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## INSECTS EMERGING FROM BROWN SLIME FLUXES IN SOUTHERN NEW ENGLAND

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### Abstract

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Samples were taken weekly from 11 June to 1 October 1968 from brown slime fluxes occurring on trees (mostly elms) in Rockport, Mass., and in central and eastern areas of Connecticut and held in the laboratory for the emergence of adult insects.

The most common emergents were *Aulacigaster leucopez* (Meigen) and its parasite, *Aphaereta cole* Marsh, *Mycetobia divergens* (Walker), and *Dasyhelea oppressa* Thomsen. The only drosophilid reared from brown slime flux was *Drosophila robusta* Sturtevant, a species that was not particularly common.

A comparison of the brown flux fauna of Great Britain with that of New England shows that some cosmopolitan species occur in flux in both countries. Species whose distribution is limited to only one of the countries are represented in the other country by closely related species (ecological homologues).

The relationship between climatological factors and the fluxing condition of trees is discussed. The factor considered most important in continuing the fluxing state is rainfall during the late summer months.

### Introduction

The purposes of this study were (1) to establish whether or not brown slime fluxes occurring in New England serve as breeding sites for *Drosophila*, (2) to

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learn what other insects live in this habitat, and (3) to find out what hymenopterous parasites attack insects living in brown fluxes. Carson and Stalker (1951) observed that eastern forests have three major carbohydrate sources that can serve as natural *Drosophila* habitats. Sap exudations were one of the sources, in addition to fleshy fungi and native wild fruits, etc. Streams (unpublished) made collections of flux from New England trees, mostly oaks, and found that they contained *Drosophila* and a characteristic association of insect species, including parasitic wasps.

Tree slime flux is a combination of a tree exudate and different groups of microflora. It appears most often on the trunk or main branches of affected trees, emanating from openings in the bark, such as frost cracks. Fluxing in elms is symptomatic of a wetwood disease occurring in the heartwood of these trees (Carter 1945). The bacterium, *Erwinia nimipressuralis* Carter, enters the elm tree through breaks in the bark and outer sapwood and flourishes in the heartwood where it causes permeability changes resulting in a water soaked condition. The fermentation carried on by *E. nimipressuralis* yields gases which create pressure inside the tree. The fluxing condition is brought about when wetwood sap and dissolved gases are forced out through frost cracks, limb butts, or other weak spots on trees.

How *E. nimipressuralis* enters the undiseased elm tree is not known. Perhaps it is wind carried, but the bacteria may also be transmitted by insects. One or more of the flux-associated insects could be perpetuating their habitat by transmitting the causal organism of wetwood disease to healthy trees.

Sap, which is usually clear as it oozes from a diseased tree, turns a tan or brownish color when exposed for a few days. The flow of sap down the side of a branch or trunk causes a characteristic staining of the bark. The stain is colored grey-brown to tan or white, and at first inspection appears to be a bleached-out condition of the natural bark color. Ogilvie (1924) and Guba (1934) attributed this staining on elms to the deposition of calcium carbonate crystals on the bark. Carter (1945) observed that the exuding wetwood sap of elms is toxic, killing portions of the cambium and preventing callus formation. The flux frequently kills grass or other undergrowth as it drips from the tree.

Brown flux has been recorded on elms and horse chestnut trees in Great Britain and on several other tree species in Europe (Ogilvie 1924). Brown fluxes occur on several tree species in New England but are found most often on species of elm (Guba 1934; authors' observations). We have also observed brown fluxes on horse chestnut, mulberry, and maple in this area. Slime fluxes of the black oak, *Quercus velutina* Lam., appear different from characteristic brown slime fluxes. These fluxes usually contain more grit and are more viscous and black.

While the emphasis of our study was on the insect emergents from characteristic brown slime flux, we did sample some oak slime flux. However, oak slime fluxes do not lend themselves to periodic sampling because the flux covers only a small area of bark and is moistened only sparingly by a slow exudation of sap. On the other hand, elm trees often show large areas of bark covered with flux that is soaked profusely by sap exudations. Such copious fluxes can be sampled without removing a substantial fraction of the flux material on any one tree, which allows for weekly collections of slime flux (from the same group of trees) that are little affected by the previous week's collection.

