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STUDIES ON THE ASSOCIATIVE ECOLOGY OF INSECTS
VI. LARVAL ASSOCIATION OF FLIES DURING THE SUMMER IN SENDAI AND ITS VICINITY, JAPAN[1]

By

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(With 3 figures)

There are many investigations concerning the habitats of various kinds of flies (Thomson 1934; Makara 1935; Baranov 1939; Hafez 1939, etc.), but there are only a few dealing with statistical treatments.

The junior author made synecological investigations in concern with the fly faunae found in the rural districts, in the urban center and in the home districts in Sendai (Hori 1949, 1950, 1951). Accordingly it was learned that in the course of the year the little house fly association in spring and summer is followed by the common house fly association in summer and autumn. The transition period of these two associations was observed from late May to middle June in the rural districts, from middle August to early September in the urban center and at October in the home districts.

A field survey of the dust bins, stables, dungs and toilet pools in Sendai and its vicinity was undertaken during the summer of 1950 to study the larval habitats of the flies.

In the present report thirty-one dust bins, twenty-seven stables including dungs on farm and ten toilet pools were observed. One or two litres of rubbish, stable manures, dungs and human feces or liquid human feces were collected and brought to the laboratory, and the flies which emerged after rearing were classified into various species and at the same time the population densities were estimated.

In the present paper the writers deal with the results of investigation of larval associations of flies from a synecological view-point.

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RESULTS AND DISCUSSION

1. In August 1950, seventeen species of flies were found from the tested habitats in Sendai.

a. Dust bin : *Ophyra nigra, O. leucostoma, Muscina stabulans, Musca domestica vicina, Lucilia sericata, L. cuprina, L. illustris, Sarcophaga peregrina, S. similis, S. melanura, S. misera,* S. sp. and *Stomoxys calcitrans* (thirteen species).

b. Stable manure and dung : *Ophyra nigra, Musca domestica vicina, M. hervei, Sarcophaga melanura, S. albiceps, Stomoxys calcitrans* and *Desmometopa* sp. (seven species).

c. Toilet pool : *Ophyra nigra, Fannia scalaris, Lucilia illustris, Sarcophaga peregrina, S. similis* and *Desmometopa* sp. (six species).

The habitats of these seventeen species of flies are summarized in table 1.

Table 1

Habitats of the various flies

Species name	Dust bin	Stable manure, Dung	Toilet pool
Ophyra nigra	+	+	+
O. leucostoma	+		
Fannia scalaris			+
Muscina stabulans	+		
Musca domestica vicina	+	+	
M. hervei		+	
Lucilia sericata	+		
L. cuprina	+		
L. illustris	+		+
Sarcophaga peregrina	+		+
S. similis	+		+
S. melanura	+	+	
S. misera	+		
S. albiceps		+	
S. sp.	+		
Stomoxys calcitrans	+	+	
Desmometopa sp.		+	+

2. Musca hervei found in the cow dung from a farm does not associate with any other flies, and it is the same in the case of *Sarcophaga similis* obtained from the toilet pool. All other flies associate with each other in various combinations and in various densities.

To clarify the various types of associations, the correlation method used in the synecological investigations by the writers and their collaborators (Katô and

Toriumi 1950a, b, 1951a, b; Katô and Hori 1952) was employed.

a. In the case of dust bin. By the reciprocal treatments thirty series composed of correlation coefficients were obtained for the corresponding number of dust bins. These are arranged in figure 1 in order of resemblance of their characters.

