Charmouth–Pinhay Bay, Dorset

[SY 359 931] and [SY 369 930]

Introduction

Coastal cliff exposures of Lower Jurassic, Sinemurian age strata (*c.* 195 Ma) around the Dorset fishing village and resort of Lyme Regis have gained international importance since the late 18th century for their fossils. It was from here in the early 19th century that the now-famous Arming family collected and sold a series of reptile fossils to collectors and museums that helped promote and shape the development of the study of palaeontology in Britain. Recently, this importance has been recognized by designation of the area as part of the Dorset–East Devon World Heritage Site.

Over the last 200 years and more, the marine Liassic limestones and shales have yielded a huge diverse fossils both vertebrate (reptiles and fishes, see Benton and Spencer, 1995 and Dineley and Metcalf, 1999) and invertebrate (ranging from protist microfossils to molluscs, echinoderms and of particular significance in the present context, insects).

Description

The abundance of ammonites within the Lower Liassic strata allowed the early application of Oppel's German biozonal scheme (Oppel, 1857) to the Lyme Regis sequence. Numerous detailed accounts have built on these early foundations (e.g. Lang and Spath, 1926), more recently by Getty (1980).

	Thickness (m)
Green Ammonite Beds	32
Belemnite Stone	0.15
Belemnite Marls	23
Armatus Limestone	0.4
Black Ven Marls	43
Shales with Beef Beds (Formation)	23
Blue Lias	27
Ostrea Beds (= Pre-planorbis Beds)	2.5

The lowest exposed strata consist of alternations of thin-bedded and frequently nodular limestones and shales of the Blue Lias, also yield insects and are exposed in the cliffs and foreshore west of the Cobb and just east of Lyme Regis (Figure 4.22). Some of the limestone beds contain bivalves and large ammonites. These limestones and shales pass up into the more nodular and more fossiliferous carbonates with thin dark shales of the Shales with Beef Beds (Formation) between Lyme Regis and Charmouth to the east. Ammonites and belemnites, along with poorly preserved bivalves and occasional well-preserved fishes, are found in these strata. Above these lie a thick (43 m) succession of the Black Ven Marls, exposed on either side of Charmouth. These blue-black mudstones and paper shales with occasional limestones are also fossiliferous but with a more diverse fauna, with the addition of other invertebrates such as brachiopods, protistans, occasional plants, as well as reptilian remains and, most importantly in the context of the present volume, insects.

The overlying light-grey Belemnite Marls have abundant interbedded lignite horizons and are capped by a distinctive thin limestone, the Belemnite Stone. Their abundant molluscan fauna includes well-preserved belemnites and pyritized ammonites. The Lower Liassic sequence is completed by a thick (16 m) succession of the Green Ammonite Beds, predominantly grey mudstones with limestone nodules containing well-preserved ammonites.

Fauna

The majority of the fossil insects found here occur in the Woodstones and Flatstones (parts of bed 83, e.g. Lang Bed 83h, Black Ven Marls) of Upper Sinemurian age (obtusum Biozone) that are naturally exposed on the coast at Black Ven and Stonebarrow, either side of Charmouth. A few insects have also been found the older turneri Biozone in the birchi Nodules (bed 75a of the Lower Sinemurian Shales with Beef). The Black Ven Marls contain the best-known Lower Liassic entomofauna (see Table 4.1).

The insects have been the subject of modern investigation that has recognized a number of new genera and species known only from Dorset, including the earliest-known Lepidoptera — the moth *Archaeolepis mane* (Figure 4.23). Charmouth has also yielded the earliest snakeflies such as *Metarhaphidia confusa* (Rasnitsyn and Quicke, 2002). More insect species remain to be described. The only comparable insect-bearing deposits that yield insects in fine-layered carbonate concretions are in the Lower Jurassic strata of Central Europe, but these are not of the same exact age. For instance, the internationally renowned German insect-bearing deposits of Dobbertin (Mecklenburg), Schandelah (Lower Saxony) are of younger (Toarcian) age. Of the same age as the Dorset insects are lowermost Liassic insects from clay lenses intercalated within deltaic sandstones in Bavaria (Konijnenburg-van Cittert and Schmeissner, 1999). Of comparable age is the remarkable insect fauna of Issyk Kul, Kyrgyzstan (Ansorge and Kzremi■ski, 1994). The Liassic insect fauna of Dorset is therefore a key part of our European palaeontological heritage and, as such, is unique.

