly in small numbers on the main dunes and the shingle.

Hypochaeris radicata L. - Cat's-ear.

Found regularly on the older dunes. It usually occurs in patches of several plants.

Hypochaeris glabra L. - Smooth Cat's-ear.

An annual plant whose small rosettes may be found on the lichen beaths and old grey dunes.

Leontodon autumnalis L. - Autumnal Hawkbit.

Rare. Recorded on the crests of some of the older lateral shingle banks.

Leontodon hispidus L. - Rough Hawkbit.

Occasionally on the older dunes and on the lateral shingle banks. It was recorded, for example, on Watch House Bank in 1956.

Tragopogon pratensis L. - Goat's-beard.

Two plants flowering on the top of the main dune ridge in the Beacon Hills and near the board walk in 2001 and 2002, spreading along the upper parts of the main dune ridge west to east towards the boardwalk in 2003. Still spreading amongst the dunes in 2004.

Sonchus arvensis L. - Perennial Sow-thistle.

On the shingle banks, often growing among the *Suaeda vera* bushes, or among the patches of *Honckenya peploides* or *Festuca rubra.*

Sonchus oleraceus L. – Smooth Sow-thistle.

Frequent on the shingle banks including the main ridge.

Sonchus asper (L.) Hill. - Prickly Sow-thistle.

This plant, which closely resembles *S. oleraceus,* has been recorded for the Point.

Lactuca virosa L. - Great Lettuce.

A tight cluster of 50 plants in flower in the dunes fringing the north side of Great Sandy Low in 2003. By 2004 there were 100 flowering plants and 100 first year rosettes.

Taraxacum sect. *Ruderalia* (*Taraxacum officinale* Weber) - Common Dandelion.

Members of this taxonomically difficult genus occur. Oliver & Salisbury (1913a) recorded *T.* sect. Erythrosperma (H. Lindb.) Dahlst from the Long Hills. It probably occurs elsewhere on the old grey dunes and lichen heaths.

Crepis biennis L. – Rough Hawk's-beard.

Occasional on the Watch House bank.

Crepis capillaris (L.) Wallr. – Smooth Hawk's-Beard.

Small patches locally frequent between NT enclosure the and south side of the Beacon Hills, and on the Yankee Bank.

Pilosella officinarum L. (*Hieracium pilosella* L.) - Mouse-ear-hawkweed.

Found regularly but not abundantly on the older dunes and lichen heaths.

Filago vulgaris Lam. - Common Cudweed.

Locally frequent to abundant in more stable grey dune around the in 1999. On Far Point in numbers on the salt-marsh side (landward) in the yellow dunes in 2002.

Filago arvensis L.

At least 30 plants of this casual were found growing on the grey dunes near the well in 1969. An introduced species from Europe now rare.

Filago minima (Sm.) Pers. - Small Cudweed.

This small, grey-green annual is extremely abundant on the grey dunes, lichen heaths and stabilized sandy-shingles. It is very short-lived and is easily overlooked since the specimens on the Point are usually minute.

Pulicaria dysenterica (L.) Bernh. - Common Fleabane.

A single plant found in Glaux Low in 1985 but not seen recently.

Aster tripolium L. - Sea Aster.

A very abundant, marsh-forming plant. It forms tussocks among the *Salicornia europaea* at the lower levels of the marsh. It accumulates mud and causes the general level of the marshes to increase and gradually forms a continuous sward. (Aster marsh). The Aster on the marshes on Blakeney Point is nearly all of the ray-less form (var. *discoideus* Rchb.) with only the yellow disc florets. A very occasional plant with the mauve ray florets will be found.

Erigeron acer L. - Blue Fleabane.

Occasional throughout the grey dunes and on shingle/sand areas of Far Point in 2004.

Conyza canadensis (L.) Cronquist (*Erigeron canadensis* L.) – Canadian Fleabane.

Observed in 1957 on the main shingle bank. In 1966 there were a number of plants in the main ternery on Near Point and it was still present in 1998. In 2002 the plant occurred on the landward side of the dunes on Far Point where it is now locally frequent.

Bellis perennis L. - Daisy.

Recorded by Oliver & Salisbury (1913a) for the Watch House Bank. Its occasional presence there, and perhaps elsewhere on the Point is probably due to human activity. It was noted on the main shingle ridge in 1957.

Seriphidium maritimum (L.) Polj. (*Artemisia maritima* L.) – Sea Wormwood.

This grey-green plant, which has a very characteristic smell when crushed, is found at the upper margins of the older marshes, and on the shingle fringing such marshes. It also occurs in some of the lows and has appeared on the Yankee Bank. Spread on to Far Point in 2002 where it occurs above the strand line in sandy shingle. There are patches where it is now locally frequent on Far Point.

Achillea millefolium L. -Yarrow.

Found in 2003 and 2004 at the side of the tractor path where the Yankee Bank meets the Main shingle bank.

Tripleurospermum maritimum (L.) W.D.J. Koch (*Matricaria maritima* L.) – Sea Mayweed.

A rare plant (on the Point) found occasionally on the main shingle bank where it was noted, for example, in 1958. There were several plants on the embryo dunes near Great Sandy Low in 1966. Now spreading and more numerous, as on Far Point.

Senecio jacobaea L. - Common Ragwort.

A common plant on both dunes and the shingle. It seems to favour disturbed ground and was especially abundant on those regions of the older dunes where there were extensive rabbit burrows, many of which had collapsed. It was much less abundant in the years following the disappearance of the rabbits. Many of the areas in which it formerly grew abundantly had become more stabilised following the disappearance of the rabbits and the consequent better growth of the grasses especially *Festuca* (White 1961). There was more *Senecio* flowering in 1966 than for some years, and there was a particularly fine show on the "rotten" dune opposite the Laboratory. *Senecio jacobaea* is the food plant of the caterpillars of the Cinnabar moth, which sometimes defoliate the plants.

Senecio vulgaris L. - Groundsel.

Found occasionally on the shingle and dunes, and in disturbed soil e.g. around the Lifeboat Houses.

Senecio sylvaticus L. - Heath Groundsel.

Recorded by Oliver & Salisbury (1913a) as very rare, occurring only on the highest part of the eighth lateral shingle bank. For some years it has been found regularly on the Hood. In 1968 it was observed on the relict dune forming the 'outlier' to the Long Hills. In 2004 found occasionally throughout the dunes and on Far Point, spreading at the end of Yankee Bank.

Tussilago farfara L. - Colt's-foot.

This plant of stiff, heavy soils is occasionally recorded as a casual. Recorded by Oliver & Salisbury (1913a). A plant was found growing on the drift line in 1956 and was still there in 1959. It was probably the result of a piece of rhizome washed up by the tide. In 2004 two plants were recorded on Far Point.

Juncaginaceae

Triglochin maritimum L. - Sea Arrowgrass.

Found as scattered plants about the mid-level of the Aster marsh. At higher levels it can be found in patches forming part of the mosaic which is referred to as the "general salt-marsh community." Odd plants of *T. maritimum* may be found in the lows where they may have been carried by high tides. It has been observed in both Glaux Low and Boathouse Low. More than 40 robust plants were found in Glaux Low in 2002.

Zosteraceae

Zostera marina L. - Eelgrass.

It is less tolerant of exposure than *Z. noltii* (see below) and occurs just above the low tide level. On the Point it is often found growing in small runnels left when the tide retreats. It is less common than *Z. noltii* on the Point.

Zostera angustifolia (Hornem.) Rchb. (*Z. hornemanniana* Tutin) - Narrow-leaved Eelgrass.

Found in 1962, growing in association with *Z. noltii.* The plants were intermediate in frond size between *Z. marina* and *Z. noltii.* Fertile specimens were collected and sent to Professor T. G. Tutin for identification.

Zostera noltii Hornem. (*Zostera nana* Roth) - Dwarf Eelgrass.

More abundant than *Z. marina* and more tolerant of exposure. It grows upon sloppy mud and is often exposed at low tide.

Juncaceae

Juncus gerardii Loisel. - Salt-marsh Rush.

A single plant appeared in Glaux Low in 1916. This was thought to be due to the tidal entry the preceding November. The plant has spread into Great Sandy Low, and is now common in Glaux Low where it is still spreading in 2003.

Juncus bufonius L. - Toad Rush.

A small, tufted, annual plant abundant in Glaux Low. In 1958 it appeared in Long Low where it is now in great quantity.

Juncus articulatus L. - Jointed Rush.

Several plants, forming an extensive patch were found flowering in Glaux Low in 1964.

Juncus maritimus Lam. - Sea Rush.

Occurs in the bay formed by the depression in the Hood where it was recorded by Oliver & Salisbury (1913a). For many years this was the only station for this plant on the Point, but in 1958 several plants appeared

in Great Sandy Low near to where it joins Glaux Low. There were nine clumps present in 1960, and in 1966 there were thirteen with two further clumps in Glaux Low. The clumps appear to be spreading and several have flowered. The plant was spreading in Glaux Low in 2003 (see map).

Luzula pilosa (L.) Willd. - Hairy Wood-rush.

Found on the Hood in 1958.

Luzula campestris (L.) D.C. - Field Woodrush.

Recorded by Oliver & Salisbury (1913a) as common on the Hood, and still present there but by no means abundant.

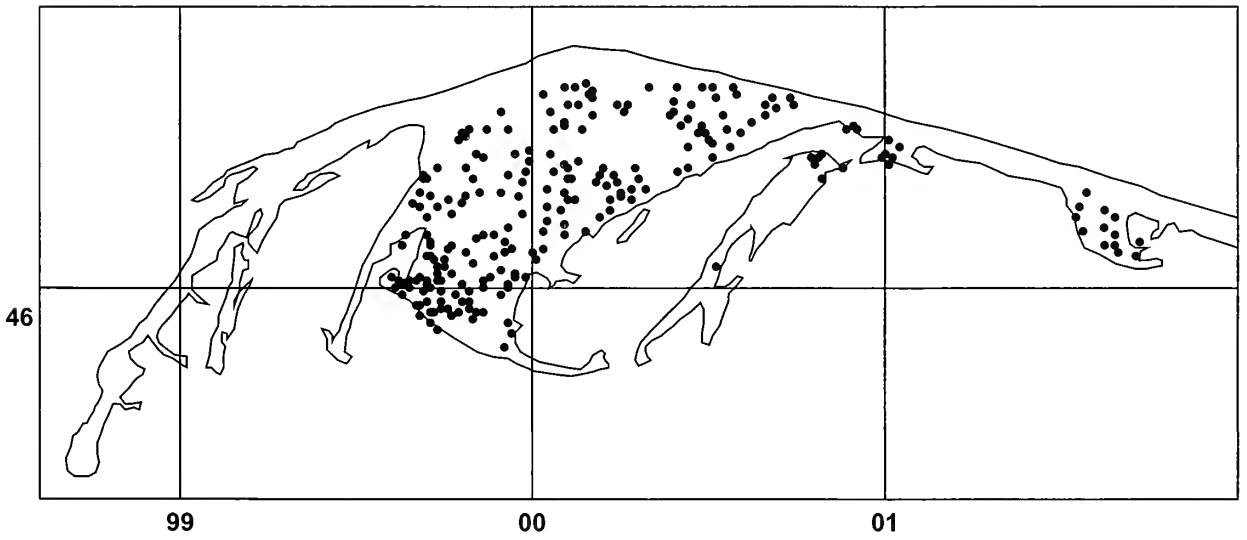
Cyperaceae

Carex otrubae Podp. - False Fox-sedge.

First recorded in 1956, on the Yankee Bank. Found in the following year in two other places on the dunes where detritus had been washed up.

Carex arenaria L. - Sand Sedge.

Abundant on the old grey dunes (*Carex* dunes) and on the Lichen heaths. Common on the Hood (see Map 12).



Map 12 *Carex arenaria*

Carex distans L. - Distant Sedge.

Found in Glaux Low in 1959.

Carex extensa Gooden. - Long-bracted Sedge.

Found in Glaux Low in 1984, identification confirmed by A. C. Jermy.

Carex viridula ssp. oedocarpa (Andersson) B. Schmid (*C. demissa* Hornem). - Yellow Sedge.

A few plants of this sedge were found in Glaux Low in 1964. In 1965 and again in 1966 there were upwards of 100 plants present, all flowering abundantly.

Poaceae (Gramineae)

Festuca arenaria Osbeck. [*F. rubra* ssp. *arenaria* (Osbeck)] - Rush-leaved Fescue.

Common throughout the dune-system. Two divergent types occur; one is restricted to the main dune ridges where wind blown sand is actively accreting, the other is widespread on the semi-fixed and fixed dunes (Anderson & Taylor 1979). There are measurable morphological differences between the two forms, which are accentuated by rabbit grazing; on the mobile dunes the fescue grows to a height of 20-90 cm, whereas on the fixed dunes it attains a height of between 8-16 cm. They also show different morphological and physiological responses to sand accretion. Plants of both types are octaploids ($2n$ =56). Identification was confirmed by C.A. Stace.

Festuca rubra L. ssp. *rubra* - Red Fescue.

Common, occurring on the consolidated shingle. Specimens collected for identification by C.A. Stace from the terminal hook of the Yankee Bank in 1984.

Festuca ovina L. - Sheep's Fescue.

Not common on the Point. Oliver & Salisbury (1913) recorded it as rather rare for some of the older lateral shingle banks. It was found on the Yankee Bank in 1956. A patch of this grass was found in flower on the crest of the main dune ridge above the Carex dunes in 1964. It was still there in 1966.

Lolium perenne L. - Perennial Rye-grass.

A casual found very occasionally. A patch was found on the Headland dunes in 1958.

Vulpia bromoides (L.) Gray - Squirreltail Fescue.

Recorded for the Watch House Bank in 1956.

Cynosurus cristatus L. - Crested Dog's-tail.

Found on the Hood in 1958.

Puccinellia maritima (Huds.) Parl. - Common Salt-marsh-grass.

This grass occurs at various levels in the salt-marshes, and along the marsh edge of the shingle. At the upper levels of the marsh it may become more or less dominant as it does locally on some of the marshes in the Marams. Provides good grazing on 'saltings'. In 1984 the plant was spreading in the upper parts of the salt-marsh below the Yankee Bank.

Poa annua L. - Annual Meadow-grass.

Sometimes, in spite of its specific name, a short-lived perennial. Can be found on the shingle, in the lows and on the eroded margins of the older

dunes.

Poa humilis Ehrh. ex Hoffm. (*P. subcaerulea* Sm.) - Spreading Meadow-grass.

Found on the older dunes of the Headland and in the Beacon Hills. In the absence of rabbits it may play an important part in the dune succession at the stage when the Marram (*Ammophila arenaria*) is deteriorating.

Poa pratensis L. - Smooth Meadow-grass.

Found on some of the older shingle banks, and also on the consolidated dunes of the Headland, notably behind the big blow-outs.

Dactylis glomerata L. - Cock's-foot.

A casual not often seen on the Point. A patch was seen on the Hood and another on the Headland dunes in 1959.

Catapodium rigidum (L.) C. E. Hubbard [*Desmazeria rigida* (L.) Tutin] – Fern-grass.

A small annual grass whose leaves often have a slight purplish tinge. Found on the sandy-gravel

Catapodium marinum (L.) C. E. Hubb. [*Desmazeria marina* (L.) Druce] – Sea Fern-grass.

Regularly found on the shingle at the beginning of the Yankee Bank where the vegetation cover is relatively sparse, and in the sandy-gravel elsewhere on the Point.

Parapholis strigosa (Dumort) C. E. Hubb. [*Lepturus fihiformis* (Roth.) Trin.] - Hard-grass.

A rather rare annual grass occurring on the sandy or muddy consolidated shingle of the older lateral shingle banks.

Parapholis incurva (L.) C. E. Hubb. [*Lepturus incurvus* (L.) Druce] – Curved Hard-grass.

An annual grass occurring on muddy gravel, near the edges of salt-marshes. A mediterranean species. It was recorded near the base of the Yankee Bank in 1956. In abundance in this area from 1993-2004. Also fairly widespread at the edges of Great Sandy Low in 2004.

Arrhenatherum elatius (L.) P. Beauv. ex. J. & C. Presl - False Oat-grass.

A casual. This plant was recorded by Oliver & Salisbury (1913a) as very rare on the main shingle bank. A patch of this grass was found on the Headland dunes in 1958 and near the board walk in 2003. Found on the Hood in 2004, may be spreading.

Trisetum flavescens (L.) Beauv. - Yellow Oat-grass.

A patch of this stoloniferous grass was found on the Beacon Hills in 1958.

Koeleria macrantha (Ledeb.) [*Koeleria cristata* auct. non (L) Pers., *Koeleria gracilis* Pers.] - Crested Hair-grass·

Recorded by Oliver & Salisbury (1913a) as occurring on the eighth lateral shingle bank. Very rare. A clump of this grass was found near the well in 1957 and another patch on the main dune ridge. In 2004 two clumps were found between the Beacon Hills and the NT enclosure.

Holcus lanatus L. – Yorkshire-fog.

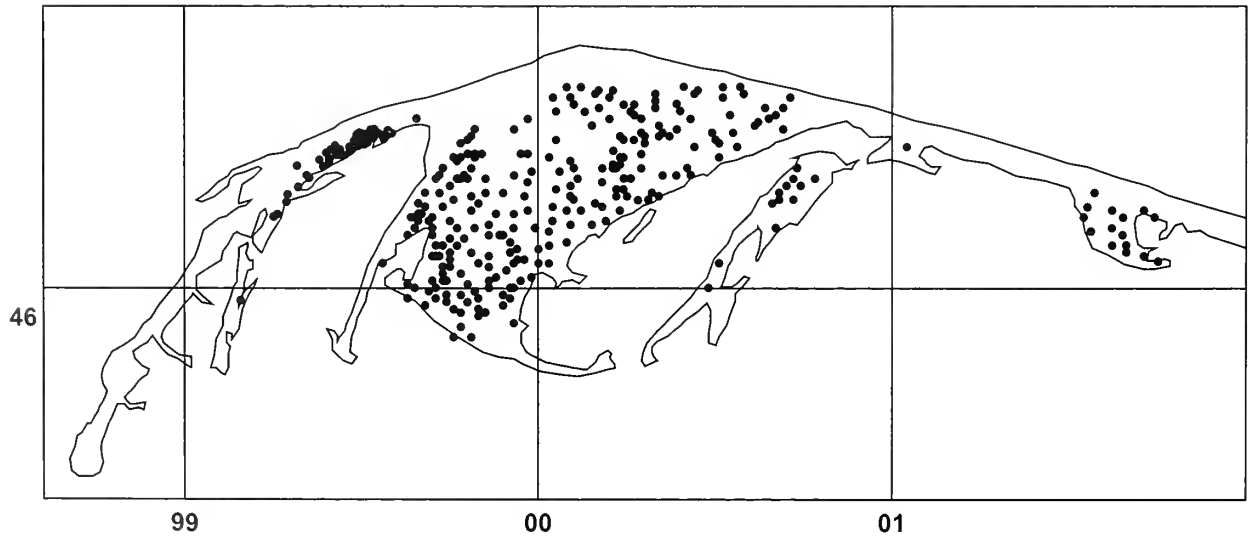
Relatively rare on the Point. It was seen on the Hood in 1958 and *1959* and is now quite common there especially along the footpaths. A small patch of this grass was found in Glaux Low in 1964. Small patches found on stable dune heath and spreading in 2004.

Holcus mollis L. - Creeping Soft-grass.

A single clump found on dunes near the strandline on Far Point in 2002.

Corynephorus canescens (L.) P.Beauv. [*Aira canescens* L., *Weingartneria canescens* (L) Bernh.] - Grey Hair-grass.

A rare grass, native to Norfolk, Suffolk and the Channel Islands. Elsewhere in the British Isles it is probably introduced. On the Point it was well established in a relatively isolated colony on the Hood in 1923. Further, there was a smaller population near the laboratory on the old *Carex* Dunes. This colony showed signs of expansion in 1956 (Jane 1960). The grass began to spread after the disappearance of the rabbits in 1954. It was noted on the Yankee Bank for the first time in 1956 and on the main dune ridge in 1957. Many seedlings were found on the Old Grey Dune in 1966. The rate of spread appears to have increased in recent years and by 2000



Map 13 *Corynephorus canescens*

this plant had spread to cover most of the more stable sand dune areas on the Point. It was still well established on the Hood. No plants were found on the newly evolving shingle and sand spit of Far Point in 1996, but an isolated colony of *C. canescens* had appeared by 2000 and by 2004 was spreading on Far Point (see Map 13).

Aira praecox L. - Early Hair-grass.

A small, short-lived, annual plant extremely abundant on the consolidated dunes, grey dunes, lichen heaths, and on sandy shingle in the lows and on the lateral shingle banks. It flowers abundantly in the early part of the year but in summer only dried remains of this plant can be found, so giving a very inadequate idea of the abundance and distribution of this species. It was exceptionally abundant in 1959 and again in 1960. There were huge drifts of it everywhere.

Anthoxanthum odoratum L. - Sweet Vernal-grass.

In 1958 it was found on the dunes where detritus bad been washed up. Also found on the Beacon Hills in the same season.

Agrostis capillaris L. (A. *tenuis* Sibth.) - Common Bent.

Found among the brambles on the Hood in 1962.

Agrostis stolonifera L. - Creeping Bent.

Forms a definite zone on the crest of the lateral shingle ridges. A zone of *A. stolonifera* occurs at the Hood on the sandy shingle in the depression, and it is also found in Long Low. Now abundant in Glaux Low and displacing *Glaux maritima* and annual *Salicornia.*

Ammophila arenaria (L.) Link - Marram.

On the Point is the dune builder *par excellence.* Continued deposition of wind-blown sand stimulates it to vigorous growth. The plant remains bright green and inflorescences appear in large numbers. When the supply of fresh sand is cut off the Marram deteriorates, the plants becoming less green, many of the leaves and shoots dying and turning brown. Under these conditions it does not flower. Such degenerate Marram can be rejuvenated by the arrival of fresh supplies of sand. Such rejuvenated dunes can be seen near the big blow-outs on the Headland, where the sand from the blow-outs has been deposited on an old dune.

While *Elytrigia juncea* is regarded as the real pioneer dune former, the Marram can, and on Blakeney Point does, function as a pioneer if numerous individuals are present to ensure good deposition of sand.

Phleum arenarium L. - Sand Cat's-tail.

Very abundant, short-lived annual plant of the consolidated yellow dunes, Carex dunes, lichen heaths and sandy shingle.

Bromus hordeaceus ssp. *hordeaceus* (*B. mollis* L.) - Lop-grass.

Occurs in some abundance on the Watch House Bank. Has been recorded by Oliver & Salisbury (1913a) as very rare on the Long Hills, and as rare on the Hood.

Anisantha sterilis (L.) Nevski (*Bromus sterilis* L.) - Barren Brome.

Found on the Long Hills in 1958.

Elymus caninus (L.) L. [*Agropyron caninum* (L.) P.Beauv] – Bearded Couch.

A native plant of hedgerows and woods which was found growing in some quantity on Yankee Bank in June, 1956. It was still there in 1959.

Elytrigia atherica (Link) Kerguélen ex Carreras Mart. [*Agropyron pungens* (Pers.) Roem & Schult] - Sea Couch.

A glaucous, grey-green, stiff, grass which occurs occasionally on the yellow, consolidated dunes and, more abundantly, on the shingle and especially on the muddy sand or gravel at the margins of salt-marshes. Fine specimens of this grass will be found on the Marams. *E. atherica* is less tolerant of saline conditions than *E. juncea.* Its leaves are rolled and their margins are toothed. The two species may hybridize

Elytrigia juncea ssp. *boreoatlantica* (Simonet & Guin.) Hyl. *[Agropyron junceiforme* (Á. & D. Löve) Á. & D. Löve - Sand Couch.

The main grass forming fore-dunes which, however, never reach more than four feet in height. The habit of the grass is spreading, a distinct contrast to the other dune forming grasses. When marram grass (*Ammophila arenaria)* starts to grow on a fore-dune the *E. juncea* is soon eliminated.

Leymus arenarius (L.) Hochst. (*Elymus arenarius* L.) - Lyme-grass.

One particular patch on the main dune ridge beside a path held its own for some years and then began to spread. There were 220 shoots in 1957, 340 in 1958, 722 shoots in 1959 and 972 in 1960. This patch reached a maximum of 1969 shoots in 1963 and has since fallen. There were 1051 shoots present in 1966. It is in a very vulnerable position. In 1959 two other patches of this plant were found. One, on the edge of the dunes near the lagoon, growing among *Elytrigia juncea,* had twenty-nine shoots, and the other on the shingle leading to Near Point had forty shoots. In 1960 these two clumps had eighty and sixty shoots respectively. The number of shoots in the lagoon patch has varied from year to year, reaching 385 shoots in 1966. The patch on the shingle has steadily increased in size. There were 499 shoots in 1964, the last time this patch was counted. Now widely established in the fore dunes, *Leymus* will be recognised among the Marram by its broad leaves, which roll up in dry conditions. The foliage

dies away in autumn and thus the plant gives but limited protection to the dune surface. It is not such an efficient dune builder as Marram. Now in isolated patches on Far Point.

Hordeum murinum L. - Wall Barley.

Occasional plants occur near the Lifeboat Houses.

Phragmites australis (Cav.) Trin. ex Steud. (*P. communis* Trin.) - Common Reed

Several plants appeared in Glaux Low in 1959. One was sending out long runners over the ground. These plants almost certainly originated from pieces of rhizome brought in by the tides during the previous winter. The plants have persisted and spread. They were looking very healthy in 1966 and several shoots flowered. Not seen recently.

Spartina maritima (Curt.) Fernald - Small Cord-grass.

Reported by Oliver & Salisbury (1913a) to occur in the Blakeney Channel adjacent to the reclaimed salt-marshes. It has not been recorded in recent years

Spartina anglica C.E.Hubb. [*S. x townsendii* auct. non H. & J. Groves (*S. maritima* x *S. alternifolia*)] - Common Cord-grass.

Spartina anglica is an amphidiploid of *S.* x *townsendii* and is highly fertile. In January, 1925, Professor Oliver sowed a few seeds on the marsh in wet, sloppy mud. There were well-developed, flowering plants present by the autumn of 1927. Oliver attempted to eradicate these plants. Probably there was some survival, perhaps of seed. This marsh is now an *S. anglica* meadow and the plant is widely spread over the Blakeney marshes. In 1979 patches of the species had appeared in the new salt-marsh developing between Far Point and Near Point. To date the plant has spread extensively in this new marsh. It is uncertain whether all the *Spartina* has come from the original plantings since *Spartina* has been widely planted around other parts of the coast.

