Investigations of a second insect assemblage from the Sweet Track

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During the 1981 excavations of the Sweet Track, samples for the investigation of the associated insect fauna were collected at site TG. A previous study has been made of the insect remains from the Drove Site situated at the southern end of the Sweet Track, near to the Burtle Sand island of Shapwick (Girling 1979). The TG site, by contrast, is near the middle of the track, which has its northern end on the slope of Westhay island. At site TG, four peat monoliths for botanical and insect investigation were collected from baulks left at intervals along the excavation, and up to a 30cm depth of peat was taken from immediately below and above the level of the track, the insect samples juxtaposed with those for botanical studies (reported by Miss Caseldine on pages __ to __) to allow close correlation between the two. The insect monoliths were divided vertically into 5cm layers and results from three of the monoliths at 7, 36.5 and 50m, form the basis of this report. Additional samples from below, between and over the component track timbers were collected during the course of the excavation and these provide direct information about trackway conditions during its construction and use. Insect and other arthropod remains were recovered from the samples by paraffin flotation, and for each taxa, the combined totals from all monolith and trackway samples are listed in TABLE 1. The individual totals for each processed sample are given in full in Fiche (TABLE __).

TABLE 1

INSECTS FROM THE SWEET TRACK TG SITE

Combined minimum totals from the monolith and track level samples, nomenclature according to Kloet and Hincks (rev. Pope) 1977.

COLEOPTERA

CARABIDAE

Carabus sp.	1
Calosoma inquisitor (L.)	3
Notiophilus biguttatus (F.)	1
Trechus quadristriatus (Schrank)	1
Bembidion humerale Sturm	1
B. fumigatum (Dufts.)	11
B. doris (Panz.)	2
B. biguttatum (F.)	1
B. lunulatum (Fourc.)	1
B. unicolor Chaud.	2
Tachys sp.	1
Pterostichus aterrimus (Herbst)	51
P. diligens (Sturm)	13
P. melanarius (Ill.)	1
P. minor (Gyll.)	21
P. niger (Schall.)	2
P. nigrita (Payk.)	1
P. strenuus (Panz.)	2
P. vernalis (Panz.)	13
Agonum thoreyi Dej.	58
Agonum versutum Sturm	1
Agonum sp.	5
Amara sp.	4
Badister dilatatus (Chaud.) or peltatus (Panz.)	6

CARABIDAE (cont.)

Chlaenius sulcicollis (Payk.)	20
C. tristis (Schall.)	2
Oodes gracilis Villa	7
O. helopioides	9
Odacantha melanura (L.)	5
Demetrias imperialis (Germ.)	1

HALIPLIDAE

Haliplus sp.	1

NOTERIDAE

Noterus clavicornis (Deg.)	158
N. crassicornis (Müll.)	17

DYTISCIDAE

Laccophilus variegatus (Germ.)	4
Hydrovatus clypealis Sharp	394
Hyphydrus ovatus (L.)	1
Bidessus unistriatus (Schrank)	111
Hygrotus decoratus (Gyll.)	23
H. inaequalis (F.)	39
Coelambus parallelogrammus (Ahr.)	2
Hydroporus gyllenhali Schiod.	3
H. obscurus Sturm	86
H. palustris (L.)	2
H. scalesianus Steph.	99
Hydroporus spp.	8
Graptodytes granularis (L.)	11
G. pictus (F.)	1
Porhydrus lineatus (F.)	8
Copelatus haemorrhoidalis (F.)	2
Agabus bipustulatus (L.)	1
Agabus sp.	2

DYTISCIDAE (cont.)

Ilybius ater (Deg.)	4
I. quadriguttatus (Lac. & Bois.)	4
Ilybius spp.	4
Colymbetes fuscus (L.)	5
Hydaticus seminiger (Deg.)	1
Graphoderus cinereus (L.)	9
Acilius canaliculatus (Nic.)	2
Dytiscus circumcinctus Ahr.	1
Dytiscus semisulcatus Müll.	7
Dytiscus spp.	9

GYRINIDAE

Gyrinus caspius Men.	4
G. natator L.	1
G. suffriani Scriba	1
Gyrinus spp.	3

HYDROPHILIDAE

Hydrochus elongatus (Schall.)	1
Helophorus brevipalpis Bed.	10
Helophorus sp.	1
Coelostoma orbiculare (F.)	347
Sphaeridium sp.	1
Cercyon marinus Thun.	7
C. sternalis Sharp	22
Megasternum obscurum (Marsh)	41
Cryptopleurum minutum (F.)	1
Hydrobius fuscipes (L.)	4
Helochares spp.	148
Enochrus spp.	1831

HYDROPHILIDAE (cont.)

Cymbiodyta marginella (F.)	12
Chaetarthria seminulum (Herbst)	97
Hydrophilus piceus (L.)	2

HYDRAENIDAE

Ochthebius bicolon Germ.	1
O. minimus (F.)	642
Ochthebius sp.	1
Hydraena palustris Er.	123
H. riparia Kug.	26
H. testacea Curt.	1
Limnebius aluta (Bed.)	201
Limnebius spp.	6

LEIODIDAE

Catops or *Choleva* sp.	1

SILPHIDAE

Silpha atrata L.	3

STAPHYLINIDAE

Acidota cruentata Man.	3
Lesteva heeri Fauv.	2
Eusphalerum sorbi (Gyll.)	4
Carpelimus or *Thinobius* spp.	13
Platystethus arenarius (Fourc.)	1
P. cornutus (Grav.)	4
Anotylus inustus (Grav.)	2
A. mutator (Lohse)	2
A. rugosus (F.)	1
A. sculpturatus (Grav.)	2

STAPHYLINIDAE (cont.)

Oxytelus sculptus Grav.)	1
Stenus kiesenwetteri Rosen.	8
Stenus latifrons Er.	4
S. opticus Grav.	2
S. pallitarsis Steph.	2
Stenus spp.	223
Euaesthetus ruficapillus Bois. & Lac.	6
Paederus spp.	75
Lathrobium rufipenne Gyll.	56
L. terminatum Grav.	39
Ochthephilum fracticorne (Payk.)	2
Lithocharis ochracea (Grav.)	29
Xantholinus linearis (Ol.)	1
Erichsonius cinerascens (Grav.)	81
Philonthus spp.	111
Staphylinus sp.	1
Quedius spp.	10
Gymnusa brevicollis (Payk.)	34
Aleocharinae indet.	149

PSELAPHIDAE

Bryaxis spp.	3
Brachygluta spp.	10
Pselaphus heisei (Herbst)	10

LUCANIDAE

Lucanus cervus (L.)	8
Dorcus parallelopipedus (L.)	4

GEOTRUPIDAE

Geotrupes pyrenaeus (Charp.)	1
G. spiniger (Marsh.)	9
G. vernalis (L.)	1
Geotrupes spp.	10

SCARABAEIDAE

Colobopterus erraticus (L.)	1
Aphodius consputus Creutz	2
A. fimetarius (L.)	1
A. granarius (L.)	1
A. luridus (F.)	2
A. rufipes (L.)	1
Aphodius spp.	16
Onthophagus ovatus (L.)	2
Phyllopertha horticola (L.)	2
Cetonia aurata (L.)	4

SCIRTIDAE

Microcara testacea (L.)	2
Scirtidae indet.	1852

BYRRHIDAE

Simplocaria semistriata (F.)	1
Cytilus sericeus (Forst.)	12
Byrrhus sp.	1

HETEROCERIDAE

Heterocerus fusculus Kies.	1
H. obsoletus Curt.	31
Heterocerus sp.	3

DRYOPIDAE

Dryops spp.	35

ELMIDAE

Oulimnius troglodytes (Gyll.)	3
Riolus cupreus (Müll.)	4

BUPRESTIDAE

Aphanasticus emarginatus (Ol.)	1

ELATERIDAE

Athous vittatus (F.)	3
Agriotes pallidulus (Ill.)	2
Dalopius marginatus (L.)	1

CANTHARIDAE

Silis ruficollis (F.)	1

ANOBIIDAE

Gastrallus immarginatus (Müll.)	1
Hemicoelus fulvicornis (Sturm)	1
Anobium punctatum (Deg.)	1

CUCUJIDAE

Uleiota planata (L.)	3
Prostomis mandibularis F.	7
Airaphilus elongatus Gyll.	1
Cryptolestes duplicatus (Waltl)	2

SILVANIDAE

Silvanus bidentatus (F.)	1

CRYPTOPHAGIDAE

Telmatophilus caricis (Ol.)	1
Cryptophagus spp.	2

PHALACRIDAE

Stilbus testaceus (Panz.) 2

CORYLOPHIDAE

Corylophus cassidoides (Marsh.) 11

COCCINELLIDAE

Chilocorus bipustulatus (L.) 1

LATHRIDIIDAE

Lathridius minutus
or pseudominutus (Strand) 4

Enicmus transversus (Ol.) 3

Corticarina spp. 5

Cortinicara gibbosa (Herbst) 1

Melonophthalma transversalis (Gyll.) 2

COLYDIIDAE

Aglenus brunneus (Gyll.) 2

SCRAPTIIDAE

Anaspis sp. 1

MORDELLIDAE

Mordellistena parvula (Gyll.) 1

ANTHICIDAE

Anthicus gracilis Panz. 1

CERAMBYCIDAE

Strangalia attenuata (L.) 1

Pogonocherus hispidulus (Pill.& Mitt.) 1

CHRYSOMELIDAE

Donacia vulgaris Zsch. 10

Donacia spp. 2

Plateumaris discolor (Panz.)
or sericea (L.) 279

CHRYSOMELIDAE (cont.)

