

BRITISH MICROPALAEONTOLOGICAL SOCIETY

FIELD GUIDE No. 5

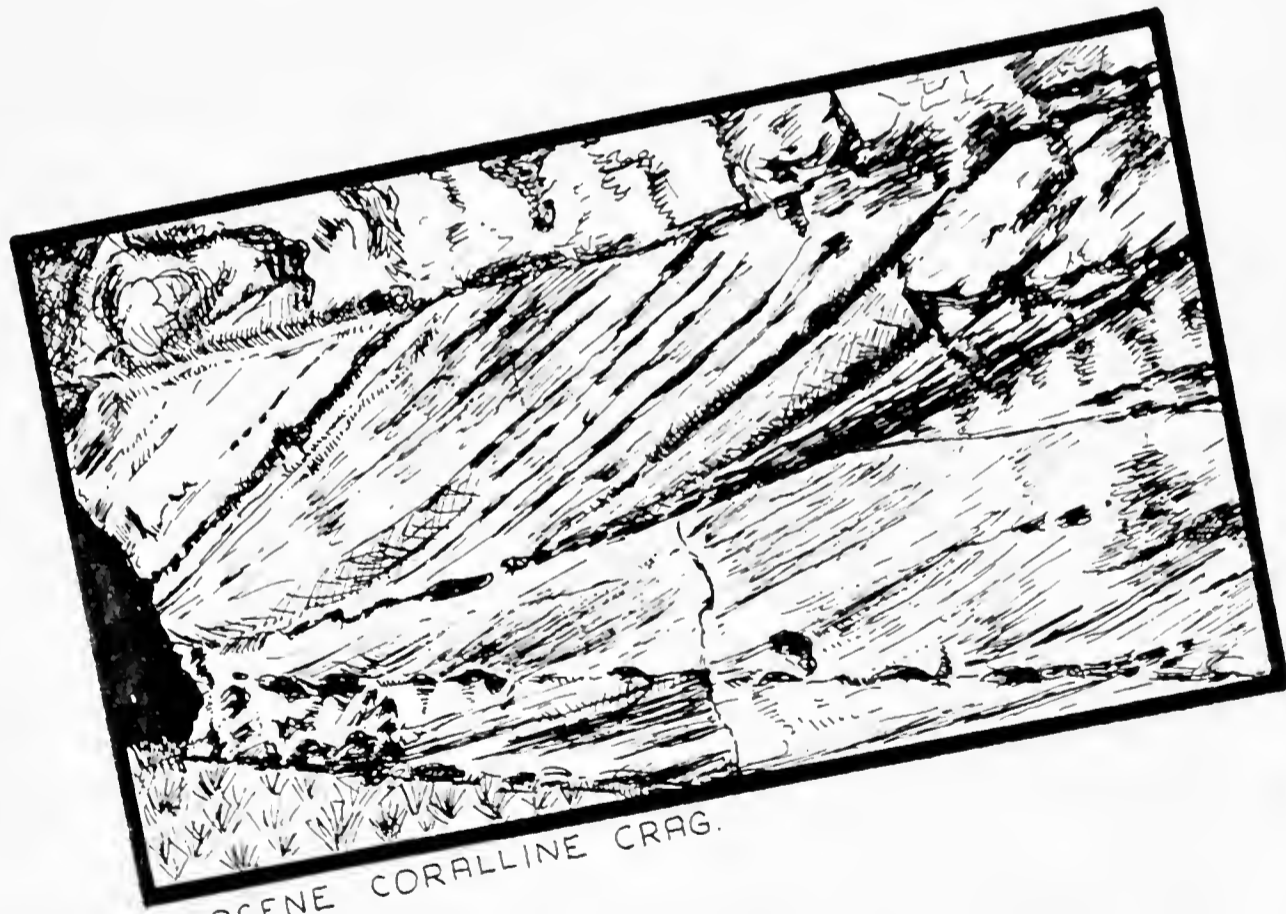
FIFTH INTERNATIONAL SYMPOSIUM ON OSTRACODA

ABERYSTWYTH 1988

BRITISH MUSEUM
(NATURAL HISTORY)
14 JUN 1994
PURCHASED
PALAEOLOGY LIBRARY

AN INTRODUCTORY GUIDE TO THE NEOGENE AND
QUATERNARY OF EAST ANGLIA
FOR OSTRACOD WORKERS

A.R. LORD, D.J. HORNE & J.E. ROBINSON



PLIOCENE CORALLINE CRAG.

SCHOOL OF EARTH SCIENCES



AN INTRODUCTORY GUIDE TO THE NEOGENE AND QUATERNARY OF EAST ANGLIA
FOR OSTRACOD WORKERS

A.R. Lord, D.J. Horne & J.E. Robinson

Introduction

Despite well over 150 years of investigation the Neogene and Quaternary deposits of East Anglia continue to yield exciting new information and to present intriguing problems of correlation and interpretation. The geology of these sediments is complex, but our ability to unravel the story they represent has much improved in recent years as a result of better understanding of modern glacial and glaciomarine sedimentation, better interpretations of age and environment, and more systematic investigation for example by the British Geological Survey.