Liliaceae

Kniphofia sp. (cultivar) - Red-hot Poker.

Originally planted at least sixty years ago. They appear to have maintained themselves satisfactorily for many years, but have not been seen since 2000.

Hyacinthoides non-scripta (L.) Chouard ex Rothm. [*Endymion non-scriptus* (L.) Garcke.] - Bluebell.

In 1968 five small patches were found growing on the relict dune near the Long Hills. This patch contained bulbs of various sizes including some which were one year old. There were two inflorescences at this

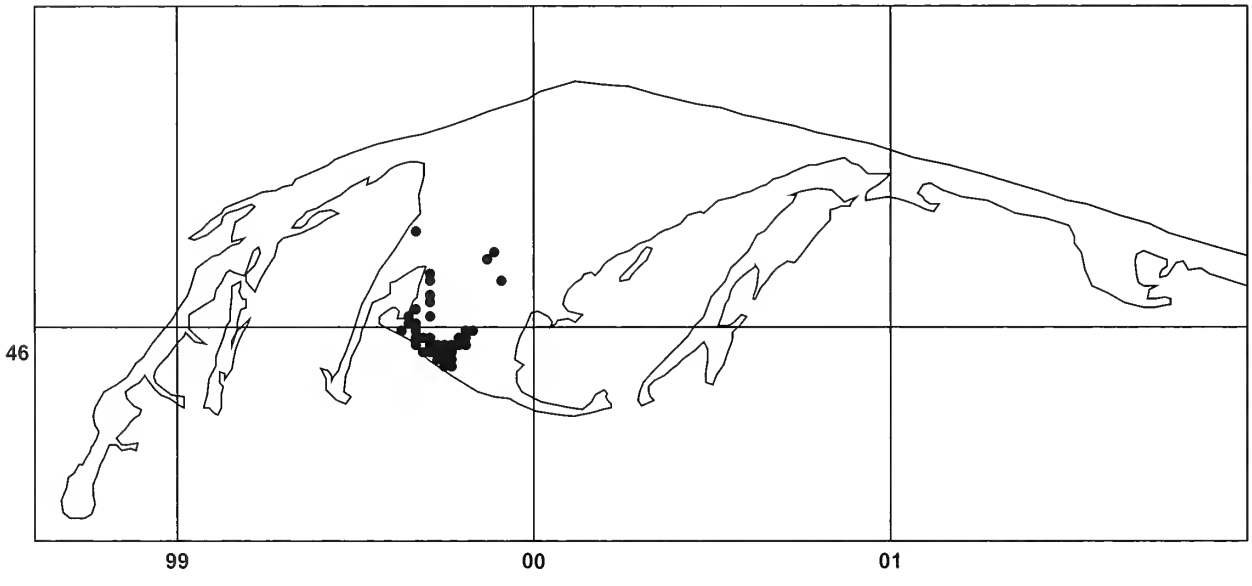
time. The plants must have been present for several years. The dune was accidentally burned over in the autumn of 1969 and the patches of bluebells were sprouting in the following April. No plants were located in 1971, but present in 2005.

Narcissus pseudonarcissus L. (cultivars) - Daffodil.

Planted in the sand near the Laboratory. They appear to be maintaining themselves and flower each year.

Asparagus officinalis L. - Asparagus.

There was a single plant to be found near the well in the NT enclosure; it was first observed in 1957 and persisted for several years. Dotted about the NT enclosure in 2002, and also next to the Elder bush in the Beacon Hills and in the Plantation. Now spreading (see Map 14).



Map 14 *Asparagus officinalis*

Iridaceae

Iris pseudacorus L. - Yellow Iris.

A solitary specimen occurred on one of the dunes in the main dune system; it was known for some years and first flowered in 1913. Yet another plant appeared in 1914. More recently a plant was found on the dunes in 1955. These plants probably originated from fragments of rhizomes brought in by the tidal drift.

Agavaceae

Yucca recurvifolia Salisb. - Yucca, Spanish–dagger.

Planted on the dunes between the Laboratory and the plantation in 1912. It is flourishing and flowers most years. In 1956 the main plant bore eleven inflorescences. Has spread more recently.

Orchidaceae

Epipactis palustris (L.) Crantz - Marsh Helleborine.

A solitary flowering specimen was found in 1914 by the late Sir Frederick Hooper, high up on the dunes of the Headland some distance north of Great Sandy Low.

Anacamptis pyramidalis (L.) Rich. – Pyramidal Orchid.

A single plant was found in 1969, growing on the slope of the dunes on the west side of Glaux low nearly opposite to the 'neck' of this Low. A single plant present in 2006 at the same site

Dactylorhiza fuchsii (Druce) Soó - Common Spotted-orchid.

Found for the first time in 2007 just 100m east of the laboratory.

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This list owes much to the collaboration of colleagues, especially Dr. D.J.B. White, and students who have botanised regularly on Blakeney Point. Our thanks are given to all the wardens at the National Trust, Blakeney Point, over the years, especially Joe and Janet Reed and David Wood. Their enthusiasm and support has been of great help.

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Whorl Snails of the Genus *Vertigo* in Norfolk

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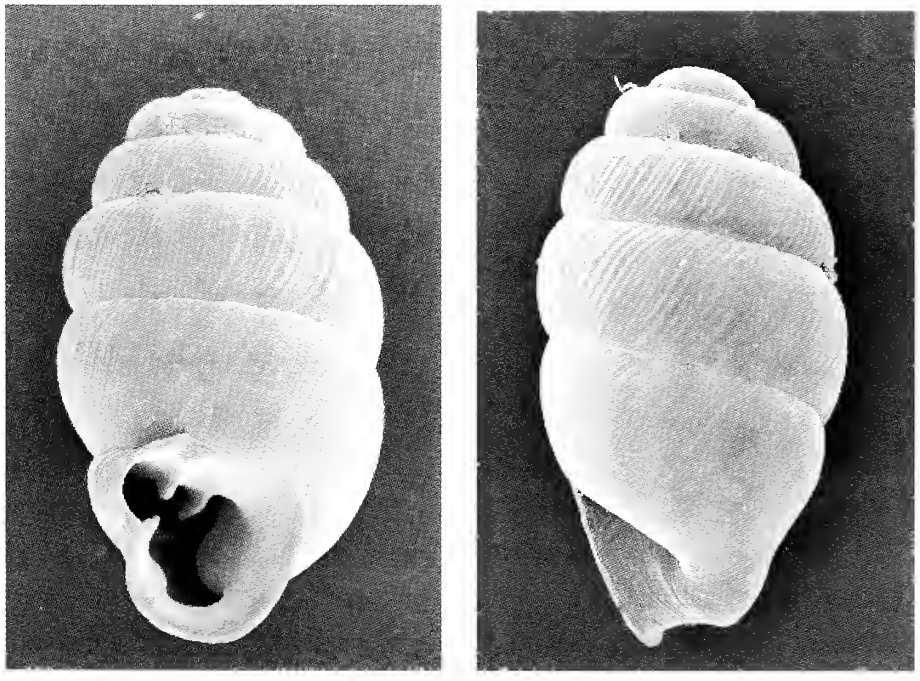
Of the fifteen European species of whorl snails *Vertigo* (Gastropoda: Vertiginidae) eleven are recorded from the U.K. of which seven are known from Norfolk. They are all very small with mature sizes between 1.7mm and 3mm. This paper aims to describe the Norfolk distribution, to examine each species in its Norfolk habitats and to indicate conservation strategies within the Norfolk context.

Vertigo angustior

The Narrow-mouthed Whorl Snail *Vertigo angustior* Jeffreys is an extremely small snail, being under 2mm in height. It has four and a half moderately convex whorls with fine sculptured striae. The suture is deep and the sinestral mouth is subtriangular with four teeth. Outside Norfolk it is known from a further ten UK sites, although it is more widespread on the west coast of Ireland.



Vertigo angustior has a short life-span, but a percentage of the population have been shown to be aphallic, no penis develops, thus allowing the population to recover from reduced density levels (Pokyrszko, 1987). Killeen (1993) and Cameron (2003) note that the Narrow-mouthed Whorl Snail can produce large numbers of young in a very short time when conditions are favourable.

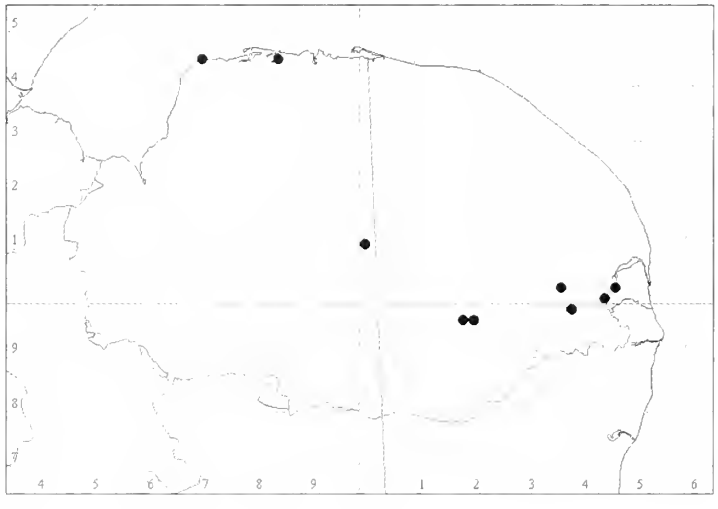
Status

Vertigo angustior is listed under Annex II of the European Union Habitats and Species Directive. This Directive requires E.U. States to designate Special Areas of Conservation (SACs) and to maintain 'at a favourable conservation status' those species listed in the Annex II. In Norfolk Natural England is the responsible body. *Vertigo angustior* is placed in the Red Data Book Category 1 (endangered) for the U.K. (Bratton, 1991).

Distribution

Vertigo angustior has been recorded from nine sites in Norfolk. These include sand dunes, sea walls, river walls bordered by saltmarsh, grazed marshes and tufa mounds. Many of these sites are in SSSIs and some are designated as SACs under the European Habitats Directive which offer some protection for the species, although the sea and river walls are often repaired and sites altered.

Vertigo angustior (Narrow-mouthed Whorl Snail)



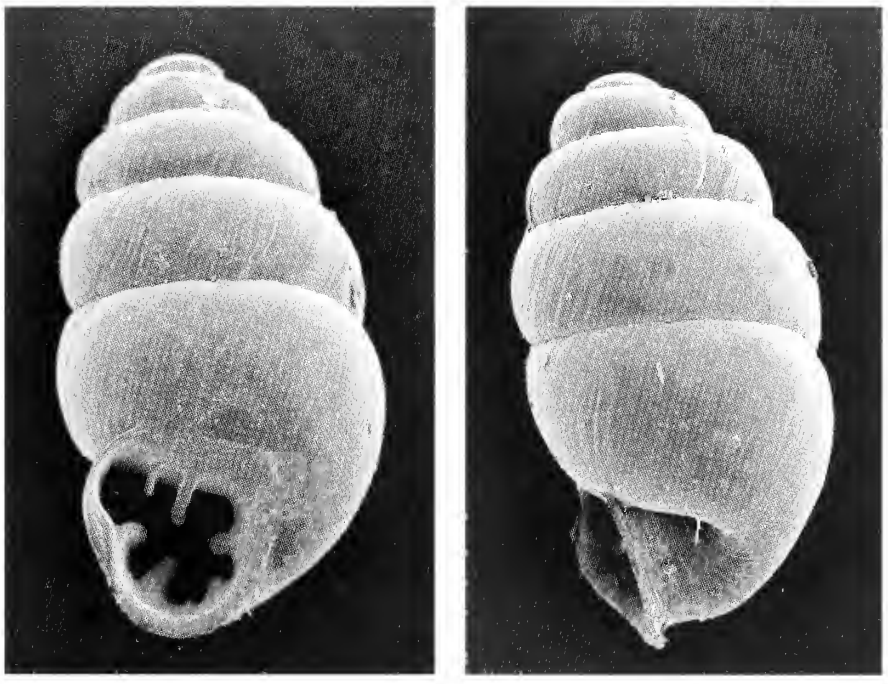
Conservation

Surveys of the known Norfolk sites for *Vertigo angustior* indicate that there are no consistent associations with specific plant communities but there are some associations with particular environmental conditions. The Narrow-mouthed Whorl Snail occurs in Norfolk in sites which are permanently damp but which are not subject to inundation, although in November 2006 a tidal surge overtopped the wall of the River Chet and flooded the marshes, which includes one of the *Vertigo angustior* sites, for several weeks. The soils are friable and not the heavy clay form of much of the county. The vegetation shows a relative openness where trees and tall herbs are absent. Lightly grazed turf, often of fine grasses and/or sedges, is preferred. However, as with other species of *Vertigo* heavy grazing can have a marked detrimental affect on the

populations. *Vertigo angustior* has a short life-span and is known to recover from very reduced levels quickly.

Vertigo pusilla

The Wall or Wry-necked Whorl Snail *Vertigo pusilla* Müller has five moderately convex whorls with irregular striae which range from being weak

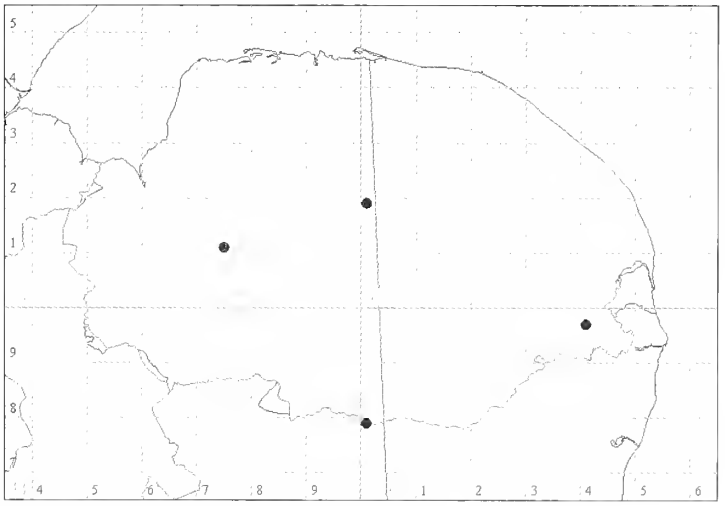


to prominent. The snail has an adult height between 1.9-2.1mm and a breadth of 1.0-1.2mm. The sinestral heart-shaped mouth has a slightly thickened and reflected edge and shows six teeth (sometimes nine): two parietal, two columellar and two palatal. The umbilicus is open and deep. The shell colour ranges from a yellowish to a golden-brown.

Status

The Wall Whorl Snail is rare in Norfolk. Nationally it is not included in any Biodiversity Action Plan or Red Data Book categories.

Vertigo pusilla (Wall Whorl Snail)



Distribution

Vertigo pusilla has been recorded from four sites in the county in the last fifty years. In the post-glacial period the snail was widely

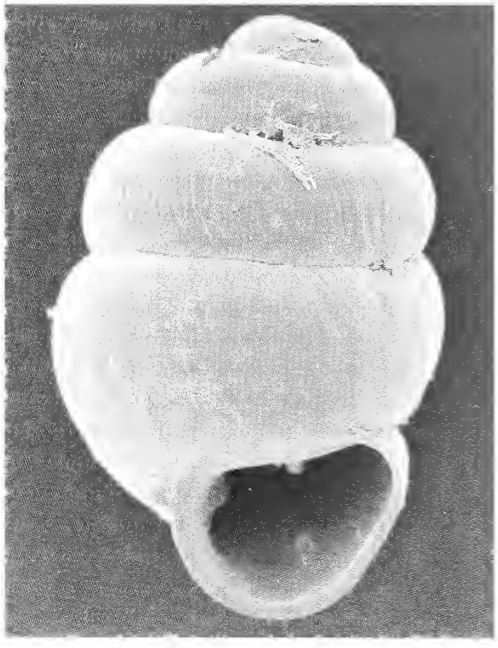
distributed but with changing land use it has sharply declined. Kerney (1999) in the *Atlas of the Land and Freshwater Molluscs of Britain and Ireland* noted three Norfolk sites. It is a mesophile species which often chooses humid spots in otherwise dry habitats. Two of the Norfolk sites are grass swards; at Blo Norton in a lane and at Billingford near Dereham under oak trees. At Narborough it was recorded in leaf litter in a small wood whilst in the Craft Plantation at Raveningham it lives on sycamore tree trunks up to 2m from the ground. The sycamore trees grow on either side of a woodland track but similar trees within the plantation show no evidence of the snail.

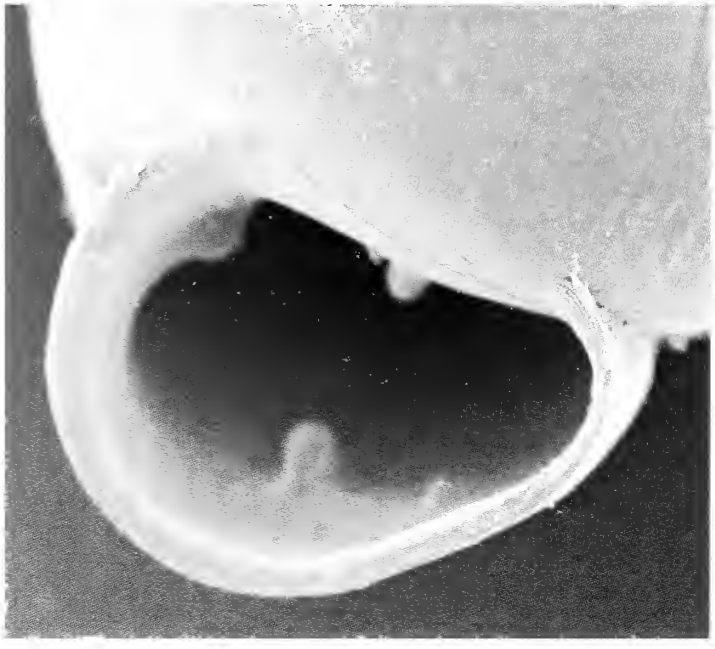
Conservation

So little is known of the ecological requirements for this species that no meaningful advice can be given for continuing conservation. The isolated colonies discovered in Norfolk can only be noted and monitoring of the populations be recommended.

Vertigo geyeri

The discovery in 2004 of the RDB1 species *Vertigo geyeri* Lindholm in a calcareous valley fen in central Norfolk indicated that the species could occur





elsewhere in suitable lowland habitats.

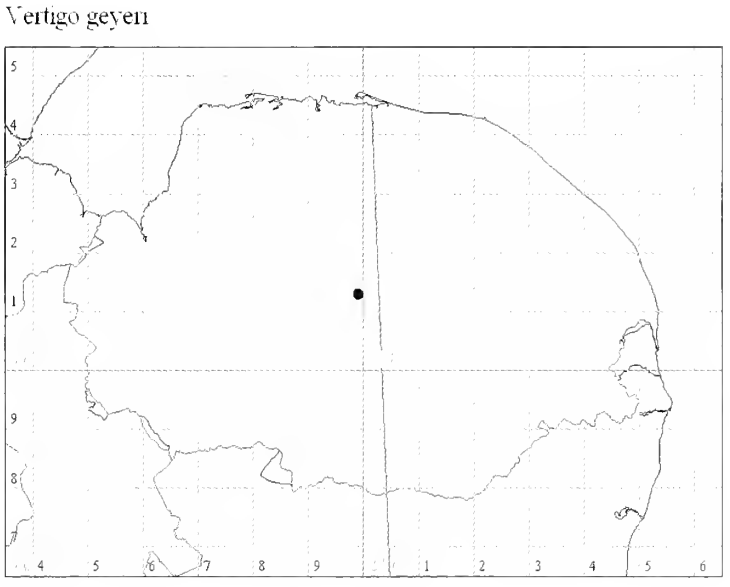
The dextral, tumid shell of *Vertigo geyeri* is small with a length of 1.7-1.9mm and a breadth of 1.1-1.2mm. It is ovate with indistinctly, spaced striae giving a glossy reddish-brown colour. The mouth normally has four teeth (one parietal, one columellar and two palatal). There are 4.5 moderately convex whorls rapidly increasing. The penultimate whorl is nearly as broad as the

body whorl. The umbilical opening is shallow.

Status

Vertigo geyeri is listed in the Red Data Book (Bratton 1991) as an RDB1 (endangered) species. It is a priority species in the UK Biodiversity Action Plan (HMSO 1996) and its status is currently being reviewed as part of the U.K. BAP Terrestrial Mollusc Steering Group as one of the top five U.K. species. It is listed under Annexe II of the European Union Habitats and Species Directive which requires the U.K. to maintain favourable conservation status and to initiate monitoring programmes for the species. There is no Norfolk Biodiversity Action Plan for this species at present.

Distribution



The species is restricted in Europe mainly to the mountains of Scandinavia, the Alps of Switzerland and S.W. Bavaria and to isolated sites in the lowlands of Ireland, Denmark, the islands of the southern Baltic, and in N.E. and S.E. Germany. In Britain it is known from a few sites in Anglesey, Caernarfon, Westmorland, North York-shire, Perthshire and Islay. One of the authors (GH) has extended its range to a number of sites in Northern Ireland and Ireland (Holyoak, 2005). It remains an extremely rare snail throughout the U.K.

Vertigo geyeri was once common in lowland Britain after the last glaciation so its discovery in 2004 by one of the authors (GH) in central Norfolk is of major significance. The decline in lowland Britain has been attributed to both postglacial forest growth and subsequent land drainage by man (Kerney, 1999).

Scarning Fen is a small calcareous valley fen on shallow peat. The central area of the fen is dominated by bryophytes, Black Bog-rush *Schoenus nigricans* and Blunt-flowered Rush *Juncus subnodulosus*. Other species include Bogbean *Menyanthes trifoliata*, Marsh Lousewort *Pedicularis palustris*, Common

Quaking-grass *Brizia media* and Cotton-grass *Eriophorum angustifolium.* The vegetation does not form a closed community such that bare ground, or ground covered by liverworts etc, occur between the rush clumps. (National Vegetation Community M13)

This fen vegetation is typically associated with oligotrophic, calcareous fens which are supplied by chalk ground water discharges.

Vertigo geyeri is found in this central fen community. The densities of the snail are very low and it appears to have a restricted area within the fen. Bare soil between the clumps of Black Bog-rush *Schoenus nigricans* means that *Vertigo geyeri* is to be found on the slightly raised clumps of the rush. At some lowland sites in Ireland *Vertigo geyeri* has been shown to be associated with *Schoenus nigricans* in calcareous fens and flushes. (Holyoak, 2005).

The water table is stable and is at or near the surface such that the fen, even in high summer, remains damp to wet. In autumn-winter conditions water collects between the tussocks but the fen is rarely, if ever, flooded. The shallow surface peat layer (30cm) lies on sandy-gravel deposits underlain by the Upper Chalk aquifer. In a number of places calcareous water seeps into the fen from the chalk aquifer. The balance between the rainwater input and run-off from the surrounding land is in part balanced by the calcareous waters of the chalk aquifer. Any lowering of the water table by extraction could be very critical to the fen communities. The increasing housing demands of Dereham and the need for water could have a detrimental affect on the hydrological balances within the fen.

The water in the upper peat layer is acidic pH 6.1 and it has a low conductivity level 724μS^{-1}. Whilst these Scarning sites appear to be acidic Holyoak (2003) recorded *Vertigo geyeri* in small highly calcareous sites even though the surrounding flush habitats were predominantly acidic moorlands. This is probably the situation at Scarning Fen where the calcareous flushes may be limited in size and distribution.

Conservation

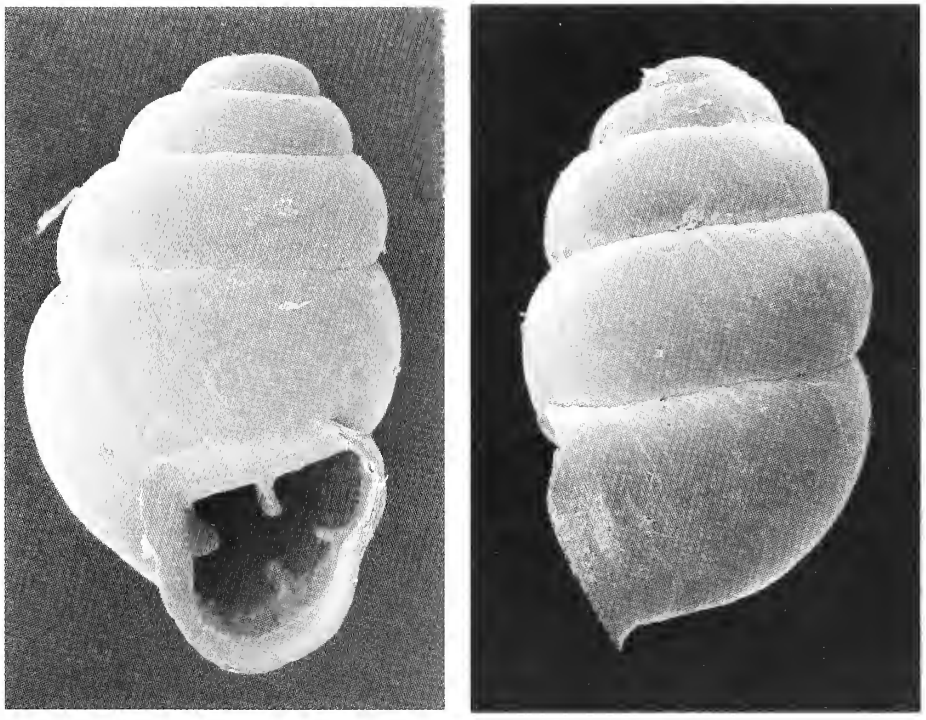
Scarning Fen is currently managed by biennial strip mowing and the removal of scrub and vegetation. This appears to be favourable for *Vertigo geyeri.* The critical importance of maintaining water levels for this fen should be central to any management plan. Abstraction and or new drainage ditches are to be discouraged. The Environment Agency monitors water levels and abstraction.

Cattle grazing at Scarning Fen is currently low. One or two cows and one or two calves graze for 3-4 weeks every summer. This mixed management strategy of mowing and grazing appears to benefit the fen flora and fauna.

Scarning Fen is of international importance and forms part of the Norfolk Valley Fens SAC and is thus protected under the European Habitats Directive.

