IPSWICH GEOLOGICAL GROUP

BULLETIN No. 17

MAY 1976

CONTENTS

"A REVIEW OF THE NEOGENE AND LOWER PLEISTOCENE DEPOSITS IN EAST ANGLIA."

THE CRAGS

Between the Eocene and the lowest part of the Crag series there is a considerable unconformity. The whole of the Miocene and probably the lower part of the Pliocene are missing, although rare traces of their faunas are found as derivatives in later beds. Before describing the East Anglian succession it is as well to discuss the meaning of the word Crag. This was a local name of unknown origin for shelly sands and was applied to various beds of Plio-Pleistocene age in East Anglia. Later writers, such as F. W. Harmer, applied the name to any beds of similar age, and the whole series were referred to as Crag. The usage was even extended to the Bridlington Beds and the series of deposits in N. W. Iceland. Later still D. Wirtz referred to the Sylter Crag of Germany. These extensions of the use are inaccurate and misleading, but the term Crag itself is a convenient loose term for the East Anglian beds and has been used for so long and in such an extensive literature, that it is unlikely to be easily dislodged.

Coralline Crag (Gedgravian.)

The Coralline Crag consists of a series of calcareous sands and soft limestones of Pliocene age and comprise a main mass, with the village of Gedgrave somewhere near its centre, and a number of smaller outliers at Sutton, Ramsholt, Tattingstone Park etc. Two main lithologies occur, the upper Rock Bed, and below this the sands. But it has been shown that the Rock Bed has been formed by the partial decalcification and induration of the sands, with the removal of the aragonitic shells leaving only calcitic fossils such as echinoids, pectens, crustaceans, polyzoans etc. Both the sands and the Rock Beds are leached to a cream, yellow or brownish colour when seen near the surface, but at depth in borings the Coralline Crag is a greyish colour, similar to the Scaldisien of the Low Countries

In large sections the sands are usually seen to be strongly current bedded and there is considerable sorting of material, suggesting that the deposit accumulated as banks in turbulent water. Several attempts have been made to divide the Coralline Crag into a series of zones but without success. D. J. Carter showed that an upper and lower division can be distinguished using certain foraminifera but considerable work remains to be done on the taxonomy of most groups.

The full extent of the sea at this period is unknown but faunistically the Coralline Crag and the Scaldisien of Holland and Belgium formed one basin. No other marine deposit of the same age is known in the British Isles.

The Coralline Crag often contains phosphatic nodules, either scattered or in thin seams. Professors Lankester and Prestwich recorded a nodule bed at the base of the Coralline Crag identical in character to that at the base of the Red Crag. However apart from this record of a single pit at Sutton it has not been demonstrated elsewhere and at the section alongside the river at the opposite side of the valley Coralline Crag is seen to rest o£ London Clay with no intervening nodule bed. The Coralline Crag was formerly worked on a small scale as a source of lime for local agriculture while the harder parts of the rock bed were used for local building and rough walling. Nearly all the pits are now much overgrown.

The Red Crag.

Surrounding the Coralline Crag, and in places overlapping it, are beds of shelly sands of a prevailing reddish colour. Like the Coralline Crag these beds are a bluish grey colour at depth. Large amounts of iron, in a reduced condition, colour the Red Crag and forms slabs, "stalactites" and partings where the iron has followed the burrows of marine organisms or percolated between beds. The sands, especially towards their base, are strongly current bedded, and the molluscan remains usually fragmentary, disassociated and worn, with occasional seams of molluscs, in which one species often predominates. The bedding of the upper part of the deposit is usually less strongly inclined and often almost horizontal. The lower part of the deposit tends to have a richer and more diverse indigenous fauna and derivative material is more common.

In places the derivative material filled hollows, in the London Clay, and consists of large flints, derived London Clay material, pieces of fossiliferous Miocene Sandstone, rare Mesozoic fossils, teeth and bone fragments of mammals (especially whales), and above all large numbers of phosphatic nodules which, may have originated In the Coralline Crag or other" Neogene deposits. This discontinuous layer of nodules was formerly worked as a source of phosphates and is variously referred to in the literature as the Red Crag Nodule bed, the Bone Bed, the Coprolite Bed, etc. As a result of the bed being hand-worked, and the presence of a number of wealthy local collectors, a large proportion of the more interesting material has been preserved in collections. Large teeth of Carcharodon, Mastodon, Rhinoceros, etc fetched good prices. Throughout the whole thickness of the deposit, minor seams of phosphatic nodules of small size, pebbles, shark teeth, etc, may occur, but never in workable quantities.

Although the total Red Crag fauna is very rich, quantitatively the majority of the fossils belong to a few species, especially such molluscan genera as Macoma, Glycimeris, Spisula, Mya, Nucella and Neptunea, which are abundant everywhere. Many of the species recorded in lists in the literature are present only in broken fragments or as rare and very worn examples, and there can be little doubt that the Red Crag contains a great deal of material derivative from Pliocene sources.

The presence of fragments of typical Coralline Rock Bed in the Red Crag shows that the Coralline Crag had already been leached and partially decalcified before the Red Crag transgression. During this transgression mammaliferous valley deposits were probably destroyed and the more resistant elements are now included in the base of the Red Crag. The worn and fragmentary condition of the fossils, together with their rarity, make certain identification difficult and various ages from Miocene to Early Pleistocene have been suggested. The mammalian fauna of the Crags is dealt with in more detail in the faunal notes. It has-been suggested that the derivative marine Miocene and Eocene in the Red Crag represents the break-up in-situ of a Miocene sandstone, and in the upper (very fossiliferous) beds of London Clay, leaving only the lower (sparsely fossiliferous) beds of the latter in the area. Equally the material may have been transported some miles from sites now covered by the North Sea. Among the mollusca found in the Red Crag are many which are probably of Pliocene age though not necessarily from the Coralline Crag. Either beds of Upper Pliocene age, similar to the upper part of the Scaldisien, were deposited and subsequently dispersed by the Red Crag seas, or material of this age was transported into the district.

F. W. Harmer established a series of “zones” for the Red Crag for which he gave names and listed typical faunas. While much of his palaeontological data is now outdated, certain basic premises he made have never been improved. His Waltonian, Newbournian and Butleyan zones , while difficult to define geographically show a gradual lateral change in the Red Crag from South to North. There is a steady drop in temperature from the Coralline Crag : 14° - 24° C to the Butleyan 5° - 18°C which can be compared with that of the present Dogger Bank: 6° - 10° C. The sub-tropical conditions of the Eocene and Miocene were followed in the Pliocene by the arrival of certain Pacific genera such as Neptunea and Nucella which probably entered the area via the Bering Straits. The Waltonian conditions were very similar to the earlier Coralline but during the Newbournian there was a further influx of forms from the North which continued to live in the area during the Icenian. As well as a change in temperature there is a gradual reduction in the number of derivative species in the Butleyan, although in all the Red Crag deposits there was a continual reworking of the existing material and derivation from the lower to higher beds. The lateral distribution of the Red Crag zones has meant that there are no recognisable cases of one zone occurring in position over another, in the normal sense.

Large areas occupied by Red Crag are now covered by glacial deposits, so that it is mainly along the river valleys, where the Red Crag outcropped, that it has been revealed by pits and “Coprolite” workings.

(The Red Crag cont)

Little is known of large areas, and the conveniently NW-SE running estuaries were used by Harmer to delineate the limits of his zones. Thus the Waltonian is confined to the area about Walton-on-the-Naze, with a "subzone" with a similar fauna at Little OakLley. The majority of the Newbournian lies between the estuaries of the Orwell and the Deben, while pits about Butley and Hollesley show the Butleyan. This has resulted in some areas being doubtfully zoned. The Crag at Sutton may be Newbournian while the exposure in the cliffs at Bawdsey is clearly similar in fauna to that at Felixstowe, although these places are on opposite sides of the Deben estuary.

At present inland exposures in the Red Crag are few, and mostly in the upper parts of the various zones as the lower parts of the pits become infilled. The twofold division into highly-inclined and current-bedded lower beds is seen in all three zones, and it is mainly the upper beds with a limited fauna which are visible in the remaining old pits. As regards geographical conditions a little more is known about the Red Crag. The Coralline Crag knoll at Sutton was certainly an island or submarine knoll in Red Crag times. Rock loving species such as Nucella lapillus abound in perfect condition in the Red Crag about the knoll, which in the past was seen to abut against Coralline Crag cliffs and to contain numerous pieces and boulders of fallen Coralline Crag. There can be no doubt that other Coralline Crag prominence helped to produce tidal currents in the area which may have contributed to the cross-bedded nature of the Red Crag. Harmer believed that the London Clay formed the border of the Red Crag sea, but since then two pits at Hascot Hill have revealed a Red Crag beach resting on the Chalk and containing a fauna, which while demonstrably Red Crag, cannot be assigned easily to one or the other of its zones, although the presence of Cardium angustatum suggests a post-Waltonian age. Fragmentary remains at a similar level in various Chalk pits in the area, show that the Red-Crag at that period reached the present 150ft. contour mark. The presence of shells of Crag age at Sudbury, and possibly at Clare, suggest that Crag seas also penetrated the Stour valley to a similar height.

The ”Scrobicularia” Crag.

In some of the pits around Butley, and extending towards Aldeburgh, is a pale-coloured sand with abundant shell fragments containing pockets and seams of complete shells. The size and thickness of the shells, the more limited fauna, and the increasing presence of Scrobicularia plana indicate a change in conditions. The beds are seen to rest on Butleyan Red Crag at Chillesford and on Coralline Crag at Aldeburgh, and may be considered at transitional between the Red Crag and the Icenian. Passing upwards beds of silt become more dominant until the Chillesford Crag with its in situ bivalves and limited fauna shew a further change. At the type section clays referred to as Chillesford Clay cap the section. The Chillesford Crag may be considered as the most southerly known extension of the Icenian.

The Icenian.

The Crag between Aldeburgh and the North Norfolk coast, rarely exposed in most of the area, was termed the Icenian by F. W. Harmer who divided it into three:

Norwich Crag
Chillesford Crag and Clay
Weybourne Crag

The molluscan fauna which he studied is, with minor exceptions, fairly uniform for the whole series. To the east and the south the Icenian rests on London Clay, the base becoming deeper towards Lowestoft and Yarmouth, passes over onto the Chalk towards Norwich and the coast of North Norfolk in a shallow water facies bordered by gravels without fossils. In the upper part of the deposit the materials are extremely variable, passing from sand to pebbles, clay to shell pockets, often within a few yards. The presence of vast numbers of Nucella lapillus and various species of Littorina suggest very shallow water. In the deeper parts of the basin dark grey or bluish sands with sparse shell beds repla.ee the littoral deposits but have only been seen from boreholes. Work is a present in hand on a number of boreholes to determine the age of the lowest Crag in this basin.

Norwich Crag.

The macrofauna of the Norwich Crag is distinct from the Red Crag though many of the species continue. There is a decrease in the number of species and a strong non-marine element is present, which was predicated by the increase of land and freshwater shells in the Butleyan Crag. The beds show great variation, both vertically and laterally, and include sands, shelly sands, pebble beds, clays and all intermediate grades.

Near Norwich the Norwich Crag can be seen resting on Chalk of the mucronata zone. The surface of the Chalk sometimes shows borings of molluscs, annelids and other marine .organisms and the junction is marked by the Stone Bed, somewhat analogous ti the basal bed 6f the Red Crag. Large comparatively unworn flints occur, presumably derived from the underlying Chalk. Mammalian bones occur scattered throughout the Norwich Crag but are more plentiful in the Stone Bed. The mineralogical state of these bones suggests that at least two distinct faunas are present, and like the earlier Red Crag transgression, the advancing Icenian seas no doubt broke up river deposits of varying ages, as well as including in its deposits stray examples of contemporary mammals. However, the scarcity of these remains, their fragmentary state, and the amount of wear they have often suffered makes taxonomic work difficult. Derived pebbles and Mezozoic fossils, including ammonite fragments, are sometimes found in the Norwich Crag, but are much scarcer than in the Red Crag. London Clay fossils are very rare if not unknown, but a few fragments of polyzoans and large foraminifera from the Pliocene have been detected.