### Materials and Methods

Weekly flux samples were taken 11 June through 1 October 1968. Two collection routes were set up, one in central and eastern Connecticut (towns of Mansfield, Coventry, Bolton, and Manchester) and the other in the north shore area of Massachusetts (town of Rockport). There was a total of 38 sites (12 in Rockport, 26 in Connecticut) but not all were sampled each week. A few slime fluxes were found after the survey had already commenced. Other flux patches, included in the original group, dried up during the summer. All fluxes sampled weekly were on elm species, except one on a horse chestnut tree and one on a red mulberry tree, both in Connecticut.

Collections were made by scraping portions of flux and bits of bark from the tree surface with a knife. Some of the larger specimens undoubtedly were injured by collecting the flux in this way. The material was kept in corked shell vials until returning to the laboratory, where each sample was placed in a plastic petri dish on two layers of moist towelling. The use of corked vials was later abandoned and plastic petri dishes were substituted as collection receptacles since they reduced possible toxic gas build-up and drowning.

Samples were checked at least four times a week for the emergence of adult insects until 10 October. Water was added to the samples as needed. Adult insects were aspirated from the samples and preserved in 70% alcohol. Parasitized pupae were isolated in cotton stoppered microvials to obtain host records for emergent parasitic wasps.

Representative specimens were sent for identification to appropriate taxonomic specialists. All specimens, except for a few retained by specialists, are now in the first-named author's private collection.

### Results

Table I is a list of the insect emergents from the brown slime fluxes sampled during the study. Two insect larval forms found commonly in flux never pupated in flux samples, and are not included in the list in Table I. One of these is a larval *Brachyopa* (Diptera: Syrphidae). European *Brachyopa*, which are detritus feeders (Krüger 1926), produce only one generation each year with the adults emerging in March and April (Lundbeck 1916). The species we found presumably has a similar seasonal history.

The second larva is *Amphicrossus ciliatus* (Oliv.) (Coleoptera: Nitidulidae). Both larvae and adults were found throughout the sampling period, more abundantly in June than in later summer months. This species may require a pupation medium drier than slime flux, such as dry areas of bark or the soil at the tree base. Alternatively, it may be that the emergence of this species was not detected because of an eclosion that occurs earlier than the first sample date of 11 June.

*Mycetobia divergens* (Walker), *Aulacigaster leucopezæ* (Meigen), and *Dasyhelea oppressa* Thomsen were the most abundant emergents from flux sites (Table II). *Aphaereta colei* Marsh, although taken from almost as many flux patches as *D. oppressa*, was less abundant. The remainder of the species listed did not emerge in great numbers even though several were recovered from a high percentage of sampled trees (e.g. *Drosophila robusta* Sturtevant, *Lymonia bryanti* (Johnson)).

It was obvious from field observations that the flux-associated species varied in abundance throughout the summer. The population size of certain species

TABLE I

The insect emergents of brown slime fluxes occurring in southern New England, during June through October 1968

## DIPTERA

## Anisipodidae

*Myctobia divergens* (Walker)

*Sylvicola alternatus* (Say)

*Sylvicola fenestralis* (Scopoli)

## Aulacigasteridae

*Aulacigaster leucopeza* (Meigen)

## Ceratopogonidae

*Dasyhelea oppressa* Thomsen

## Dolichopodidae

*Systemus* n. sp.

## Drosophilidae

*Drosophila robusta* Sturtevant

## Muscidae

*Phaonia* sp.

## Psychodidae

*Psychoda cinerea* Banks

*Psychoda satchelli* Quate

*Psychoda alternata* Say

*Telmatoscopus superbus* (Banks)

*Brunettia nitida* (Banks)

## Scatopsidae

*Scatopse fuscipes* Meigen

## Tipulidae

*Lymonia bryanti* (Johnson)

## HYMENOPTERA

## Braconidae

*Aphaereta colei* Marsh

*Aphaereta pallipes* (Say)

## Cynipidae

*Pseudeucoila* sp.

appeared to fluctuate more than that of others although no exact determinations of species abundance were made. It was impractical to estimate seasonal variation in species abundance on the basis of laboratory emergence records because the number of individuals emerging in the laboratory was not necessarily a good index of the numbers emerging in the field. Instead, the weekly percentages of slime fluxes showing emergence of a given species were used as an estimate of the percentages of flux sites containing immature specimens of the species (Figs. 1, 2). Generally, these percentages can be used as an index of the seasonal trend of a species except in late summer or fall when some immature forms may be in winter diapause and would not emerge until spring.