Fine anatomical details such as wing scales and hairs are preserved although the majority of insects are disarticulated. Their remains usually occur sporadically and are associated with a normal Liassic marine fauna including ammonites, fishes and crinoids, which probably accumulated a few miles from land within a coastal embayment possibly fed by rivers. The proximity of the land is suggested by the presence of both plant fragments and the insect remains especially indicated by the relative abundance of beetles (Coleoptera) and true bugs (Heteroptera).

The insects are terrestrial and non-marine aquatic, but no larval stages have been described. Aquatic insects include Odonata, Heteroptera (true bugs) and some beetles (Coleoptera). The majority, however, are terrestrial, inhabiting 'bush'-type vegetation such as ferns (Ficales), Bennettitales, seedferns, Cycadales and Coniferales (gymnosperms). The fauna is dominated by beetles (Coleoptera, 40% i.e. 66 species), 'grasshoppers' and crickets (22%) followed by true bugs and dragonflies.

The insects probably lived on the Cornubian landmass with the alternative terrestrial sources of the Welsh Massif or Western Approaches being less likely, since distinctive families from these regions such as the Bintoniellidae (Orthoptera) are absent in the Dorset strata. The endemic dragonfly *Dorsettia laeta* shows sexual dimorphism, and elaterid beetles preserve the 'click' escape mechanism of these Coleoptera. The extinct Pseudpolycentropidae would have been true fly-like scorpionflies.

Table 4.1 Charmouth–Pinhay Bay GCR site from EDNA, the international online fossil insect database hosted by the Palaeontological Association at http://edna.palass-hosting.org/search.php. See also (Figure 4.24); (Figure 4.25); (Figure 4.26); (Figure 4.27); (Figure 4.28); (Figure 4.29)

Dorset Liassic Insects

Order	**Family**	**Name**
Odonata	Archithemistidae	*Dorsettia laeta* Whalley, 1985
Odonata	Liassophlebiidae	*Hypsothemis fraseri* Whalley, 1985
Odonata	Liassophlebiidae	*Liassophlebia anglicanopsis* (Zeuner, 1962)
Odonata	Liassophlebiidae	*Liassophlebia jacksoni* Zeuner, 1962
Odonata	Liassophlehiidae	*Liassophlebia pseudomagnifica* Whalley, 1985
Blattaria	Caloblattinidae	*Nannoblattina petulantia* Whalley, 1985
Orthoptera	Elcanidae	*Archelcana durnovaria* Whalley, 1985
Orthoptera	Gryllidae	*Micromacula gracilis* Whalley, 1985
Orthoptera	Haglidae	*Regiata scutra* Whalley, 1985
Orthoptera	Triassomantidae	*Orichalcum ornatum* Whalley, 1985

Orthoptera		*Locustopsis spectabilis*
Phasmatodea	Aerophasmatidae	*Durnovaria parallela* Whalley, 1985
Dermaptera	Protodiplatyidae	*Brevicula gradus* Whalley, 1985
Hemiptera	Belostomatidae	*Lethonectes naucoroides* Popov, Dolling and Whalley, 1994
Hemiptera	Belostomatidae	*Tarsabedus menkei* Popov, Dolling and Whalley, 1994
Hemiptera	Corixidae	*Liassocorixa dorsetica* Popov, Dolling and Whalley 1994
Hemiptera	Hylicellidae	*Cycloscytina fennahi* (*Whalley,* 1985)
Hemiptera	Hylicellidae	*Cycloscytina fennahi* (Whalley, 1985)
Hemiptera	Tettigarctidae	*Paraprosbole rotruda* Whalley, 1985
Raphidioptera	Mesoraphidiidae	*Mesoraphidia confusa* (Whalley, 1985)
Raphidioptera	Priscaenigmatidae	*Priscaenigma obtusa* Whalley, 1985
Coleoptera	Cupedidae	*Liassocupes giganteus* Whalley, 1985
Coleoptera	Cupedidae	*Liassocupes maculatus* Whalley, 1985
Coleoptera	Elateridae	*Elaterophanes regius* Whalley, 1985
Coleoptera	Schizophoridae	*Tersus crowsoni* Ponomarenko, 2006
Mecoptera	Orthophlebiidae	*Orthophlebia capillata* Whalley, 1985
Mecoptera	Pseudopolycentropodidae	*Pseudopolycentropus prolatipennis* Whalley, 1985
Diptera	Mycetophilidae	*Eoptychoptera spectra* (Whalley, 1985)
Diptera	Oligophryneidae	*Oligophryne britannica* Ansorge and Kzremi■ski, 1994
Lepidoptera	Archaeolepidae	*Archaeolepis mane* Whalley, 1985

