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Saproxylic Insect Survey of the Virginia Water and Bishopsgate areas of Windsor Park, 2002-2003

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Contents

1. Introduction

In 2002 I was invited to carry out an investigation of the old trees in the Valley Gardens area of Windsor Park with the hope of discovering further sites for the violet click-beetle *Limoniscus violaceus.* I was to seek the advice of Mr E.E.Green concerning the precise areas to be searched and it was he who recommended the woods around Virginia Water and Bishopsgate. The search was to be part of a several year investigation aimed at assessing the range and status of the *Limoniscus* in Britain. In this search, the writer has visited many areas of southern England where concentrations of old ash and beech trees are known to exist. These localities were recommended by English Nature staff at Peterborough and by local staff in the regions visited.

Insofar as the main purpose of the surveys has been concerned, this one included, namely the discovery of further colonies of *Limoniscus*, the programme has been unsuccessful. However, it may be possible to suggest the reasons for failure. See below under section 2.

In the process of searching for *Limoniscus* a number of other discoveries have been made. Thus in this study the breeding location of the **RDB1** stilt-legged fly *Rainieria calceata* was discovered and the puparium is figured here for the first time. With the *Rainieria puparia* an empty, incomplete *Potamia* puparium was found which differs slightly from specimens of *P.littoralis* studied and described by the writer (Skidmore 1985), and this may belong to another **RDB1** fly *Potamia setifemur*, which is only known in Britain from decaying beech trees in Windsor Park. In another hollow beech tree pupae of the **RDB1** snipe-fly *Chrysopilus laetus* were collected and an adult reared out. The pupa of this species is also figured and described here and compared with the common *C.cristatus*.

Another interesting and potentially useful result of this survey was the clear demonstration that trunk cavities in alien trees can repay close investigation in the quest for nationally rare saproxylics (see section 4).

The method of search for saproxylic Coleoptera favoured by the author is the analysis of organic accumulations in tree-cavities by means of the long-established palaeoentomological method of flotation (Buckland and Coope 1991) This is less destructive to the habitat and has the advantage that it monitors the total period of time during which the material has been building up. A disadvantage is that any dead insects obtained by this means are likely to have at least partially disintegrated and the identification of the remains requires a wide and deep knowledge of the insects favouring the habitat under study and access to an extensive collection of complete, mounted specimens for comparison. Published keys are seldom of great help as descriptions and figures are normally far too superficial.

2. The Search for additional localities for the violet click-beetle Limoniscus violaceus in southern England

Over the past four years the writer, at the request of English Nature has searched for this species in the following areas of southern England.

1997-1998 Chilterns- Naphill Common, Low Scrub and Coombe Hill, Pollards Wood, Greenfield Copse, Nettlebed Woods, Rassler and Davenport woods, Pulpit Hill and Frithsden Beeches.

1998-1999 New Forest and Savernake Forest.

2000-2001 Dorset sites- Holt Forest, Kingston Lacy Park, Melbury Sampford Park and Greenhill Down near Milton Abbas.

2002-2003 Windsor Park-Valley Gardens and Bishopsgate (Windsor Park).

In most of the localities visited, great difficulty was experienced in finding any trees of a suitable age and condition. It is well-known that *Limoniscus* is one of the most fastidious of species, requiring hollow trees in which the internal microclimate has not been disturbed by external weather conditions. At the same time it is known to require a degree of animal protein in its diet and optimum conditions are found in hollow trees in which raptors or corvids are nesting in the roof of the cavity. It is also believed that the black rot in which *Limoniscus* develops should contain quantities of decaying fungal sclerotia (Mendel *et al.* 1996). These form when a tree-killing fungus is arrested by adverse conditions, or by competition from another fungus, when both enter a resting stage, which may last for a very long time. Indeed, a hollow tree in which the activities of heart-rot fungi are thus suspended effectively enters a "new lease of life", its trunk effectively forming a reservoir of nutrients as organic debris accumulates inside.

In the search for *Limoniscus* the only site visited over the period of the search which has a quantity of trees closely approaching, or largely satisfying, these conditions is Valley Gardens. Indeed , unlike the old trees in the New Forest, those at Windsor have a very marked tendency to become hollow with age.

A major problem with *Limoniscus*, as indeed with many rare insects with very narrow ecological requirements, lies in the fact that the activity of the collector may seriously compromise the survival of the colonies of the target species. Opening up the microhabitat to the elements can render it inimical to the continued survival of the colony. In the case of *Limoniscus* it is highly probable that once external access, even by natural processes, becomes such as to enable the investigator to actually disturb the breeding site, the future of the colony may already have become precarious. There can be no doubt that over-zealous searching is in any case likely to precipitate the local extinction of many such fastidious insects.

The writer feels that the best way to proceed with investigating the status of this species may be by means of the palaeoentomological approach, whereby fragments of the species are sought in samples of matrix from deep deposits of decayed material in the floors of hollow trees. In tree cavities wide open to the elements these deposits may be extremely barren of living invertebrates but often contain massive assemblages of dead ones. The lowest horizons within the debris are of course generally the oldest but local knowledge may provide a more precise temporal framework, concerning age of the tree in question, and details such as the approximate time of onset of the sickly state, or the time of collapse or of felling, perhaps in the interest of public safety. A disadvantage with the palaeoentomological approach is that it may only reveal whether the species had once bred in the tree under scrutiny. As stated above, once the matrix is accessible *Limoniscus* may have ceased to breed in it. Also with increasing exposure to the elements, the cavity will be utilised by species seeking shelter from inclement weather, for hibernacula, or for resting stages, so that many species found in such situations do not belong to the saproxylic association. Whitehead (1986) reported on an assemblage of beetle remains in the cache of a wood mouse in a hollow tree, demonstrating another means whereby insect remains can be found in other than their natural microhabitat. The same situation will be found where birds have nested or bats have roosted. But these anomalies should become apparent during the interpretation of the assemblages being analysed This will often demonstrate the faunal changes which have occurred in the microhabitat (see sections 3 and 4 below).

The other problem with the palaeoentomological approach is that only fragments are normally available, owing to invertebrate activity *in situ* or through the process of extraction from the matrix. However, before commencing the process, larger fragments of the matrix must be broken and this preliminary operation sometimes reveals complete dead specimens.

The identification of fragments is by no means as difficult as might be imagined, providing one has a reasonable understanding of basic insect structure enabling one to recognise body parts, and a comprehensive collection of specimens for comparison. There should for instance be no difficulty in recognising pronota or elytra of a species as distinctive as *Limoniscus.* The most abundant beetle fragments are head-capsules, pronota and elytra.

Complete, live or freshly dead specimens of adults and larvae sometimes reveal that a particular species is still breeding in the matrix. Thus, in the analysis of material from the hollow beech log described in section 3 below, several young larvae of *Ischnomera sanguinicollis* were found, some in the matrix during the preliminary fragmenting process.

Many collectors of course have an inherent aversion for collecting insect fragments as they are less aesthetically satisfying than complete specimens, symmetrically mounted. It must however be admitted that removing a dead specimen of a protected species from the site is more acceptable than taking a live specimen.

A small quantity of material from inside a hollow felled beech at Valley Gardens was analysed in this way and the results discussed in section 3. A contrasting sample from a hollow horse chestnut is discussed in section 4.

3. Analysis of insect remains from a hollow beech at Valley Gardens

I am grateful to my friend Professor Paul Buckland for the processing some of the material from this log, in his department at Sheffield University. The method is that normally applied by palaeoentomologists for separating chitinous material from a peat, soil or siliaceous matrix and involves breaking the matrix up by hand then passing it into washing soda followed by paraffin, when chitinous material floats up to form a scum. This is then skimmed off and transferred to spirit for subsequent examination (Buckland & Coope 1991). The process can be surprisingly efficient in that subsequent careful searching of a residue after several flotations reveals very little remaining chitinous material.