Phyllotreta exclamationis (Thunb.)	3
P. ochripes (Curt.)	5
P. undulata Kuts.	2
P. vittata (F.)	6
Longitarsus holsaticus (L.)	38
L. nigerrimus (Gyll.)	77
Longitarsus sp.	3
Altica britteni Sharp	18
Chaetocnema concinna (Marsh.)	2

APIONIDAE

Apion spp.	12

CURCULIONIDAE

Sitona sp.	1
Tanysphyrus lemnae (Payk.)	27
Rhyncolus lignarius (Marsh.)	1
Dryophthorus corticalis (Payk.)	2
Bagous frit (Herbst)	102
Bagous sp.	1
Thryogenes scirrhosus (Gyll.)	3
Ceutorhynchus sp.	1
Litodactylus leucogaster (Marsh.)	1
Curculio glandium Marsh.	3
Rhynchaenus quercus (L.)	14
Rhynchaenus spp.	2

SCOLYTIDAE

Scolytus mali (Bech.)	2
Hylesinus oleiperda (F.)	2
Acrantus vittatus (F.)	6
Xyleborus saxeseni (Ratz.)	4
Ernoporus caucasicus Lind.	1

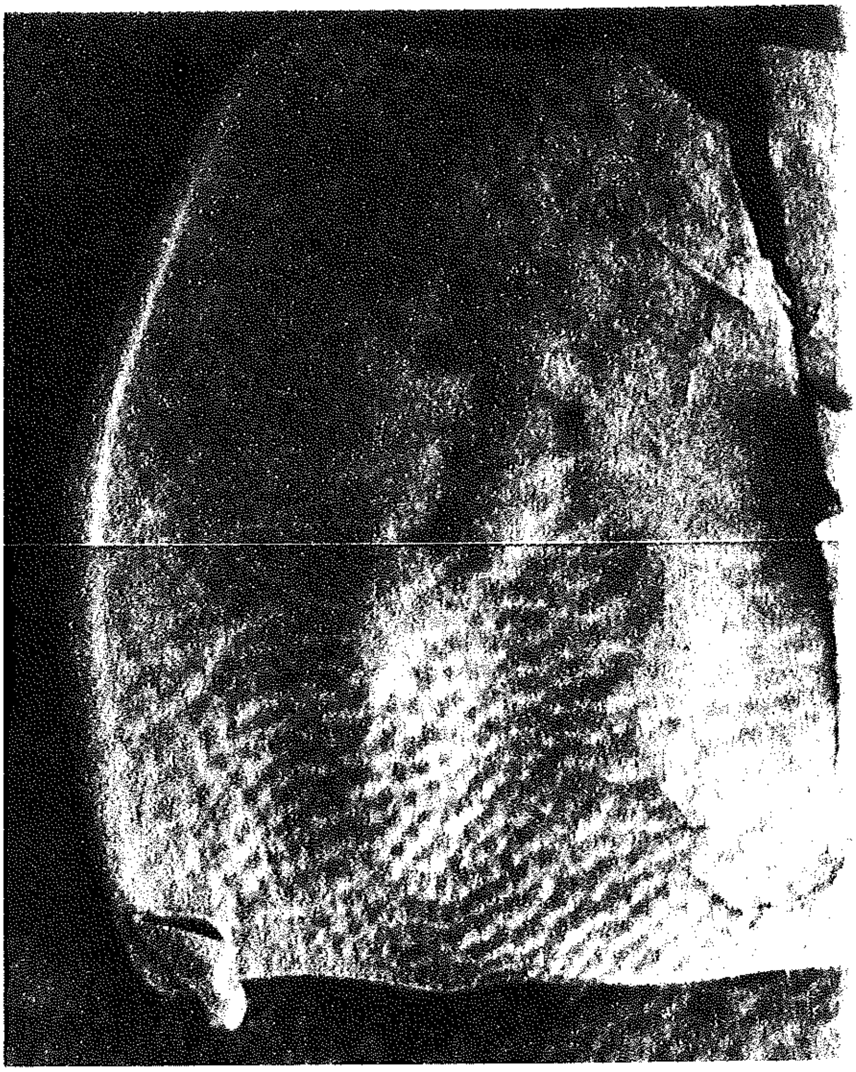
Comments on important species

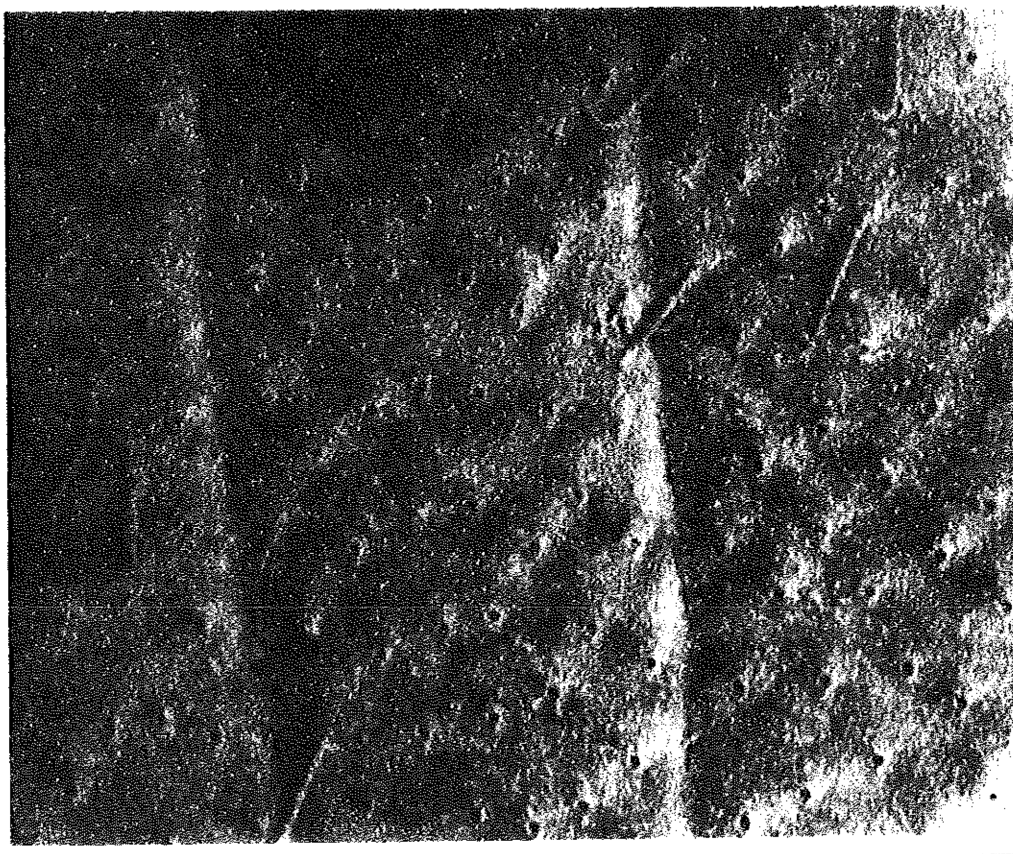
The investigation of the Sweet Track TG insect remains represents the most intensive study undertaken of a Somerset Levels trackway insect fauna and the samples have yielded the richest and most diverse assemblage encountered from any track site. Five beetle species present in the samples are now extinct from Britain and the present status in this country of other species is doubtful. For the first time from the Levels, the fauna includes a probable beetle import. These are discussed below.

Chlaenius sulcicollis: This striking marshland carabid, or ground beetle, is represented by at least 20 individuals from the trackway and monolith peats, with the exception of the uppermost samples of the latter. Part of a pronotum and elytron are shown in figs 1 and 2. The species is known in this country only by fossil records from the Somerset Levels; in addition to the Sweet Track specimens, a single example was recovered from peats overlying the Bronze Age track at Meare Heath (Girling 1982a). At present it occurs sporadically in North and Middle Europe, its range extending from NE Denmark, S Sweden and S Finland where it occurs rarely, France, Germany, N and Central Italy, SE Alps and into W and S Russia and Siberia (Horion 1941). In France, it is always rare, especially in the north and north west of the country, and has been recorded sporadically from Central and SE France, including the Camargue (Jeanell 1942). An important feature of this distribution, shown in fig 12 is the close correlation of its present northern limit with the $17^{0}C$ mean July isotherm, and its rarity in areas with an oceanic climatic regime like that of SW Britain today. The climatic implications of the species, discussed later, are emphasised by its relatively high recorded total at the site which suggests that during the early Neolithic, C.sulcicollis was locally not uncommon. The major factor in the disappearance since the Bronze Age of this markedly

Fig 1 and 2

Chlaenius sulcicollis; 1) left half of pronotum (X40)
2) detail of elytral sculpture (X70)





thermophilous species is almost certainly climate, although its required eutrophic marshland habitat is one at risk from drainage. Two records were made of C.tristis, the rarest of the four British representives of the genus. In the past, the species has been collected from Eastern England, possibly from Wales although these records are in doubt and from Ireland, but no captures have been made in this century and Lindroth (1974) regards the species as now extinct in Britain.

Oodes gracilis: Originally recorded from remains in a peat block washed up on the East Anglian Coast (Blair 1935), this carabid is otherwise known in Britain only from Neolithic peats of the Somerset Levels. It was present at the Abbot's Way site (Girling 1976) and at the Sweet Track Drove Site. Like C.sulcicollis, O.gracilis is a highly thermophilous species (Lindroth 1945). Its present European range is sporadic, and it occurs in S. Spain, W. France, S. Germany, Austria and continues into E. Europe. The exception to this central and southern distribution are records from the Stockholm area of S. Sweden, but this sheltered locality on the S. Baltic coastline enjoys a favourable climate with a mean July temperature of 17^{0}-18^{0}. Within its range the species is restricted to warm, protected places; for instance Lindroth records that in W. France it lives by eutrophic pools which are strongly heated by the summer sun, and similar demands for the warmest locations have been noted elsewhere.