In addition, about 100 new 'species' of fossil fish have been recovered and named from the sequence around Lyme Regis, but only about 50 of these are now recognized (see Dineley and Metcalf, 1999). Similarly, about 100 new 'species' of fossil reptile were also named in the 19th century when virtually every bone was given a new name. These have now been rationalized down to about 14 species (see Benton and Spencer, 1995, p. 109) but nevertheless include internationally important specimens, especially of plesiosaurs and ichthyosaurs. The presence of occasional dinosaur remains also has considerable significance, especially for interpretation of the changing environment of deposition in the succession, since their remains indicate the presence of nearby land.

Of the invertebrates, the ammonites have been of particular biostratigraphical importance. Some of the other fossil molluscs have historical and interpretative importance. The presence of plant and insect remains in the Black Ven Marls, Shales with Beef and Blue Lias also supports the conclusion that although still essentially marine, land cannot have been far away.

Interpretation

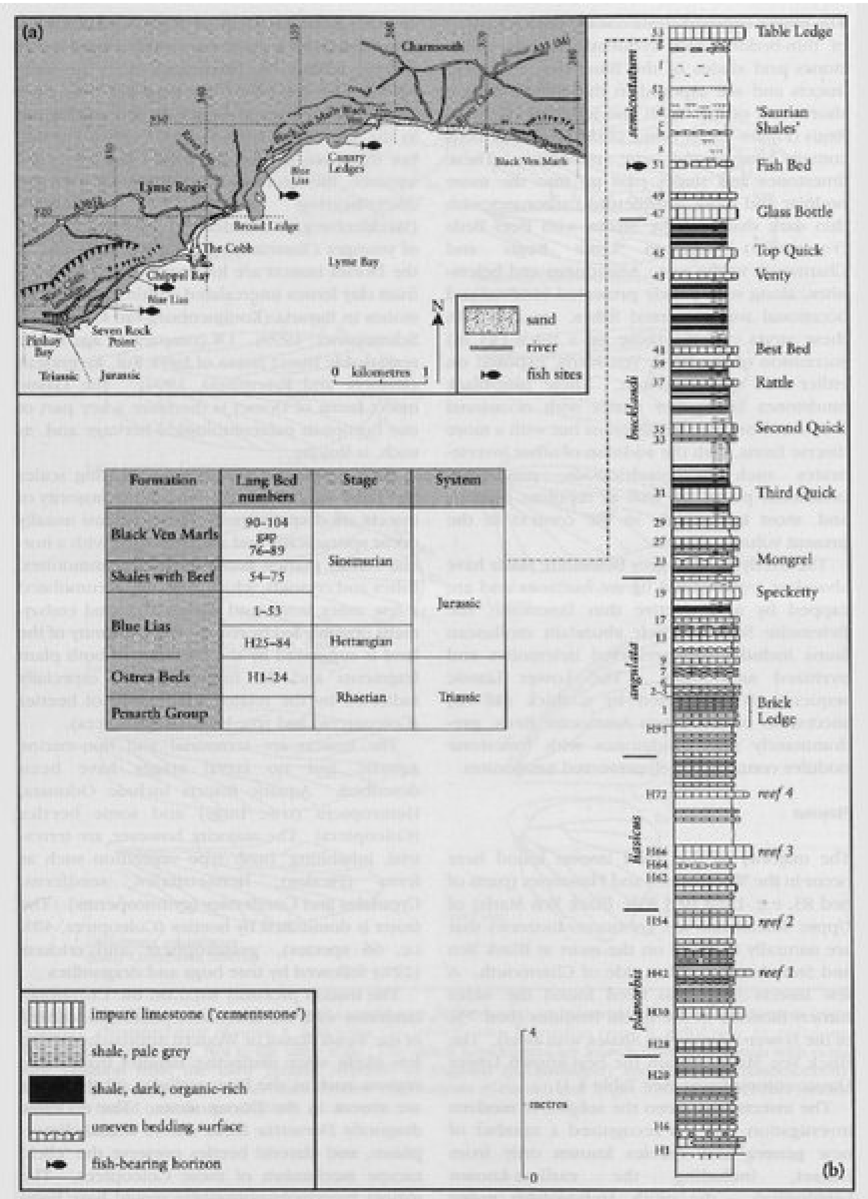
Renewal of marine deposition in Britain began with the Rhaetian transgression in latest Triassic times as documented by strata exposed to the west of Lyme Regis and by the Penarth Group strata seen at localities such as Aust Cliff and west of Lyme Regis. By early Jurassic times fully marine conditions were established with a shallow epicontinental sea flooding much of northern Europe to form a huge area of shelf sea. Within this region, largely protected from strong tidal or storm influences, distinctive facies of laminated bituminous shales and rhythmic sequences of lime mud and marl were laid down. Lyme Regis lies in the south of the region and its Lower Liassic biota suggests that seabed conditions were often inimical to benthic life. It was mostly the remains of free-swimming organisms such as marine reptiles, fish, ammonite and belemnite cephalopods that accumulated within seabed sediments and were recruited to the fossil record.

