ON THE FAUNA OF A BROWN FLUX OF AN ELM TREE, *ULMUS PROCERA* SALISB.

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(With 2 Figures in the Text)

The following observations were made on an elm tree brown flux in Sheffield over a period of about two years. During this time the flux had a continuous existence and carried a fauna which formed a balanced association. The purpose of the investigations was to throw light on the ingredients of this association, its seasonal fluctuations and the interdependence of its members.

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THE FLUX

Records of brown fluxes and their faunas have previously been made by Ludwig (1888); Massee (1897); Ogilvie (1924) and Keilin (1921, 1927). The flux here under consideration owes its existence to an out-pouring of sap from the wound of a branch scar at the height of about 6 ft. above ground-level. The sap oozes continually, though less copiously in winter than in spring and summer. In so doing, it forms a stream over the tree bark varying in width from 9 in. to 1 ft. In this position the substance of the flux develops as a spongy mass which holds the sap emerging from the tree and thus provides a stable micro-aquatic environment to which certain organisms are attracted and in which they live and often breed.

In spring and early summer the flux is dark brown and slimy. In winter, on the other hand, the lower parts are dry and light stone-coloured—features in agreement with the findings of Ogilvie (1924). The pH of the flux material was 8·7 throughout the year. Ogilvie (1924) records a pH of a similar elm flux as 9·0–9·5. Standard tests for starches, sugars, fats and proteins yielded negative results though a polysaccharide, not starch and possibly cellulose, was indicated.

The animals inhabiting the brown flux form a characteristic fauna which is constantly undergoing change throughout the year. The members of this fauna are:

(*a*) The mite *Hericia hericia* Kramer (Tyroglyphidae).

(*b*) The larvae of the following Diptera: *Dasyhelea obscura* Winnertz (Ceratopogonidae), *Aulacigaster leucopeza* (Meigen) (Aulacigasteridae), *Brachyopa insensilis* Collin (Syrphidae), two undetermined species of *Systenus* (Dolichopodidae), one undetermined species of *Phaonia* (Anthomyidae).

(*c*) The Staphylinid beetle *Thamiarea hospita* Maerk.

Keilin (1921) recorded the following from brown fluxes of elm trees in Cambridge. Dipterous larvae: *Dasyhelea obscura* Winn., *Rhyphus fenestralis* (Scop.), *Mycetobia pallipes* Meig., *Systenus adpropinquans* Loew., *Systenus scholtzii* Loew., *Aulacigaster rufitarsis* (Meig.), *Phaonia cincta* Zett. and an undetermined Syrphid larva closely allied to the genus *Ceria*; larvae of two Staphylinid beetles, one belonging to the genus *Quedius* (subfamily Staphylininae), the other being possibly a *Thamiarea* sp. (subfamily Aleocharinae); and the mite *Hericia hericia* Kramer (Tyroglyphidae).

In 1927 Keilin also recorded the following dipterous larvae in the sap exudation of a horse-chestnut tree in Cambridge: *Dasyhelea obscura* Winn., *Rhyphus fenestralis* (Scop.), *Mycetobia pallipes* Meig., *Aulacigaster rufitarsis* (Meig.). There is thus a considerable resemblance between the elm and chestnut tree fluxes of Keilin and that of the Sheffield elm tree. Such differences as there are between the latter and the two former ones are probably attributable to geographical causes.

The seasonal sequences are shown diagrammatically in Fig. 1.