*Drosophila robusta*, the only drosophilid recovered from brown slime fluxes in this study, was taken regularly but in small numbers from several sites throughout the sampling period in both Massachusetts and Connecticut. (One *Drosophila* adult, perhaps of another species, that emerged was too badly damaged to be identified.) The percentage of Connecticut fluxes sampled each week from which *D. robusta* emerged are graphed in Fig. 1. Only one flux site, this on an elm in Rockport, yielded large numbers of this species. Some possible reasons why certain fluxes are inhabited to the exclusion of others will be discussed later.

*Aulacigaster leucopeza*, one of the most common flux inhabitants, was more often found in flux patches at the start of the sampling period than later (Fig. 2a). The midsummer reduction in slime fluxes containing *A. leucopeza* may have been

TABLE II

The numbers and percentages of slime flux sites showing the emergences of flux associated species in sample areas, summer, 1968

Species	Slime fluxes			
	Conn. (26 total)		Mass. (12 total)	
	No.	%	No.	%
<i>Mycetobia divergens</i>	23	88	11	92
<i>Aulacigaster leucopeza</i>	23	88	10	83
<i>Dasyhelea oppressa</i>	18	69	11	92
<i>Aphaereta colei</i>	16	62	11	92
<i>Aphaereta pallipes</i>	0	0	1	8
<i>Drosophila robusta</i>	13	50	3	25
<i>Lymonia bryanti</i>	12	46	3	25
<i>Scatopse fuscipes</i>	8	31	2	17
<i>Systemus</i> n. sp.	7	27	1	8
<i>Telmatoscopus superbus</i>	6	23	0	0
<i>Psychoda cinerea</i>	3	12	6	50
<i>Psychoda satchelli</i>	2	8	0	0
<i>Psychoda alternata</i>	1	4	0	0
<i>Sylvicola alternatus</i>	3	12	0	0
<i>Sylvicola fenestralis</i>	1	4	3	25
<i>Pseudeucoila</i> sp.	0	0	1	8
<i>Phaonia</i> sp.	2	8	2	17
<i>Brunettia nitida</i>	0	0	1	8

caused by a decrease in the number of fluxes suitable as oviposition sites. Large numbers of larvae in slime fluxes may deter oviposition by females, as observed by Carson (1951) for *D. robusta*. Lack of rainfall also may have caused changes in the slime fluxes that made them less attractive to ovipositing females.

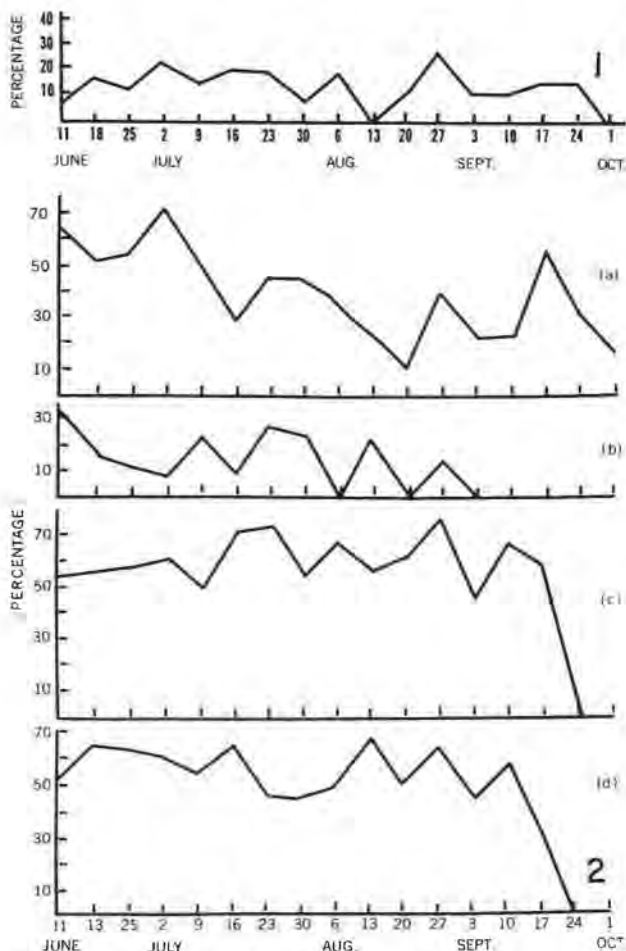
*Aphaereta colei* is a solitary endoparasite of *Aulacigaster leucopeza*, killing its host after the latter has pupated. The specimens obtained in this study provided the type specimens used by Marsh (1969) in his description of this species. Field observations and laboratory emergences suggested that this braconid was more abundant in Rockport than in Connecticut towns. We collected one wasp belonging to the Alysiinae that was not *Aphaereta*; this specimen could not be identified because the genera of the subfamily are confused (Marsh, pers. comm.).

