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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 17 OCTOBER 1966 PART 11

The Life Cycles of Four Species of Psocoptera on Larch Trees in Yorkshire

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In the course of an investigation into the ecology of two closely related *Mesopsocus* species (*M. immunis* (Steph.) and *M. unipunctatus* (Müll.)), on larch at Harrogate in Yorkshire, information was also obtained on the abundance of all the other Psocid species and of the major invertebrate predators on the branches of these trees at approximately weekly intervals from March to October in the four years 1958-61. All the Psocid species occurring in this larch plantation feed on the same food, *viz.* the *Pleurococcus*-fungal spore mixture present on the bark of trunk and branches. The two *Mesopsocus* species have only one generation a year. They hatch from the overwintering eggs at the same time in late March or early April and their populations feed in spring and early summer, the adults dying out in August. The other species feed, for the most part, later in the summer from June to October. Four of these later summer species were sufficiently abundant at Harrogate to enable quantitative descriptions of their life cycles to be made and these are presented in this paper. The species are *Philotarsus picicornis* (F.), *Elipsocus westwoodi* McL., *Elipsocus hyalinus* (Steph.) and *Amphigerontia bifasciata* (Latr.). Notes on their eggs and nymphal instars are given by Thornton & Broadhead (1954) and Broadhead & Wapshere (1961). Comparison of the biomass of the total population of these four species with that of the *Mesopsocus* populations in this 4-year period will be published elsewhere (*Ecological Monographs,* in press). Three other Psocid species feeding on this *Pleurococcus*-fungal spore mixture also occurred in this larch plantation at Harrogate—*Graphopsocus cruciatus* (L.), *Stenopsocus immaculatus* (Steph.) and *Cuneopalpus cyanops* (Rost.). These appear to have two generations a year but the numbers collected are insufficient to establish this with certainty.

Census Method

The plantation at Harrogate, consisting largely of European larch (*Larix decidua* Mill.) and pine (*Pinus sylvestris* L.), was made up of a large number of square blocks of trees, each block

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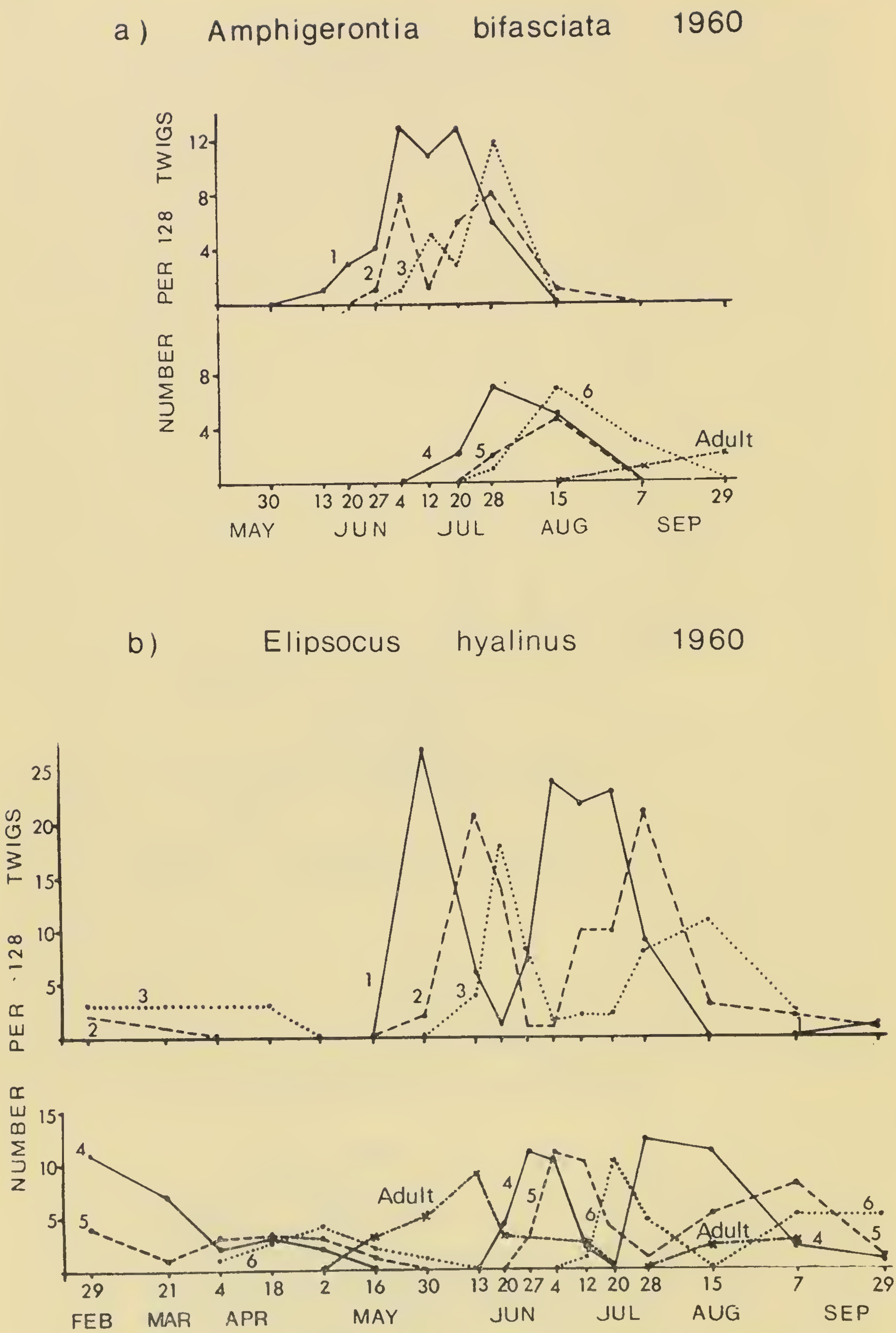

