Chironomid Fauna in the Emergent Plant Zone of Lake Kasumigaura, Japan

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Abstract

The chironomid fauna was studied in the emergent plant zone of Lake Kasumigaura in May, August and November of 1986. A total of 2,181 adults were reared and emerged from plant samples and sediments in the emergent plant zone. We identified 1957 specimens belonging to 31 species of 18 genera. Ten species were abundant, of which five were recovered from plant samples, two from sediments and others from both. Species composition did not differ much from May to August, which might have corresponded with the change of *in situ* larval density. The abundance of the chironomids was highest in May and low in August for plant samples, while it was highest in August for sediments. On plant samples, it correlated with the chlorophyll a amount on the reed stems, which was higher in May than in August. In November, only two species predominated. Species composition differed more markedly among substratum types than among localities in the lake. Some chironomid species seemed to select specific sediments. Chironomid fauna in littoral hydrophyte zones was more diverse than in pelagic zones in Lake Kasumigaura.

Key words : Chironomidae, Lake Kasumigaura, littoral zone, emergent plants

1. Introduction

Chironomid larvae live in almost all types of water bodies. They often dominate in eutrophic lakes or polluted rivers. Sometimes they prosper in the shallow littoral hydrophyte zones (BOERGER *et al.*, 1982). In Japan, chironomid fauna has been studied in some eutrophic lakes or ponds (e.g. SASA, 1985a, b; SASA and KAWAI, 1987). However, the chironomid fauna in littoral zones of lakes or ponds, especially hydrophyte zones, has not been studied sufficiently (KONDO and HAMASHIMA, 1985; KONDO, 1988), though the important role of the littoral zone of lakes has been pointed out by some authors (e.g. WETZEL and CORNERS, 1979). As for Lake Kasumigaura, ecological studies on chironomids in the pelagic zone were made by IWAKUMA *et al.* (1984) and IWAKUMA (1987). Several authors reported on the benthic fauna in the sublittoral zone (e.g. MIYADI, 1932; TSUDA

and MORISHITA, 1973), and some chironomid species collected around the lake were described by SASA (1979). Most of these studies focused on pelagic zones. Recently, primary production of algae was studied minutely in the hydrophyte zone of Lake Kasumigaura (TAKAMURA *et al.*, 1990), though benthic fauna have yet to be studied in the hydrophyte zone.

Studies on the habitat preference of the chironomids between emergent plant and sediment have been very few (LEARNER *et al.*, 1989; MASON and BRYANT, 1975), whereas interactions between hydrophytes and chironomid larvae have been drawing attention for a long time, i.e. direct feeding on plants (McGAHA, 1952; NODA *et al.*, 1986), feeding on the epiphyton (MENZIE, 1981) or utilization of the decomposed plants (SMOCK and STONEBURNER, 1980). Most of these studies have been conducted on floating and submersed plants in lotic systems.

In the present paper, we studied the epiphytic

Fig. 1. Map of sampling stations with major sediment type.

S: sand, M: mud, C: cobble, P: plant debris.

and benthic chironomid fauna in emergent plant zones in Lake Kasumigaura and the habitat specificity of some chironomid species.

2. Study sites

Lake Kasumigaura is a hypertrophic lake with a surface area of 171 km², a perimeter of 136 km and mean depth of about 4 m. Since the lake is shallow and has a complicated shoreline, hydrophytes grow thick in the littoral zone. Total vegetation areas of emergent, floating and submerged plants were estimated as 3.0 km², 0.8 km² and 3.6 km², respectively (SAKURAI, 1981). We selected 23 sampling stations in emergent plant zones at intervals of 4 km to 5 km along the shoreline (Fig. 1). Lake Kasumigaura consists of three large bays, i.e. Tsuchiurairi Bay (Stas. 1-3, 21-23), Takahamairi Bay (Stas. 13-19), Edosakiiri Bay (Sta. 5), and a main basin (other stations). Total phosphorus concentration was generally higher in Takahamairi Bay and Tsuchiurairi Bay than in the Main Basin and Edosakiiri Bay in 1986 (AIZAKI *et al.*, 1988a; AIZAKI *et al.*, 1988b). Surface sediment type was sand or mud at most stations, but cobble predominated in Sta. 23, and plant debris in Stas. 5, 16 and 21. Table 1 shows some botanical parameters at each station. Dominant hydrophyte species was a reed, *Phragmites australis* (CAV.) TRIN. ex STEUD.,

except at Sta. 6 and Sta. 9. A cattail, *Typha angustifolia* L. dominated at Sta. 6, and no hydrophytes were found at Sta. 9. Though hydrophytes were dead by November, dead stems of *P. australis* remained as substrata for epiphyton; woolly masses of epiphytic organisms adhered to their surface throughout the winter.