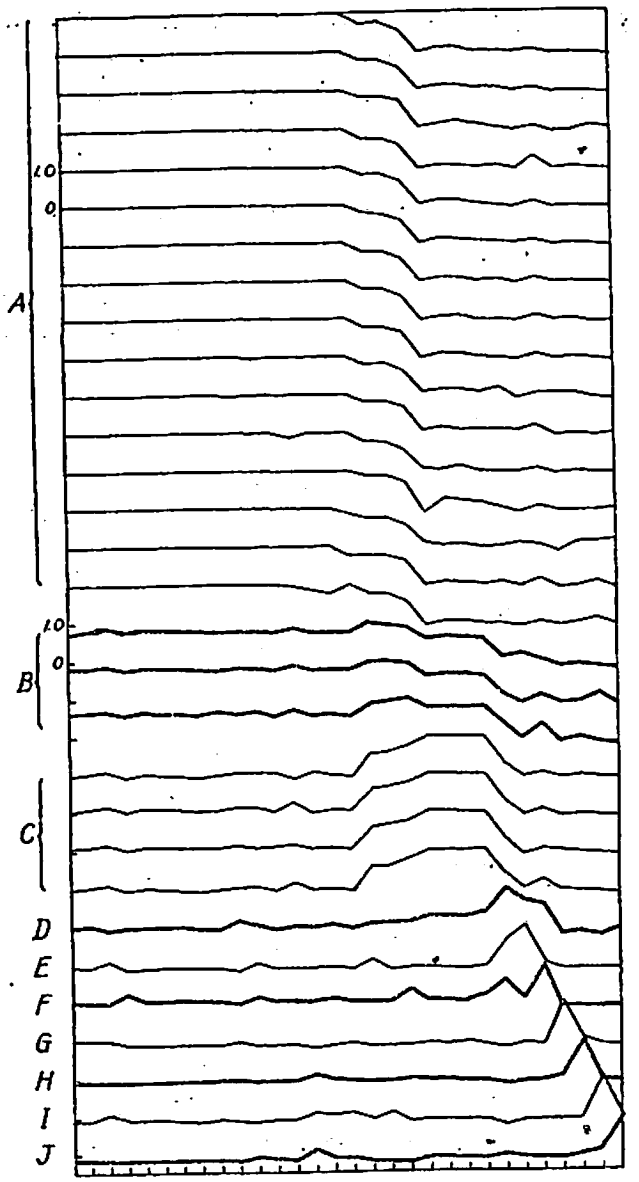

Fig. 1. Thirty series of correlation coefficients obtained by the reciprocal treatments of thirty associations of flies found in thirty localities of dust bins. Alphabetical letters in figure are illustrated in text.

It is known that the first sixteen series resemble each other, and, therefore, seem to form similar associations where the relative abundance between each species is approximately equal. It is named A-group for the convenience of further discussion. Thus for the same reason, distinguished are, B-group, which is composed of three series, and C-group of four series. The remaining seven series do not resemble each other and seem to have their own respective characteristic association.

The population density of each species found in each group is shown in figure 2.

In A-group, *Musca domestica vicina* is dominant and the number of individuals attains nearly 93 per cent of all the larvae. *Lucilia cuprina* is the second species in population, but its individual numbers amount to only five per cent. Therefore A-group designates the *Musca domestica*

vicina association.

On the contrary, in C-group, *Lucilia cuprina* becomes dominant, the individual numbers reach about 83 per cent of all the larvae, and *Musca domestica* decreases to only six per cent. C-group is therefore regarded as the *Lucilia cuprina* association.

