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The Pleistocene Vertebrate Faunas of West Runton, Norfolk, England

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SUMMARY

West Runton, on the Norfolk coast, is the most important single fossil vertebrate locality of the Cromer Forest Bed Formation. The Lower Pleistocene (Pre-Pastonian and Pastonian stages) marine 'crags' have yielded a sparse fauna including *Mammuthus meridionalis*, *Mimomys pliocaenicus*, and *M. blanci*.

The organic fluvial deposits of the West Runton Freshwater Bed, Cromerian type site, have produced an exceptionally rich early Middle Pleistocene vertebrate assemblage, comprising: 8 fish taxa; 5 amphibians; 3 reptiles; several birds; and 43 mammals. The mammals include: voles *Mimomys savini* and and *Pliomys episcopalis*; extinct beaver *Trogontherium cuvieri*; monkey *Macaca sylvanus*, mammoth *Mammuthus* cf. *meridionalis*, rhinoceros *Dicerorhinus etruscus*, and giant deer *Megaloceros verticornis*.

Pollen and plant macrofossils show that this fauna lived in association with regional temperate forest in the first half of the temperate stage.

SAMENVATTING

West Runton, aan de Norfolk kust in Engeland, is de meest belangrijke vindplaats van vertebraten fossielen afkomstig uit de Cromer Forest Bed Formatie. In de Vroeg Pleistocene (Pre-Pastonien en Pastonien stages) mariene 'crags' zijn een relatief klein aantal zoogdierresten van o.a. *Mammuthus meridionalis*, *Mimomys pliocaenicus* en *M. blanci* verzameld.

De organische, fluviatiele afzettingen van de West Runton Freshwater Bed, type-lokaliteit van het Cromerien, hebben een buitengewoon rijke vroeg Midden Pleistocene vertebraten fauna opgeleverd met 8 soorten vissen, 5 soorten amphibiën, 3 soorten reptielen, meerdere vogels en 43 soorten zoogdieren. De zoogdierfauna bevat o.a. woelmuizen *Mimomys savini* en *Pliomys episcopalis*, de uitgestorven bever *Trogontherium cuvieri*, de aap *Macaca sylvanus*, de mammoet *Mammuthus* cf. *meridionalis*, de neushoorn *Dicerorhinus etruscus* en het reuzenhert *Megaloceros verticornis*.

Pollen en plantaardige macroresten tonen aan dat de fauna heeft geleefd in een bosrijke omgeving tijdens de eerste helft van de gematigd warme periode.

Introductie

The Cromer Forest Bed Formation (C.F.B.F.), exposed along the coasts of northeast Norfolk and Suffolk, has been famous for its fossil mammal remains since the early part of the last century (GREEN, 1842; OWEN, 1846). The classic nineteenth century study of the stratigraphy and palaeobotany of these complex deposits by Clement Reid (REID, 1882; 1890), was matched by excellent work on the vertebrates by E.T. NEWTON (e.g. 1882a; 1886; 1891).

Other major contributions on the vertebrates include those made last century by OWEN (e.g. 1846) and DAWKINS (e.g. 1883); and earlier this century by HINTON (1908; 1911; 1926), and AZZAROLI (1953). More recent work includes MCWILLIAMS (1967); STUART (1975; 1982; 1992); STUART & WEST (1976); and LISTER (1992a; 1992b).

WEST's (1980) massive reinterpretation of the stratigraphy and palaeobotany of the C.F.B.F., utilizing palynology - a technique unknown to Reid - provided an invaluable framework for sorting out the sequence of vertebrate faunas. According to West the C.F.B.F. covers several climate-based stages, from the oldest to the youngest: Pre-Pastonian (cold); Pastonian (temperate); Beestonian (cold); and Cromerian (temperate), the deposits of which are succeeded by tills and outwash of the Anglian Glaciation. A major stratigraphical hiatus is present within the sequence, with the Pre-Pastonian and Pastonian of Lower Pleistocene age, and the Beestonian and Cromerian dating from the early Middle Pleistocene. Some deposits assigned to the Beestonian may date from a distinct Lower Pleistocene cold stage. Recent work suggests that the Forest Bed also covers one or more early Middle Pleistocene temperate stages which are post- Cromerian, but still pre-Anglian (MEIJER & PREECE, 1992; STUART, 1992).