The presence of insect fossils within the Black Ven Marls, Shales with Beef Beds and Blue Lias along with other fossils, such as plant remains and the skin impressions of the terrestrial dinosaur *Scelidosaurus* (Martill, 1991), shows that there was land nearby.

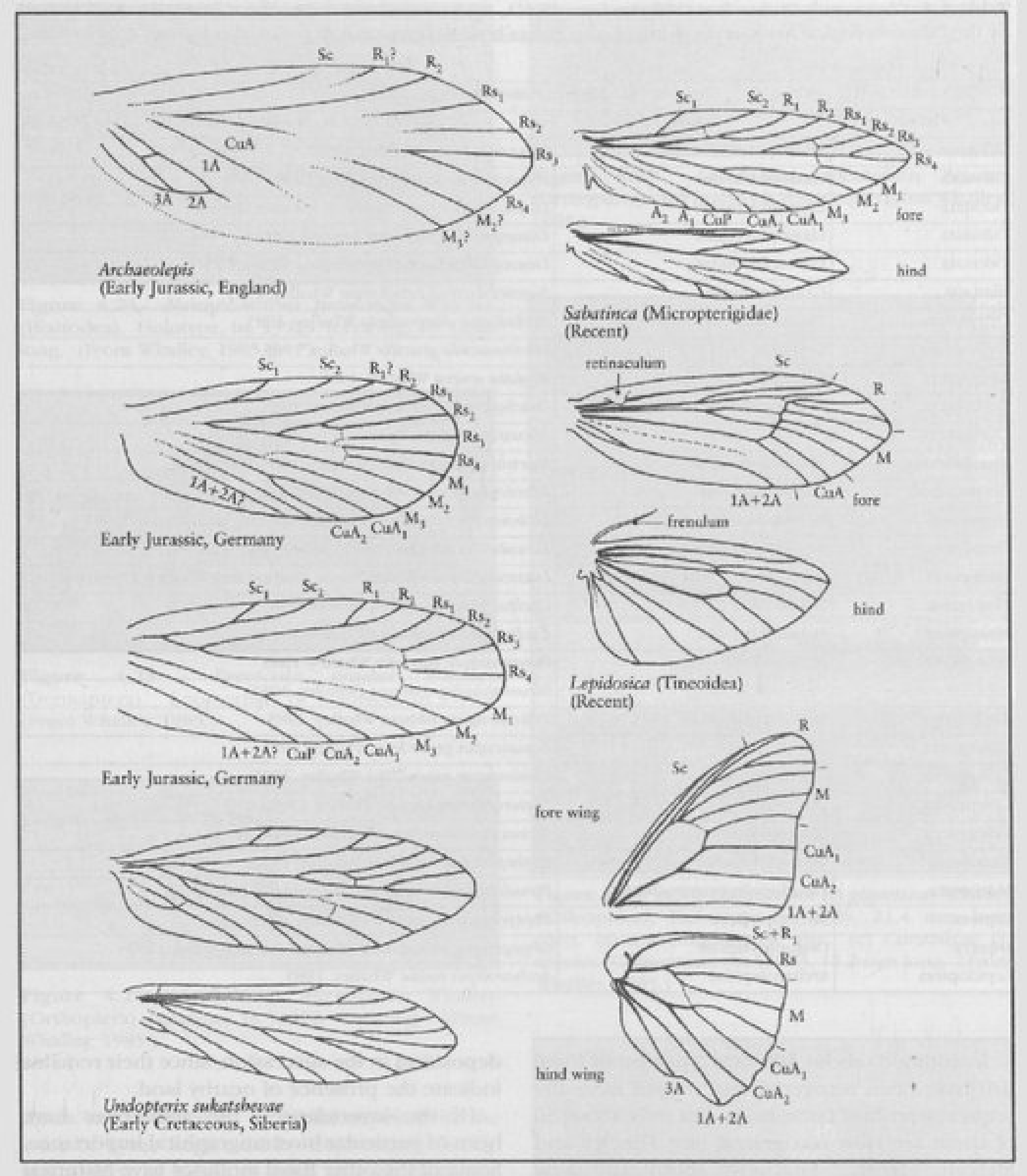
Conclusions

Charmouth lies within the Dorset to east Devon World Heritage Site which is inscribed in particular for its geological value. In addition to its international renown and conservation value as a site that preserves a diverse fish and reptile fauna, and indeed its marine invertebrate fauna, Charmouth is one of the most productive sites for fossil insects of Liassic age (Lower Jurassic, Sinemurian, *c.* 197 Ma) in Britain. These terrestrial arthropods are fossilized in marine deposits and include dragonflies (odonatans), bugs (hemipterans), beetles (coleopterans) and crickets (orthopterans) some of which are unique to the site. The exposure is maintained by coastal erosion so there is the potential for new finds to be made at any time.