Anthicus gracilis: This beetle has occurred with the preceeding species at the Abbot's Way and Sweet Track Sites, but it is otherwise unknown from Britain. It is widespread in Central Europe from the Channel Coast of France to E Europe, but it is rare in the north, with Scandinavian records confined to a limited coastal area of Denmark and the S. Baltic Sea, all below latitude 60^{0}N. This range suggests that the beetle could survive today in S. Britain, and it is possible that it does occur here but has been overlooked by collectors. The head and pronotum are however sufficiently distinct that if captured, the beetle is unlikely to be wrongly attributed to a known British species. It is equally possible that the species is truly extinct, having disappeared during a period of climatic deterioration since when it has been prevented from re-establishing itself by the barrier of the English Channel. Its habitat is decaying vegetation by water, and it is known to overwinter in stems of Typha (Horion 1956).

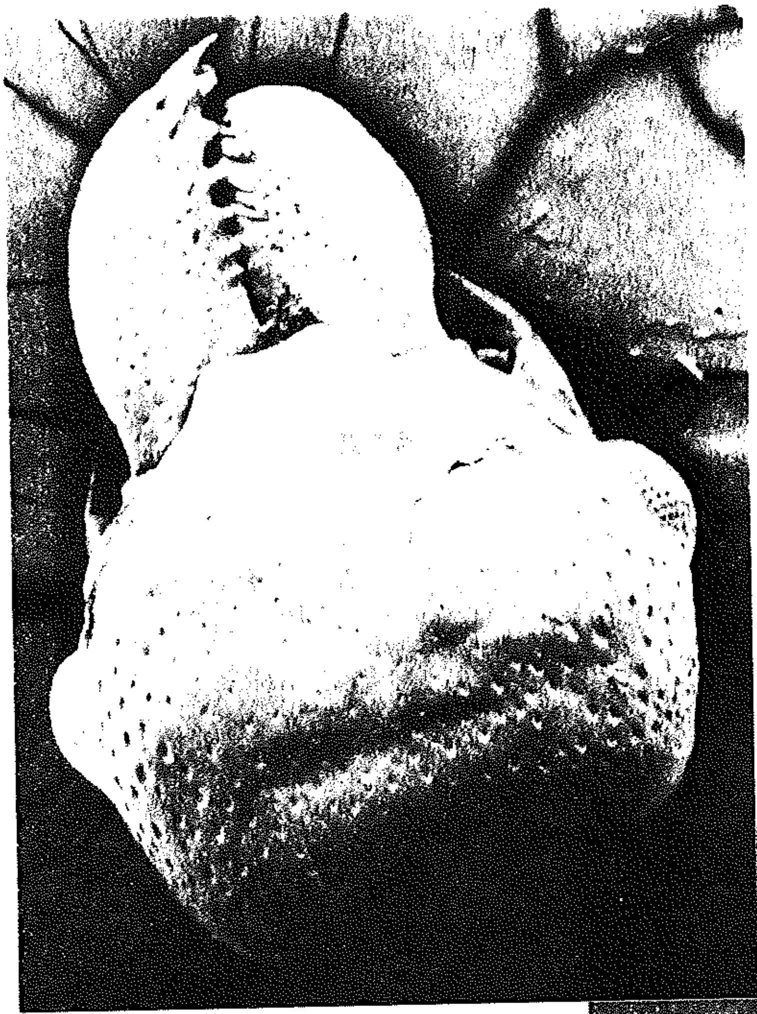
Airaphilus elongatus: This tiny cucujid is not at present known to occur in Britain but it has been recorded from Pleistocene deposits of interglacial and late glacial age, and it was first recovered from an archaeological context by Osborne (1974) in the infill of a 4th century Roman Well at Droitwich. In his discussion of the species, the possibilities were considered that the beetle either lives, but has remained undiscovered in Britain, or that the Roman example represents an importation from the continent in a shipment of hay or straw. Osborne also proposed that the species could have been truly native and has disappeared since the end of the Roman period, one likely cause being the Little Ice Age. The Sweet Track record adds support to native status for the beetle although the possibility remains that it could yet be found in Britain and that its scattered European distribution reflects the rarity of captures rather than its true occurrence. The beetle lives in flooded meadows and in accumulations of grass or hay.

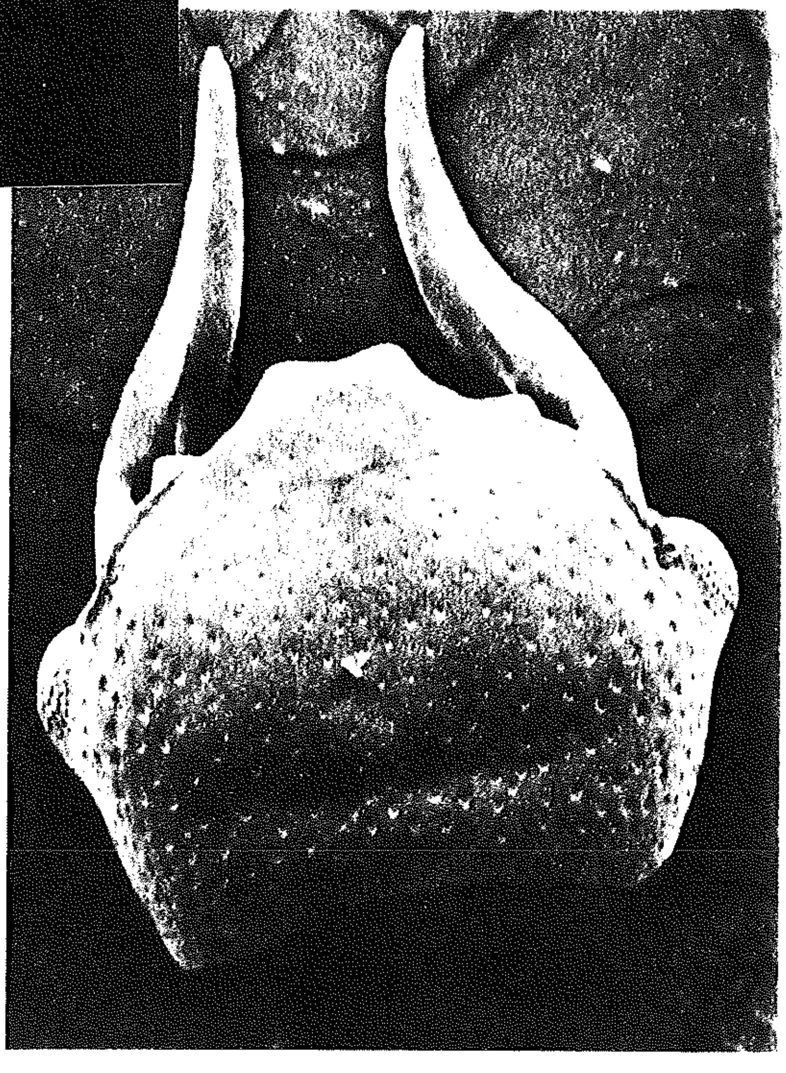
Prostomis mandibularis: In contrast with the other four species which are typical marsh or fen animals, living on vegetated banks or in decaying plant remains adjacent to pools or streams, the final species identified as not on the British list is a member of the old forest fauna. The only other record for P. mandibularis is the late Bronze Age trackway site at

Fig 3 and 4

Prostomis mandibularis; fossil remains from Thorne Moors, Yorkshire.

3) head with mandibles (X70)   4) head without mandibles (X70)



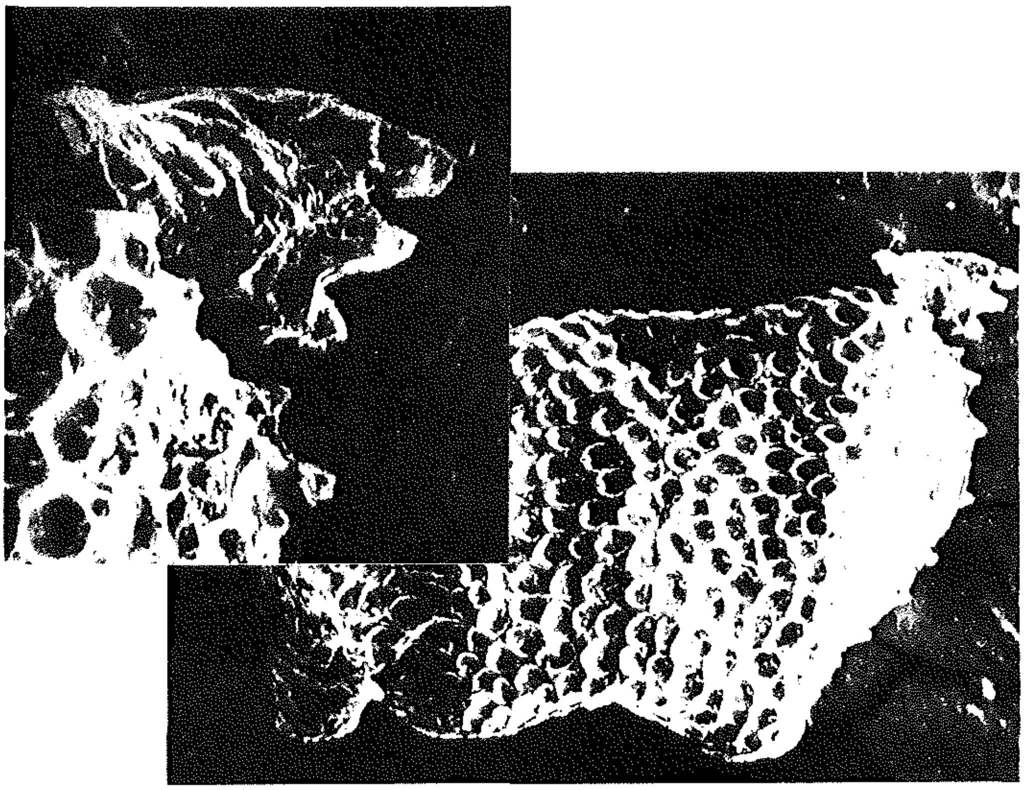


Thorne Moors, Yorkshire (Buckland 1979) where 65 individuals were recorded, 56 of these from the trackway level. The Sweet Track samples yielded elytra of at least 6 individuals, but unfortunately the striking heads, bearing the characteristic mandibles, were not recovered. The heads featured in figs 3 and 4 are Thorne Moors specimens loaned by Dr Buckland for a scanning electron microscope study of the beetle. In mainland Europe, P. mandibularis is exceedingly rare (fig 13) and considerable retraction of its range has been noted since serious collection records began in about the 19th century, with a prediction by Horion (1960) that in Central Europe it would soon disappear altogether. The species lives in damp decaying trees, especially oak and it is perhaps relevant that at both Thorne Moors and the Sweet Track there is evidence for abundant standing water, the Thorne Moors forest having been eventually overwhelmed by the rising water table (Buckland loc. cit).

