

## AN INITIAL STUDY OF THE FEEDING AND EGG-LAYING PREFERENCES OF BARK DWELLING PSOCIDS (PSOCOPTERA) USING COMPOSITE BARK BLOCKS

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### Abstract

*In vitro* studies on the feeding and egg-laying preferences of a selection of species of Psocoptera were undertaken. It was discovered that *Loensia variegata* (Latreille), Psocidae, is capable of eating alga (probably mainly *Apatococcus lobatus*) and the lichen *Xanthoria parietina*. It did not feed on any of the crustose lichens offered to it or two other foliose lichens. A sample of bare bark showed signs of having been eaten. Eggs were laid primarily on foliose lichens (*Parmelia sulcata* and *Melanelia subaurifera*) but also on one of the crustose lichens (*Cliostomum griffithii*). *Trichadenotecnum sexpunctatum* (L.), Psocidae, fed upon alga (probably mainly *Apatococcus lobatus*), the crustose lichen *Cliostomum griffithii* and the foliose lichens *Parmelia sulcata* and *Xanthoria parietina*. No eggs were laid. *Pteroxanium kelloggi* (Ribaga), Lepisopsocidae, was only found to eat alga (probably mainly *Apatococcus lobatus*). No eggs were laid. Result of the study using *Reuterella helvimacula* (Enderlein), Elipsocidae, was inconclusive.

**Keywords:** Psocoptera, feeding studies.

### Introduction

The psocid species *Loensia variegata* (Latreille) (Plate 4) is generally only recorded in low numbers on the trunks of trees with one specimen per tree being the norm. Consequently the author was surprised to find at least fifteen specimens on the trunks of three trees (two oak, one sycamore) at Rosebery, Midlothian (O.S. grid reference NT 304577) on 16.viii.2009. One possible explanation of the find was that the trunks of these trees held exceptionally large amounts of *L. variegata*'s preferred foodstuff.

Little is known about the food preferences of barkflies (outdoor Psocoptera) with Broadhead's studies of species occurring in larch plantations in Yorkshire providing the principle work (Broadhead, 1958). Twenty-four psocid species were recorded during these studies and food preference experiments were carried out on the commonest nine species: *Philotarsus picicornis* s.l., *Reuterella helvimacula*, *Elipsocus westwoodi* (now *E. pumilis*), *E. mclachlani* (now *E. abdominalis*), *Amphigerontia bifasciata*, *A. contaminata*, *Mesopsocus immunis* and *M. unipunctatus*. In these experiments specimens of each species were given the choice of feeding on lichen or alga (using composite twigs) and their preferences determined by 1) their proximity and the proximity of their faeces to each food type and 2) the composition of their gut contents. At the time of the study the only lichen present in the plantations was the pollution-tolerant *Lecanora conizaeoides* and the alga was *Pleurococcus* (not identified to species

level). The study demonstrated that two species, *R. helvimacula* and *E. abdominalis*, preferred to feed on the lichen whereas the other seven preferred alga.

The food preferences of outdoor species other than the ones in Broadhead's study are not known; consequently the author devised an experiment to find out what epiphytes *Loensia variegata* would eat.

The trunks of the trees each had a number of epiphyte zones as follows 1: areas of dry bark lichen communities consisting predominantly of crustose lichens, 2: areas that were more dominated by foliose lichens, 3: algae-dominated areas and 4: virtually bare bark. The places where the specimens of *L. variegata* were resting on the trunk were found to be predominantly in the dry bark areas dominated by crustose lichens. The assumption was that the most likely foodstuff for *L. variegata* was one or more of the crustose lichens.

Other bark dwelling psocid species (*Trichadenotecnum sexpunctatum*, *Pteroxanium kelloggi* and *Reuterella helvimacula*) were also recorded on the trunks and the study was extended to include these species. These experiments were designed to determine which specific lichen/alga species were preferred by each psocid species.

### Method

In this study the choice of foodstuff was provided using composite blocks of epiphyte-covered bark approximately 1.5 x 1.0 cm consisting of six mini-blocks of approximately 0.5 x 0.5 cms. The six mini-blocks were glued onto thick cardboard. One of the mini-blocks was used to support a composite block number written on paper, the remaining five had coatings of different epiphytic lichen/alga species (Plate 5). Each coating consisted predominantly of one species except one alga mini-block that had a mixture of two algae.

Each composite block was then photographed, placed in a covered Petri dish, and specimens of one of the psocid species placed in the dish. After a variable number of days the composite block was re-photographed and the new photograph compared with the original to determine where feeding damage had taken place. Eggs were sometimes laid and notes were kept of the numbers and positions of the eggs.