The other two hymenopterans reared from flux samples, *Aphaereta pallipes* (Say) and *Pseudeucoila* sp., were represented by a single specimen of each. Both are undoubtedly parasites of dipterans. *A. pallipes* has been recorded from several dipteran hosts and *Pseudeucoila* are known to parasitize *Drosophila* (Muesebeck *et al.* 1951). The fact that the specimen of *Pseudeucoila* sp. came from a flux sample on the one elm that gave the greatest emergence of *D. robusta* suggests that the latter may have served as its host.

The anisipodid *Mycetobia divergens* and the midge *Dasyhelea oppressa* were consistently present in slime fluxes (Fig. 2c, d). These two species apparently can tolerate a wide variety of temperature and moisture conditions. Larvae of both have been observed in brown slime fluxes that were almost completely dry and as late as 20 October 1968.

Two other species of anisipodids, both of the genus *Sylvicola*, were recovered only occasionally (Tables III, IV). *S. alternatus* (Say) was recorded as a flux emergent at least once during each month (except October) that samples were





FIGS. 1, 2. The weekly percentages of Connecticut slime fluxes showing the emergence of *Drasophila robusta*, summer 1968 (Fig. 1) and of the four major emergent species, summer 1968: (a) *Aulacigaster leucopeza*, (b) *Aphaereta colei*, (c) *Dasyhelea oppressa*, (d) *Mycetobin divergens* (Fig. 2).

taken, while *S. fenestralis* (Scopoli) was not seen in samples taken after 16 July. We did not obtain *S. alternatus* from any Massachusetts samples although this species has been recorded previously from that state (Stone *et al.* 1965).

Five species of Psychodidae were reared from brown slime fluxes, four from Connecticut samples but only two from the Massachusetts samples. *Telmato-scopus superbus* (Banks) occurred at six Connecticut slime fluxes but emerged regularly at only one of them. This one slime flux showed very few other emergent species, the most common being *D. oppressa* and *M. divergens*. Interestingly, the common species *A. leucopeza* was never recorded as an emergent at this site. This particular flux patch occurred on a dying elm in Storrs, Conn., and there were moist areas of decaying bark adjacent to the fluxing area. *T. superbus* adults also emerged from collections of detritus from holes in two sugar maples. It appears that they are primarily attracted to decaying matter on trees and seldom to slime fluxes.

TABLE III

Numbers of weekly slime flux samples collected in the Hartford-Storrs area (1968) from which each flux associated species emerged

