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Local Variation of the Habitat Preference of the Streamside Drosophilid Flies in Hokkaido

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Synopsis At various localities in Hokkaido where two close relatives (*D. sordidula* and *D. pseudosordidula*) of the streamside drosophilid flies are absent or rare, local variation of the habitat preference of the streamside drosophilid flies was investigated by modification of the spatial microdistribution of neighboring streamside species to the vacant space which was occupied by *D. sordidula* or *D. pseudosordidula* in the central part of Hokkaido. In general the habitat preference of each streamside dweller was stable in such localities, but two streamside dwellers (*D. moriwakii* and *D. lacertosa*) which have rather wide habitat preference in the central part of Hokkaido showed small modification in the vertical microdistribution.

Introduction

Although the serial works titled as "*Drosophila* Survey of Hokkaido" revealed distributions of drosophilid species in Hokkaido, only a few brief notes were given on the distribution of the streamside dwellers (Members of the Streamside–Tree Sap Feeder Guild, cf. MINAMI *et al.*, 1979). WAKAHAMA (1963) reported that *D. lacertosa* had the most wide distribution and highest occurrence in the *robusta* group in Hokkaido, and *D. okadai* distributed in the northern parts of Hokkaido. Further, *D. moriwakii* and *D. sordidula* were rather rare in occurrence in Hokkaido. However, BEPPU (1979) revealed that the habitat preference of each streamside dweller is species specific, though overlap of habitats is supposed. Therefore, previous records are insufficient to discuss their distributions in Hokkaido, because the collections were carried out without enough considerations for their characteristic habitat preferences.

On the other hand, in the ecology it has been one of the most important problem whether interspecific competitions play a basic role to the community organization, or not. An approach to this problem is to observe responses of neighboring species to a vacant niche when one species has been artificially or accidentally excluded from the community, or at different localities where some members of the community lack. As mentioned in the previous paper (BEPPU, 1979), streamside dwellers belong to the *robusta* or *virilis* group, and wild species of these groups have species specific habitat in the vicinity of watersides. Consequently, if some species of these groups were rare or absent in a locality, influence of the interspecific competition from the absent species to other species would be supposed by modification of the habitat preference of the remaining species.

Having such idea in mind, habitat preferences of the streamside dwellers are compared at various localities in Hokkaido where two close relatives (*D. sordidula* and *D. pseudosordidula*) are absent or rate, together with a brief discussion on the life cycle modes.

Before going further, the author wishes to express his sincere thanks to Professor Eizi MOMMA of Hokkaido University for his kind advice and suggestion. Cordial thanks are also due to Dr. Masahito T. KIMURA and Mr. Masanori J. TODA for their useful suggestions.

Studied Areas and Collecting Methods

Abbreviations of studied areas and collecting methods are decided in below, and each survey is codified by such abbreviations. Each abbreviation is shown in parenthesis and Table 1.

1. *Location of Studied Areas*

Surveys were carried out at Kami-otoineppu (KO) in the northern part of Hokkaido, at Sakurano (SK) in the southern part of Hokkaido, and at Ashoro in the eastern part of Hokkaido. In Ashoro two studied areas were selected; one was at the lower altitude (200 m), Kakkomi (KK), and the other was at the higher altitude (600 m), Ashoro Pass (AP). Locations of these areas are shown in Fig. 1. General environmental conditions of each locality are shown in below.

1.1. Kami-otoineppu

The studied area was set in the Nakagawa Experimental Forest of Hokkaido University. The forest is composed of the deciduous broad-leaved trees (*Quercus crispula* etc.) with a mixture of Saghalien fir, *Picea glehnii* and so on. The undergrowth layers consist of mainly *Sasa senanensis*, which hangs over the streamside of small streams in the forest.

Traps were set along the Otoineppu River and its branch stream. The Otoineppu River is about 5 m in width and has a wide dry riverbed (about 3 m in width). The branch stream runs through this forest and runs together with the Otoineppu River at the edge of this forest. Space above this branch stream is covered with tree canopy. Streamsides of main and branch streams are stony, but sandy area is seen partly at the main river riverside.

1.2. Sakurano

Vegetation of this studied area is not so different as that of Sapporo City, the

Table 1. Codes of the studied areas and collecting methods.