Palaeontology has played an important part in interpreting the Neogene and Quaternary of East Anglia, especially studies of palynology, foraminifera, molluscs and vertebrates, but up until now ostracods have not been an important aid. The literature consists of:

Jones (1857, 1870, and Jones and Sherborn 1889) - monograph of English Tertiary Ostracoda.

Brady (1865) - four new species from the Nar Valley Clay.

Brady, Crosskey & Robertson (1874) - some East Anglian records in, essentially, a Quaternary taxonomic study.

Wouters (1973, 1978) - included East Anglian material in his work on Belgium.

Lord and Robinson (1978) - short account of Nar Valley Clay (Hoxnian) ostracods.

Robinson (1978) - illustrated marine and non-marine forms from East Anglia.

Wilkinson (1980) - Coralline Crag (Pliocene) ostracods.

Athersuch, Horne and Whittaker (1985) - taxonomic revision of Brady (1865).

De Deckker (1979) - taxonomic and environmental analysis of the West Runton Freshwater Bed.

Current investigations include a survey of the pre-glacial, Crag ostracods by Horne and a borehole through the marine Nar Valley Clay deposits by Lord & Robinson.

Geological Background and Sources

The Neogene and Quaternary sequence of East Anglia rests unconformably upon a basement formed of units with a regional dip eastwards into the southern North Sea Basin. The basement youngs eastwards, consisting of Upper Jurassic and Lower Cretaceous sediments in West Norfolk, Upper Cretaceous chalk over the rest of the area, and which is in turn overlain in eastern areas by Palaeogene units, especially Eocene London Clay.

The Miocene is absent, except possibly as phosphatic nodules beneath the Pliocene Coralline Crag. The Pliocene and Pleistocene consist of three contrasting sequences:

(a) Pre-glacial marine sands with subordinate clays, together with pebble and gravel units. These are marine units, commonly full of molluscs

BRV 258873
AN 416491

and molluscan debris (the term 'Crag' applies to shelly sands) which are really deltaic sequences. The East Anglian sequence is now known to have a number of hiatus and a much more complete sedimentary sequence is present in The Netherlands and below the southern North Sea. The local lithostratigraphic sequence consists of the Coralline Crag, Red Crag and Norwich Crag Formations. Opinion about the position of the Pliocene-Pleistocene boundary in this shallow-water (littoral to inner neritic) sequence has varied widely. Planktonic foraminifera are rare, palaeomagnetic data are sparse, and much reworking and redeposition has clearly taken place. Until recently the boundary was drawn at the unconformity between Red and Coralline Crags, but *Neogloboquadrina atlantica* indicates a Pliocene age for the Red Crag (Funnell 1987, 1988 in Gibbard and Zalasiewicz), and the boundary may in fact be higher in the (Norwich Crag) sequence. A number of cool and temperature climatic stages are recognised, based upon pollen and benthic foraminifera.

- (b) Cromer Forest Bed Formation, of marine, brackish and freshwater sediments found in northern and northeastern Norfolk. These complex sediments have attracted considerable attention and a detailed description can be found in West (1980). The sediments and contained organisms reflect climatic and sea-level fluctuations prior to the onset of glaciation.
- (c) Glacial sequence, of tills, sands, etc. left by ice and outwash waters. The precise nature and sequence of events continues to be hotly debated. The stages listed below follow Bowen et al (1986):