References



(Figure 4.22) (a) Map of the coastal outcrop of the Lower Lias, Charmouth to Lyme Regis (after Benton and Spencer, 1995); (b) rock succesion (after House, 1993).

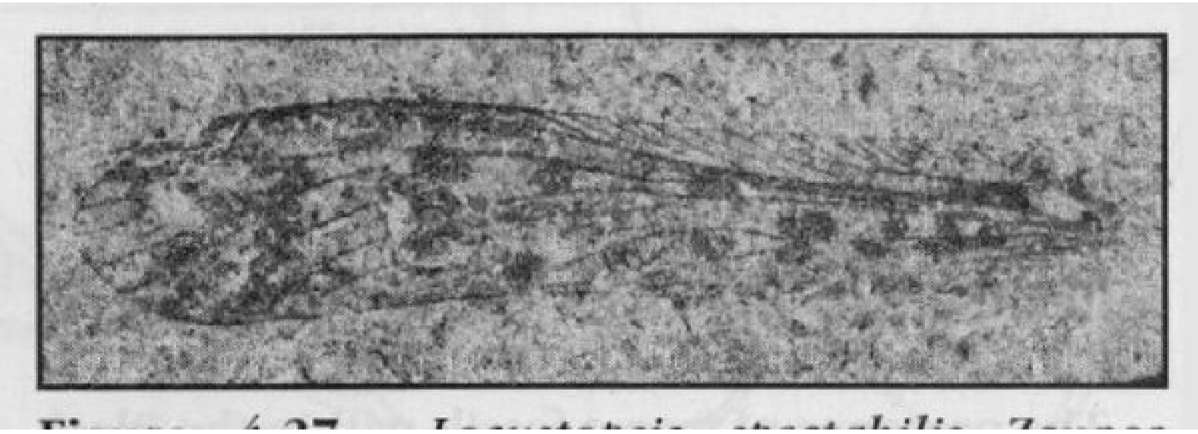


(Figure 4.23) Wing venation of early fossil Lepidoptera (left column) and assorted Holocene Lepidoptera (right column). (Nomenclature of veins: A, anal veins; Cu, cubital veins; M, median veins; R, radial vein; Rs, radial sector; Sc, subcostal vein.) Not to the same scale. The oldest Lepidoptera are known from wing fossils with primitive venation from the Early Jurassic deposits of England (Archaeolepis)and Germany (undescribed). Archaeolepis venation is revised based on new observations (Grimaldi and Engel, 2005); the German Jurassic wings are based on Ansorge (2003).