The Forest Bed mammal "localities" are shown in Fig. 1. Forest Bed fossils found on the beach at Eccles, appear to have been washed out of deposits below low tide level. Stray, probably wave-transported, finds occur on the beaches even further to the southeast at Sea Palling and Winterton. It should be stressed that many of the Forest Bed 'localities', as recorded in museum labels and catalogues, are not specific fossil sites, but merely give a general indication of where specimens were found in relation to the nearest coastal village or town. Moreover, in many cases fossils were found loose on the beach, having been washed out of deposits in the cliff or foreshore, so that it is difficult or impossible to assign these to particular stratigraphic units. Exposures were generally better in the past, as nowadays most are obscured by sea defences, but some localities are still available and important finds continue to be made.

The most important single locality where Forest Bed vertebrates have been found *in situ* is the cliff section at West Runton (Figs. 2,3), the stratotype for the Cromeri-

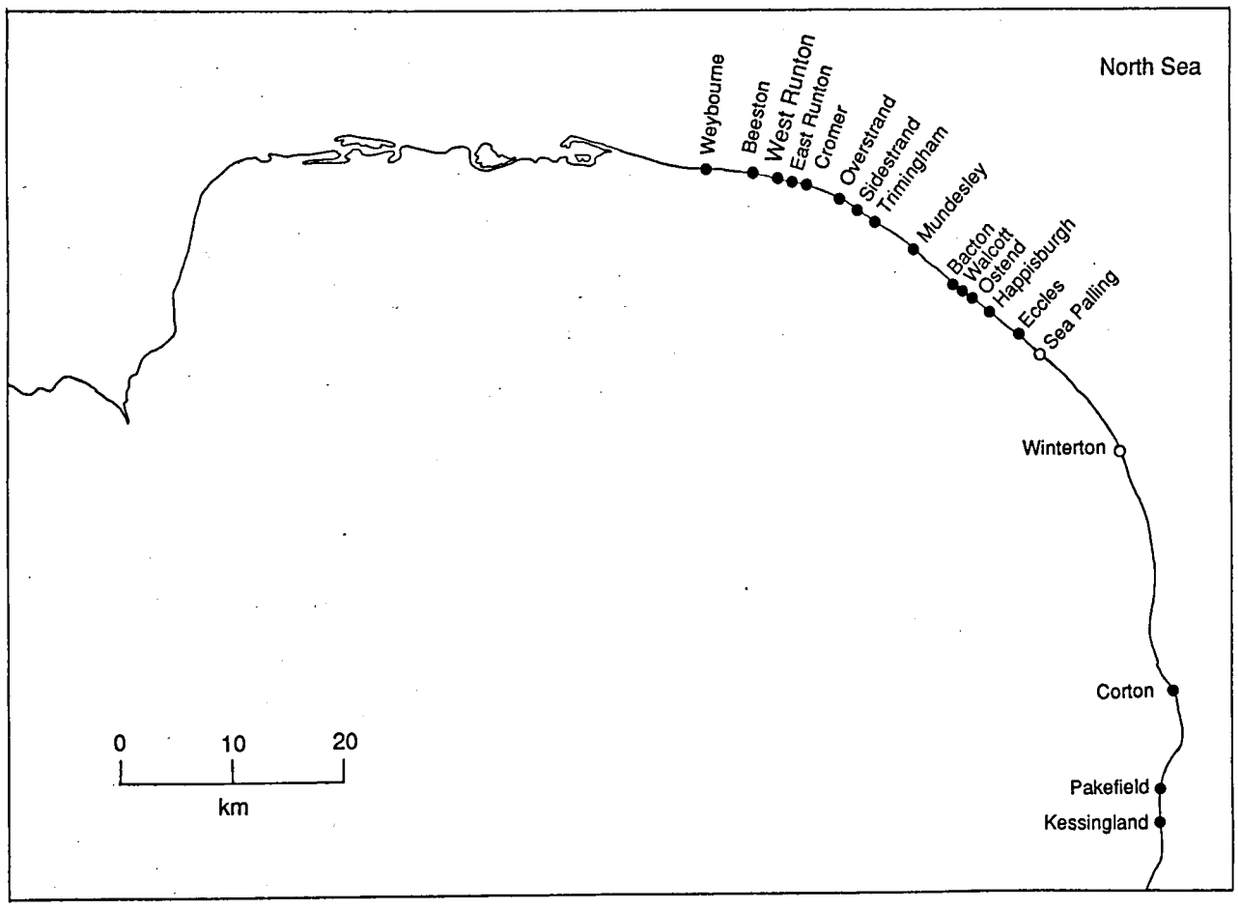

Fig. 1: Forest Bed Vertebrate Localities. Open circles indicate localities where Forest Bed deposits do not occur *in situ*. Corton, Pakefield and Kessingland are in the County of Suffolk; the rest are in Norfolk.

Fig. 1: Vindplaatsen van gewervelden van Forest Bed. Open rondjes geven de plaatsen aan waar Forest bed afzettingen niet *in situ* voorkomen. Corton, Pakefield en Kessingland liggen in Suffolk, de andere in Norfolk.

an Temperate Stage, and designated a geological S.S.S.I. (Site of Special Scientific Interest) by English Nature (formerly Natural Environment Research Council). Although threatened on more than one occasion, this prime palaeontological locality is still allowed to erode more or less naturally, and thus remains available for study.