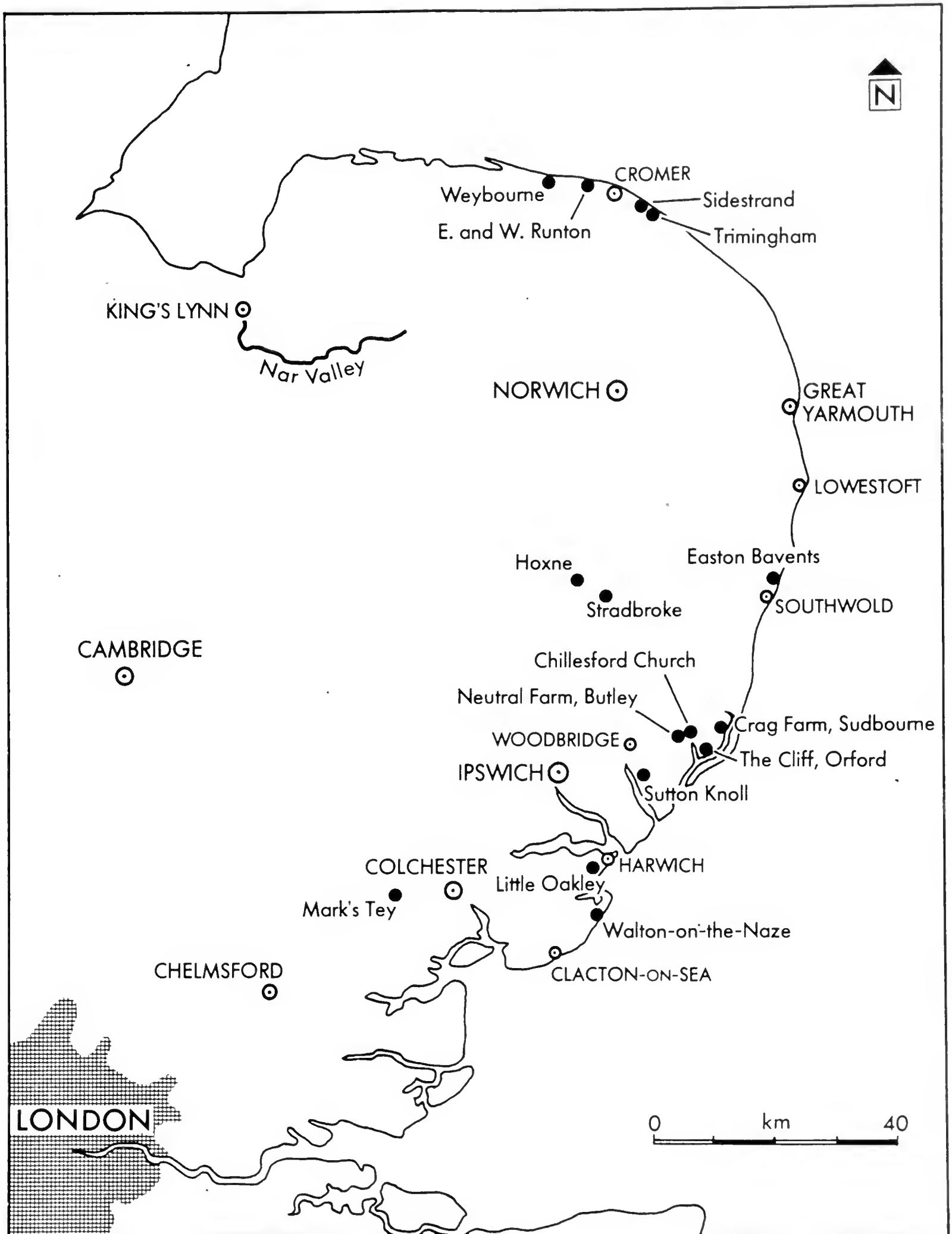
Flandrian	
Devensian	(gl)
Ipswichian	
- hiatus -	
"Wolstonian"	(gl)
Hoxnian	
Anglian	(gl)
Cromerian, etc (see Table 1)	

(gl) = glacial

High stands of sea-level during the Hoxnian, Ipswichian and Flandrian resulted in marine/brackish sedimentation in the Fenland and estuaries of some modern rivers. The Nar Valley Clay of West Norfolk reflects high Hoxnian (= Holsteinian of north Germany) sea-level.

Three Quaternary Research Association guidebooks provide valuable introductions to the complexity and variety of the Neogene and Quaternary of East Anglia.

Gibbard, P.L. and Zalasiewicz, J.A. (Eds) 1988. 'Pliocene - Middle Pleistocene of East Anglia'. Field Guide. Quaternary Research Association. 195 pages.



	Stages	Age (Ma)	Lithostratigraphic Units	Netherlands Stages provisional correlation	Netherlands Stages not recognised in East Anglia	
PLEISTOCENE	CROMERIAN	0.2	Bacton Member Mundesley Member West Runton Member	CROMERIAN IV		
		0.5			? Cromerian I - III	
		0.8	Forest-Bed Formation	? Menapien Waalien	Bavelian Menapien (part)	
	0.5 - 1.6	BEESTONIAN	0.8	Runton Member		
		PASTONIAN	1.3	Paston Member		
		PRE-PASTONIAN B-D	1.3	Sheringham Member		
		PRE-PASTONIAN A	1.6	Sidestrand Member	? Eburonian	
	PLIOCENE	BRAMERTONIAN	1.6	Westleton Beds Mbr.	? Early Eburonian	Eburonian (part)
		BAVENTIAN		Easton Baven's Clay Mbr.		
				Chillesford Clay Mbr.		
ANTIAN		2.0	Chillesford Sand Mbr.		Tiglian B	
THURNIAN LUDHAMIAN PRE-LUDHAMIAN / WALTONIAN		2.4	Thorpeness Member			
	2.4	Sizewell Member	NORWICH CRAG FORMATION	Tiglian C		
	3.2		RED CRAG FORMATION	Praetiglian Reuverian C	Tiglian A	
			CORALLINE CRAG FORMATION	Reuverian Brunsumian	Reuverian (part)	
Basement of Eocene London Clay, Upper Cretaceous Chalk, etc.						

After Funnell (1987) and Gibbard & Zalasiewicz (1988, fig. 3)

Allen, P. 1984.

'Field Guide to the Gipping and Waveney Valleys, Suffolk'. Field Guide. Quaternary Research Association. 116 pages. (revised edition).