Ulieota planata: Although a considerable rarity, recent captures from under tree bark indicate that breeding populations exist in the wild (Pers. comm. P. M. Hammond). The Sweet Track records of the species (fig 5) serve to confirm it as a member of the old forest fauna' the species diversity and population level of which have been severely restricted by forest clearance (Girling 1982b). Several published accounts of its distribution, however, appear to link it with the importation of timber (eg Fowler 1889 and Joy 1932 "London, Cumberland, very rare, probably always an importation") and the accidental introduction of specimens is still being noted. Whilst the present colonies might represent relict survival from the pre-clearance populations, its association with imported timber must raise the possibility that existing populations have arisen through such introductions, or that both mechanisms have operated.

Fig 5

Ulieota planata; pronotum (X70) with inset (200) to show crenulation at the side



Strangalia attenuata: As with the preceding species, the early Neolithic record places this wood-borer in the old forest fauna. Rare examples of this may be found in old collections (for example, Donisthorpe (1939) mentions it in that of Desvignes), but some doubt exists about whether the specimens represent British or mainland European captures, and more recent finds of the beetle have not been made. It is listed as extinct in the Revised Checklist of British Beetles (Kloet and Hincks 1977) and Kaufmann (1948) and Duffy (1952) do not include it in their works on British Cerambycidae. It is unlikely that a solution can be found to the problem of whether S. attenuata occurred in Britain during the past few hundred years, or whether it was a much earlier casualty of forest clearance. It must be noted, however, that in some cases where rarities in old collections were regarded as being of possible non-British origin, subsequent captures of the questionable species have tended to confirm their native status. This occurred with one of the spiders described below. Also, occasional additions to the British list are still being made and two such examples are present in the Sweet Track species: Ernoporus caucasicus and Bembidion humerale (Allen 1969, Crossley and Norris 1976)

Aglenus brunneus: The records of two specimens of A. brunneus are significant for two reasons, the beetle is strongly synanthropic and it has commonly been regarded as an imported species. A. brunneus occurs in a range of decaying plant and animal substances including manure heaps, stable sweepings, mouldy straw and haystack refuse, decaying mushrooms, spoiled grain and corn bin residues, rotten wood, leather, skins and bones (Fowler 1889, Hinton 1945, Horion 1961, Woodruffe 1967). Most Colydiidae live under bark, particularly of rotten or fungus-infested wood, and appear to prey on larvae of wood boring insects. Whilst the biology of A. brunneus is not fully known, it clearly favours habitats with moulds or fungi. It is regarded by Horion as strongly synanthropic, as the beetle, which is blind and flightless, is usually recorded in man-made habitats. The species has occurred regularly and often abundantly in Roman and post-Roman deposits and its history and biology have been detailed by Kenward (1975, 1976) who has further demonstrated that the suggestion that the beetle was imported by man from North America (Peyerhimoff 1945) is untenable in view of the archaeological records. Robinson (1979) has recorded the species from an Iron Age pit at an Iron Age and Roman Thames Valley Site. The Sweet Track record extends its presence in Britain to at least the early Neolithic but the question arises as to whether it first reached Britain in the early post glacial period when the ameliorating climate permitted the recolonisation of the formerly glaciated landscape, or whether it was imported from Europe by the trackway builders. Kenward (Loc. cit) has drawn attention to the beetle's sensitivity to temperature factors in the north of its range, and there appears to be a climatic control limiting its occurrence in the open to the warmer parts of its range, whereas further north it is confined to buildings, stables or dung and manure heaps where the decay of vegetation produces a warm microclimate. North Americanrecords of the species in the open are of especial relevence to the site; Casey (1888) and Essig (1926) noted it in turves, the former find from beneath a board. The Sweet Track examples were recovered from the basal monolith sample, up to 5cm below the rail of the track. The cryptic beetles burrow into the plant or animal material on which they live, and it appears likely that they originated from the surface on which the track was being constructed. At this point, it should be stressed that although the burrowing habits of the beetles might lead to their presence in samples which slightly predate their actual occurrence at a site, there is no evidence to suggest that the Sweet Track specimens are "contaminants" from a much later period. The waterlogged nature of the peats prevent deep burrowing by arthropods below the top layers of the previous year's or several years' fallen and decaying vegetation.

Contaminant insects, especially ants, appear to be confined in Somerset Levels sample series to the uppermost layer of dry, weathered peat where this forms the existing ground surface, and such material is never included in site investigations. Similar problems can arise where peat sections have been exposed for some time, hence the importance of cutting back to expose a fresh face from which samples are to be collected. Occasional modern insects inadvertantly trapped while collecting samples are readily identifiable as the soft tissues are present, and the outer waxy layer of the cuticle is intact. (In fossil assemblages, only the exoskeletal structures survive, and prolonged leaching removes the waxes in the epicuticle). The preservation of the Sweet Track Aglenus specimens is identical to that of the rest of the fauna, and in common with other sclerites, their remains are prone to crumpling and cracking if they are dried.

A survey of the present occurrence of the beetle provides no records of fen habitats although it is likely that decaying reed litter would support it. Whether the species would naturally colonise an area prone to flooding is doubtful and as this part of the Sweet Track is roughly equidistant between two islands, it appears probable that the species was carried there. The wingless beetle usually achieves natural dispersal by the phoretic habit of clinging to other mobile species (Woodruffe Loc. cit). Coles and Orme (page __) suggest that during construction, piles of timber were carried out from the islands and left at intervals along the line of the track. Such a practice provides a possible mode of transport for the beetle from the possible settlement sites on the islands, or similarly, other products must have been carried along this route. Beetles from the wood dumps, or from spillages of other goods, might have survived in the decaying reeds, particularly in view of the inference for higher summer temperatures, but the constant flooding must have prevented successful colonisation.

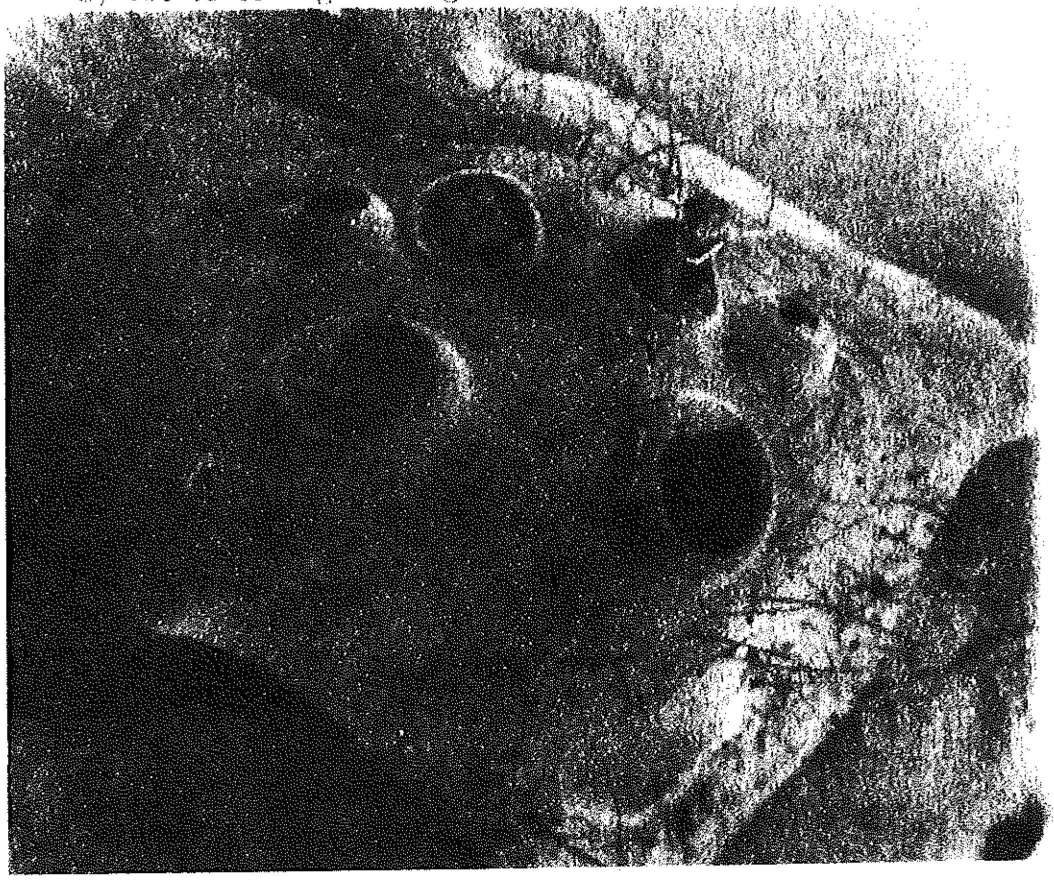
Concerning the origins of A. brunneus in the British fauna, all the ancient occurrences of the species have been closely associated with man; the Iron Age record is from a settlement and the Roman and later finds are largely concentrated in urban sites. In support of this, no records have been made from any of the early - mid post glacial insect studies not associated with archaeological sites (eg Osborne 1972, 1974a) although negative evidence as such must be treated with caution. Now, its earliest known record at the Sweet Track, links it with the first arrival of Neolithic man. The trackway rail level coincides with the elm-decline (see Caseldine, page --) and from the effort expended in the construction of the Sweet Track, there are indications that man was very active in the area. On present evidence it appears likely that A. brunneus was indeed imported by man, a mechanism which would have been easily accomplished in stored food, seeds and probably with transported livestock which he shipped to this country.