### Results

In order to estimate how readily the insects fed on the feeding blocks two measures were needed – how much time they had to feed (feeding time) and how much food was eaten during that time (feeding damage).

Feeding time (measured in days) is the pooled time that all the individual insects had to feed on a block. For example if five specimens were on a block for three days the feeding time would be 15 days. It was noted that the insects only lived for a limited time during the study (ranging from one to seven days).

Feeding damage would ideally be measured in terms of the weight or volume eaten. Since the main purpose of this study was to determine whether or not a



Plate 4. *Loensia variegata* (Latreille), Rosebery. Midlothian, 2009.

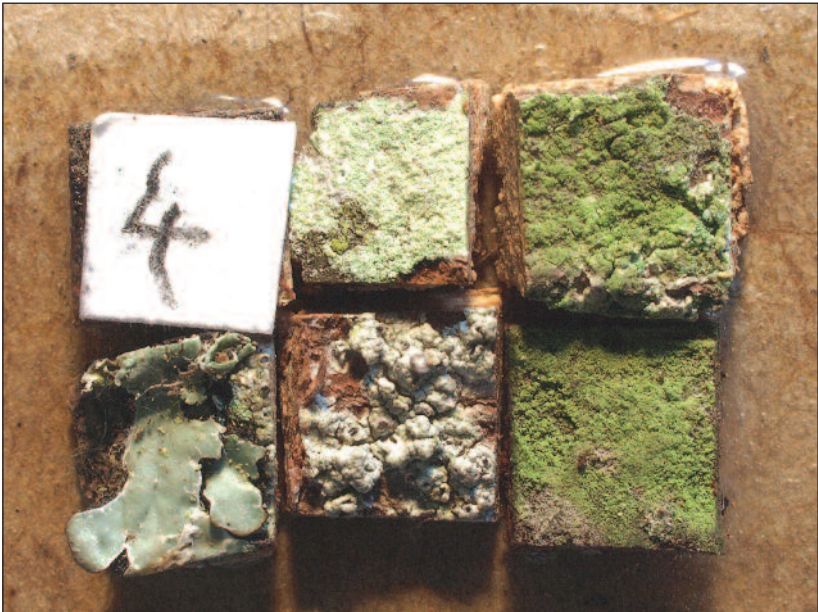


Plate 5. Example of a 'composite block' and mini-block position key.

BLOCK NUMBER	A	B
C	D	E

particular epiphyte species was eaten a cruder measure was used: the area of damage to the epiphyte. The area of damage is the area where significant feeding has taken place (not just a slight grazing of the surface).

A coding system has been used to represent the various degrees of feeding damage:

- 0 – no damage;
- 1 – slight damage (<1% of area);
- 2 – moderate damage (1-5% of area);
- 3 – substantial damage (>5% of area).

The feeding results for *L. variegata*, *T. sexpunctatum* and *P. kelloggi* are shown in Table 1.

### Species accounts

#### *Loensia variegata* (Latreille)

Two female specimens were used in the study. Initially both specimens were allowed to feed on one composite block but it was noticed that they seemed to avoid being in close proximity to each other. If one specimen was dominant then it might have prevented the other from feeding, so it was decided to only use one specimen per block.

Four of the epiphytes on composite block Lv1 were found on the trees at Rosebery (one alga, two crustose lichens and one foliose lichen). An additional crustose lichen, *Lecanora expallens* from a different site was also included to test whether the specimen would only eat lichens from the favoured site. It was found that only the alga was eaten. The alga on the block was identified as a mixture mainly consisting of *Apatococcus lobatus* with some *Trebouxia* sp. (darker green than *A. lobatus*). After feeding had taken place a close examination of the mini-block found that the remaining algae had a higher proportion of *Trebouxia* sp. than before feeding.

It was also noticed that over the period eight eggs were laid on the foliose lichen (*Parmelia sulcata*). In this block the foliose lichen mini-block was positioned adjacent to the alga mini-block (positions B and E – see Fig. 1) so it was feasible that the insect only laid eggs on it because it was in close proximity to the alga food source. A second composite block, Lv2, was made to test whether this was true and also to discover whether there was a preference for different sources of algae. In this second block the foliose lichen (again *P. sulcata*) was moved to the opposite end of the block from the algae mini-blocks (position C). In Lv1 the alga was growing on sycamore bark; in Lv2 a second mini-block was added with alga on Sitka spruce bark (solely *Apatococcus lobatus*). The results showed that again only alga was eaten with grazing on both algae mini-blocks. Over the period three eggs were laid on the foliose lichen and in addition two eggs were laid on one of the crustose lichens (*Cliostomum griffithii*).