West, R.G. and Whiteman, C.A. (Eds) 1986. 'The Nar Valley and North Norfolk'. Field Guide. Quaternary Research Association. 102 pages.

Members of the excursion are provided with a copy of Gibbard and Zalasiewicz (1988), to which frequent reference is made in the ensuing pages. Conventional geological maps are of limited value in glaciated Quaternary terrains. Many important modern data have in any case been obtained from subsurface investigations.

Thursday 21 July

Marks Tey (TL911243)

Hoxnian, interglacial lacustrine clays.

An important site for the Hoxnian interglacial sequence in lacustrine facies. The pit is worked by W.H. Collier Ltd., a family concern making handmade bricks.

To many Pleistocene geologists, Marks Tey would form a preferable type site for the Hoxnian Interglacial than Hoxne itself. Both are lake basins located in hollows of the top surface of a boulder clay, but at Hoxne, there is dispute over the upward passage into a definite deposit which everyone accepts as a boulder clay or something equivalent representing a glacial climate of pre-Eemian age. Hoxne moreover has lost the clear stratigraphy it once showed when it was a working brick-pit. Marks Tey has the advantage of fresh pit faces exposed over a considerable area. In very recent time, this site too has been said to have uncertain limits, with a possibility that the highest lake clays may actually be of Eemian (Ipswichian in English terminology) age, resting upon undoubted Holsteinian (Hoxnian) main thicknesses.

The important literature for the Marks Tey site is a paper by Charles Turner, published in 1970 which documents from boreholes and surface outcrops the lacustrine clays which provide a full pollen range from late glacial flora of late Lowestoft Till, through Ho I, II, III and IV and climatic deterioration prior to a succeeding glacial. The sediments of the lake basin are markedly laminated, grey clay bands being broken by thin white layers which on analysis, prove to be crowded with diatoms (Stephanodiscus astraea). Marginally, these clays passed into near-bank muds which contained ostracods, but these faunas have never been documented (Turner pers.com.) and the sections are now obliterated.

What can be collected are clays which formed the fill of the lake to a maximum thickness of over 25 m in the deepest part of the basin. These yield a typical Pleistocene lacustrine assemblage, dominated by Limnocythere inopinata (Baird 1843), Limnocythere falcata Diebel 1968, Cytherissa lacustris (Sars 1863), rare Ilyocypris quinculminata Sylvester-Bradley 1973, and rare Notodromas monacha (O.F. Muller 1776). In the middle of the sections some horizons show a dramatic contrast in yielding a fauna of Cyprideis torosa (Jones 1850). This species is present as adults together with juvenile moults (to A-IV), and must signify the flooding of the lake basin with saline waters from the nearby Thames drainage (via the Colne valley). There are no distinguishing features for these marine-brackish intercalations to the

naked eye (JER).

Walton-on-the-Naze (TM 267236)

Pliocene Red Crag Formation; littoral marine.

The cliffs of the promontory of The Naze expose Red Crag, as strongly cross-bedded shell sands, resting on Eocene London Clay. The cliff is commonly slumped and the contact not visible. The upper part of the cliff exposes a series of sands, gravels and clays resting on the Red Crag and showing periglacial features (cryoturbation, etc); these sediments are younger than the Red Crag but their age is uncertain (Hails and White 1970).

The abundant molluscs of the Craggs were intensively studied during the nineteenth century (see for example Harmer 1902), but many other organic groups are represented included terrestrial vertebrates.

Ostracods:

Specimens obtained from washings of the sediment infilling mollusc shells (mostly Neptunia). The fauna definitely shows closer affinities with the Coralline Crag than with the Butleyan Red Crag (DJH).

Aurila strongyla Wouters 1973

Aurila trigonula (Jones 1857)

?Bonnyannella exigua Wouters 1978

Callistocythere sp.

?Cytheretta harmeri Wilkinson 1980

Cytheropteron sp

?Haplocytheridea pinguis (Jones 1857)

Hermanites haidingeri haidingeri (Reuss 1850) (sensu Wilkinson 1980)

Leptocythere (2 species)

Microcytherura sp.

Muellerina lacunosa (Jones 1857)

Paradoxostoma normani Brady 1868

Pontocythere lithodomoides (Bosquet 1852)

Thaerocythere sp.(= Quadracythere macropora (Bosquet) sensu Wilkinson 1980)

To Woodbridge via Little Oakley (TM217290) - site famous for Red Crag molluscs (described by F.W. Harmer) and for an interglacial site of Cromerian age (Bridgland, Gibbard and Preece, in press).

Little Oakley is site which has just been extensively studied by a large team of Pleistocene specialists covering sedimentology, mammals, pollen, beetles, molluscs, and ostracods, their results to be published by the Royal Society in the near future. The site(s) were discovered when pipelines were being laid along the road passing through the village, the trenches showing a shallow channel filled with sand and gravel, cut into the London Clay top surface. The sands and gravels are shelly, and poorly sorted as sediments. Washings provided an ostracod fauna dominated by Ilyocypris, but in what seemed to be marginal bank deposits there were specimens of Candona, Darwinula, and Paralimnocythere. Several species of Ilyocypris were recorded from different points in the channel, Ilyocypris lacustris Kaufmann 1900, I. quinculminata Sylvester-Bradley 1973, I. schwarzbachi Kempf 1967, but one has been described as new: I. papillata by Robinson (in press).