KO : Kami-otoineppu (The studied area)	HZ : Horizontal microdistribution survey
SK : Sakurano (The studied area)	VE : Vertical microdistribution survey
KK : Kakkomi (The studied area)	S_1 : Collections were done once in each season except for winter
AP : Ashoro Pass (The studied area)	
MC : Milk Can Trap	S_2 : Collections were done twice in each season except for winter
RT : Retainer Trap	
	W_2 : RT was set for two weeks.

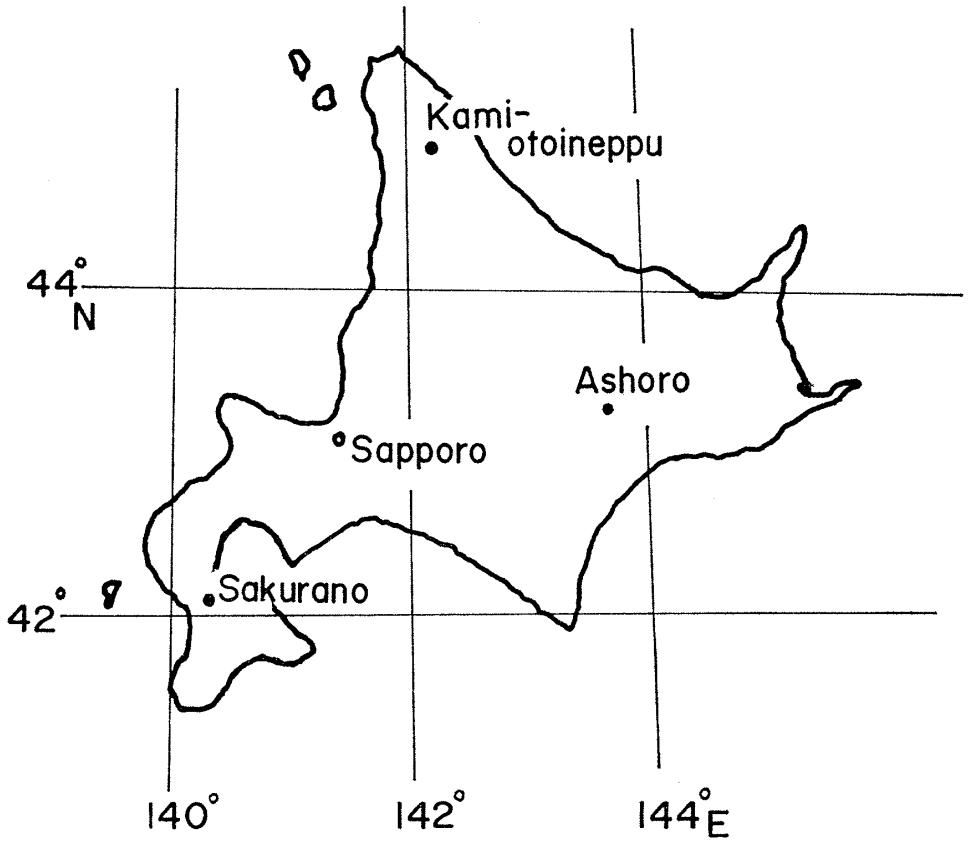


Fig. 1. Location of the studied areas.

central part of Hokkaido. Secondary broad-leaved natural forests extend, and dominant tree species are *Quercus crispula*, *Betula platyphylla*, and *Prunus sargentii* etc. Undergrowth layers consist of *Sasa senanensis* etc.

Trap spots were set along the Noda-oi River and its branch stream. The main stream is about 10 m in width and stony dry riverbed extends. The branch stream is about 1.5 m in width and space above this stream is covered with tree canopy.

1.3. Ashoro

1.3.1. Kakkomi

Broad-leaved natural forests extend, and dominant tree species is *Quercus crispula*. Undergrowth layers consist of *Rhododendron dauricum* and *Sasa amphitricha* etc. Trap spots were set along a narrow stream (1 m in width) canopied by mentioned trees, but these spots were not far from Ashoro Lake. Therefore, some flies living in the open streamside were also collected. In comparison with the bamboo-grass at the central part of Hokkaido, height of the bamboo-grass at this locality was shorter.

1.3.2. Ashoro Pass

Coniferous forests extend, and dominant tree species are *Abies sachalinensis* and *Picea jezonensis*. Subarboreal layers consist of *Sorbus commixta*, *Acer mono*

and *Acer ornatum* etc. Undergrowth layers consist of *Sasa amphitricha* etc., but *Petasites japonicus* subsp. *giganteus* was seen near streamsides. Trap spots were set in the mentioned forests, at the pond near forest edge, and at streamsides in the forest. The stream is about 0.5 m in width and canopied by the trees mentioned above.