The section of hollow beech trunk from which the material was collected (site 1 on map) was one of several which had been placed in a large mass of such sections. The bole of the tree was still *in situ* and, whilst the trunk cavity clearly extended through at least ten feet of the trunk, it did not reach down to the actual bole which was about three feet high. The section concerned in this analysis was partially filled with moss and small twigs, possibly parts of an old birds' nest, as well as copious quantities of decayed wood-mould. On examining a sample of the matrix in the field it was seen to contain very large numbers of elytra and pronota of *Cylindronotus laevioctostriatus* and *Melanotus villosus* together with many large puparia, thought initially to be calliphorids. But in the field the material appeared to highly dessicated and totally devoid of life. Furthermore, it appeared to contain only the three "taxa" just named.

The tree was evidently mature, perhaps around two centuries old. The wood of the inner wall of the cavity at the broader end was in part very hard wood such as would typically support *Ptilinus pectinicornis*, remains of which were indeed present in the debris. The presence of wood-dust in this hard wood itself showed that insects had been, and probably still were, breeding in the wood. Other parts of the inner wall were well decayed though with hard, dark, intercalations such as commonly support *Ampedus*.

On analysing samples of the debris from the cavity, the following 31 species of Coleoptera, 10 Diptera and 4 Hymenoptera were found, together with some additional unidentified taxa.

Coleoptera

Carabus problematicus elytral fragment

Nebria brevicollis adults (heads, pronota, elytra)

Nebria salina adults (elytra)

Agonum assimile adult fragments (heads, pronota, elytra etx.)

Dromius quadrimaculatus elytron

Abraeus globosus remains of adults and a live one

Abraeus granulum one live adult

Paromalus flavicornis remains of many adults

Quedius ventralis remains of many adults (heads, pronota, elytra etc.)

Dorcus parallelipipedus one elytron

Hoplia philanthus one adult head capsule and right foreleg

Byrrhus ?pilula one foreleg

Prionocyphon serricorne one elytron

Melanotus villosus numerous fragments of larvae(end-segments) and adults (heads, pronota, elytra etc.)

Ampedus rufipennis fragments of adults (heads, pronota and elytra)

Athous haemorrhoidalis several pronota, head-capsules and elytra

Eucnemis capucinus remains of at least two adults (head, pronotum, 3 elytra and sternal fragments. Two of the elytra appeared to belong to the same individual, the other was a decidedly larger specimen.

Tillus elongatus one elytron

Ptilinus pectinicornis pronotum and elytron

Cerylon ferrugineum many elytra and pronota

Cerylon histeroides remains of many adults (heads, pronota, elytra etc.)

Cis bilamellatus one live adult
Mycetochara humeralis one elytron
Ischnodes sanguinicollis remains of many adults (heads, pronota and elytra)
Cylindronotus laevioctostriatus by far the most abundant species, lots of fragments of adults.
Phloiotrya vaudoueri pronotum and elytron
Tetratoma fungorum one elytron
Cossonus parallelopipedus adult head capsule
Euophryum confine numerous fragments of adults
Phloeophagus ligniarius remains of adults (heads, pronota, elytra).
Acalles ptinoides adult head and pronotum

Diptera
Ctenophora ornata wing and pupal fragments
Xylomyia maculata three large, dead larvae
Oedalea apicalis wing fragment
Myathropa florea remains of adult
Xylota sp. puparia
Lonchaea sp. puparia
Tephrochlamys flavipes pupartia
Fannia sp. one empty puparium
Phaonia exoleta several puparia (in the field these were thought to be calliphorids)
Phaonia subventa/rufiventris puparia.

Hymenoptera
Lasius brunneus many head-capsules
Myrmica spp. head capsules of two species
Bombus sp. three wings
Apis mellifera three wings

There were also many remnants of a very large spider, possibly *Nuctenea umbratica*, very large numbers of earthworm egg-cocoons and woodlice, a few millipedes (*Cylindroiulus punctatus*) and false scorpions.

The preceding list includes a remarkably diverse assemblage, presumably testifying to a long history of the cavity. Firstly, there were the true wood-borers like *Eucnemis* and the cossonine weevils which were probably boring into the cavity walls along with *Ptilinus. Tillus* was doubtless preying on the latter, its normal prey species. Dead specimens of these would fall to the cavity floor. The cavity itself was clearly at some stage water-filled, hence the presence of puparia of the fly *Phaonia exoleta* and the rot-hole beetle *Prionocyphon serricorne*, both of which have aquatic larvae. Later, as debris filled the cavity moss began to develop and *Byrrhus* moved in, indicating that the at least now, the cavity was open to the elements. In the accumulated debris in the cavity, and the softer decaying wood and wood-mould lining the cavity wall, beetles like *Melanotus, Paromalus, Mycetochara, Cerylon, Ischnomera* etc., the ant *Lasius brunneus* and the crane-fly *Ctenophora ornata* presumably started to colonise. The cavity was also utilised by non-saproxylics like hive-bees and bumble-bees, various carabids etc. Proximity to waterside or marshy ground could have been inferred from the frequency of the ground-beetle *Agonum assimile* a typical inhabitant of damp woodland.

At the time of preparation for analysis of the matrix, during the preliminary fragmentation stage, a few young larvae of *Ischnomera* were found. Apart from these, the other taxa which were identified from remains of immatures, and hence indicating that they developed in the cavity, were *Melanotus* and most of the Diptera.

The presence of *Cossonus* is somewhat problematical as this is more often associated with *Salicaceae.* However, since other trees are sometimes utilised it is possible that the beetle had developed in this beech tree. Alternatively it could have been a casual immigrant from willows or even conifers nearby.

The following species were found alive under the bark of the same log and others adjacent to it on 13 vi, 13 xi 2002 and/or 23 February 2003.- *Carabus problematicus* (xi), *Paromalus flavicornis* (vi,xi (JW),ii)*, Scaphosoma agaricinum* (vi)*, Phloeonomus punctipennis* (xi (JW)), *Gabrius splendidulus* (vi, xi (JW))*, Quedius cruentus* (xi (JW)), *Sepedophilus lusitanicus* (vi, xi (JW))*, Atrecus affinis* (xi (JW)), *Bolitochara lucida* (vi, in *Pleurotus*), *Lordithon lunulatus* (vi, in *Pleurotus*), *Autalia impressa* (vi, in *Pleurotus*), *Dinaraea linearis* (xi (JW)), *Homalota plana* (xi (JW), *Euplectus ?fauveli* (xi (JW)), *Dorcus parallelopipedus* (xi (JW)), *Ampedus rufipennis* (vi,xi,ii)*, Stenagostus rhombeus* (larvae-vi,xi)*, Melanotus villosus* (larvae-xi ((JW)), *Silvanus bidentatus* (vi)*, Silvanus unidentatus* (vi,ii, xi (JW))*, Ryzophagus bipustulatus* (xi (JW)), *Ryzophagus ferrugineus* (xi (JW)), *Uleiota planate* (vi,xi)*, Pediacus dermestoides* (xi (JW)), *Triplax aenea* (vi, in *Pleurotus*), *Cerylon ferrugineum* (vi,xi (JW),ii), *Cerylon histeroides* (vi,xi (JW),ii), *Endomychus coccineus* (ii), *Sulcacis bicornis* (vi)*, Litargus connexus* (vi,xi (JW),ii), *Bitoma crenata* (vi,xi (JW),ii), *Colydium elongatum* (xi (JW)), *Cylindronotus laevioctostriatus* (xi (JW), *Rhinosimus ruficollis* (xi (JW)), *Leptura scutellata* (xi (JW)), *Euophryum confine* (xi (JW)), *Platypus cylindrus* (ii); *Lasius brunneus* (xi (JW)), *Leptothorax acervorum* (vi, in *Pleurotus*). Species taken on 13 November 2002 by J.R.Webb are indicated JW above.

