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Drosophila Survey of Hokkaido, XVI. Some Ecological Notes on the Attractiveness of Different Yeasts to Drosophilid Flies^{1), 2)}

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(With 2 Text-figures and 1 Table)

Sympatric coexistence of species must be ecologically compatible, besides being genetically isolated (Mayer 1949). Two or more species cannot live together in the same region, if they exploit the same ecological niche in the same way. This was clearly shown by Gause's experiment (1934) on the struggle for existence. Differences of nutritional preferences may remedy such a competition of the sympatric species. The relationship of drosophilid flies to different nutritional conditions has been studied by Wagner (1944, 1949), Shehata and Mrak (1952), Suzuki (1955) and Robertson (1959). One's knowledge on the attraction of *Drosophila* to different yeasts has remained rather meagre, a few papers having been published by Dobzhansky and da Cunha (1955), da Cunha *et al.* (1957), and some others. The present author has been interested in ecological features of drosophilid flies attracted to different kinds of yeasts in relation to their seasonal variation at a certain restricted locality. The present paper describes the results of some observations on the Drosophilidae which are attracted to several different kinds of yeasts.

Here, the author's cordial thanks are expressed to Professor Sajiro Makino who showed keen interest in this subject with important suggestion and to Dr. Eizi Momma who directed this investigation with helpful advices. Thanks should be extended to Mr. Haruo Takada for his important criticism, to Dr. Yuji Sasaki, for supplying the yeasts used, to Mr. Hideo Hara, for cooperation in collecting flies, and to Mrs. Yasuko Toyofuku for here helpful advices with friendly aid in the course of this study.

Method of collection: The kinds of yeasts used in this observation were as follows: (A) *Saccharomyces cerevisiae*, (B) *Hansenula anomala*, (C) *Saccharomyces rouxii*, (D) *Candida pelliculosa*, and (E) *Pichia membranaefaciens*. Five traps were set in each of three different stations in the University Botanical Garden, Sapporo. Flies were collected with examination of the traps five times a day between sunrise and sunset for three successive days at intervals of two weeks, during the period from May to November, 1959. The traps baited with fermenting banana to which sufficient amount the respective yeast-rich solutions had been added, were placed in each station at intervals of 2 to 5 meters with the aid of

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strings to the branches of trees and bushes. The containers are paper beer cups, about 180 cc in capacity. Flies were readily trapped in the containers by means of covering them with a vinyl sack.

Results

The results involving the collection records are as summarized in Table 1. Among 32 species collected, *D. auraria* was most common, being 39.6 per cent in frequency, while *D. nigromaculata* ranked next showing 24.6 per cent of frequency. In Figure 2, a histogram is shown in which is exhibited the frequency-distributions of nine dominant species of *Drosophila* obtained in this collection. It was observed that yeasts A, B and D attracted many flies (22 to 23 %), while yeast E showed the lowest attractiveness (12.4%).

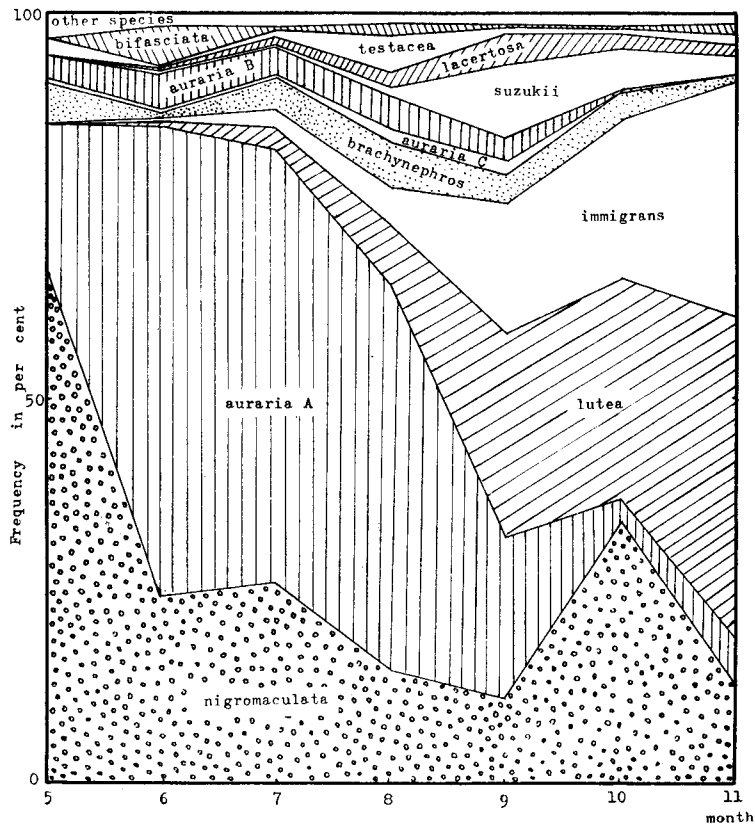


Fig. 1. Diagram showing a seasonal variation of drosophilid flies attracted by five kinds of yeasts.