Species	June			July					Aug.				Sept.				Oct.
	11	18	25	2	9	16	23	30	6	13	20	27	3	10	17	24	1
TS:	13	23	24	23	22	20	15	13	12	9	10	8	9	9	7	7	6
<i>Aphaereta colei</i>	4	4	3	2	5	2	4	3	0	2	0	1	0	0	0	0	0
<i>Aphaereta pallipes</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Aulacigaster leucopezæ</i>	8	12	13	16	11	6	7	6	4	2	1	3	2	2	4	2	1
<i>Brunettia nitida</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Dasyhelea oppressa</i>	7	13	14	14	11	15	11	7	8	5	6	6	4	6	4	0	0
<i>Drosophila robusta</i>	1	4	3	5	3	4	3	1	2	0	1	2	1	1	1	1	0
<i>Lymantria bryanti</i>	1	2	4	0	2	5	4	3	4	3	4	0	2	0	0	0	0
<i>Mycetobia divergens</i>	7	15	15	14	12	13	7	6	6	6	5	5	4	5	2	0	0
<i>Phaonia</i> sp.	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
<i>Pseudeucoila</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Psychoda alternata</i>	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Psychoda cinerea</i>	0	1	0	1	1	1	0	0	0	1	0	1	0	0	0	0	0
<i>Psychoda satchelli</i>	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Scatopse fuscipes</i>	1	1	1	4	1	3	1	1	0	1	1	0	0	0	0	0	0
<i>Sylvicola alternatus</i>	0	0	1	0	2	0	0	0	1	0	0	0	1	0	0	0	0
<i>Sylvicola fenestralis</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Systemus</i> n. sp.	1	0	2	1	0	1	1	2	1	2	1	1	0	0	0	0	0
<i>Telmatoscopus superbus</i>	0	1	3	2	1	4	4	3	2	1	1	0	0	0	0	0	0

ABBREVIATION: TS, total samples.

*Psychoda alternata* Say and *P. satchelli* Quate were taken from Connecticut samples only. They are very similar to *P. cinerea* Banks, a species which emerged more regularly, and from both sample areas, during the sampling period (Tables III, IV). One specimen of *Brunettia nitida* (Banks) emerged from the 30 August sample of a Rockport elm which showed only a small amount of flux throughout the summer season.

*Scatopse fuscipes* Meigen, a cosmopolitan member of the poorly known family Scatopsidae, emerged regularly from flux that contained detritus. This species was recovered more commonly in Connecticut than in Massachusetts (Table II), perhaps because more Connecticut samples contained decaying matter.

The tipulid *Lymantria bryanti* was recorded regularly from samples taken in both sample areas (Tables III, IV). This species was never observed in abundance, there never being more than one or two individuals per sample. The dolichopodid *Systemus* sp. also appeared regularly but in low numbers and in only a few samples each week (Tables III, IV). This species and *L. bryanti* were probably present in more slime fluxes than the record shows. The failure to detect them in a greater number of cases was caused by their scarcity in any one flux patch, allowing them to escape collection when non-exhaustive sampling methods are used. According to Dr. G. Steyskal (pers. comm.) *Systemus* sp. represents a new species.

The Paurometabola appear not to use this habitat for a breeding site, although some members of this group may be found feeding at slime fluxes. An adult anthocorid (Hemiptera: Heteroptera) was found in a sample taken in Coventry, Conn. Dr. James Slater (pers. comm.) identified it as *Asthenidia temmostethoides* Reuter, and stated that this is the first record of the species in Connecticut. Four anthocorid nymphs collected from a Rockport elm are probably the same species

TABLE IV

Numbers of weekly slime flux samples collected in the Rockport, Mass., area (1968) from which each flux associated species emerged

Species	TS:	June			July					Aug.			
		11	18	25	2	9	16	23	30	6	13	20	27
		5	11	12	12	11	10	8	8	8	0	4	3
<i>Aphaereta colei</i>		2	5	6	5	6	4	2	2	2		2	0
<i>Aphaereta pallipes</i>		0	1	0	0	0	0	0	0	0		0	0
<i>Aulacigaster leucopeza</i>		1	4	8	7	7	5	1	0	1		1	0
<i>Brunettia nitida</i>		0	0	0	0	0	0	0	0	0		0	1
<i>Dasyhelea oppressa</i>		0	4	5	9	10	6	6	5	4		0	2
<i>Drosophila robusta</i>		1	1	0	1	3	2	1	0	1		1	1
<i>Lymantria bryanti</i>		0	0	0	1	2	2	3	2	2		1	0
<i>Mycetobia divergens</i>		0	4	6	6	8	6	6	6	7		2	2
<i>Phaonia</i> sp.		6	0	0	1	0	0	0	0	1		0	0
<i>Pseudeucoila</i> sp.		0	0	0	0	0	1	0	0	0		0	0
<i>Psychoda alternata</i>		0	0	0	0	0	0	0	0	0		0	0
<i>Psychoda cinerea</i>		2	1	4	2	3	3	2	0	3		1	0
<i>Psychoda satchelli</i>		0	0	0	0	0	0	0	0	0		0	0
<i>Scatopse fuscipes</i>		0	1	0	0	0	0	1	0	0		0	0
<i>Sylvicola alternatus</i>		0	0	0	0	0	0	0	0	0		0	0
<i>Sylvicola fenestralis</i>		1	1	0	0	0	1	0	0	0		0	0
<i>Systemus</i> n. sp.		0	0	0	0	0	1	0	0	0		1	0
<i>Telmatoscopus superbus</i>		0	0	0	0	0	0	0	0	0		0	0