3. Materials and methods

In 1986, emergent plants and sediments were collected on 21 May (Stas. 1-21), 6 June (Stas. 22, 23), 27 August (Stas. 1-16), 29 August (Stas. 17-23), 12 November (Stas. 1-13) and 13 November (Stas. 14-23) 1986. Emergent plants were cut off at the bottom of their stems from a 33 × 33 cm quadrat. Submerged parts of emergent plants were then cut off and stored in polyethylene bags. Mean density and mean surface area of emergent plants at 22 stations (except Sta. 9) were estimated in May and August. Mean density of emergent plants was 134 m⁻² and 144 m⁻² in May and August, respectively. Mean surface area of emergent plants, multiplying mean perimeter of stems by water depth and mean density, was 0.93 m² · m⁻² and 1.03 m² · m⁻² in May and August, respectively. Sediments were collected from about 0.1 m² area of bottom surface within emergent plant stands with a D-frame net (25 × 20 cm, 0.3 mm opening). Duplicate emergent plant samples and a sediment sample were taken at each station and transported to the laboratory. One of the plant samples and the sediment sample from each station were transferred to transparent plastic containers (30 cm in diameter and 12 cm in height). The containers were filled with tap water to a depth of about 7 cm, and air was supplied with a diaphragm pump. Each container was covered with fine nylon net fixed with a rubber band and was kept in doors under 12 hr light and 12 hr dark photoperiod at 20°C (May and August) or 15°C (November). Chironomid midges, which emerged from samples in the containers were collected with an aspirator every two or three days for about two months after rearing started. Collected midges were anesthetized with diethyl ether and were preser-

Table 1. Some sedimentary and botanical parameters at each station.

Station	Loss on ignition ^a of surface sediment (%) (<i>n</i> =3)	May				August				November ^b	
		Depth (cm)	Density of plants (m ⁻²) (<i>n</i> =4)	Surface area of plants (m ² •m ⁻²) (<i>n</i> =1)	Epiphyton chlorophyll <i>a</i> (μg•cm ⁻² plant surface) (<i>n</i> =1)	Depth (cm)	Density of plants (m ⁻²) (<i>n</i> =3)	Surface Area of plants (m ² •m ⁻²) (<i>n</i> =1)	Epiphyton chlorophyll <i>a</i> (μg•cm ⁻² plant surface) (<i>n</i> =1)	Depth (cm)	Epiphyton chlorophyll <i>a</i> (μg•cm ⁻² plant surface) (<i>n</i> =5)
1	2.0±0.6 ^c	31	77±13 ^c	0.63	2.0	26	131±98 ^c	0.98	0.7	36	16.0± 7.9 ^c
2	2.1±0.3	39	139±27	1.46	2.3	39	189±53	2.04	0.4	57	7.3± 5.4
3	0.7±0.0	38	83±17	0.79	3.2	50	71±30	0.63	5.8	25	14.4± 4.7
4	1.6±0.3	18	118± 5	0.53	9.5	25	173±42	0.66	1.5	50	14.6± 7.4
5	1.8±1.0	38	117±34	1.03	0.6	23	44±26	0.48	0.7	40	0.9± 0.6
6	0.9±0.2	17	130±27	0.42	1.0	18	144±03	0.50	2.2	18	8.2± 4.2
7	0.8±0.1	30	169±78	1.01	2.4	26	118±09	0.62	0.9	55	14.2±16.8
8	2.7±0.7	40	60± 8	0.62	1.8	38	96±63	0.95	0.8	30	11.4± 9.0
9	0.6±0.1	—	0	0	—	—	0	0	—	85	—
10	1.4±0.3	45	74± 8	0.82	6.4	38	117±15	2.07	0.5	52	13.9± 6.3
11	1.0±0.3	22	150±33	0.71	2.7	45	227±73	1.21	0.6	25	11.8± 3.4
12	1.1±0.3	24	89± 1	0.56	6.4	32	153±19	1.00	0.2	45	8.6± 1.7
13	1.3±0.8	20	156±50	0.72	4.1	34	165±47	0.77	3.3	38	21.5± 3.6
14	0.6±0.1	23	139±24	0.84	6.2	36	167±26	0.84	3.4	28	1.6± 0.8
15	1.8±1.1	38	164±34	1.46	1.3	49	183±49	1.53	0.5	47	1.7± 0.4
16	59.9±6.5	5	61±10	0.08	4.3	5	82±23	0.10	1.3	6	1.2± 0.6
17	0.6±0.1	39	111±23	0.92	6.2	55	152±15	1.11	1.1	49	6.3± 8.5
18	1.0±0.2	42	136±24	1.48	6.8	36	139±26	1.48	1.3	45	2.8± 0.4
19	0.8±0.4	43	100± 7	1.23	5.1	42	150±29	1.74	0.2	47	11.3±11.5
20	0.9±0.3	25	130± 8	0.73	8.2	41	137±30	0.75	4.8	46	5.5± 3.1
21	1.5±0.4	20	207±14	1.08	11.2	38	251±51	1.28	3.0	47	14.7±12.1
22	2.0±0.4	25	243±47	1.55	5.2	29	134±25	0.88	0.8	35	6.6± 4.1
23	1.3±0.4	27	287±37	1.73	4.7	28	153±33	1.08	0.9	37	11.4± 7.8