D. auraria was attracted at the rate of 27.1 per cent of a total 9387 specimens to yeast A, at 22.2 per cent to yeast C, at 20.5 per cent to yeast D, at 19.5 per cent to yeast B, and at 10.7 per cent to yeast E.

D. nigromaculata showed no preference to the yeasts used: yeast A and yeast C attracted 22.3 per cent and 22.2 per cent, respectively, in the total number of this species caught. Yeast B and yeast D attracted 20.2 and 19.4 per cent of this species, respectively. The least attractive to this species was also yeast E (15.4%).

The collection records of *D. lutea* were greater in yeast D (31.3%) and yeast B (28.1%) than in yeast A (17.9%), yeast C (13.5%) and yeast E (9.2%). This species showed the lowest frequency in collection with yeast E.

Table 1. *Drosophilid* flies attracted by five kinds of yeasts, from the data obtained in the University Botanical Garden, Sapporo, 1959

Species	Yeast					Total
	A	B	C	D	E	
<i>D. auraria</i>	2490	1856	2051	1986	1004	9387
<i>D. nigromaculata</i>	1294	1175	1292	1121	921	5803
<i>D. lutea</i>	577	905	435	1011	298	3226
<i>D. immigrans</i>	276	863	289	688	338	2454
<i>D. brachynephros</i>	235	229	114	169	135	882
<i>D. suzukii</i>	117	160	81	127	79	564
<i>D. lacertosa</i>	132	71	54	76	24	357
<i>D. testaceae</i>	112	65	44	67	50	338
<i>D. bifasciata</i>	41	91	28	55	36	251
<i>D. unispina</i>	12	30	12	28	15	97
<i>D. sordidula</i>	14	24	13	35	8	94
<i>D. histrioides</i>	23	8	4	9	4	48
<i>D. histrio</i>	4	14	1	8	3	30
<i>D. funebris</i>	2	5	5	9	5	26
<i>D. coracina</i>	9	6	3	5	3	26
<i>D. virilis</i>	1	—	4	4	—	9
<i>D. ezoana</i>	3	—	—	6	—	9
<i>Leucophenga maculata</i>	1	2	—	—	2	5
<i>D. busckii</i>	1	1	—	1	1	4
<i>D. moriwakii</i>	1	—	—	1	1	3
<i>Aulacigaster leucopezae</i>	1	1	—	—	1	3
<i>Scaptomyza disticha</i>	1	1	—	—	1	3
<i>D. sexvittata</i>	—	2	—	—	—	2
<i>D. nipponica</i>	—	1	—	1	—	2
<i>D. rufa</i>	—	2	—	—	—	2
<i>Drosophila</i> sp. of fenestrarum group	—	2	—	—	—	2
<i>D. trivittata</i>	—	—	—	—	1	1
<i>D. alboralis</i>	—	—	1	—	—	1
<i>D. melanogaster</i>	—	—	—	—	1	1
<i>D. okadaii</i>	1	—	—	—	—	1
<i>D. multispina</i>	—	—	—	—	1	1
<i>Amiota variegata</i>	—	—	—	—	1	1
Total	5348	5514	4431	5407	2933	23633

For *D. immigrans*, yeast B (35.1%) and D (20.5%) were most attractive. Yeast A, C and E had attractiveness to this species at 11.3, 11.8 and 13.8 per cent, respectively : the attractiveness of yeasts A and C was the lowest.

The collection of *D. brachynephros* by yeasts A (26.7%) and B (26.0%) was remarkably effective. Yeast C showed the lowest attractivity to this species at 12.9 per cent.

D. suzukii was strikingly attracted by yeast B (28.3%). To other yeasts the attractivity was represented by 22.5 per cent to yeast D, 20.8 per cent to yeast A, 19.4 per cent to yeast C and 13.9 per cent to yeast E.

D. lacertosa exhibited a strong preference for yeast A (36.0%). The flies at the rate of 21.3 per cent were attracted by yeast D, at 19.9 per cent by yeast B, at 15.1 per cent by yeast C. The lowest value was obtained in yeast E at 6.7 per cent.