ABBREVIATION: TS, total samples.

(Slater, pers. comm.). In both instances these bugs were probably present on the flux at the time the sample was taken. Slater (pers. comm.) suggested that the anthocorids are attracted to brown fluxes by the presence of Diptera larvae upon which they feed.

Other insects commonly present in brown slime fluxes were a few species of Collembola. In addition to insects there were mites and several species of nematodes that appeared in nearly all samples. Mites, nematodes, and Collembola were not identified for inclusion in this survey. Rarely, other organisms such as pseudoscorpions, snails, and earthworms were observed in flux samples. The snails were determined by Dr. Lowell Getz to be *Zonitoides arboreus* (Say) (Stylommatophora: Zonitoidae).

The species of insects that emerged from the small number of slime flux samples collected on black oaks, *Quercus velutina*, are listed in Table V. In addition to the emergents listed, larvae of *Amphicrossus ciliatus* (Oliv.) and *Brachyopa* sp. were also present in several oak fluxes. While no attempt was made to obtain an adequate survey of the slime fluxes on oaks, the list in Table V suggests that these fluxes have many insects in common with brown slime fluxes. The three most common species in brown fluxes were also recorded in the few oak fluxes sampled. However, the oak slime flux fauna is undoubtedly different in some respects, as indicated by the presence of a midge, *Culicoides villosipennis* Root and Hoffman, and a drosophilid, *Chymomyza amoena* (Loew), not found in the extensive survey of brown slime fluxes. Different species might favor one or the other kind of flux because of a difference in the flux and its included flora or because of a difference in the general habitat of the trees on which these fluxes occur.

An indication of the persistence of brown fluxes as a potential breeding site for insects is shown by the percentages of the original sample groups that



TABLE V  
Some insect emergents from slime fluxes of black oaks  
(*Q. velutina*) in Connecticut, summer 1968

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DIPTERA

Anisipodidae

*Mycetobia divergens* (Walker)

*Sylvicola alternatus* (Say)

Aulacigasteridae

*Aulacigaster leucopeza* (Meigen)

Ceratopogonidae

*Dasyhelea oppressa* Thomsen

*Culicoides villosipennis* Root & Hoffman

Dolichopodidae

*Systemus* n. sp.

Drosophilidae

*Drosophila robusta* Sturtevant

*Chymomyza amoena* (Loew)

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continued to flux throughout the summer (Table VI). The numbers of trees in the original sample groups are taken as 12 for Rockport and 24 for the Hartford to Storrs area despite the fact that the 11 June and 18 June samples were drawn from a lesser number of trees. It is assumed that trees added to the sample groups shortly after the survey began were in the fluxing condition for the 2 weeks previous to their discovery. Two trees added to the Connecticut collection group in midsummer are not considered as part of the sample group in Table VI. The first trees began to dry up in early July and half had dried up by early August.

### Discussion

There are several earlier records of *Drosophila* species breeding in slime flux or sap exudations. These include *D. tripunctata* Loew breeding in the sap of grapevine (Sturtevant 1921), *D. colorata* Walker in unspecified tree sap (Malloch and McAtee 1924), *D. subobscura* Collin and *D. obscura* Fallén in elm exudates (Gordon 1942), and *D. pseudoobscura* Frolova and *D. persimilis* Dobzhansky and Epling in the sap exudations of wild grapevine and an introduced cedar, *Cedrus deodara* Loud, in California (Dobzhansky and Epling 1944). Carson and Stalker (1951) reared several species of *Drosophila* from slime flux samples collected from trees occurring around St. Louis, Mo. These species were *D. robusta*, *D. melanica* Sturtevant, *D. victoria* Sturtevant, *D. athabasca mahican* Sturtevant and Dobzhansky, and *D. repleta* Wollaston. Carson (1951) found four species of *Drosophila* breeding in fluxes of *Quercus kelloggii* Newb.: *D. pseudoobscura*, *D. persimilis*, *D. victoria*, and *D. californica* Sturtevant.