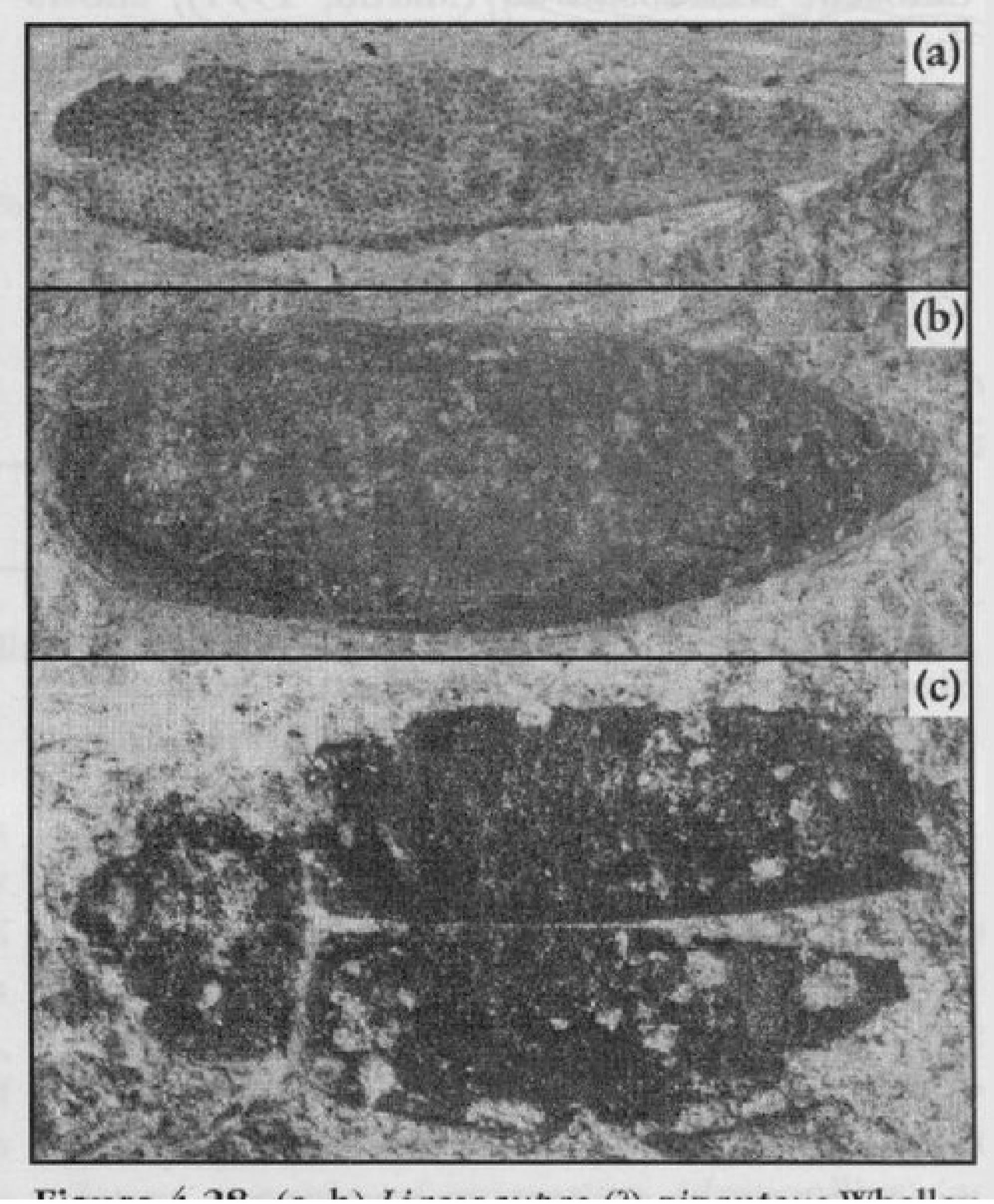
(Figure 4.24) Nannoblattina petulantia Whalley (Blattodea). Holotype, In.53929. forewing, 16.3 mm long. (From Whalley, 1985.)