Two groups of deposits and faunas widely separated in time are present at this locality. The older, Lower Pleistocene, assemblages need more detailed study and are only considered briefly here.

Crag (pre-Pastonian Cold Stage and Pastonian Temperate Stage)

Overlying the Upper Chalk, which can be seen exposed on the foreshore at low tide, are Lower Pleistocene marine deposits; the Stone Bed and crag ("Weybourne Crag") which occur both on the foreshore and beneath the modern beach. Pollen assemblages obtained from interdigitated silt horizons show that the crag covers the Pre-Pastonian and Pastonian stages (WEST,1980). A few large-mammal remains have been found in the foreshore exposures, including a molar of the extinct elephant *Mammuthus meridionalis* from the Stone Bed (Pre-Pastonian a substage) (WEST, 1980). Vole material was obtained by sieving crag dug from beneath the beach by mechanical excavator during the construction of a concrete sea wall immediately to the east of West Runton Gap (MAYHEW & STUART, 1986).

The vole fauna, which comprises *Mimomys pliocaenicus, Mimomys reidi, Mimomys newtoni, Mimomys blanci* and *Mimomys pitymyoides*, is very different to that of the West Runton Freshwater Bed, which occurs in a stratigraphically higher position, but is similar to those recorded from East Runton (MAYHEW & STUART, 1986). A desman upper P4 from the same deposits has been referred to *Galemys kormosi* by HARRISON et al. (1988). The above material is preserved in the University Museum of Zoology, Cambridge.

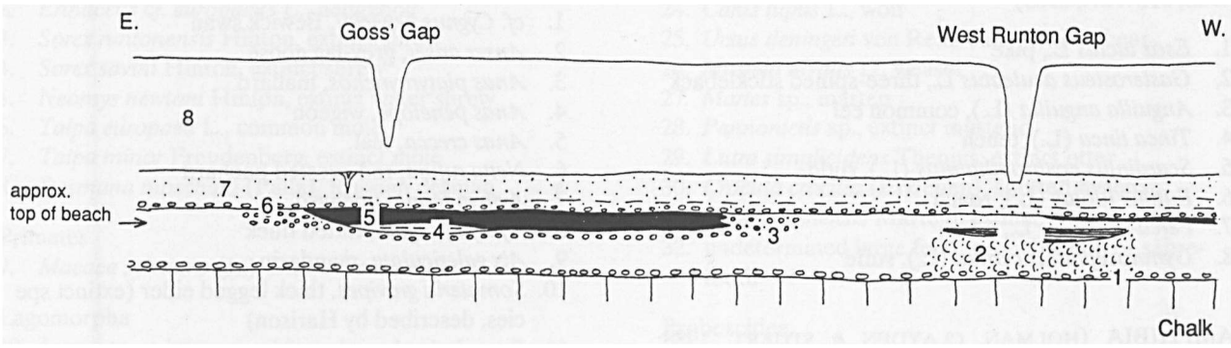

Fig. 2: Schematic section of cliff and foreshore deposits at West Runton, Norfolk (based on WEST, 1980). Length of section approximately 500 metres; depth 22 metres. The V-shaped structure is an ice-wedge cast.