4. Analysis of debris in hollow horse chestnut log

This tree had been cut into three sections with a cavity running through all three. The bole of the tree was not located so it was not ascertained whether the cavity reached ground level. The logs lay on the wood-edge some yards from the metalled road midway between the bridges by Johnson's Pond and Blacknest Gate, about opposite to the access road to Temple Bungalow (site 3 on map). The initial view was that sampling from the main log would be unproductive as the cavity at its widest part was only about 8 inches in diameter and the material itself rather dry. Also, horse chestnut is not normally a productive tree. However, on initial examination, a large living larva of *Xylomya maculata* was found in the debris inside the trunk, so two bags were taken.

Living specimens, or remains of dead examples of the following 9 Coleoptera, 3 Diptera and 3 Hymenoptera were present:

Coleoptera

Acupalpus dubius one live adult

Sepedophilus immaculatus one live adult

Dorcus parallelipipedus one hind leg

Elater ferrugineus pronotum and cast skins of 2 fully grown larvae, along with several younger ones and a pupal exuvium

Procraerus tibialis pronotum

Stenagostus rhombeus remains of large larva

Anobium ?punctatum elytron

Prionychus ater one larva

Euophryum confine remains of adults

Diptera

Xylomya maculata one live larva

Ornithomyia avicularia puparium

Dolichovespula media remains of two queens.

Hymenoptera

Myrmica and *Lasius* adults in pellets comprising of nothing else

Dolichovespula media remains of two queens

Also present were various other unidentified insects fragments and the usual assortment of centipedes (including *Lithobius variegatus*) and woodlice along with a few false-scorpions.

This sample was interesting in several respects. The presence of the puparium of the louse-fly *Ornithomyia avicularia* showed that this cavity had been used by birds; the pellets consisting of masses of ants perhaps suggested that the bird was a woodpecker. A single feather of a nestling was also present but no attempt was made to ascertain the species.

The presence of *Elater ferrugineus* was surprising in this not very inspiring-looking situation, and the species had clearly developed in this cavity as shown by the presence of larvae of different ages and a pupal exuvium. Horse Chestnut is not one of the tree species from which this beetle has previously been recorded in Britain, elm, beech, ash, and oak (one record only) being given by Alexander (2002).

The other surprising beetle here was *Procraerus tibialis*, a very local elaterid which is believed to prey on cossonine weevils in decaying wood of old trees. The cossonines *Euophryum confine* and *Phloeophagus ligniarius* are very abundant throughout this area, the former being present in this sample. Alexander (2002) gives oak, beech and ash as the usual host trees, but suggests that it probably develops in other trees.

Dolichovespula media queens are now frequently found hibernating under bark of dead trees, or in cavities.

The presence of such an interesting assemblage in a horse chestnut (including *Elater ferrugineus*, graded **RDB1**, *Xylomya maculata*, graded **RDB2** and *Procraerus tibialis*, graded **RDB3**) serves as a salutary reminder that in a top quality site like Windsor Park even alien trees are likely to support nationally rare saproxylic insects.

5. Other observations

The area of search in this survey (see map) comprised the eastern side of Windsor Great Park, extending eastwards from the westernmost end of Virginia Water (Lake) near Titness Park, via the metalled road from Blacknest Gate to Bishopsgate and bounded to the south and south-east by the A329 and the A30. The area thus occupies some four square kilometres, so in the time available it was possible only to gain a general overall impression of the area and to sample from a few stations.

Apart from the large open area around Smiths Lawn, and of course Virginia Water and Obelisc Pond, most of the area is open to closed canopy woodland. There are a few veteran oaks by Bishopsgate and Blacknest Gate (for instance trees 4371 and 4374 near Blacknest) which could well support some of the saproxylic specialities of Windsor which favour this tree species (ie. *Lacon querceus, Ampedus ruficeps* and *Gnorimus variabilis*). The two trees just mentioned evidently contain large trunk-cavities but they are largely inaccessible. However, since *Limoniscus* is not generally associated with oaks, these were not examined on this occasion.

The main tree species of interest was beech and as was pointed out to me by Mr E.E.Green, large beeches are scattered through the whole of this area, with higher concentrations in some parts, notably at the eastern end of Virginia Water, to the east of the Totem Pole bridge, and about Blacknest Gate. But the southern side of Virginia Water, between the eastern end of the lake and the Woodlee entrance is probably the main area of tall beech trees, many of them fallen or felled and most of them hollow. Whilst none of the beech trees here appear to be of great age or girth, a detailed survey of this area would probably prove productive. On 14 November a brief visit was paid to this area to assess the potential only in terms of numbers of suitable trees. Amongst the few things noted on rotten beeches here were- *Abraeus globosus*, *Paromalus flavicornis*, *Quedius cruentus*, *Triplax russica*, *Tetratoma fungorum, Ennaearthron cornutum* and the ant *Lasius brunneus*. On 23 February the following were found in this area- in totally rotted *Meripilus giganteus* on a beech stump- *Quedius cruentus, Tachinus subterraneus, Autalia impressa, Ocypus* sp. (larva), *Cylindronotus laevioctostriatus*; in rotten wood of the same stump- *Paromalus flavicornis*, *Stenagostus rhombeus* (several very large larvae); about old fruiting-bodies of *Pleurotus* and under adjacent loose bark on dead, standing beech tree- *Paromalus flavicornis, Plegaderus dissectus, Cerylon ferrugineum, Tetratoma fungorum*; on ?*Trametes* on adjacent felled beech were *Lordithon trinotatus, Cis bilamellatus, C.boleti, C.hispidus* and *C.setiger.* Also many larvae of *Pyrochroa*.

The woods adjoining the A329 are mainly oak and sweet chestnut, with some Scots Pine and other conifers with, in the eastern end a dense understory of rhododendrons and some large beeches. Birch is very widespread, with some very large, old specimens.

Under oak bark in this area the following were taken at site 5 on 23 February- *Ptinella aptera, Gabrius splendidulus, Quedius cruentus, Pediacus dermestoides, Uleiota planate, Silvanus unidentatus, Cerylon ferrugineum, Cis bilamellatus, Pyrochroa* larvae and a larva of *Rhagium*; also one larva of the fly *Xylophagus ater.* Normally one would expect *Rhagium mordax* rather than *bifasciatum* in oak but Donisthorpe (1939) gives the former for Scots Pine and oak here; he had no records of *R. mordax* from Windsor! Strangely enough this was the only larva of *Rhagium* seen at Windsor during this survey. In a small rot-hole in the same log were *Paromalus flavicornis* and *Dropephylla vilis.* Nearby *Hylurgops palliatus* and *Trypodendron domesticum* were flying in the warm sunshine over a heap of mixed logs and *Endomychus coccineus* adults and larvae were seen under oak bark here, along with a hibernating shield-bug *Cyphostethus tristriatus*. Some conifer logs here had borings which appeared to be *Molorchus minor*, but no sign of adults could be found.

On the upper ride to the west of Blacknest Gate a number of beeches were examined. A large log lying on the woodland floor contained larvae and a dead adult of *Ampedus rufipennis,* two larvae of *Denticollis linearis* and some large limoniid larvae. Some hundred yards further west a large dead standing beech was found to have a huge open trunk cavity (site 4 on map). On analysis, a large sample of the debris from this cavity produced the following 7 species of Coleoptera, 3 Diptera and 2 Hymenopteraon analysis-

Coleoptera

Abraeus globosus dead adult

Dorcus parallelipipedus a few remnants of adults

Orthoperus sp. one complete adult

Grynobius planus one elytron

Ptilinus pectinicornis a few fragments of dead adults

Euophryum confine huge numbers of dead adults

Phloeophagus ligniarius great numbers of dead adults

Diptera

Xylomyia maculata one empty "puparium"

lonchaeid sp. one empty puparium

Tephrochlamys flavipes one puparium

Hymenoptera

Lasius brunneus many adult head capsules

Myrmica sp. many adult head capsules and gasters.