While this survey shows that brown slime fluxes of elms in New England serve as a breeding site for a number of insect species, particularly dipterans, *Drosophila* were not well represented. The only emergent of the genus, *D. robusta*, appeared in samples from only 50% of the Connecticut and 25% of the Massachusetts slime flux sites (Table II) and emerged from only 43 out of the total of 322 samples (13.3%) taken from the 38 slime flux sites during the sampling period. *D. robusta* was recovered in substantial numbers from only one flux site. A total of 102 adults were reared from the 11 collections at this site, nine of which contained *D. robusta*. The most specimens bred from a sample of this one slime flux was 28 (from approximately 20–30 cc of flux material).

TABLE VI

The percentages of trees in the sample group maintaining the fluxing condition during each week of the sampling period

Week	Connecticut towns (%)	Rockport, Mass. (%)
6-11	100	100
6-18	100	100
6-25	100	100
7-2	96	100
7-9	92	92
7-16	83	83
7-23	63	67
7-30	54	67
8-6	50	67
8-13	38	—*
8-20	38	42
8-27	38	25
9-3	33	0
9-10	29	
9-17	21	
9-24	21	
10-1	17	

\*Trees not observed.

Carson and Stalker (1951), who transferred immature *Drosophila* from slime fluxes to artificial media, recorded *D. robusta* from 24.5% of their 110 samples. They concluded that slime fluxes are the "primary breeding sites" of this species.

One reason for *D. robusta* being less abundant in our flux samples may have been in the isolation of the fluxing trees, many of which were scattered in suburbs or parks. Speiss (1949) stated that *D. robusta* prefers dense forested areas and showed from bait trap collections that this species was less common in more urbanized areas. Carson and Stalker (1951) also stated that *D. robusta* is not abundant in "exposed or park-like areas." On the other hand, brown slime flux is found more often on shade trees in "streets, parks and estates" than in the forest (Guba 1934; authors' observations), which suggests that *D. robusta* breeds in other kinds of fluxes or on some other food source in forested areas.

It is also possible that the peak of emergence of *D. robusta* occurred before 11 June 1968, when sampling began. Banana trappings and slime flux recoveries in the St. Louis vicinity showed that the height of the breeding season for *D. robusta* occurred in June and "probably also in the month of May" (Carson and Stalker 1951). Speiss (1949) did not find an early breeding abundance of *D. robusta* in New England; however, his only early season collections were made in Boston where *D. robusta* is probably rare at all times.

Carson and Stalker (1951) have shown that *D. robusta* is differentially attracted to slime fluxes as they change with age or state of infection. Running sap, before it becomes slime flux, is attractive to the flies for feeding. As microflora invade the sap, fewer flies are seen feeding, and finally the flux ceases to be a feeding attractant altogether. Later, the flux becomes suitable to females for oviposition. Only one or two females at a time will visit the slime flux to oviposit. *Drosophila* species in the Sierra Nevada avoid fluxes containing larvae and pupae for oviposition, and *D. robusta* apparently follows this pattern in eastern areas as well (Carson 1951). Therefore, the period of oviposition by *D. robusta* at a particular slime flux is probably limited by the numbers of developing larvae already there.