	Sediment	Environment	Stage
8.	till and outwash sands and gravels, occasional ice wedge casts penetrate the underlying sands and silts	glacial permafrost	Anglan Cold Stage Anglian Cold stage
7.	laminated silts and sands (below), sands (above)	marine tidal	Cromerian Temperate Stage, substage III, IV
6.	gravel ("Monkey Gravel") palaeoasol	marine subaerial	Cromerian Temperate Stage, substage III
5.	West Runton Freshwater Bed	freshwater,fluvial	Cromerian Temperate Stage, substage Ib-IIb
4.	Calcareous silt	freshwater,lacustrine	Late Beestonian Cold Stage to early Cromerian substage Ia
3.	Gravels and sands	marine	Beestonian Cold Stage
2.	Crag and silts	marine	Pre-Pastonian Cold Stage and Pastonian Temperate Stage
1.	Stone Bed on frost-shattered chalk	marine	Pre-Pastonian Cold Stage

The Pleistocene deposits rest on Chalk (Upper Cretaceous, Campanian).

Fig. 2: Schematisch profiel van de klif en de afzettingen voor de kust van West Runton, Norfolk (gebaseerd op WEST, 1980). Lengte van de doorsnede is ongeveer 500 m.; diepte 22 m. De V-vormige struktuur is een vorstwig.

West Runton Freshwater Bed (Cromerian Temperate Stage)

This famous deposit, known since the early nineteenth century, has produced one of the richest Quaternary vertebrate faunas in Europe. So far it has escaped being obscured by coastal sea defences and important new material, including new species records, continues to be found.

The West Runton Freshwater Bed occupying a broad channel about 200m across in section and up to about 2m thick, cut in sands and gravels attributed to the Beestonian Cold Stage, crops out at the base of the cliff east of West Runton Gap (Woman Hythe) (Fig. 2,3). Details of the stratigraphy, pollen and plant macro assemblages are given by WEST (1980). The channel filling is designated the stratotype for the Cromerian Stage.

The basal bed of the channel filling, bed a (of WEST, 1980), occurs only in a limited area near Goss' Gap near the eastern end of the exposure. It comprises freshwater marls with pollen assemblages assigned to the late Beestonian Cold Stage and subzone Cr Ia of the Cromerian (Table 1, Fig. 4). On its eroded surface rest beds c-e, fluvial shelly organic muds and sands with numerous reworked marl lumps and small pebbles (mainly flint), with pollen spectra essentially of subzones Cr Ib - Cr IIa. The clast size decreases upwards and the upper part of the deposit, bed f, comprises detritus muds (shelly in part), mainly of subzone Cr IIb age. The altered top of the bed, interpreted as a palaeosol, indicates a substantial period of subaerial exposure prior to marine deposition of the overlying basal gravel ("Monkey Gravel") and thin bedded silts and sands attributed to the second half of the Cromerian Interglacial. The top of the Freshwater Bed is extensively bored by the marine mollusc *Mya*. Occasional shells can be seen in life position.

The Freshwater Bed pollen and plant macro assemblages (WEST, 1980) (Fig. 4) record changes from woodland with pine, elm, birch, extensive herbaceous vegetation and restricted fen and reedswamp (Cr Ib), to a more diverse woodland with oak and other thermophilous trees more widespread, persistent local open habitats and fen and reedswamp (Cr IIa, Cr IIb).