Chillesford Clay.

Various deposits of somewhat similar clay were plotted in East Anglia by F. W. Harmer who considered the resulting map to be the sinuous course of a river or estuary, roughly aligned north-south. Later work has shown that the clays are not all at the same horizon and that several similar clays occur at different depths in the Norwich Crag Series.

Weybourne Crag.

On the North Norfolk coast, and inland in the Bure Valley in old pits at Crostwick, Belaugh, etc., Crag resembling the Norwich Crag is to be seen. The fauna is slightly more restricted and shows the sudden appearance in large numbers of the bivalve Macoma balthica. Like the Norwich Crag it has at its base a Stone Bed, often containing many pieces of wood, as well as mammalian remains, where it rests on the Chalk. At Weybourne this Crag rests on a disturbed Chalk surface some twenty feet above high water mark; at West Runton the Weybournian beach level coincides with the recent beach level and a few miles away to the south east it has disappeared below the sea level.

In coastal sections near Sidestrand large rafts of Chalk may be seen in the glacial deposits, overlain and underlain by Boulder Clay. On top of most of these a Crag with Macoma balthica may be seen practically undisturbed, despite the tremendous kinetic forces involved in raising and moving such huge masses of Chalk. The Chalk is zonally some of the highest in Britain.

Cromer Forest Bed.

In the 'classic' succession the pre-Glacial beds come to an end with a series of Estuarine, freshwater and marine deposits. The plant remains varied from Artic to Temperate and there is a large mammalian fauna. Many of the beds are poorly and irregulary exposed so that earlier Workers found great difficulty in correlating the various deposits.

Corton Beds.

The Upper Artic Freshwater Bed shows the oncoming of severe cold conditions and is followed by the Cromer and Lowestoft Tills. At various points within the tills, or resting on them in the form of basins, are sands referred to as the Corton Sands. Although strictly speaking outside the scope of the present guide, the presence of Neogene fossils. in these sands makes a mention necessary. For the most part the contained molluscan fragments are the same as those in the Till but rare examples of Scaphella, Nassarius, Neptunea, etc. show a link with the earlier Crag Beds. On the other hand, near west Runton, Cromerian non-marine shells have been found in these sands.

Some geologists have claimed the sands represent an interglacial with the return of warm-loving molluscs to the area, after being eliminated by glacial conditions. The condition of the shells, however, the structure of the beds, and the distribution of the species along the coast all point to the material being derived from existing Crag beds and the finding of at least one of the species considered unique to the Corton beds in the Ludham borehole helps to confirm this view.

RECENT WORK ON THE CRAGS

In the preceding paragraphs what may be termed the "classic" succession has been followed, but recent work, particularly on the 1Icenian1 has thrown new light on the conditions under which these deposits were laid down. Emphasis has been on the evidence of microfossils rather than molluscs and wherever these are present they have been used to determine the climatic conditions. In the main, work on foraminifera and pollen has tended to complement each other. Boreholes have been made specially to investigate the deposits at depth and work still continues on the material thus collected.

Coralline and Red Crag.

Very little has been published on either of these deposits during the last thirty years. Work on a small group of Gedgravian foraminifera by D. J. Carter has already been mentioned. In 1960, D. F. W. Baden-Powell published a paper on the Coralline Crag in which he attempted to correlate the British Crags with the deposits of the Mediterranean area. The difficulty of doing this with such widely separated basins in our present state of knowledge is perhaps too great, and the choice of a genus like Turritella (whose species tend to be extremely variable) as fossils with zonal significance is unfortunate.

Attempts to find suitable pollen-bearing clays in the Red Crag at outcrop have been unfruitful and the foraminifera are generally missing or poorly preserved.

Icenian.

In 1958 B. M. Funnell examined the Norwich Crag on Bramerton Common, in an excavation specially made for the purpose. Earlier workers on the mollusca had suggested that some change in temperature had occurred during the deposition of the Crag in the area and an examination of the foraminifera not only confirmed this view but showed that three stages could be recognised, the lowest of which was comparatively warm while the highest was extremely cold or even glacial.

Deep borings at Ludham in 1950 and 1959 penetrated more than 130 feet of Crag, and subsequent study of the cores has enabled a series of stages based on climatic conditions to be recognised. Since then attempts at correlating the surface exposures in various parts of East Anglia with these stages has commenced. The various stages, in ascending order are briefly discussed.

Ludhamian.

Shelly marine sands, 25m thick at the base of the borehole with a temperate flora including the hemlock spruce Tsuga The stage is named after the borehole locality. Its exact relationship to the Red Crag is unknown but it may either entirely post-date it or possibly represent the later part of it. The presence of the ostracod Cythere hoptonensis, first described from the Corton Beds, is of interest.

Thurnian.

Silty clays 7m thick at Ludham indicate cooler conditions. This stage is named after the River Thurne to the east of Ludham and it has been recognised in a borehole at Southwold.

Antian.

The River Ant gives its name to this stage. At Ludham it is 3m thick with a temperate marine fauna and a, flora including Tsuga. The Norwich Crag at Easton Bavents probably belongs to this stage.

Baventian.

Marine silty clays, 8rn thick at Ludham with a cool flora and flora also known at Easton Bavents, South Cove, Aldeby and in parts of the Weybourne Crag on the Norfolk coast. (Cont.)

Pastonian.

R. G. West includes estuarine silts, freshwater peat of the. Cromer Forest Bed Series, Norwich Crag (in part), Weybourne Crag (in part) and the beach gravels of the Westleton Beds in this stage which is a few metres thick at Ludham, and has a temperate flora without Tsuga.

Beestonian.

Sands and gravels overlying the Pastonian silts in the Norfolk cliffs with Arctic freshwater plants and evidence of permafrost, includes the so called Lower Freshwater Bed of the old Cromer Forest Bed Series.

Cromerian.

Temperate freshwater peaty muds overlain by marine sands and gravels, include the so-called Upper Freshwater Bed.

Lowestoftian.

The top of the Upper Freshwater Bed of the Cromer Forest Bed Series shows a return to Artic conditions and is followed by the Cromer and Lowestoft Tills with the intercalated Corton Bods.

The stages quoted above are based largely on the evidence of pollen spectra and foraminifera. Only a synthesis of all available evidence can give the best answer and it now remains to see how new studies of the marine mollusca, and groups which have not yet been fully studied, such as the non-marine mollusca, or the small mammals whose remains are common in some Icenian beds, will fit into the structure outlined above.

BEDS RELATED TO THE CRAGS OUTSIDE EAST ANGLIA.

Lenham.

Marine beds of Miocene age occur as sandstone in Chalk pipes at Lenham, Kent. The chalk pits are no longer being worked and therefore specimens can no longer be obtained, but casts in sandstone reveal a molluscan fauna and the abundance of Anadara diluvi suggests a younger age for the Lenham Beds compared with the Red Crag Boxstone fauna.

Rothamsted, Herts.

Several large blocks of ferruginous sandstone were discovered in a sandy clay and nine specimens of lamellibranchs were determined from impressions. Such species as Pholas cylindrical and Cardium parkinsoni indicate the Red Crag age of the specimens.

Netley Heath, Surrey.

Similar ferruginous sandstone was discovered on the North Downs at Netley Heath where Lentidium complanatum was the most abundant species. In both cases the amount of "material was limited and scattered, and it is not certain whether either is in situ. Ironstone with casts of Crag shells has also been found at Sudbury, Suffolk, and in parts of Essex.

Ireland.

Glacial gravels at Killincarrig, Co.Wicklow, Ireland, hapve yielded worn shells which include such typical Crag species as Scaphella lamberti, Nassarius reticosus, Neptunea antiqua, Glycymeris glycjgmcris and several forms of Searlesia, which were described by Mrs. N. McMillan as new species.

Elsewhere in Ireland and the Isle of Man are various gravels and shell beds containing shells of Pleistocene age but most of these appear to be Atlantic rather than Crag forms. The St.Erth clays, Cornwall, with a fauna which includes Euthria corneus, Turritell.a erthensis and other distinctive forms, while of Upper Pliocene age, have no connection with the Crag beds of East Anglia.

Scotland.

In Aberdeenshire, Professor Jamieson recorded shells of Craig Age from glacial gravels. Since the specimens appear to have been lost and no further examples have come to light. The shells recorded include such distinctive forms as Scaphella lamberti which could hardly have been misidentified and thus forms a link with the County Wicklow occurrence.

Corton Beds.

As already mentioned the Corton sands interbedded in East Anglian tills include such typical forms of Crag shells as Scaphella lamberti, Nassarius reticosus and Glycymeris glycymeris, as well as Cromerian freshwater species such as Valvata goldfussiana and Viviparus. The Corton sands also usually contain a large amount of Chalk debris and among this are many derivative Chalk fossils, including small Terebratulina, worm tubes, echinoid remains and polyzoa, some of which show that they were derived from Chalk of a higher zone than that at present occurring in East Anglia. The inference is that the chalk from which these Cretaceous fossils were derived came from areas now covered by the North Sea rather from the Chalk to the west.

Bridlington Crag.

Apart from the name, this 'Crag' bears no connection with the East Anglian Crags. It consists of masses of material caught up in the base of Saale or earlier Till, yielding a cold fauna including Tachyrhynchus erosa, Astarte montagui, A sulcata, Dentalium and many other species. The Bridlington Beds include the Dimlington Clay, and the Bridlington Sands.

The term Crag has also been misapplied elsewhere. D. Wirtz referred to part of the Sylter Stufe as the Sylter Crag and presumed a Waltonian age for the fossils occurring as casts in a ferruginous sandstone ("Limonitsandstein"). Due to misidentifications the fauna was made to look more like that of the Red Crag, whereas the bed is almost certainly late Miocene in age.

The term Iceland Crag or Tjornes Crag was also another unfortunate use of this term, especially as the material has even less resemblance to the shelly sands of East Anglia. Nevertheless the study of these Icelandic beds will eventually lead to a wider understanding of many problems in the Pleistocene.

PALAEONTOLOGY.

Eocene.

Where exposed, the London Clay of East Anglia is almost unfossiliferous. Pyritised wood and sharks' teeth are the most commonly met fossils. Mollusca, when they occur, are generally in pockets, sometimes in association with large pieces of drift wood. Fossil turtles are reported as being dredged off Harwich when septaria were sought for use in making cement.

The Crags.

The Crag beds are dominated by the Mollusca, which occurs in vast numbers in many of the sections. Early classifications were almost all based on the abundance of certain species or on associations of species of Mollusca. Thus Harmer referred to the Walton Horizon as the zone of Neptunea contraria: an unfortunate choice as the species is known from the Pliocene of Holland and Belgium; it occurs throughout the Red Crag and is found in the Weybournian, and continues to live to the present day.

The Coralline Crag.

In the Coralline Crag, Polyzoa equal the Mollusca in quantity, and it was from their presence that the name Coralline was derived. Several pieces of solitary corals occur, as well as the unusual Cryptangia which occurs intimately related with a polyzoan and a barnacle Pyrgoma anglica. In some parts, as at Ramsholt, beds of oysters and large barnacles, show fairly static conditions; elsewhere the Coralline Crag may consist wholly of well-sorted, strongly-drifted and current-bedded material including disarticulated remains of echinoids, barnacles, fish otoliths, foraminiferans, small shells and fragments of polyzoans.

The Red Crag.

Once again Mollusca dominate the fauna. A solitary coral, Balanophyllia is probably the only true Red Crag form, and is commonly met with. Polyzoa are mainly adnate mainly occurring inside the valves of bivalves, and usually forming only small colonies before the host shell was buried. Bivalves frequently form the majority for the beds in which they occur; gastropods occur less frequently.

(Continued - Red Crag)

The only common echinoid is the small Echinocyamus. Large gastropods sometimes have a covering of balanids of several species. Dermal tubercles of rays occur occasionally; other fish remains are mostly derivative shark teeth.