In B-group, *Musca domestica* and *Lucilia cuprina* are approximately equal in

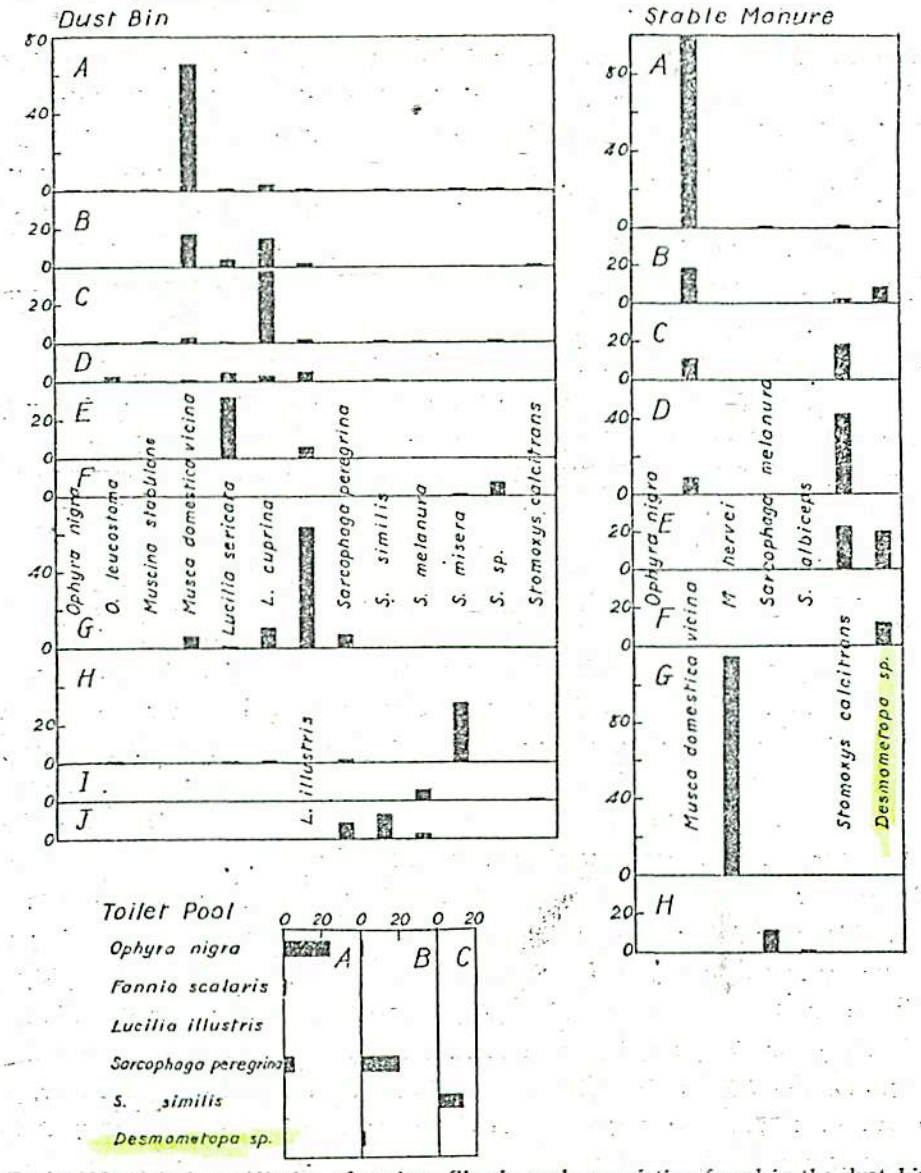

Fig. 2. Numerical constitution of various flies in each association found in the dust bin, stable manure and toilet pool.

population, being 44 per cent in the former and 40 per cent in the latter. Thus, B-group is the *Musca domestica*=*Lucilia cuprina* association. This group seems to be the intermediate form of the above mentioned two associations.

From the fact that these three associations are found at twenty-three localities among thirty dust bins, the larval association of the dust bin seems to be characterized by various combinations of the two species, *Musca domestica vicina* and *Lucilia cuprina*.

The remaining seven types show independent associations. D-type is the *Lucilia* association and includes *L. sericata*, *L. cuprina* and *L. illustris* whose population densities are very low, E-type is the *Lucilia sericata* association, F-type is the *Sarcophaga* sp. association, G-type is the *Lucilia illustris* association, H-type is the *Sarcophaga misera* association, I-type is the *Sarcophaga melanura* association and J-type is the *Sarcophaga similis*=*S. peregrina* association. Excluding G and H types, each association is not so dense, that is not the conspicuous one.

Conclusively, though there are thirteen species of flies in the dust bin, only five species, viz. *Musca domestica vicina*, *Lucilia cuprina*, *L. sericata*, *L. illustris* and *Sarcophaga misera*, especially the former two, are dominant in population density, and therefore, from the synecological view-point the larval association of the dust bin during the summer is represented by the *Musca domestica vicina* association and *Lucilia cuprina* association.

b. In the case of stable manure and dung. Among twenty-seven series, the character of eleven series resembles each other, where the dominancy of *Musca domestica* is very high, occupying 98 per cent of the total individuals (A-group) (figures 2 and 3). D-group is contrary to A-group, in the former the dominant species is *Stomoxys calcitrans*, being 92 per cent of total population. In C-group, populations of *Musca domestica* and *Stomoxys* are approximately equal. B-group has another structure, the individuals belonging to *Musca domestica* being about 64 per cent of all, and *Desmometopa* sp. about 29 per cent.