PISCES (provisional identifications) (STUART, 1975; 1988; STINTON, 1985)

1. *Esox lucius* L., pike
2. *Gasterosteus aculeatus* L., three-spined stickleback
3. *Anguilla anguilla* (L.), common eel
4. *Tinca tinca* (L.), tench
5. *Scardinius erythropthalmus* (L.), rudd
6. *Rutilus rutilus* (L.), roach
7. *Perca fluviatilis* L., perch
8. *Gymnocephalus cernua* (L.), ruffe

AMPHIBIA (HOLMAN, CLAYDEN & STUART, 1988; HOLMAN, 1989)

1. *Triturus vulgaris* L., common newt
2. *Bufo bufo* (L.), common toad
3. *Rana arvalis* Nilsson, moor frog
4. *Rana 'esculenta'* or *Rana ridibunda*, edible frog or marsh frog
5. *Rana temporaria* L., common frog

REPTILIA (HOLMAN, CLAYDEN & STUART, 1988; HOLMAN, 1989)

1. *Anguis fragilis* L., slow worm
2. *Natrix natrix* (L.), grass snake
3. *Vipera berus* L., adder

AVES (according to C.J.O. HARRISON, 1979)

1. *cf. Cygnus bewickii*, Bewick swan
2. *Anser anser*, grey-lag goose
3. *Anas platyrhynchos*, mallard
4. *Anas penelope*, wigeon
5. *Anas crecca*, teal
6. *Netta rufina*, red-crested pochard
7. *Aythya ferina*, pochard
8. *Aythya fuligula*, tufted duck
9. *Aix galericulata*, mandarin
10. *Somateria gravipes*, thick legged eider (extinct species, described by Harison)
11. *Bucephala clangula*, goldeneye
12. *Mergus albellus*, smew
13. *Mergus serrator*, red-breasted merganser
14. *Gallinula chloropus*, moorhen
15. *Turdus ?merula*, ?blackbird
16. *Sturnus ?vulgaris*, ?starling
17. *Garulus ?glandarius*, ?jay

MAMMALIA (sources include: AZZAROLI, 1953; HINTON, 1908; 1926; NEWTON, 1882a; 1909; STUART, 1975; 1982; 1988; 1992; D L HARRISON & BATES, 1984); WILLEMSEN, 1990; LISTER, 1992a)

Chiroptera

1. *Nyctalus noctula* Schreber, noctule bat

Small-vertebrate remains are fairly common, and the majority have been found by wet-sieving the sediments. Large-mammal remains are much rarer, but over the years numerous bones and teeth have been collected, especially when the fossils have been exposed after a combination of gales and high tides has eroded the cliffs.

The list of vertebrates from The Freshwater Bed has been significantly extended in the last few years (STUART, 1975; 1981; 1982; 1988b; 1992). J. A. Holman has studied the reptile and amphibian material and discovered two taxa not recognized by NEWTON (1882), *Rana arvalis*, moor frog and *Rana ridibunda* or R. *'esculenta'*, marsh or edible frog (HOLMAN, CLAYDEN & STUART, 1988).

Recent additions to the mammal list include: *Nyctalus noctula*, noctule bat (see D. HARRISON & BATES, 1984); *Pliomys episcopalis*, extinct vole (first recognized by A. P. Currant, on the basis of material collected by J Clayden); a small hamster, species not yet determined (tooth collected by J. Clayden) and *Megaloceros savini*, giant deer (antler collected by J. Lightwing and identified by A. M. Lister). In addition *Macaca sylvanu*, macaque monkey, is now recorded from the Freshwater Bed on the basis of an incisor tooth collected by P. Bergdahl; the previous find of macaque from West Runton was from the "Monkey Gravel" (HINTON, 1908).

In a major review of European Quaternary otters, WILLEMSEN (1990) has referred the West Runton material to the extinct species *Lutra simplicidens*. Carnivores, are clearly underrepresented in the collections considering the wide variety of available prey. Hopefully, more material will be discovered in the future.