Nucella lapillus is among the commoner gastropods and shows useful evolutionary tendencies. The large, heavy N. laplllus incrassata which is the form met with, in the Scaldisien, occurs rarely in the Waltonian and the lower parts of the Newbournian. The characteristic form in the Red Crag is smaller, and while retaining the angularity and strong shoulder keel, is thinner and less strongly ribbed than N. incrassata, with a tendency for varices to occur. Less angular and finer ribbed specimens occur more often in the Upper Red Crag and the form found in the Icenian approaches the modern shell. Several other persistent species show similar evolutionary tendencies and can be used to separate the different Crags in a broad way.

The Upper Red Crag at Butley begins to show the first arrival of species more characteristic of the Icenian - rare examples of Turritella communis, Macoma calcarea, and Scrobicularia plana for instance. Certain derivative Pliocene shells, such as Cardita senilis and Astarte omali occur as high as the Scrobicularia Crag.

The Icenian.

Lower temperatures, and perhaps lower salinity result in fewer species. Many groups are unrepresented, e.g. the corals. Polyzoa are rare and few in species. Apart from isolated spines, echinoids are restricted to Echinocyamus. Mollusca still dominate the fossiliferous beds but the shells are mostly smaller, thinner and more eroded. In typical Norwich Crag, bones of a remarkable fish, described by Agassiz as Platax woodwardi are not uncommon. These bones are remarkably thickened, a condition known in modern examples of Platax. However, it is possible that the bones do not all belong to the same genus. Dermal defences of Raia are common and the teeth of Mimomys and other small mammals are common in parts of the Norwich and Weybourne Crags. Non-marine shells, both land and freshwater, occur and Corbicula fluminalis makes its appearance in the Norwich Crag of Wangford and Yarn Hill.

Some remarkably distorted fossils occur in a limited area around Bramerton and Postwick in the Norwich Crag. This has been suggested as due to decreased salinity or stagnation but no theory seems to satisfy all the facts. While Nucella and Littorina are affected no other species of mollusc is affected. The distortion consists of a remarkable series of monstrosities, including heavily ribbed forms, keeled examples, depressed or elongate forms or any combination of these. This is all the more remarkable in a genus like Littorina, where any variation is extremely unusual and whose members are frequently found in contact with brackish or stagnant waters. No common food factor is apparent and all the other shells are normal and abundant. Certain foraminifera are also affected. A series of these monstrosities were figured by Woodward, Wood and Harmer. Elsewhere in the Norwich Crag similar communities of Nucella and Littorina are unaffected.

P.G. CAMBRIDGE.

(The above article is a reprint (with permission) and with some additions, from ‘A Review and Guide to the Neogene and Lower Pleistocene deposits of East Anglia’, for the Norwich meeting (1970) of the ‘Colloque pour 1’etude du Neogene Nordique’.)

INCLUSIONS IN AMBER.

I recently took the opportunity to examine the North Sea amber in the collection of the Ipswich Museum. Of 57 pieces, 22 contained real inclusions. (Other pieces had fractured internally, forming circular patches of discontinuity which resembled seeds when viewed in certain lights.)

Two pieces contained wood and wood fibres and three more contained small dicotyledonous leaves. One of these latter also contained a twig. Other plant material comprised a portion of thick leaf and a small spray of cypress leaves. One piece of smooth bark was found. This was particularly interesting for on it were attached spangle galls, similar to those seen on the underside of oak leaves.

The insects and spiders were distributed as follows:

FLIES - (Diptera)

Chirononidae -one piece contained a veritable swarm of small midges.

Dolichopodidae - Five individuals in three pieces of amber. These flies resembled those of a common bark-frequenting genus, Medeterus, but are much larger than the present British Species.

Empididae - A pair of Rhamphomyia species in one piece.

Ceratopogonidae - Three specimens in two pieces, of these small biting midges. (I wonder what they were annoying then ?)

Sciaridae- Two. specimens, in separate- pieces of amber.

Gecidomyidae - One specimen of a gall midge.

Phoridae - One specimen in poor condition,

and one intriguingly large, but unidentifiable fly.

BEETLES - (Coleoptera.)

Altogether there were one weevil (Curculionidae),one small rove beetle (Staphylinidae) and two beetles which I could not place in a family.

BUGS - (Hemiptera) Two bugs were found.

These were a last-instar (pre-adult) leaf hopper (Cicadellidae) and a very immature unidentified bug.

OTHER INSECTS.

Hymenoptera - one minute gall-wasp (Cynipidae). It is conceivable that the species was that which caused the spangle galls mentioned above.

Trichoptera - one adult caddisfly. An indication of the proximity of fresh water. ?

? Isoptera - one badly -preserved winged neuropteran, which resembled a termite.

Dictyoptera - one cockroach (Blattidae.)

Collembola - two springtails in one piece of amber which also contained the rove beetle and the weevil. The amount of particulate dirt in this piece suggested that it was very close to, or in contact with the ground. This would also explain the presence of springtails which are not normally bark -frequenting insects.

This piece of amber also contained two different spiders. Two other spiders were present in separate pieces of amber. All the spiders were of the orb-web type (like our common garden spider.)

One mite (Prostigmata) was found.

There remains but one inclusion I have not mentioned. This still evades a satisfactory explanation. The piece of amber was a cut slice and well polished. The inclusions resembled nothing more closely than breadcrumbs.? Any suggestions ?

Many of the pieces described above can be viewed in a new display of amber at Ipswich Museum.

A. G. IRWIN.

<u>LITTLE OAKLEY EXCAVATION 1973 – 1975.</u>

<u>Location:</u> TM224292. Upper surface of Red Crag 21.39 metres. (70ft.) above 0.D.

<u>Extent and Orientation:</u> The excavation is about 8ft. in length, in a N.E. to S.W. direction. The width (N.E. end) is 3ft. 2ins, and the depth at the N.E. end is 7ft. 6ins. to the Water Table, and 11 ins below W.T. giving a total depth of 8ft. 5ins. The pit is stepped downwards from the S.W. end.

<u>Section description</u>:

The surface slopes gently downward in a southerly direction:

9ins	soil. There is a fairly constant cover of at least 9n of soil. In a few placed the Crag occurs above this, but is has probably been brought up by agricultural activity.	
15ins	soil or crag or mixed soil and crag. Sharp drops occur in the line of junction between soil and crag. In plaices soil can be found, without a trace of crag, down to a depth of about 2ft.	
21ins	mostly crag, some mixed crag and soil. Soil tends to be encountered at a greater depth at the N.E. end of the pit.	
45ins	Crag (to Water Table)	Shells, which are abundant towards the surface, tend to become scarcer with increasing depth, also shell particles become finer. However, whole and reasonable well preserved specimens, chiefly of N. contraria, S. arcua.ta and G. glycymeris occur throughout. I have also found C. scalaria, C. opercularis, T. incrassgta, H. reticosa H. ? costata, Gibbula ?cineroides and Natica sp. down to the base of the crag. These seem to occur in thin bands, separated by more or less unfossiliferous sand. The colour of the deposit ranges from a distinct orange at the top to almost grey towards the base.
11ins	Crag (below Water Table)	

<u>The London Clay:</u>

The base of the Crag rests on London Clay, the junction, being below waiter, is obscured, but samples brought up from the surface of the clay show it to be light greyish-brown in colour, such as one would expect had the clay been subjected to weathering prior to the deposition of the Crag. Pebbles of clay of a similar colour and texture occur throughout the Crag, suggesting an exposed clay surface, probably at no great distance, at the time of crag deposition.

<u>Stratigraphy of the Crag</u>:

The bedding of the Crag appears to be almost horizontal; however, there is a slight dip detectable - about 8G - in a. southerly direction. The fewer, and better preserved shells at the lower levels have probably not been carried far from the place in which they lived; the occurrence of a S. arcuata with both valves united seems to support this view. On the other hand, the shells of the upper levels show signs (in most cases) of considerable wear, and have probably been transported from a greater distance or subjected to more disturbed conditions. The more frequent occurrence, and larger size of clay pebbles towards the top would also indicate a stronger current. The presence of these pebbles might also be taken to indicate a decrease in the depth of water.

... thus the shells in the upper part of the deposit may have at some time come under the influence of wave action. Throughout, the Lamellibranch valves lie in the position of greatest stability.

Fossils of the Crag:

In general, the assemblage of fossils I have found so far is similar to that of Walton-on-the-Naze. However, a few differences do emerge. (At this point I must stress that the following is based entirely on my own somewhat limited observations to date, and do not take into account faunal lists produced by workers in the past.) Some species, rare, or possibly absent at Walton, occur fairly commonly at Little Oakley. Most notable among these are M. praeteniiis and (to a somewhat lesser extent) M. obliqua. N. Tetragona (both typica and var. alveolata) may be found at Little Oakley but not as frequently as at Walton. N. lapillus, on the other hand seems slightly more common. I have found a few specimens of H. reticosa at Little Oackley, which look fairly typical, but by no means as many as at Walton. However, the variety costata seems to be abundant at Little Oakley. So far, I have the impression that H. granulata (typica and var. gracilis) and T. muricatus are less common at Little Oakley than at Walton. Also, L. catenoides may come into this category as well. Obviously these are early impressions, but I think I have progressed sufficiently to make them of some value. The following faunal list contains only those species and varieties of which I am reasonably certain of the identity. The comments accompanying the list are also restricted entirely to my own observations to date, and are intended primarily for comparison with previously published literature, not as an attempt to supersede this.

FAUNAL LIST

Abra (Sydesmya) alba	W. Wood	
Aporrhais pes-pelecani	Linne	
Astarte burtini		
A. gracilis	Munster	
A. obliquata	J. Sowerby	
A. omalii	De la Jonkaire	
Balanophyllia caliculus	S. V. Wood	
Balanus ?porcatus	Da Costa	One whole specimen
Calliostoma subexcavatum	S. V. Wood	Not as common as at Walton
Calyptraea chinensis muricata	Linne (Brocchi)	Not common
Capulus ungaricus	Linne	Not common
Cardita senilis	Lamarck	
Cardium edule	Linne	Common
C. clodiense Linne	(S. V. Wood)	One specimen found
C. ?interruptum	S. V. Wood	No whole specimen found
C. parkinsoni	J. Sowerby	
Cassidaria bicatenata	J.Sowerby	Fragment

(continued - Little Oakley Excavation - FAUNAL LIST CONT.)

Chlamys harmeri	Pennant	
C. opercularis	Linne	
C. tigrina var. 8	Muller (S. V. Wood)	One specimen found
Carbula ?gibba.	Olivi	
Corbulomya complanata	J. Sowerby	Typical form
Corbulomya complanata	J. Sowerby	Shorter rounded form more common
Cryptangia woodi	Edwards & Haime	In bryozoan: Poss. derived from Coralline Crag,
Cyclocardia chamaeformis	Leathes	Less common than C. scalaris
C. scalaris	J. Sowerby	Fairly common
Digitaria digitaria	Linne	Some quite large specimens
Dosinia exolita	Linne	Remarkably common
Drilla icenorum	S. V. Wood	One specimen found
Echinocyamus pusillis	Muller	
Fissurella graeca	Linne	Not common
Gastrochaenia dubia	Pennant	
Gibbula ?cineroides	S. V. Wood	
Glycymeris glycymeris	Linne	Very common
Hiatella arctica	Linne	Not common
Hinia granulata	J. Sowerby	Not as common as at Walton
H. elongata	J. Sowerby (Harmer)	Not as common as at Walton
H. gracilis	J. Sowerby	Not as common as at Walton
H. propinqua	J. Sowerby	
H. reticosa	J. Sowerby	
H. costata	J. Sowerby	Poss. more common that "Type”
H. ?curta	J. Sowerby	?
H. pulchra	J. Sowerby (Harmer)	
H tiara	J. Sowerby (Harmer)	Not common
Leiomesus dalei	J. Sowerby	
Lunatia catena	Da Costa	Not common
L. catenoides	S. V. Wood	Not common
L. (Natica) proxima	S. V. Wood	
L. woodii	S. V. Wood (Harmer)	Poss.= Polinices hemiclausus oakleyensis
Macoma obliqua	J. Sowerby	
M. praetenuis	Woodward	More common than M. obliqua
Murex tortuosa	J. Sowerby	One specimen found
Nassa.?dautzenbergi crassisculpta	Harmer (Harmer)	
N. labiosa	J. Sowerby	
Natica affinis	Gmelin	Shell thicker than N. affinis from exposures farther north
N. clrriformis	J. Sowerby	Immature specimens.
N. multipunctata	S. V. Wood	Common
N. ?consors	S. V. Wood (S. V. W.)	Poss.=N. stercus-muscarum
N. pusilla	Say	
N. stercus-muscarum	Gmelin	Poss = N. multipunctata consors.
N. tigrina	Defranco	

(continued - Little Oakley Excavation - FAUNAL LIST CONT.)