These four associations were found at twenty-two among twenty-seven localities. The remaining five series have independent structures, excepting the *Stomoxys*=*Desmometopa* association which is composed of two series (E-type), namely the *Desmometopa* association (F-type), the *Musca hervei* association (G-type) and the *Sarcophaga melanura* association (H-type).

A-group, the *Musca domestica* associations were found in horse, cow, pig, sheep and duck manures; D-group, the *Stomoxys* associations in cow, goat and sheep manures, and, the *Stomoxys*=*Desmometopa* associations were observed only in rabbit manures.

It is noticeable that in horse manure the *Musca domestica* association is formed, but the *Stomoxys* association was not found.

c. In the case of toilet pool. As is shown in figures 2 and 3, three associations are distinguishable; A-group is the *Ophyra nigra* association and B-group where *Sarcophaga peregrina* is the dominant species but contrary to A-group in relative abundance of each species. C-group, or the *Sarcophaga similis* association was found only at one locality among ten.

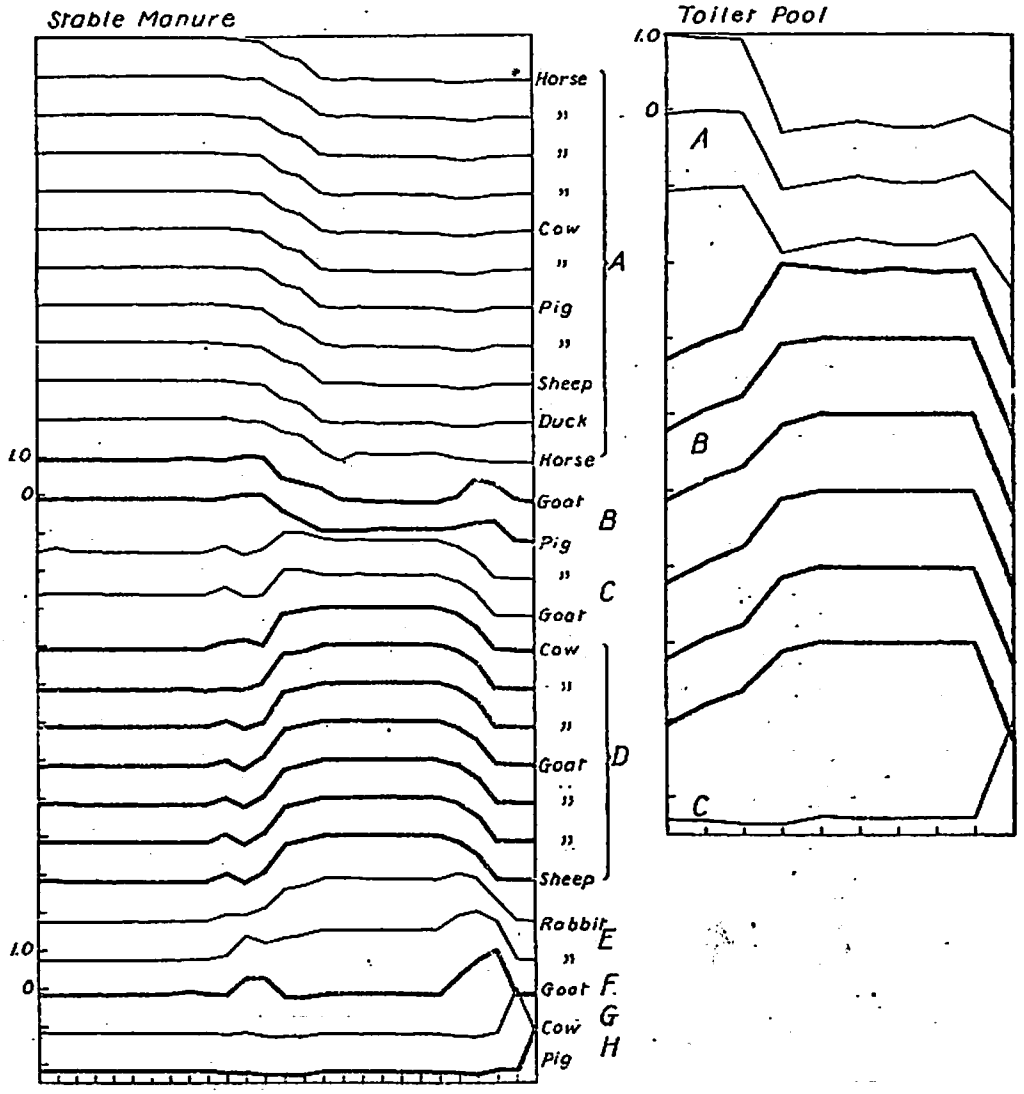

Fig. 3. Series of correlation coefficients obtained by the reciprocal treatments of twenty-seven associations of flies found in twenty-seven localities of stable manures and of ten associations in ten localities of toilet pools.

3. As mentioned above, seventeen species of flies were obtained by the survey of larval associations of flies during the summer of 1951, and it was ascertained that from their habitat preference twenty-one associations could be distinguished.

Among these twenty-one associations, the *Musca domestica* association is common to the dust bin and the stable manure and the *Sarcophaga similis* association is found in both the dust bin and the toilet pool, but the constitution of the associations are slightly different from each other.

Table 1

Individual number of male and female of each species found in various associations

1. Dust bin

a. *Musca domestica vicina*

	Musca domestica association	*Musca-Lucilia cup.* assoc.	*Lucilia cuprina* association	*Lucilia* association
♂	542	23	2	2
♀	510	29	9	4

b. *Lucilia cuprina*

	Musca domestica association	*Musca-Lucilia cup.* assoc.	*Lucilia cuprina* association	*Lucilia* association
♂	24	24	77	3
♀	29	22	74	8

2. Stable manure

a. *Musca domestica vicina*

	Musca domestica association	*Musca-Desmo.* association	*Musca-Stomoxys* association	*Stomoxys* association
♂	545	23	10	3
♀	568	15	12	3

b. *Stomoxys calcitrans*