Although known to palaeontologists for more than a century and a half the Freshwater Bed continues to surprise us with new discoveries; the most recent of which is the most spectacular ever found at this site and indeed in the entire Cromer Forest Bed Formation. Until recently only very sparse material of elephant was available from the Freshwater Bed. However in December 1990, after a gale and high tide, Mr and Mrs H. Hems discovered the pelvis of an adult male elephant. A year later, further erosion exposed several more bones which were found by R. Sinclair. A controlled excavation in January 1992 recovered the mandible, most of the vertebral column, right humerus and ulna, several ribs and a number of other bones of *Mammuthus* cf. *meridionalis* (Figs. 4,5). More precise identification awaits the removal of the mandible from its plaster jacket. The finds so far comprising about a quarter of the entire skeleton, are in the Castle Museum, Norwich. The presence of two hyaena coprolites found in situ with the elephant bones, plus characteristic toothmarks on a phalanx, show that hyaenas fed on the carcass. The evidence for

Insectivora
2. *Erinaceus cf. europaeus* L., hedgehog
3. *Sorex runtonensis* Hinton, extinct shrew
4. *Sorex savini* Hinton, extinct shrew
5. *Neomys newtoni* Hinton, extinct water shrew
6. *Talpa europaea* L., common mole
7. *Talpa minor* Freudenberg, extinct mole
8. *Desmana moschata* (Palla), Russian desman

Primates
9. *Macaca sylvanus* (L.), Barbary macaque

Lagomorpha
10. *Lepus sp., a hare*

Rodentia
11. *Sciurus whitei* Hinton, extinct squirrel1
12. *Trogontherium cuvieri* Fischer, exti
13. *Castor fiber* L., beaver
14. *Cricetus cricetus* (L.), common hamster
15. small hamster, species not yet determined
16. *Clethrionomys glareolus* Schreber, bank vole
17. *Pliomys episcopalis* Mehely, extinct vole
18. *Mimomys savini* Hinton, extinct water vole
19. *Pitymys arvaloides* Hinton, extinct pine vole
20. *Pitymys gregaloides* Hinton, extinct pine vole
21. *Microtus cf. arvalis* (Pallas), common vole
22. *Microtus oeconomus* (Pallas), northern vole
23. *Apodemus sylvaticus* (L.), wood mouse

Carnivora
24. *Canis lupus* L., wolf
25. *Ursus deningeri* von Reichenau, extinct bear
26. *Mustela nivalis* L., weasel
27. *Martes* sp., marten
28. *Pannonictis* sp., extinct mustelid
29. *Lutra simplicidens* Thenius, extinct otter
30. *Crocuta crocuta* (Erxleben), spotted hyaena
31. *Felis cf. lunensis* Martelli, extinct cat
32. undetermined large felid, probably lion or sabre-tooth

Proboscidea
33. *Mammuthus* cf. *meridionalis* (Nesti), extinct elephant.

Perissodactyla
34. *Equus* sp. (caballine), a horse
35. *Dicerorhinus etruscus* (Falconer), extinct 'Etruscan' rhinoceros

Artiodactyla
36. *Sus scrofa* L., wild boar
37. *Megaloceros verticornis* (Dawkins), a giant deer
38. *Megaloceros savini* (Dawkins), a giant deer
39. *Dama dama* (L.), fallow deer
40. *Cervus elaphus* L., red deer
41. *Alces latifrons* Johnson, extinct elk (moose)
42. *Capreolus capreolus* (L.), roe deer
43. *Bison schoetensacki* Freudenberg, extinct bison

1 Species recorded so far only from marine gravel overlying West Runton Freshwater Bed (probably reworked)

Table 1: Faunal List West Runton Freshwater Bed (West, Runton, Norfolk, England). Cromerian Interglacial (stratotype), substages Cr Ib-IIb

rapid burial of the skeleton implies much faster deposition of the Freshwater Bed than had been assumed previously.
Sparse small-vertebrate remains, have also been found in the marine "Monkey Gravel", which rests directly on the Freshwater Bed. According to WEST (1980), this horizon belongs to Cromerian substage Cr III. The vertebrates, which include *Mimomys savini* (see above), are very similar to those of the Freshwater Bed, and are probably derived partly or entirely from it. However, one species the squirrel *Sciurus whitei* is recorded, on the basis of a single upper P4, so far only from the "Monkey Gravel".

To date 43 mammalian taxa, 17 birds, 5 amphibians, 3 reptiles and at least 8 fishes are recorded from the West Runton Cromerian. Some of the bird identifications, in particular the diagnosis of an extinct species of eider (C HARRISON, 1979) may be questioned on the grounds of insufficient material. The fish identifications should be regarded as provisional. The material is at present under study by B. Irving.