The site is in line with projections of the Middle Pleistocene Thames flowing towards a North Sea confluence with the Rhine, but fails to satisfy identification as 'main Thames' in the shallow form of the channel, the poorly sorted sand-fill (low energy), and the absence of tidal influx and brackish water elements which would be expected in a

Thames estuary setting. Tributary status only, rather than main channel must be the conclusion. Sadly, nothing is likely to be visible at surface when we pass through (JER).

Friday 22 July.

Woodbridge via Sutton Hoo (Saxon ship burial site) to Sutton.

Sutton Knoll, Pettistree Hall Farm (TM304440)

Pliocene Coralline Crag Formation; shallow-water marine sands.

A famous site studied by geologists for over 150 years and recently described in detail in Gibbard and Zalasiewicz (1988, pp.66-72); inappropriately cited as Rockhall Wood in that publication. The small hill is an island of Coralline Crag (approximately 12m thick) with younger Red Crag banked around its periphery against 'cliffs'. Extremely rich molluscan assemblages known, together with benthic and rarer planktonic foraminifera (Carter 1951, 1957), Jenkins and Houghton 1987, Jenkins et al. 1988).

Ostracods, described by Wilkinson (1980):

Aurila convexa (Baird 1850), A. trigonula (Jones 1857), Cushmanidea lithodomoides (Bosquet 1852), Haplocytheridea pinguis (Jones 1857), Hermanites haidingeri (Reuss 1850), Loxoconcha rhomboidea (Fischer 1855), Murrayina lacunosa (Jones 1857), Quadracythere macropora (Bosquet 1852) and nineteen other species. Of these species A. convexa, M. lacunosa and Q. macropora were the most common and occurred in all Coralline Crag samples studied from the area; they are interpreted as the original biocoenosis of the deposit (Wilkinson 1980, p.293), but this may also apply to others of the species listed. Sutton Knoll is type-site for Schizocythere pliocenica Wilkinson.

Neutral Farm, Butley (TM372511)

Pliocene Red Crag Formation; littoral marine

Classic outcrop of 'Butleyan' Red Crag in cross-bedded molluscan sands. Foraminifera cited in Funnell (1961).

Ostracods:

Dominant species:

Baffinicythere howei Hazel 1967 - adults and juveniles, mostly valves; a characteristic sublittoral marine Arctic species extending south to about 59° N in the eastern N Atlantic and about 41° N in the western N Atlantic, with an approximate depth range of 20-200m.

Cytheropteron nodosum Brady 1868 - mostly adult carapaces; a shallow sublittoral marine species well-known from the Recent of NW Europe, occurring from the Bay of Biscay to 70° N.

Finmarchinella logani (Brady & Crosskey 1871) - adults and juveniles, mostly valves; an Arctic marine shallow sublittoral species, occurring as far south as 60° N on the Greenland coast.

Kuiperiana venepidermoidea (Swain 1963) - adult and juvenile valves and carapaces; an Arctic marine species originally described from the Pleistocene Gubik Formation of Alaska, it also occurs in the Recent of the Alaskan Shelf, although no specimens with appendages have yet been found.

Leptocythere psammophila Guillaume 1976 - mostly adult carapaces; a littoral/shallow sublittoral species living around the British

Isles and coasts of NW Europe, in marine or slightly reduced salinities, usually on sandy substrates.

Other species:

Aurila strongyla Wouters 1973

Aurila cf. A. cimbaeformis (Seguenza 1882)

Callistocythere sp.

Cytheropteron sp.

Hemicytherura clathrata (Sars 1866)

Heterocyprideis sorbyana (Jones 1857)

Leptocythere sp.A

Leptocythere sp.B

Microcytherura sp.

Muellerina lacunosa (Jones 1857)

Paijenborchella tsurugasakensis Tabuki 1986*

Palmenella limicola (Norman 1865)

Palmoconcha sp.

Pontocythere sp.

Pterygocythereis sp.

Robertsonites tuberculatus (Sars 1866)

Semicytherura affinis (Sars 1866)

Semicytherura cf. S. cornuta (Brady 1868)

Semicytherura undata (Sars 1866)

Semicytherura sp.

Thaerocythere cf. T. crenulata (Sars 1866)

Thaerocythere hoptonensis (Brady, Crosskey & Robertson 1874)

Thaerocythere sp.

*described from the Plio-Pleistocene of the Tsugaru Basin, North Honshu, Japan. (DJH).

Chillesford Church Pit (TM38285230)

Pliocene Red Crag and (?) Pleistocene Norwich Crag Formations; littoral marine to brackish estuarine.

