

NOTES ON THE BIOLOGY OF *HARMINIUS UNDULATUS* (DEGEER)

By J. A. OWEN*

H. undulatus is one of the more local British elaterids, occurring in upland woodlands in northern England (one record) and highland Scotland. These notes are based on observations during 1982 to 1985 at six Scottish sites, from experience gained in rearing adults from wild larvae and from the collated observations of others. Though the evidence is somewhat fragmentary, and in places anecdotal, the picture should at least be of help to anyone wishing to investigate the life history of the species in greater detail.

Habitat

The early stages of the beetle occur in dead timber. Larvae, adults and, more rarely, pupae have been recorded in Britain mostly from dead birch (e.g. Blackburn, 1866; Leech, 1969; Orton, 1971; Skidmore, 1978) and this has been my experience exclusively with about 25 larvae, but the beetle is also recorded in association with Scots pine (Hunter, 1977). On the Continent, it is reported to occur in both coniferous and broad-leaved trees (Lohse, 1977). The larvae live usually under the bark or in the dead wood immediately beneath the bark of trunks of trees lying on the ground but occasionally occur in suitable standing dead trees. They prefer trunks with fairly thick bark, possibly because this maintains more suitable (? damper) subcortical conditions over the several years which the larvae take to mature. I have found half to full grown larvae in trunks of trees which looked as if they had been fallen for 3 to 10 years. I have the impression that they occur more often in the trunks of birch trees which have been deliberately felled than in those which have died and then fallen over, perhaps because felled dead trees are more attractive to the adult for oviposition than trees which have been dead some time and have dried out before falling over.

The sites where I have come across *Harminius* as early stages or adults have been in central highland Scotland in birch woods on variously facing slopes at altitudes from 100 to 400 m in areas with mean annual rainfall of 1200 to 1800 mm. It could be that a relatively high rainfall helps to maintain fallen birch trunks in an appropriate state for the larvae and this could explain the apparent absence of *Harminius* from Speyside and Deeside which are drier.

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Larvae

The larvae of *Harminius* are of typical Athoine larval shape, in their later stages shiny black on the dorsal surface and pale yellow-ochre below. To the naked eye, they are similar in appearance to those of the related species *Stenagostus villosus* (Fourcroy) and, in the case of smaller examples, to those of *Denticollis linearis* (Linnaeus). Larvae of the three species, however, can be readily distinguished on various microscopic features, especially the shape of the terminal abdominal segment (Van Emden, 1944). Larvae of *Denticollis* which occur in dead birch and pine wood in the same areas as *Harminius* tend to burrow more deeply into the rotten timber. Larvae of *Stenagostus* live immediately under the bark especially of dead hardwoods such as beech and oak but the distribution of this species in Britain is southern and does not overlap with that of *Harminius*, so that there should not be confusion in the field.

In captivity I have kept larvae in large (Nescafé) jars two-thirds filled with soft rotten birch wood and latterly, also, with a few harder lumps. The jars were kept capped to reduce the rate of the wood drying out but the plastic caps had a series of 3mm diameter holes for ventilation. The material was kept moist by occasionally pouring a little water onto the inside wall of the container holding the latter at an angle so that the water ran down the inside of the jar to the foot. This maintained the material at the bottom of the jar damper than the material at the top allowing the larvae to choose the preferred degree of dampness. The jars were normally kept in an unheated garage but some were transferred to a relatively warm sunroom for some months at the end of winter and through spring. Periodically (every 3 or 4 weeks in the summer and less frequently in the winter) a small piece of cheese was placed on the surface of the material in the jar. This went soft and mouldy after a few days and usually attracted small diptera which gained access through the ventilation holes and laid eggs on the cheese. Larvae developed from these eggs and eventually pupae developed.