FIG. 2—The weekly incidence of the nymphal instars and of adults of (a) *A. bifasciata* in 1960 and (b) *E. hyalinus* in 1960 in larch twig samples at Harrogate. To avoid congestion, early and late instars are plotted separately.

reveals that *P. picicornis* differs from *E. westwoodi* and *A. bifasciata* in having a much shorter incidence of 1st instars, evidently the result of a shorter period over which hatching occurs. The speed of development is, however, approximately the same, the period between the dates of maximum numbers of 1st and of 6th instar nymphs being 7-8 weeks in all three species. In each species, the time spent by any one nymph between moults is the same for each instar because the period between the first appearance and the final disappearance of an instar is the same for all instars. The peak numbers of individuals recorded for each instar therefore reflect loss from instar to instar. *P. picicornis* shows considerable loss between 1st and 2nd instars and much less loss between any two successive instars subsequently. This pattern occurred in all four years, and probably represents mortality rather than emigration since the nymphs of this species are relatively sedentary and since the peak abundance of the predaceous mite, *Anystis,* coincides with the appearance of the 1st instar nymphs (Fig. 3).

The incidence of 1st instar *E. westwoodi*, present on these twigs for 9 weeks, shows, in each of the years 1958, 1959 and 1960, an unexpected bimodal form which is reflected in all the later instars, although in them progressively less pronounced. This bimodal pattern in the later instars is therefore the result of events influencing the 1st instar only. It seems very unlikely that the overwintered eggs hatch in two phases, and, although a hatching rate varying considerably during these 9 weeks could produce this pattern, no relation was found in any year between mean daily temperatures and the numbers of 1st instars for each week. This pattern may, then, be produced by a disappearance of 1st instar nymphs from the sampled zone in the middle of the hatching period either by death or by emigration. This disappearance may be due to the presence in the habitat at this time of large numbers of 1st instar *P. picicornis* (Fig. 3) since the trough in the incidence of 1st instar *westwoodi* coincides with the peak abundance of 1st instar *picicornis* in all three years. It has already been pointed out that 1st instar *picicornis* suffers considerable mortality, the period of maximum numbers being probably the period of maximum mortality. The bimodal form of the *westwoodi* curve of incidence would result if predators, entering the habitat to feed on the large numbers of freshly emerged *picicornis,* attacked also the *westwoodi* and then left the habitat when the *picicornis* had been greatly reduced. *P. picicornis,* in the 1st instar, is less active than 1st instar *westwoodi* and also at this time has not produced the loose silken shelters in which the later instars are found and which presumably confer considerable protection. Possible predators on these small Psocids at this time are Syrphid larvae, Coccinellid larvae, spiders and the active red mite *Anystis baccarum* (L.). The two latter forms have been recorded with Psocid prey (Broadhead, 1958, p. 68), and, from the occurrence of predators on living and on dead

