THE OCCURRENCE OF AN INSECT WING AND BRANCHIOPODS (EUESTHERIA) IN THE LOWER KEUPER MARL AT STYAL, CHESHIRE

by

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Summary

These fossils occur in dolomitic, illitic, silty shales deposited in the upper parts of thin, generally fining-upwards cyclothems. The occurrence of the broken wing in tranquil flow evaporitic sediments is consonant with its transportation and settling from floodwaters which have entered a shallow lake or lagoon. There is some evidence that the branchiopods may have lived in the basin and undergone little transportation.

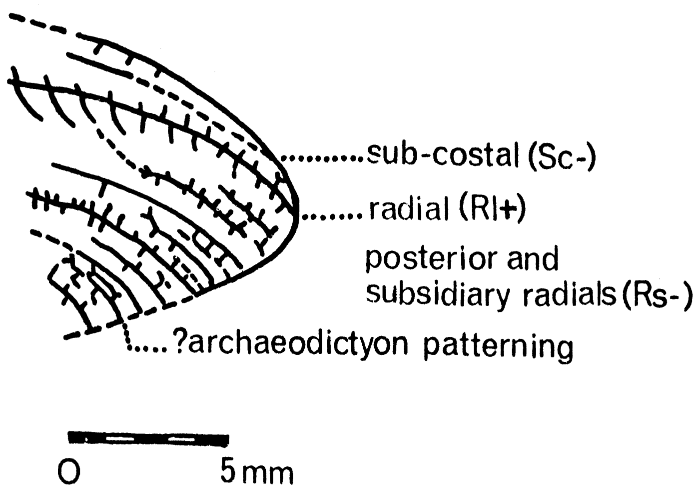
Introduction

A part of an insect wing was found by two members of a North Manchester Grammar School field excursion party (T. L. Jones and J. R. Chatten). The wing lies in the upper part of a thin sub-cycle of sedimentation 11.5 cm. thick. The branchiopods were found by G. W. Martin in the upper part of the next sub-cycle which is generally taken as the base of a larger cycle of sedimentation, probably some 12 metres thick, and known as the Giant's Castle Skerry belt.

These strata outcrop at Giant's Castle Rocks, immediately to the north west of the suspension bridge on the north side of the River Bollin, Styal, North Cheshire, (grid reference SJ 82778348). The section has not been described previously, though a very general account of the Lower Keuper Marl of this area is to be found in Taylor et al. (1963, p.72 - 77).

The specimens are now housed in the Manchester University Museum.

A greatly abbreviated description of the strata is presented here. It is intended to describe and interpret the sediments of these and other similar cycles in the future. Details of the flow regimes mentioned can be found in Elliott(1965 in press).



Text-Fig. 1.   The insect wing, showing structure.

The upper sub-cycle, 36 cm. thick, has at its base 24 cm. of ripple-statified green dolomitic sandstones and dolostones, which in one place occupy an erosion channel. The strata are repeatedly affected by penecontemperaneous deformation structures which include open slumping, ball and pillow structures, load and flame casting, crinkle marks, a sand volcano, and salt pseudomorphs. These strata gradually pass upwards into light green silty dolomitic, illitic, micaceous shales which are repeatedly interbedded with dark green, highly illitic, laminated claystones. These upper strata contain salt pseudomorphs and crinkle marks. The Euestherias lie in the upper part of a bed of light green, very finely laminated, micaceous silty shale, some 6 mm. thick, which bears large halite pseudomorphs (1.75 cm. across) on its base, and crinkle marks in the laminae which contain the fossils.

The lower cycle, averaging 11.5 cm., has similar dolomitic sandstones up to 8 cm. thick at its base, but contains both flat laminations as well as cross-lamination, clay galls, an erosion channel, and an undersurface which bears groove casts, prod casts, and salt cube wrench-out marks. The interbedded laminated siltstones, silty shales and claystones which follow are similar to those described above, and bear similar structures, together with mudcracks. The insect wing was found in the less fissile, silty, micaceous shales at the base of these upper beds. Further small fragments of dark organic matter are found scattered in the laminated strata above.

The insect wing

(1) Mode of Preservation: Preservation is either by carbonisation or in original chitin, such that the major and minor veins stand out well on one or other of the two fragments.

(2) Description: The main specimen is 8 mm. x 9.5 mm., and represents the apical portion of an insect wing. The analysis of its veins is uncertain, but fig. 1 and plate 15 show the probable arrangement.