2. *Collecting Methods*

Horizontal (HZ) and vertical (VE) microdistributions were surveyed by means of Milk Can Traps (MC) or Retainer Traps (RT). In the vertical survey two types of collections were done; one was done by the use of Milk Can Traps (VE–MC), and the other was by the use of Retainer Traps (VE–RT). The number in parenthesis next to each trap code indicates the number of traps used in the survey. In addition to the mentioned codes, according to collecting codes by Toda and KIMURA (1977) and BEPPU (1979), each survey was codified as follows.

2.1. The horizontal survey (HZ)

HZ was carried out at KO, SK, and AP (Tf–KO–'76 and Tf–SK, AP–'77) by means of MC. In HZ, Roman numerals show the traps set along the main stream (open stream), but small letters of Roman alphabet show the traps set along the branch stream (canopied stream). Detailed codes of each survey of HZ are shown in below.

Survey 1. KO–HZ–MC(10)–H_1D_1–S_1–'76.

Microenvironmental conditions around each trap spot were as follows;

I, II and III: On the stony dry riverbed of the Otoineppu River.

IV: On the sandy dry riverbed of the Otoineppu River.

a, b, c and d: At streamsides of the branch stream of the Otoineppu River.

α: At confluence of the main and branch streams.

F_1: In the streamside forests, distance from a branch stream to the trap was about 10 m.

Survey 2. SK–HZ–MC(8)–H_2D_2–S_1–'77.

Microenvironmental conditions around the trap spots;

I and II: At the riverside of the Noda-oi River,

a and b: At the branch streamside of the Noda-oi River,

α: At confluence of the main and branch streams,

F_1 and F_2: In the streamside forest,

C.S.: In front of the cliff shelter of the branch stream.

Survey 3. AP–HZ–MC(9)–H_2D_2–S_1–'77.

Microenvironmental conditions around the trap spots;

I and II: At the edge of the pond near forests.

a, b, c, d and e: At stony canopied streamsides.

F_1 and F_2: In the streamside coniferous forest.

2.2. The vertical survey (VE)

VE was carried out at SK, KK, and AP (Tf–SK, KK, AP–'77).

2.2.1 The vertical survey by means of MC (VE–MC)

This survey was carried out in order to investigate the vertical microdistributions of each streamside species from the stream surface to 2 m high. A MC was set at a height of 0 m, 1 m, and 2 m from the stream surface. This was done at SK and AP, and collections were carried out at the canopied streamside. Codes of each survey are as follows:

Survey 4. SK–VE–MC(3)–H_2D_2–'77. This was done once in autumn.

Survey 5. AP–VE–MC(3)–H_2D_2–'77. This was done once in summer and autumn.

2.2.2 The vertical survey by means of RT (VE–RT)

This survey was carried out in order to investigate the vertical microdistributions of streamside dwellers from the stream surface to the tree canopy. Trap spots at each studied area are shown in Fig. 3 schematically. This was done at SK, KK, and AP. In SK this survey was done at canopied and open streamsides, but in KK and AP this was done at canopied streamsides.

Survey 6. SK (at open)–VE–RT(4)–W_2–S_2–'77.

Survey 7. SK (at canopied)–VE–RT(3)–W_2–S_2–'77.

Survey 8. KK–VE–RT(3)–W_2–S_2–'77.

Survey 9. AP–VE–RT(4)–W_2–S_2–'77.