Taking the palaeontological evidence together, one can picture a slow-flowing river, rich in aquatic plants and fringed by fen, supporting a wide variety of fishes, such as is found in a typical English lowland river today, plus frogs and toads, grass snake, waterfowl, and mammals of waterside habitats, including Russian desman, beaver, extinct beaver *Trogontherium cuvieri*, otter and extinct water vole *Mimomys savini.*

Much of the fauna, is consistent with temperate forest as indicated by the pollen spectra (WEST, 1980); e.g. wild boar, macaque, fallow deer and woodmouse. However, the abundant remains of grassland voles *Microtus* spp. and *Pitymys* spp. indicates the presence of at least local areas of herb vegetation, while the presence of elk and two species of giant deer, in which the males carried enormous outspread antlers, together with horse, indicates more extensive open habitats than are suggested by the pollen spectra. The activities of large herbivores, especially elephants - possibly present in substantial herds - would have probably promoted and maintained more open areas within the forest.

Fig. 3: West Runton cliffs east of West Runton Gap (Woman Hythe). The West Runton Freshwater Bed can be seen as a dark band above the top of the beach.

Fig. 3: West Runton kliffen ten oosten van West Runton Gap (Woman Hythe). Het West Runton Freshwater Bed is te zien als een donkere band boven de top van het strand.

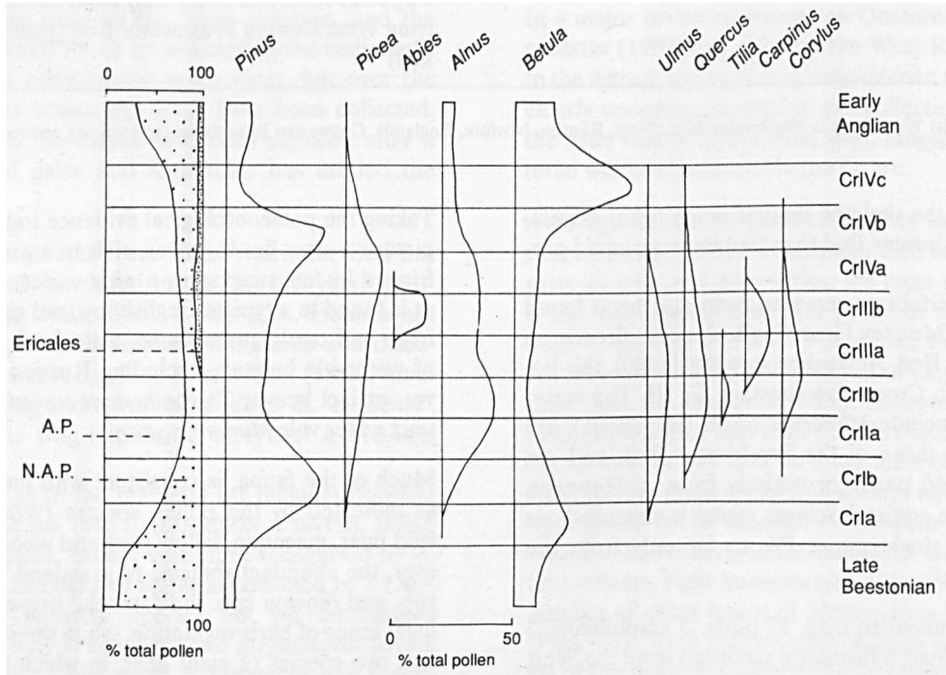

Fig. 4: Schematic pollen diagram for the Cromerian Temperate Stage (based on WEST, 1980a). Cr Ia - Cr IVc are pollen substages of the Cromerian. The diagram also includes the end of the preceeding Beestonian Cold Stage and the beginning of the succeeding Anglian Cold Stage.

Fig. 4: Schematisch pollendiagram van het gematigd warme Cromerien s.str. (gebaseerd op WEST, 1980a). Cr Ia - Cr IVc zijn pollen stages van het Cromerien. Het diagram bevat ook het laatste deel van de voorafgaande koude periode, het Beestonien en het begin van het Anglien, de koude periode die volgt op het Cromerien.