Since eggs were laid on the foliose lichen on both blocks this led to the question of whether the particular lichen species was significant and composite

block Lv3 was made to investigate this. This block consisted of one alga, three foliose lichens and one bare bark mini-blocks. In this case two eggs were laid on the same foliose lichen as on blocks Lv1 and Lv2 (*Parmelia sulcata*) and, in addition, one egg was laid on *Melanelia subaurifera* (Plate 6). Again the alga was eaten but, unexpectedly, one of the foliose lichens (*Xanthoria parietina*) was also extensively eaten. The bare bark mini-block showed some signs of grazing.

### ***Trichadenotecnum sexpunctatum* (L.)**

Five female specimens were used in the study. Unlike *L. variegata*, the specimens appeared to tolerate the presence of other individuals on the composite blocks. All five specimens were allowed to feed on the same block to ensure that feeding damage was noticeable as quickly as possible.

The epiphytes on composite block Ts1 consisted of one alga, three crustose lichens and one foliose lichen. In the first half of the feeding period (14 days) three of the epiphytes were eaten: the alga, *Apatococcus lobatus/Trebouxia* sp. mixture, the crustose lichen, *Cliostomum griffithii* and the foliose lichen, *Parmelia sulcata*. The whole thallus of *P. sulcata* was eaten in one area of the mini-block, in another area, only the upper cortex. In the second half of the feeding period (14 days) only *P. sulcata* was eaten. No egg-laying was observed.

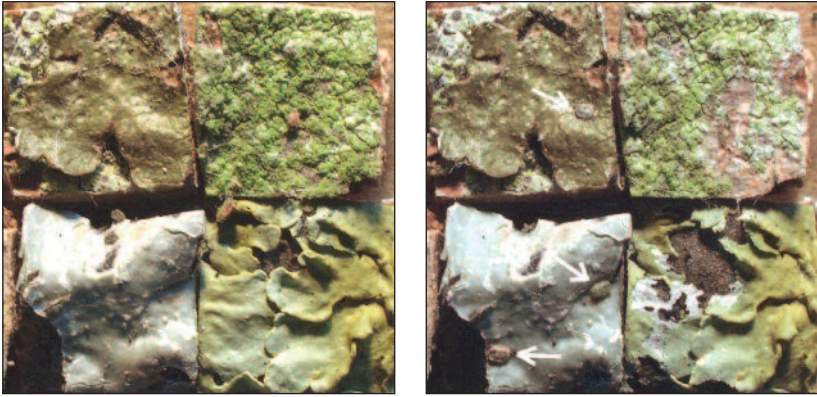
In order to investigate which other lichen species *T. sexpunctatum* would eat, one specimen was allowed to feed on composite block Ts2 which consisted of one alga, three foliose lichens and one bare bark. Only the lichen *Xanthoria parietina* was eaten while the *Parmelia sulcata* that was previously eaten on Ts1 was untouched. Again no egg-laying was observed.

### ***Pteroxanium kelloggi* (Ribaga)**

Three specimens of *P. kelloggi* were allowed to feed on a block consisting of two algae, two crustose lichens and one foliose lichen. The specimens (which were noticeably fast moving) had the opportunity to feed for 13 days but appeared reluctant to approach the composite block. If placed onto the block they would quickly move off. However a moderate amount of feeding damage was noted on both the algae mini-blocks.

### ***Reuterella helvimacula* (Enderlein)**

Five female specimens of *Reuterella helvimacula* were allowed to feed on a block consisting of one alga, three crustose lichens and one foliose lichen. This species is significantly smaller than the other species in the study and it was noticed that the specimens entered the crevices between the blocks where they produced the characteristic webbing. Slight damaging was noted on the epiphytes but the lost fragments were always on the edge of the mini-blocks and it was feasible that they had been dislodged rather than eaten. Consequently the study was considered inconclusive and the results have not been included in Table 1.



**Plate 6.** Composite block Lv3 (component squares A, B, D & E) before (left) and after (right) feeding and egg-laying by *Loensia variegata*.

**Table 1.** Composite block feeding results for three psocid species.

Psocid species	<i>L. variegata</i>			<i>T. sexpunctatum</i>		<i>P. kelloggi</i>
	Lv1	Lv2	Lv3	Ts1	Ts2	Pk1
Composite block code						
Feeding time (days)	3	5	4	28	4	9
<b>Algae:</b>						
<i>Apatococcus lobatus</i>		3				2
<i>A. lobatus/Trebouxia</i> sp.	3	3	3	2	0	2
<b>Crustose lichens:</b>						
<i>Cliostomum griffithii</i>	0	0		2		0
<i>Lecanora expallens</i>	0	0		0		0
<i>Lepraria incana</i>	0			0		
<b>Foliose lichens:</b>						
<i>Melanelia subaurifera</i>			0		0	
<i>Parmelia sulcata</i>	0	0	0	3	0	0
<i>Xanthoria parietina</i>			3		2	
<b>No epiphytes</b>						
Bare bark			1		0	

### Discussion

The study shows that different psocid species are capable of eating different alga/lichen species. *T. sexpunctatum* ate the greatest diversity of species (4), followed by *L. variegata* (2) and finally by *P. kelloggi* (1).