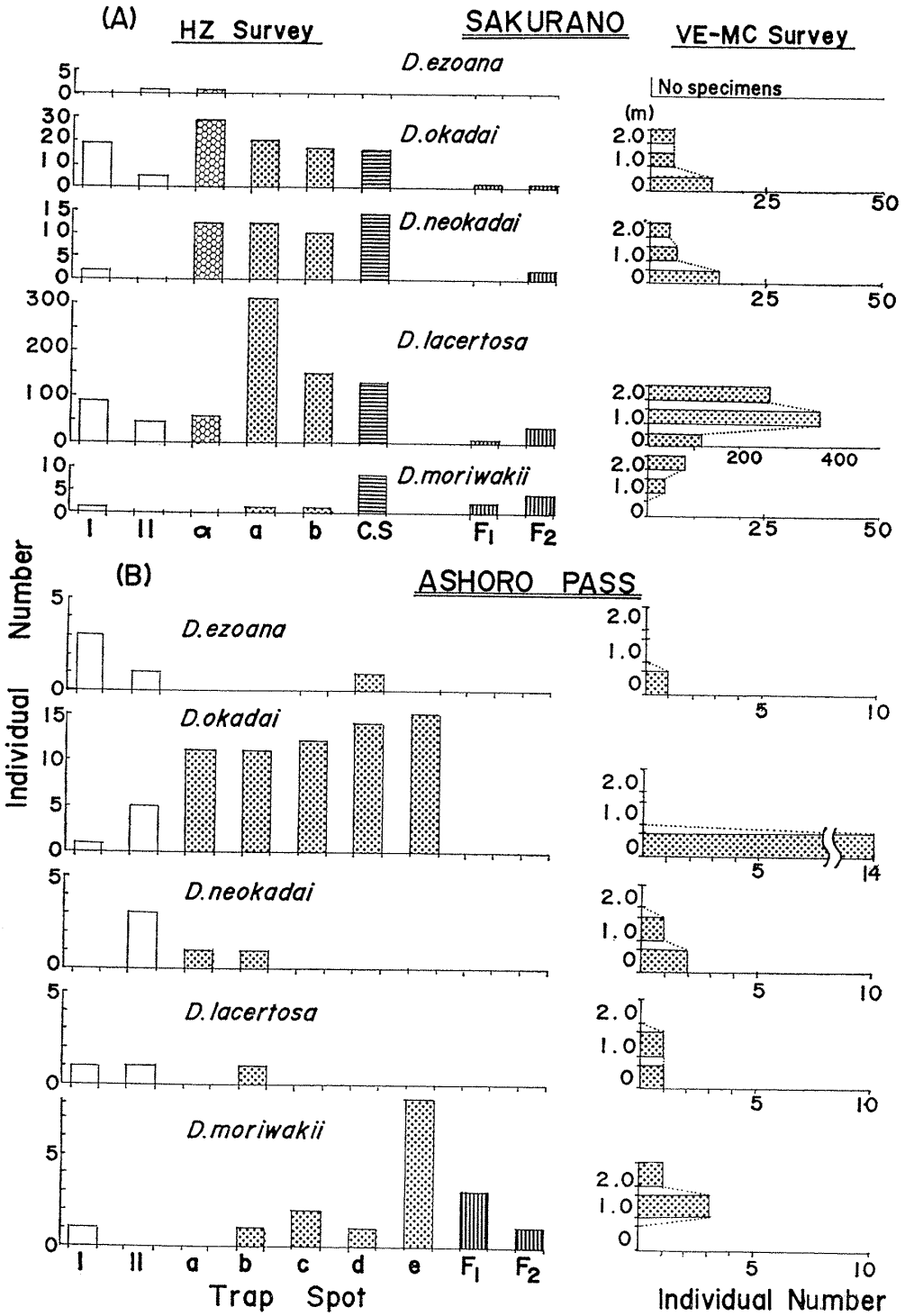
Results and Discussion

1. *The Horizontal Survey*

No specimen of *D. sordidula* and *D. pseudosordidula* which were abundant in the undergrowth layers in the central part of Hokkaido was collected in HZ. Individual numbers of collected specimens of each streamside dweller are shown in Fig. 2. Their general microdistribution patterns are very similar to those seen in the central part of Hokkaido (BEPPU, 1979): *D. ezoana* was abundant at open streamsides, *D. okadai* and *D. neokadai* were abundant at stony streamsides, *D. lacertosa* was particularly abundant at canopied streamsides, and *D. moriwakii* was seen not only in the vicinity of streams but also in the streamside forest. From these facts it may be allowed to conclude that conspicuous modification of the horizontal microdistribution pattern does not occur by decrease or absence of *D. sordidula* and *D. pseudosordidula.*

2. *The Vertical Survey by Means of MC*

No specimen of *D. sordidula* and *D. pseudosordidula* was collected in VE–MC. Results of this survey are shown in Fig. 2 with the ones of the horizontal survey. As shown in this figure, three species (*D. okadai*, *D. neokadai* and *D. ezoana*) were abundant at the lowest trap spot. In addition to these species *D. lacertosa* showed the similar trend, but the restriction to the lowest spot seemed to be weaker than that of the mentioned three species. The microdistribution pattern of these four