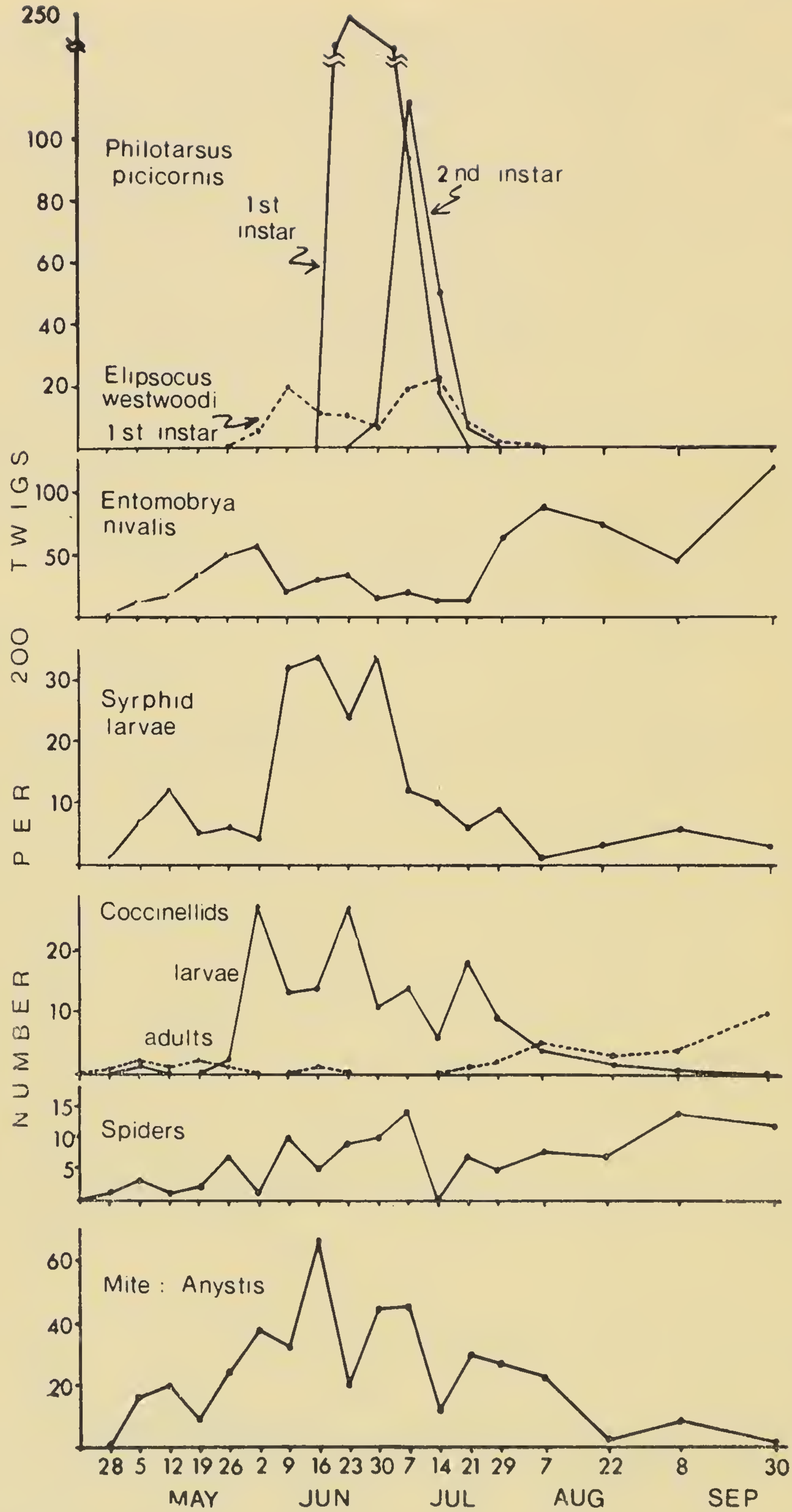

FIG. 3—The numbers of individuals present on 200 larch twigs each week at Harrogate, 1958, of the small herbivores—*Elipsocus westwoodi* (1st instar), *Philotarsus picicornis* (1st and 2nd instars) and the Collembolan *Entomobrya nivalis*—and of four groups of predators.

branches of larch (Broadhead, 1959, p. 252), it appears that *Anystis* is an important predator although spiders and possibly certain Syrphid larvae may also be important. In Fig. 3 is plotted the incidence, in 1958, of the above predators and of three species of herbivores—all at this time of similar size—viz. 1st and 2nd instar *P. picicornis*, 1st instar *E. westwoodi* and the Collembolan *Entomobrya nivalis* (L.). The greatest total number of all these predators, particularly of the Syrphid and Coccinellid larvae, appears in the sampled zone of the tree at the time of the hatching period of *E. westwoodi* and of *P. picicornis,* and this is the period of the greatest loss of individuals of these two species from this zone. The bimodal pattern of incidence of 1st instar *westwoodi,* alternatively, could result from direct competition between the newly emerged nymphs of the two species, those of *westwoodi* moving out of the sample zone, to return when the *picicornis* nymphs had been reduced by predation. The repetition of the bimodal pattern in all the later instars suggests, however, that the animals remain within the sampled zone. In 1961 both *picicornis* and *westwoodi* were greatly reduced, the numbers of *westwoodi* obtained in the samples being too small to indicate the presence or absence of a bimodal pattern.