There is present a length of the sub-costal and main radial veins, and many subsidiary, posterior-radial branching veins, three of the eight sets of nerves typical of these primitive wings. There are many cross-veins, but no sign of archaeodictyon patterning, except possibly in the most posterior area of the subsidiary radials. Part of the skin of the intravenous areas is present, and bears tiny spinules which are readily seen under high magnification (plate 15). A counterpart of part of the block which bears the largest fragment is available, but its impression covers a smaller area, and reveals little that is not present in the main specimen. It is important in one respect, for it shows the Sc(-) for almost the whole of its length (fig. 1) and it is clear that it will not terminate against the R1 (+).

(3) Diagnosis: Photographs of the specimens were submitted to Dr. Laurentiaux, of the University of Paris, who noted that the absence of part of the anterior border and the vein pattern nearer to the body, did not allow accurate identification. He reports: "Etant donné l'allure plutot triadique et lache de l'archaeodictyon intercalaire et les trop rares traces nervuraires visibles, il pourrait s'agir d'une extrémité d'aile d'Euplecoptera (May-Fly), mais ce n'est qu une très vague presomption. Je ne vois en l'état de l'échantillon aucun autre indice de détermination au plus pourrait on penser à une extrémité égalament de Calvertiellidae, mais tout cela reste bien incertain".

These alternatives are classified as follows: (Piveteau 1953, p. 415 - 424, 426 - 430; Brues et al. 1954, p. 784 - 786, 802):-

1. Super-order EPHEMEROPTERA: Laurentiaux 1953. Primitive group; Carboniferous to present.
   Order Plecoptera: Packard 1886 (emend. Tillyard 1932)
   Permian to present.
   Sub-order Euplecoptera: Tillyard 1932. Permian to present.

2. Super-order PALAEODICTYOPTERA: Goldenburg 1854. Carboniferous to Permian.
Order Protohemiptera: Handlirsch 1908.
Family Calvertiellidae: Martynov 1932. (Range of family not given but one genus present in Permian of Kansas.)

Brues et al. (1954, p. 786) indicate that one vital feature of this latter family is that the Sc(-) should terminate on the R1(+). Preservation of the present specimen is sufficiently good to discern that this is not so, and for this reason the author believes that this alternative is unlikely. If it were so, it would extend the range of the super-order and the family into the Trias. In view of this, the first alternative is favoured as the most likely possibility.

The Branchiopods

The specimens of Euestheria comprise a group of 19 individual half carapaces. None are fragmentary: most are weakly preserved. The carapaces are of oval shape, but a considerable variation of shell shape exists, between one specimen which is elongate-oval and others which are sub-discoidal. The largest is 3 mm. x 2 mm., the smallest 1.75 x 1 mm. (see fig. 2). The hinge is not always clearly preserved, but where it is the ventral margins are both symmetric and asymmetric with respect to it and always evenly rounded. The umbo is displaced towards the anterior, with most of the variation of length and shape occurring posterior to it; in a few cases it is sub-central. Growth striae are generally faint, but a fairly wide spacing of 6 per mm. can be discerned on the best preserved type. Preservation is too poor to discern any trace of reticulum between the striae.

Despite the poor preservation, the specimens can be referred to Euestheria minuta (Alberti in von Zeiten) var. brodieana (Jones).

The specimens are found lying on top of, within, or slightly across, three laminations which occupy a vertical distance of 1.5 mm. In most cases the half carapaces lie flat, but some are sub-horizontal and affected by the crinkle marks which occur at the base and on the top; one lies across the bedding and tends towards the vertical. In one case the valves are so close to each other and in such a position as to suggest that they had been barely separated; this may be true in the case of the two largest specimens which lie only 2.5 mm. apart, one concave, the other convex upwards. Otherwise the shells are scattered, eleven concave upwards, eight convex upwards, the nearest 1 mm. apart, the furthest 1.2 cm, the average separation being 4.4 mm. Unfortunately the specimens were not orientated with respect to the locality, but they can be related to an arbitrary datum line and the upper and lower crinkle marks, which, with respect to the datum, lie at 010 and 080 degrees respectively. The frequency distribution for the direction of elongation of the shells is bimodal, and the maxima appear to be within 25 degrees of being perpendicular to either one or the other of the crinkle marks. Since the crinkle marks are held to be the result of frictional drag of the prevailing currents upon the hydroplastic sediment below, the length of the carapaces would appear to be orientated sub-parallel to the current.