^a Loss on ignition determined in November.^b In November, density and surface area of reeds was not determined.^c Mean value±standard deviation(σ_{n-1}).

— No Data

ved in 70% ethanol together with pupal exuviae. Some specimens were dissected under binoculars and mounted on slide glasses for identification (SASA, 1978; SASA and HASEGAWA, 1983). They were identified according to the key by PINDER (1978), SASA (1989) and CRANSTON and OLIVER (1988) and counted. Each sample was calculated for the following Simpson's index of concentration (C) (SIMPSON, 1949):

$$C = \sum_i (n_i)^2 / N^2$$

where n_i is the number of individuals of the species i and N is the total number of individuals emerged.

Chlorophyll a amount of epiphyton in each plant sample was determined as follows: Dead stems of hydrophytes and epiphytic matter removed from live stems in some of the other plant samples were put together into a screw-capped bottle in May and August, or put individually into screw-capped glass tubes in November. They were extracted with 100% methanol and stored in the dark for a week. The solution was poured into a 10ml glass tube, centrifuged at 3,000 r.p.m., and the optical density of the supernatant was measured at 750, 664 nm in wavelength with a spectrophotometer (Beckman DU-30). Chlorophyll a amount was calculated based on MARKER *et al.* (1980), and plant surface areas per unit of lake bottom area were estimated.

Three core samples were taken to determine loss on ignition of sediment at each station in November. Surface sediment to a depth of 5cm was extruded from each core. Then the three sediments from each station were homogenized and mixed. A small amount of the mixture up to 150mg was transferred into a ceramic pot, oven-dried at 120°C for 1hr and combusted at 500°C in an electric oven for 8hr. Loss on ignition was calculated from the difference between weights at 120°C and at 500°C.

4. Results

Loss on ignition varied from 0.6% to 2.7%, except at Sta. 16 where organic matter accounted for 59.9%. Mean epiphyton chlorophyll a of

22 stations was $4.6 \mu\text{g} \cdot \text{cm}^{-2}$ plant surface in May, decreasing to $1.6 \mu\text{g} \cdot \text{cm}^{-2}$ plant surface in August and reaching a maximum $9.4 \mu\text{g} \cdot \text{cm}^{-2}$ plant surface in November (Table 1).

During this study, 2,181 chironomid midges were obtained, and 1957 specimens belonging to 31 species were identified (Table 2). A total of 1,529 specimens of 24 species and 428 specimens of 22 species emerged from hydrophytes and sediments, respectively. Of these species, one was a member of Tanypodinae, one of Diamesinae, nine were of Orthocladiinae and 20 of Chironominae. Still unidentified were 224 specimens, 207 of which were females of the tribe Tanytarsini. Many of them was identical to *Paratanytarsus grimmii* (SCHNEIDER, 1885) (= *P. parthenogeneticus* (FREEMAN, 1961)) in SASA (1979), which is known to breed usually by parthenogenesis. Table 3 shows number of species (S), number of identified individuals (N) and concentration indices (C). Both S and N were high in May and low in November. The C values were frequent at 0.3-0.4 in May or August and at 1.0 in November for plant samples. Though the C values showed no noticeable differences among three occasions on sediment samples, median value was low in May (0.5) and high in August (0.9) and November (1.0). So the chironomid fauna was more diverse in May or August than in November regardless of substratum.