Also many earthworm egg-cocoons, centipedes, millipedes (*Cylindroiulus punctatus*), and woodlice.

The quantity of debris collected from this tree was comparable to that discussed in section 3 but the results were extraordinarily poor by comparison. The tree was in a deeply shaded part of the wood, on a north facing slope and in a damp situation.

One of the most ubiquitous beetles under bark was *Silpha atrata*; the most widespread of conspicuous beetle larvae were those of *Pyrochroa*, many of which were evidently *P. coccinea*. Interestingly, whilst Donisthorpe (1939) was familiar with larvae of this species he never found an adult. Also, he said that *P. serraticornis* was not common either. Evidently they are both much commoner now than in his day.

An insect which was seen in remarkable abundance on 13 and 14 November, wherever were thickets of rhododendrons, was the spectacular Rhododendron froghopper *Graphocephalus coccineus.*

A very large compost heap (site 6 on map), examined on 13 November contained *Cryptopleurum subtile, Hypomedon propinquus, Philonthus quisquiliarius, Philonthus varius, Cilea silphoides, Monotoma picipes, Ahasverus advena*. Of these, the last three were in great abundance.

Ash appears not to be one of the commonest tree species but a few mature ones were noted. By the lakeside ride west of Blacknest bridge for instance is a large, partially decayed one, which, on 23 February supported large numbers of the fungus *Daldinia concentrica*. A little further west, at the junction of the upper and lower paths is a large decaying beech.

Valley Gardens itself is basically a mixed woodland in which there are many exotics and part of the gardens are more formal. The main foliferous trees however are probably oak and sweet chestnut; no beech were noted. Savill Gardens are mainly formal but some beeches were noted near Obelisc Pond.

The main feature of Bishopsgate are the veteran oaks and damp woodland around the small lake. There are some old beech trees here but little was found on those which were examined as they were not hollow. Birches are again numerous here and many are of some age and dimensions (see section 10).

The whole of the area covered in this survey is open to the public and is thronged with walkers during fine weather. It is clearly a major asset to the local populace, but the deleterious effects of heavy visitor pressure were not apparent. Inevitably some visitors see tree-holes as receptacles for rubbish but whether this poses a major problem for invertebrates developing in such situations is uncertain. Woodland management appears to be exemplary from a wildlife conservation standpoint, there being copious quantities of dead wood of all sizes and stages of decay. It appears that dead trees are cut up and left on site, insofar as this can be achieved with public safety considerations of over-riding concern.

6. The pupa of Chrysopilus laetus (Plate 2)

On 13 June a hollow beech log at site 1, adjacent to that described under section 3, was found to contain, amongst the mass of debris inside, several pupae of *Chrysopilus laetus* along with copious remains of *Ampedus rufipennis, Cylindronotus laevioctostriatus* and *Melanotus villosus* and an elytron of *Prionychus ater.* Most of the *laetus* pupae had hatched but one was close to emergence of the adult; in fact a female emerged from it on the following day.

The pupa of *Chrysopilus cristatus* has been figured and described several times (Hobby and Smith 1961) but it may be useful to explain how the pupae of *C .cristatus* and *laetus* differ. Beling (1875) described the immature stages of five species, *C. auratus* F., *laeta* Zett., *nubeculus* Fall., *nigrita* F. and *nigricauda* Bel. , but problems of synonymy render his conclusions unceretain.

Within its habitat the pupa of *Chrysopilus laetus* is unlikely to be confused with anything else (**Plate 2a**). It differs from *Chrysopilus cristatus* (**f**) in many respects, amongst which may be mentioned the following:

1 Apical spine-bands on the abdominal segments composed of a small number of large, widely-spaced, stout simple spines (**a, b**), with a few scattered minute spicules in between. In *cristatus* there are numerous (**f**), finer, more irregularly shaped spines, many of which are bifurcate in apical half (**h**).

2 Mesonotum relatively shorter and broader (**c**). Rather longer and narrower in *cristata* (**g**)

c) Abdominal spiracles much less well-defined, less elevated and more wart-like; not linked by median transverse carina (**a**). In *cristata* abdominal spiracles strongly produced, to shortly tubular, each on a strongly raised raised transverse carina encircling each segment medially (**f**). (In *Rhagio* there are a pair of dorsal discal spines on each abdominal segment, approximately alligned with the spiracular processes.)

d) In *cristatus*, but somewhat less markedly in *laetus,* the pronotal lobe is bounded behind by a very deep transverse furrow which runs under the prospiracular lobe and a small lobe on the mesonotal front margin (**j**). In *laetus* these features similar but rather less pronounced. (In *Rhagio* the pronotal lobe lacks a posterior transverse furrow altogether.)

e) Facial mask in *laetus* with three pairs of very prominent raised tubercles on vertex (**d**). These are absent in *cristata* or at most the anterior pair very weakly indicated. Before these however in *cristata*, and much closer to the antennal bases, are a pair of more distinct weakly convex tubercles (**i**). These are clearly seen in the figure given by Hobby and Smith (*loc. cit.*).

f) Perianal disc quite different in the two species (**e** *laetus,* **k** *cristatus*).

Published descriptions of pupae of rhagionids are generally inadequate for specific identifications at present, but these two should be readily separable on the characters given above. The larva of *C. erythrophthalmus* is aquatic (Thomas 1978; Stubbs and Drake 2001) and the pupa, according to Stubbs & Drake's figure (*loc. cit.*) apparently resembles that of *cristatus* in the numerous spines on the abdominal segments. *C .cristatus* occurs in humus soil, often in very damp situations at the sides of water (as were those described by Hobby and Smith (*loc. cit.*). *Rhagio* pupae apparently differ amongst other respects, most obviously in having a pair of mid tergal spines aligned with the spiracles. Donisthorpe (1939) was the first person to record *Chrysopilus laetus* in Britain. He claimed that his specimen was reared from a "puparium" which he had taken from the mud around a pond. Clearly he had his records confused and there can be little doubt that he actually found it in decaying beech, a habitat which he spent a great amount of time researching at Windsor. The present writer found larvae of this species with those of *Elater ferrugineus* and *Gnorimus variabilis* in oak wood-mould near High Standing Hill during the early 1960s.

7. The puparium of Rainieria calceata (Plate 4)

On a group of felled beeches at site 2 (see map) on 13 June the following were found- *Abraeus globosus, Paromalus flavicornis, Cis boleti, Cis micans, Tomoxia bucephalai, Anoplodera scutellata, Platyrhinus resinosus* and the ant *Lasius brunneus*. A single female *Ctenophora pectinicornis* was also observed on the exposed end of a rotten beech log and large numbers of the hoverflies *Chalcosyrphus nemorum* and *Xylota segnis* were patrolling the bark. Several queens of *Vespa crabro* were also in evidence. But the most conspicuous insect here was the micropezid fly *Rainieria calceata* which was seen in some numbers walking over the logs in bright sunshine. The presence of a strong colony of *Rainieria* amongst a number of felled beech trunks exhibiting a wide range of microhabitats raised the possibility of locating their breeding quarters.