Vertigo moulinsiana

Desmoulin's Whorl Snail *Vertigo moulinsiana* (Dupuy) has a reddish-brown shell. It is larger than other British *Vertigo* species with a height of 2.2-2.7mm

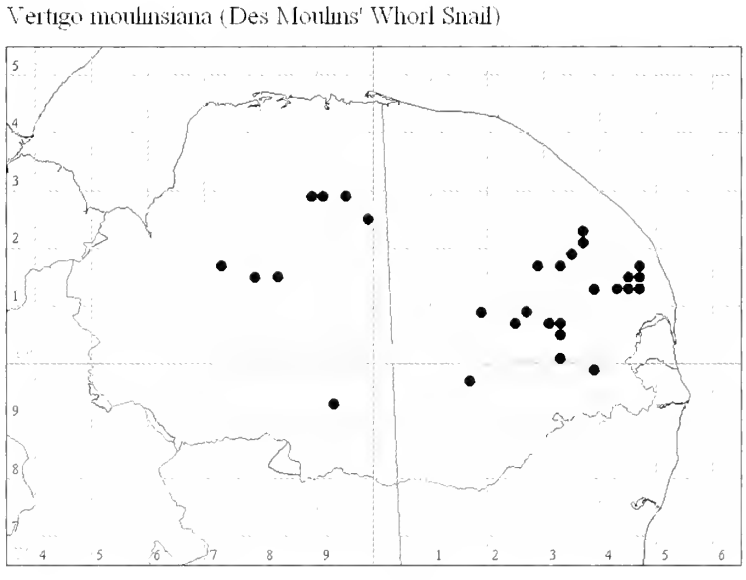


and a width of 1.5mm. The shell is dextral, and the body whorl is twice the height of the spire. The shell mouth has four large teeth (occasionally five). *Vertigo moulinsiana* is hermaphrodite and mostly self-fertilising (Pokryszko, 1987). The eggs develop in less than two weeks. Records from other U.K. sites show that the main reproductive period is in the summer with peak densities of adults being present then, with large numbers of juveniles appearing in the autumn. In the three years 2004-2006 a monitoring programme for the Trinity Broads, Ormesby, Rollesby and Filby, confirms this picture. Whilst densities of more than 1000/m^2 have been noted for the species the norm appears to be densities of between <100 and 200/m^2 which reflect the Trinity Broads populations (Baker *et al.*, 2004/5/6).

Status

Desmoulin's Whorl Snail is listed under Annex II of the European Union Habitats and Species Directive. It is a priority species in the UK Biodiversity Action Plan (HMSO, 1996) and is listed in the Red Data Book (Bratton, 1991) as an RDB3 (Rare) species. This Directive requires the U.K. to maintain favourable conservation status and to initiate monitoring programmes for the species.

Distribution



The snail inhabits calcareous fens and marshes bordering rivers, lakes and broads. In the Trinity Broads complex it is associated with sedges (eg *Carex paniculata, Cladium mariscus*) and Reed *Phragmites australis*. Other associated species include Yellow Flag *Iris pseudacorus* L., reedmaces (*Typha latifolia* And *Typha angustifolia*), and Branched Bur-reed *Sparganium erectum*. Desmoulin's Whorl Snail is also known to inhabit wet alder-sallow carrs where sedges (*Carex* spp.) and Yellow Flag form small dense stands of vegetation (Ellis, 1941). The snail is widespread in the Norfolk Broads and in suitable habitats in central and west Norfolk, excluding the fens.

Conservation

In general Desmoulin's Whorl Snail requires few active conservation measures in Norfolk, although the authors, in a three-year study on Burgh Common have observed that grazing does adversely affect populations numbers (Baker *et al.,* 2004/5/6). The critical factor in the changes in the population densities between August and October is the increased effects of grazing which reduces the plant cover to between 10-20cm in height. In both 2004 and 2005 the total population peaked in August but as grazing continues so the densities dramatically declined. The overwintering adult populations for the three years remains low.

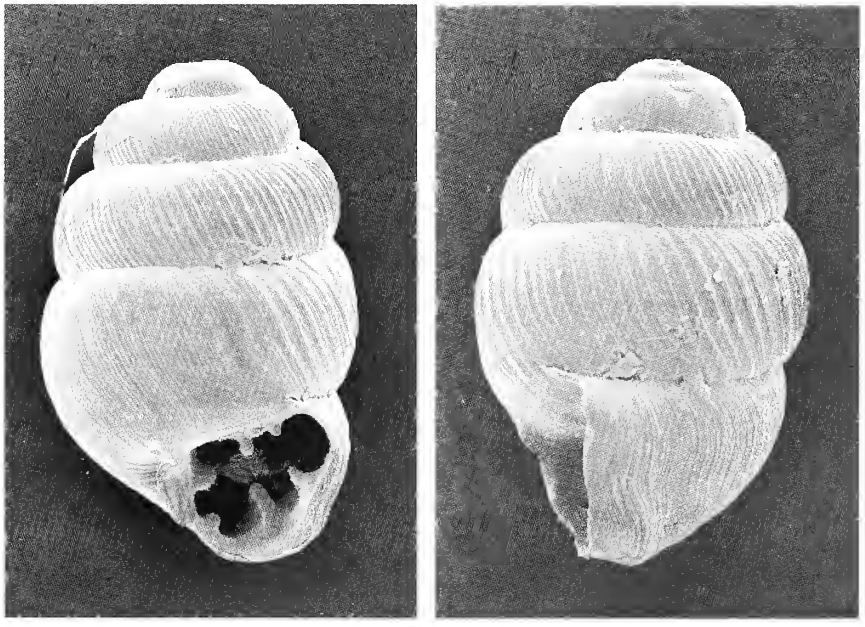
On Burgh Common it is difficult to advise on management since the levels of cattle grazing (approximately 20 beasts graze the Common during the

summer months) are probably determined by the farmer(s) and trustees. Clearly the overall affect of the browsing and trampling by the beasts is detrimental to the health of the fen plant community and consequently to the invertebrate populations. The vegetation is cropped at a height of 10-20cm and as a habitat for *Vertigo moulinsiana* is effectively destroyed. The tussock sedge mounds are comparatively dry since their sides are exposed to direct sunlight rather than being shaded by other fen plants. At other Norfolk sites tussock sedge is a favourite habitat for *Vertigo moulinsiana* but the exposed mounds at Burgh Common show low densities of the whorl snail. The cattle are removed from the Common by 31st October.

Table 1. Density of *Vertigo moulinsiana* in Site 8 Burgh Common: July-October 2004/5/6

		18 Aug 2004	**9 Oct 2004**	**29 Oct 2004**
Density/m^2 total	n/a	28	12	8
adults		12	4	1
juveniles		16	8	7
	17 Jul 2005	**29 Aug 2005**		**21 Oct 2005**
Density/m^2 total	18	61	n/a	13
adults	14	18		6
juveniles	4	43		7
	14 Jul 2006	**5 Sep 2006**		**22 Oct 2006**
Density/m^2 total	20	32	n/a	17
adults	20	8		0
juveniles	0	24		17

Desmoulin's Whorl Snail can survive in habitats subjected to heavy grazing but the effects are detrimental for healthy populations. In ungrazed Burgh Common the snail attains densities noted elsewhere in the Trinity Broads.



Vertigo substriata

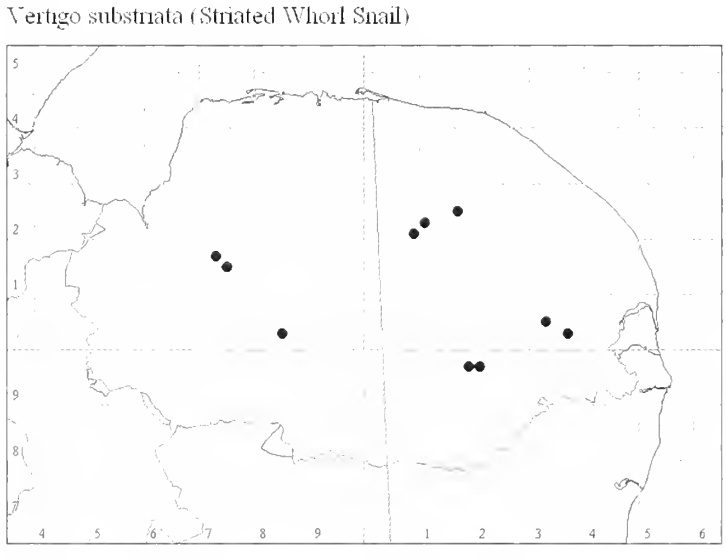
The Striated Whorl

Snail *Vertigo substriata* (Jeffreys) has 4.5 strongly convex whorls with deep sutures. The shell sculpturing is formed of strongly regular striae. The yellow-brown shell has a height of 1.48-1.98mm and a breadth of 0.95-1.19mm. The semi-circular aperture normally has 5-6 teeth; two parietal, one or two columellar and two palatal. The umbilicus is shallow and closed.

Status

The Striated Whorl Snail is rare in Norfolk. Nationally it is not included in any Biodiversity Action Plan or Red Data Book categories.

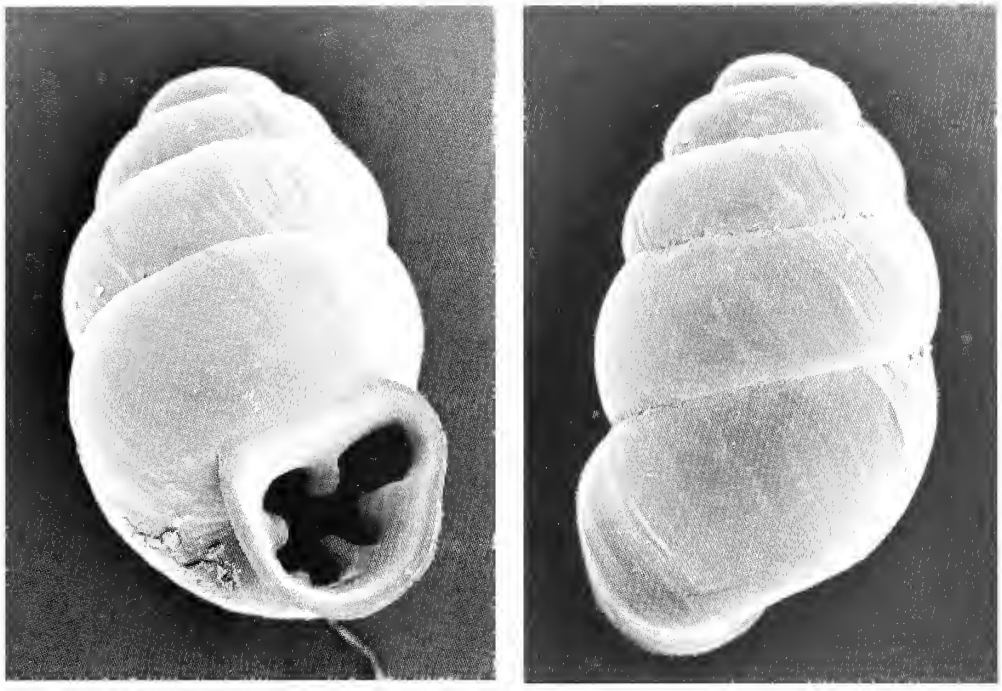
Distribution



The Striated Whorl Snail is intolerant of human disturbance and is mainly confined to marshes, damp deciduous woods and hillside spring flushes. It tolerates acidic soils and is infrequent in base-rich habitats with a high diversity of mollusc species. Of the nine sites in Norfolk a number reflect the spring flush requirements for the snail. At Flordon and Saxlingham Thorpe (Smockmill Common) there are numerous spring line flushes whilst in the headwaters of the Mermaid River near Aylsham the Striated Whorl Snail can be found in grass sward below the spring line. The other Norfolk sites are at Whitwell Common, East Walton/Adcock's Commons, Booton Common in mixed fen, Wheatfen Broad, where the snail occurs in mosses and mossy stumps of alder and sallows, Great Cressingham Fen along the spring line and Langley Marsh where a spring fed calcareous grass sward on the edge of the River Yare flood plain supports a healthy population.

Conservation

Eight of the Norfolk sites are SSSIs or managed by the local council or a conservation trust so some protection is given to these habitats. Four of the sites form part of the Norfolk Valley Fen SAC (E. Walton, Flordon, Booton and Great Cressingham) and one (Wheatfen) part of the Broads SAC. A potential problem is the maintenance of the water table for the spring flushes. At East Walton Common and Wheatfen Broad the Environment Agency monitors water levels but there is little information on the autoecology for



the Striated Whorl Snail at these sites.

Vertigo pygmaea

The ovate shaped Common Whorl Snail *Vertigo pygmaea* (Draparnaud) has five gently convex whorls with very fine sculptured striae. The shell is between 1.7-2.2mm in height and 1.0-1.2mm in breadth. The semi-circular aperture shows a slightly thickened mouth edge with a strong pale transverse rib present behind the outer lip, separated from it by a depression. There are normally between four and seven teeth but only one parietal tooth is present. The shell colour is brown.

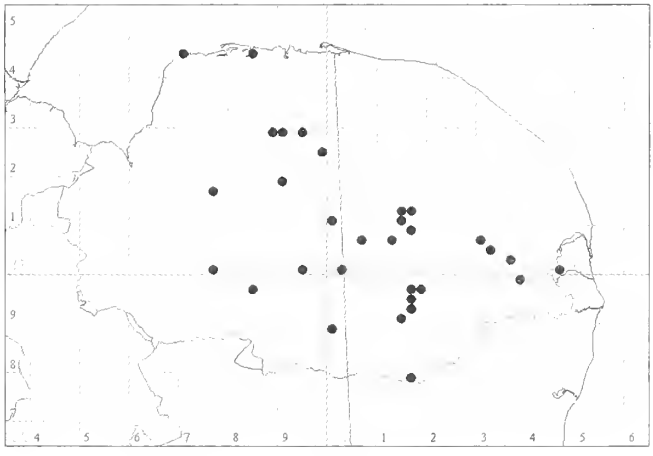
Status

No special status is given to the Common Whorl Snail either in Norfolk or nationally.

Distribution

The Common Whorl Snail is widely distributed throughout Norfolk where it can be described as common. The snail is a frequent species at the roots of grasses in dry, base-rich places, roadside banks and marshes.

Vertigo pygmaea (Common Whorl Snail)



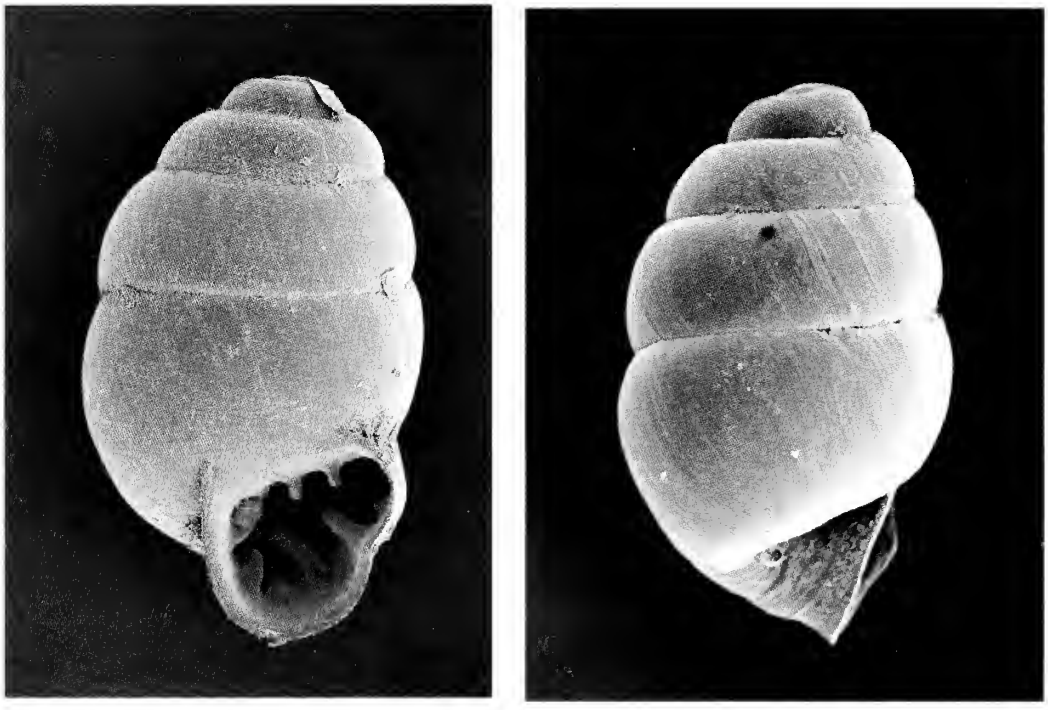
Conservation

No special measures are

necessary for the conservation of the Common Whorl Snail in Norfolk.

Vertigo antivertigo

The Marsh Whorl Snail *Vertigo antivertigo* (Draparnaud) has five moderately



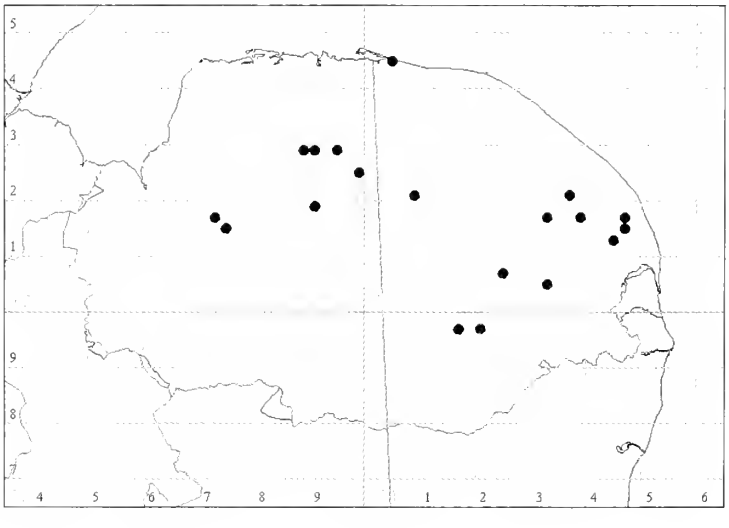
convex reddish-brown whorls with shallow sutures. The sculpture is weak. The height ranges between 2.0-2.2mm and the breadth from 1.2-1.4mm. The heart-shaped aperture has a deep palatal incision and the basal and palatal margins are reflected. There are normally 6-10 teeth, at least two parietal, two columellar and two palatal. The umbilicus is shallow and closed.

Status

No special status is given to this snail.

Distribution

Vertigo antivertigo (Marsh Whorl Snail)



The Marsh Whorl Snail is found across the county in fens, reed swamps and marshes, often on the dead leaves of sedges. Kerney (1999) observes that it avoids places where the water table fluctuates but this is at variance with the authors observations along the primary reed swamps

of the Trinity Broads where the water table fluctuates throughout the year and the tidal margin of Rockland Broad where at times the area can be completely engulfed. The snail is widely distributed and common in Norfolk.

Conservation

No special measures are necessary for the conservation of the Marsh Whorl Snail in Norfolk. Site management is dependent upon maintenance of the microhabitat conditions and this is best achieved on a site-to-site basis.

ACKNOWLEDGEMENTS

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Fenland drainage and the effects on the spider fauna: a case study at East Ruston Common, Norfolk

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INTRODUCTION

Fenland wildlife habitats are particularly vulnerable to destruction by agricultural
drainage, deepening of nearby rivers, creation of cut-off channels to alleviate flooding and by siting boreholes for public water supply on their boundaries. The two boreholes sited by Redgrave and Lopham Fens on the Norfolk/ Suffolk boundary in the 1950s until their removal in 2002 caused profound changes to the vegetation when the water table fell by as much as a metre, but very little is known about the effects on the wetland invertebrate fauna. Two boreholes were also sited by the fens on East Ruston Common, Norfolk, in the 1950s and by the mid-1980s when abstraction of water was doubled, the fens seemed to be quite dry. In this case, however, two invertebrate surveys separated by 20 years were able to record some of the changes to the spider fauna.

The nomenclature of spider species follows Harvey *et al.* (2002).

EAST RUSTON COMMON

This SSSI was first scheduled in 1959 and again in 1986 when it was given a more secure degree of protection under the 1981 Wildlife and Conservation Act. It covers 38 ha (94 acres) and consists of two fens which make up about two-thirds of the total area. Both merge into dry sandy heathland (Figure 1). The distinguished Norfolk naturalist, the late Dr E.A. Ellis, wrote a short article about the fens in the mid 1960s:

> *In 1810 300 acres of common were allocated to the poor of East Ruston. Much of the land consisted of fen and reedswamp with turf pits from which common-holders were permitted to cut up to 5000 hovers each annually. People gathered rushes for candle-wicks and sent them to the*

rush fair held each year in Norwich. Regular summer mowing of litter made the fens very attractive to snipe and there can be little doubt that parishioners never went hungry for rabbits and wildfowl with so vast a paradise in their midst.

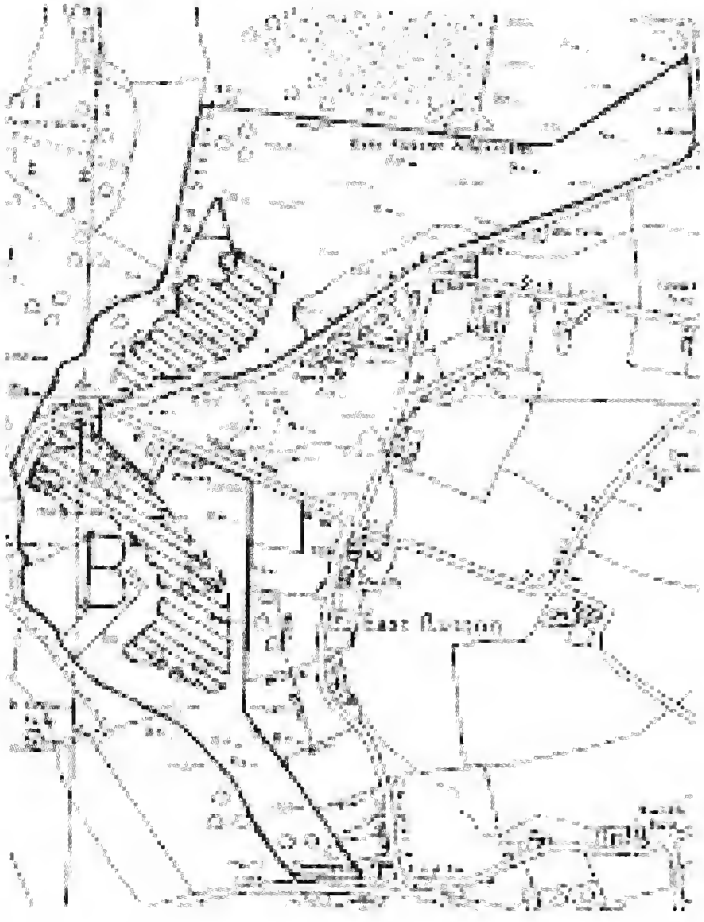

Fig. 1. East Ruston Common SSSI. A, Kings Fen; B, Mown Fen. Shaded area is approximate extent of removal of surface vegetation and oxidised peat in 1998-99. Copied by hand from aerial photograph.

Low-level exploitation by local people who did not have modern machinery seemed to be in balance with the preservation of wildlife. The produce taken from the fen required the maintenance of a high water-table and habitat diversity was probably enhanced by peat-cutting and mowing in certain areas.

I first visited the fens in 1962 and was impressed by the flora, the wetland habitat, the number of Swallowtail butterflies and the abundance of the larval foodplant Milk-parsley *Peucedanum palustre* (L.) Moench. From 1969 to 1974 I organized a survey (unpublished) of the spider faunas of over 50 fens in Norfolk and Suffolk with seven members of the British Arachnological Society and we were able to spend a day collecting by hand on both fens at East Ruston. We did not know at the time that two boreholes had been sunk to a depth of 40m on the northeast boundary of Mown Fen (Figure 1). The Environment Agency (Water Resources) report that work on the first borehole began in 1953 and the second in 1956 but water abstraction was low up to 1984. In 1985 the abstraction rate jumped from 159 thousand cubic metres (tcm^3) to 794 tcm^3 and increased further in the following five years. In 1974 I noted in my diary that the fens seemed rather dry although the ground leaf litter and peaty soil were moist. Mown Fen was also being invaded by bush growth, a sure sign of drying out.

I visited the fen again in 1980 and made another collection on my own. On a third visit in 1984 the fens were so dry I could have walked across them barefoot without finding moisture anywhere. In the very dry period which followed there was a severe fire in 1990 which burnt the top 15-20 cm of the peat surface.

After the fire English Nature decided that the oxidised peat and ash had to be removed before normal water levels could be restored. This was done in 1998 and 1999, the peat surface being lowered to below the level of the normal permanent water-table in the fens so that eventually two large ponds were created (Figure 2). In 1999 the Water Company voluntarily reduced pumping by 50% and in 2005 water abstraction ceased as a new borehole site had been found.

THE CHANGE IN THE SPIDER FAUNA 1974-1994

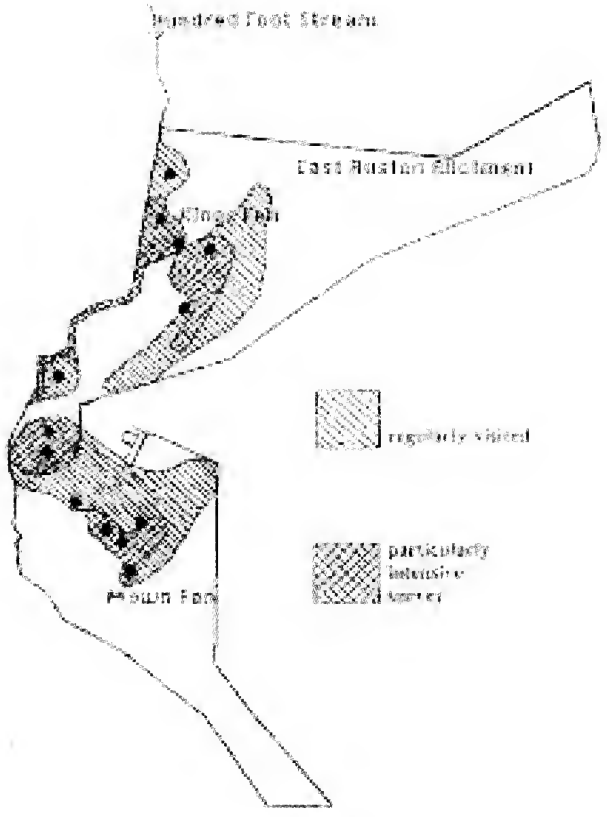

Fig. 2. The 1994 invertebrate survey. The distribution of pitfall clusters (•) during May and June. Each cluster consisted of five pitfall traps and one water trap. The comments 'regularly visited' and 'intensive survey' were made by the 1994 Report compilers.