A combination of ten leading species accounted for 84.5% of the chironomid midges emerged: *Cricotopus sylvestris*, *Hydrobaenus pilipes*, *Limnophyes tamakitanoides*, *Chironomus yoshimatsui*, *Dicrotendipes nervosus*, *Dicrotendipes pelochloris*, *Glyptotendipes tokunagai*, *Polypedilum cultellatum*, *Polypedilum nubifer* and *Tanytarsus oyamai*.

Five species, *C. sylvestris*, *L. tamakitanoides*, *D. nervosus*, *D. pelochloris* and *P. cultellatum*, emerged in larger numbers from hydrophytes than from sediments. Two species, *P. nubifer* and *T. oyamai*, emerged in larger numbers from sediments than hydrophytes. Three other species, *C. yoshimatsui*, *H. pilipes* and *G. tokunagai*, emerged well from both types of substratum. *C. sylvestris*, *D. pelochloris*, *G. to-*

kunagai and *P. cultellatum* emerged mainly from May samples. *C. yoshimatsui*, *P. nubifer* and *T. oyamai* emerged mainly from August samples. *H. pilipes* emerged only from November samples. All specimens of *L. tamakitanaides* but one emerged from November samples. *D. nervosus* emerged from both May

and August samples.

Cryptochironomus sp. emerged only from sediments in every season, though it was not a major species.

Four species of *Cricotopus* were recovered in this study. *Cricotopus sylvestris* emerged mainly from hydrophytes in May and exclusively from

Table 2. Numbers of individuals emerging for each species by substratum and season

Species	Substrata		Season		
	Plants	Sediments	May	August	November
Tanypodinae					
<i>Ablabesmyia monilis</i> (LINNAEUS)		2		2	
Diamesinae					
<i>Potthastia gaedii</i> (MEIGEN)	1				1
Orthoclaadiinae					
<i>Cricotopus bicinctus</i> (MEIGEN)	18	4	2	1	19
<i>Cricotopus bimaculatus</i> TOKUNAGA	4				4
<i>Cricotopus sylvestris</i> (FABRICIUS)	542	16	459	95	4
<i>Cricotopus tricinctus</i> (MEIGEN)	1	1	2		
<i>Hydrobaenus pilipes</i> (MALLOCH)	199	46			245
<i>Limnophyes immucronatus</i> SÆTHER	1				1
<i>Limnophyes tamakitanaides</i> SASA	44			1	43
<i>Orthocladius glabripennis</i> (GOETGHEBUER)	1				1
<i>Paratrichocladius rufiventris</i> (MEIGEN)	3		1		2
Chironominae: Chironomini					
<i>Chironomus circumdatus</i> (KIEFFER)		1		1	
<i>Chironomus kiiensis</i> TOKUNAGA	3	8	2	9	
<i>Chironomus samoensis</i> EDWARDS		2		2	
<i>Chironomus yoshimatsui</i> MARTIN ET SUBLETTE	31	49	6	74	
<i>Cladopelma viridula</i> (LINNAEUS)	1	1	2		
<i>Cryptochironomus</i> sp. nr. <i>fulvus</i> (JOHANNSEN)		21	6	10	5
<i>Dicrotendipes nervosus</i> (STAEGER)	54	5	24	35	
<i>Dicrotendipes pelochloris</i> (KIEFFER)	344	24	307	61	
<i>Glyptotendipes fujisecondus</i> (SASA)	1		1		
<i>Glyptotendipes tokunagai</i> SASA	80	20	80	20	
<i>Pentapedilum shirokanense</i> SASA	5	4	1	8	
<i>Polypedilum cultellatum</i> GOETGHEBUER	159	2	114	44	3
<i>Polypedilum japonicum</i> (TOKUNAGA)		2	2		
<i>Polypedilum nubeculosum</i> (MEIGEN)		3		3	
<i>Polypedilum nubifer</i> (SKUSE)	29	130		157	2
<i>Stenochironomus membranifer</i> YAMAMOTO	1			1	
Chironominae: Tanytarsini					
<i>Cladotanytarsus vanderwulpi</i> (EDWARDS)	1	10	7	4	
<i>Rheotanytarsus aestuarius</i> (TOKUNAGA)	2		1	1	
<i>Tanytarsus oyamai</i> SASA		69	1	68	
<i>Tanytarsus unagiseptimus</i> SASA	4	8	6	6	
Unidentified	156	68	162	54	8
Total	1,685	496	1,186	657	338
Number of species	24	22	19	21	12

Table 3. Number of species (*S*), number of identified individuals (*N*) and Simpson's concentration index (*C*) for chironomid midges emerging from plant and sediment.