D. testacea was most abundantly collected by yeast A (33.2%) as observed in *D. lacertosa*. The attractivity was shown as 19.8 per cent to yeast D, 19.2 per cent to yeast B, 14.8 per cent to yeast E, and 13.0 per cent to yeast C.

D. bifasciata disclosed the highest preference for yeast B (36.3%), and the lowest for yeast C (11.2%). The attractivity of other yeasts to this species was found as 21.9 per cent to yeast D, 16.3 per cent to yeast A and 14.3 per cent to yeast E.

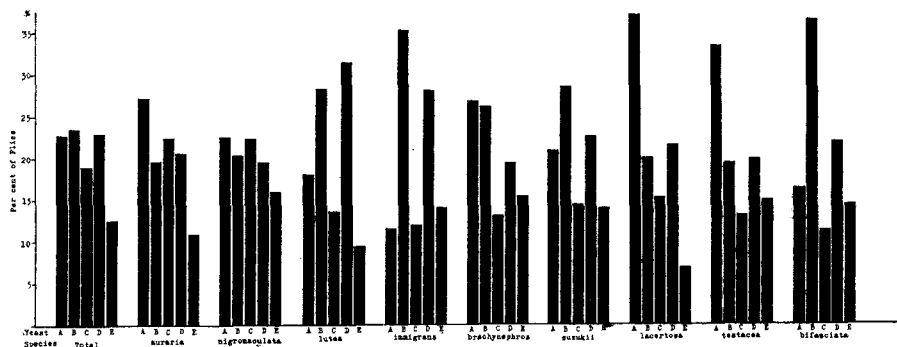


Fig. 2. Histograms showing frequency-distributions of nine dominant species of *Drosophila* attracted by five kinds of yeasts.

By referring to Figure 2, one may see evidently that nine dominant species as named above seem to be classified into three categories as follows : (1) species which show no significant preference for any of the five species of yeast here considered, (2) species which preferred two kinds of yeasts, and (3) species which showed a remarkable attractiveness to only one kind of the yeasts used. *D. auraria* and *D. nigromaculata* belong to category 1, *D. brachynephros*, *D. lutea* and *D. immigrans*

to category 2, and *D. lacertosa*, *D. suzukii*, *D. testacea* and *D. bifaciata* to category 3. The data presented seem to justify the statement that the dominant species tend to show an extensive preference for the yeasts.

Discussion

The results of the present observations with five kinds of yeasts (A, B, C, D and E) have indicated that the drosophilid flies attracted to yeast E were significantly lower in number than those attracted to other yeasts. A similar ecological situation was found to occur in the study of da Cunha *et al.* in Brazil (1957). The evidence presented has shown that closely related species do not always show preference for the same kind of yeast. This may be due to different ability of utilization of yeasts in closely related species (Dudgeon 1954). *D. nigromaculata* was less dominant in occurrence than *D. auraria*. It was observed that the former species was rather more universally attracted to the yeasts here used than the latter. It is suggested that *D. nigromaculata* carrying many inversions (Toyofuku 1957, 1958a, 1958b) has become more widely adapted to various foods in the field in order to avoid the competition within *D. nigromaculata*. This idea is supported by the alteration of frequency in the inversions of *D. willistoni* by means of changing the culture medium (Brich & Battaglia 1957), by the adaptability to different yeasts (Levine 1952), and by some experiments on migration (Takada 1959).

It was found that the species which were especially attracted to one kind of yeast were also attractive to other kinds of yeasts in more or less degree. In this connection the following statements may be significant: diversity of nutritional requirements exists not only between species of *Drosophila* as shown by Wagner (1944, 1949) and Dudgeon (1954), but also between variants of the same species (da Cunha *et al.* 1959).

It is worth while to mention on the basis of the present results that flies which show a particular liking for one kind of yeast were less in number than those attracted by two or more kinds of yeast. It is suggested that yeast preference may play an important rôle in coexistence of sympatric species of *Drosophila*.

Summary

The preference or attraction of drosophilid flies to five different kinds of yeast was observed in the Hokkaido University Botanical Garden, Sapporo, during a period from May to November, 1959. The results are summarized in Table 1, Figures 1 and 2.

Among nine dominant species collected, the most common were *D. auraria* and *D. nigromaculata*. They showed no significant preference for the yeasts used with the one exception of yeast E. The other seven dominant species showed their own characteristic preference for different yeasts.

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