The concern expressed by English Nature about the future of the fens prompted the National Rivers Authority to commission an invertebrate survey in 1994 by Binnie and Partners in association with the Environmental Consultancy, University of Sheffield. This survey studied numerous invertebrate groups including spiders. During the months of May and June 1994 65 pitfall traps and 13 water traps were operated (Fig. 2) in the two fen areas, Kings Fen and Mown Fen. 1994 happened to be a very wet year and the Report of the Survey (Anon. 1995) claims that 36% of the pitfall traps and 53% of the water traps were lost due to flooding and vandalism. In addition to collection by trapping the survey included sweep-

netting, beating shrubs and trees, sieving leaf litter, and hand searching tussocks and tall fen vegetation.

On 13 June 1974 my party spent a total of eight hours timed hand-collecting in Mown Fen and the same in Kings Fen. Each hourly collection was bottled separately so that the number of species and individual spiders could be related to the duration of fieldwork, 16 hours. During each hour every spider seen, whether adult or immature, was collected.

The very different collecting methods and durations of study of these two surveys means that comparisons can only be made in terms of species recorded.

Table 1 lists the 62 species of spiders recorded in May-June 1994 and Table 2 the 65 species recorded on 13 June 1974. The larger total for 1974 suggests that the spider fauna was richer in that year than 20 years later because more species were taken in a day by hand collecting than in two months trapping by pitfall and water traps.

In 1994 the survey found that the fauna of Kings Fen was much less interesting than that of Mown Fen. The former recorded 25 species and the latter 44, while 20 were taken in both fens. In addition five species were found only in Kings fen while Mown Fen recorded 34. This difference in species diversity of the two faunas was not noted in 1974, when both species lists were similar. Perhaps this suggests that desiccation was more advanced in Kings Fen in 1994. Only one species, *Theridiosoma gemmosum*, was classified as Notable B in that year, following the system of Merrett (1990). This has six categories based on an assessment of rarity and vulnerability, RDB1 (Endangered), RDB2 (Vulnerable), RDB3 (Rare), Notable A (recorded in 16-30 National Grid 10-km squares), Notable B (31-100 National Grid 10-km squares).

The remainder of the 62 species (1994) were widespread or common and capable of living in different habitats. Nevertheless, 16 could be labelled as preferring wet places based on assessments in Harvey *et al.* (2002) and my personal experience in East Anglia. Habitat preferences may differ according to geographical location of a species so it is important to assess this in terms of East Anglia rather than to assume that preferences are the same all over the country. Using the same criteria the 1974 list includes 32 wetland species, of which one was classified RDBK, *Baryphyma gowerense* (the 'K' indicates status unknown but see comment below), one Notable A, *Entelecara omissa*, and two Notable B, *Notioscopus sarcinatus* and *Sitticus caricis*. Another Notable A has been claimed for East Ruston (*Hygrolycosa rubrofasciata*) but

Table 1. Species of spiders recorded on Mown Fen and Kings Fen in 1994. Using 65 pitfalls and 13 water traps during May and June. Total 62. Wetland species indicated*.

	Agyneta conigera	*	*Pachygnatha clercki*
	Arctosa leopardus		*Paidiscura pallens*
	Bathyphantes gracilis		*Pardosa amentata*
	Ceratinella brevipes		*Pardosa nigriceps*
	Clubiona lutescens		*Pardosa palustris*
*	*Clubiona phragmitis*		*Pardosa prativaga*
	Clubiona reclusa		*Pardosa pullata*
	Dicymbium tibiale		*Pardosa saltans*
	Dismodicus bifrons		*Phylodromus dispar*
	Drassodes cupreus	*	*Pirata hygrophilus*
	Episimus angulatus	*	*Pirata latitans*
	Entelecara erythropus	*	*Pirata piraticus*
	Erigone atra		*Porrhomma pygmaeum*
	Erigone dentipalpis		*Pisaura mirabilis*
	Gnathonarium dentatum		*Pocadicnemis juncea*
	Gongylidium rufipes		*Robertus lividus*
*	*Gongylidiellum latebricola*		*Savignia frontata*
	Gongylidiellum vivum	*	*Silometopus elegans*
	Haplodrassus signifer		*Silometopus reussi*
*	*Hypomma bituberculatum*	*	*Taranucnus setosus*
	Kaestneria pullata		*Tetragnatha montana*
	Lepthyphantes tenuis	*	*Theridiosoma gemmosum*
	Linyphia clathrata		*Tiso vagans*
	Maso sundevalli	*	*Trochosa ruricola*
	Micrargus herbigradus		*Trochosa terricola*
	Micrargus subaequalis	*	*Walckenaeria alticeps*
	Oedothorax fuscus	*	*Walckenaeria nudipalpis*
*	*Oedothorax gibbosus*		*Xysticus cristatus*
	Oedothorax retusus	*	*Xysticus ulmi*
*	*Ozyptila brevipes*		*Zelotes latreillei*
	Ozyptila trux		*Zora spinimana*

Table 2. Species of spiders recorded on Mown Fen and Kings Fens in 1974. Sixteen hours hand-collecting on 13 June. Total 74. Wetland species indicated*.

	Agyneta conigera		*Micaria pulicaria*
	Agyneta decora		*Micrargus herbigradus*
	Agyneta ramosa		*Neottiura bimaculata*
*	*Antistea elegans*	*	*Notioscopus sarcinatus*
*	*Aphileta misera*	*	*Oedothorax gibbosus*
*	*Baryphyma gowerense*	*	*Ozyptila brevipes*
*	*Baryphyma pratensis*		*Ozyptila praticola*
*	*Baryphyma trifrons*		*Ozyptila trux*
*	*Bathyphantes approximatus*		*Pardosa nigriceps*
	Bathyphantes gracilis		*Pardosa prativaga*
	Bathyphantes parvulus		*Pardosa pullata*
	Centromerus dilutus		*Pholcomma gibbum*
	Centromerus sylvaticus		*Pirata hygrophilus*
	Clubiona lutescens	*	*Pirata latitans*
*	*Clubiona phragmitis*	*	*Pirata piraticus*
	Clubiona reclusa		*Pocadicnemis juncea*
*	*Clubiona stagnatilis*		*Pocadicnemis pumila*
*	*Clubiona subtilis*		*Porrhomma pallidum*
	Cnephalocotes obscurus		*Porrhomma pygmaeum*
	Crustulina guttata		*Robertus lividus*
	Dictyna arundinacea		*Rugathodes instabilis*
*	*Diplocephalus permixtus*	*	*Silometopus ambiguus*
*	*Dismodicus bifrons*	*	*Silometopus elegans*
	Enoplognatha ovata	*	*Sitticus caricis*
	Entelecara erythropus	*	*Taranucnus setosus*
*	*Entelecara omissa*	*	*Tetragnatha extensa*
	Ero cambridgei	*	*Tibellus maritimus*
	Euophrys frontalis	*	*Trochosa spinipalpis*
	Gongylidiellum vivum		*Trochosa terricola*
	Hypomma bituberculatum		*Walckenaeria acuminata*
	Kaestneria pullata	*	*Walckenaeria antica*
	Lepthyphantes ericaeus	*	*Walckenaeria kochi*
	Lepthyphantes mengei		*Walckenaeria nudipalpis*
	Lepthyphantes tenuis	*	*Walckenaeria unicornis*
	Lepthyphantes zimmermanni	*	*Walckenaeria vigilax*
	Linyphia clathrata	*	*Xysticus ulmi*

I cannot find this species in any of the lists compiled by my party in 1974. In view of this doubt I have not included this species in the faunal list.

Baryphema gowerense. First recorded as new to science in July 1964 (Locket 1965). It was taken on the upper saltmarsh of Whiteford Dunes in Gower, South Wales. Since 1984 *B. gowerense* has been found on several Welsh coast sites from Gower to Anglesey and appears not to be endangere. In England it was discovered at Woodbastwick Fen and Sutton Fen in the Norfolk Broads in 1988. (D. Procter pers. comm.) and these are the only known English sites if we assume, for the time being, that it is extinct at East Ruston. Outside the UK it is known from freshwater sites in Sweden and Ireland so it is adapted to inland wetlands as well as saline habitats as are several, more common, British spiders. The present-day information available for this species suggests that its rarity/vulnerability assessment should be RDB2 or 3 as it is very rare in England but not so rare in Wales. In 1974 it seemed to be fairly widely distributed in the East Ruston fens, though not numerous. Five members of our party, out of eight, took specimens. Eight were taken in Kings Fen and three in Mown Fen. The party collected over a wide area which coincided with the distribution of the 1994 pitfalls as shown in Figure 2.

Entelecara omissa. Widely distributed in the East Anglian fens of Norfolk and Suffolk but appears to be very rare elsewhere in England. In the period 1969-74 our survey of 53 collecting sites on fens in Norfolk and Suffolk recorded *E. omissa* in 19 of them which together with previous records now total 29 localities. Some of the large fens had more than one recording location. Harvey *et al.* (2002) show no records for Wales and Scotland and of the eight for England outside East Anglia only one is post-1980.

Notioscopus sarcinatus. Recorded from England, Wales and Scotland (Harvey *et al.* 2002) but from very few localities. In 1969-1974 we took specimens in five Norfolk wetlands but it appears not to have been recorded during the 1988 Nature Conservancy survey. Perhaps it is able to avoid pitfall and water traps.

Sitticus caricis. A very local jumping spider taken in open unshaded wetland vegetation. There are scattered records for southern and eastern England and two for Anglesey

Table 3 lists the 10 most numerous species in 1974 and similarly for 1994. Most of those recorded in 1994 are common or even abundant throughout the UK. Three (1,4,10) are associated with wet places but not confined to

them. The 1974 list includes five specialised wetland species (2,6,8,9,10), three normally found in wetlands (1,3,7) and two which may be found in a variety of different habitats (4,5). The 1994 list is a clear demonstration of a change to dry conditions. However, the floods of summer 1994 may have influenced the fauna by maintaining a strong population of *Pirata hygrophilus*. Another *Pirata* species, *P. uliginosus* was recorded in 1980 and 1984 by hand collecting but does not appear in the 1974 or 1994 lists. This species is not closely associated with wet habitats.

Collections at East Ruston fens between 1974 and 1994

In 1980 and 1984 I was able to make personal visits to East Ruston and make collections in Mown Fen. In the former year I collected 33 species and in the latter 19. These collections only give an indication of the survival of certain

Table 3. The ten most numerous species. Taken by hand-collecting at East Ruston Common on 13 June 1974 and in pitfall traps and water traps during May and June

Rank	Hand-collecting 1974	Number	Traps 1994	Number
1	*Oedothorax gibbosus*	132	*Pirata hygrophilus*	1479
2	*Entelecara omissa*	56	*Erigone atra*	386
3	*Pirata hygrophilus*	83	*Pardosa prativaga*	249
4	*Kaestneria pullata*	69	*Pirata piraticus*	62
5	*Pocadicnemis pumila*	30	*Bathyphantes gracilis*	56
6	*Taranucnus setosus*	22	*Pardosa amentata*	48
7	*Silometopus elegans*	20	*Oedothorax fuscus*	42
8	*Aphileta misera*	15	*Erigone dentipalpis*	33
9	*Sitticus caricis*	11	*Silometopus elegans*	28
10	*Baryphyma gowerense*	11	*Oedothorax gibbosus*	20

species. Table 4 lists nine specialist wetland species for 1974, of which three were taken again in 1980, one in 1984 but none in 1994. In both these middle years Mown Fen was dry with increasing bush growth. On the other hand much more tolerant species, capable of living in drier habitats, *B. trifrons, O. gibbosus, P. clercki* and others (see Table 2), survived in 1994, perhaps helped by the wet summer of that year.

DISCUSSION

The creation of large scrapes (Figure 2) which removed the surface burnt peat and vegetation in July 1990 probably had little effect on the specialist spider fauna most of which was already extinct except possibly for *Theridiosoma*

gemmosum. Harvey *et al.* (2002) list over 60 localities for this species in the south of England and Wales. In Europe it is recorded from reed beds, alder

Table 4. The decline of some wetland species in relation to the duration of desiccation. Present + Not recorded –

Wetland species	1974	1980	1984	1994
Baryphyma gowerense	+	-	-	-
Notioscopus sarcinatus	+	-	-	-
Walckenaeria kochi	+	-	-	-
Trochosa spinipalpis	+	-	-	-
Tibellus maritimus	+	-	-	-
Entelecara omissa	+	+	-	-
Rugathodes instabilis	+	+	-	-
Aphileta misera	+	+	-	-
Antistea elegans	+	+	+	-

carr, willow shrub mires and dry beech forests (Hänggi *et al.*,1995) so may be more tolerant of habitat change than other wetland species.

On 18 September 2006 I was able to visit East Ruston Fen to inspect the two excavations dug in 1998-99 to remove oxidised peat. I found two lakes fringed by dense reedbeds of Common Reed *Phragmites australis* and Bulrush *Typha latifolia*. The water depth is not known but appears to be deeper than the 6″-8″ (15-20 cm) of oxidised peat which it was intended to remove. The water surface may persist for many years and even when the lakes become shallower it seems most likely that large reedbeds will form so that the previous mixed fen vegetation and acidic flushes will not be able to re-establish. However, Bogbean *Menyanthes trifoliata* and Milk-parsley *Peucedanum palustre* are said to have survived and it is still important to survey the spider fauna at regular intervals to find out how it has changed.

SUMMARY

1 The impoverishment of the spider fauna due to desiccation by two boreholes is recorded during 20 years, 1974-1994, in East Ruston Common, Norfolk.

2 In 1974 74 species were recorded in one day (13 June) by eight arachnologists, while in 1994 62 species were taken in pitfall and water traps during May and June. The spider fauna appears to have been substantially more diverse in 1974.

3 Thirty-two species known to prefer wetland habitats were recorded in 1974, including one national rarity and three classified as Notable. Twenty years later 16 wetland species were recorded and only one classified as Notable.

4 In 1994 the spider fauna of King's Fen was found to be much inferior to Mown Fen. In 1974 no difference between the two fens was recorded. This suggests that desiccation was more severe in Kings Fen.

5 The survival of nine specialised wetland species is plotted from 1974 to 1994. Three were last recorded in 1980, one in 1984 and none in 1994.

6 The 10 most abundant species in 1974 included only three recorded again in 1994. The 1994 list consists mostly of common and widespread species and only three normally associated with wet places but not confined to them.

ACKNOWLEDGEMENTS

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The changing status of Lepidoptera in Norfolk and its possible causes

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INTRODUCTION

Since the late Georgian period of British history the study of lepidoptera has been quite prolific. These studies, along with those of many other taxa, were enhanced by the inquisitive nature of the Victorians and were predominantly carried out by wealthy landowners or the clergy. This has left modern-day lepidopterists with a wealth of records that can be compared with current findings.

In Norfolk, C.G. Barrett and E.A. Atmore compiled an extensive record of all lepidoptera found within the county and commented on the status of each species at that time. Much of this information was subsequently published in the Transactions of the Norfolk and Norwich Naturalists' Society (NNNS), between 1873 and 1913 (Hall, pers. com.). In June 2006, funding from Norfolk County Council Planning and Transportation Section (Environment - Policy and Planning) for the Norfolk Biological Records Centre enabled my employment on contract to input data. In consultation with the County Moth Recorder, Ken Saul, it was agreed that the input of data from Mike Hall's unpublished *Annotations of Norfolk Lepidoptera recorded by Barrett and Atmore in Transactions of the NNNS (1873-1913)* would provide useful comparative historical data to facilitate research into changes of status and the possible causes.

Mike Hall's work was aimed at comparing the nomenclature used by Barrett and Atmore with current names. It was taken from a literature search carried out to provide historical detail for the on-going Norfolk Moth Survey but remained unpublished in the Transactions of the NNNS as he regarded it as excessively long (72 pages). In this short paper I have compared the findings of Barrett and Atmore with modern records and given selected examples.

CHANGES IN STATUS

Many species have exhibited no obvious change in their status over this

period. In general, it appears that those species that exhibit less specific requirements, both in habitat and food resource, have remained at a relatively stable level, both in population and distribution, over the study period. However, most of the more specialised species have suffered declines and, in some cases, extinction, either locally or at a national scale (see Appendices 1 & 2). Habitat specialist butterflies have not only fared badly in Britain but also elsewhere in Europe and indeed globally (Wenzel *et al.* 2006; van Swaay *et al.* 2006). This trend is almost certainly reflected in moth populations, although by comparison little research has been carried out on this more numerous taxon.

In addition to those species present on Barrett and Atmore's lists, Norfolk has also 'gained' a number of records. These have tended to be the result of species extending their ranges, the advent of continental migrants such as the Vestal (*Rhodometra sacraria* Linnaeus), or a simple reallocation of the species concerned. This third point is well demonstrated by the Fen Square-spot (*Diarsia florida* Vieweg), which is now considered to be undergoing an evolutionary separation from the more common and widespread Small Square-spot (*D. rubi* Vieweg) (Waring & Townsend 2003). There may also be cases of 'difficult' species being overlooked or misidentified. Even today it is likely that some moths are under-recorded and this may be particularly true of those species that are not attracted to light traps or those that are active during the hours of daylight. This problem has long been suggested for certain groups such as the Sesiidae (clearwings), which are easy to overlook in the field, are only attracted to pheromone lures and have a lifecycle that is difficult to study.

In contrast to many moth species, Britain's butterflies are well studied and understood. Recent publications by Fox *et al.* (2006a) and Watts and McIlwrath (2002) have made it possible to contrast the fortunes of all species present in Norfolk today with those present in the late 19th and early 20th centuries (Barrett & Atmore 1873-1913) (see Appendix 1).

Butterflies

As previously stated, those species that specialise in a particular habitat or food resource have, in general, suffered significant declines. Some butterfly species, such as the Silver-studded Blue (*Plebeius argus* Linnaeus), have shown such substantial declines that they are now designated as Biodiversity Action Plan (BAP) Priority Species. However, Barrett and Atmore (1873-1913) recorded that *P. argus* could be found on every heath in Norfolk and

this was probably true for Southern Britain as a whole.

Another heathland species that was generally common in the late 19th century (Barrett & Atmore 1873-1913) is the Grayling (*Hipparchia semele* Linnaeus). However, modern records show that this species has suffered a significant long-term national decline (Fox *et al.* 2006a) and this is reflected in records for Norfolk, although the coastal population appears to be stable (Watts & McIlwrath 2002). This decline has been so substantial that *H. semele* has been proposed as a BAP species (Fox *et al.* 2006a).

The butterfly family that has suffered possibly the greatest declines in Norfolk, and indeed nationally, is Nymphalidae, more specifically, the fritillaries. Of the six species that occurred in Barrett and Atmore's records, all but one is now extinct as a breeding species within the county. The remaining species, the Dark Green Fritillary *(Argynnis aglaja* Linnaeus) was regarded by Barrett as "local and almost exclusively coastal" in distribution. This status appears to remain true today (Watts & McIlwrath 2002). These fritillaries, with the exception of *A. aglaja,* have also suffered long-term (1976-2004) national distribution declines ranging from 29%-79% (Fox *et al.* 2006a). Specific studies carried out on the Pearl-bordered Fritillary (*Bolaria euphrosyne* Linnaeus) show that this species currently shows a 61% loss in distribution and a 66% decline in population nationally, over the last 30 years (Hoare 2006). Therefore it seems unlikely that *B. euphrosyne* will become re-established in the county and this is probably the case for the other fritillary species. However, while the fritillaries have suffered dramatic declines other nymphalids have shown the opposite trends.

Of the resident species the most dramatic changes have occurred with the population and distribution of the Comma (*Polygonia c-album* Linnaeus). Barrett and Atmore recorded this species as "very rare in Norfolk" whereas the present national status shows a 305% increase in population size and a 37% increase in distribution, over the last 30 years (Fox *et al.* 2006a) and this is reflected within Norfolk. The Peacock (*Inachis io* Linnaeus) has also shown a considerable positive long-term change in status (population +90%, distribution +17% nationally) (Fox *et al.* 2006a), while the Small Tortoiseshell (*Aglais urticae* Linnaeus) has remained at a relatively unaltered status. However, Barrett and Atmore already regarded the last two species as common.

Notable changes in population and distribution have also been recorded in migrant species. The Red Admiral (*Vanessa atalanta* Linnaeus), Painted Lady

(*Vanessa cardui,* Linnaeus) and Clouded Yellow (*Colias croceus* Geoffroy) have all shown large long-term national population increases. In the case of *C. croceus* this is a massive increase of 1117% in 30 years (Fox *et al.* 2006a). The changes of status have not been as dramatic in Norfolk but the general trend is for increasing numbers and more numerous records of adults overwintering.

Another species that has exhibited a substantial expansion of its range and an increased population is the Speckled Wood (*Pararge aegaria tircis* Linnaeus). Nationally this shade-loving species has shown a 160% population rise and a 31% expansion in its distribution (Fox *et al.* 2006a). This success is mirrored in Norfolk where the species had greatly declined by the end of the 19th century; Barrett and Atmore described it as "not common" and it was regarded as sporadic and uncommon until the 1980s, at which time it began to expand from its core population in Breckland (Watts & McIlwrath 2002). Current records now show that *P. aegaria tircis* has spread to all parts of the county.

Moths

Changes in the population and distribution of British moths have, until very recently, been relatively poorly studied. The publication of Fox *et al.* (2006b) has been a great step forward in showing the downward trends being exhibited by a majority of Britain's larger species. However, many of the smaller species (micros) remain poorly understood and are certainly under-recorded. This is in part due to a lack of interest and the difficulties encountered when identifying species, some of which can only be achieved by dissection.

Within Barrett and Atmore's moth lists there are, potentially, two anomalous records; these concern the Chocolate Tip (*Clostera curtula* Linnaeus) and the Small Chocolate Tip (*Clostera pigra* Hufnagel). *C. curtula* is described as "rare" while *C. pigra* is regarded as common and "probably in all fens and boggy heaths". Hall (pers. com.) suggests that Barrett and Atmore (1873-1913) almost certainly have the records of distribution and comments for these two species in reverse. If this is not the case *C. curtula* has suffered a dramatic decline over the ensuing period.

In common with butterflies, specialist moth species have exhibited the greatest negative trends over the last 130 years. However, a number of species have shown an increase in population and distribution and, as has been the case with the butterflies, there have been some species added to the county list.

Of those species exhibiting population or distribution declines perhaps some of the more striking examples include the Garden Tiger (*Arctia caja* Linnaeus), the Tapestry Moth (*Trichophaga tapetzella* Linnaeus), the Dentated Pug (*Anticollix sparsat* Treitschke) and the Coast Dart (*Euxoa cursoria* Hufnagel). These examples have all suffered significant declines but it is possible that the driving factors for each species are different, although all are likely to be anthropogenic in origin.

The Garden Tiger moth (*A. caja*) was once widespread and common in the UK. However, over recent decades this species has shown a dramatic decline (Conrad *et al.* 2002), both in Norfolk and nationally. This decline appears to have accelerated since the mid 1980s (Waring & Townsend 2003) and although this species still has a widespread distribution its population has significantly decreased. It is now an uncommon species in many locations and completely absent from some. Yet Barrett and Atmore describe this species as "common everywhere". The Tapestry Moth (*T. tapetzella*) was also found everywhere and even considered a pest species; it is now a nationally scarce moth as are the Dentated Pug (*A. sparsata*) and the Coast Dart (*E. cursoria*) (Waring & Townsend 2003).

Barrett and Atmore (1873-1913) recorded that *A. sparsata* was common in fen areas while *E. cursoria* was regarded as "excessively" abundant on coastal sand dunes. Present records indicate that both species are now extremely restricted in their distribution within Norfolk and nationally. This should perhaps not be surprising as both are habitat specialists and, as previously mentioned, more likely to have suffered declines since the 19th century.

Several species that were either highly specialised or extremely local in their distribution during the late 19th century have now disappeared completely from Norfolk. Indeed, species such as the Marsh Dagger (*Acronicta strigosa* (Denis & Schiffermüller), Viper's Bugloss (*Hadena irregularis* Hufnagel), Spotted Sulphur (*Emmelia trabealis* Scopoli) and the pyralid moth *Loxostege sticticalis* (Linnaeus) are now extinct nationally (see Appendix 2) (Waring & Townsend 2003). With exception of *A. strigosa,* which had a core population in the Cambridgeshire fens, these species were already predominantly restricted to the Breckland area of Norfolk (Barrett & Atmore 1873-1913) and had little potential for extending their range.

In common with butterflies, there have been success stories since the publication of Barrett and Atmore's lists. Species such as the Pine Hawk-moth (*Hyloicus pinastri* Linnaeus), Triple-spotted Clay (*Xestia ditrapezium*

Denis & Schiffermüller) and Beautiful Golden Y (*Autographa pulchrina* Haworth) have improved their status from rare, very rare or scarce and are now well established within Norfolk, indeed occasionally abundant (Waring & Townsend 2003). Other species are more recent additions to the county list with the majority being species that have extended their range nationally. Examples of this are the Spruce Carpet (*Thera britannica* Turner, H.G), Twin-spotted Wainscot (*Archanara geminipuncta* Haworth) and Vine's Rustic (*Hoplodrina ambigua* Denis & Schiffermüller); *H. ambigua*, has undergone quite a rapid and significant distribution increase since the 1940s (Waring & Townsend 2003).

Perhaps the most dramatic addition to the county, and indeed the national record, is Blair's Shoulder-knot (*Lithophane leautieri* Boursin). This species was first recorded in Britain in 1951, on the Isle of Wight, (Waring & Townsend 2003) but has since spread to most areas, including Scotland, by 2001. It is now a well-established species in Norfolk and is occasionally abundant, its larvae feeding on cypresses. Nationally *L. leautieri* has undergone a population growth of 21000% (Fox *et al.* 2006b) and this is probably due to increase in the use and popularity of *Cupressus leylandii* hybrids in domestic gardens over the last 50 years.