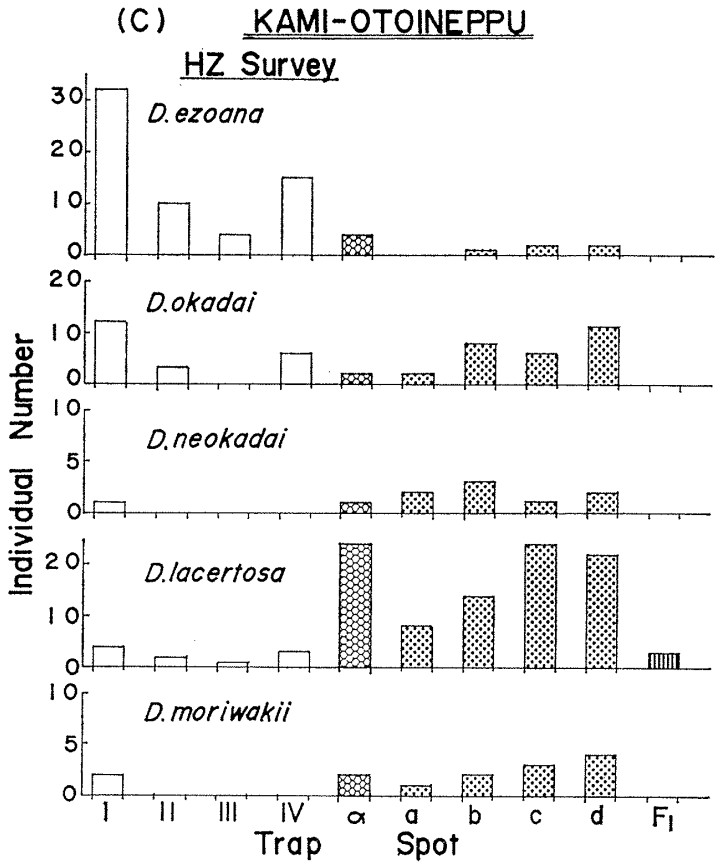


Fig. 2. Microdistribution pattern of the streamside dwellers in the horizontal and the vertical (by the use of the Milk Can Traps) surveys. Roman numerals: traps set at the open streamside; small letters: traps set at the canopied streamside; α: the trap set at the confluence; F_1 and F_2: traps set in the streamside forest; C.S.: the trap in the shelter of the cliff in the vicinity of the stream.

species in this survey is very similar to that seen in the central part of Hokkaido (BEPPU, 1979).

As against these four species, *D. moriwakii* was abundant at the upper and middle spots. This trend of *D. moriwakii* coincides with that seen in the central part of Hokkaido (BEPPU, 1979). From these it is concluded that microdistributions of each streamside species do not change in the space near stream surface, and the habitat preference of the streamside dwellers may not be influenced by decrease or absence of *D. sordidula* and *D. pseudosordidula*.

3. *The Vertical Survey by Means of RT*

Individual numbers of collected specimens of the streamside dwellers and their two relatives are shown in Table 2, and percentage microdistribution patterns of them are shown in Fig. 3. As shown in this figure, four streamside dwellers (*D. okadai*, *D. neokadai*, *D. ezoana* and *D.* sp. 4) were abundant at the lowest spot in