Classic site described in detail in Gibbard and Zalasiewicz (1988 pp.79-86). Red Crag can be seen at the base of the north pit, overlain by Norwich Crag in one of the few places where a junction can be recognised. However, the Chillesford Sand and Chillesford Clay Members are not typical of the Norwich Crag Formation, and until recently the position of these units was ambiguous - correlation is still difficult. Restricted assemblages of benthic foraminifera have been recorded by Funnell (1961, p.356) and Gregory (in Gibbard & Zalasiewicz 1988, p.81).

The following ostracods have been identified from the Funnell Collection:

Chillesford Church (25) Muellerina sp., Finmarchinella
angulata (Sars 1866).

Chillesford Church (15) Leptocythere sp.

Chillesford Stackyard (22) F. angulata

Chillesford Stackyard (22) Aurila cf. A. strongyla Wouters 1973,
Baffinicythere howei Hazel 1967 juv.,
Cytheropteron sp., Heterocyprideis sp.,
Leptocythere sp., Hemicytherura
clathrata (Sars 1866), Thaerocythere sp.

The Cliff, Orford (TM398486)

Pliocene, Coralline Crag Formation; shallow-water marine sands.

Exposure of the lower part of the Coralline Crag, a soft shelly sand. Wilkinson (1980) calls this site The Rods, and described the following ostracods:

Aurila convexa (Baird 1850), A. trigonula (Jones 1857), Cushmanidea lithodomoides (Bosquet 1852), Loxoconcha rhomboidea (Fischer 1855), Murrayina lacunosa (Jones 1857), Quadracythere macropora (Bosquet 1852) and 22 other species.

Crag Farm, Sudbourne (TM431524)

Pliocene, Coralline Crag Formation; shallow-water marine sands.

This site shows the upper part of the formation, a cemented, strongly cross-bedded sand called the 'Bryozoan Rock Bed'. Wilkinson (1980) recorded the following ostracods:

Aurila convexa (Baird 1850), Cushmanidea lithodomoides (Bosquet 1852), Cytheretta harmeri Wilkinson 1980, C. woodiana (Jones 1857), Hermanites haidingeri (Reuss 1850), Murrayina lacunosa (Jones 1857), Quadracythere macropora (Bosquet 1852) and nineteen other species.

Easton Bavents, Southwold (TM518787)

(?)Pleistocene Norwich Crag Formation, Easton Bavents Clay Member; littoral marine.

The clay is the type-site for the Baventian cold stage, as defined by pallen, while the underlying sands are correlated with the Antian temperate stage (West in Funnell and West 1962). A full description of the section is given in Gibbard and Zalasiewicz (1988, pp.107-112). Foraminifera have been described by Funnell (in Funnell and West 1962) and the following ostracods have been identified from the Funnell Collection:

Easton Bavents (1) Baffinicythere howei Hazel 1967,
Cythere lutea Muller 1785,
Pontocythere sp.

To Norwich via Stradbroke, site of a borehole through a thick sequence of 'Crag' deposits in a linear trough in Upper Cretaceous chalk (see Beck, Funnell and Lord 1972), and Hoxne, the type locality for a lake basin sequence from which West (1956) defined the Hoxnian interglacial - but little is exposed for inspection.

Saturday 23 July

A number of classic sites for the Quaternary geology of the Norfolk coast will be visited.

West and East Runton (TG201429 - TG185433)

The section along the coast reveals the Cromer Forest Bed Formation and the complex glacial sequence traditionally called the 'Contorted Drift' (= Cromer Till Formation, Anglian glaciation). The section is described in some detail in Gibbard and Zalasiewicz (1988, pp.142-166).

The Cromer Forest Bed is in fact a complex sequence which contains vertebrates and has been studied in detail palynologically for interpretation of palaeoclimate (e.g. West 1980).

Any discussion of the cliff and foreshore exposures of the Cromer-Sheringham coast would do well to adopt the Continental usage 'Cromerian Complex' for the varied sequence which we meet when we study the sections at West Runton on this excursion. A first reason is the simple truth that in The Netherlands, there are grounds for the recognition of perhaps four climatostratigraphical units which may be named Cromerian I, II, III, and IV; warm periods with characteristic vegetational histories recorded by pollen and macroflora, separated by cold if not glacial intervals. Not all of these units are known to occur in Norfolk and, as yet, no interpretation of what was the Cromerian type locality (West Runton) has been published identifying the European-recognised units. A second reason is very frustrating for ostracod micropalaeontologists. From the earliest accounts (Clement Reid, 1882), there have been recognised estuarine and marine beds identified by very fragile macrofossils (Mya is the commonest to be found) as well as freshwater horizons (uppermost Cromerian-early Anglian). It is the sandy nature of these sediments which effectively allowed the destruction of ostracod fauna, if it was ever present, by groundwater leaching. So, it is virtually impossible from collecting so far, to support or deny the environmental interpretations which have been made of the greater part of the West Runton sections.