CAUSES OF STATUS CHANGES

It is probable that anthropogenic forces drive the significant majority of lepidopteran population and distribution changes, both at national and county levels. These factors may be either direct (e.g. habitat loss) or of a more subtle nature (e.g. climate change).

Habitat loss and fragmentation has long been heralded as one of the foremost drivers of species decline and extinction. This is particularly true for specialist species and is applicable at county, national and global scales. Many lepidopteran specialist species are declining as a result of this process and although conservation actions typically aim to stem rates of decline they are not generally structured to bring about genuine recovery (Davies *et al.* 2005). It has even been suggested by Davies (2005) that government targets to achieve 'favourable status' for SSSIs may be detrimental to some threatened species. This has already been shown by recent research using butterfly transect data from protected areas in Britain (Davies 2005). Many of Norfolk's butterfly species, threatened and common, rely on traditional agricultural practices and the advent of agri-environment schemes designed to maintain or reinstate appropriate management have indeed benefited

target butterfly species nationally. However, recent research has suggested that these schemes have failed to halt the general decline of butterfly species on farmland (Brereton *et al.* 2005) and this decline includes areas protected as SSSIs as well as the wider countryside. Norfolk may be particularly susceptible to this form of species loss and decline due to the intensive nature of modern agriculture within the county, although many farmers are now more conscious of the need for conservation and indeed get payments for implementing conservation strategies. Again, it is probable that similar effects could be detected within moth species. However this requires more long-term studies.

A moth species that may exhibit this reaction to agricultural intensification is the Ruddy Carpet (*Catarhoe rubidata* Denis & Schiffermüller). This species prefers rough banks, hedgerows and field edges, usually on calcareous strata (Waring & Townsend 2003). As farms have become more efficient and fields have become larger, particularly in Norfolk, and more of a monoculture this type of habitat has declined. Thus it is likely that this was partially responsible for the decline of *C. rubidata.*

Changes in farming practice since the late 19th century have probably led to the loss and decline of several species of lepidoptera in Norfolk. During the 19th century the Small Ranunculus (*Hecatera dysodea* Denis & Schiffermüller) was recorded in large numbers on cultivated lettuce crops, particularly in Norfolk and the South-East of England (Waring & Townsend 2003). The larvae of this species eat mainly the flowers and seeds of the lettuce. It may be that in the 19th century large numbers of the lettuces were allowed to form seed whereas modern horticultural practice harvests the plants long before they reach this stage. It is also possible that the natural food items, Prickly Lettuce and Great Lettuce, were reduced in abundance, due to intensification and the use of herbicides. The resulting effect on *H. dysodea* was its virtual extinction in Britain by 1914 and complete disappearance by 1939. However, the species has since returned to Britain, possibly as a migrant, but not to Norfolk.

Ashwin & Davison (2005) show large areas of Norfolk as marsh or fen in the late 1800s that today have been 'drained and improved'. This policy has caused the decline or loss of several wetland species. An example of this is the Marsh Fritillary (*Euphydryas aurinia*) recorded on marshy meadows by Barrett and Atmore (1873-1913) but which has now disappeared from the county and has suffered a severe decline nationally. The Marsh Dagger (*A. strigosa*) has also gone and was last recorded in Britain in 1933 (Waring

& Townsend 2003). The Purple-bordered Gold (*Idaea muricata* Hufnagel) was described as "rather common" in wet fens but is now highly localised in Norfolk and designated as Nationally Scarce A. These declines and losses clearly demonstrate the vulnerability of habitat specialist species to landscape changes and habitat loss.

It has been suggested that many species are dependent on a metapopulation structure and many threatened British butterfly species appear to conform to the metapopulation theory including the Silver-studded Blue (*Plebeius argus*) (Thomas *et al.* 1992), a BAP priority species for Norfolk and nationally.

Metapopulation theory suggests that species will not survive on individual fragments of habitat, but require a network of sites between which they can migrate (Thomas *et al.* 1998). Therefore, habitat fragmentation may cause the eventual extinction of a species, even in those remaining patches of apparently suitable habitat (Hanski 2003). The size and degree of isolation of a habitat fragment will influence long-term persistence of a species in that patch (Thomas *et al.* 1998). Data from butterflies, birds and plants demonstrate that populations with reduced genetic diversity often experience reduced growth and increased extinction rates. Thus, it may be necessary to retain gene flow among increasingly fragmented habitat patches to sustain populations that are sensitive to inbreeding (Keller & Waller 2002).

Conservation efforts therefore need to be on a landscape-scale in order to create a network of suitable habitats and so ensure the long-term survival and enhancement of threatened lepidopteran populations. This is rather stating the obvious as the loss and fragmentation of habitat, along with the associated effects on biodiversity, has occurred on a landscape-scale, particularly over the last 200 years (Ashwin & Davison 2005).

It is likely that environmental changes on a landscape scale would have influenced lepidopteran populations prior to Barrett and Atmore's records. The effects of these changes would almost certainly be apparent in moth and butterfly communities today.

A possible example of this is the increase in both number and distribution of the Centre-barred Sallow (*Atethmia centrago* Haworth). This species prefers open habitat with isolated Ash trees, including hedgerows, riverbank and gardens (Waring & Townsend 2003). It is possible that the advent of Parliamentary Enclosure in the 18th and 19th centuries encouraged the creation of this type of environment through the planting of hedgerows and the use of large, isolated trees as boundary markers (Rackham 2001).

Barrett and Atmore described *A. centrago* as "local and scarce" and although the last act of enclosure in Norfolk was at Saxlingham in 1863 (Ashwin & Davison 2005), some ten years prior to their records, this is a rather short period in ecological time in which to observe trends in distribution and abundance. The expansions in range and population of this moth would probably have occurred at a much slower rate and are possibly still ongoing.

Habitat loss has not been restricted to the open countryside, it has also occurred within human habitation and wider urban areas. The larvae of the Tapestry Moth (*T. tapetzella*) were recorded by Barrett and Atmore (1873-1913) as "devouring stuffing of saddles, chairs, sofas; carpets, furs etc and articles of wool and hair generally". This species was regarded as a pest and extremely common within houses and warehouses but occupied a specific ecological niche. However, as warehouses, particularly those in Norfolk's ports, disappeared and man-made materials replaced many organic products the decline of this species became inevitable. This decline has been shared by several species that use human environments to reproduce. As modern products and lifestyles have changed the opportunities for species such as *T. tapezella* have disappeared.

Not all landscape changes have led to species decline. The planting of large areas of conifer forest has led to the increase in those species dependent upon them. However, it might be argued that those areas used for forestry, generally in Breckland, were specialist habitats and potentially had their own, sometimes unique, species. The advent of large-scale conifer forests has led to the addition of the Spruce Carpet (*Thera britanica* Turner) to the county list and an increase in abundance and distribution of the Pine Hawk-moth (*Hyloicus pinastri* Linnaeus) and the Pine Beauty (*Panolis flammae* Denis & Schiffermüller). The spread of *H. pinastri* may have also been affected by changes in Britain's climate.

Potentially the most important long-term factor driving changes in lepidopteran status is global climate change. Studies have shown some indication of this process since the industrial revolution and it is clear from current research that the climate is changing. This will have a profound effect on invertebrate and indeed all life on the planet (King 2005). The effect of climate change on butterfly population size and distribution has been clearly demonstrated using British monitoring data (Brereton *et al.* 2006) and these alterations to butterfly phenology, ranges and ecology will almost certainly be reflected in other lepidopteran species.

While there are no records of any butterfly species colonising Britain during the current period of human-induced climate change, two migrant species that have bred here during the summer (Clouded Yellow and Red Admiral) now appear to be able to successfully overwinter. Therefore it is reasonable to assume that this may be the prelude to these species becoming resident (Dennis *et al.* 2006). Potentially this may also apply to all migrant species so that it is conceivable that the Painted Lady (*V. cardui*) would also become resident. Similar processes may also apply to migrant moth species and records of increasing numbers of overwintering Hummingbird Hawk-moths may support this theory (pers. obs.). This may also result in the Bedstraw Hawk-moth (*Hyles galli* Rottemburg) re-establishing a resident population, as this species was briefly resident in North Norfolk between 1956 and 1958 (Waring & Townsend 2003).

Climate change may also have contributed to the range expansions and population increases encountered in other Norfolk lepidoptera. Species such as Maple Prominent (*Ptilodon cucullina* Denis & Schiffermüller), Vine's Rustic (*H. ambigua*), Golden Plusia (*Polychrysia moneta* Fabricius), Beautiful Golden Y (*A. pulchrina*) and Twin-spotted Wainscot (*A. geminipuncta*) have all exhibited increases in range and population within Norfolk. However, the positive changes in the status of *A. geminipuncta* may also have been influenced by more recent policies of reed bed creation and management.

Although climate change may have been favourable for many of Norfolk's moths and butterflies it may also have had negative effects on some species. It has been suggested that those species of moth that overwinter as larvae may suffer declines brought about by this period being warmer and wetter (Conrad *et al.* 2002). As previously stated, the Garden Tiger (*Arctia caja* Linnaeus) was once widespread and common but over recent decades has shown a dramatic decline. It has been suggested that warm, wet winters and springs may be detrimental to *A. caja* (Conrad *et al.* 2002) and it is therefore predicted to decrease further in line with global climate change. These declines may be a result of a number of factors, either singly or combined. It is possible that the increasingly mild winters have led to increased survival rates of certain parasitoid species that are then able to prey on the moth larvae. Equally, it is possible that the milder, wetter conditions lead to an increase in fungal pathogens or that the larvae require cold, dry winters to trigger certain genetic responses. These are all plausible theories but require further long-term research.

Although pollution is not generally thought of as a directly contributing factor

to species decline in Norfolk, it should be considered outside the realms of global climate change. It is probable that agricultural and atmospheric depositions have a more direct and immediate effect on biodiversity. Along with the obvious effects of pesticides it has been shown that, in agricultural areas, species dependent on nutrient-poor conditions tended to decrease while species dependent on nutrient-rich conditions tended to increase. This indicates a negative effect of increased soil nitrogen levels resulting from the active use of fertilisers and/or atmospheric nitrogen deposition (Öckingera *et al.* 2006).

CONCLUSION

Clearly there have been changes in Norfolk's lepidopteran species, between the late 19th century and today, but the overall diversity recorded by Barrett and Atmore (1873-1913) appears to be predominantly intact within Norfolk today. However, assessing trends in distribution and population is somewhat problematic. There have been some losses from the county list but these have mainly consisted of species that were already uncommon, localised and/or habitat specialists in the 1800s. The more noticeable status changes are illustrated in Appendices 1 & 2.

Population trends in moths are difficult to accurately assess as Barrett and Atmore show very little numerical data. It might also be considered that attracting moths to light was still at a relatively primitive stage and the understanding of the ultraviolet spectrum was limited. The wavelengths at which moths are attracted had not yet been defined and the ability to produce that particular light source was not available. Therefore the number, and possibly species, of moths attracted to light would have been limited. By comparison the ongoing Rothamsted trapping network and the National Moth Recording Scheme are designed to give a good overview of the state of moth communities. However, it remains likely that individual species were more numerous in the 19th century and this may have helped to balance the possible inefficiency of the light sources. Furthermore, much of recording for certain species would have been done using direct search techniques (i.e. simply looking for them) either for larvae or the adult insects.

Unlike moths, butterflies present no such problems and are therefore likely to be more accurately represented, although there is still no numerical data. Within this group there seems to be a significant change within the community. Approximately a third of the butterfly species recorded by Barrett and

Atmore (1873-1913) have either suffered declines or have disappeared from Norfolk completely. These declines appear to have been driven by habitat loss or fragmentation. A further 11 species show increases in distribution or population and this appears to be the result of species adjusting to changing environments. This may be habitat change or dietary adjustments, although it has also been suggested that climate change is, for the time being, beneficial to these species.

Although most responses have been favourable thus far, predictive climate change models suggest that climate change will become a significant influence on rates of decline and extinction in butterflies (Fox *et al.* 2006) and this will almost certainly be mirrored in moth populations. Until recently, published evidence for the responses of species to climate change had revealed more examples of species expanding than retracting their distributions. However, recent papers on butterflies now show that population-level and species-level extinctions are occurring (Thomas *et al.* in press). Indeed, this new evidence suggests that climate-driven extinctions and range retractions are already widespread (Thomas *et al.* in press).

Habitat loss and fragmentation are potentially easier to deal with. Although some areas may have been irrevocably lost, the creation of new sites and utilisation of other habitats, by lepidopteran species, may partially offset the initial problems. Current initiatives for heathland and reed bed recreation, plus continued management of woodland and the Breckland area, will aid the habitat specialist species dependent on those environments. However, recreating ancient woodland habitat in Norfolk may be impossible. The creation of a network of SPAs (Special Protected Areas), SSSIs (Site of Special Scientific Interest) and other conservation areas will aid in the reconstruction of connective habitats, although there will be inherent problems caused by government conservation targets.

A more flexible approach to habitat management is required to conserve such habitats as late-successional grassland. This is an important environment supporting a diverse ecosystem, often containing habitat specialists and often threatened species (Balmer *et al.* 2000). It is possible that some grassland species can be encouraged to utilise road verges, therefore these areas should be considered an important reserve for species dependent on semi-natural grasslands (Saarinen *et al.* 2005). Evidence of the effectiveness of these areas can be observed along many of the county's roads, including the major trunk routes (*pers. obs.*). High nectar abundance may be the most important factor governing increased numbers of meadow butterflies along road verges, while

meadow moths largely favour areas of shelter provided by taller vegetation (Saarinen *et al.* 2005). Therefore the planting of shrubs and the use of wild flowers is critical to the success of these areas.

Brownfield sites often become refuges for early-successional moth and butterfly species, and for wildlife in general. However, this habitat often does not have a history of management, either for agriculture or woodland purposes. (Benes *et al.* 2003; Key 2000) and may not receive sufficient protection. Although these areas are probably sub-optimal habitat they will allow species to persist in an otherwise hostile environment.

The butterfly list for Norfolk (Appendix 1) and the selected moth species (Appendix 2) used in this paper indicate some striking changes to the status of many species. The reasons behind these trends in general remain unproven and potentially require many years of research to fully understand the processes. It is unlikely that a single factor resulted in any status change. However, it does appear that the majority of species decline in Norfolk have been strongly influenced by habitat destruction and fragmentation, while many population and distribution increases may have been predominantly driven by climate change.

Climate change may bring opportunities for some species as well as threats but grave concerns have been raised about the overall and long-term impact on biodiversity and the ecosystem as a whole (Thomas *et al.* 2004). It should not be forgotten that lepidoptera form a key link in the ecological chain, both as pollinators and as a food source, without which many other species may not survive.

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Appendix 1: BUTTERFLY SPECIES OCCURRING IN NORFOLK; THEIR STATUS IN THE LATE 19th CENTURY AND THE PRESENT. Declining species in bold type; increasing species in italics.

SPECIES	**STATUS** (Barrett & Atmore 1873-1913)	**STATUS** (Fox *et al.*2006a)
Chequered Skipper	One specimen recorded.	**Absent from Norfolk.**
Small Skipper	Relatively common.	Stable or a slight increase.
Essex Skipper	Absent from Norfolk.	*Increasingly common.*
Large Skipper	Common in woods.	Common but showing a decline over the past 10 years nationally.
Dingy Skipper	Localised but not uncommon.	**Declining in line with national trends. Now UK BAP Priority species.**
Grizzled Skipper	Localised but not uncommon.	**Declining in line with national trends.**
Swallowtail	Relatively common in all fens of the Yare and its tributaries.	Current population levels appear stable.
Pale Clouded Yellow	Variable rates of migration but common in 1868.	**No modern day records.**
Clouded Yellow	Occurring generally but in irregular numbers.	*A substantial increase in immigration numbers in the last 10 years.*
Brimstone	Generally common.	Generally common with little change in long term population trends.
Large White	Abundant.	Abundant. Showing a slight decline in recent years.
Small White	Abundant.	Abundant. Little population change.
Green-veined White	Abundant.	Abundant. Little population change.
Orange Tip	Generally common.	Common, showing little long-term population change.
Green Hairstreak	Relatively common but localised.	Showing a steady long-term decline.
Purple Hairstreak	Common in oak woodland.	*A recent run of good years has led to an increase in the population.*

continued

SPECIES	STATUS (Barrett & Atmore 1873-1913)	STATUS (Fox *et al.*2006a)
White-letter Hairstreak	Not common but probably under-recorded at this time.	A stable population in Norfolk, although declining nationally.
Small Copper	Common.	Common and stable.
Small Blue	Generally scarce but locally abundant at Swaffham.	**Absent from Norfolk.**
Silver-studded Blue	On all heaths.	**Declining. Now a BAP Priority Species.**
Brown Argus	Common.	*Stable population but showed a spectacular increase in the 1980s.*
Common Blue	Common.	Common. Little long-term population change.
Chalk-hill Blue	Very local distribution.	**No modern records but increasing nationally.**
Holly Blue	Not common.	*The distribution and population levels are currently increasing both locally and nationally.*
White Admiral	Relatively common in suitable habitat.	Appears stable in Norfolk but showing a significant decline nationally.
Purple Emperor	Very localised populations.	**Absent as a breeding species in Norfolk but individuals may still be located.**
Red Admiral	A generally common summer migrant.	*Increasing numbers of migrants and overwintering specimens.*
Painted Lady	Generally common migrant.	*Showing a steady increase in numbers, in line with national trends.*
Small Tortoiseshell	Abundant.	Shows no long-term population change.
Large Tortoiseshell	Declining but formerly common. Appeared commonly in 1873	**Extinct in Britain. Occurs occasionally as a rare migrant.**
Peacock	Common.	*Common; increasing population and distribution.*
Comma	Very rare in Norfolk.	*Common and showing a significant increase in both population and distribution.*

continued

SPECIES	**STATUS** (Barrett & Atmore 1873-1913)	**STATUS** (Fox *et al.*2006a)
Small Pearl-bordered Fritillary	Localised breeding populations.	**Extinct as breeding species in Norfolk. Declining nationally.**
Pearl-bordered Fritillary	Localised breeding populations.	**Extinct as breeding species in Norfolk. Declining nationally.**
High Brown Fritillary	Localised breeding populations.	**Extinct as breeding species in Norfolk. Declining nationally.**
Dark Green Fritillary	Localised breeding populations.	Stable and localised population. Nationally showing a slight increase.
Silver-washed Fritillary	Widely distributed but not common.	**Extinct as breeding species in Norfolk. Stable nationally.**
Marsh Fritillary	Found in marshy meadows.	**Extinct as a breeding species in Norfolk. Declining nationally.**
Speckled Wood	Not common.	*Common. Shows spectacular long-term increases in population and distribution.*
Wall	Abundant.	**Showing declines in inland populations and a significant long-term national decline.**
Grayling	Generally common on heath and coastal sand dunes.	Coastal populations appear stable but inland the species shows significant declines.
Gatekeeper	Abundant.	Common and widespread.
Meadow Brown	Abundant.	Stable and common.
Small Heath	Abundant.	**Declining, in line with national trends.**
Ringlet	Common.	*Increasingly abundant, in line with national trends.*

Appendix 2: SELECTION OF MOTH SPECIES OCCURRING IN NORFOLK; THEIR STATUS IN THE LATE 19th CENTURY AND THE PRESENT Declining species in bold type; increasing species in italics.

SPECIES	STATUS (Barrett & Atmore 1872-1913)	STATUS (Waring & Townsend 2003; Fox *et al.* 2006b)
Goat Moth	Found in many places on many tree species.	**Nationally Scarce B.**
Lichen Case-bearer	Abundant in Breckland.	**Nationally Scarce B.**
Tapestry Moth	Found everywhere. Considered a pest.	**Nationally Scarce B.**
Loxostege sticticalis	Common in Breckland but not elsewhere.	**Extinct in Britain.**
Mocha	Regarded as "not uncommon".	**Nationally Scarce B. Very few modern records in Norfolk.**
Tawny Wave	Core population in Breckland but also found on heaths elsewhere.	**Red Data Book 3. Much reduced distribution in Norfolk.**
Purple-bordered Gold	Described as "rather common" in wet fens.	**Nationally Scarce A.**
Vestal	Not recorded in Norfolk.	*Recorded quite regularly in Norfolk and annually in Britain.*
Oblique Striped	Very common on coastal sand dunes and remnant population in Breckland.	**Restricted to Breckland where it can be locally common.**
Ruddy Carpet	Widespread.	**Nationally Scarce B. Few modern records in Norfolk.**
Spruce Carpet	Not recorded in Norfolk.	*Found frequently in Norfolk.*
Satyr Pug	Not recorded in Norfolk.	*Now found in Norfolk but with a localised distribution.*
Oak-tree Pug	Rare.	*Common, locally frequent.*
Dentated Pug	Common in fen area.	**Nationally Scarce A.**

continued

SPECIES	**STATUS** (Barrett & Atmore 1872-1913)	**STATUS** (Waring & Townsend 2003; Fox *et al.* 2006b)
Scorched Wing	Not common.	*Well distributed but local. Appears to be increasingly common.*
Brussels Lace	Generally common.	**Uncommon, appears to be declining.**
Pine Hawk-moth	Rare.	*Well established and frequent.*
Lime Hawk-moth	Not common.	*Increasingly common and widespread.*
Bedstraw Hawk-moth	Very rare but periodic irruption events.	Temporarily resident(1956-1958). Occasionally overwinters.
Iron Prominent	Not common, sometimes scarce.	*Common and widespread.*
Coxcomb Prominent	Not very common. However, common at Foxley Wood (1884).	*Common and well distributed.*
Maple Prominent	Very rare.	*Increasingly common but formerly Nationally Scarce.*
Garden Tiger	Common everywhere.	**Significant population decline since mid-1980s.**
Coast Dart	Excessively abundant on coastal dunes.	**Nationally Scarce B. Very restricted distribution.**
Dark Sword-grass	Described as "probably everywhere".	**Transitory resident and migrant only.**
Portland Moth	On coastal sand dunes and occasionally in Breckland.	**Rare. Nationally Scarce B.**
Fen Square-spot	Not recorded in Norfolk.	*Local. Split from Small Square-spot.*
Triple-spotted Clay	Very rare.	*Locally common.*
Double Square-spot	Not very common.	*Common.*
Pale Shining Brown	Rather local.	**Proposed RDB. Has undergone massive and continuing decline.**
Small Ranunculus	Widespread and locally frequent.	**RDB, virtually extinct by 1914.**
Viper's Bugloss	Found in larval state wherever food-plant (*Silene otites*) occurs, in Breckland.	**Presumed nationally extinct since the 1960s.**

continued

SPECIES	STATUS (Barrett & Atmore 1872-1913)	STATUS (Waring & Townsend 2003; Fox *et al.* 2006b)
Pine Beauty	Not common.	*Common among pines. A major pest species in Scotland.*
Centre-barred Sallow	Local and scarce.	*Common and well distributed.*
Barred Sallow	Very scarce.	*Common but not abundant.*
Marsh Dagger	Rare but core population in Cambridgeshire so expected to occur in West Norfolk.	**Extinct in Britain. Last recorded in 1933.**
White-spotted Pinion	Local among elms.	**Proposed RDB, formerly Nationally Scarce A.**
Twin-spotted Wainscot	Not recorded in Norfolk.	*Local but sometimes abundant.*
Vine's Rustic	Not recorded in Norfolk.	*Common. Spread rapidly in the 1940s.*
Blair's Shoulder Knot	Not recorded in Norfolk.	*Common. 21000% increase in population over last 30 years.*
Marbled Clover	Local but common on coastal sand dunes.	**RDB species, primarily restricted to Breckland.**
Spotted Sulphur	Confined to the sands of Breckland.	**Extinct in Britain. Lost in the 1950s.**
Golden Plusia	Not common, only a handful of records.	*Common; a recent colonist since late 19th Century.*
Beautiful Golden Y	Scarce.	*Common and widespread.*
Light Crimson Underwing	Very local but sometimes plentiful in favoured habitat.	RDB species. Probably now absent from Norfolk.
Four-spotted	Confined to the Breckland area.	**Nationally Scarce A. Very rare; almost absent from Norfolk.**
Marsh Oblique-barred	Plentiful in extremely boggy areas.	**Nationally Scarce B. Rare and local.**
Common Fan-foot.	Not common.	**Nationally Scarce A. No modern records for Norfolk.**

Swanton Novers Wood NNR, Norfolk, and its Coleoptera: Supplement No.1

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INTRODUCTION

The purpose of this paper is to update that by Sage (2006), particularly in respect of the additional 37 species of beetle recorded there during 2006.

In the original paper mention was made of the fact that both Great and Little Woods were once surrounded by a number of commons, as shown on Faden's map of Norfolk (Barringer 1989). One drawback of this version of Faden's map is that it does not accurately depict how the distribution and shapes of commons and heaths varies so much over the county. This problem has now been rectified with the publication in 2006 by the Society of Cartographers of a digitalised version of Faden's 1797 map. This is a map of great clarity on which the woods are shown in green, and commons and heaths in light brown (on my copy of this map these are in a dark yellow or mustard colour). The area labelled Stock Heath shows Great and Little Woods surrounded by Fulmodeston Common to the south-west, Barney Common to the west, Orbury Common to the north, Swanton Common to the east, and Hindolveston Common to the south-east. What is of particular interest here is the fact that because the parliamentary enclosures were later in Norfolk than in many other counties, the map essentially shows the situation at Swanton Novers before enclosure. In contrast, Bryant's 1826 map of Norfolk (Barringer 1998) shows the landscape after nearly all enclosure acts had been put into effect.

Ancient woodland and wood-pasture

The publication of Rackham (2006) has reopened discussion of these aspects. Woodland is defined as having "*trees so close together that their canopies meet. Trees are managed by coppicing or are allowed to grow on into timber.*" From this it follows that since woodlands have been enclosed and are managed for coppice or timber, old trees and deadwood would be extremely rare. Ancient woodlands are defined as woodlands which have been in existence since 1600.The present boundaries of the Great Wood are all delimited by old banks with associated ditches, and similar features can

be seen to a large extent in Little Wood. Within the Great Wood old banks can be seen in various locations. There seems little doubt that these features are of medieval origin. The current management of Swanton Novers Wood includes the continuation of coppicing (albeit on a much smaller scale than in earlier times), particularly in the south of the Great Wood and in Little Wood. One example of former oak coppice left to grow into high timber can be seen in Compartment 8 in the Great Wood. Scattered through the wood are a number of quite old oak trees, and dead trees and fallen timber are now left *in situ*, unless blocking a ride. This is of great importance insofar as saproxylic beetles are concerned.