Until the 1990s the only known locality in Britain for *Rainieria calceata* was Windsor Forest, where it was first recorded by Donisthorpe (1930). Very few people appear to have seen it for the next 40 years, but in early June 1966 I was fortunate enough to see several on a fallen, decayed beech at High Standing Hill, a site which I visited on several occasions with my old friend the late Andrew Low of West Drayton. Then, in July 1998 I found a specimen on the laboratory window at Juniper Hall Field Centre in Surrey (the specimen is now in Cardiff Museum) and a day or two later I saw another flying around a dying beech on the plateau of nearby Box Hill. Denton (2001) saw "at least ten specimens on a large fallen beech" at West End Common, Esher, Surrey on 7 August 2000.

There can be little doubt that the hurricance which felled large numbers of old beeches and other trees across southern and eastern England during the late 1980s proved a turning point in the fortunes of this magnificent species in England, for, with increase in suitable habitat it evidently burst out of its former confines in Windsor Forest and is spreading across Surrey. It is also known from Burnham Beeches (Alexander 2002).

The immature stages of *Rainieria calceata* were hitherto unknown but Sabrosky (1942) described and figured the puparium of the North American *Rainieria antennaepes* Say (sub nom. *brunnipes* Cresson) from an old American elm. He records that the puparia were against dead but firm wood adjacent to softer rotten wood possibly permeated by fungal mycelia. Clearly the habits of the two species are similar for in this survey large numbers of old, empty puparia of *R.calceata* were found in solidified black rot in a hollow beech lying on the ground at site 2 in Valley Gardens, within an hour of having noted the first adults on 13 June 2002.

The *Rainieria* log exhibited an astonishing array of microhabitat conditions, presumably arising from different processes of fungus-induced decay. The area where the *Rainieria* puparia were found was in solidified black rot, but close by were masses of dry and sodden pale wood-mould, whilst at the other end of the cavity was a mass of whitish wood having a gelatinous consistency. Like the beech logs discussed in section 3 these lay on a dry sandy substrate, unlike that to the west of Blacknest which contained a meagre assemblge of species.

The likelihood of the puparium of *Rainieria calceata* (**Plate 4a-d**) being confused with that of any other British fly is very remote on account of the remarkable posterior spiracles. *R.calceata* resembles *R.antennaepes* Say (Sabrosky 1942) in this regard, namely, the usual three respiratory slits, as seen in most cyclorrhaphous flies are replaced by a complex pattern of tortuous necklace-like lines of rounded pores (**d**). Similar forms are of very rare occurrence in acalyptrates but occur in some syrphids, tachinids and oestrids. In the nearctic *Calobatina geometroides,* which, like *Rainieria* breeds in moist organic debris in hollow tree-trunks, the structure of the slits appears to show a further progression from *Rainieria,* the tortuous slits of that genus being replaced by numerous tiny scattered pores which do not run in lines (Ferrar 1987). The other British micropezids possess the triple-slitted form (Brindle 1965, Mueller 1957, Ferrar 1987), though the alignment is unusual. All known micropezids have the laterodorsal tooth on the outer edge of the peritreme and the very elongate, parallel-sided body form. Unfortunately no puparia were found complete with the cephalopharyngeal skeleton, so it is not yet possible to figure this structure.

The ventral ambulatory welts in *R.calceata* consist of a continuous transverse row of very large spicules along the crest, preceded by three very much finer rows of minute serrations in front and a similar one behind (**c**). No papillae could be discerned either in the anal region or around the perispiracular field, the rim of which forms a very strong, partly foliaceous flange (**d**). Prothoracic spiracular processes with at least 20 papillae, in two or three irregular rows (**b**). Length 5.5-10mm. The remarkable respiratory slits in this species are probably an adaptation to life in an anaerobic environment., the form of these slits greatly increasing surface area for gaseous exchange.

In the matrix containing the puparia of *Rainieria calceata,* and in adjacent loose wood-mould etc., were live larvae of *Eupachygaster tarsalis* and a large *Xylomya maculata* larva. Also the extraction method outlined in section 3 above revealed remains of *Notiophilus* sp., *Abraeus globosus, Paromalus flavicornis, Dorcus parallelipipedus, Ampedus rufipennis, Melanotus villosus, Cylindronotus laevioctostriatus, Anoplodera scutellata, Euophryum rufum*; remains of adults and pupae of *Ctenophora pectinicornis* and an empty puparium of *Ornithomyia avicularia*, indicating the former presence of avian occupants in the cavity.. There were also many fragments of a brachyceran pupa which could have belonged to *Oedalea apicalis* (see under section 9 below). Live adults and puparia of *Phyllomyza ?longipalpis* were also present along with head-capsules of the ant *Lasius brunneus*.

It seems likely from the above observations that *Rainieria* colonises damp dead wood which is being worked by larvae of *Dorcus, Melanotus, Ampedus* and *Anoplodera scutellata*. The ant *Lasius brunneus* is commonly present in such situations at Windsor and the milichiid fly *Phyllomyza ?longipalpis* was probably occurring as an inquiline with the ants. An association with ants is quite common amongst milichiid flies (Ferrar 1987). Interestingly no positive indications of large scale breeding by *Dorcus, Anoplodera scutellata* were found at site 1 and *Rainieria* was not found there either, perhaps suggesting that the first two may be associated with the conditions required by *Rainieria.* If this is so, *A. scutellata* is presumably the pioneer coloniser, followed by *Dorcus* then *Rainieria*. *Eupachygaster tarsalis* and *Xylomya maculata* are presumably amongst the later colonisers of decaying wood.

In *Coriolus versicolor* on beeches at this site the following were taken or noted on 13 June- *Paromalus flavicornis, Scaphosoma agaricinum, Phloeonomus punctipennis, Bolitochara lucida, Ryzophagus bipustulatus, R. dispar, Mycetophagus quadr-pustulatus, M.multipunctatus, Dacne bipustulatus, Octotemnus glabriculus, Cis hispidus, Aridius nodifer, Silvanus unidentatus, Lasius niger.* A beech stump close to the felled trunks supported large populations of the beetle *Platypus cylindrus*.

8. The possible puparium of *Potamia setifemur* (Plate 5)

A single incomplete puparium of a primitive azeliine muscid was found amongst the *Rainieria,* The puparium of *Hydrotaea lundbecki* has not been described but it has been reared from rotten beech wood, and hence it must remain a possible contender for the identity of this specimen from Valley Gardens (**Plate 5**). In known *Hydrotaea,* none has a posterior spiracular form and arrangement of the respiratory slits quite as in this specimen which appears more like *Potamia.* It is in fact extremely similar in most respects to the fairly common, eurytopic *Potamia littoralis*, except that the posterior spiracular respiratory slits are more distinctly curved towards their outer apices than has been seen by the writer in that species (compare figs. **c** and **d**). In fact they display quite the same shape and alignment as those of the Australian *Australophyra rostrata* (Skidmore 1985). *P.setifemur* has only been taken in Britain on hollow beech trees at Windsor, where I took a teneral female on High Standing Hill in early June 1966.

The larvae of the more primitive *Hydrotaea* species, such as members of the subgenus *Hydrotaeoides* and those formerly placed in *Ophyra,* are trimorphic facultative carnivores which are capable of attaining maturity without resorting to carnivory (Skidmore 1985). *H. lundbecki*, formerly placed in a separate genus *Cryptophyra* most probably belongs to this more primitive section of *Hydrotaea*. *Potamia* species are similar in this respect. *P. littoralis* has been reared from a very wide range of media including not only faeces and decaying animal matter and fungi, but also from rotten wood and tree ulcers (Skidmore *loc. cit.*) but *setifemur* is only known from rotten beeches. The nearctic *P. scabra* is remarkable in apparently lacking distinct accessory oral sclerites, which may infer a wholly saprophagous diet. In *littoralis* these structures are present though weakly sclerotised.