(Figure 4.25) Brevicula gradus Whalley (Dermaptera). Counterpart of holotype, In.53993. (From Whalley, 1985.)

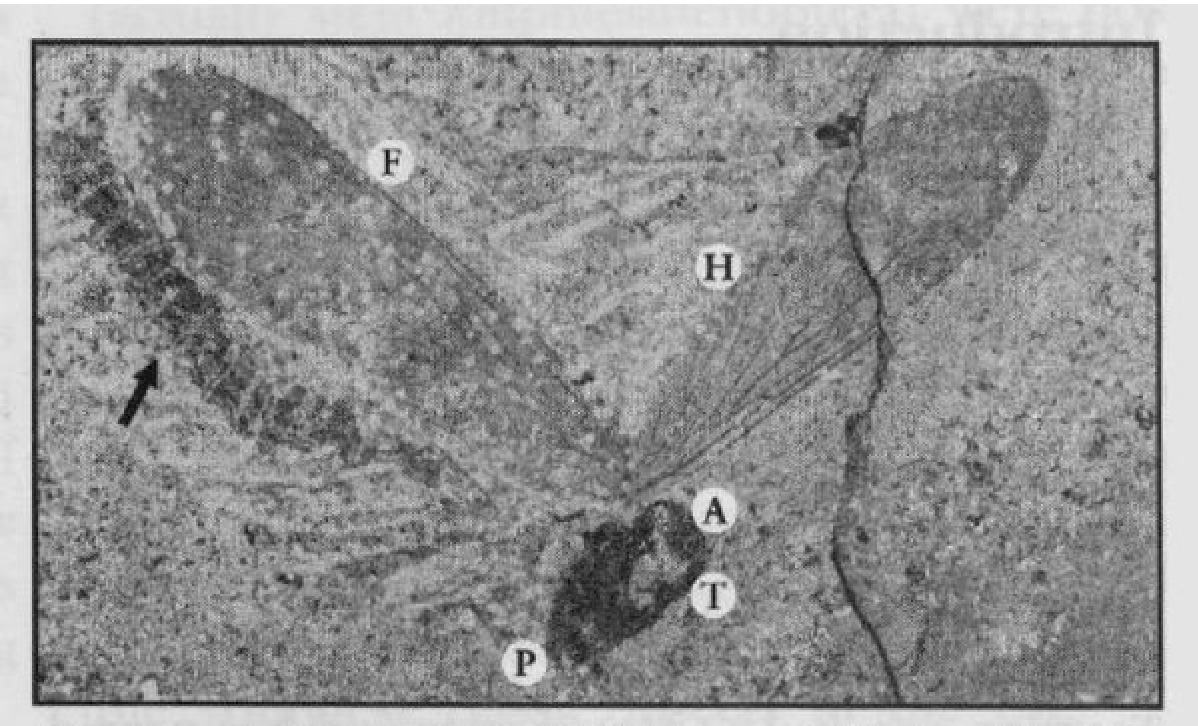
(Figure 4.26) Archelcana durnovaria Whalley (Orthoptera) paratype, In.53922, forewing. (From Whalley, 1985.)



(Figure 4.27) Locustopsis spectabilis Zeuner (Orthoptera). (c) In.49593, forewing. (From Whalley, 1985.)



(Figure 4.28) (a, b) Liassocupes (?) giganteus Whalley (Coleoptera), Holotype, In.51026, 21.4 mm long (part, (a) and counterpart, (b). (c) Carabidae (?)species (Coleoptera). In.53923, 11.2 mm long. (From Whalley, 1985.)



(Figure 4.29) Orthophlebia capillata Whalley (Mecoptera), holotype, In.53924. A = anterior of thorax; P = posterior of thorax; F = forewing; H = hind-wing; T = thorax. Arrow indicates chisel marks, not abdomen. (From Whalley, 1985.)