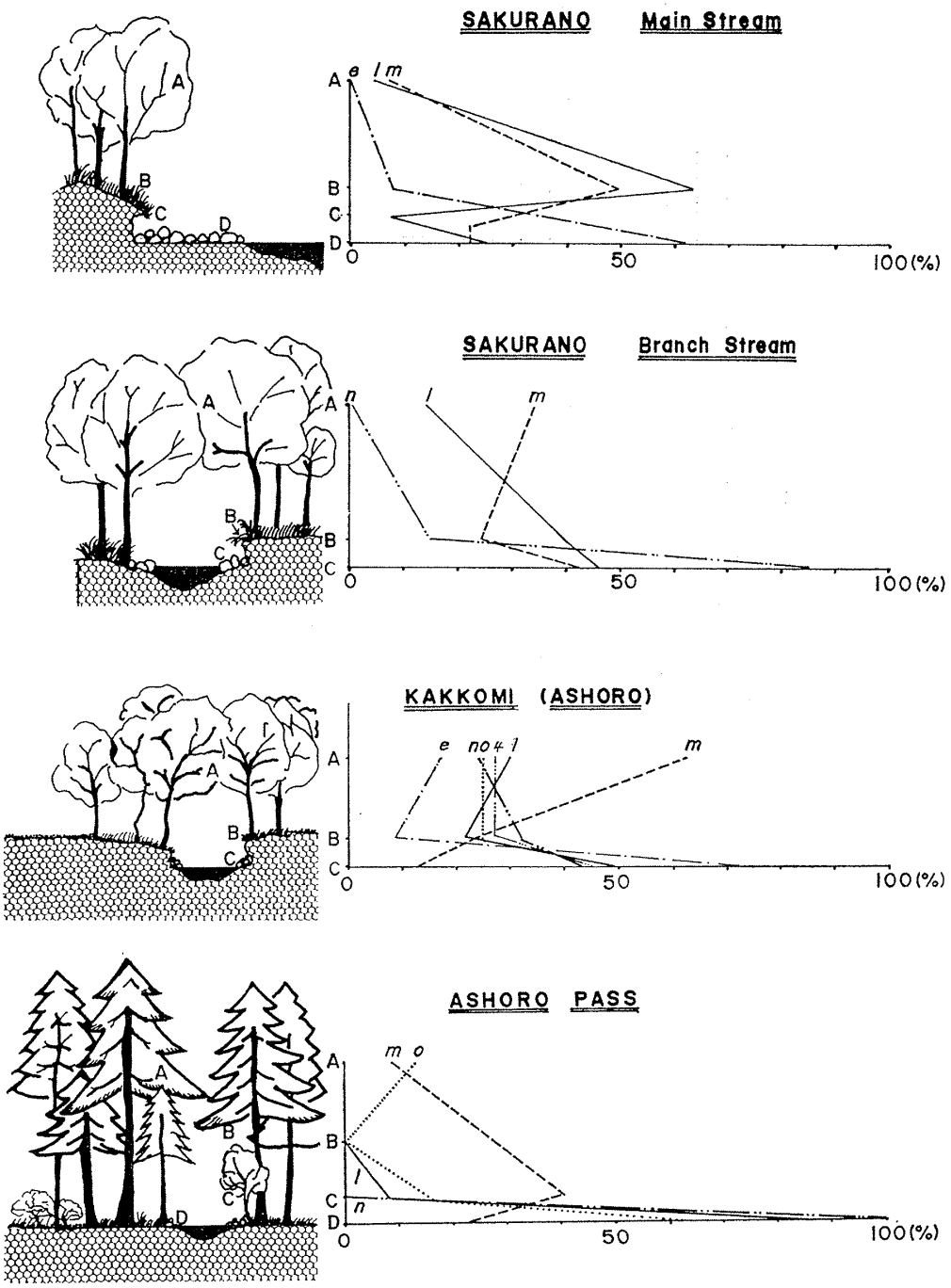


Fig. 3. Percentage microdistribution pattern of the vertical survey (by the use of the Retainer Traps). *l: lacertosa; m: D. moriwakii; o: D. okadai; n: D. neokadai; e: D. ezoana; 4: D.* sp. 4.

Table 2. Individual numbers of the streamside dwellers and two close relatives collected in the vertical microdistribution survey (VE-RT).

Locality	Sakurano (branch)				Sakurano (main)					Kakkomi				Ashoro Pass				
Trap Spot	A	B	C	Total	A	B	C	D	Total	A	B	C	Total	A	B	C	D	Total
D. ezoana	—	—	1	1	—	1	4	8	13	2	1	9	12	—	—	—	3	3
D. sp. 4	—	—	—	—	—	—	2	1	3	6	6	10	22	—	—	—	—	—
D. okadai	—	1	2	3	—	—	—	1	1	1	1	2	4	1	—	2	5	8
D. neokadai	—	3	17	20	—	1	—	—	1	12	16	22	50	—	—	—	11	11
D. lacertosa	113	327	382	822	61	976	113	380	1,530	178	124	297	599	—	—	1	11	12
D. moriwakii	39	28	49	116	3	23	10	10	46	486	186	103	775	17	64	93	52	226
D. sordidula	—	2	2	4	—	2	1	1	4	—	1	1	2	—	—	—	—	—
D. pseudosordidula	—	—	—	—	—	1	—	—	1	1	—	—	1	—	—	—	—	—

these localities. This fact shows that these four species have strong dependence to watersides in the vertical microdistribution. Such strong dependence of them to watersides seen in this survey coincides with that seen in the central part of Hokkaido.