Neptunia contraria	Linne	Good specimens very common
N. angulata	Linne	Not common
N. sinistrorsa	Linne (Deshays)	
N. informis	Linne (Harmer)	
N. despecta	Linne	Not common
N. despecta decemcostata	Linne	Not common
Nucella lapillus ?imbricata	Linne (Lamarck)	
N. lapillus oakleyensis	Linne (Harmer)	
N. lapillus (varieties)	Linne	Not common
N. tetragona	J. Sowerby	Not as common as at Walton
N. tetragona alveolata	J. Sowerby (J. Sowerby)	Not as common as at Walton
Nucula laevigata	J. Sowerby	Not common
N. ?nucleus	Linne	More common than N. laevigata
Pecten maximus	Linne	Fragments
Phacoides borealis	Linne	
Pholas crispata	Linne	No whole specimens found
P. cylindrica	J. Sowerby	No whole specimens found
Polinices hemiclausus	J. Sowerby	
P. hemiclausus oakleyensis	J. Sowerby (Harmer)	Poss. = L. proxima woodii
Pteromeris corbis	Philippi	
Pycnodonte cochlear	Poli	Not common
Scaphella lamberti	J. Sowerby	
Searlisia costifera (varieties)	S. V. Wood	
Sipho curtus	Jeffreys	
Sipho ?gracilis	Da Costa	
Sphenotrichus botonensis	Tomes	Not common
S. intermedium	Munster	
Spisula arcuata	J. Sowerby	Common. One specimen with united valves
S. ?solida	Linne	
Tectura virginia	Muller	
Tectura virginia conica	Muller (S. V. Wood)	
Terebratula sp.	n/a	One specimen found, broken and rather worn
Trivia avelana	J. Sowerby	One specimen found
Trivia coccinelloides	J. Sowerby	
Trophon muricatus	Montagu	Not common
T. clathratus attenuata	Linne (Harmer)	Not common (doubtful variety)
Turritella incrassata	J. Sowerby	
T. incrassata	Brocchi	
T. ?triplicata	Brocchi	Poss. = T. incrassata

The exposure has also yielded:

- Barnacle valves, with occasional whole specimens
- Belemnites, very worn and obviously derived.
- Bryozoa
- Scaphopods (fragments)
- Sharks teeth

(Cont.)

<u>Section on N. W. side of pit at Lt. Oakley, Essex</u>

Key;

1. Soil with some crag at lower levels.

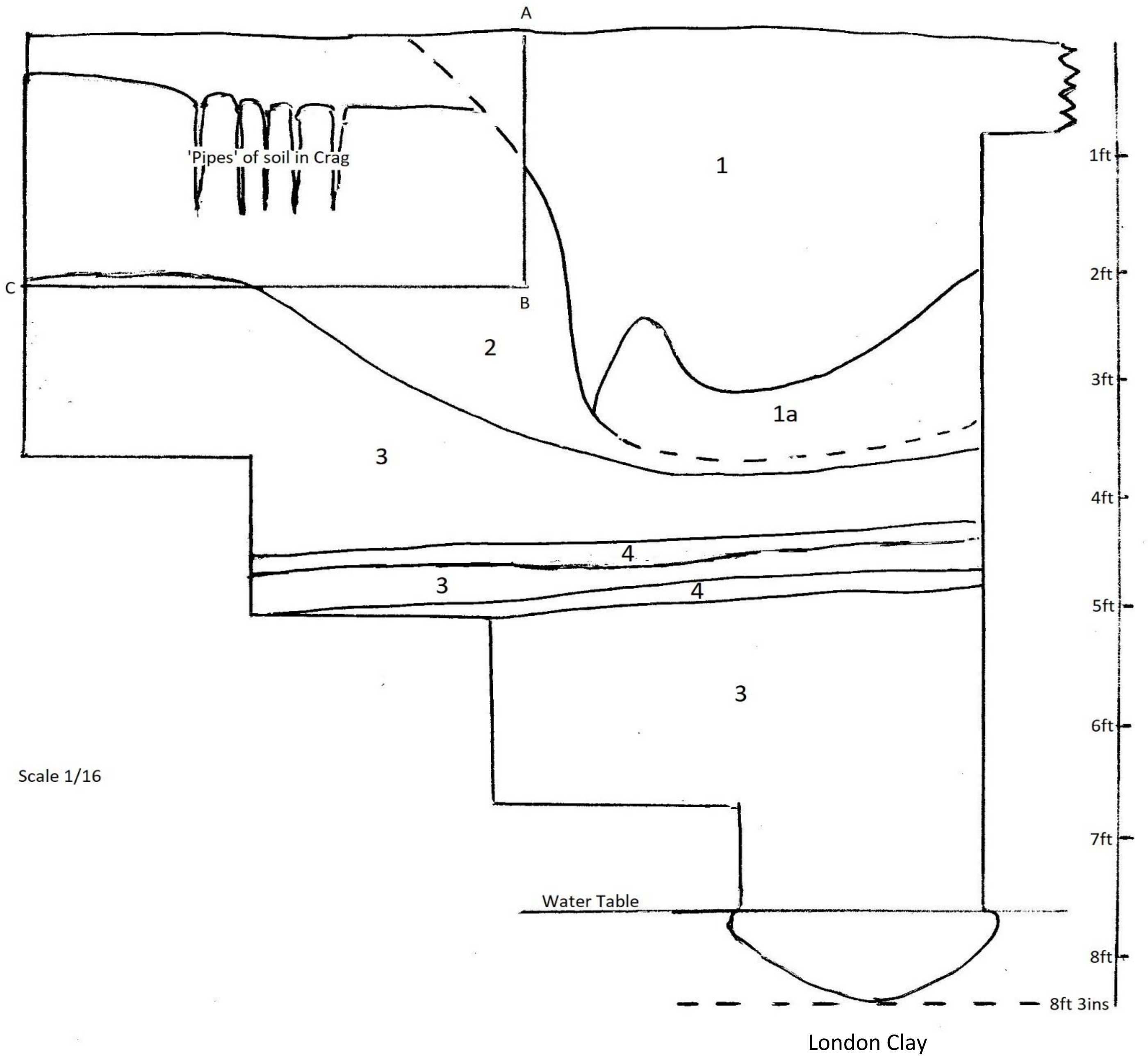
1a. Mixed crag and soil.

2. Orange coloured crag with some mixed soil in places.

3. Lighter coloured crag.

4. Shelly bands (apparent dip about 3°)

The line “A” “B” “C” represents a step out into the N.W. face.



N.B.
1 (to the right of the broken line) and 1a represent an infilled Iron Age ditch.

(continued - Little Oakley Excavation)

Since writing this account it has been demonstrated to me by Capt. R. Farrands that the north-west face of the excavation cuts across an Iron Age ditch, which is a continuation of one of the twin ditches visible in his archaeological excavation some 200 yards W.N.W. This ditch is shown in the Fig on page 15 by the broken line which encloses section 1a and the greater part of section 2. It will be seen that the lower part of the ditch is infilled with mixed crag and soil, while the upper part is infilled almost entirely with soil; thus the sudden drop in the upper crag surface at the eastern end of the pit is explained. Possibly the "pipes" of soil in the crag to the west of the ditch section may have resulted from cracks which developed in association with the ditch.

A further point of interest is the apparent absence in the Red Crag in this exposure of a marked upper zone of decalcification. In fact, shell fragments tend to be larger and more numerous in the upper layers. That these upper layers have been subjected to surface oxidation is apparent from the rich orange colour, but I could find no evidence of more decalcification at this level than deeper; nor does the crag at greater depth show any indication of cementation by re-precipitated calcium carbonate.

The following information, kindly made available to me by Mr. A. Boatman, refers to a sample taken from the lower part of the excavation at Little Oakley.

Description of sample: sand, fine-medium grained, yellow. The whole sample contained 68% finely comminuted shell debris, but this was not included in the particle size analysis.

Particle size range from 0.055mm to 1.0mm; the median diameter being 0.29mm.

It appears that the sand grains are white, or almost so, and that the colouration of the deposit is due to the abundance of iron oxide present in the silt fraction.

W. I. STIDWILL

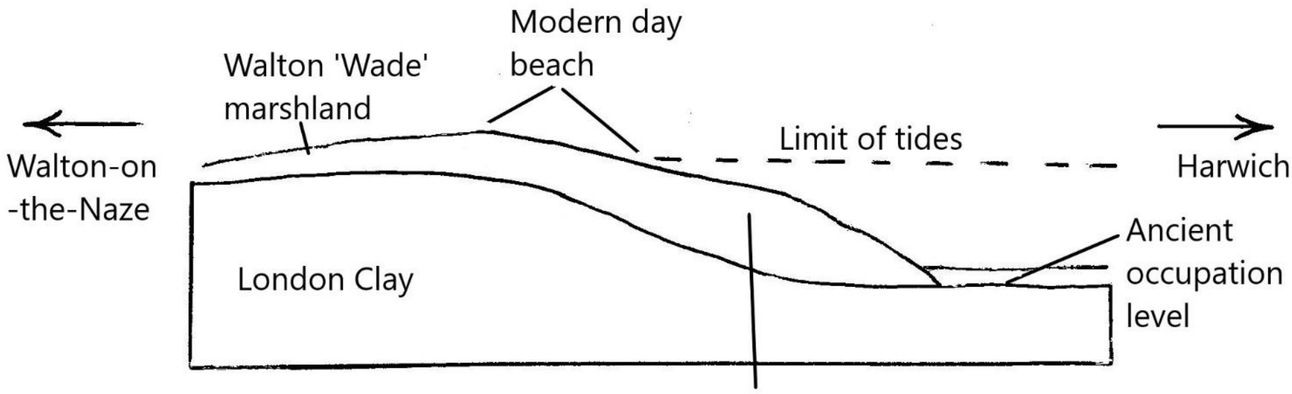
A PREHISTORIC SETTLEMENT AT STONE POINT, WALTON-ON-THE-NAZE.

Walton-on-the-Naze at the moment is suffering from the same coastal erosion as it did several thousand years ago, although the phenomenon is slightly different.

At the beginning of the Beaker Period some 1800-1600 B.C. there was a sudden submergence of the land north of Walton itself. This submergence was also experienced at Dovercourt and Clacton, but to a lesser degree. The land slipped by approx. 10ft. at Walton whilst only 3-4 ft at the other locations. All three sites have basal limits of London Clay with a varying depth of Red Crag covering this, covered in turn by a loamy topsoil.

At Walton, or rather Stone Point, Walton, there existed a very sizeable prehistoric occupation site dating from the middle Stone Age or Mesolithic Period.

Although several people have collected from this site very little written information is available to anyone interested in this area. The only information being a booklet of a few pages written for the Fenland Research Committee and three pages in the Essex Archaeological book for the year 1936.



A Section from Stone Point Walton.

As Dovercourt and Clacton experienced a similar such phenomenon, but have offered little or no important finds, I shall concentrate on Stone Point, Walton.

The section shows the old occupation level resting on the London Clay, not on Red Crag which, however, exists only a few hundred yards away. The submergence is clearly visible as shown by the slope of the level, all of which is covered by a marine deposit known as Scrobicularia Clay, which is approximately 8 -10ft thick. The clay gets its name from the molluscs that live in it. The occupation level can be seen as being below low tide, which makes inspection only really possible at exceptionally low tides. However, during the 1930s it was usually visible between tides, which furthermore points out the erosion that had taken place, in a mere forty five years.