I have never seen a *Harminius* larva feeding but larvae of the moth *Aegeria culiciformis* (Linnaeus) and of the beetle *Scolytus ratzeburgi* Janson (both of which inhabit the subcortical layer of dead birch trunks) placed in the same container disappeared within a few days. In contrast, larvae of the beetles *Sinodendron cylindricum* (L.) and *Rhagium mordax* (Degeer) survived as did maggots of a *Calliphora* sp. Occasionally what appeared to be small nibble marks were visible on the pieces of cheese placed in the container after the cheese had gone soft but a larva was never seen in the act of nibbling even though the jars were often examined by torch light after dark. It is possible that the *Harminius* larvae eat some of the

small dipterous larvae associated with the mouldy cheese. Up to four *Harminius* larvae were kept in the same jar and no evidence of cannibalism was ever noted.

From the rate of growth of larvae in captivity, it would seem that the complete larval stage lasts 4-5 years. The captive larvae, however, may have had a better food supply than those in the wild and it could be that, under adverse conditions, the larval stage lasts longer than 5 years.

Pupation

The pupa like those of many wood inhabiting beetle species is colourless except for one or two tiny yellow marks on the dorsum of the pronotum. I have only once found a pupa under natural conditions. This was in Glen Lyon, Perthshire on the 28/iv/83. It was discovered on removal of the bark from a large dead birch log lying on the ground on a south facing slope and was in a chamber eaten out of relatively hard wood immediately beneath the bark at a position where the trunk would be warmed by the sun's rays. Leech (1969) has described the discovery of a pupa of this species in a birch log on 18/v/69.

In captivity, with one exception, pupation occurred towards the end of April or during May. If there were hard lumps of wood in the jar, the pupal chamber (found in retrospect) was usually in one of these but, if there were no lumps of wood in the jar, the pupal chamber was usually at the foot of the jar as if the larva had burrowed as far as it could trying to find harder wood. When this happened the pupating larva and the pupa were partly visible through the foot of the jar, which made it possible to determine the duration of the pupal stage without disturbance.

I have been unable to make any observations in the wild on the duration of pupation, but the pupa which I found in Glen Lyon hatched 12 days later and two of the pupae which developed in captivity had pupal stages of about 16 and 24 days respectively. It is possible that pupae in the wild develop more slowly because the habitat is at a lower mean temperature than in captivity. Warming of logs containing larvae by the sun's heat, however, could mean that pupae in the wild are kept on the average, above air temperature. The pupa reported by Leech (1969) produced an adult 22 days later.

One larva behaved differently. Soon after capture at the beginning of July 1982 it burrowed into a thick layer of bark and remained without sign of activity until the following July. Believing that it must have succumbed, I broke open the bark on 20/vii/83 and discovered a live pupa, which presumably had developed not much earlier than the end of June. Unfortunately it was damaged in the process and died a few days later. It may be that, in the wild,

larvae form pupal chambers in late summer but do not pupate until the following spring. Another example of pupation in July has been related to me by my friend Mr. R. M. Lyszkowski who put a larva in a tube when he went on holiday at the beginning of July. When he returned two weeks later there was an adult in the tube. I am inclined to believe, however, that these two instances of pupation in July represented anomalous behaviour related to captivity and that, in the wild, pupation normally takes place in late spring or early summer.

Adults

In captivity, adults remain in their pupal chambers for up to several weeks and then appear on the surface of the material in the jar. If they are removed from the chamber and kept in a cool, moist environment, they remain alive for several weeks. There is evidence that, in the wild, adults similarly remain in their pupal chambers for a period. Dr. P. Orton (1971) has recorded finding a number of adults under thick bark of birch logs at the beginning of June and I have found adults under a large piece of firmly attached bark at the beginning of July in circumstances strongly suggesting that the adults had developed under the bark rather than crawled under to hide. Lohse (1977) states that on the continent the adults are found in dead wood in May and at large later in the season.

I have not met with an adult in the open but I have kept adults (1 male and 3 females) under observation for about 10 days in a disused aquarium containing portions of a dead birch log. During the daytime, the females in particular were intermittently quite active, running over the dead wood and round their 'cage' in a series of somewhat jerky, wasp-like movement. When the aquarium was placed in direct sunlight, the females often took to flight (as far as the 'cage' allowed). When it got dark, the beetles hid in crevices in the bark or under the logs. Inspection at night with the aid of a torch failed to reveal any nocturnal activity.