The life cycle of *Amphigerontia bifasciata* shows a simple succession of instars, the double peak in the 1st and 2nd instars probably being due to sampling error. The adults occur over a prolonged period in the autumn, lasting until the end of October.

The life cycle of *E. hyalinus* (Fig. 2b) is more complex than that of these other species. There are two peaks of incidence of the 1st instar during the summer months. The first peak slighty precedes the peak incidence of adults in early June, so that these 1st instars could not have hatched from the eggs laid by these adults and must have emerged from overwintering eggs. The synchronization of appearance of 1st instar nymphs suggests that they may well have come from diapausing eggs. The second peak of 1st instar nymphs has evidently been derived from eggs laid in early June. These two groups of individuals remain separable by their distinct peaks of incidence throughout their nymphal life. The data for the autumn of 1960 are insufficient to establish adult incidence, but in 1959—a warm summer in which development was advanced—two overlapping peaks of adults occurred in the late summer. Should these two groups of adults both lay non-diapausing and diapausing eggs, then they would give rise both to the overwintering eggs and the overwintering nymphs, which appear as 1st instars at the end of September, and the cycle would be complete in one year with one or two generations a year. Should the later one of these two groups of adults lay diapausing eggs only and the earlier one non-diapausing eggs only, then the complete cycle of three generations would take two years and two independent cycles must be present to explain the occurrence of adults and of 1st instar nymphs together in the spring. This second alternative seems less likely than the first.

At Malham Tarn, 1300 feet (396 m.) above sea level in the Pennine Hills, where the winter is more severe and the summer shorter than at Harrogate, there is only one generation a year (Broadhead & Thornton, 1955), and it is the generation involving the overwintering nymphs and the early spring adults which is suppressed.

Comparison of the phenologies (Table 1) shows that there is a 2-3 week variation in the onset of hatching over the four years, this variation apparently being related to temperature, and that *P. picicornis* consistently hatches from the egg later than *E. westwoodi* and first generation *E. hyalinus*. The small number of *A. bifasciata* in three of the years precludes comparison with the other species.

TABLE 1

Dates of first appearance of 1st instar nymphs of three Psocid species in the four years 1958-1961

	1958	1959	1960	1961
Elipsocus hyalinus (first generation)	2 June	18 May	30 May	29 May
Elipsocus westwoodi	2 June	25 May	16 May	(6 June)*
Philotarsus picicornis	23 June	1 June	13 June	13 June
Mean of daily max. and min. temperatures for April (°F.)	44·0	47·5	47·2	47·1

*unreliable owing to small numbers existing in 1961

Summary

The succession of the instars and the weekly changes in the numbers of individuals on living larch twigs has been followed through four generations in four common Psocid species in a larch plantation at Harrogate, Yorkshire, at 500 feet altitude.

Philotarsus picicornis, Elipsocus westwoodi and *Amphigerontia bifasciata* all have one generation a year, the overwintering eggs hatching in late May-early June and the adults occurring in August and September. The bimodal pattern of incidence of 1st instar nymphs of *E. westwoodi* in 1958, 1959 and 1960 is discussed in relation to the appearance on these twigs of 1st instar *P. picicornis* and to the presence of predators, particularly the mite, *Anystis*.

The life cycle of *E. hyalinus* at Harrogate is more complex, with two peaks of incidence of 1st instar nymphs in the summer and other 1st instar nymphs appearing in late September. The succession of the instars is followed to the adult stage. This is compared with the simple life cycle of *E. hyalinus* at Malham (1300 ft.) where only one generation per year occurs.

Acknowledgments

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References

Broadhead, E. 1958. Some records of animals preying upon psocids. *Ent. mon. Mag.*, **94**: 68-69.

Broadhead, E. 1958. The psocid fauna of larch trees in northern England—an ecological study of mixed species populations exploiting a common resource. *J. anim. Ecol.*, **27**: 217-263.

Broadhead, E. & Thornton, I. W. B. 1955. An ecological study of three closely related psocid species. *Oikos*, **6**: 1-50.

Broadhead, E. & Wapshere, A. J. 1961. Notes on the eggs and nymphal instars of some psocid species. *Ent. mon. Mag.*, **96**: 162-166.

Broadhead, E. & Wapshere, A. J. 1966. *Mesopsocus* populations on larch in England—the distribution and dynamics of two closely-related coexisting species of Psocoptera sharing the same food resource. *Ecol. Monogr.* (in press).

Thornton, I. W. B. & Broadhead, E. 1954. The British species of *Elipsocus* Hagen (Corrodentia, Mesopsocidae). *J. Soc. Brit. Ent.*, **5**: 47-64.