The exception to this last situation are the organic-rich layers (especially Cromerian II) which stand out so prominently on the beach. These deposits represent the peaty accumulations in back-water creeks of a broad, sluggishly moving river system, and it is from these horizons that the very rich fauna (mammal and bivalve) and flora (plant macro-remains, have been collected. The ostracod fauna is very fully documented by De Deckker (1979) from late Beestonian through Cromerian (mainly II and IV) in a model account of ostracod palaeoecology. The fauna is dominated by the distinctive Scottia browniana (Jones 1850), which living is found in the reed swamps of the Danube delta (Danielopol & Vespremeanu 1964), an environment which seems fitting for this part of the Cromerian. Scottia can make up some 90% of the total fauna, but the accessory fauna of Paralimnocythere compressa (Brady & Norman 1889), Eucypris dulcifons Diebel & Pietrzeniuk 1969 and some aspects of the Candona fauna give some affinity with the Cromerian fauna of Sussenborn (Diebel & Pietrzeniuk, 1969), the Cromerian site in Saxony. We actively seek for elements of the newly discovered Little Oakley fauna here at Cromer, but the two deposits are of very contrasted facies, the one an organic-rich creek, the other a much more open-water river channel, low in organics (JER).

Trimingham (TG276390)

The Cromer Ridge, an ice margin feature of the Anglian glaciation, meets the coast at Trimingham where a sequence of tills (= diamicton) and outwash sediments can be seen (see Gibbard and Zalasiewicz 1988, pp. 167-171). The locality is also noteworthy for the occurrence of Trimingham chalk, the youngest Cretaceous to be seen exposed in England and of Maastrichtian age.

Sidestrand (TG252410)

A Quaternary sequence can be seen, resting on an Upper Cretaceous chalk

basement, which consists of 'Crag' deposits (with foraminifera and molluscs indicative of cold, shallow-water conditions), sands, gravels and clays (one of which is of freshwater origin). The section is described in West (1980, p.50-55; summarised in Gibbard and Zalasiewicz 1988, pp.172-179).

Weybourne (TG111438)

Weybourne Crag, a shelly sand with a sparse, cold foraminiferal assemblage, rests on Upper Cretaceous chalk.

Sunday 24 July

Norwich to Aberystwyth, via Kings Lynn, Birmingham and Shrewsbury.

Nar Valley, West Norfolk (TF675138)

The Nar Valley contains channel sequences of Quaternary sediments including a marine clay of Hoxnian age, the Nar Valley Clay, which is only rarely exposed. Brady (1865) described four ostracod species from the Nar Valley Clay of this area, which Lord and Robinson (1978) tried to re-identify on the basis of assemblages from several sites in the area. Subsequently the type-material of Brady was rediscovered for 3 of the 4 species (Athersuch, Horne and Whittaker 1985). These authors recognised:

Cythere punctillata Brady = Sarsicytheridea punctillata (Brady)

Cythere carinata Brady = Loxoconcha rhomboidea (Fischer 1855)

Cythere arborescens Brady = Aurila arborescens (Brady)

Cythere aspera Brady = Carinocythereis whitei (Baird 1850)

In addition, Lord and Robinson recognised:

Elofsonella concinna (Jones 1857), Hirschmannia tamarindus (Jones 1857), Leptocythere species, Robertsonites tuberculatus (Sars 1865) and Semicytherura cf. S. sella (Sars 1866).

Acknowledgements: We are indebted to landowners for access to their property and to Professor B.M. Funnell for providing ostracods encountered during his foraminiferal studies. Mrs. P. Cooper (University College London) kindly processed the text and Mr. C. Stuart (UCL) prepared the diagrams.

REFERENCES

- Allen, P. 1984. Field guide to the Gipping and Waveney Valleys, Suffolk. May, 1982. Quaternary Research Association: Cambridge, 116 pp. (Revised edition, October 1984).
- Athersuch, J., Horne, D.J. & Whittaker, J.E. 1985. G.S. Brady's Pleistocene ostracods from the Brickearth of the Nar Valley, Norfolk, U.K. Jl Micropalaeo. 4, 153-158.
- Beck, R.B., Funnell, B.M. & Lord, A.R. 1972. Correlation of Lower Pleistocene Crag at depth in Suffolk. Geol. Mag. 109, 137-139.
- Bowen, D.Q., Rose, J., McCabe, A.M. & Sutherland, D.G. 1986. Correlation of Quaternary Glaciations in England, Ireland, Scotland and Wales.