Discussion

The abbreviated description of lithology, sedimentary structures and cyclical sedimentary organisation given previously is sufficient to demonstrate a general upward diminution of grain size, a fall in the flow regimes from high, through low, to tranquil, and an increase in aridity. Detailed interpretation will be attempted on another occasion, but it is enough to draw attention to the similarity of these descriptions to those of Smith (1910) and Elliott(1961) in the skerry belts of the Keuper Marl of Nottinghamshire. Smith believed these cycles to be due to influx of sediment and floodwater in the wet season followed by gradual dessication throughout a dry season. There is no reason to disagree with this view. A provisional interpretation of environment involves deposition near the margin of lakes, as suggested by Klein (1962) for his type II sedimentary structures in the Keuper Marl.

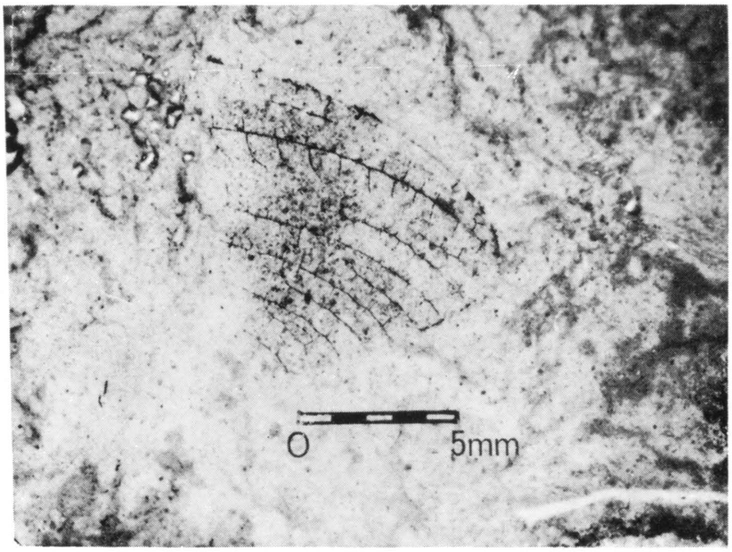
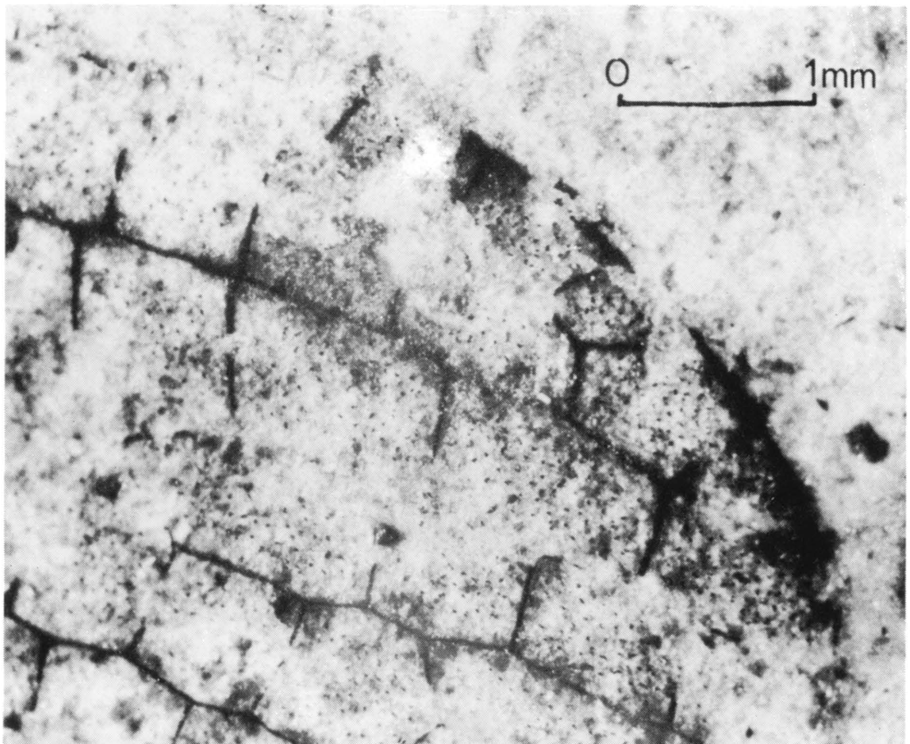


Fig. 1. x 4.75

Apical portion of insect wing at Giants Castle Rocks, Lower Keuper Marls, Styal, Cheshire. For analysis of venation see fig. 1.
The photographs of the wing were taken through a cover glass below which liquid paraffin was in contact with the specimen.