9. Saproxylic Quality Index for Virginia Water Woods

The following table lists all of the saproxylic Coleoptera collected on this survey in the Virginia Water area. On the basis of the calculated Saproxylic Quality Index for Coleoptera and according to the table of selected sites in Britain in Fowles, Alexander and Key (1999), Valley Gardens qualifies amongst the top 10 sites in the UK for saproxylic beetles. The limited evidence available also suggests that the same may apply in relation to the dipteran fauna.

Coleoptera

Plegaderus dissectus	*8*
Abraeus globosus	*4*
Abraeus granulum	*8*
Paramalus flavicornis	*2*
Nossidium pilosellum	*8*
Ptinella aptera	*2*
Scaphosoma agaricinum	*2*
Phloeonomus punctipennis	*2*

Gabrius splendidulus	*1*
Atrecus affinis	*1*
Quedius ventralis	*8*
Bolitochara lucida	*2*
Dinaraea aequata	*1*
Homalota plana	*2*
Euplectus fauveli	*8*
Dorcus parallelipipedus	*2*
Prionocyphon serricornis	*8*
Melanotus villosus	*1*
Ampedus rufipennis	*24*
Procraerus tibialis	*16*
Stenagostus rhombeus	*4*
Elater ferrugineus	*32*
Eucnemis capucina	*32*
Grynobius planus	*2*
Anobium punctatum	*1*
Ptilinus pectinicornis	*1*
Tillus elongatus	*8*
Ryzophagus bipustulatus	*1*
Ryzophagus dispar	*1*
Ryzophagus ferrugineus	*2*
Cerylon ferrugineus	*2*
Cerylon histeroides	*4*
Octotemnus glabriculus	*1*
Cis boleti	*1*
Cis festivus	*2*
Cis hispidus	*4*
Cis micans	*4*
Cis setiger	*2*
Ennaearthron cornutum	*2*
Sulcacis affinis	*2*
Sulcacis bicornis	*8*
Litargus connexus	*2*
Mycetophagus multipunctatus	*2*
Mycetophagus quadripustulatus	*2*
Dacne bipustulatus	*2*
Triplax aenea	*2*
Triplax russica	*4*

Silvanus bidentatus	*8*
Silvanus unidentatus	*4*
Pediacus dermestoides	*4*
Uleiota planate	*16*
Pediacus dermestoides	*4*
Bitoma crenata	*4*
Endomychus coccineus	*2*
Colydium elongatum	*16*
Tomoxia biguttata	*16*
Mycetochara humeralis	*16*
Ischnomera sanguinicollis	*8*
Prionychus ater	*8*
Rhinosimus ruficollis	*2*
Pyrochroa coccinea	*4*
Tetratoma fungorum	*2*
Phloiotrya vaudoueri	*8*
Anoplodera scutellata	*16*
Platyrhinus resinosus	*4*
Cossonus parrallelipipedus	*8*
Euophryum rufum	*-*
Phloeophagus ligniarius	*2*
Acalles ptinoides	*2*
Hylurgops palliatus	*1*
Trypodendron domesticum	*2*
Platypus cylindrus	*8*

SPP 71 SQS 394 SQI 555.4

Diptera

Ctenophora ornata	**RDB1**
Oedalea apicalis	**Nb**
Xylomya maculata	**RDB2**
Eupachygaster tarsalis	**Nb**
Myathropa florea	
Xylota sp.	
Lonchaea sp.	
Tephrochlamys flavipes	
Phaonia exoleta	**RDB3**
Phaonia subventa/rufiventris	

Hymenoptera

Lasius brunneus

As stated above the small brachyceran pupae which were found in numbers with the *Rainieria* puparia could perhaps belong to the hybotid fly *Oedalea apicalis.* The Empidoidea is probably the least well-known of brachyceran families in terms of the morphology of the immature stages. Extremely few hybotid and empid pupae are known; all that can be said at this stage is that they exhibit a remarkably wide range of forms. The pupa figured here (**Plate 3**) conforms to the basic empidoid type but is evidently not a dolichopodid because of the absence of the very long, tubular prospiracular horns which characterise all known pupae of that family. The few hybotid and empid pupae which have been described, or have been seen by the writer, have well-developed posterior spine bands on the abdominal segments. Sometimes these spines are extremely long and abundant, at least in the Empididae. The present pupa is therefore rather unusual in being totally devoid of such excrescences (**a**). The entire integument is covered in microscopic, uniformally scattered granules (**e**). The prothoracic spiracular process is reduced to a tiny asymmetrical umbonate wart (**a**). Apical abdominal segment with two dorso-apical lobes and ventrally with anal region bounded laterally and behind by a raised arcuate rim (**c,d**).

10. Bishopsgate

On the advise of Mr E.E.Green this site was visited on 14 June 2002 when a small amount of collecting was carried out. The primary reason why more time was devoted to the Virginia Water area was the greater quantity of hollow, decaying beech trees there. Only one or two large beech trees were noted at Bishopgate and these, for example a large one at site 7 (see map) lacked cavities, the decay, as in the New Forest beeches, appearing to be predominantly from the outside inwards. Consequently they did not look promising for *Limoniscus violaceus* and the small amount of time spent on these trees was also much less productive than by Virginia Water.

A notable feature however at Bishopgate is the larger number of old oaks, one or two of which clearly contain large quantities of wood-mould which may support local rarities such as *Gnorimus variabilis* and *Lacon querceus* which the writer and F.A.Hunter found in the early 1960s near High Standing Hill. The oaks here would clearly repay study. A partially dead one closer to Cumberland Lodge exhibited a diversity of flight-holes from *Dryocoetinus* to *Sinodendron* size

Amongst species taken at Bishopgate were- *Cis micans* in *Ganoderma* on beech (site 7), *Cis nitidus* in ?*Phellinus* on birch, *Euryusa sinuata* one under oak bark, *Malachius bipustulatus, Ptilinus pectinicornis, Pyrochroa coccinea, Judolia cerambyciformis* one on umbel (*Conopodium*)*, Dryocoetinus villosus* under oak bark*, Paromalus flavicornis* under oak bark, *Euophryum rufum* under beech bark*, Metalimnobia quadrimaculata* larvae in *Ganoderma* on beech, one of which produced an adult in July (site 7), *Lasius niger* one queen. The only wasp-beetle *Clytus arietis* seen on this survey was on a large dead beech at Bishopsgate. *Judolia cerambyciformis* was not recorded from Windsor by Donisthorpe (1939).

Metalimnobia quadrimaculata develops in a wide range of bracket fungi in old woodlands but is decidedly local, being graded **RDB2**. The pupa was figured by Brindle (1967) who drew attention to the distinctive form of the prospiracular processes.in which feature he distinguished *Metalimnobia* from other subgenera of *Limonia.* However the figure lacks details such as the prospiracular papillae and the facial mask. Plate 1 shows the facial mask (**c**) and the thoracic region of the pupa in dorsal and lateral view (**a,b**). The prospiracular papillae are ocelliform, arranged in a row around the periphery of the prospiracular disc.

Euryusa sinuata has been recorded from below oak and beech bark in old forest areas, including Windsor (Donisthorpe 1939), often in company with the ant *Lasius brunneus*. It is graded **RDBI** (Alexander 2001).

11. Future searches for *Limoniscus violaceus*

As stated earlier, *Limoniscus violaceus* is believed to be one of the most fastidious of saproxylic beetles and, doubtless for this reason, apparently one of the rarest throughout its range. It is however most probable that being a primary tree cavity species, it is normally inaccessible to collectors save if such are present when an inhabited tree is felled or wind-blown. The beetles may then be found in the cavity or stump. Obviously the adults must disperse from breeding sites to form new colonies and it is probably on such occasions that they have been taken on flowers of *Crataegus* etc. Invariably the field worker first searches the tree-cavities after they have been open to the elements for a considerable period, when they are probably no longer ideal for *Limoniscus*.