This brings us to the wood-pasture habitat which Rackham (*op. cit.*) defines as "*where the trees are widely spaced and grassland, heather, etc. grow between them. There are grazing animals (cattle, sheep, deer), and the trees are mostly a secondary land use.*" This describes very well the conditions which must have existed widely around the Swanton Novers area in earlier times and, as shown in Sage (*op. cit.*), certain beetles on the site list are known to have been strongly associated with ancient wood-pastures, for example *Ampedus quercicola*, *Bitoma crenata*, *Eledona agricola*, *Hallomenus binotatus* and *Prionychus ater*. Grazing pastures are still present around the Swanton Novers woodland complex. It seems clear that many woodlands are actually derived from wood-pastures, because early peoples enclosed trees and made the enclosures stock-proof so that regrowth from cut stems would not be browsed off.

Precipitation

For the period September 2005 to August 2006 the average rainfall was 698.5mm. This is 5.7% below the average rainfall for the five-year period 2001/2002 to 2005/2006 which was 740.5mm. The summer rainfall in 2006 was the second highest recorded in the past five years, being 29.5mm above average (Baker, 2007).

Woodland management

Management activities within the wood are clearly of great importance in the ecological context. In Sage (*op. cit.*) mention was made of the increase of Holly *Ilex aquifolium* that has taken place in recent years, a phenomenon that may partly be related to climate change. Action has been taken to reduce the extent of this species and extensive clearance has been undertaken in Compartment 8 in the Great Wood, and on a smaller scale elsewhere in the

wood, as for example in the northern part of Compartment 6. One beneficial result of this action can be seen in Compartment 8 where there are signs that the ground-living moss *Leucobryum glaucum* may be increasing. During the winter of 2006/2007 Compartment 20 in the south-east corner of the Great Wood was coppiced as part of a long-term programme to restore areas of over-age coppice. This is the first occasion in recent history that such a large area has been coppiced. Work also began on the widening of the main rides by the removal of encroaching scrub. It is to be expected that the flora in these areas will benefit accordingly. New and highly efficient deer fencing has been put in place round Compartment 20, and long-term monitoring of the vegetation changes will be carried out. In order to encourage the spread of Heather *Calluna vulgaris*, during the winter of 2005/2006 and again in the winter of 2006/2007, a section of Ride 61 was litter-stripped to remove dense Purple Moor-grass *Molinia caerulea* tussocks to promote a more varied heath sward dominated by ericoids.

BIODIVERSITY

Flora

There were no additions to the list of flowering plants during 2006. It is perhaps worth commenting further on the Bird Cherry *Prunus padus* which is so much a feature of Great and Little Woods in spring. It is generally accepted that this species is native to Norfolk. However, the Norfolk populations are effectively an outlier, since its natural range otherwise is in the north from the Derbyshire Dales right up to the north of Scotland, and in the west in Wales and the Welsh borders (Preston *et al.* 2002). Where the species occurs in the intervening area it is a result of introductions.

There are three additions to the list of fungi, bringing the total number of species to 753. The first of these is the parasitic fungus *Vouauxtomyces truncates* which was found on the lichen *Flavoparmelia caperata* in the Great Wood on 21 October 1989. This was only the sixth record of this fungus for the United Kingdom. During 2006 Ash Murray found *Helvella crispa* and *Volvariella gloiocephala* in the Great Wood.

Mammals

The species total is increased from 21 to 22 with the addition of Chinese Water Deer *Hydropates inermis*, two of which were seen recently in the Great Wood by a deer stalker (Baker *op. cit.*).

Birds

There is no change in the number of breeding species, but it may be noted that the Common Redstart is barely hanging on with just one territory recorded in the Great Wood in 2006. On the credit side two pairs of Common Buzzards nested in the Great Wood, and a post-breeding group of 11 were seen over this wood on 14 August. The total number of species recorded in Great and Little Woods, excluding species only seen passing over, is about 70. Two further species were noted in 2006: a male Woodlark was singing in display flight in Little Wood on 29 April but did not stay; Approximately a dozen Rooks were seen feeding in the treetops in May, and later in the month small groups were frequently found feeding amongst leaf litter in both Great and Little Woods (Baker *op. cit.*).

Woodlice (Isopoda)

Although woodlice are a common feature of the woodland ecosystem and a number of species are present at Swanton Novers, no research on this group has been carried out there. However, whilst looking for ground beetles in the Great Wood on 24 September 2006, Dr Mark Telfer found a woodlouse beneath Heather in ride 61. He believed it to be *Armadillidium pulchellum* which later proved to be the case (Telfer 2007). This is a most extraordinary record of what, according to Sutton (1972), is a very rare species only rediscovered in Britain in 1971 in the southern Lake District, amongst Juniper on limestone. More detailed information is given in Harding & Sutton (1985) which summarises data gathered by the Isopod Survey Scheme from 1970-1982. Most British records were from inland districts on Carboniferous limestone in Derbyshire, Yorkshire, north Wales and the Lake District, or from coastal cliffs and cliff tops on various Paleozoic rocks. The species is also found sparsely in Ireland. The distribution map in this book clearly shows this northern and western distribution pattern, An updated map recently obtained from the National Biodiversity Network (NBN) Gateway, based on the British Myriapod and Isopod Group database, shows little change in this distribution (see Figure 1), the most noticeable being a number of records in Cornwall and two from Hampshire. Other than

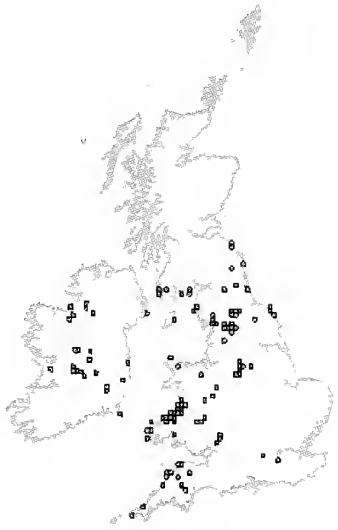

Figure 1 Distribution of *Armadillidium pulchellum* in Britain

the current Norfolk occurrence, the most recent records are one from north Hampshire and one from north Derbyshire in 1986. The nearest known location to Norfolk is the Derbyshire Peak District (about 200km NNW). The British Isles probably contain the greatest concentration of known sites of this species, which appears to be confined to north-western Europe including southern Scandinavia.

The present record is the first for East Anglia and as such is a distant outlier from the predominantly northern and western distribution in Britain outlined above. It may thus be the case that Swanton Novers Wood holds a truly isolated population of this woodlouse. The Norfolk record also represents an ecological divergence in habitat terms in that there are no previous woodland records, though 11 per cent of British records were from acid heath/moorland (Harding & Sutton *op. cit.*). The Great Wood site is, of course, acidic.

False-scorpions (Pseudoscorpiones)

This is another group that has not yet been studied at Swanton Novers. They are small and easily overlooked animals but are probably not uncommon in the wood. On 12 December whilst sieving the litter heap in Ride 61 I found several false-scorpions one of which was collected. This was later identified by reference to Legg & Jones (1988) as *Neobisium muscorum*, a widely distributed species found in woodland litter, in moss and under stones.

Moths (Lepidoptera)

The number of species of macro-moths can now be increased from 401 to 403 by the addition of the Ghost Moth *Hepialus humuli* one of which was trapped in Little Wood on 19 June, and Mother Shipton *Callisege mi* seen in Ride 67 in Great Wood on 9 June. It is worth mentioning that the Small Mottled Willow *Spodoptera exigua*, a migrant species, was found in Jubilee Avenue, near the SE entrance to the Great Wood, on 17 August. This location is just outside the reserve boundary.

One species of micro-moth, the Twenty-plumed Moth *Alucita hexadactyla* was trapped in Ride 65 on 20 July. This increases the number of species in this group from 143 to 144.

Butterflies (Lepidoptera)

The Dark Green Fritillary *Argyllis (Boloria) aglaja* has been regarded as possibly extinct as a breeding species in the wood (Sage 2006). On 5 August 2006 one was seen frequently in the coppiced area of compartment 20, and it

was joined by a second individual for a few days from 15 August. Whilst there was no direct evidence of breeding this was an encouraging development (Baker, *op. cit.*).

Dragonflies (Odonata)

The number of dragonfly species recorded on the reserve is increased from 18 to 19 by the addition of the Black Darter *Sympetrum danae*. A male was seen in Ride 62 in the Great Wood on 9 October. This is a very scarce species in Norfolk due to its preference for acid bogs, usually where *Sphagnum* mosses are present, and there has been no evidence of breeding away from a cluster of sites in West Norfolk (Taylor 2003).

Leafhoppers (Hemiptera)

During 2006 a survey was undertaken by Robert Baker to identify the species present along the more open grassy rides in the Great Wood and nine were recorded:

Common Froghopper *Philaenus spumarius* which proved to be widespread and common in less acidic areas. Recorded on every sampling visit between 21 June and 5 September, with a total of 230 individuals found.

Stenocranus minutus, common but absent from acidic areas. Taken on every sampling visit with a total of 336 individuals located.

Epiptera europea uncommon with only four specimens found between 12 and 29 June.

Neophilaneus lineatus, although recorded on only four visits a total of 36 were taken between 21 June and 5 September.

Cicadella viridis, frequently found on sedges *Carex* sp. and wood rushes *Luzula* sp. with a total of 64 taken between 21 June and 28 August.

Delphacodes pillucida, taken on *Carex* sp. and *Festuca* sp. and common in the rides with 190 individuals found on eight dates.

Aphrodian bifacutus, Uncommon with a total of nine taken on 29 June and 6 July.

Aphrophora alni, a total of 13 taken on three dates between 29 June And 14 July.

Forest Bug *Pentatoma rufipes,* particularly common with 60+ taken in moth traps during July (Baker *op. cit.*).

BEETLES (COLEOPTERA)

The total number of species recorded in Swanton Novers Wood up to the end

of December 2005 (not the end of August as incorrectly shown in Appendix 3 to Sage, *op. cit.*) was 500. This figure excludes the *Pterostichus nigrita* aggregate. During 2006 a further 37 species were recorded which brings the total to 537. These additions are listed in Appendix 1 where, for ease of reference, both families and species are given in alphabetical order. The new species include two that have not previously been recorded in Norfolk (see below). The number of families is increased from 54 to 55 by the addition of the Cucujidae and Phloiophilidae, and by the transfer of the family Scaphidiidae to the Staphylinidae as a subfamily (Scaphidiinae). A further taxonomic point that should be noted is that the family Rhizophagidae in Sage (*op. cit.*) is now considered to be a sub-family (Rhizophaginae) of the family Monotomidae

The species list in Sage (*op. cit.*) included 35 that are considered rare or scarce, using Hyman & Parsons (1992 & 1994) as the reference point. Among the 37 species added to the site list in 2006 are a further eight that come within this category as shown below:

RDB3 (Rare)

Rhizophagus parvulus

Nationally Notable (Scarce) Category A

Amara nitida

Epuraea distincta

Nationally Notable (Scarce) Category B

Cryptarcha strigata

Harpalus smaragdinus

Mycetoporus longicornis

Phloiophilus edwardsi

Scaphisoma boleti

The table below summarises the overall situation if the figures in this paper are combined with those in Sage (*op. cit.*):

RDB1 (Endangered)	1
RDB2 (Vulnerable)	1
RDB3 (Rare)	1
RDBK (Insufficiently Known)	1
Nationally Notable (Scarce) Category A	5
Nationally Notable (Scarce) Category B	33
Nationally Notable (Scarce)	1
Total RDB & Nationally Notable (Scarce) species	**43**

A few of the species recorded in 2006 are worth further comment. There are two species new to Norfolk, the first of which is *Amara nitida* (Sage 2007). This is a rare species that is difficult to identify and which has a widely scattered distribution in England and Wales. The National Ground Beetle Recording Scheme database contains a number of post-1970 records, amongst which the most fully verified occurrences are singles from Hamsterley Forest, Co. Durham, in 1985, and on moorland in Teesdale, Co.Durham, in 1990. The nearest to Norfolk that the species has been recorded was at Skegness, Lincolnshire, in 1950 (Riggall 1953). The Norfolk example was found in a litter heap in Ride 61 in Great Wood on 11 June. Also new to the county is *Thamiaraea cinnamoneum* taken at the same site on the same date. A banana-baited trap on an oak tree yielded one *Epuraea distincta* on 11 June, only the second Norfolk record, the first being just a few weeks earlier at Reedham Marsh in the Broads on 6 May by O.M.Vorst (M.Collier pers. com.). According to Alexander (2002), this species develops in the bracket fungi *Daedaleopsis confragosa* on waterside *Salix* species. This fungus has been recorded in the wood, and of course water and willows are also present. Particular interest also attaches to *Rhizophagus parvulus*, one example of which was found in a banana-baited tree trap on 10 May. The first records for Norfolk were from Felbrigg Great Wood on 15 May and 6 June 2003 by P.Kirby (M.Collier pers. com.) This species was only added to the British list in 1962 when a number were taken on 12 June in Glen Affric, East Inverness-shire (Johnson, 1963). There were three subsequent records from the Scottish Highlands but the first record for England was from Holme Fen, Cambridgeshire, on 17 October 1999 (Welch 2000). A grapefruit-baited trap on an oak tree was checked on 27 June and found to contain one *Cryptarcha strigata*. The only other Norfolk records being from Costessey in 1874 (Edwards 1893) and an undated record from Wheatfen by Ted Ellis (M.Collier pers. com.). The staphylinid *Ischonosoma longicornis* is said by Fowler (1888) to be found in moss, haystack refuse etcetera. One was found in the litter heap in ride 61 on 19 April. There are three previous Norfolk records, all from fen-type habitats: Horning Fen, no date or collector's name given (Fowler, *op. cit.*); Old Buckenham Fen on 6 March 1982 by P.Hammond & J.A.Owen (M.Collier pers. com.), and Wheatfen on 19 October 1997 (by M.Collier).

The litter heap in Ride 61 mentioned above proved a rich source of beetles providing no fewer than 26 of the 37 new species in seven different families. One of these species, *Bradycellus verbasci*, was also found in moss. The habitat in Ride 61 includes an area with Heather *Calluna vulgaris*, Bracken *Pteridium aquilinum*, Western Gorse *Ulex gallii* (rare), Purple Moor-grass

Molinia caerulea and Silver Birch *Betula pendula* seedlings. Part of this area had been litter-stripped during the winter of 2005/2006 as part of the management to encourage the spread of Heather, and it was these cuttings which formed the litter heap. The 26 new species taken therein were as follows:

Carabidae
Acupalpus dubius
Amara nitida
Bembidion guttula
Bradycellus verbasci
Harpalus smaragdinus
Pterostichus diligens
Coccinellidae
Chilocorus bipustulatus
Curculionidae
Hypera nigrirostris
Elateridae
Agriotes obscurus
Leiodidae
Agathidium nigrinum
Catops nigricans
Scydmaenidae
Neuraphes elongatulus
Staphylinidae
Anthobium unicolor
Ischonosoma longicornis
Ischonosoma splendidum
Lathrobium elongatum
Olophrum fuscum
Rugilus rufipes
Rybaxis longicornis
Sepedophilus nigripennis
Stenus aceris
Stenus providus
Tachyporus chrysomelinus
Tachyporus pusillus
Tasgius globulifer
Thamiaraea cinnamomea

Fungi provided two of the new species: *Autalia longicornis* and *Scaphisoma boleti*. Two more, *Atholus duodecemstriatus* and *Ontholestes tessellatus,* were taken in a flight interceptor trap. Three species were sieved from moss: *Bradycellus verbasci*, *Demetrias atricapillus* and *Phloiophilus edwardsii.* The weevil *Apion violaceum* was found on *Rumex* species. Finally, in addition to the species mentioned earlier, a banana-baited tree trap produced *Pediacus dermestoides* on 10 May.

It should be mentioned that very few of the 26 species found in the litter heap would be permanent residents therein. Some would be overwintering, some just using it as a temporary shelter, and others scavenging. The weevil *Hypera nigrirostris* for example is normally found on clovers *Trifolium* species.

Saproxylic beetles

Eight of the additions to the site list are saproxylic beetles and are therefore additional to the 72 qualifying saproxylic species listed in Appendix 5 in Sage (*op. cit.*). It may be noted that the score of 4 for *Leiopus nebulosus* given in Sage (*op. cit.*) should now be reduced to 2. The eight new species are:

Agathidium nigrinum	*Phloiophilus edwardsii*
Cryptarcha strigata	*Rhizophagus parvulus*
Epuraea distincta	*Scaphisoma boleti*
Pediacus dermestoides	*Thamiaraea cinnamomea*

These are listed in Appendix 2 which also shows the rarity score for each species for the purpose of calculating the Saproxylic Quality Index (SQI), and their ecology based on Alexander (2000). These additions raise the number of saproxylic species at Swanton Novers Wood from 72 to 80 with a total score of 333, this has the effect of increasing the SQI from 376.4 to 416.2. A full explanation of how these calculations are made is given in Sage (*op. cit.*). When compared with six other sites in East Anglia, as was done in the previous paper, the result is:

Hatfield Forest, Essex	610.9	Wicken Fen, Cambs.	436.5
Wimpole Estate, Cambs.	568.6	Swanton Novers Wood, Nflk.	416.2
Stanford PTA, Nflk.	474.8	Felbrigg Great Wood, Nflk.	377.6
Staverton Park, Suffolk	473.6		

It should be mentioned that sites with the richest saproxylic beetle fauna are not usually woodlands, but more usually old wood-pastures or ancient

parklands. Moccas Park, Herefordshire, for example has an SQI of 638.4.

Index of Ecological Continuity

Another method available for assessing the ecological importance of a site for saproxylic beetles is the Index of Ecological Continuity (IEC). The first attempt to use species assemblages to develop an IEC was by Rose (1974). He was seeking a way of using site lists of epiphytic lichens to generate a meaningful and easy to use statistic, which could then be used in site assessment. He realised that a wide range of ecological types of lichens may be present in a wooded site and different species may be there for different reasons. His research at various sites revealed that a number of lichen and bryophyte species are only normally found in mature, or old, stands of trees. Their presence or absence may indicate continuity, or otherwise, of the forest environment, and thus provide some evidence that particular sites really are long established and little altered with time. Eventually a list was drawn up of 20 lichen species that are widespread in lowland southern Britain in old forest areas, but become rarer northwards. He suggested that these species may be relics of the ancient forest epiphyte flora of Britain, and pointed out that Coleoptera show a similar pattern and could be used as evidence of continuity of ancient forest conditions. It was these 20 lichens that he then used to calculate an IEC.

In Harding & Rose (1986) this concept is applied to the Coleoptera and a list of 196 species of saproxylic beetles associated with wood-pastures is given. These species are grouped 1-3 according to the extent to which they have been consistently recorded from areas of ancient woodland with continuity of dead-wood habitats, particularly in wood-pastures. The three groups are as follows:

Group 1: Species which are known to have occurred in recent times only in areas believed to be ancient woodland, mainly wood-pasture.

Group 2: Species which occur mainly in areas believed to be ancient woodland with abundant dead-wood habitats, but which also appear to have been recorded from areas that may not be ancient woodland or for which the locality data are imprecise.

Group 3: Species which occur widely in wooded land, but which are collectively characteristic of ancient woodland with dead-wood habitats.

Each species on the list is thus given a score of 1-3, with those species in

Group 1 showing the highest affinity to sites of ecological continuity for dead wood. Although this list was a tentative one with certain limitations, it enabled the later development of an Index of Ecological Continuity (IEC) for use with saproxylic Coleoptera, and this is discussed in detail by Alexander (2004). A differential scoring system was devised to reflect the higher value of Group 1 species in comparison to Group 3, so these groups were given continuity grade scores of 3, 2 and 1 respectively for calculating the IEC.

In his report Alexander (*op. cit.*) revised the Harding & Rose list and reduced the number of species from 196 to 180. These 180 species, which are listed in his Table 1, are thought likely to be the remnants of the saproxylic beetle assemblage of Britain's post-glacial wildwood, and which have survived through a history of wood-pasture management systems. The IEC therefore focuses primarily on relict old forest or old growth assemblages rather than all saproxylic species. Sites with an IEC of 80+ are of *International Importance*, with an IEC of 25-79 are of *National Importance*, and IEC of 15-24 are of *Regional Importance* (see Alexander *op.cit.*). The Harding & Rose (*op.cit.*) list is used to calculate the IEC, and Alexander's list to calculate a Revised Index of Ecological Continuity (RIEC).

The total number of saproxylic species at Swanton Novers Wood is 80, of which 22 (27%) qualify to be used in calculating the IEC, and 20 (25%) for calculating the RIEC. All these species are listed in Appendix 3 which shows their continuity grade scores, the IEC scores and the RIEC scores. The 22 qualifying saproxylic species give an IEC of 30, and the 20 species an RIEC of 28. Applying the criteria given above shows that Swanton Novers Wood is a site of *National Importance*. Table 3 in Alexander (*op. cit.*) lists the British sites with the highest IEC values, and it can be seen that Swanton Novers is on a par with Brampton Bryan Park, Herefordshire, Rockingham Castle Park, Northamptonshire, Shrubland Park, East Suffolk, and Stockton's Wood, East Lancashire, all of which have an RIEC of 28. Staverton Park, Suffolk, has an RIEC of 49. As mentioned earlier in the context of the SQI, it is old wood-pastures and ancient parklands that score the highest rather than dense forests or woodlands, and Moccas Park, Herefordshire, has an RIEC of 125, and Windsor Great Park and Forest, Berkshire, has an RIEC of 249, both thus being sites of *International Importance.*

SUMMARY

The main points of interest are the discovery of a nationally rare species of woodlouse in the Great Wood, and the addition of a further 37 species to

the list of Coleoptera. This figure includes two species new to Norfolk, a further eight nationally rare or scarce species, and an additional eight species of saproxylic beetle which brings the site total for this group to 80. As a consequence of this the Saproxylic Quality Index (SQI) has risen from 376.4 to 416.2. The Index of Ecological Continuity (IEC) is introduced for the first time in the context of this site, and with an RIEC of 28 Swanton Novers is ranked as a site of *National Importance*. There are also additions to the mammal, moth and dragonfly lists. The first records for Pseudoscorpions and leafhoppers are given.

CORRECTIONS

Some minor corrections to Sage (2006) are required:

Page 16, paragraph 3 – line 1, for 501 read 500; line 2, for July read December.

Page 23, last paragraph – line 2, for August read December.

Page 36, penultimate paragraph – line 5, for 501 read 500.

Appendix 3, in the heading, for August read December.

Page 43, under Chrysomelidae – for *Phyllotreta atrata* (Fab.) read *Phyllotreta atra* (Fab.).

Page 44, under Curculionidae – the synonym *Cidnorhinus quadrimaculatus* (L.) shown after *Hypera (Erirnomorphus) rumicis* (L.) should be deleted and inserted after *Nedyus quadrimaculatus* (L.). An * should be placed after *Magdalis (Odontomagdalis) carbonaria* (L.); this does not affect the number of Qualifying Saproxylic Species shown at the end of page 48. For *Parethelcus (Ceutorhynchus) pollinarius* (Forst.) read *Parethelcus pollinarius* (Forst.) = *Ceutorhynchus pollinarius* (Forst.).

Page 47, under Staphylinidae – insert *Lordithon trinotatus* (Erichson).

Appendix 5, page 51 – for *Leptura melanura* (L.) read *Stenurella melanura* (L.).

Page 53, under Elateridae – insert *Denticollis linearis* (L.) 1 1999 larvae under bark of decaying heartwood; broad-leaved trees and *Pinus*.

ACKNOWLEDGEMENTS

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Appendix 1: ADDITIONAL SPECIES OF COLEOPTERA RECORDED IN SWANTON NOVERS WOOD DURING 2006

APIONIDAE
Apion (Perapion) violaceum (Kirby)

CARABIDAE
Acupalpus dubius Schilsky
Amara nitida Sturm. Not. A
Bembidion guttula (Fab.)
Bradycellus verbasci (Duft.)
Harpalus smaragdinus (Duft.) Not. B
Pterostichus diligens (Sturm)

COCCINELLIDAE
Chilocorus bipustulatus (Stephens)

CUCUJIDAE
Pediacus dermestoides (Fab.)*

CURCULIONIDAE
Hypera nigrirostris (Fab.)

ELATERIDAE
Agriotes obscurus (L.)

HISTERIDAE
Atholus duodecemstriatus (Schrank)

LEIODIDAE
Agathidium nigrinum Sturm.*
Catops nigricans (Spence)

NITIDULIDAE
Cryptarcha strigata (Fab.)* Not. B
Epuraea distincta (Grimmer)* Not. A

PHLOIOPHILIDAE
Phloiophilus edwardsii Stephens* Not. B

RHIZOPHAGIDAE (a)
Rhizophagus parvulus (Paykull)* RDB3

SCYDMAENIDAE
Neuraphes elongatulus Muller & Kunze

STAPHYLINIDAE
Anthobium unicolor (Marsh.)

Autalia longicornis Scheerpeltz
Ischnosoma longicornis Maklin Not. B
Ischnosoma splendidum (Grav.)
Lathrobium elongatum (L.)
Olophrum fuscum (Grav.)
Ontholestes tessellatus (Geoff.)
Rugilus rufipes Germar
Sepedophilus nigripennis (Stephens)
Stenus (Hemistenus) aceris Stephens
Stenus (Hemistenus) impressus Germar
Stenus providus Erichson
Tachyporus chrysomelinus (L.)
Tachyporus pusillus Grav.
Tasgius globulifer (Geoff.)
Thamiaraea cinnamomea (Grav.)*

Pselaphinae
Rybaxis longicornis (Leach)

Scaphidiinae
Scaphisoma boleti (Panzer)* Not. B

It may be noted that the Family Rhizophagidae used here is, under the latest classification, regarded as a subfamily (Rhizophaginae) of the Family Monotomidae.