The only prehistoric material to be found is flint chips and broken implements that have been eroded out of this very thin occupation level which is only about eight inches thick, and occasionally, very rarely, pottery and broken animal bones. The flints are usually of a very black colour and are usually in good condition though frequently they occur with rolled and broken edges, caused by abrasion in the beach shingle.

From the sheer size of the collections made by Mr. John Hassell and Mr. Stuart Hazzledine-Warren and Messrs. Piggott, Clarke and Godwin, the site must have represented a terrific occupation of many people for about two to three thousand years, which in itself is a long period of continuous occupation. But through all this period only one burial has ever been found there and that was by accident in 1909 when two men strolling up the beach noticed some bones protruding from the mud. The burial represented that of a young girl about sixteen who had been buried in the familiar crouched position. But, unfortunately, even through all this early interest there are only the two written accounts with odd drawings of this astonishing wealth of material. It is known for instance that over one thousand five hundred arrowheads alone have been found here, one indeed still hafted with sinew binding after this tremendous period of time. A close friend of mine Ben Knights-Branch tells me when Mr. Hassell visited this site before the 1939 - 1945 war he would sometimes pick up as many as twenty arrowheads, scrapers, knives etc. in one day l

But alas those days have long since gone, however it is still possible to find the odd scraper or flake after a good tide and very rarely there is a broken or rolled arrowhead washed up onto the beach. It is a wonderful feeling to pick up a scraper or knife and to know you are the first person to touch this tool for four thousand year !

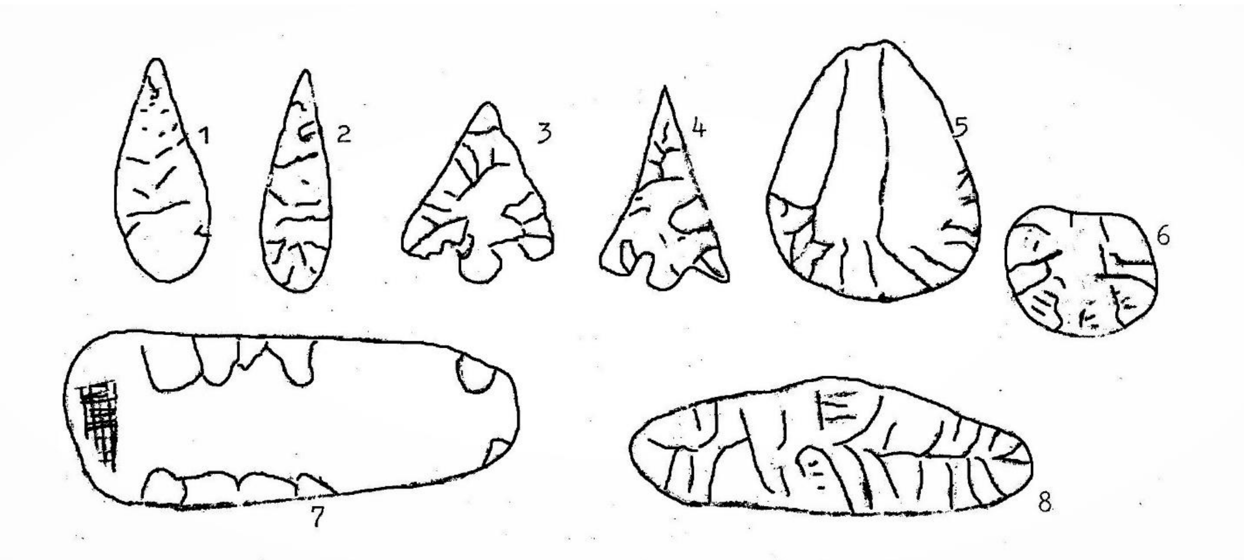
The site was occupied by three distinct cultures.

(i) The Mesolithic people who produced small geometrically flaked flints called miscroliths (Greek miscro =-small, lithos = stone) usually about ½ - 1ins long and varying between ¼ and ⅛ ins wide, they were used for fishing, hunting, woodworking and even domestically. These people also produced scrapers and occasionally crude axes, all of which are in flint. The condition of this older material is usually poor and very rolled.

(ii) The Neolithic people (Neo = new, lithos =-stone) who generally produced finer work which is usually in a better state of preservation. i.e. leaf arrowheads, knives, polished axes and finely flaked blades.

(iii) The Bronze Age people who inherited Neolithic traditions usually improving designs and adding different implements.

From the wealth of material it is true to say that the Neolithic peoples produced the vast majority i.e. leaf arrowheads outnumbering the Bronze Age barbed and tongued by four to one. Another important fact is that fourteen more or less complete sickles were found at Walton, whilst throughout the country they are extremely rare. Also the typology of the great majority of material strongly suggests that these people arrived at Walton from the Low Countries or Denmark.



<u>SOME OF THE FLINT TYPES</u>. (Not to scale.)

No. 1-4 arrowheads. 1-2 Neolithic. 3-4 Bronze- Age. 5-6 Scrapers. 7, Polished flint axe. 8, flaked knife blade.

As a summary it may be said that Walton experienced a terrible submergence during the Beaker Period, causing the whole site to be flooded. What effect this had on the people, we do not know - whether it killed some or not;- but the site was left undisturbed for centuries. It was immediately covered by marine deposits all of which is even now being eroded away.

The site itself must have rivalled Star Carr and Grimes Graves but it was never professionally documented, much of the material is now lost, although some flints are on display in Colchester Castle in the Benham Collection and are worthwhile seeing, amongst the Roman Antiquities.

R. L. FORSDIKE.

The study of local coastal erosion and deposition is a common subject for investigation by students. It is hoped that this bibliography will be of some use. Additions to the list will be welcome. Geology of strata within cliffs not included.

Gillingwater, E. 1790. "An Historical Account of the Ancient Town of Lowestoft, in the County of Suffolk, &c." London, (coast changes &c., pp. 23-32, 44-49).

De Luc, J. A. 1811. "Geological Travels" London. (Translated from the French MS) (coast waste, vol.2, pp. 2-8, 16-18).

Alexander, H. 1841 "0n the Annual Destruction of land at Easton Bavent Cliff, near Southwold." Proc. Geol. Soc., vol. iii, no. 79, p. 445.

Walcott, M. E. C. 1860. "A Guide to the Coasts of Essex, Suffolk, and Norfolk". London.

Redman, J. B. 1864. "The East Coast between the Thames and the Wash Estuaries". Min. Proc. Inst. Civ. Eng., vol. 23, pp. 186-224.

Palmer, C. J. 1872. "The Perlustration of Great Yarmouth, with Gorleston and Southtown." vol. i. Yarmouth, (coast changes, pp.1-5).

Coode, Sir J. 1875. "Report to the Board of Trade on the Coast-line at Landguard Common". Parliamentary Papers, Sess. 1875, no. 57. London.

Woodward, H. B. 1883. "The Scenery of Norfolk". Trans. Norfolk & Norwich Nat. Soc., 3, 439-466.

Anon. 1898. "Serious subsidence of the cliff at Walton-on-the-Naze". Essex Nat., 10, 236-237.

Leslie, J.H. 1898. "The history of Landguard Fort in Suffolk". London.

Hotblack, J. T. 1899. "The Stones on Mundesley Beach". Trans. Norfolk & Norwich Nat. Soc., 7, 7-12.

Geological Survey Memoirs;-

1877. Walton-Naze & Harwich (W. Whitaker).

1882. Cromer (C. Reid).

1884. Pakenham, Wells & Holt (H. B. Woodward).

1885. Ipswich, Hadleigh & Felixstowe (W. Whitaker).

1886. Aldeburgh, Framlingham, Orford & Woodbridge (W. H. Dalton).

1887. Southwold, and Suffolk Coast from Dunwich to Covehithe (W. Whitaker).

1890. Yarmouth and Lowestoft (J. H. Blake).

1899. Borders of the Wash, including Hunstanton (W. Whitaker & A.JC Jukes-Browne).

Pearson, H.W. 1901. "Oscillations in the Sea Level". Geol. Mag., 38, 167-174, 223-231, 253-265.

(Anon.). 1902. "Notes relating to coast erosion in Essex and Suffolk". Essex Naturalist, vol. 12, pp. 221-224.

Willson, B. 1902. "Our Lost England".

Willson, B. 1902. "The Story of Our Submerged Coasts."

Geikie, A. (Sir). 1903. "Observations on Changes in the Sea Coast of the United Kingdom." Brit. Assoc. (Southport), 258-281.

Spillar, J. 1904. "Recent Coast Erosion in Suffolk? Dunwich to Cove Hithe". Brit. Assoc. (Cambridge), pp. 544-545. Geol. Mag., vol.41, pp.502-504.

Spillar, J. 1904. "Coast Erosion in East Anglia". Essex Naturalist, vol. 13, p. 362.

Royal Commission. 1907. First Report on Coast Erosions.

Redstone, V. B. 1908. "Memorials of Old Suffolk". London.

Whitaker, W. 1909. "On the Geological Conditions affecting the Coasts of England and Wales, with Special Reference to the Coastline from Lynn to Wells, Norfolk, and from Yarmouth to Eastbourne, Suffolk, Essex, Kent and Sussex". Geol. Mag., vol.46, pp.49-56; 113-119.

Royal Commission. 1911. Third report on coast erosion. London.

Oliver, F. W. I913. "Part 1 -Topography" (Blakeney Point, Norfolk). Trans. Norfolk & Norwich Nat. Soc., 9, 486-50I.

Reid, C. 1913. "Submerged Forests". C. U. P.

Hill, E. 1915. "Coast erosion in Norfolk", (letter). Geol. Mag., 52, 476.

Patterson, A. H. 1916. "The January' Flood of 1916 at Great Yarmouth". Trans. Norfolk & Norwich Nat. Soc., 10, 162-167.

Cooper, E. R. 1925. "The Suffolk Coast". Journ. Ipswich & District Nat. Hist. Soc., vol.1, pp.49-68.

Steers, J. A. 1925. "The Suffolk Shore". Suffolk Inst. Archaeol. and Nat. Hist., vol.19, 1.