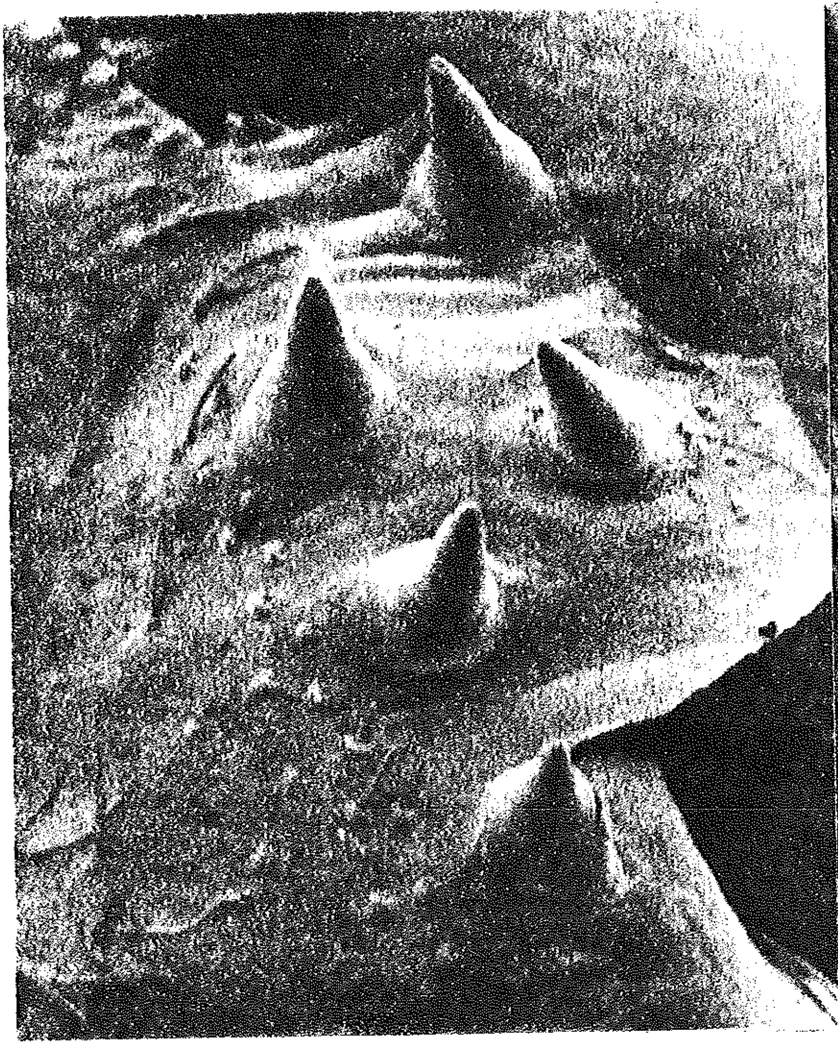
Records of spider remains

In addition to insect remains, almost all of the treated samples also produced arachnids, principally exoskeletal parts of mites and spiders. The most commonly occurring elements of the spider faunas are members of the Salticidae and Linyphiidae (jumping and money spiders). Present in most of the lower monolith samples, however, were remains clearly belonging to very large spiders. Attention was first drawn to these by the recovery of part of a carapace, the covering of the cephalothorax, which measured 8mm. As the general shape suggested that it represented about half of the carapace, it would appear to have belonged to a spider with a body length (cephalothorax and abdomen combined, but excluding legs) of around 25mm! The size and arrangement of the eight eyes (two rows of large behind four small), at first suggestive of a lycosid, or wolf spider, indicated that the specimen belonged to the Pisauridae of which there are two genera in Britain, Pisaura and Dolomedes. Body length evidence suggested the latter genus: males and females of the former measure about 12mm and 12-15mm and of Dolomedes 9-13mm and 13-20 or larger (Locket and Millidge 1951). Comparison with modern reference collection material at the British Museum (Natural History) indicated that the remains were clearly referable to Dolomedes. In addition to a number of carapaces ranging from small juvenile to larger than 20mm specimens (fig 6), other remains include chelicerae (mouthpart appendages for grasping prey) with their double rowof teeth (fig 7), numbers of disjointed legs (fig 8) and, significantly, several examples of male palps. Dolomedes, an aquatic species, has the erroneous name of "the Raft Spider" because it was thought to construct rafts of leaves. It lives by permanent bodies of water which are not in danger of drying up, and hunts acquatic insects and small fish by running across the water surface (Lockett and Millidge 1951), Bristow 1958). Dahl (1927) records the spider's occurrence in swampy birch or alder carr with growths of Iris and rushes. Until 1956, it was thought that in Britain there was a single species, D fimbriatus (Clerck). The rarer relative, D. plantarius (Clerck) had been noted in the collection of J Blackwall, but as he was known to have received many foreign specimens, D. plantarius was not generally accepted as a British species. In 1956, however, captures of this rare spider were made in the Upper Waveney Valley, Norfolk (Duffey 1957). D. plantarius specimens are often bigger than those of fimbratus, and the two light longitudinal bands which characterise the body of the latter are often broken or absent in plantarius. There are differences in the male palp which allow positive separation of the species. A preliminary assessment of the Sweet Track remains indicates that both species appear to be present. Today D. fimbatus is spread over the British Isles but are more records for the south, and D. plantarius is known only from Norfolk and Suffolk.

Figs 6, 7 and 8

Dolomedes (the Raft Spider); 6) posterior of carapace to show eye arrangement (X40) 7) left chelicera with teeth (X70) 8) detail of leg showing dense hairs





Approaching the size of the larger Dolomedes were a number of carapaces which, unlike that spider, were almost hairless and had eyes more equal in size and arranged in two rows. These are referable to Argyroneta aquatica "the Water Spider", the only species which truly lives under water, breathing air from a bubble which it carries or from its underwater silk tent which it stocks with air. It hunts aquatic insects, crustacea and larger specimens will attack tadpoles, and it is found throughout Britain in pools and ditches (Neilson 1932, Bristowe 1958). A full report on the Sweet Track spiders will be produced at a later date.

Notes on the identification of certain species

The recovery of a number of intact abdomens and the subsequent dissection of several male aedeagii permitted the specific identification of groups which are otherwise difficult to name, and also the confirmation of other identifications based on skeletal elements. The commonest abdomens were from Stenus, exoskeletal parts of which proved difficult to name with the exception of kiesenwetteri characterised by the pale spot on each elytron and the coarse puncturation. Three species were identified from aedeagal characters, most were latifrons, two were opticans and there were two examples of pallitarsus. The latter were also checked against specimens of brutrinensis Smet., a closely related species but despite similarity of the two the fossil aedeagii proved to be pallitarsus. The badly preserved aedeagus of a Longitarsus confirmed the presence at the site of the marsh inhabitant, nigerrimus, and also in the leaf beetle family, Altica britteni and not the close ally ericeti, were indicated by several aedeagii. Examples of aedeagii from several species are shown in figure 9a-i. A


a
b
c
d
e
f
g
h
i
j
k

coxal plate of Hydrovatus clypealis and the apex of characteristically fused elytra of Noterus clavicornis are also shown (figs 9j and k). Specimens of Bidessus occurred in most samples, an elytron and coxal plate of which are shown in figs 10 and 11. These have proved identical to British reference material of B. unistriatus, but according to Dr G.Foster (Pers. comm) the British species is not equivalent to European unistriatus and it appears that all captures from this country must be referred to another species (Foster in press).

Environmental implications of the fauna

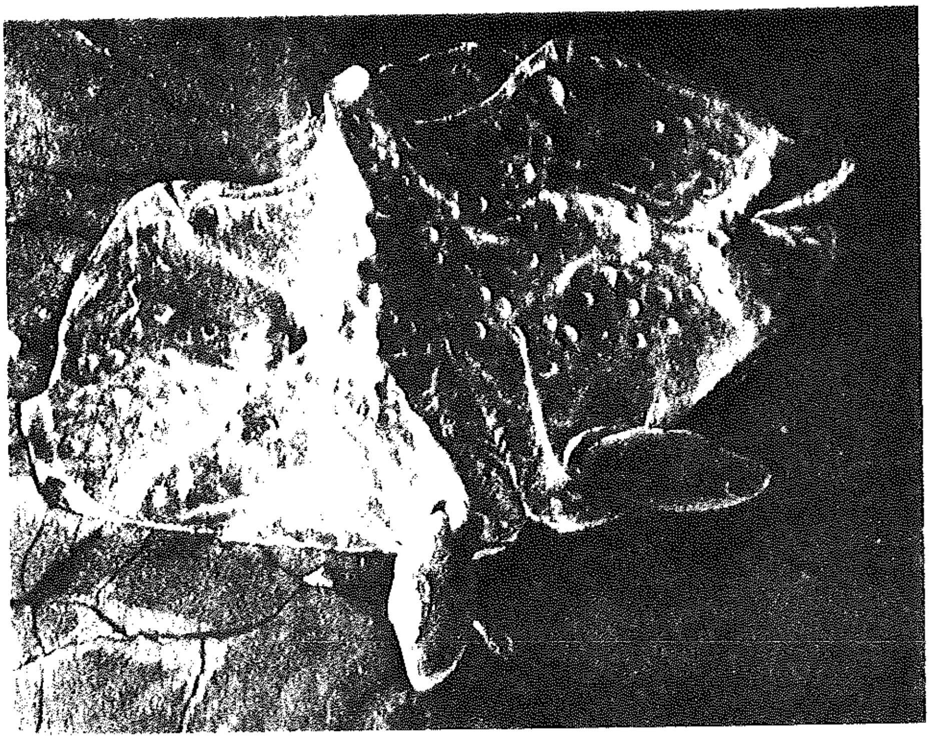
The insect assemblages extracted from the monolith and track samples present evidence for fairly uniform environmental conditions spanning their deposition and it appears valid, therefore, to describe this as a whole then to detail the differences apparent in successive layers. The landscape at this part of the track is of a very swampy eutrophic fen with abundant stretches of open water and locally growing carr woodland. The presence of man is indicated by several synanthropic beetle records and there is some evidence to suggest the keeping of cattle.