It is suggested above that the best means of locating the species in Britain may be by means of palaeoentomological analysis of cavity floor deposits, especially in newly felled or wind-blown trees. Site visits by collectors are likely to be extremely transient and are subject to climatic conditions. Cavity debris analysis on the other hand may build up over centuries- the Major Oak in Sherwood is thought to have been hollow for over 800 years!

Of all of the sites surveyed for *Limoniscus* during this four-year programme this is the only locality in which the species is confidently expected to occur. Here alone was a high incidence of suitable trees found, many of them occupied by jackdaws or other birds. Whilst the present survey concentrated on beech trees, evidence is provided that alien broad-leaved trees are also worthy of examination.

A more detailed survey of the entire eastern fringes of Windsor Great Park would be highly desirable, both for *Limoniscus* specifically and for data on the status there of other nationally rare saproxylics. Large, potentially important trees were also noted in adjacent areas including the grounds of Savill Court and around Woodlee, Fort Belvedere, Wentworth, Blacknest Pool, Titness park etc.

12. Acknowledgments

My thanks are offered to English Nature for the opportunity to carry out this programme of surveys, and especially to Dr R.S.Key and Mr J.R.Webb for their advise and help in many respects. Also special gratitude is acknowledged to Mr E.E.Green for his keen interest in this survey and his advise on suitable collecting sites within the area. Finally to my wife Heather for her support in many ways, for her organising skills in transport, finding accommodation and in computer expertise.

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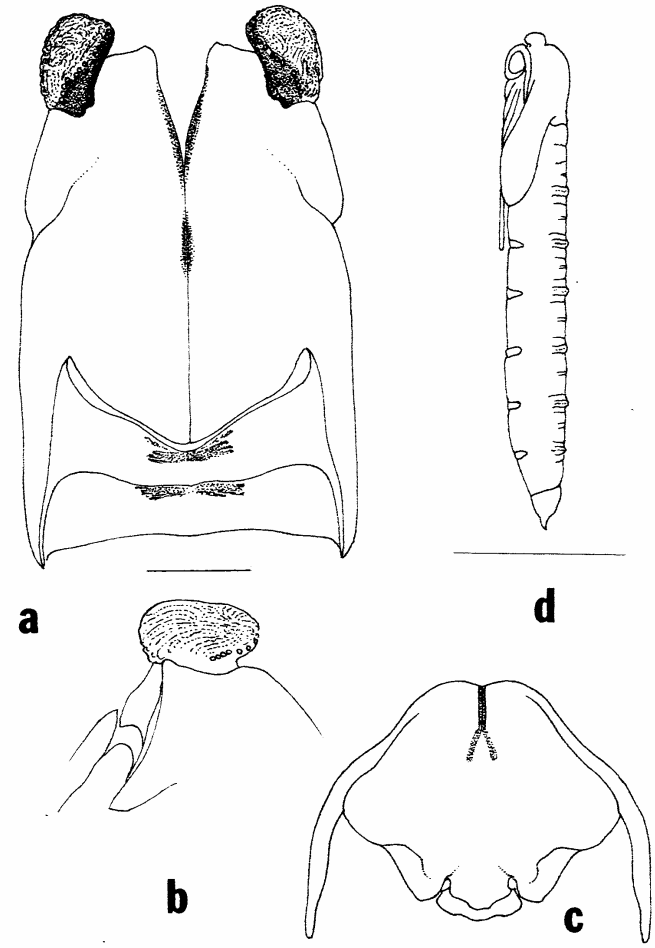


Plate 1: Pupa of *Metalimnobia quadrimaculata*

a thoracic region (dorsal view); b same (lateral view); c facial mask; d lateral view of pupa (after Brindle 1967). Scale 0.8mm. (a-c orig.)

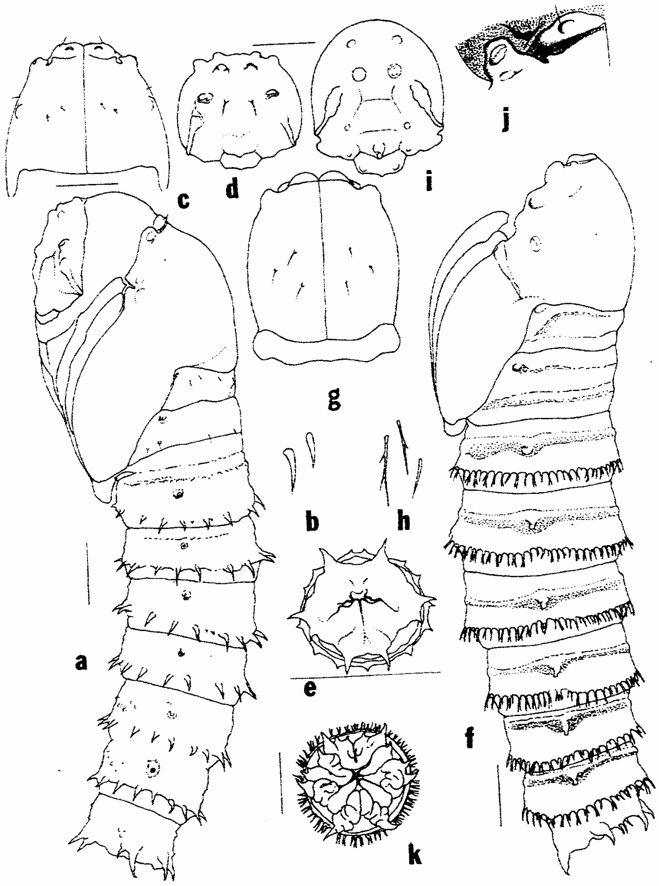


Plate 2: Pupae of *Chrysopilus laetus* and *C. cristatus*

C. laetus, a lateral view of pupa; b form of spines in spine-band; c thoracic region (dorsal view); d facial mask; e end-segment in posterior view. *C. cristatus*, f lateral view of pupa; g thoracic region (dorsal view); h form of spines in spine-band; i facial mask; j detail of pronotal region showing deep transverse posterior furrow. Scales 0.8mm. (Orig.)

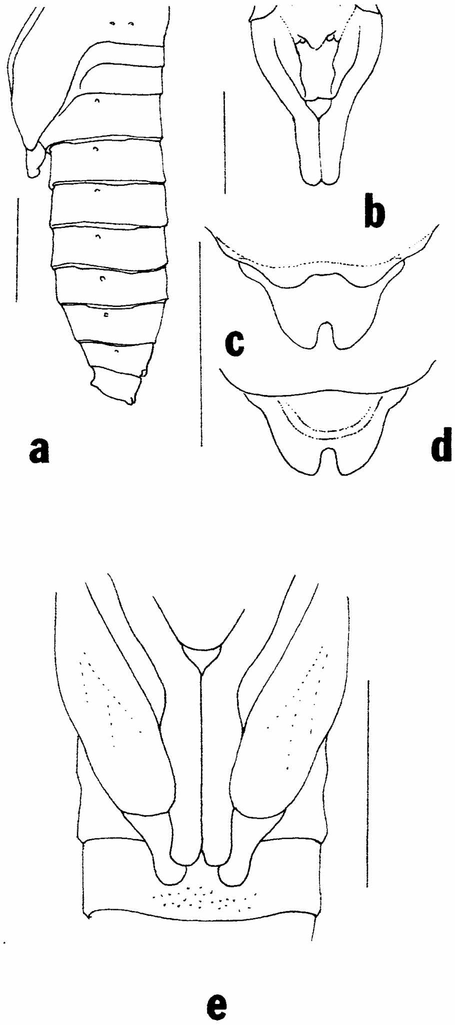


Plate 3: Empidoid pupa

a lateral view of pupa (head and facial mask detached); b facial mask; c end-segment (dorsal view); d same (ventral view); e posterior part of wing and leg-sheaths (ventral view), showing microsculpture on adjacent sternite. Scales 0.8mm. (Orig.)