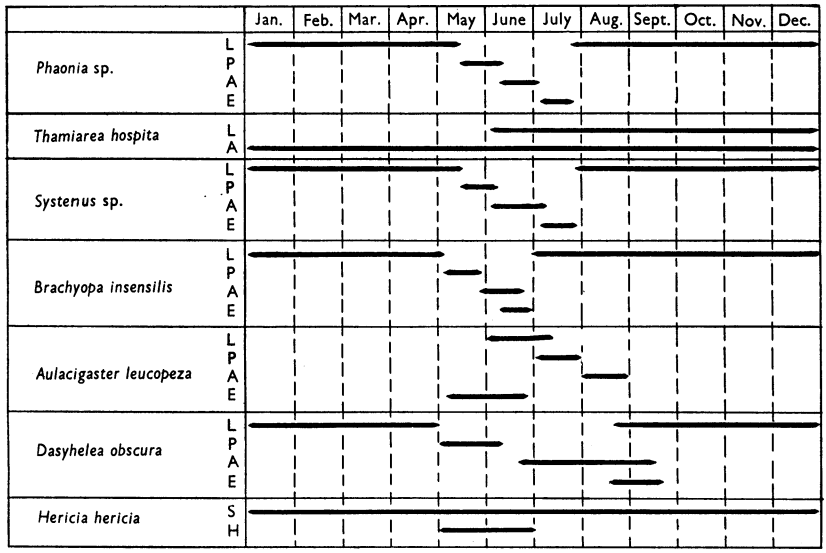

Fig. 1. The seasonal sequences of the flux-inhabiting animals. L=larvae; P=pupae; A=adults; E=eggs; S=all stages except the hypopus; H=hypopus.

Hericia hericia. All stages in the life history of this mite except that of the hypopial nymph (egg, hexapod larva, ordinary nymphs, adult males and females) are found in the flux material throughout the year. There is a seasonal increase in reproductive activity in May when an increased number of eggs is to be found. Only during May and June is the hypopial nymph found.

Dasyhelea obscura. Oviposition takes place in August and early September. The larvae live in the flux throughout the winter, pupating and emerging the following spring.

Aulacigaster leucopeza. Oviposition takes place in May and early June. The larvae live in the flux during the summer, pupate in late July and emerge in August. No larvae or pupae were seen in the flux during the winter months—only the empty puparia from the preceding summer. The absence of living stages of this species from

the flux during winter may be accidental. On the other hand *Aulacigaster* may have other hibernating quarters in either or both the adult and larval states; nothing is known of this.

Brachyopa insensilis. Oviposition takes place in June. The larvae live in the flux throughout the year, pupating and emerging in May and June.

Systenus spp. Oviposition takes place in July, pupation and emergence in June of the following year.

Phaonia sp. Oviposition takes place in June and July, pupation and emergence in the following June.

Thamiarea hospita. The adults are found on the flux surface throughout the year, as also are the larvae during the summer months.

Attempts were made to work out the feeding relationships of the animals inhabiting the tree fluxes by direct observations and by examination of the gut contents and of the structure of the animal (see Fig. 2). The larvae, ordinary nymphs and adults of *Hericia*

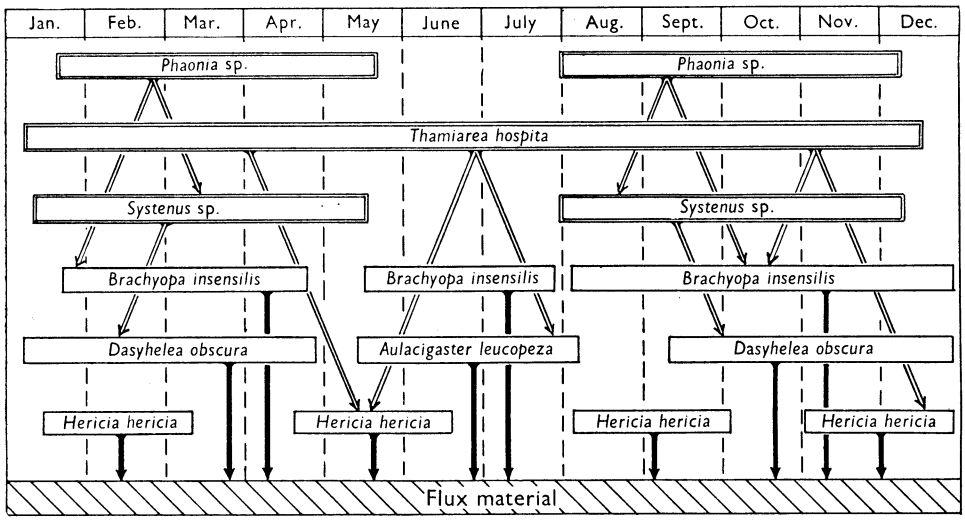

Fig. 2. The food-chain of the flux fauna. ⧈, carnivores; □, flux-feeders.