Oliver, F. W. 1926. "Report of the Blakeney Point Research Station, 1924-6". "Trans. Norfolk & Norwich Nat. Soc. 12, 207-228.
Steers, J. A. 1926. "Orford Ness. A Study in Coastal Physiography." Proc. Geol. Assoc., vol. 37, pp.306-325.
Boswell, P. G. H. 1928. "The Geology of the Country around Woodbridge, Felixstowe and Orford". Mem. Geol. Surv.
Steers, J. A. & Thomas, H. D. 1929. "Visit to Blakeney Point and Hunstanton". Proc. Geol. Assoc., 40, 353-356.
Francis, A. G. 1932. "On subsidence of the Thames estuary since the Roman period, at Southchurch, Essex." Essex Nat., 23, 151-170.
Slater, L. 1932. "Sedimentation in the Salt Marsh on Scolt Head Island." Trans. Norfolk Norwich Nat. Soc., 13, 133-40.
Johns, C. 1934. "Significance of the British Quaternary Strandline Oscillations." Geol. Mag., 71, 66-76.
Johns, C. 1934. "The Quaternary Changes of Ocean Level." Geol. Mag., 71, 408-424.
Steers, J. A. & Thomas, H. D. 1935. "Report of Week-end Field Meeting at Scolt Head Island & Hunstanton". Proc. Geol. Assoc., 46, 65.
D. R. 1936. "The city beneath the sea". East Anglian Mag., Sept. 36, pp.642-644.
Warren, S. H., Piggott, S., Clark, J. B., Burkitt, M. C., Godwin, H & Godwin, M. E. 1936. "Archaeology of T he Submerged Land-surface of the Essex Coast." Proc. Prehistoric Soc., 2, 178-210.
Mobbs, S. W. 1937. "The plight of East Anglia*s seaboard." East Anglian Mag., Nov. 1937, pp.58-63.
Steers, J. A. 1938. "Scolt Head Island Report for 1936-7 and some notes on the North Norfolk Coast." T rans. Norfolk Norwich Nat. Soc. 14, 210-6. (also Scolt Head Island notes by Steers and others in Trans. Norfolk & Norwich Nat. Soc., vol. 12, pp. 229-254; vol. 13, pp.324-329; vol. 14, pp.55-60, 131-137, 391-397; vol. 15, pp. 41-46).
Mosby, J. E. C. 1939. "The Horsey Flood, 1938". Geogr. Journ., vol.93, p.413.
Sainty, J. E., Mosby, J. E. G., Buxton, A. & Ellis, E. A. 1939. "The Norfolk Sea Floods, Feb. 1938". Trans. Norfolk & Norwich Nat. Soc., vol. 14, pp. 334-390.
Steers, J. A. 1941. "The Physiography of East Anglia." Trans. Norfolk Norwich Nat. Soc. 15, 231-258.
Steers, J. A. 1948. "Accretion on Scolt Head Island Marshes." Trans. Norfolk & Norwich Nat. Soc., vol.16, p.280-282.
Steers, J. A. 1948. "Note on the New Map of Blakeney Point". Trans. Norfolk & Norwich Nat. Soc., vol.16, 283.
Steers, J. A. 1948. "The Sea Coast." Cambridge.
Steers, J. A. 1949?. "The Coast of East Anglia." New Naturalist, no.6, pp.4-15.
Mander, R. P. 1951. "Lost East Anglia." East Anglian Mag. Jan.51, 296-300 (letter March 51, 399-400).
Steers, J. A. 1951. "Notes on Erosion Along the Coast of Suffolk." Geol. Mag., vol.88, pp.435-439.
Steers, J. A. 1952. "Recent Changes in the Marshland Coast of North Norfolk." Trans. Norfolk & Norwich Nat. Soc., vol. 17, pp.206-213.
Green, C, Larwood, G. P. & Martin, A. J. 1953. "The Coastline of PIegg: from Caister Point to Hemsby Gap, Norfolk." Trans. Norfolk Norwich Nat. Soc., vol. 17, pp.327-342.
Grieve, H. 1953. "The Great Tide. The story of the 1953 flood disaster in Essex." Chelmsford.
Robinson, A. H. W. 1953. "The Changing Coastline of Essex." Essex Naturalist, vol. 29, pp.78-93.
Steers, J. A. & Jenson, H. A. P. 1953. "Winterton Ness." Trans. Norfolk & Norwich Nat. Soc., vol. 17, p.259- 274.
1953. (Coast erosion at Cley). letter and photo., Feb. 53, 226. East Anglian Mag.
Mayes, W. J. 1954. "The vulnerable coast." East Anglian Mag. March 54, 242-248 (letter June 54, 484).
Steers, J. A. & Grove, A. T. 1954. "Shoreline Changes on the Marshland Coast of Norfolk, 1951-3." Trans. Norfolk & Norwich Nat. Soc., vol.17, pp.322-326.1954. (Coast erosion at Pakefield). East Anglian Mag., letter & photo. May 54, 395.
Beaufoy, A. 1956. "Coastal Erosion." (Notes and observations). Trans. Suffolk Nat. Soc., vol. 9, p. 372.
Williams, W. W. 1956. "An east coast surveys some recent changes in the coast of East Anglia." Geogr. J., 22, 317-334.
1956. (Coast erosion and exposed wells at Easton & Pakefield). East Anglian Mag., letter and photo, July 56, 533.

Cobb, R. T. 1957. "Shingle Street - a brief geographical introduction." Annual report of the Field Studies Council, 1956/57. pp.31-42.

Spencer, H. E. P. 1957. "The Changing Suffolk Coast." Trans. Suffolk Nat., Soc., 10, 123-125.

Kidson, C, Carr, A. P. & Smith, D. 1958. "Further experiments using radioactive methods to detect movement over the sea-bed and elsewhere." Geogr. J., 124, 210-218.

Chapman, V. J. 1938, 1939, 1941, 1959. "Studies in Salt-marsh Ecology," I-V, VIII, IX." J. Ecol., 26, 27, 29, 17.

Cobbold, M. H. 1959. "East Anglia under the sea." East Anglian Mag., Feb. 59, pp. 182-9 (letter July 59, p. 529).

Kidson, C. & Carr, A. P. 1959. "The movement of shingle over the sea-bed close inshore". Geogr. J., 125, 380-389.

Anon. 1960. "Clacton coast protection works completed." Civ. Eng. and Pub. Works Review, Nov. (No. 652), 1432-33.

Steers, J. A. 1960. "Defence against the Sea." Adv. of Science, 17, 7-15.

Steers, J. A. 1960. "The Coast of England and Wales in pictures." (2nd. edtn.).

Steers, J. A. 1960. "Scolt Head Island"'(including info, on Salt Marsh Ecology). Heffer, Cambridge.

Chatwin, C. P. 1961. "East Anglia and Adjoining Areas". (4th. ed.). British Regional Geology.

Green, C. T. 1961. "East Anglian Coast-line levels since Roman times." Antiquity, 35, 21,

Jelgersma, S. 196I."Holocene sea-level changes in the Netherlands."Meded. gebl. Sticht. Ser. C-VI, no. 7.

Hallam, S. 196I. "Wash Coast-Line Levels since Roman Times." (Notes and News) Antiquity, 35, 152-156.

Kidson, C. 196I. "Movement of beach materials on the East Coast of England." East Midland Geographer, no. 16.

Lambert, J. M. 196I. "The chief Norfolk habitats" in ‘Norwich and its Region’, 51-58. Brit. Assoc. Adv. Sci., Jarrold, Norwich.

Steers, J. A. 1961. "The Physical Background: Physiography", in 'Norwich & its Region’, 31-41. Brit. Assoc. Adv. Sci. Jarrold, Norwich.

Carr, A. P. 1962 "Cartographic record and historical accuracy". Geography, 47 (2), 135-144.

Kestner, F. J. T. 1962. "The Old Coastline of the Wash." Geogr. J., 128, 457-478.

Bird, E. C. F. & Wain, J. 1963. "Changes at Blakeney Point since 1953". Trans. Norfolk Norwich Nat. Soc., 20, 1.

Hutchinson, J. N. 1963. "The Coastal Landslip of May, 1962, between Cromer and Overstrand, Norfolk." ull. Norfolk Research Committee, no. 15, p. 4.

Markham, R. A. D. & Barnes, R. M. 1963. "Norfolk Scenery." Norwich Museums.

Anon. 1964. (Photograph of Frinton slip of 6th. September 1964). The Times, 8 September 1964.

Steers, J. A. 1964. "The Coastline of England and Wales." (2nd. edn.).

Carr, A. P. 1965. "Shingle spit and river mouths short term dynamics." Trans. Institute of British Geographers, 33, 117-129.

Churchill, D. M. 1965. "The displacement of deposits formed at sea level 6,500 years ago in Southern Britain." Quaternaria 7, 239.

Green, C. & Hutchinson, J. N. 1965. "Relative land and sea levels at Great Yarmouth." Geogr. J. 131? 86.

Greensmith, J. T. & Tucker, E. V. 1965. "Salt Marsh Erosion in Essex." Nature, 206, 606-607.

Clymo, R. S. 1966 "Movement of the Main Shingle Bank at Blakeney Point, Norfolk,” Trans. Norfolk & Norwich Nat. Soc., vol. 21, pp.3-6.

Clymo, R. S. 1966. "Accretion Rate in Two of the Salt Marshes at Blakeney Point, Norfolk." Trans. Norfolk & Norwich Nat. Soc., 21, 17-18.

Greensmith, J. T. & E. V.Tucker. 1966 "Field Meeting at Bradwell, Essex". Proc. Geol. Assoc., 77, 281-282.

Greensmith, J. T. & Tucker, E. V 1966. "Morphology and Evolution of Inshore Shell Ridges and Mud -Mounds of Modern Intertidal Flats, near Bradwell, Essex." Proc. Geol. Assoc, 77, 329-346.

Hydraulics Research Station. 1966. "Erosion - Gorleston Beach." Preliminary Report.

Robinson, A. H. W. 1966. "Residual currents in relation to shoreline evolution of the East Anglian Coast." Marine Geology, 4, 57-84.

1966. "Orford Ness - a selection of maps mainly by John Norden." W. Heffer & Sons Ltd., Cambridge.

Markham, R. A. D. 1967. "Some examples of recent induration from the. Norfolk coast" Bull. Ipswich Geol. Group, no. 3, p. 6.

Carr, A .P. 1969. "The Growth of Orford Spits Cartographic and Historical Evidence from the Sixteenth Century." Geogr. J., 135, 28-39.

Greensmith, J. T. & Tucker, E. V. 1969. "The Origin of Holocene Shell Deposits in the Chenier Plain Facies of Essex, England." Marine Geology, 7, 403-25.

Carr, A. P. 1970. "The Evolution of Orfordness, Suffolk, before 1600 A.D.s Geomorphological Evidence." Zeits. fur. Geomorph., 14, 289-300.

Markham, R. 1970. "Aldeburgh. Beachcombing." Bull. Ipswich Geol. Group, no. 8, pp. 17-18.

Craig-Smith, S. J. 1971. "Report on the behaviour of 14 selected beach sections during the six months January to June 1971".East Anglian Coastal Study - Report 1.

Craig-Smith, S. J. 1971. "Gorleston Beach." East Anglian Coastal Study - Report 2.

Craig-Smith, S. J. 1971. "The Changing system." East Anglian Coastal Study - Report 3.

Greensmith, J. T. & Tucker, E. V. 1971. "The Effects of Late Pleistocene and Holocene Sea-Level Changes in the Vincinity of the River Crouch, East Essex." Proc. Geol. Assoc., 82, 301-22.

Carr, A. P. 1972. "Aspects of spit development and decays the estuary of the River Ore, Suffolk." Fld. Stud., 4, 633-653.

Craig-Smith, S. J. & Cambers, G. 1972. "Report on a Field Meeting to the Norfolk Coast at Yarmouth and Sidestrand." Bull. Geol. Soc. Norfolk, no. 21, pp.29-40.

West, R. G. 1972. "Relative land - sea-level changes in southeastern England during the Pleistocene." Phil. Trans. R. Soc. Lond. A. 272, 87-98.

Funnell, B. M. 1973. "Environmental Geology of Sheringham." Bull. Geol. Soc. Norfolk, no. 24, pp.37-44.

Randall, R.E. 1973- "Shingle Street, Suffolk? an analysis of geomorphic cycle." Bull. Geol. Soc. Norfolk, no. 24, pp.15-35.

Tucker, E. V. & Greensmith, J. T. 1973. "Itinerary II. South East Essex. A. East Mersea. B. Sales Point, Bradwell-on-Sea.", In Geologists1 Association Guide No. 12, The Estuarine Region of Suffolk and Essex.

R. M.

A GUIDE TO THE- TAXODONT BIVALVE MOLLUSCS OF THE CRAG.

These notes should be used in conjunction with illustrations of the fossils in the publications mentioned and where possible with identified specimens.

The hinge of this group of molluscs is taxodont, i.e. there are numerous alternating small teeth and sockets. There are five main groups – 'Nucula', 'Leda', Arca, Glycymeris, and Limopsis.

KEY TO MAIN GROUPS

Anterior and posterior rows of teeth each side of internal ligament pit (small triangular pit below beaks);

- Shell roughly triangular, no pallial sinus ……………………………………………………..."Nucula"
- Shell elongate; pallial sinus present ……………………………………………………………."Leda"

Teeth arranged in a continuous line across the hinge line; ligament external

Circular to oval outline

- Ligament pit below and on either side of beaks ………………………………………... Glycymeris
- Ligament pit immediately below beaks ………………………………………………………. Limopsis

Shell longer than deep:

- Ligament area wide (not triangular area as in Glycymeris and Limopsis) …..… Arca'

NUCULA

Three groups may be recognised, using the following key;-

Lower margin of shell notched inside (crenulate)………………………………………………Nucula (Nucula *s.s.)*

Lower margin of shell smooth inside

- External sculpture of zig-zag grooves and ridges …………………………..……….. Acila
- Smooth surface ………………………………………………………………………………….….Nucula (Nuculoma of some authors}

Nucula (*s.l.)* is used for all these groups in many publications.