i) Ground surface. Most of the Carabidae from the site form an ecological group with strongly overlapping habitat requirements for nutrient rich fen conditions. Oodes gracilis demands gyttja, or highly organic substrates adjacent to eutrophic water and vegetated by dense swathes of Phragmites, Carex and Typha. Similarly, O. helopioides lives on gyttja or moist loam by stagnant water amongst Phragmites, Equisitum, Scirpus and other fen vegetation, the stems of which the beetles use to climb below the water surface, (Lindroth 1945). Another fen carabid, Pterostichus atterimus is today in Britain largely confined to Cambridgeshire and Norfolk, where collecting records note cut sedge as a habitat, but is has also been

Figs 10 and 11

Bidessus unistriatus (of British authors) 10) elytron (X100)

11) coxal plate (X130)



recorded from a marshy district of the New Forest (Appleton 1969). Lindroth details its habitat demands as wet organic and thickly vegetated soils by eutrophic water, and other European records indicate that it is a peat ditch specialist (Horion 1941). Similar habitats are required by both Chlaenius sulcicollis and C. tristis and it is relevant to note Lindroth's records of the association of P. atterimus, O. helopioides and C. tristis, the latter also overwintering with C. sulcicollis. Odacantha melanura lives by Phragmites rich lakes or ponds, or under heaps of Typha detritus. The beetle overwinters in the leaf sheaths of that plant and is said by Lindroth to be constantly associated with Agonum thoreyi, a species common in the Sweet Track samples. All the Bembidion species are strongly hygrophilous. B. fumigatum is a marsh species which also lives on salty soils or near the coast (Jeanell 1941). Sedge refuse is another recorded habitat (Joy 1932). B. lunulatum lives on moist soils, usually on river banks, also a typical habitat for B. biguttatum. B. unicolor occurs in marshes, fens or fairly moist soils in forests and habitats for B. doris include swampy carr woodland or banks of dense vegetation such as Carices. Swampy conditions suit Pterostichus diligens, P. gracilis, P. minor, P. nigrita and P. vernalis which occur in most samples. Two other species, P. cupreus and P. melanarius represented by single records usually prefer drier conditions such as open soils or fields, but both are widespread today.

The inference from the ground beetles for eutrophic fen is confirmed by other faunal elements. Amongst the Staphylinidae are a number of species which require wet vegetated soils or accumulations of plant debris, notably reeds or sedges. Stenus kiesenwetteri is a typical inhabitant of reedy banks or decaying plant material and S. pallitarsus is found on reed stems or in moss (Horion 1963). Another bank or fen species is Erichsonius cinerascens, preferring damp mossy places or decaying vegetation, also suitable for Lithocharis ochracea.

Aquatic environment. The water beetle fauna from the site is rich in both species diversity and individual totals, a reflection of the nutrient rich status of the water. There is abundant evidence for pools with pond plants and fringed with reeds or rushes and for areas of more open water. The fauna includes records of two species of great diving beetles, Dytiscus semisulcatus and the rarer D. circumcinctus and amongst other notable dytiscids are Graphoderes cinerea and Acilius sulcatus. Three species of whirligig beetles occur at the site: Gyrinus caspius, G. suffriani and G. natator. The Hydrophilidae and Hydraenidae are also very well represented; these beetles usually live at the weedy margins of pools. The commoner species, for example Coelostoma orbiculare and Ochthebius minimus occur in their hundreds but there are also occassional records for the now very rare silver diving beetle, Hydrophilus piceus. There is general correspondance between totals for these pond edge dwellers and the numbers of Scirtidae, a separate family of beetle which generally occur at water edges or on flooded groun. Two species of elmids, Riolus cupreus and Oulimnius troglodytes, might suggest that the stretches of water were extensive enough to allow some wavelet activity, or that there were currents, as the species' demand for well oxygenated water is usually met in flowing water. Their restriction at the site to monolith 454 (50 m) possibly indicates a local area of water movement.

Fen vegetation. The botanical evidence, particularly from macroscopic remains, of plant occurrences shows considerable overlap with the host plant requirements of most of the phytophages at the site. The beetles are divided into a group which live predominantly on aquatic or water edge plants and the tree dependent species discussed in the next section. One of the commonest plant feeders, Bagous frit lives on Urtricularia or amongst moss, and it is today found only rarely. Another weevil, Thryogenes scirrhosus includes amongst its hosts Scirpus and Sparganium species, while Litodactylus leucogaster feeds on marsh plants such as Myriophyllum and on moss. There is no record at the TG site for duckweed, the host of Tanysphyrus lemnae but the plant is common elsewhere at the Sweet Track and is likely to be a frequent member of the local vegetation.

Pond plants of the Polygonaceae family and aquatic Cruciferae are possible hosts for Phyllotreta species which occur at the site. A further indication of plant types is provided by the buprestid Aphanasticus immarginatus whose larvae develop on Eleocharis and Juncus species. The host plant data is summarised in Table 2.

Carr woodland As with the previous section, there is general concordance between the botanical evidence for carr woodland and the proportion of beetles typical of such a habitat. A variety of deciduous trees are attacked by the bark beetles Acrantus vittatus, Scolytus mali and Xyleborus saxeseni, but Hylesinus oleiperda more frequently occurs on ash and Ernoporus caucasicus feeds on lime. As both trees were used in the track construction, their beetle pests could have been introduced to the site in unbarked timber. The oak leaf-miner, Rhynchaenus quercus, is the commonest tree feeder, and another weevil found on this tree is Curclio glandium, an acorn borer. Dead wood borers include Rhyncolus lignarius, Dryophthorus corticalis and Gastrallus immarginatus, the latter of which has been recorded from Windsor Forest on cut elm. Striking examples of beetles whose larval development takes place in wood are provided by two representatives of the stag beetle family, Lucanidae. A male head of a

TABLE TWO

Host plants of the phytophagous beetles from the Sweet Track

P. undulata, *P. vittata*	Dry ground Cruciferae
P. exclamationis, *P. ochripes*	Marsh land Cruciferae
D. vulgaris	*Sparganium*, *Scirpus*, *Typha*, *Carex*
L. holsaticus	*Pedicularis palustris*, *Veronica beccabunge*
L. nigerrimus	Marsh plants
A. britteni	*Calluna*
C. concinna	Polygonaceae including *Polygonum*
T. lemna	*Lemna*
B. frit	Moss, *Urtricularia*
T. scirrhosus	*Sparganium*
L. leucogaster	*Myriophyllum*
S. semistriata, *C. sericeus*	Moss

stag beetle, Lucanus cervus was encountered by the excavators whilst exposing the track, and further examples particularly of mandibles and legs have been recorded in monolith samples. There were also rarer examples of Dorcus parallelipipedus, the lesser stag beetle. Their larvae live in dead beech, willow and other deciduous wood. The longhorn beetles Pogonocherus hispidulus and Strangalia attenuata attack a variety of deciduous trees especially in a damp, moribund state. Crytolestes duplicatus lives under bark and two of the elaterid species, Athous vittatus and Dolopius marginatus are typically found in light woodland, (Horion 1953). Calosoma inquisitor hunts oak defoliating caterpillars and the small suite of woodland beetles is completed by the occurrence of the other predators Ulieota planata and Prostomis mandibularis which feed mainly on the larvae of wood boring insects.

The diversity of the habitat requirements of these tree dependent species, including bark, leaves and fruits as well as the wood, indicates natural tree cover in the vicinity. The track timbers could well have provided further habitat opportunities, especially for dead wood specialists as numbers of such beetles are higher in the track levels. Alternatively, this might reflect forest clearance activity on the islands initially increasing the availability of dead wood. Two of the wood borers from the site however, Anobium punctatum and A. fulvicorne, known as woodworm beetles, are so strongly linked today with the use of dry wood or timber that trackway wood probably provides a more suitable pabulum than the damply situated carr fen trees.