	Musca domestica association	*Musca-Stomoxys* association	*Stomoxys* association	*Stomoxys-Desmo.* assoc.
♂	5	21	137	11
♀	11	15	156	12

3. Toilet pool

a. *Ophyra nigra*

	Ophyra association	*Sarcophaga pereg.* assoc.
♂	28	3
♀	45	1

b. *Sarcophaga peregrina*

	Ophyra association	*Sarcophaga* association
♂	8	42
♀	8	75

It seems that the dust bin forms complicated environments as the habitats of flies.

It is very interesting that the *Stomoxys* associations were found only in the southern part of the rural districts in Sendai.

4. Sex ratio of various flies. As, in the present investigations, the fly larvae were collected and identification of species names was done on the emerged adult flies after rearing, the sex ratio obtained from the present experiments might be more accurate than that obtained from the collection of adult flies.

The sex ratio from the data obtained from samples of 67 localities is given in table 2, where the numbers of individuals of male and female are represented according to their associations.

According to the statistical treatments, it is recognized that the sex ratio of all the species examined falls within 50 per cent by 95 per cent reliability.

SUMMARY

Seventeen species of flies were found by the survey of fly larvae in Sendai and its vicinity during the summer of 1950. The following facts were ascertained from the synecological investigations.

1. There are thirteen species of flies in the dust bin. The larval association is characterized by the *Musca domestica vicina* association, the *Lucilia cuprina* association and the *Musca domestica=Lucilia cuprina* association; the former is found very frequently, while the latter two were seen in about equal numbers but, their occurrence is rather rare. Except for these three characteristic associtions seven more associations were found.

2. In stable manure and dung, seven species of flies were found to form eight associations; the *Musca domestica* association and the *Stomoxys* association were observed frequently.

The *Musca hervei* association was found in the cow dung in the farm.

3. Six species of flies were recognized to form three associations in the toilet pool, which is characterized by the *Ophyra nigra* association and the *Sarcophaga peregrina* association.

4. A definite distribution among the localities was recognized in the case of *Stomoxys calcitrans*.

5. The sex ratio obtained from rearing of larvae is ascertained to be 50 per cent by the statistical treatments.

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