hericia, and the larvae of *Dasyhelea obscura*, of *Aulacigaster leucopeza* and of *Brachyopa insensilis* are found to be saprophytic. They can be seen feeding directly on the material of the flux and are able to live for prolonged periods on flux material which has been previously heated to kill any living organisms present. They are found in the fauna of the slime flux in relatively large numbers. In confirmation of this transverse sections of larvae of *Aulacigaster leucopeza* and *Brachyopa insensilis* revealed the presence of longitudinal ridges in the floor of the pharynx, characteristic of saprophytic cyclorrhaphous dipterous larvae (Keilin 1915).

The *Systenus* larva is carnivorous, feeding chiefly on the larvae of *Dasyhelea obscura*, as many as ten head-capsules of the latter having been found in its mid-gut. Keilin (1921) reported similarly on this food habit of *Systenus*, stating that both larvae and pupae of *Dasyhelea obscura* are destroyed by *Systenus adpropinquans* and *S. scholtzii*. On occasions *Systenus* has been found to be cannibalistic. The larvae of the *Phaonia* sp. are also carnivorous, and they have been observed to attack larvae of *Brachyopa*

insensilis, *Dasyhelea obscura* and *Systenus* sp. In *Phaonia* as in *Systenus*, the pharynx floor is smooth and its cuticle thick. The adults and larvae of *Thamiarea hospita* freely devour the mite *Hericia hericia*, larvae of *Dasyhelea obscura* and *Aulacigaster leucopeza*.

Although the fauna of the flux is undergoing change throughout the year (Fig. 1) it is nevertheless a balanced association at all times. Thus there are always forms which feed directly on the flux pasturage and there are also those others which feed on the herbivores. Of the herbivores *Hericia* and *Brachyopa* are permanent inhabitants. *B. insensilis* has a prolonged larval association with the flux materials only interrupted in May and June by reproductive activity (Fig. 1). *Aulacigaster* larvae are only operative on the basal medium in June and July. *Dasyhelea obscura*, also a herbivore, is cut off from active feeding association with the flux for a period of four months from May to August. This species pupates at a time such that the newly hatched larvae of *Aulacigaster* can take its place in the food chain. All these forms provide food for the carnivores.

Thamiarea is present as an adult throughout the year and feeds mainly on *Hericia* which also is a permanent resident of the flux. *Phaonia* sp. has a life cycle which coincides with, but slightly succeeds that of, *Brachyopa* on which it feeds. *Systenus* fairly precisely coincides in its life cycle with *Dasyhelea* on which it also feeds. *Aulacigaster* has a short larval period covering the months of June and July and it is in this period that the *Thamiarea* larva is available to feed on it. Times of feeding and of reproductive activity are such that the association of individuals in this isolated environment with its steady food supply is maintained. In such a restricted environment as this problems of dispersal loom large. The brown flux appears to have a definite attraction for certain flies. For instance the following species were taken from the flux surface on 8 June 1948: *Systenus pallipes* Ross. (Dolichopodidae), *Brachyopa insensilis* Collin. (Syrphidae), *Aulacigaster leucopeza* Meig. (Aulacigasteridae), *Gymnochaeta viridis* Fall. (Tachinidae), *Phaonia laeta* Fall. (Muscidae), and *Mycetobia pallipes* Meig. (Anisopodidae). These observations suggest that flies visiting different fluxes for egg laying are the main agents of dispersal. The same might be said of the beetle *Thamiarea* in the adult stage.

Hericia presents a special problem, reference to which has been made in a separate publication (Robinson, in press). The hypopus stage of this mite is resistant to desiccation, is hydrofuge and floats easily on the flux water surface. In this position it attaches itself by means of suckers to flux-visiting Diptera which then act as vehicles carrying the mite from one flux to another.

SUMMARY

1. The elm tree brown flux exists throughout the year as a wet spongy mass in which a rich and characteristic fauna is present.

2. A precise timing of developmental processes enables a balanced relationship to exist amongst the animals.

3. The interdependence of the animals with regard to feeding and dispersal is described.

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