Evidence about the early Neolithic climate

The Sweet Track beetle fauna provides the strongest evidence so far recovered from a site of this age for a climate with distinctly warmer

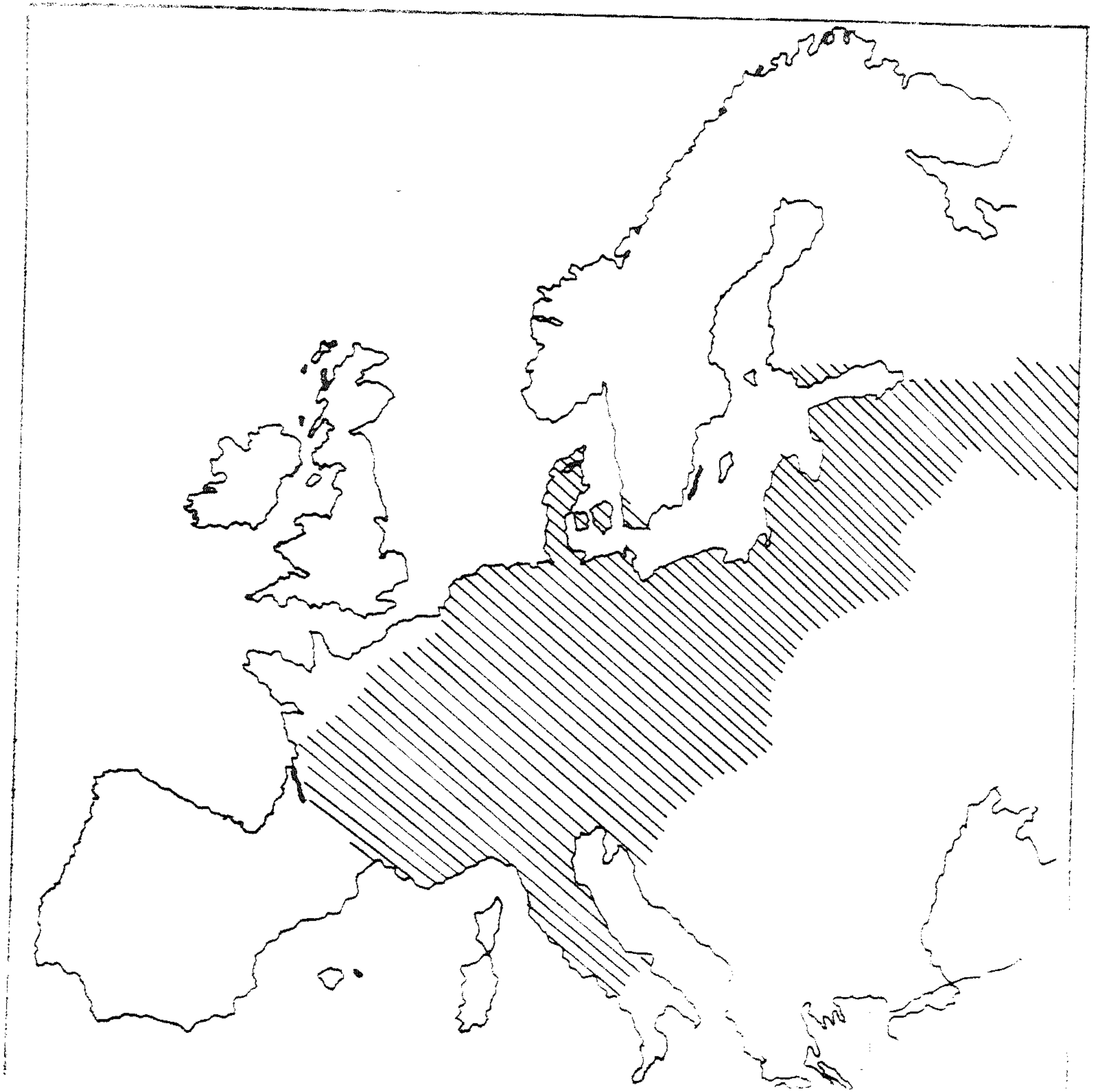


Fig 12

Present day range of *Chlaenius sulcicollis*

The species occurs very sporadically within the area shown.

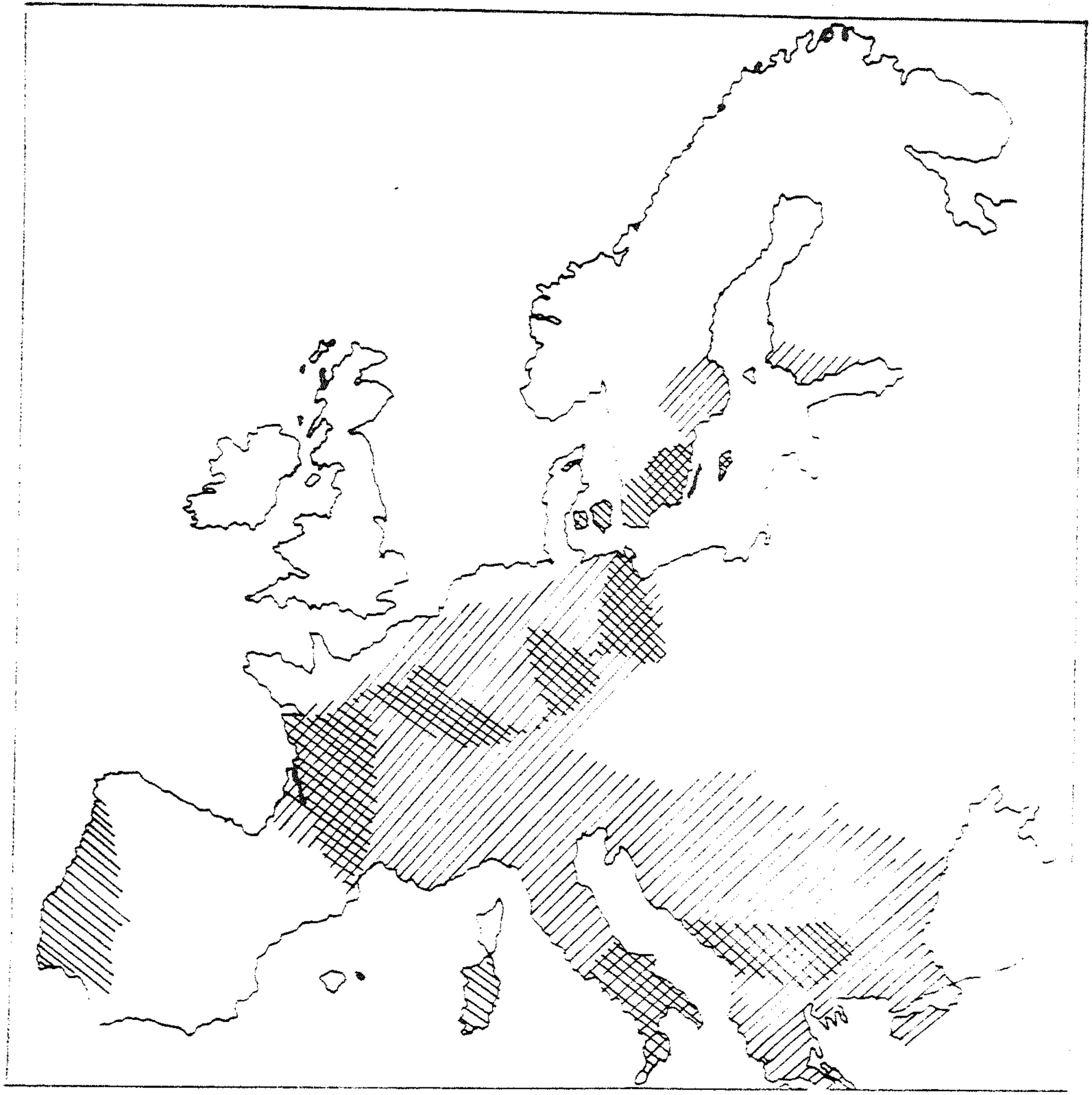


Fig 13

Present day ranges of two Cucujidae species no longer found in Britain.

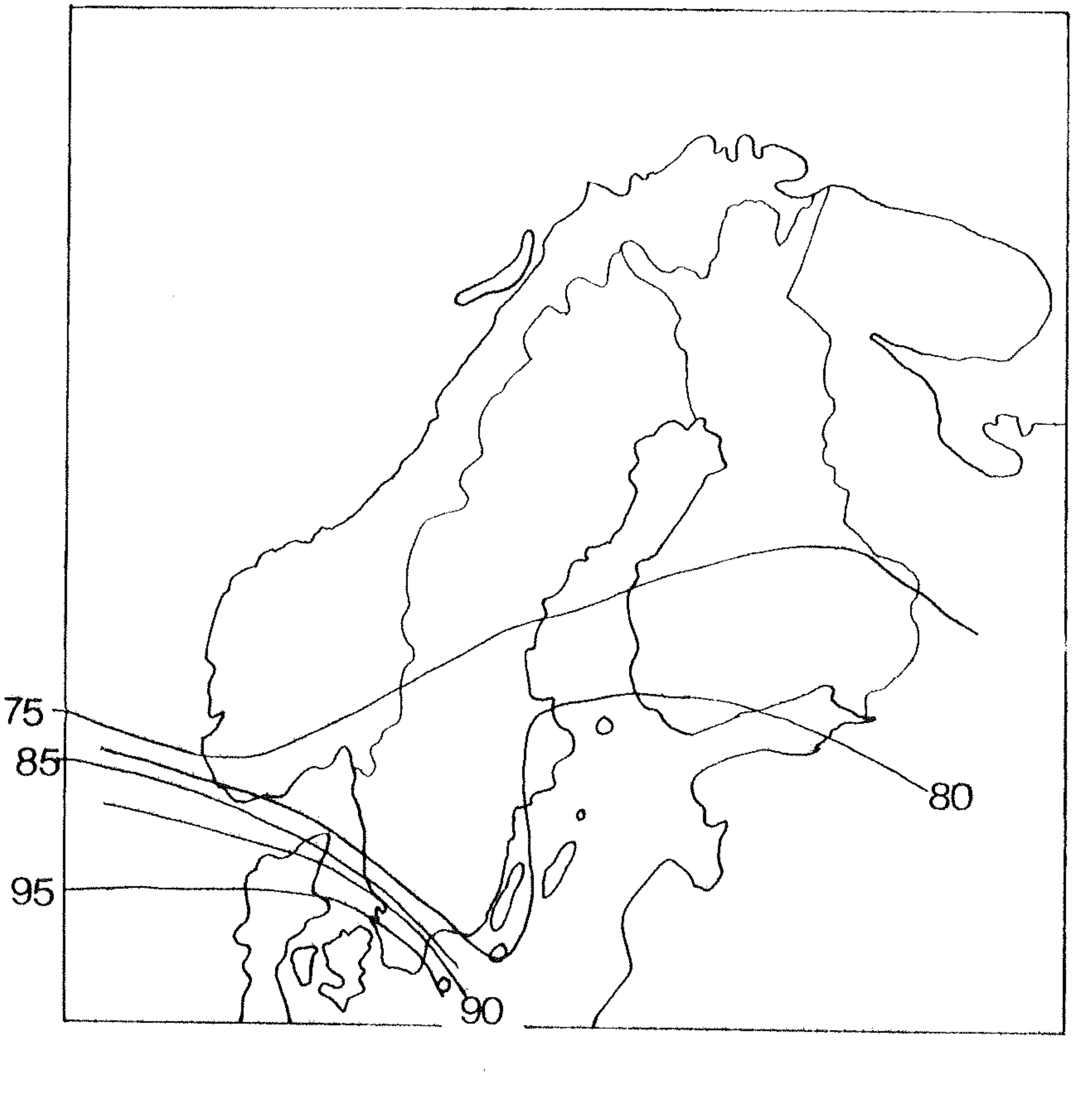
Both occur very rarely within the areas shown.