***Qualifying saproxylic species:** 8 **Total species:** 37

Appendix 2: QUALIFYING SAPROXYLIC SPECIES

Species	Index	Ecology
CUCUJIDAE		
Pediacus dermestoides (Fab.)	4	Develops beneath bark on dead broad-leaved timber in early stages of decay
LEIODIDAE		
Agathidium nigrinum Sturm	2	Under bark on dead timber, usually associated with fleshy fungi
NITIDULIDAE		
Cryptarcha strigata (Fab.)	8	Associated with freshly exposed and fermenting sap on oak
Epuraea distincta (Grimmer)	8	Develops in the bracket fungi *Daedaleopsis confragosa* on waterside willows
PHLOIOPHILIDAE		
Phloiophilus edwardsii Stephens	8	Develops in the fungus *Phlebia merismoides* which grows on the bark of dead boughs and branches of various broad-leaved trees
RHIZOPHAGIDAE		
Rhizophagus parvulus (Paykull)	24	Under bark of dead broad-leaved trees
STAPHYLINIDAE		
Scaphisoma boleti (Panzer)	8	A specialist of wood-decay fungi
Thamiaraea cinnamomea (Grav.)	2	At the exuding frass of Goat Moth *Cossus* colonised trees

Oxborough Hythe

NNNS Research Committee project

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INTRODUCTION

Oxborough Hythe is situated in west Norfolk, 12km east of Downham Market on the edge of the Fenland Basin, map reference TF730001. It is a 12 hectare compartment of long-term pasture almost surrounded by arable land. There is about three hectares of scrub which is largely mature Hawthorn *Crataegus monogyna* with some scattered Gorse *Ulex europaeus* and bramble *Rubus* sp. It was formerly part of the Oxborough estate and records show that it has been grazed grassland for more than a century. In 2001 the estate sold the Hythe to Mr & Mrs Brearley of Cambridge who have continued the long-term grassland management by letting the grazing to the owner of a summer calving beef suckler herd. The fact that the area is close-grazed by cattle helps maintain the botanical importance of the site. However, this regime may not be beneficial to certain groups of invertebrates such as Lepidoptera, but is preferable to sheep which can eliminate many of the choicer plant species. It is a County Wildlife Site and is being managed to prescription in an ongoing DEFRA environmental scheme.

The higher part of the site towards the north and north-eastern boundaries is rich chalk grassland. Though highest is a relative term in this part of Norfolk as it is on the five metre contour suggesting that the peaty-looking field over the western boundary must be at or below sea level. Towards the western and north-western part of the site, the flora is less interesting and more indicative of clay except round the margins of a number of depressions, some of which are round, others less symmetrical. At the south-eastern corner of this more or less triangular site, the soil is very different, being sandy and acid, with Sheep's Sorrel *Rumex acetosella* and Changing Forget-me-not *Myosotis discolor* and this is also the headquarters of Gorse *Ulex europaeus*, with some Bracken *Pteridium aquilinum* along the perimeter fence.

It has been suggested that some of the hollows which sometimes have water in at very wet periods, and always have rushes (*Juncus* ssp), may be pingoes.

However, Gillian Beckett has searched through historical records and has ascertained that Oxborough Hythe, the landing place on the River Wissey for boats which used to navigate as far inland as this, used to be quite busy and that there was a brickworks nearby. It would therefore seem more likely that the hollows were actually clay pits attached to the brickworks.

There is a tree shaded pond about 50 metres from the eastern boundary in one place, but this was only dug round about 1990 and has little in the way of peripheral vegetation, as it is heavily poached by the cattle accessing it for drinking. A few years ago, a lady living nearby took the contents of an aquarium containing tadpoles and tipped it into the pond. Unfortunately the aquarium also contained New Zealand Pygmyweed *Crassula helmsii* and Curly Waterweed *Lagarosiphon major*. When alerted to the consequences of letting these spread, Mrs Brearley immediately took action. The latter was not visible in 2006 whilst most of the former had been suppressed by covering it with black polythene.

Not far from the pond is a rather anomalous area of natural wetland of very limited extent, but it does support Water-violet *Hottonia palustris* and Milk- parsley *Peucedanum palustre*. It may have formerly been much more extensive before the pond was dug.

History of the survey

Efforts have been made each winter to halt the advance of the scrub, some of the management being carried out by members of the Conservation Corps. A member attended meetings of the West Norfolk section of the county Flora Group and suggested to Gillian Beckett that the area appeared to be botanically rich. Mr & Mrs Beckett visited the site in 2004. With permission from Mrs Brearley they visited again in 2005 with the Flora Group and produced an impressive list of vascular plants, many of them chalk grassland specialists. At that meeting, Mrs Brearley expressed an interest in having as full a survey of the wildlife on the site as possible. This resulted in Mrs Beckett passing her plant list on to the Chairman of the Norfolk and Norwich Naturalists' Society Research Committee suggesting that a full survey might reveal hidden riches, as part of the area comprised chalk grassland with ancient anthills comparable with parts of Foulden Common just two miles away. Although by then 2005 was well advanced, the Research Committee involvement began with a visit by A L Bull on 29 September 2005. This was followed by further visits for fungi that autumn and subsequent visits in 2006.

RESULTS

Plants and fungi

The chalky area is carpeted with Salad Burnet *Sanguisorba minor* ssp. *minor*, Large Thyme *Thymus pulegiodes*, Small Scabious *Scabiosa columbaria* and Dwarf Thistle *Cirsium acaule*; there are also a few patches of Wild Marjoram *Origanum vulgare* and Crosswort *Cruciata laevipes*.

A visit by the Bryophyte Group produced few surprises, the only 'chalky' moss found being *Fissidens dubius*. However, the most interesting records were made round some old Elders *Sambucus nigra* and on the bare clay round the pond. In all, eleven new 10km records were made including *Bryoerythrophyllum recurvirostrum* on Elder, *Bryum laevifilum* on Elder and Ash *Fraxinus excelsior*, *Syntrichia papillosa* on Elder, and one or two woodland floor mosses such as *Cirriphyllum piliferum* and *Thamnobryum alopecurum.*

Fungi were surveyed on the 28 September, 17 October and 2 November 2005 resulting in a combined list of fungi for the season of just over 60 species, of which 53 were grassland specialists. Ten of these were members of the genus *Hygrocybe*, the waxcaps, the site was therefore of considerable importance for these alone. It had been hoped that a second season might add considerably to the number of species if the weather was right. The autumn rains arrived in due course but the 2006 fungus season (visited on 11 September and 26 October) was relatively poor at Oxborough, probably due to the fact that the grazing regime had been interrupted by broken fences and the grass had become too long at the relevant period.

Birds

In addition to the botanical and mycological interest, the variety of bird species seen during the Research Committees sporadic visits were very encouraging, with a total of 41 species seen or heard. There are several reasons for this. The Gorse and young Hawthorns provide excellent nesting sites for birds such as warblers, Yellowhammers *Emberiza citrinella* and Linnets *Carduelis cannabina*, whilst thrush family members visit the mature Hawthorns for their berries. The cattle-grazed grassland provides feeding opportunities for many insectivorous species. The pond fulfils bathing and drinking needs as well as providing a habitat to support nesting Moorhens *Gallinula chloropus*.

Of the species of national concern which may breed at Oxborough Hythe,

two stand out, these being Grey Partridge *Perdix perdix* and Turtle Dove *Streptopelia turtur* and may also include the Yellowhammer. The single record of Reed Bunting *Emberiza schoeniclus* was during the summer, and it may possibly find a suitable nest site in one of the damp hollows but this would more probably be along the margins of the reed-grown dyke already mentioned. In places, the 'hawthorn wood' has a fringe of Blackthorn *Prunus* , ideal for nesting Long-tailed Tits *Aegithalos caudatus* and Bullfinch *Pyrrhula pyrrhula*, and probably also for the Garden Warbler *Sylvia borin* and Willow Warbler *Phylloscopus trochilus*. The Common Whitethroat *Sylvia communis* and Linnet *Carduelis cannabina* would prefer the Gorse bushes scattered about the site, but especially toward the south-eastern end. The hooting Tawny Owl *Strix aluco* heard on one occasion must have come from some hollow tree nearby as it is doubtful if any of the trees on the site would have a cavity large enough for a tenant of that size. Green Woodpecker *Picus viridis* droppings were frequently seen around the many ancient anthills in the chalky 'upland' area.

Whilst visiting on his own, Geoff Nobes added several birds to the list including a singing Skylark *Alauda arvensis* on March 11, a bird that was not seen subsequently, possibly due to the close-grazed nature of the sward and the risk of nest trampling from numbers of large bovine feet. He is also to be credited with the Teal *Anas crecca*, Woodcock *Scolopax rusticola* and Lesser Redpoll *Carduelis cabaret* during one of his unscheduled visits to the pond area.

Invertebrates

Only six species of butterfly in total were seen during all our visits and only Meadow Brown (*Maniola jurtina*) and Small Copper (*Lycaena phlaeas*) could be regarded as grassland species. The other four being, Peacock (*Inachis io*), Red Admiral (*Vanessa atalanta*), both along the northern perimeter hedge, and Large (*Pieris brassicae*) and Small White (*P. rapae*), strays from the nearest cabbage patch. This may be because the short sward was unsuitable for grass feeding caterpillars. It was for this reason no light trapping for moths took place.

There are many anthills on the site, many of these contained colonies of the Yellow Ant *Lasius flavus*. However, a number of other species were seen, including the Red Ant *Myrmica rubra* and a small, mid-brown ant, darker coloured than the Yellow Ant, but much browner than the Red. This suggests that there are more possible finds of interest to a hymenopterist.

It also appears that the Gorse bushes are an important feature for spiders. Pip Collyer came on our final visit at a time of year when many species are immature and thus not identifiable and recorded a number of species unknown or rare in West Norfolk. In fact, *Micrargus apertus* does not appear to have been recorded in East Anglia, judging from the copy of a map he included, taken from the recent Spider Atlas. Pip is hoping to visit Oxborough on a number of occasions during 2007.

Much the same could be said about the Orthoptera when David Richmond visited Oxborough Hythe on 11 September with his bat detector. He recorded seven species in all, including two species that are advancing northwards in response to global warming. The first of these was Roesel's Bush-cricket *Metrioptera roeselii* found in one area of the site, whilst the hollows with their somewhat rank vegetation seemed to be literally alive with Long-winged Coneheads *Conocephalus discolor*. The resident relative of the latter. the Short-winged Conehead (*C. dorsalis*) was located in the reed-filled ditch adjoining the fenny fields nearby.

Geoff Nobes visited the site several times at the beginning of our survey, visiting the damp hollows and the pond. At all times, there was insufficient water in the hollows to support aquatic life and the pond was not very suitable either, being shaded and with virtually no aquatic vegetation. *Agabus uliginosus* was 'notable' as were *Hydroglyphus pusillus*, *Rhantus grapii* and *Rhantus suturalis*, all of which are diving beetles and also the scavenger beetle *Helochares lividus*, whilst three other species were 'common'. He also listed four terrestrial beetles of which *Dromus longiceps* was also 'notable'. Amongst other aquatic invertebrates recorded were four species of water boatmen, all common, the Water Scorpion, *Nepa cinerea* and the Water Measurer *Hygrometrica stagnorum.* In addition, on 2 November 2005 he recorded the larvae of both Great-crested (*Triturus cristatus)* and Smooth Newts (*Triturus vulgaris*). He felt that the pits, pingoes or whatever they are, would only hold a worthwhile water beetle population in a year when they held water well into the summer.

CONCLUSION

Oxborough Hythe has proved to be an interesting site, and one that might repay further study, especially for Hymenoptera. Further visits in suitable autumns for fungi and possibly also for land snails would be useful.

ACKNOWLEDGEMENTS

The Research Committee would like to thank Mr & Mrs Brearley for giving us the opportunity to visit the site and record its wildlife, thus completing another small piece of the jigsaw puzzle of land use in the Norfolk landscape and its impact or otherwise on the wildlife.

We are grateful for the following surveyors who contributed their time and expertise: Members of the Research Committee, A. Bull,. T. Dove, L. Hall, J Negal and G. Nobes. Plus the following P. Collyer, D. Richmond, G Beckett and members of the Flora and Bryophyte Groups

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Appendix 1: VASCULAR PLANTS

Recorded by members of the Norfolk Flora Group and of the Norfolk & Norwich Naturalists' Society Research Committee. Nomenclature follows Stace 1997. Some orchid names have changed recently, but for the sake of consistency, those in Stace have been retained for this list.

Equisetaceae
Equisetum arvense Field Horsetail
Equisetum palustre Marsh Horsetail

Dennstaedtiaceae
Pteridium aquilinum Bracken

Dryopteridaceae
Dryopteris dilatata Broad Buckler Fern
Dryopteris filix-mas Male Fern

Ranunculaceae
Caltha palustris Marsh Marigold
Ranunculus acris Meadow Buttercup
Ranunculus bulbosus Bulbous Buttercup
Ranunculus ficaria ssp. *bulbilifera* Lesser Celandine
Ranunculus ficaria ssp *ficaria* Lesser Celandine
Ranunculus repens Creeping Buttercup
Ranunculus sceleratus Celery-leaved Buttercup
Ranunculus trichophyllus Thread-leaved Water-crowfoot

Ulmaceae
Ulmus minor agg. Small-leaved Elm

Cannabaceae
Humulus lupulus Hop

Urticaceae
Urtica dioica Stinging Nettle
Urtica urens Small Nettle

Fagaceae
Quercus robur Pedunculate Oak

Betulaceae
Alnus glutinosa Alder
Corylus avellana Hazel

Chenopodiaceae
Chenopodium album Fat Hen
Chenopodium rubrum Red Goosefoot
Atriplex patula Common Orache

Caryophyllaceae
Arenaria serpyllifolia ssp *leptoclados* Thyme-leaved Sandwort
Moehringia trinervia Three-nerved Sandwort
Stellaria graminea Lesser Stitchwort
Stellaria media Chickweed
Stellaria uliginosa Bog Stitchwort
Cerastium arvense Field Mouse-ear
Cerastium fontanum Common Mouse-ear
Cerastium glomeratum Sticky Mouse-ear
Sagina procumbens Procumbent Pearlwort
Spergularia rubra Sand Spurrey
Silene latifolia White Campion
Silene vulgaris ssp. *vulgaris* Bladder Campion

Polygonaceae
Persicaria amphibia Amphibious Bistort
Persicaria lapathifolia Pale Persicaria
Persicaria maculosa Redshank
Fallopia convolvulus Black Bindweed
Rumex acetosella Sheep's Sorrel
Rumex acetosa Common Sorrel
Rumex conglomeratus Clustered Dock
Rumex crispus ssp. *crispus* Curled Dock
Rumex obtusifolius Broad Dock
Rumex palustris Marsh Dock
Rumex sanguineus Wood Dock

Clusiaceae
Hypericum tetrapterum Square-stalked St.John's-wort

Malvaceae
Malva neglecta Dwarf Mallow

Violaceae
Viola arvensis Field Pansy
Viola odorata Sweet Violet
Viola riviniana Common Dog Violet

Cucurbitaceae
Bryonia dioica White Bryony

Salicaceae
Salix alba White Willow
Salix cinerea ssp *cinerea* Grey Willow

Brassicaceae
Sisymbrium officinale Hedge Mustard
Alliaria petiolata Garlic Mustard
Arabidopsis thaliana Thale Cress
Rorippa microphylla Narrow-fruited Watercress
Rorippa amphibia Great Yellowcress
Cardamine flexuosa Wavy Bittercress
Cardamine pratensis Cuckooflower
Capsella bursa-pastoris Shepherd's Purse
Sinapis arvensis Charlock
Raphanus raphanistrum Wild Radish

Resedaceae
Reseda luteola Weld

Primulaceae
Primula veris Cowslip
Primula vulgaris Primrose
Hottonia palustris Water Violet
Anagallis arvensis Scarlet Pimpernell
Samolus valerandi Brookweed

Crassulaceae
Crassula helmsii New Zealand Pygmyweed

Saxifragaceae
Saxifraga granulata Meadow Saxifrage

Rosaceae
Filipendula ulmaria Meadowsweet
Rubus adspersus Blackberry
Rubus cantabrigiensis
Rubus nemoralis
Rubus pruinosus
Rubus ulmifolius
Rubus vigorosus
Potentilla anserina Silverweed
Potentilla argentea Hoary Cinquefoil
Potentilla erecta Tormentil
Potentilla reptans Creeping Cinquefoil
Potentilla sterilis Barren Strawberry
Geum urbanum Wood Avens
Agrimonia eupatoria Agrimony
Sanguisorba minor ssp. *minor* Salad Burnet
Aphanes arvensis Parsley-piert
Aphanes australis Slender Parsley-piert
Rosa arvensis Field Rose
Rosa canina Dog Rose
Prunus domestica ssp *insititia* Bullace
Prunus padus Birdcherry
Prunus spinosa Blackthorn
Malus sylvestris Crab Apple
Crataegus monogyna Common Hawthorn

Fabaceae
*Lotus corniculatus*Common Bird's-foot-trefoil
Lotus pedunculatus Greater Bird's-foot-trefoil
Ornithopus perpusillus Bird'sfoot
Vicia cracca Tufted Vetch
Lathyrus pratensis Meadow Vetchling
Ononis spinosa Spiny Restharrow
Medicago lupulina Black Medick
Trifolium dubium Lesser Clover
Trifolium micranthum Slender Trefoil
Trifolium pratensis Red Clover
Trifolium repens White Clover
Ulex europaeus Gorse

Onagraceae
Epilobium ciliatum American Willowherb
Epilobium hirsutum Great Willowherb
Epilobium parviflorum Hoary Willowherb
Epilobium tetragonum Square-stemmed Willowherb

Cornaceae
Cornus sanguinea Dogwood

Rhamnaceae
Rhamnus catharticus Buckthorn

Linaceae
Linum catharticum Fairy Flax

Aceraceae
Acer campestris Field Maple
Acer pseudoplatanus Sycamore

Geraniaceae
Geranium dissectum Cut-leaved Cranesbill
Geranium molle Dove's-foot Cranesbill
Geranium pusillum Small-flowered Cranesbill
Geranium robertianum Herb Robert

Araliaceae
Hedera helix ssp *helix* Common Ivy

Apiaceae
Chaerophyllum temulum Rough Chervil
Anthriscus caucalis Bur Chervil
Anthriscus sylvestris Cow Parsley
Pimpinella saxifraga Burnet Saxifrage
Oenanthe aquatilis Fine-leaved Water Dropwort
Aethusa cynapium Fool's Parsley
Conium maculatum Hemlock
Peucedanum palustre Milk Parsley
Pastinaca sativa Wild Parsnip
Heracleum sphondylium Hogweed
Torilis japonica Upright Hedge Parsley

Solanaceae
Solanum dulcamara Bittersweet
Solanum nigrum Black Nightshade
Convulvulaceae
Convulvulous arvensis Field Bindweed

Boraginaceae
Lithospermum officinalis Common Gromwell
Symphytum x uplandicum Russian Comfrey
Myosotis discolor Changing Forget-me-not
Myosotis laxa Tufted Forget-me-not
Myosotis ramosissima Early Forget-me-not
Myosotis scorpioides Water Forget-me-not
Cynoglossum officinale Hound's-tongue

Lamiaceae
Stachys sylvatica Hedge Woundwort
Ballota nigra Black Horehound
Lamium album White Deadnettle
Lamium purpureum Red Deadnettle
Galeopsis tetrahit Common Hempnettle
Ajuga reptans Bugle
Glechoma hederacea Ground Ivy
Prunella vulgaris Selfheal
Origanum vulgare Wild Marjoram
Thymus pulegioides Large Thyme
Mentha aquatica Water Mint

Callitrichaceae
Callitriche agg. Starwort

Plantaginaceae
Plantago lanceolata Ribwort Plantain
Plantago major Great Plantain
Plantago media Hoary Plantain

Oleaceae
Fraxinus excelsior Ash
Syringa vulgaris Lilac
Ligustrum vulgare Wild Privet

Scrophulariaceae
Scrophularia auriculata Water figwort
Digitalis purpurea Foxglove
Veronica arvensis Wall Speedwell
Veronica beccabunga Brooklime
Veronica catenata Pink Water-speedwell
Veronica chamaedrys Germander Speedwell
Veronica officinalis Heath Speedwell
Veronica persica Green Field Speedwell
Veronica scutellata Marsh Speedwell
Veronica serpyllifolia Thyme-leaved Speedwell
Odontites vernus Red Bartsia
Rhinanthus minor Yellow Rattle

Orobanchaceae
Orobanche minor Common Broomrape

Campanulaceae
Campanula rotundifolia Harebell

Rubiaceae
Galium aparine Cleavers
Galium palustre ssp *palustre* Common Marsh Bedstraw
Galium saxatile Heath Bedstraw
Galium uliginosum Fen Bedstraw
Galium verum Lady's Bedstraw

Caprifoliaceae
Sambucus nigra Elder
Viburnum opulus Guelder Rose

Dipsacaceae
Succisa pratensis Devil's-bit Scabious
Scabiosa columbaria Small Scabious

Asteraceae
Arctium minus Lesser Burdock
Carduus nutans Musk Thistle
Cirsium vulgare Spear Thistle
Cirsium arvense Creeping Thistle
Cirsium acaule Dwarf Thistle
Centaurea nigra Common Knapweed
Lapsana communis Nipplewort
Hypochoeris radicata Cats-ear
Leontodon autumnalis Autumn Hawkbit
Leontodon hispidus Rough Hawkbit
Leontodon saxatilis Lesser Hawkbit
Tragopogon pratensis ssp *minor* Common Goatsbeard
Sonchus arvensis Perennial Sowthistle
Sonchus asper Prickly Sowthistle
Sonchus oleraceus Smooth Sowthistle
Taraxacum agg. Dandelion
Taraxacum section *Erythrospermum* Red-fruited Dandelions
Crepis capillaris Smooth Hawksbeard
Crepis vesicaria Beaked Hawksbeard
Pilosella officinarum Mouse-ear Hawkweed

Pulicaria dysenterica Yellow Fleabane
Bellis perennis Daisy
Artemisia vulgaris Mugwort
Achillea millefolium Yarrow
Leucanthemum vulgare Ox-eye Daisy
Tripleurospermum inodorum Scentless Mayweed
Senecio erucifolius Hoary Ragwort
Senecio jacobaea Common Ragwort
Senecio sylvaticus Heath Groundsel
Senecio vulgaris Groundsel

Alismataceae
Alisma plantago-aquatica Water Plantain

Hydrocharitaceae
Lagarosiphon major Curly Waterweed

Potamogetonaceae
Potamogeton trichodes Hair-like Pondweed

Araceae
Arum maculatum Lords-and-ladies

Lemnaceae
Lemna minuta Least Duckweed

Juncaceae
Juncus articulatus Jointed Rush
*Juncus bufonius*Toad Rush
Juncus effusus Soft Rush
Juncus inflexus Hard Rush
Juncus subnodulosus Blunt-flowered Rush
Luzula campestris Field Woodrush

Cyperaceae
Eleocharis palustris Common Spike-rush
Carex arenaria Sand Sedge
Carex caryophyllea Spring Sedge
Carex disticha Brown Sedge
Carex flacca Glaucous Sedge
Carex hirta Hairy Sedge
Carex muricata ssp *lamprocarpa* Prickly Sedge
Carex nigra Common Sedge
Carex otrubae False Fox Sedge
Carex panacea Carnation Sedge
Carex riparia Great Pond Sedge

Poaceae
Festuca gigantea Giant Fescue
Festuca rubra Red Fescue
Lolium perenne Perennial Rye-grass
Cynosurus cristatus Crested Dog's-tail
Briza media Quaking Grass
Poa annua Annual Meadow -grass
Poa humilis Spreading Meadow-grass
Poa pratensis Smooth Meadow-grass
Poa trivialis Rough Meadow-grass
Dactylis glomerata Cock's-foot
Glyceria fluitans Floating Sweet-grass
Glyceria maxima Reed Sweet-grass
Glyceria notata Plicate Sweet-grass
Helictotrichon pubescens Downy Oat-grass
Arrhenatherum elatius False Oat-grass
Trisetum flavescens Yellow Oat-grass
Koeleria macrantha Crested Hair-grass
Deschampsia cespitosa Tufted Hair-grass
Holcus lanatus Yorkshire Fog
Holcus mollis Creeping Soft-grass
Aira praecox Early Hair-grass
Anthoxanthum odoratum Sweet Vernal Grass
Phalaris arundinacea Reed Canary-grass
Agrostis capillaries Common Bent
Agrostis giganteum Black Bent
Agrostis stolonifera Creeping Bent
Alopecurus pratensis Meadow Foxtail
Phleum bertolonii Smaller Cat's-tail
Bromus hordeaceus Soft Brome
Anisantha sterilis Barren Brome
Brachypodium sylvaticum False Brome
Elytrigia repens Common Couch
Phragmites australis Common Reed

Iridaceae
Iris pseudacorus Yellow Iris

Dioscoriaceae
Tamus communis Black Bryony

Orchidaceae
Anacamptis pyramidalis Pyramidal Orchid
Ophrys apifera Bee Orchid

Appendix 2: BRYOPHYTES

The Bryophyte Group visited the site on 22nd January 2006 and recorded 38 mosses and one liverwort. This is likely to be the vast majority on a site of this type. Nomenclature follows the Checklist and Census Catalogue of British and Irish Bryophytes (Blockeel & Long,1998)

Mosses

Amblystegium serpens
Barbula unguiculata
Brachythecium albicans
Brachythecium rutabulum
Bryoerythrophyllum recurvirostrum
Bryum capillare
Bryum dichotomum
Bryum laevifilum
Bryum rubens
Calliergonella cuspidata
Campylopus introflexus
Ceratodon purpureus
Cirriphyllum piliferum
Dicranella varia
Dicranowiessa cirrhata
Didymodon tophaceus
Fissidens adianthoides
Fissidens dubius
Fissidens incurvus
Fissidens taxifolius
Homalothecium sericeum
Hypnum cupressiforme
Hypnum resupinatum
Kindbergia praelonga
Leptodictyum riparium
Orthotrichum affine
Orthotrichum diaphanum
Plagiomnium affine
Plagiomnium undulatum
Pohlia melanodon
Polytrichum juniperinum
Pseudoscleropodium purum
Rhynchostegium confertum
Rhytidiadelphus squarrosus
Syntrichia intermedia
Syntrichia papillosa
Thamnobryum alopecurum
Zygodon viridissimus

Liverwort

Metzgeria furcata

Appendix 3: FUNGI

Recorded by A. L. Bull & T. Dove

Nomenclature of the Basidiomycota follows Legon & Henrici (2005); that for the Ascomycota follows Brietlingbach & Kranzlin (1984).