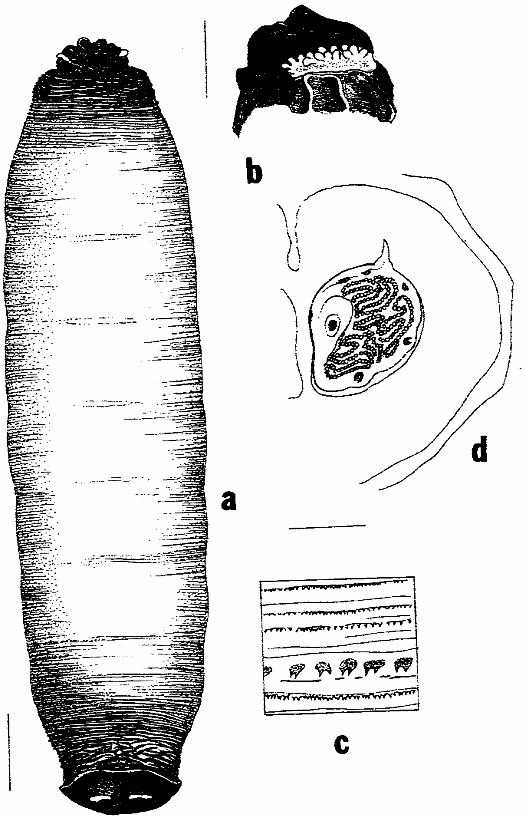


Plate 4: Puparium of *Rainieria calceata*

a puparium (dorsal view); b prothoracic spiracular process; c detail of spiculation on ambulatory welt 4; d posterior spiracle in posterior view showing tortuous respiratory slits and dorsal tooth. Scales- a 0.8mm; b,c,d 0.2mm. (Orig)

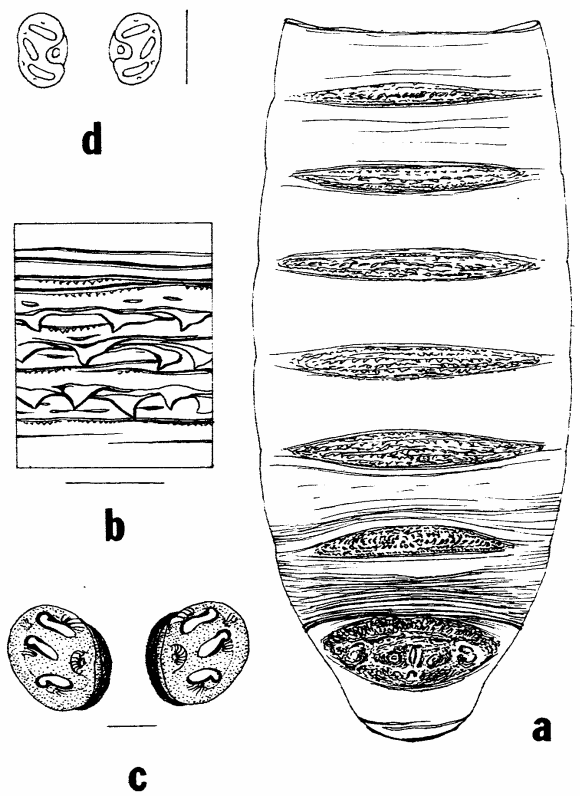
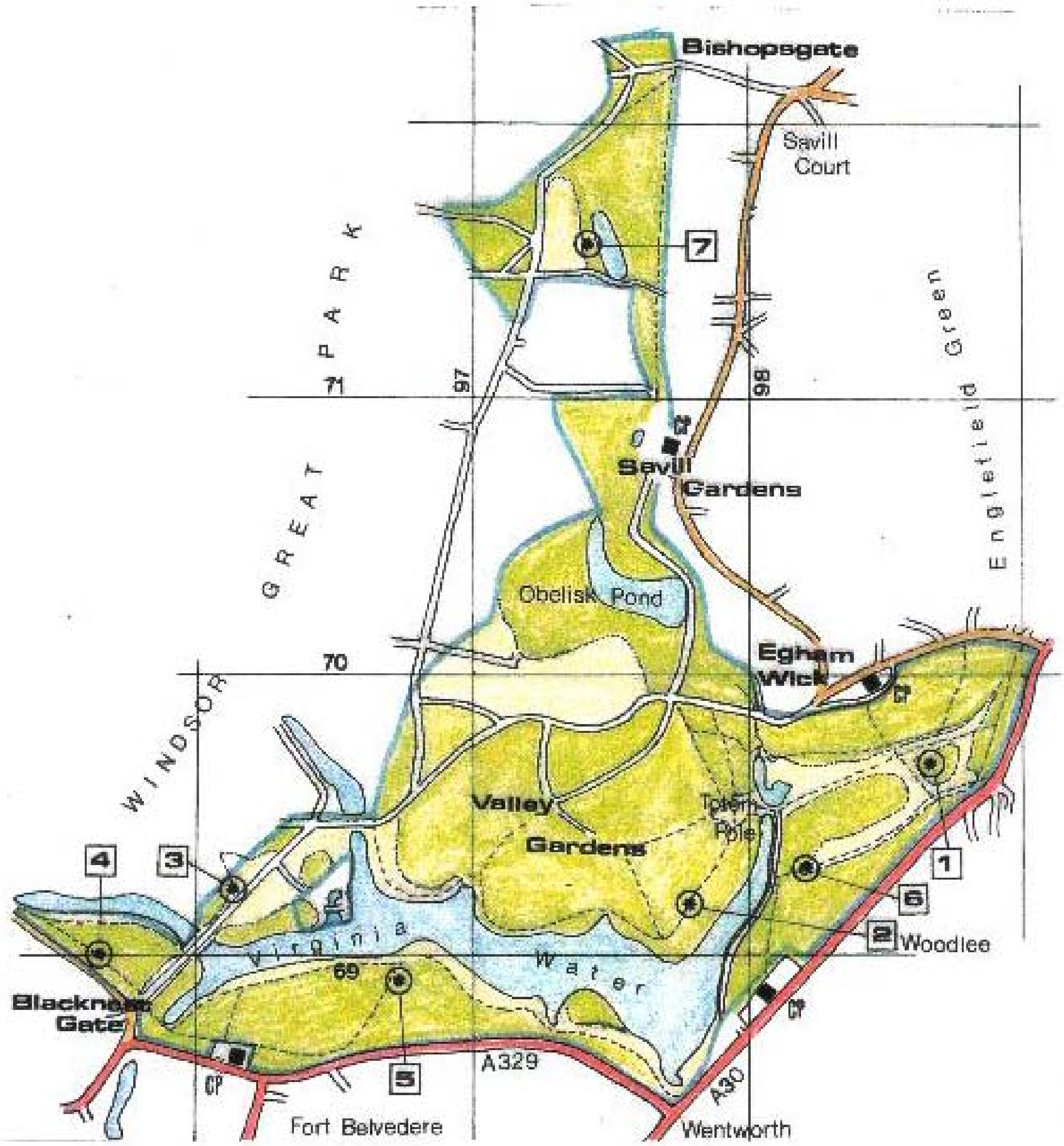


Plate 5: Puparium of ?*Potamia setifemur*

a puparium (ventral view) (front caps missing); b detail of spiculation on ambulatory welt 4; c posterior spiracles (posterior view); d posterior spiracles of *Potamia littoralis* showing straighter respiratory slits. Scales a 0.8mm, d 0.2mm; b,c 0.1mm. (a-c orig., d after Skidmore 1985)



Map of Area covered by this survey

The area of search is outlined in blue and the main blocks of woodland are shown in green, though some of these may be open canopy. Sampling sites 1 to 7 are indicated.

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