Although the primary aim of the study was to find out which alga/lichen species the different psocids were capable of eating, a secondary aim was to find

out whether they had preferred foodstuffs. *L. variegata* fed on both alga (probably mainly *A. lobatus*) and the foliose lichen *X. parietina* and the evidence from feeding block Lv3 suggested that both species were equally palatable. *T. sexpunctatum* ate a greater diversity of species. The evidence from block Ts1 suggests that it may prefer to eat the lichen *P. sulcata* (substantial damage) over the lichen *C. griffithii* (moderate damage) and the alga (probably mainly *A. lobatus*) (moderate damage). The evidence from block Ts2 suggests that it strongly favours eating the lichen *Xanthoria parietina* (moderate damage) over *P. sulcata* (no damage) and alga (no damage).

The alga on block Lv1 was identified as a mixture mainly consisting of *Apatococcus lobatus* with some *Trebouxia* sp. After feeding, the algae remaining on the block was closely examined and was found to have a higher proportion of *Trebouxia* than before feeding. This observation suggests that *L. variegata* may have a preference for feeding on *A. lobatus* over *Trebouxia*. However, more systematic experiments using pure cultures of algae species and, ideally, gut content analysis would be necessary to prove this. The possibility that different species of *Trebouxia* may have different palatability would also need to be investigated. Consequently it was not considered worthwhile estimating the composition of the alga remaining after feeding on other composite blocks.

Egg-laying was only observed by *L. variegata* and most were laid on foliose lichens (particularly *P. sulcata*) but also on the crustose lichen *Cliostomum griffithii*. Pearman noted that the eggs of *L. variegata* are each thickly covered with minute brown flakes of bark probably applied by means of an anal secretion (Pearman, 1928). On block Lv3 it was noted that some bare bark had been eaten, presumably for this purpose. If this covering of bark was to provide camouflage then it might have been expected that eggs would have been laid on bare bark but that wasn't observed during the study.

A single study of this kind is insufficient to prove that these observations represent genuine trends. Repeat studies are needed to either confirm the trends or show that other factors are operating and influencing the results. There are a range of possible factors that may need to be taken into account e.g.

- Individuals of a psocid species have different preferences;
- Species have different feeding preferences at different periods e.g. when egg-laying or when they first become adult;
- The age of a lichen/alga affects its palatability;
- Psocids from different geographical areas have different preferences.

The insect specimens only lived for a short time (1-7 days) during this initial study. This was probably due to dehydration and steps should be taken in any future studies to ensure that the atmosphere inside the Petri dishes is kept sufficiently humid.

### Conclusions

The initial reason for carrying out the study was to find out whether *L. variegata* preferred to eat the crustose lichens that the Rosebery specimens had been resting on. *L. variegata* did not feed on any crustose lichens so it is very unlikely that this explains why the Rosebery trees were so favourable and another theory needs to be looked for. The study, however, did demonstrate that composite blocks of epiphyte covered bark can be used to determine which lichens/algae species different psocid species will feed on and to investigate the factors that may influence their preferences. Although not the intention of the study, the blocks were also found to be useful for demonstrating preferences for egg-laying on different substrates.

### Acknowledgements

I am very grateful to Hans Sluiman and Brian Coppins for identifying the algae and lichens respectively used in this study. The work would not have been possible without their help. Photograph of *L. variegata* by David Jones.

### References

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### ***Cosmopterix zieglerella* (Hb.) (Lep.: Cosmopterigidae) in Staffordshire: A new moth to the West Midlands area**

While visiting my mother (mother not moth-er!) who lives on the edge of Cannock Chase in Staffordshire (VC 39) during early October 2009, we took a short walk up to The Chase on 1 October, a walk of about ten minutes from her house. To access this area we had to go by the edge of suburbia. While skirting a row of bungalows we noticed some hop amongst hedgerows next to one of the gardens in Brereton, Rugeley (O. S. grid reference SK 045168) which hosted several distinctive mines of *Cosmopterix zieglerella*.

We are informed by John Langmaid and Dave Emley that they represent the first record of this species both for VC39 and also for the West Midlands area.— JON & AD CLIFTON, Kestrel Cottage, Station Road, Hindolveston, Norfolk NR20 5DE (E-mail: jon.clifton@btinternet.com).