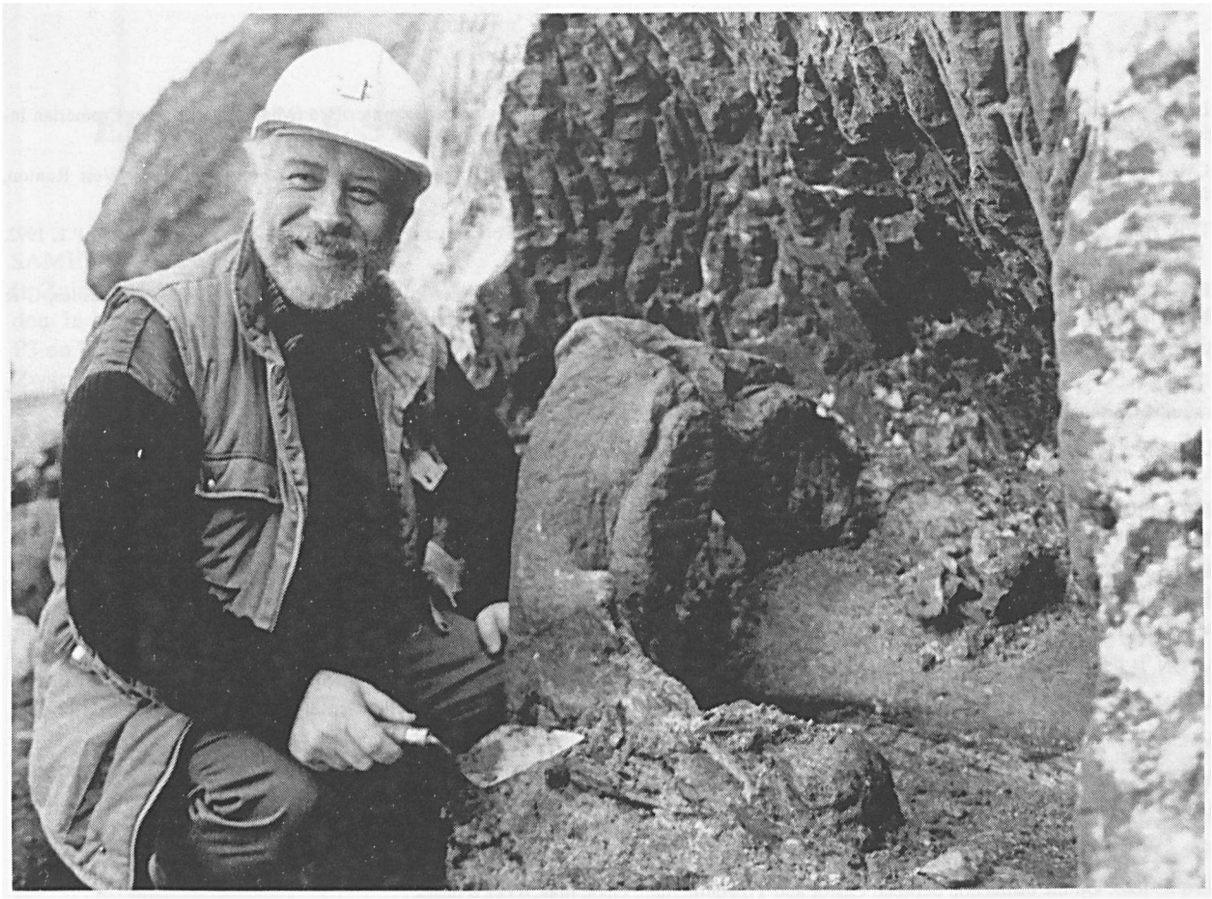

Fig. 5: Elephant mandible in situ, January 1992. (Courtesy of Eastern Caonties Newspapers).
Fig. 5: Onderkaak van een olifant in situ, januari 1992.

The large amount of material from the West Runton Freshwater Bed is divided between several museums, notably: Natural History Museum, London; Norwich Castle Museum; Harrison Museum, Sevenoaks; and University Museum of Zoology, Cambridge.

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