Plate 15
Fig. 2. $\times 2^4$

Detail of the anterior extremity of the wing. Note that there is no sign of the Sc (-) terminating on the R1 (+).



This interpretation of events is not out of keeping with observations of the present day on the transport and settling of insect debris, for example in the neritic zones of the Mediterranean Sea. It is common for chitinous wings of insects to be transported by floodwaters, since they have a great surface area compared with their weight and volume and they easily float. Myriads of wings can be seen floating close inshore after being brought down from the mountainous regions of Lycia, (Wills, 1950, p. 94, quoting Forbes).

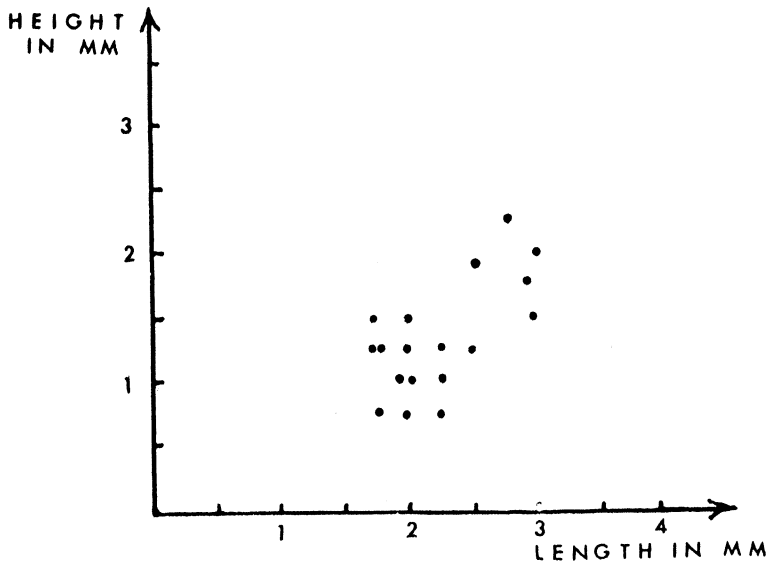
No insect wings have been described from the earlier Triassic of the British Isles, but Harrison (1876, p. 214) mentions the finding of an insect wing in the Tea Green Marl (Upper Keuper) of Nottinghamshire. Horwood (1916, p. 414) commented that the specimen perished in the hand, and that in fact, it was likely to be an Euestheria. Wills, following Richardson and Ramsey (see Wills 1950, p. 93 – 4), notes that the Rhaetic has many fossil insect wings in the Pseudomonotis Bed, and that these belong to types which have cool climate characteristics. They were interpreted as existing in marginal highland parts, for example upland Wales, from which they were presumably washed down by streams.

Kobayashi (1954, p. 54) believed that failing any other guide fossils, Euestheriae might be useful in correlating heterotopic facies in adjacent hydrographic provinces. He suggests that E. minuta was particularly characteristic of the Lettenkohle (lowest Keuper) in Germany and that E. minuta var. brodieana was indicative of the Rhaetic, where it was found prolifically (Lomas 1905, p. 166). Finds by Lomas (1901, p. 77) in the red Keuper Marls of Oxton, Wirral; by Brockbank (1891, p. 12 – 13, 31) and Warrington (1963, p. 318) in the Lower Keuper Sandstone of the Alderley area; north-east Cheshire; by Fowler and Robbie (1961, p. 103) at two marl horizons up to 1000 feet below the top of the Bunter sandstone facies in Northern Ireland, have extended its range considerably. Specimens of Euestheria are common in dolomitic rocks in Germany, often in the Keuper in association with species of the brachiopod Lingula and marine molluscs, and the lowest record of the present mutation seems to be the Lettenkohle (Jones, in Brockbank 1891, p. 31).