Prostomis mandibularis

Airaphilus elongatus

summer temperatures combined with more pronounced continentality. That the data come from the south west of the country where the prevailing climate is oceanic, serves to underline the contrast with conditions in the early Neolithic. It is hoped that further study of the fauna will provide more closely defined limits to the amplitude of climatic variation, but some preliminary conclusions are presented here. Two lines of evidence from the site have been used to estimate climatic parameters: the present geographical range of species no longer found in Britain and the composite distribution of northern limits of the most temperature sensitive beetles. Of the five species from the site which appear now to be extinct, Prostomis mandibularis is not considered, as its loss must be attributed to forest clearance, and any possible climatic effect would be difficult to predict. The remaining four consist of two carabid species Oodes gracilis and Chlaenius sulcicollis, whose ranges are likely to be well known as the family has been widely studied in Europe, and which are also regarded as thermophilous, or temperature sensitive (Lindroth 1945 Horion 1941). The distribution of the third species, Anthicus gracilis appears to be well established for Europe, but the scattered records of Airaphilus elongatus are likely to under-represent the true spread of this inconspicuous beetle.

Some coincidence is shown by the northern limits of C.sulcicollis, A. gracilis and A.elongatus in their marked avoidance in Fennoscandia of all but the most southerly regions around the Danish and Baltic coasts. C. sulcicollis in particular is confined south of latitute 60^0 and with occurrences concentrated in extreme south of Sweden and over Denmark. O. gracilis, as discussed earlier, occurs west of Stockholm. The northern limits of the four species all lie well within the 16^{0}C mean July isotherm and argue for considerably higher summer temperatures. In order to refine their possible climatic inferences, the Fennoscandian ranges of all Carabidae from the site have been amalgamated and their percentage occurrences plotted. This technique was used by Osborne (1974) to investigate the climatic implications of all species in an early post glacial fauna and its merits are discussed by that author. At the Sweet Track site, the study is restricted to ground beetles, generally the best studied family whose present ranges are most likely to be controlled by climatic, especially temperature, factors. (Other families are often, although not exclusively, more dependent upon availability of limited habitats, for instance the present range of host plants and trees of phytophages). Data on the occurrence by province of the 27 carabids (one further species was excluded because of a possible confusion in synonomy) were taken from Lindroth, Hanson, Klefbeck, Sjoberg, Stenius and Strand (1960), and the resulting percentages are shown in fig 14. Studies of British distribution records indicate that only about 60% are present in Somerset today. A survey of the Fennoscandian occurrences demonstrates that 95% are present today in E Denmark and Skane, the southernmost area of Sweden and that all are present in Northern Germany. More than half the ground beetles occur no further north than the 15^{0}C July isotherm and there is distinct avoidance of the coast of West Norway where markedly oceanic conditions prevail. It is oversimplistic to assume that the area with greatest faunal correlation gives the best approximate of the climate prevailing when the species occurrred in Britain. Too many unknown factors are likely to effect these results. It can be said, however, that today, over 95% live in areas with temperatures similar to those of E. Denmark (in Copenhagen mean January and July temperatures are 2.5 and 20^{0}C) and N Germany (about 2^0 and 18^{0}C) and this probably provides a closer match to the early Neolithic climate than the corresponding figures of 4–7^0 and 15–16^{0}C. found today in South West England. Providing additional support, those beetles confined south of the 75% line include species regarded as pronounced thermophiles (O. gracilis, P. atterimus) as well as those whose overall restriction in Britain and mainland Europe argues for close


75
85
95
90
80

temperature control over distribution. The faunal avoidance of the oceanic Norwegian coast, with its inherent implication for greater continentality accords well with other evidence; currently, the mean annual temperature variation in Somerset is approximately 12^{0}C whereas values for East Denmark and the North German Plain lie between 16-17.5^{0}C and approach 19-20^{0}C near the East Germany/Poland border. As with the suggestions for summer temperature, any prediction of the degree of increased continentality must remain speculative at this stage, but even a moderate rise in the annual temperature range to 16^{0}C (similar to that in North East France, Belgium and the Netherlands) requires a depression of winter temperature to about 2^{0}C. Such colder conditions would, in fact, favour the presence in Britain of a number of beetles which have become extinct for climatic reasons, including the four Sweet Track examples, by allowing them to overwinter more successfully. In Britain, especially the more oceanic parts, beetles often awake from winter hibernation during a mild spell, and finding little food, perish when colder conditions return. The fact that only about 60% of the Sweet Track carabids occur today in Somerset perhaps reflects the present oceanicity of the area, especially as today several are restricted to Central Southern, South Eastern and East England. From other sites close in age, a small number of identifications of probable beetle extinctions have been made (Osborne 1974, Kelly and Osborne 1965), but mostly of forest animals whose natural habitats have been removed by man. Two exceptions are Agabus wasastjernae Sahl. An acid pool specialist which has a pronounced north east restriction in Europe and Austriacus porthmidius which possibly is also a forest species as many Elateridae larvae develop in wood, but whose life history is unknown. At the present time it has a predominantly E. European range. No straightforward explanation can be made to explain the presence and subsequent disappearance of the apparent northerner although a study of factors controlling its range would be valuable, but both species might be favoured conditions. The very preliminary suggestion of January and July temperatures in the region of 2 and 18^{0}C for Somerset in the early Neolithic accords with the Flandrian expansion of the breeding range of the Pond turtle, Emys orbicularis, one of the strongest lines of evidence for formerly warmer climate.

Insects associated with man and human activity

It appears likely that Aglenus brunneus owes its presence at the site to transportation by man. Sometimes classified as a pest species, it is thought not to damage stored foods and products directly but rather, to take advantage of spoiled goods where infestation by other insects or poor storage has resulted in mouldy residues. One possible interpretation of the species occurrence is that it provides tentative evidence for organised storage and transport of materials, some possibly shipped to the country if the species is genuinely non-native, which accords with the need for the trackways. There are a low number of records of species such as Lathridius which may be regarded as secondary synanthropes, or opportunists in the native fauna which are quick to take advantage of man-made features which resemble their natural habitats and the protection afforded by shelters. The woodworm are similarly advantaged by man. Beetles which suggest animal husbandry are the largest element in the group of insects influenced by human activity in the area. Concentrated at the track level are numbers of dung beetles including Onthophagus ovatus, Colobopterus erraticus, Aphodius luridus, A.consputus and several other species. Accompanying these are numbers of other species predominantly, or frequently, found in dung, amongst them Geotrupes spinniger, G.pyreneus, Sphaeridium sp. and a number of Platystethus and Anotylus species. It is very unlikely that such beetles would occur as commonly in a swampy fen area if they depended upon local indiginous mammals, principally deer, but suggest, instead, the keeping of stock. Grassland with its implication for grazing, is slightly indicated by the root-mining beetles Phyllopertha horticola and Agriotes pallidulus. The dung related fauna, whilst perhaps originating from the drier high ground, appears with sufficient regularity at the track level to suggest a more immediate origin, that cattle were themselves led along the trackway route.

Landscape change indicated by variation in the faunas

The main change displayed by the faunal succession is the decrease in diversity and insect numbers accompanied by the loss of the most nutrient demanding spaces in the topmost column samples. This reflects the change from eutrophic to mesotrophic conditions indicated by the botanical remains. Therefore, although most climatically significant beetles are not present in the latest peats sampled at the site, this is because they demand the highly eutrophic fen conditions which typified the lower part of the depositional sequence. Generally, records of decaying wood feeders coincide with the track layers, whereas lower peats contain first records of the bark beetles and leaf feeders which occur throughout the succession. Dung associated beetles are also concentrated in the track layers, especially B4-B3 of 454 and B5-B4 of 478 which contain the highest totals at the site. Differences between the monoliths are so slight as to be insignificant apart from the restriction at 454 of running water beetles, perhaps indicative of a current or slight wave agitation to produce locally aerated water.

Comparison with the Drove site

At the Drove site, samples were collected from 100cm below the track and slightly above the clay/peat interface of the underlying marine deposits.

Its fauna, therefore, contains elements relating to the reed swamp conditions which mark the start of peat formation. Most of the species present at the Drove site, but not found at TG, are reed swamp inhabitants such as Plateumaris braccata (Scop.), Prasocuris phellandrii (L.) and Psammoecus bipunctatus (F.). The fauna at the track levels which corresponds to that spanned by the TG samples is very similar, with most species occurring at the latter site although as more material was processed, and a larger fauna extracted from TG, the converse is not true. Records unique in the two to the Drove site track samples include the elmid, Esolus parallelepipedus and the pond edge dweller, Anacaena globulus. They are mostly, however, wood or tree feeders, and as natural forests support an enormous range of insect species, the different representatives at each site simply reflect this diversity. Additional forest beetles from the Drove site include Ochina ptinoides (Marsh.) Cerylon ferrugineum Steph., Prionychus melanarius (Germ.) and Oedemera lurida. These records serve to confirm the importance of woodland clearance in the early Neolithic landscape.

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