Acila cobboldiae (J. Sowerby, 1817).

Nucula cobboldiae	J. Sowerby, 1817. PI. 180, fig. 2.
Nucula cobboldiae	S. V. Wood, 1851. p. 82. PI, X, figs. 9a-b,
Nucula cobboldiae	S. V. Wood, 1874. p. 111. PI. X, fig. 2.

Young specimens generally have only one series of diverging lines5 in older specimens the lines show the characteristic oblique zig-zac pattern, although the marginal area may be free of these markings.

A. Bell (1871, p. 353) referred an imperfect specimen from Butley to Nucula (Acila) lyallii (a living Pacific species), but Wood (1874, p. 112) thought it to be cobboldiae.

Nucula (Nuculoma group).

Nuculoma laevigata (J. Sowerby, 1818)

Nucula laevigata	J. Sowerby, 1818. p. 207. PI. 192, figs. 1, 2.
Nucula laevigata	S. V. Wood, 1851. p. 81. PI. X, fig. 8a-b.
Nucula laevigata	S. V. Wood, 1874. P. 113. PI. VIII, fig. 5a-b.
Nuculoma laevigata	v. Reg. Altena, et al, 1962. p.7. PI. 1, fig. 3.

A large species. One side is much produced, the other shorter and usually angulated; the lunule is deeply impressed. In 1874 S. V. Wood described the variety calva, which is smaller, more truncate, and without the projecting part of the margin at the shorter side of the valve.

Nuculoma tenuis (Montagu, 1808).

Nucula tenera	S. V. Wood, 1840(a). p. 295. PI. 14, fig. 2
Nucula tenuis	S. V. Wood, 1851. p. 84. PI. X, fig. 5a-b.
Nuculoma tenuis	v. Reg. Altena, et al, 1962. p. 7. PI. 1, fig. 3.

N. tenuis may be distinguished from N. laevigata by its general outline. N. tenuis is less transverse and has a more rounded edge outline than laevigata. Fully grown, tenuis is smaller and shorter (less than ½ins) than laevigata (over 1¼ins).

Nucula (Nucula Group)

Living British species are difficult to identify, the general outline of the shell being useful in distinguishing them (Tebble, 1966, p. 24).

In 1840 (a) S. V. Wood identified two Crag species, Nucula nucleus (p. 294, PI. 14, fig. l) and the one he named N. trigonula (p. 295; PI. 14, fig. 3); Wood gave the same species in 1851 - N. nucleus (p. 85; PI. X, fig. 6a-b) and N. trigonula (p. 865 PI. X, fig. 7a-b). Jeffreys (in Prestwich, 1871, p.140) referred N. trigonula of Wood to N. proxima, a living North American species. In 1872, A. and R. Bell (p. 211) gave specific status to N. radiatra as a Crag shell, but other authors have referred to such Crag forms as a variety of N. nucleus: however it is given specific status (as N. hanleyi) as a living British shell. In 1874 S. V. Wood (p. 113, PI. X, fig. 12) gave N. nitida as a Crag shell. N. turgida or N. nitidosa is the name now given to the living mollusc. In 1879 Wood named another Crag form, N. turgens (p. 44, PI. V, fig. 6a-b): he knew of only one specimen. Some crag shells in museum collections are named as N. sulcata, but the name does not appear to have been published in reference to crag specimens.

As mentioned above, living species (British) may be distinguished by their general outlines. However, some specimens in the Crag may be intermediate, and a study of Nucula *s.s.* of the North Sea basin from Miocene to Recent would be useful in understanding the relationships of the various forms, varieties and 'species' which have been descibed. At present, after van Regteren Altena et al (1962) I use only the generic name Nucula (Nucula) sp.; shape variations may be described as varieties.

Nucula trigonula of Wood (N. proxima, after Jeffreys) is a distinct Crag form within the Nucula *s.s.* group, and Irrespective of its status (species, variety, or young form) it may be best, until more is known of the history of Nucula, to retain Wood's name trigonula, which refers to the Crag shell, rather than to equate the shell with the living American form.

N. proxima is often given as named by Say in 1822 (Journ. Acad. Nat. Sci. 2, p. 270), but reference by Say in 1820 (Amer. Journ. Sci., 1st. ser. 2: 40) is earlier.

"LEDA"

A key to the Crag 'Leda's is given below.

Not keeled ………………………………………………………………………….Jupiteria pygmaea

Keeled (posterior end extended into a keel)

- Keel bicarinate ………………………………………………………….. Nuculann minuta
- Not bicarinate

Smooth exterior…………………………………………..Yoldia oblongoides

Striated exterior

Oblique striations………………………………..Yoldia lanceolata

Centre of shell transversely striated……….Yoldia semistriata

Jupiteria pygmaea	(von Munster, 1837)
Nucula pygmaea	S. V. Wood, 1840. p. 298. PI. 14, fig. 7.
Nucula philippiana	Nyst, 1844. p. 224. PI. 17, fig, 5a-c.
Leda pygmaea	S. V. Wood, 1851. p. 95. PI. X, fig. 11a-b.
Jupiteria pygmaea	Altena, 1962. p. 9. PI. 1, fig. 9

The Crag shell was identified with the living species by S. V. Wood. In 1932 R. Winckworth (J. Conch., 19, 239 and 251) recognised that the living British species called Leda pygmaea was not the same as Nucula pygmaea of Munster, and he proposed the name Yoldiella tomlini for the British shell. Bowden & Hepple (1966, p. 112), referring to the shell, give reasons for adopting philippiana Nyst 1844, an earlier name, instead of tomlini. Ag Nyst's work was on Belgian fossil shells, philippiana may be an appropriate name for the Crag shell. However, van Regteren Altena (1962, p. 9) calls this species Jupiteria pygmaea, after Leda pygmaea of von Munster in Goldfuss 1837, with Nucula pygmaea von Munster 1835 being considered nom. nud.; I have here followed Altena.

This is a very small shell, with a more oval outline than others in this group.

Nuculana minuta (Muller, 1776).

Nucula minuta	S. V. Wood, 1840(a). p. 298. PI. I4, fig. 6.
Leda caudata	S. V. Wood, 1851. p. 92. PI. X, fig. 12a-b.
Leda minuta	Jeffreys, 187I. p. 483.

Two ridges extend from the beak to the posterior, giving its characteristic bicarinate form. There is clear concentric sculpture over the whole of the surface.

Heering (1950, p.20) gives (as Leda pernula) Nuculana pernula (Muller, 1779), a living Arctic species, from the Icenian Crag of Bramerton. N. minuta and N. pernula are related shells, and the relationships of the modern forms to the Crag shell would appear to require further Crag specimens for study.

van Regteren Altena et al (1962, p.9, PI.1,fig.8) record Portlandia intermedia (M. Sars,1865), a living Arctic species, from the Lower Pleistocene of the Netherlands. This has not been recorded from the English Crags. It is a thin, oval, and obliquely truncated shell.

Yoldia oblongoides (S.V.Wood, 1840).

Nucula oblongoides	S.V.Wood, 1840(a), p.297. PI.14, fig.4.
Leda myalis	S.V.Wood, 1851. p.90. PI.X, fig.l7a-e.
Leda hyperborea	A.Bell, 1870.
Yoldia oblongoides	S.V.Wood, 1874- p.114.
Yoldia myalis	Heering, 1950. p.24. PI.9, fig.9-12

I here include the various Crag shells called oblongoides, myalis and oblongoidea under the name oblongoides. S. V. Wood called the Crag shell oblongoides in 1840, but in 1851 referred it to myalis, a living North American species. A. Bell added hyperborea, a living Arctic species, to the Crag fauna in 1870. Opinions of authors have varied since then as to the number of species in the Crag, what specific name(s) they should have, and as to whether certain forms are restricted to certain beds (e.g. to the 'Leda myalis1Bed' of Norfolk). Myalis and- oblongoides have both been used by authors as a name for this shell during the last decade.

I here call the Crag shell obiongoides because the various forms in the Crag are all closely related, and because the name oblongcides was originally given to a Crag shell, and does not lead to possible confusion with other names originally applied to non-Crag shells.

A. Bell (1911) gives Leda limatula from the Crag of Beccles; Bell's specimen was perhaps a member of the oblongoides group.

Yoldia lanceolata (J. Sowerby, 1817).

Nucula lanceolata	J. Sowerby, 1817.PI. 180, fig.l.
Nucla oblonga	S. V. Wood, 1840. p.296.
Leda lanceolata	S. V. Wood, 1851. p.88. Pl.X, fig.16a-b.
Nucula arctica	Jeffreys, 1871. P.483.

A thick shell. Externally, the lines of growth are cut at a small angle by striae which cross the shell in an oblique direction.

Yoldia semistriata (S. V. Wood, 1840).

Nucula semistriata	S. V. Wood, 1840. p.297. PI.14, fig.5
Leda seraistriata S	S. V. Wood, 1851. P. 91. PI.10, fig.10a-b.

The central part of the exterior is transversely striated.

Wirtz (1949, p.73) –gives Yoldia glaberrina Muenst. from the Coralline Crag. This species occurs in pre-Pliocene beds on the Continent: it is similar to Y. semistriata, and it may be that Wirtz's specimens belong to this group.

GLYCYMERIS.

Glycymeris da Costa 1778 is earlier than Pectunculus Lamarck 1791.

In 1824 J. Sowerby (p. 117: plate 471, fig.1) named the Crag shell Pectunculus variabilis. S. V. Wood (1840,a) referred the Crag shells to two species, P. pilosus (Plate 13, fig. 7) and a form he named P. subobliquus (p.233$ plate 13, fig.6). In 1851 Wood (p.66; PI. IX, fig.la-h) referred the Crag shell to P. glycimeris, with subobliquus as a variety. A. Bell (1871, p.353) added P. insubricus and also P. pilosus. In 1879 Wood (p.43) mentions P. pilosus var. insubricus (plate VI, fig.4a-b) also plate IX, fig.1d of 1851) and P. pilosus var. numraarius (plate VI, fig.5.b). Heering (1950, p.34) says that Wood's P. pilosus var. insubricus resembles Glycymeris pilosa var. tumida rather than G. insubrica.

There are two main forms in the Crag-

(a) a thick tumid variety, round, and with a prominent protruding beak
-it has usually been called pilosa.
-this is the prevailing form in the Coralline Crag; Wood noted that in some Coralline Crag specimens with double valves, one valve had a greater tumidity than the other.
(b) a thinner, flatter .variety, the beak hardly protruding.
-it has usually been called glycymeris.
-this Crag form generally has a greater length (transverse variety) in comparison to its height than does the recent (living) G. glycymeris, although an elongated variety occurs. Wood's var. subobliquus is an oblique form of this Crag shell.

At the present day Glycymeris glycymeris is a living British form and G. pilosa a Mediterranean form. If the specific names glycymeris and pilosa are restricted to the recent shells, the Crag forms may be-

(i) given as varieties of the living species, e.g. G. pilosa var. tumida and G. glycymeris variabilis (after Heering, 1950, pp. 30-34), or, G. glycymeris forma tumida and G. glycymeris forma variabilis (after Gilbert, 1957, p. 16).
(ii) revert to J. Sowerby's original 1824 specific name for the Crag shell (after van Regteren Altena, et al, 1962, p. 16). Glycymeris variabilis (J. Sowerby-, 1824) seems an appropriate name for this variable Crag shell.
(iii) given another name, e.g. G. lunulata baldii for the former- P. pilosus (see Laga, 1973, p.13).

I have here used only the generic name Glycymeris for this variable group; varieties may be described by thickness, tumidity, form of beak and shape of outline.

ARCA.

I here use the well-known name Arca other generic names are in use and are noted below.

Key to species--

Teeth much the same size
Ventral margin with wide gape……………………………………….A. tetragona.
Ventral margin without gape………………………………………. A. lactea.
Teeth very small in centre of hinge line, and larger at ends……… A. pectunculoides.