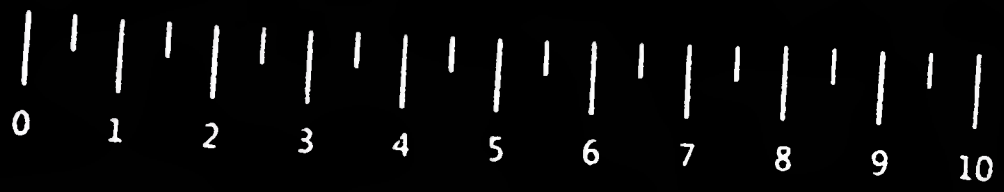
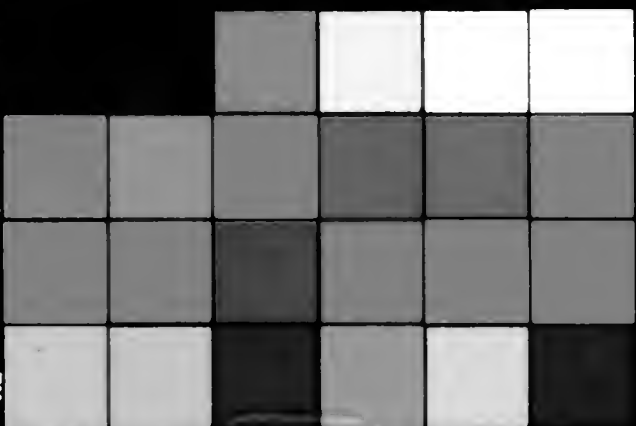
- Brady, G.S. 1865. On undescribed fossil Entomostraca from the Brickearth of the Nar. Ann. Mag. Nat. Hist. London, Series 3, 16, 189-191.
- Brady, G.S., Crosskey, H.W. & Robertson, D. 1874. A monograph of the Post-Tertiary Entomostraca of Scotland (including species from England and Ireland). Palaeontogr. Soc. [Monogr.], 1-274.
- Bridgland, D.L., Gibbard, P.L. & Preece, R.C. In press. The geology and significance of the interglacial sediments at Little Oakley, Essex. Phil. Trans. R. Soc. Lond. B.
- Carter, D.J. 1951. Indigenous and exotic Foraminifera in the Coralline Crag of Suffolk. Geol. Mag. 88, 236-248.
- Carter, D.J. 1957. The distribution of the Foraminifera Alliatina excentrica (Di Napoli Alliata) and the new genus Alliatinella. Palaeontology 1, 76-86.
- Danielopol, D. & Vespremeanu, E. 1964. The presence of ostracods on floating fen soil in Rumania. Fragm. Balcan. 5, 29-36.
- De Deckker, P. 1979. The middle Pleistocene ostracod fauna of the West Runton Freshwater Bed, Norfolk. Palaeontology 22, 293-316.
- Funnell, B.M. 1961. The Palaeogene and Early Pleistocene of Norfolk. Trans. Nflk. Norwich Nat. Soc. 19, 360-364.
- Funnell, B.M. 1987. Late Pliocene and Early Pleistocene stages of East Anglia and the adjacent North Sea. Quat. Newsl. 52, 1-11.
- Funnell, B.M. & West, R.G. 1962. The Early Pleistocene of Easton Bavents, Suffolk, Q. J. geol. Soc. Lond. 118, 125-141.
- Gibbard, P.L. & Zalasiewicz, J.A. (Eds) 1988. Pliocene-Middle Pleistocene of East Anglia. Field Guide. Quaternary Research Association, Cambridge, 195 pp.
- Hails, J.R. & White, P.C.S. 1970. Periglacial Features at Walton-on-Naze, Essex. Proc. Geol. Ass. 81, 205-220.
- Lord, A.R. & Robinson, J.E. 1978. Marine Ostracoda from the Quaternary Nar Valley Clay, West Norfolk. Bull. geol. Soc. Norfolk 30, 113-118.
- Reid, C. 1882. The Geology of Country around Cromer. Memoir Geol Surv. G.B.
- Robinson, E. 1978. The Pleistocene in Bate, R.H. and Robinson E. (Eds) A stratigraphical index of British Ostracoda. Seel House Press, pp. 451-472.
- Turner, C. 1970. The Middle Pliocene deposits at Marks Tey, Essex. Phil. Trans. R. Soc. Lond. B. 257, 373-440.
- West, R.G. 1956. The Quaternary deposits at Hoxne, Suffolk. Phil. Trans. R. Soc. Lond. B. 239, 265-356.
- West, R.G. 1980. The pre-glacial Pleistocene of the Norfolk and Suffolk coasts. Cambridge University Press, 203 pp.

- West, R.G. & Whiteman, C.A. 1986. The Nar Valley and North Norfolk, Field Guide. Quaternary Research Association, Cambridge, 102 pp.
- Wilkinson, I.P. 1980. Coralline Crag Ostracoda and their environmental and stratigraphical significance. Proc. Geol. Ass. 91, 291-306.
- Wouters, K. 1973. Le genre Aurila Pokorny (Crustacea, Ostracoda) dans le Plio-Pleistocene de Belgique. Rev. de Micropal. 16, 194-201.
- Wouters, K. 1978. Een Systematische, Biostratigrafische en Palaeobiologische Studie van de Ostracoda uit Miocene afzettingen in Noord-Belgie. Unpublished thesis, Leuven. 3 volumes.



ISBN 1 870984 20 X

24ColorCard Camera-Cray.com



R

ET ARCHI