TABLE VII  
Some British slime flux inhabitants (from Keilen 1921) and  
their New England counterparts

British flux inhabitants	New England counterparts
<i>Aulacigaster leucopez</i>	<i>Aulacigaster leucopez</i>
<i>Sylvicola fenestralis</i>	<i>Sylvicola fenestralis</i>
<i>Dasyhelea obscura</i>	<i>Dasyhelea oppressa</i>
<i>Mycetobia pallipes</i>	<i>Mycetobia divergens</i>
<i>Phaonia cincta</i>	<i>Phaonia</i> sp.
<i>Systemus adpropinquans</i>	<i>Systemus</i> n. sp.
<i>Systemus scholtzii</i>	

A few authors have reported insects other than *Drosophila* living in brown slime fluxes. Keilen (1921) identified some insect larvae in the "decomposed sap" of elm tree wounds. Ogilvie (1924) listed insect larvae from a brown flux occurring in Cambridge; however, this list did not show any new species records for slime fluxes in Great Britain.

It is interesting to compare the species found here with those listed by Keilen (1921) for elm fluxes in Great Britain. Some species are found in both places, while others found in New England are represented in Great Britain by closely related congeners (Table VII). These species, exploiting what appears to be the same niche in different geographical areas, can be considered "ecological homologues" (DeBach and Sundby 1963).

It is surprising that psychodids were not included in Keilen's list. *Psychoda cinerea* and *P. alternata* are flies which regularly breed in sewage filter beds where they feed on bacterial, algal, and fungal matter. The larval forms of these species prevent blockage of sewage filters (Terry 1956). Terry also mentioned that *Sylvicola fenestralis* breeds in certain filter beds along with *Psychoda* flies.

As expected, predaceous larvae were less abundant than prey larvae. *Systemus* sp. is probably predatory, as are most dolichopodids (Smith 1952). *S. adpropinquans* and *S. scholtzii* prey on *Dasyhelea obscura* larvae in British elm fluxes (Keilen 1921). *Phaonia* sp. is also probably predaceous. *P. cincta* preys on several dipteran larvae in brown fluxes of Great Britain (Keilen 1919).

A number of insect species are attracted to slime fluxes but do not oviposit in them. These include different species of large wasps and bees, a common staphylinid beetle, and rarely, tree crickets, lightning beetles, and leaf hoppers. Wilson (1926) and Sokoloff (1964) have discussed the insects attracted to white slime flux and the slime fluxes of California black oaks, respectively.

A number of individuals (20-30) of the picnic beetle, *Glischrochilus quadrisignatus* (Say) (Coleoptera: Nitidulidae), were observed on one brown slime flux in Massachusetts (11 June 1968). This species emerges in June and July and feeds for the remainder of the season on a variety of plant materials, including sap from infected tree wounds (Luckmann 1963). Connell (1957) found it abundant in oak sap from 15 May to 24 October. Eggs are laid in the spring in the soil near decomposing plant materials, and pupation occurs in the soil.

*Amphicrossus ciliatus* is the nitidulid more commonly found in brown slime fluxes. It occurs only rarely in such habitats as fungus, rotting melon, and the sap flow of *Liriodendron* sp. and *Quercus* sp. (Connell 1957). Both larvae and adults of *A. ciliatus* occur in great numbers in many brown fluxes and it appears likely that this is the main habitat of this species.

TABLE VIII  
Monthly rainfall in Rockport and the Hartford-Storrs area  
for the summer months, 1968

Month	Inches of rainfall*	
	Rockport	Hartford-Storrs
June	6.97	6.85
July	.88	1.58
August	1.64	2.96
September	.98	2.72
Total	10.47	14.11

\*Taken from U.S. Dept. Commerce Climatological Data.

As shown in Table VI some of the fluxes included in the sample group began drying up in July. The amount of rainfall may have an effect on the maintenance of the fluxing condition of trees. The monthly rainfall during the sampling period for both Rockport, Mass., and the Connecticut towns are shown in Table VIII. The data for Connecticut represent the average of figures reported by the two weather stations located at Storrs and Windsor Locks. The greater amount of rainfall occurring in Connecticut during July-September may have been a factor in continuing the fluxing condition of trees in this area. As shown in Table VI, certain of the trees in the Connecticut sample group showed flux during October, whereas flux patches in the Rockport sample group had dried up by the second week of September.

Temperature and humidity apparently were not important factors in controlling the fluxing condition of trees. Weekly temperature differences between sample areas were slight for the entire sampling period (av. 2°F, range 1-5°F), and the monthly averages for relative humidity in Rockport and the Hartford-Storrs area differed by only one or two percentage points.

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