Arca tetragona Poli, 1795.

Arca noae	S. V. Wood, 1840(a) p. 231. PI. 13, fig. 2 and 2a.
Arca tetragona	S. V. Wood, 1851. p. 76. PI. X, fig. 1a-d.
Arca tetragona	S. V. Wood, 1879. P. 44. PI. VI, fig. 8a-b.

Posterior side angular, with prominent ridge from umbo to posterior ventral margin.

Bell & Bell (1872, p. 204) gave Arca nodulosa (?) from Coralline Crag, but Wood (1879, p. 44, also PI. VI, fig. 8a-b) referred the specimen to A. tetragona. Arca puella has also been .suggested for this form, with coarser ornament than usual. Jeffreys (1871) referred the Red Crag shells to Arca imbricata, but Wood (1874) did not agree.

Arca lactea Linnaeus, 1758.

Arca lactanea	S. V. Wood,1840(a). p. 232. PI. 13, fig. 3.
Arca lactea	S. V. Wood, 1851. P.77. PL X, fig. 2a-b.
Striarca lactea	Glibert, 1957. p. 18.

Rather rhomboidal in outline.

van Regteren Altena, et al, (1962) record Bathyarca philippiana (Nyst, 1848) from the Plio-Pleistocene of the Netherlands, and suggest that previous records of lactea from the Netherlands are philippiana.

B. philippiana has longitudinal furrows on its ligament: area, whereas A. lactea has transverse stripes. Crag examples may be worn, in which case Wood's name A. lactanea could perhaps be used to cover this group.

Arca pectunculoides Scacchi, 1834.

Arca raridentata	S. V. Wood, 1840(a). p.232. PI. 13, fig. 4.
Arca pectunculoides	S. V. Wood, I85I. p.79. PL X, fig. 3a-b.
Bathyarca pectunculoides	Glibert, 1957- p.18.

3-5 large teeth at ends of hinge.

van Regteren Altena, et al (1962) record Barbatia barbata (Linnaeus, 1758) from the Plio-Pleistocene of the Netherlands.

LIMOPSIS.

Limopsis aurita (Brocchi, 1814)

Pectunculus sublaevigatus	S. V. Wood, 1840. b) _ Catalogue.
Limopsis aurita	S. V. Wood, 1851. p.70. PL IX, fig.2.

L. aurita may be distinguished from the young of Glycymeris as L. aurita has a smooth margin and Glycymeris has a crenulated edge. Older specimens especially are more or less obliquely oval.

Limopsis anomala (Eichwald, 1830).

Pectunculus pygmeaus	S. V. Wood, 1840(a). p.234. PL 13, fig. 5.
Limopsis pygmaea	S. V. Wood, 1851. p.71. PL IX, fig. 3.
Pectunculina anomala	Glibert, 1957. p. 17.

L. anomala may be distinguished from L. aurita by its having a crenulated margin (aurita has a smooth margin). The shape of the shell and of the hinges-line also differ in the two species.
Older specimens especially, are tumid.
anomala Eichwald, 1830, has priority over pygmaea Philippi, 1836.

PLEURODON.

Pleurodon ovalis S. V. Wood, 1840.

Pleurodon ovalis	S. V. Wood, 1840(a). p. 231. Pl. 13, fig. 1.
Pleurodon miliaris	S. V. Wood, 1840(b). Catalogue.
Nucinella miliaris	S. V. Wood, 1851. p. 73. Pl. X, fig. 4a-c.
Nucinella ovalis	Reid, 1890. p. 271.

Form rather like Nucula, but the ligament is external. The teeth are linear, and there is one large lateral (side) tooth.
miliaris of Deshayes, 1829, is an Eocene form.

SOME PUBLISHED RECORDS OF OCCURRENCES OP CRAG TAXODONT BIVALVES.

(these records have not been checked by reference to the specimens.).
CC - Coralline Crag. RC - Red Crag. IC - Icenian Crag. FB - Forest Bed.

Acila cobboldiae
RC - Sutton, Bawdsey, near Ipswich, Felixstowe, Waldringfield, Butley (Wood), Walton-Naze (Kendall).
IC - Thorpe Norfolk, Bramerton, Chillesford, Bulchamp, Thorpe by Aldbro, Yarn Hill, Aldeby, Easton Bavent, Belaugh, Weybourn (Wood), Brundall, East Runton (Mus. Pract. Geol.) .
FB - (Reid).

Nucula laevigata
CC - Sutton, Orford (Wood), Boyton (Bell), Gedgrave (Jeffreys).
RC - Walton-Naze (Wood), Waldringfield, Butley (Jeffreys), Felixstowe (Wood), Boyton (Mus. Pract. Geol.).
IC - (Bell).

Nucula tenuis
CC - Gedgrave (Jeffreys),
RC - Bawdsey (Wood), Walton-Naze, Waldringfield (Jeffreys), Butley (Morley).
IC - Chillesford (Wood), Bramerton, Easton Bavent, Aldeby (Jeffreys).

Nucula
CC - Sutton, Ramsholt, Sudbourne, Gedgrave, Orford, Boyton.
RC - Sutton, Bawdsey, Felixstowe, Butley, Waldringfield, Walton-Naze.
IC - (Bell).

Yoldiella philifappiana (Leda pygmaea)
CC - Sutton, Ramsholt, Gedgrave (Wood). RC - Walton-Naze (Bell).
IC - (Bell). Nuculana minuta
RC - Sutton (Wood), Bawdsey (Morley).

Yoldia oblongoides
RC - Sutton, Butley (Wood).
IC - Chillesford, Bramerton, Thorpe, Bulchamp, Thorpe by Aldbro, Yarn Hill, Aldeby, Easton Bavents, Horstead, Coltishall, Burgh (Wood), Wangford (Morley), Sudbourne, Southwold (Mus. Pract. Geol.).

Yoldia lanceolata
RC - Bawdsey (Wood), Butley (Jeffreys).
IC - Chillesford (Wood), Bramerton (Jeffreys).

Yoldia semistriata
CC - Sutton, Ramsholt (Wood), Orford (Jeffreys).
RC - (Bell).
IC - (Bell).

Glycymeris

CC - Ramsholt, Sutton (Wood), Sudbourne, Gedgrave, Aldeburgh (Morley), Orford (Mus. Pract. Geol.), Boyton (Bell)

RC - Walton-Naze (Wood), Sutton, Ramsholt, Ufford, Bentley, Bawdsey, Tattingstone, Shottisham, Newbourn, Foxhall, Chillesford, Butley (Morley), Felixstowe (Mus. Pract. Geol.).

IC - Bramerton, Thorpe Norfolk, Thorpe Suffolk (Jeffreys), Aldeby (Wood).

Arca tetragona

CC - Ramsholt, Sutton, Sudbourne, Gedgrave (Wood).

RC - Sutton (Wood), Butley (Jeffreys), Walton-Naze (Kendall).

Arca lactea

CC - Sutton (Wood), Sudbourne (Morley), Boyton (Bell).

RC - Sutton, Walton-Naze (Wood), Butley (Jeffreys).

Arca pectunculoides

CC - Sutton (Wood), Gedgrave (Jeffreys).

Limopsis aurita

CC - Gedgrave (Wood), Orford (Jeffreys), Sudbourne, Sutton (Morley).

RC - Waldringfield (Bell), Foxhall (Morley).

Limopsis anomala

CC - Sutton (Wood), Gedgrave (Jeffreys), Ramsholt, Sudbourne (Morley).

RC -Walton-Naze, Waldringfield, Felixstowe (Bell), Chillesford (Morley).

Pleurodon ovalis

CC - Ramsholt, Sutton (Wood), Gedgrave (Jeffreys)

REFERENCES

Bell, A. (1870). "On some New or Little-known Shells, &c. of the Crag Formation1'. Ann. Nat. Hist., ser. 4, 6, 213.

Bell, A. (1871). "Contributions to the Crag Fauna". Ann. Nat. Hist., ser.4, 7, 351.

Bell, A. (1911). "On the Zones of the East Anglian Crags". Journ. Ipswich & District Field Club, 3, 5.

Bell, A. & Bell, R. (1872). "On the English Crags and the Stratigraphical Divisions indicated by their Invertebrate Fauna." Proc. Geol. Assoc., 2, I85.

Bowden, J. & Heppell, D. (1966). "Revised List of British Mollusca. I. Introduction; Nuculacea-Ostreacea. “. Journ. Conchology, 26, 99.

Glibert, M. (1957-1958). "Gastropods et Pelecypodes du Diestien, du Scaldisien et du Merxemien de la Belgique". Bull. Inst. roy. Sci. Nat. Belg., 33 & 34.

Heering, J. (1950). "Pelecypoda (and Scaphopoda) of the Pliocene and Older-Plistocene deposits of the Netherlands". Meded. geol. Sticht. Ser. C-IV-1, no. 9.

Kendall, P. P. (1931). "The Red Crag of Walton-on-the-Naze". Geol. Mag., vol. LXVIII.

Laga, P. G. (1973). "The Neogene Deposits of Belgium." Guide book for Geologists’ Association field meeting.

Morley, C. (1934). "A Table for Naming Bivalve Shells of the Crag". Trans. Suffolk Nat. Soc., vol. 2, pp. 232-262.

Newton, E. T. (1878). "A Catalogue of the Tertiary and Post Tertiary Fossils in the Museum of Practical Geology." London.

Nyst, P. H. (1843-1846). "Description des coquilles et des polypiers fossiles des terrains tertiaries de la Belgique". Mem. cour. Mem. Sav. etr. Acad. r. Sci. Belgique, 17.

Prestwich, J. (1871). "On the Structure of the Crag-beds of Suffolk and Norfolk, with some Observations on their Organic Remains". Quart. Journ. Geol. Soc., 27, 115, 453.

Reid, C. (1890). "The Pliocene Deposits of Britain". Mem. Geol. Surv.

Sowerby, J. (1812-1829). "The Mineral Conchology of Great Britain." London.

Tebble, N. (1966). "British Bivalve Seashells." Brit. Mus.(Nat. Hist.), London,

van Regteren Altena, C. O., Bloklander, A. & Pouderoyen, L. P. (1962). "De fossiele schelpen van de Nederlandse stranden en zeegaten (tweede serie, 1). Basteria, 26, 5.

Winckworth, R. (1932). "The British marine Mollusca". Journ. Ccnch., 19, 211.

Wirtz (1949). (reference to be given in a future bulletin.

Wood, S. V. (1840,a). "On the Fossil Shells of the Crag". Mag« Nat. Hist., ser. 2, vol. iv
Wood, S. V. (I840,b). ”A Catalogue of shells from the Crag". Ann. Nat. Hist., vol. vi.
Wood, S. V. (1851-1861). "A Monograph of the Crag Mollusca, Vol. II. Bivalves. Monograph Palaeontographical Society, London.
Wood, S. V. (I874). "Supplement to the Crag Mollusca .... Part II. Bivalves." Palaeontograph. Soc. London
Wood, S. V. (1879). "Second Supplement to the Monograph of the Crag Mollusca. Palaeontograph. Soc, London.

R. Markham.

ADDENDA TATTINGSTONE HALL.

(see Ipswich Geol. Group Bull. no. 15, pp. 6-8).

No systematic collecting of Red Crag fossils was undertaken, but the following were noticed during the course of the ‘digs’.

Glycymeris	Turritella incrassata
Cardium edule	‘Nassa’ reticosa
C. "parkinsoni "	Neptunea contraria
C. (Laevicardium)	N. sp.
Spisula	Trivia
Gastrana laminosa	Buccinum
Macoma obliqua	Searlisia costifera
M. praetenuis	
Chlamys opercularis	
C. harmeri	
Pecten	
Ensis	
Mytilus edulis	
Dosinia exoleta	Balanus
Mya arenaria	
Pygocardia rustica	
Ostrea	
Astarte obliquata	
Astarte sp.	
Cardita senilis	
Corbula	Balanophyllia calicula (coral)

R. M.