However, small modification of the habitat preference was seen in the two streamside dwellers, *D. lacertosa* and *D. moriwakii*. *D. lacertosa* also showed the similar trend seen in the mentioned four species, but respectable specimens of this species were collected at upper traps at SK and KK. Particularly at the streamsides of the main stream in SK, this species was most abundant at the undergrowth layers (Spot B) in which *D. sordidula* and *D. pseudosordidula* were abundant in the central part of Hokkaido. As it is known that this species was abundant near stream surface in the central part of Hokkaido (BEPPU, 1979), this fact suggests that the abundant height of *D. lacertosa* rose up some extent in these areas. Small modification of the spatial microdistribution was also seen in *D. moriwakii* at the main stream in SK and in AP. In these areas *D. moriwakii* was abundant at the height of the undergrowth layers. As it is known that this species was abundant at the lower part of the tree canopy in the central part of Hokkaido (BEPPU, 1979), mentioned fact shows that the abundant height of *D. moriwakii* dropped some extent. Since these two species have rather wide habitat preference in the streamside dwellers (BEPPU, 1979), if the vacant space occurred in the vicinity of a stream, these two species would have possibility of habitat enlargement. Therefore, it is assumed that small modification of the habitat preference seen in these two species would be due to decrease or absence of *D. sordidula* and *D. pseudosordidula*.

In comparison with mentioned two species of the streamside dwellers, habitats of four species (*D. okadai*, *D. neokadai*, *D. ezoana* and *D.* sp. 4) seem to be stable in spite of decrease or absence of *D. sordidula* and *D. pseudosordidula*. This suggests that these four species are isolated from other drosophilid flies by acquisition of strong dependence to watersides. Therefore, decrease or absence of *D. sordidula* and *D. pseudosordidula* has no influence on their habitat preference.

Concluding Remarks

As shown above, modification of the habitat preference of the streamside dwellers was investigated at various localities in Hokkaido. At the present stage of the collecting method it is impossible to exclude one species from others selectively in a locality. Therefore, in order to ascertain whether habitat segregation of the streamside dwellers is due to interspecific competition or not, there is nothing for it but to observe responses of neighboring species to the vacant space in another localities where one or some close relatives are absent or rare.

According to the result of this investigation, general microdistribution patterns of each streamside dweller seem to be stable, but small modification is supposed in two streamside species (*D. moriwakii* and *D. lacertosa*) which show rather wide habitat preference, when two close relatives of them were absent or rare.

Next, the altitudinal distribution of the streamside dwellers is considered from the voltinism. Up to the present the altitudinal distribution of the streamside dwellers has been treated by KANEKO and TOKUMITSU (1968) alone. According to their inference, *D. lacertosa* was predominant at lower elevations, but *D. moriwakii* was predominant at higher elevations. Furthermore, *D. okadai* and *D. neokadai* predominated at higher elevations. Conspicuous decrease of *D. lacertosa* at AP seen in this investigation well coincides with the report mentioned above.

According to WATABE and BEPPU (1977), *D. moriwakii*, *D. okadai* and *D. neokadai* spent uni-voltine life cycle, but *D. ezoana* and *D. lacertosa* (BEPPU, unpubl.) spent multi-voltine life cycle in a year near Sapporo City, the central part of Hokkaido. Uni-voltine life cycle seems to be the adequate tactics to live in the higher elevations, so that decrease of *D. lacertosa* at AP may be due to multi-voltine life cycle of this species.

However, LUMME *et al.* (1974) revealed that voltinism of *D. littoralis* (close relative of *D. ezoana*) was different by latitude. Further, BRADSHAW (1976) also revealed that latitude is not only responsible for voltinism, and accurate latitude–altitude dependence has been found in some insects. Judging from conspicuous decrease of *D. lacertosa* at AP, variation of voltinism of *D. lacertosa* (from multi to uni) cannot be supposed, though the information on such problem is insufficient now. Yet, *D. ezoana* does not show such conspicuous decrease at higher elevations. It is revealed by TAKADA and TOYOFUKU (1960) that this species showed the resistance for the cold temperature in hibernation experiments. Considering from these facts, variation of voltinism and acquisition of any tactics for the cold temperature are assumed in *D. ezoana*.