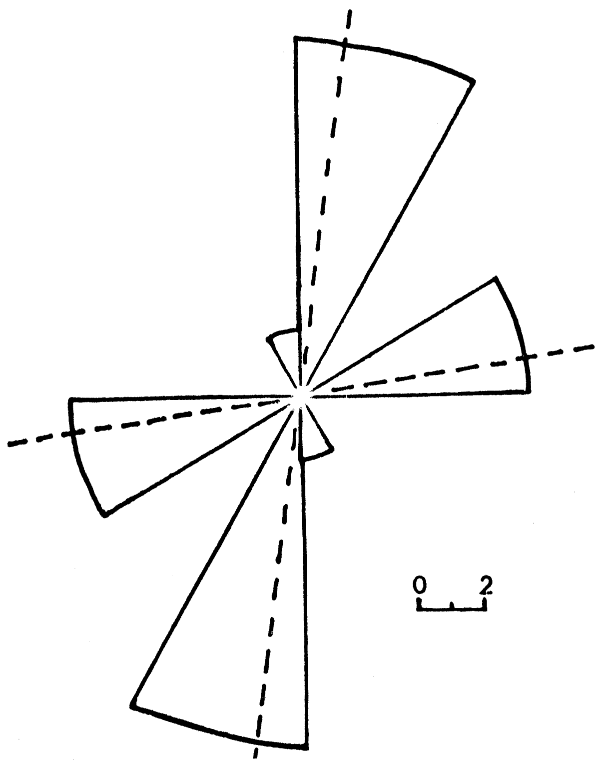
Lomas (1905,p. 166) showed that these animals have a wide distribution in fresh, stagnant or brackish waters, and in saltpans, but never in marine waters: that they endured great extremes of heat or cold, frequently occurring in regions of great dessication. Kobayashi (1954), in a worldwide review, added that dispersal is mostly achieved by transportation of the egg stage (ibid., p. 3) which is sufficiently durable to resist 3 – 5 years dessication. The light, dried, flexible carapaces were observed to be drifted widely by wind and water: small size, as in these specimens, is usually associated with cooler climates (ibid., p. 43) and inland habitats (ibid., p. 38): close development of growth lines with warm or hot environmental conditions (ibid., p. 42). Modern types are both nektonic and mud eaters. Kobayshi suggested that most, if not all, brackish water types are exotic (ibid., p. 50) though some workers infer brackish water habitats for certain Carboniferous types (see Weller in Ladd (ed.). 1957, p. 333). This was also the view of some German workers who found Triassic specimens of Euestheria with clear brackish water associates (see for example Buerlen, 1931).

In the present case, the two examples of barely disarticulated valves suggest that the animals were living a short time before they were interred; the preferred orientation of the valves and the scattered nature of the majority suggest that they were subject to the influence of currents, albeit weak and barely able to move sediment on the bottom; the pseudomorphs testify to considerable dessication. All these facts promote the view that the branchiopods may have lived locally, enjoyed fairly fresh water at first, had tolerated increasingly brackish conditions (which perhaps had stunted their growth) before succumbing to the high salinity of the evaporite phase. The corpses were, perhaps, carried a little distance before settling with the rest of the micaceous, illitic, suspended load which had probably travelled from much further afield.

The presence of fresh mica, abundant at times, is a characteristic which the Lower Keuper Marls of the north east Cheshire basin shares with the underlying Keuper Sandstone and Waterstone Formations. The author belives that this testifies to weathering in the source region of fresh rock, of a type which is alien



Text-Fig. 2 Relationship of length to height in eighteen Euestherias at Giants Castle Rocks, Styal, Cheshire.



Text-Fig. 3. The orientation of nineteen Euestherias with respect to crinkle marks. The datum line for north is arbitrary.

to upland Wales or the Midlands but could possibly be found in the now buried Mercian Ridge or even further south in Armorica. This view does not preclude the advent of local floodwaters from any local upland, but it does mean that the main waters came from very far afield. Hence the lakes and lagoons, which were mentioned previously, must have lain at the northern end of a more or less unified environmetal complex which extended from North Cheshire through the Midlands to the south or far south of England.

Conclusions

Branchiopods and an insect wing occur at the top of separate cycles of sedimentation.

It is concluded that the broken wing of the possible May-Fly was transported by floodwater and settled out under tranquil conditions on the bottom of a basin. Near the same place at a later time a number of *Euestherias* lived and were killed off, carried a short distance, and buried.

Acknowledgements

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