The only account I have of the adults being seen at large in Britain was from Mr. Lyszkowski who, one hot day in July, saw many adults flying in the sunshine at a site in central Scotland. The absence of other records of daytime activity in Britain may simply be because the beetle is rare and inhabits somewhat remote areas where appropriate conditions for flight are uncommon.

Only two of the 16 adults which I have reared from larvae (and 1 pupa) collected in the wild have been males. While this preponderance of females may simply have been a chance phenomenon, it may be significant. Among other insects, an unequal sex incidence among captured adults, has often been shown later to result from the different sexes having different habits. It is

possible, but a little unlikely, that male *Harminius* larvae have different habits from female larvae, which make them harder to find. The overall mortality of larvae and pupae in captivity has proved less than 25% so that, even if all those which died were males, there would still be a preponderance of females. Another possibility is that the species is partly parthenogenetic.

In their biologies, the elaterids *Harminius*, *Stenagostus* and *Elater* (= *Ludius*) present a number of similarities. In Britain, anyway, all three species are much more commonly found as larvae than as adults. Indeed, in the case of *Elater*, there appear to have been only two occasions (apart from ancient records) where adults have been observed at large and on only one of these was more than one adult seen (Verdcourt, 1983). The other occasion involved a single injured adult (Tyler, 1955). *Stenagostus* and *Elater* presumably fly almost invariably at night and this has been reported also for *Harminius* (Lohse, 1977) though my captive adults were apparently inactive in the dark.

As has been pointed out by my friend Mr. A. A. Allen (1952), in most of British elaterid species pupation occurs in July or August and adults, developing 3-4 weeks later, remain in their pupal chamber until the following summer. Larvae of *Harminius*, *Stenagostus*, and *Elater*, (and also *Denticollis*) however, pupate in late spring or in the first half of summer and the adults emerge that summer and do not hibernate. The relative advantages of these two forms of behaviour remain to be determined.

Associated beetle species

The habitat of *Harminius* larvae is shared with the larvae of various other beetles including *Sinodendron cylindricum* (L.), *Melanotus erythropus* Gmelin (= *rufipes* Herbst.), *Rhagium mordax* Degeer, *R. bifasciatum* Fabricius and *Schizotus pectinicornis* Linnaeus and many of the trunks had the borings of *Hylecoetes dermestoides* (Linnaeus) and of *Xyloterus lineatus* (Olivier). It is possible that *Harminius* larvae prey on the larvae of some of these species. It is probable that the larvae of *M. erythropus*, in turn, are predatory on the larvae of *Harminius*; three large *Melanotus* larvae were placed in a container in which three *Harminius* larvae had placed a few days previously. After six weeks, all three *Melanotus* larvae remained but only one *Harminius* larva could be found.

Summary

In Scotland, at least, *Harminius* larvae live mostly in the sub-cortical region of dead birch wood taking 4 or 5 years to reach maturity. Pupation occurs in the spring or early summer. Adults develop in about three weeks but remain inactive for a period. Adults are rarely seen at large. This is probably a consequence

of their rarity and of the remoteness of their habitat but they may fly at night.

Acknowledgements

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CLOUDED YELLOWS IN FIFE IN 1982 — In the recent supplementary note on immigration of Lepidoptera to the British Isles, Bretherton and Chalmers-Hunt (*Ent. Rec.* **97**: 76-84) give Westmorland as the northern most sighting for *Colias croceus* for 1982, which prompts me to submit the following records. Dr. M. P. Harris saw a clouded yellow on the Isle of May on 3rd June, which was the first recorded on the island; Mrs. M. Wilkinson reported *C. croceus* over several days in early August in her garden in Dunfermline, Fife. Surprisingly I received no reports of this species during the 1983 invasion. P. K. KINNEAR, 11 Hillview Road, Balmullo, St. Andrews, Fife, KY16 0DE.



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