Summary

In order to investigate responses of neighboring species to the vacant space, local variation of the habitat preference of the streamside drosophilid flies was investigated at various localities in Hokkaido (Kami-otoineppu, Sakurano and Ashoro) where two close relatives (*D. sordidula* and *D. pseudosordidula*) of the streamside drosophilid species were absent or rare. Habitat preferences of each streamside dweller were investigated from three aspects; the horizontal microdistribution, the vertical microdistribution near stream surface, and the vertical microdistribution from the stream surface to the tree canopy.

According to these surveys the general microdistribution pattern of each streamside dweller is stable, but most abundant height of *D. moriwakii* dropped some extent (from the lower part of the tree canopy to the undergrowth layers in which *D. sordidula* and *D. pseudosordidula* were abundant in the central part of Hokkaido). Further, such height of *D. lacertosa* rose up some extent (from the stream surface to the undergrowth layers). Since *D. moriwakii* and *D. lacertosa* have rather wide habitat preference in the streamside dwellers, if vacant space occurred, they would have the possibility of habitat enlargement. Therefore, small modification of the habitat preference of the mentioned two streamside dwellers seems to be due to conspicuous decrease of *D. sordidula* and *D. pseudosordidula* in these studied areas.

On the other hand, other streamside dwellers (*D. okadai*, *D. neokadai*, *D. ezoana* and *D.* sp. 4) had stable habitat preference in these localities. As these four species have strong dependence

to watersides, it seems probable that decrease or absence of mentioned two close relatives has no influence on the spatial microdistribution of these four species.

References

BEPPU, K., 1979. Habitat segregation of the drosophilid flies in the vicinity of streams. *Kontyû, Tokyo*, **47**: 443–455.

BRADSHAW, W. E., 1976. Geography of photoperiodic response in diapausing mosquito. *Nature*, **262**: 384–386.

KANEKO, A., and T. TOKUMITSU, 1969. *Drosophila* Survey of Hokkaido, XXVIII. On drosophilid flies from seven localities of the Hidaka district in southern Hokkaido. *J. Fac. Sci. Hokkaido Univ.*, (VI), **17**: 244–256.

LUMME, J., A. OIKARINEN, S. LAKOVAARA and R. ALATALO, 1974. The environmental regulation of adult diapause in *Drosophila littoralis*. *J. Ins. Physiol.*, **20**: 2023–2033.

MINAMI, N., Masanori, J. TODA and K. BEPPU, 1979. Ecological structure of drosophilid assemblage in Tomakomai Experiment Forest, Hokkaido University. Appendix: Some discussions on the calculation of niche parameters. *Res. Bull. Coll. Exptl. For., Coll. Agr., Hokkaido Univ.*, **36**: 479–508. (In Japanese with English summary.)

TAKADA, H., and Y. TOYOFUKU, 1960. Notes on hibernation of Drosophilidae in Hokkaido. *Zool. Mag., Tokyo*, **69**: 7–16. (In Japanese with English summary.)

TODA, M. J., and M. T. KIMURA, 1978. Bionomics of Drosophilidae (Diptera) in Hokkaido I. *Scaptomyza pallida* and *Drosophila nipponica*. *Kontyû, Tokyo*, **46**: 83–98.

WAKAHAMA, K., 1963. Some ecological studies in *Drosophila*. *Bull. Shimane Univ.*, **13**: 50–122.

WATABE, H., and K. BEPPU, 1977. *Drosophila* Survey of Hokkaido, XXXIII. Ovarian development of *Drosophila* in relation to wild population *J. Fac. Sci. Hokkaido Univ.*, (VI), **20**: 611–620.

「昆虫分類学報」の刊行

中国では昆虫分類の原稿が編集局の箪底深くしまいこまれ，陽の目をみない状態が長く続いていたが，「四人帮」が排除された現在でも出版は容易でないという．今回政府の補助をうけ上記の雑誌が企画され，1巻1号が昨年 10 月に，また2号が同12月に発行された．日本の分類学徒にとって中国の重要性は今さらいうまでもない．中国の生物について材料や情報が今なお乏しい現状が私たちの共通した不幸であるといってよいだろう．中国自身この分野にはなお大きな困難があるに違いない．私たちは辛抱強くともに進むことを考えたい．新雑誌は交換に応ずるので，希望者は下記に連絡されたい．また日本での代理店が決まれば購入もできる．

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(高木貞夫)