BASIDIOMYCOTA

Agaricales and Boletales

Agaricus arvensis
Agaricus bitorquis
Agrocybe praecox
Bolbitius titubans
Calocybe carnea
Clitocybe metachroa
Clitocybe rivulosa
Conocybe tenera
Coprinus friesii
Coprinus lagopus
Coprinus micaceus
Coprinus niveus

Coprinus plicatilis
Crinipellis scabella
Dermoloma cuneifolium
Entoloma asprellum
Entoloma sericeum
Entoloma undatum
Flammulina velutipes
Galerina laevis
Galerina uncialis
Hygrocybe ceracea
Hygrocybe coccinea
Hygrocybe colemanniana
Hygrocybe conica
Hygrocybe glutinipes
Hygrocybe insipida
Hygrocybe mucronella
Hygrocybe pratensis
Hygrocybe psittascina
Hygrocybe quieta
Hygrocybe virginea
Hypholoma fasciculare
Laccaria laccata
Lactarius quietus
Macrolepiota rhacodes
Marasmius oreades
Melanoleuca grammopodia
Melanoleuca melaleuca
Mycena aetites
Mycena galericulata
Mycena galopus var nigra
Mycena leptocephala
Mycena luteo-alba
Mycena rorida
Mycena sanguinolenta
Mycena speirea
Mycena stylobates
Panaeoleus fimicola
Panaeoleus papillionaceus
Psathyrella candolleana
Psathyrella conopilus
Psathyrella corrugis
Psilocybe semilanceata
Rickenella fibula
Rickenella swartzii
Russula nigricans
Russula parazurea
Stropharia coerulea
Stropharia coronilla
Stropharia inuncta
Tubaria dispersa
Tubaria furfuracea
Volvariella gloiocephala

Aphyllophorales (bracket, club and resupinate fungi)
Abortiporus biennis
Clavulinopsis corniculata
Clavulinopsis fusiformis
Daedalea quercina
Ganoderma australe
Hyphodontia sambuci
Laetiporus sulphureus
Mycoacia uda
Peniophora incarnata
Stereum hirsutum
Trametes versicolor

Heterobasidiomycetes (jelly fungi)
Auricularia auricula- judae

Gasteromycetes (puffballs)
Bovista nigrescens
Calvatia gigantea
Handkea utriformis
Scleroderma verrucosum

ASCOMYCOTA
Coprobia granulata
Diatrypella quercina
Geoglossum cookeianum
Hypoxylon multiforme
Peziza repanda
Xylaria hypoxylon.

Appendix 4: INVERTEBRATES

COLEOPTERA (AQUATIC)
Recorded by G. Nobes.

Haliplidae
Haliplus ruficollis

Hygrobidae
Hygrobia hermanni Screech Beetle

Dytiscidae (diving beetles)
Laccophilus minutus
Hydroglyphus pusillus Not. B
Hydroporus angustatus
Hydroporus planus
Hydroporus striola
Agabus bipustulatus
Agabus nebulosus
Agabus sturmi
Agabus uliginosus Not. B
Rhantus grapii Not. B
Rhantus suturalis Not. B

Helophoridae
Helophorus aequalis
Helophorus grandis

Hydrophilidae (scavenger water beetles)
Anacaena limbata
Laccobius bipunctatus
Helochares lividus Not. B
Cymbiodyta marginellus
Hydrobius fuscipes

COLEOPTERA (TERRESTRIAL)
Recorded by G. Nobes (except ladybirds)

Carabidae
Bombidion clarkii
Dromius longiceps Not. A
Dyschirus globulus Local

Scarabidae
Aphodius fossor

Nitulidae
Glischrochilus hortensis

Coccinellidae (ladybirds)
Coccinellia septempunctata
Micraspis 16-punctata

AQUATIC HEMIPTERA & HETEROPTERA
Recorded by G. Nobes.

Nepidae
Nepa cinerea Water Scorpion

Corixidae (water boatmen)
Corixa punctata
Sigara distincta
Sigara lateralis
Notonecta glauca

Pleidae
Plea minutissima

Hydrometridae
Hydrometra stagnorum Water Measurer

ORTHOPTERA (grasshoppers etc.)
Recorded by D. Richmond. Nomenclature follows Marshall & Haes (1988).

Metrioptera roeselii Roesel's Bush-cricket
Conocephalus discolor Long-winged Conehead
Conocephalus dorsalis Short-winged Conehead
Leptophyes punctatissima Speckled Bush-cricket
Tetrix subulata Slender Groundhopper
Chorthippus brunneus Field Grasshopper
Chorthippus albomarginatus Lesser Marsh Grasshopper

ODONATA (dragonflies)

Recorded by Research Committee members.
Aeshna cyanea Southern Hawker
Sympetrum striolatum Common Darter

LEPIDOPTERA (butterflies)
Recorded by Research Committee members.

Pieris brassicae Large White
Pieris rapae Small White
Lycaena phlaeas Small Copper
Vanessa atalanta Red Admiral
Inachis io Peacock
Maniola jurtina Meadow Brown

HYMENOPTERA (bees, wasps, ants)
Recorded by A.L.Bull

Lasius flavus Yellow Ant
Vespula vulgaris Common Wasp
Ammophila campestris (sand wasp)

DIPTERA (flies)
Recorded by A.L.Bull.

Empis tesselata
Eristalis arbustorum
Eristalis tenax
Lucilia caesar
Scatophaga stercorarium
Tipula paludosa

GALLS
Recorded by J.Negal.

Dasyneura urticae on Stinging Nettle
Jaapiella veronicae on Germander Speedwell
Ureomyces cardui on Creeping Thistle

ARACHNIDA (spiders)
Recorded by Pip Collyer. Nomenclature follows Checklist of the British Arachnological Society's Spider recording scheme (2000).

Thomasidae
Tibellus oblongus

Linyphiidae
Bathyphantes gracilis
Dicymbium tibiale
Diplocephalus latifrons
Diplostyla concolor
Erigone atra
Eregonella hiemalis
Gongylidiellum vivum
Lepthyphantes flavipes
Lepthyphantes tenuis
Micrargus apertus
Micrargus subequalis
Microneta viaria
Monocephalus fuscipes
Neriene clathrata
Oedothorax fuscus
Savignia frontata

Earlier in the season, members of the Research Committee also recorded:

Araniella marmorea ssp *pyramidata*
Araneus diadematus.

MOLLUSCA
Recorded by A.L.Bull

Cepaea hortensis White-lipped Snail
Cepaea nemoralis Brown-lipped Snail
Helicella itala Heath Snail

Appendix 5: VERTEBRATES

AMPHIBIANS
Smooth Newt *Triturus vulgaris*
Great Crested Newt *Triturus cristatus*

BIRDS
Order and nomenclature follows that currently in use in the Norfolk Bird & Mammal Report.

Teal *Anas crecca*
Grey Partridge *Perdix perdix*
Pheasant *Phasianus colchicus*
Heron *Ardea cinerea*
Kestrel *Falco tinnunculus*
Moorhen *Gallinula chloropus*
Woodcock *Scolopax rusticola*
Wood Pigeon *Columba palumbus*
Turtle Dove *Streptopelia turtur*
Tawny Owl *Strix aluco*
Swift *Apus apus*
Green Woodpecker *Picus viridis*
Skylark *Alauda arvensis*
Swallow *Hirundo rustica*
Wren *Troglodytes troglodytes*
Dunnock *Prunella modularis*
Robin *Erithaca rubecula*
Blackbird *Turdus merula*
Fieldfare *Turdus pilaris*
Redwing *Turdus iliacus*
Garden Warbler *Sylvia borin*
Common Whitethroat *Sylvia communis*
Willow Warbler *Phylloscopus trochilus*
Long-tailed Tit *Aegithalos caudatus*
Blue Tit *Cyanistes coeruleus*
Great Tit *Parus major*
Jay *Garrulus glandarius*
Magpie *Pica pica*
Jackdaw *Corvus monedula*
Rook *Corvus frugilegus*
Carrion Crow *Corvus corone*
Starling *Sturnus vulgaris*
Chaffinch *Fringilla coelebs*
Greenfinch *Carduelis chloris*
Linnet *Carduelis cannabina*
Lesser Redpoll *Carduelis cabaret*
Bullfinch *Pyrrhula pyrrhula*
Yellowhammer *Emberiza citrinella*
Reed Bunting *Emberiza schoeniclus*

Recent bryological discoveries in Norfolk

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The last account detailing new moss and liverwort finds in Norfolk was by Mott & Stevenson (2003); that listed changes up to 2002. A lot has happened in the intervening four years.

Throughout this period the Bryological Group has been very active, and a great many new records have been made for both specific sites, and for 10 kilometre grid squares. This means that much of the information about distribution in the Flora of Norfolk (Beckett *et al.,* 1999) is now out of date. A substantial number of species are now regarded as less rare than formerly, a good example being *Hookeria lucens* which, at the time of publication of the Flora, was known from only two sites, both in East Norfolk (vc27): Holt Lowes and Honing Common. It has, since then, been found at two further sites in East Norfolk: in Edgefield Woods, by Simon Harrap, and by Barry Nicholson at Carlton Forehoe Poor Fen. It has also been found at two localities in West Norfolk (vc28), i.e. Sculthorpe Moor, where it was found by Mary Ghullam, and East Harling Fen when it was found on a Flora Group excursion. It is possible that this is a species that is expanding its range, but it seems much likelier that there are simply more active bryologists looking than at any time in the past.

Increased activity is a major key to finding new records, and the Spring Meeting of the British Bryological Society, which took place in the county in 2003, certainly illustrated that principle, since an influx of outside experts quickly made a number of significant new discoveries. On the very first day *Sanionia uncinata*, new to vc28, was discovered by Mark Hill, who also made the second county record of the epiphyte *Orthotrichum tenellum*. The only other new vice county record was made by Sean O'Leary – of the stubble field species *Weissia longifolia* var *longifolia*. This was new to vc27. The other records made were not quite so exciting, but even at well worked spots, such as the Ted Ellis Reserve at Surlingham, substantial numbers of interesting new site records were made.

There is, despite the increased interest in bryophytes, still a lot of unexplored

terrain in Norfolk, such as the soft cliffs at Overstrand, where Bob Ellis and Robin Stevenson found (again in 2003) healthy colonies of a number of small leafy liverworts, such as *Scapania compacta, Lophozia ventricosa*, and *Nardia scalaris*. These are all plants which seem to have become much scarcer than in the days of Petch and Swann (1968).

Another underworked habitat is the intermittently wet ground round the edges of ponds and lakes. In 2003, again, *Physcomitrella patens* was found at the edge of the lake at Wolterton Park. This inconspicuous species is the bryological equivalent of the fruit-fly *Drosophila*: it has a very simple genetic make-up, and consequently has been studied very intensively by geneticists so that we know more about its structure than that of any other species of moss.

One of the problems facing any attempts at the conservation of lower plants is the sheer paucity of reliable data. Stubble fields are a habitat that were known to be species rich in the past, but recent changes in agricultural practise had led to a fear that they had deteriorated. To try and clarify the situation the British Bryological Society instigated a nation-wide survey which ran through from 2002 to 2006. A substantial amount of the local effort at recording stubble fields seemed to have occurred in 2004. There were few surprises, although north-east Norfolk was confirmed as a national stronghold for the liverworts *Sphaerocarpos texanus* (which is an endangered species) and *S. michelii*. Another endangered species, *Bryum gemmilucens*, was found in a field near Fulmodeston, whilst Mary Ghullam managed to find a second Norfolk site for the hornwort *Anthoceros agrestis*, near Felbrigg.

Most recording trips produce a few records which are new to the site and / or the 10km square, however, occasionally one encounters a really rich site which sets the heart a-flutter. One such site was Sculthorpe Moor (Hawk & Owl Trust Reserve). This single site yielded 65 moss and 15 liverwort species, including *Hookeria lucens* (detailed above), and new records for the rarities *Rhytidiadelphus loreus* and *Moerckia hibernica*.

The rest of 2004 proved fairly mundane, except for the discovery of a previously seriously neglected habitat: orchards. These yielded second and third records for several species, such as *Sanionia uncinata* and *Orthotrichum stramineum*. *Leucodon sciuroides* which in East Anglia was regarded as a rarity of calcareous stonework, has now turned up several times in orchards – on both apples and pears. Recording in this habitat has continued over several years now, 2005 producing *Orthotrichum striatum* at Gunton Hall

(second record for vc27) and *Orthotrichum rupestre* (new county record) at Flitcham. *Orthotrichum striatum* also turned up in Flitcham, as a species new to vc28.

Flitcham also hosted what started out as a species new to Britain, but ended up as a mere variety of something common – albeit the variety is both rare and still new to Britain. This was what is now called *Hypnum cupressiforme* var *heseleri*. It is a very distinctive species which does not resemble normal *Hypnum cupressiforme* at all, which is why it was originally named as a new species. However, genetic investigations have shown it to be a mutant of the common species.

Whilst most records have been made on Group excursions a few stalwart individuals, notably Alec Bull, periodically contribute to the pool, Alec's offerings generally being of a rather superior quality – like *Thuidium philberti*, from inside the Stanta Battle Area. A visitor to the county, David Holyoak, found *Sphagnum contortum, Drepanocladus exannulatus*, and *Plagiomnium ellipticum* – all new to Holt Lowes.

Even fairly dull habitats can occasionally produce surprises, as when Richard Fisk found *Bryum donianum*, new to Norfolk, at Sheringham Park. (This is a clear case where an individual has 'got his eye in', since Richard has gone on to find *Bryum donianum* in West Norfolk too (in 2006), at Gressenhall Old Carr).

The year 2006 produced the usual rash of extra records of already known species. Some of these were the result of visiting new localities, some the result of chance discoveries in known localities; a significant re-discovery was *Brachythecium populeum*, which was found at Smockmill Common in January. It was regarded by Burrell (1914) as 'rather common' in East Norfolk, but had not been recorded since then. It is to be hoped that, having got our eye in for it, that it may prove more widespread.

Taxonomic revision has also increased the counties species total. The common liverwort, *Conocephalum conicum*, was recently investigated by some Polish bryologists (Szweykowski J et al. 2005) who discovered that there were in fact two species involved: *C. conicum* and *C. salebrosum*. The latter has now been found in both Norfolk vice-counties.

2006 went out with a bit of a bang when, investigating a pond at Syderstone Common, Colin Dunster found *Riccia cavernosa, Physcomitrella patens,* and *Physcomitrium eurystomum*. The first two are by no means common,

whilst the latter is a rare Red Data Book species; this was its first record for the county away from the Breckland meres which are its stronghold.

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Orthoptera Report 2006

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This was a remarkable year with the first ever December record for an orthopteran in Norfolk and with the rediscovery of Bog Bush-cricket in West Norfolk after a gap of over 50 years. Roesel's Bush-cricket and Long-winged Conehead continued to expand their range, with the former being reported from 45 new tetrads. The species accounts below list all new 10km square records.

Oak Bush-cricket *Meconema thalassinum* (De Geer)

Records from Stanhoe (TF83) and Hindringham (TF93) plug a gap in the distribution maps in the north-west of the county. This species remains significantly under-recorded throughout Norfolk and all records would be welcome.

Bog Bush-cricket *Metrioptera brachyptera* (L.)

The Marsham Heath colony first reported last year has proved to be quite an extensive one reaching two or three hundred metres into the adjoining tetrad to the north (TG1624) adding to the cluster of sites in the main part of the species' range in mid Norfolk. But the highlight of the year was the discovery of this species in the Leziate area, where it was heard with a bat detector and confirmed by visual sighting. This is the first record for this part of the county for 86 years and the first vice-county record for over 50 years, the last being at Thornham in 1952.

Roesel's Bush-cricket *Metrioptera roeselii* (Hagenbach)

This species is now well established in the south-west of the county. In a single day the author secured eighteen new tetrad records between Hockwold Fen and Downham Market. It was abundant at all sites so must have been present in this area for several years. Tom Lowe provided two valuable records from sea banks in the Terrington area. Other new 10km square records included four tetrads around Pott Row and five tetrads around Castle Acre. The latter included a number of sites that the author had been monitoring for several years in anticipation of its arrival, so its presence here in 2006 is known to be new. It is likely that the hot weather in June and July led to the development of large numbers of the fully-winged form, and the new 10km square records from Cawston, Buxton Heath, Horsford and Burnham Overy probably represent dispersal of this form.

Long-winged Conehead *Conocephalus discolor* (Thunberg)
This was recorded from seven new 10km squares at Hockwold Fen, Foulden (three tetrads), Dunham / Castle Acre (five tetrads), Fakenham, Mileham, Saxthorpe and Old Catton. It has now been recorded from twenty-two 10km squares with a wide distribution across the county.

Short-winged Conehead *Conocephalus dorsalis* (Latreille)
There were two new 10km square records from Coxford (TF82) and Syderstone Common (TF83) in the north-west of the county, plus considerable tetrad infilling around Denver, Hockwold Fen, the Wensum catchment at Worthing and Hoe, and the Tud valley at East Tuddenham. This is now becoming a very difficult species to census, because of the concurrent expansion of Lesser Marsh Grasshopper *Chorthippus albomarginatus* (De Geer) which has a very similar courtship song when heard through a bat detector. Wherever possible significant new records have been backed up by visual sightings. The species is expanding nationally and has now been reported as far north as Grange-over-Sands in Cumbria.

Lesser Earwig *Labia minor* (L.)
Robert Maidstone reported finding "thousands" in a compost bin at Long Stratton in early December, and "hundreds" in another bin at Sisland (TM39) a new 10km square. This species needs warm microclimates to survive as it is continuously brooded with a life span of about 80 days. Anyone with compost bins is asked to check for this species. The body length is 4-6mm with forceps up to 1.25mm, but beware of confusion with nymphs of Common Earwig *Forficula auricularia* L. early in the season.

Early and late dates
Hot weather in June and July led to the early maturing of some species with stridulating Short-winged Conehead on 8 July and Long-winged Conehead on 25 July being the author's earliest dates for these species in Norfolk. Mild weather at the end of the season meant Field Grasshopper *Chorthippus brunneus* (Thunberg) was recorded up until 20 November and Dark Bush-cricket *Pholidoptera griseoaptera* (De Geer) to 24 November. Speckled Bush-cricket *Leptophyes punctatissima* (Bosc) survived at Reepham to 6 December. This was the author's first ever December record for an orthopteran and a full twelve days after the previous latest date for this species.

Plant Notes 2006

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To botanists it was a strange year, the spring was late, then summer arrived all in a rush and with high temperatures and little rain, plants had no sooner come through than they were withering in the sun (as were many of the botanists)! This made the recording of small ephemerals very difficult and may account for their poor showing in the lists of finds though Clustered Clover *Trifolium glomeratum* was surprisingly abundant in its one West Norfolk site.

A number of meetings was held on the coast to cover all the areas where Rock Sea-lavender *Limonium binervosum* had been found and it proved to be doing well, especially on the sandy edge of the saltmarshes. Quadrats were set up and populations of the sea-lavender and associated species were estimated. The somewhat less pleasurable work of analysing all the records is under way and, all being well, will be appearing separately in due course. Two other coastal meetings were particularly productive: Yarmouth North Denes in early May and Overstrand cliffs in late June. The former turned up such spring delights as Sea Mouse-ear *Cerastium diffusum*; Musk Stork's-bill *Erodium moschatum*; Bulbous Meadow-grass *Poa bulbosa*; Shepherd's Cress *Teesdalia nudicaulis* and Suffocated Clover *Trifolium suffocatum*. The latter rewarded us with a range of marsh-orchids; Marsh Helleborine *Epipactis palustris*; a great abundance of Kidney Vetch *Anthyllis vulneraria*; the delicate Silver Hair-grass *Aira caryophyllea* and, most excitingly, the rediscovery of Purple Broomrape *Orobanche purpurea*.

One of the tasks facing the botanical recorders is getting as many of our records computerised as possible. This is a very time-consuming task, but it is surprisingly satisfying to be able to produce a map which shows the way that plant distribution can change – or does it just record plants which were formerly missed? Even if that is so, it does show that we are still exploring new areas and finding new records. **Please** do send in your plant records so we can keep things really up to date.

Finds of interest in 2006 included:

Aristolochia clematitis, Birthwort. Carrow Abbey, R.W. Ellis, 28th September 2006. The annual Biodiversity Conference was held at the Abbey

conference centre, which provided a good opportunity to see that this species was still thriving at a site where it was first recorded in 1793.

Barbarea verna, American Winter-cress. Caister-on-Sea, Flora Group, 6th May 2006.

Brassica juncea, Chinese Mustard. Felthorpe, L. Hall, 20th July 2006.

Bromus commutatus var. ***pubens***, Meadow Brome. Snettisham, K. & G. Beckett, conf. A. Copping, 23rd May 2006. The variety *pubens* was found here by Eric Swann in 1954, a naming which was then confirmed by T.G. Tutin. However, some doubts have been raised as to whether this should be treated as a distinct taxon.

Carlina vulgaris, Carline Thistle. Overstrand, Flora Group, 27th June 2006 and Cley, R.W. Ellis & M. Ghullam (previously reported by C. Dunster). Although this is not especially uncommon in West Norfolk, it is rare in the east and only one site (Alderford Common) was reported in *A Flora of Norfolk* (1999).

Dactylorhiza incarnata **subsp.** ***coccinea***, Early Marsh-orchid (dark red form). Burnham Overy, A. & S. Harrap, July 2006 – a new locality. This subspecies was also seen in great abundance at Overstrand cliffs when the Flora Group visited in late June.

Eleocharis quinqueflora, Few-flowered Spike-rush. Southrepps Common, R.W. Ellis & M. Ghullam, 28th June 2006 and Smallburgh Fen, R.M. Leaney, 28th June 2006.

Filago lutescens, Red-tipped Cudweed. Santon, N. Gibbons, det. P. Wilson – a new colony.

Filipendula vulgaris, Dropwort. Crostwight churchyard, A.L. Bull, J.W. Negal & F.M. Schumann, 30th September 2006 – an unusual site for this species and the first East Norfolk record since Petch & Swann's 1968 Flora.

Hydrocotyle ranunculoides, Floating Pennywort. Rockland, D.A. Nobbs, 4th June 2006 and Coltishall, R.M. Leaney, 30th August 2006 – this is a very invasive non-native aquatic plant.

Ophrys apifera var. ***chlorantha***, Bee Orchid (white form). Loddon, S.R. Martin, 16th June 2006

Orobanche purpurea, Purple Broomrape. Overstrand, Flora Group, 27th June 2006 – the first record from this location since 1978.

Potentilla anglica, Trailing Tormentil. Beetley, S. Plant, 8th June 2006.

Potentilla **x** ***mixta***, Hybrid Cinquefoil. Beetley, S. Plant, 8th June 2006.

Rosa **x** ***pseudorusticana***, a hybrid rose (*R. arvensis* × *stylosa*). Sustead, R.M. Leaney, det. R. Maskew, 17th August 2006.

Salicornia pusilla* x *ramosissima. Morston, C. Dunster, conf. I.K. Ferguson, 9 Sept, 2006.

Salix* x *smithiana, a hybrid willow (*S. cinerea* × *viminalis*). Felthorpe, L. Hall, det. R.D. Meikle

Veronica* x *lackschewitzii, (*V. anagallis-aquatica* × *catenata*), Hybrid Water-speedwell. Blickling, R.W. Ellis & M. Ghullam, 27th August 2006.

Southern Migrant Hawker *Aeshna affinis* (Latreille) : a new species for Norfolk

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2006 was an exceptional year for the appearance of several migratory odonata following the fine weather through June and July. During a very hot afternoon on 21st July we met by chance at Roydon Common, sharing a similar interest in photographing insects, with Black Darter *Sympetrum danae* a particular species in mind. We finally reached some small pools on the edge of Grimston Warren where we soon found much activity, despite the fact that they were rapidly drying out. This included several *S. danae*, a few Ruddy Darter *S. sanguineum*, a Four-spotted Chaser *Libellula quadrimaculata*, and a male Emperor *Anax imperator* amongst other species.

After about half an hour or so, our attention was drawn to an unusually bright blue hawker dragonfly, patrolling erratically to and fro on the opposite side of the pool, no more than about 10 metres away. Both of us quickly realised that we had seen nothing quite like it before, and luckily we were able to watch it through binoculars for about two or three minutes, enough to observe the salient features. After several skirmishes it was finally chased off by the aggressive and much larger Emperor.

It was strikingly similar in abdominal colour to the Emperor but resembled in size and general behaviour a male Migrant Hawker *Aeshna mixta.* The entire head and body gave the impression of being generally pale blue at a distance, and in particular we noticed that the eyes were a pale blue as the insect flew

towards us – a striking feature. We also noted many large, paired blue spots on the abdomen and the plain, pale greenish sides to the thorax lacking the strong double stripes shown by *A. mixta*.

Between skirmishes with the Emperor, it patrolled rapidly at about waist height around the rushy margin of the pool, briefly hovering at least twice and occasionally flying out towards us over the pool. Unfortunately it was not seen to settle. Checking a field guide on return to our cars instantly confirmed our identification – unmistakably a male *A. affinis*.

This sighting appears to have coincided with the arrival of other migratory insects including the first of a large influx of Yellow-winged Darters *S. flaveollum* elsewhere in the county at that time. The record has been accepted by the Odonata Records Committee and was one of at least four sightings between mid July and mid August 2006 (Parr, 2007). These comprise the first confirmed records of this species since the only previous accepted British record in Kent in 1952 and a published 'probable' in Avon in 1993. Similarly most of the 2006 records were from the southern counties.

On the continent *A. affinis* usually emerges earlier than *A. mixta*, flying from late May or June to the end of August (Askew, 1988), and is known to be as strongly migratory as the latter species. Therefore it is likely to appear in a variety of habitats similar to *A. mixta,* but is noted as preferring standing waterbodies that dry up over the course of the summer, often overgrown with low rushes, bulrushes or reeds (Dijkstra & Lewington, 2006).

In common with several other species such as Lesser Emperor *Anax parthenope,* this essentially Mediterranean species has been extending its range north, with increasing frequency of records on the near continent. There were some 50 individuals reported in The Netherlands in 2006 (A. Parr, pers. com.). As these species are clearly responding to changes in the climate, it is likely that *A. affinis* could occur with increasing frequency in the next few years and may even attempt to colonise. Any bright 'migrant hawker' appearing during midsummer may therefore be worthy of a closer look!

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NORFOLK & NORWICH NATURALISTS' SOCIETY

The County's senior natural history society has as a principal aim the investigation and recording of Norfolk's wildlife and to this end it publishes:

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CONTENTS

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