Station	Emergent plants									Sediments								
	May			August			November			May			August			November		
	<i>S</i>	<i>N</i>	<i>C</i>	<i>S</i>	<i>N</i>	<i>C</i>	<i>S</i>	<i>N</i>	<i>C</i>	<i>S</i>	<i>N</i>	<i>C</i>	<i>S</i>	<i>N</i>	<i>C</i>	<i>S</i>	<i>N</i>	<i>C</i>
Tsuchiurairi Bay																		
1	0	0		3	17	0.7	3	10	0.4	0	0		0	0		0	0	
2	3	13	0.4	1	1	1.0	1	3	1.0	3	5	0.4	1	1	1.0	0	0	
3	4	15	0.4	4	11	0.3	2	11	0.5	2	5	0.7	0	0		0	0	
21	3	5	0.4	3	4	0.4	1	5	1.0	1	2	1.0	0	0		0	0	
22	10	196	0.4	3	15	0.4	2	11	0.7	6	9	0.2	1	31	1.0	0	0	
23	3	176	0.8	3	4	0.4	1	5	1.0	7	28	0.4	0	0		0	0	
Mean	3.8	67.5	0.5	2.8	8.7	0.5	1.6	7.5	0.8	3.2	8.2	0.5	0.3	5.3	1.0	0.0	0.0	
Median	3	14	0.4	3	8	0.4	2	8	0.9	3	5	0.4	0	0	1.0	0	0	
Takahamairi Bay																		
13	3	36	0.6	4	49	0.9	0	0		0	0		0	0		1	1	1.0
14	4	10	0.4	6	42	0.4	7	39	0.5	1	1	1.0	4	80	0.9	2	2	0.5
15	3	4	0.4	0	0		3	43	0.6	2	2	0.5	2	17	0.9	1	4	1.0
16	1	2	1.0	1	1	1.0	1	1	1.0	3	3	0.3	1	4	1.0	2	5	0.5
17	2	7	0.6	5	14	0.3	3	12	0.4	2	2	0.5	3	51	0.9	0	0	
18	0	0		1	1	1.0	2	27	0.6	0	0		4	17	0.5	1	5	1.0
19	5	51	0.4	4	11	0.3	2	13	0.6	0	0		0	0		1	18	1.0
Mean	2.6	15.7	0.6	3.0	16.9	0.7	2.6	19.3	0.6	1.1	1.1	0.6	2.0	24.1	0.8	1.1	5.0	0.8
Median	3	7	0.5	4	11	0.7	2	13	0.9	1	1	0.4	2	17	0.9	1	4	1.0
Edosakiiri Bay																		
5	3	236	0.5	6	46	0.4	1	1	1.0	1	1	1.0	6	58	0.6	1	1	1.0
Main Basin																		
4	3	10	0.4	4	6	0.3	0	0		1	3	1.0	1	5	1.0	0	0	
6	3	19	0.5	0	0		2	10	0.7	0	0		0	0		2	9	0.6
7	3	63	0.7	3	5	0.4	1	1	1.0	2	2	0.5	0	0		1	1	1.0
8	3	33	0.7	2	10	0.5	2	12	0.9	3	10	0.5	0	0		0	0	
9	—	—	—	—	—	—	—	—	—	0	0		5	9	0.2	1	1	1.0
10	3	14	0.4	5	33	0.4	0	0		1	1	1.0	2	2	0.5	1	4	1.0
11	4	37	0.6	4	18	0.4	1	6	1.0	1	2	1.0	3	11	0.6	0	0	
12	3	7	0.4	4	15	0.3	6	48	0.6	3	5	0.4	2	4	0.6	1	3	1.0
20	4	8	0.3	4	10	0.3	3	16	0.6	1	1	1.0	0	0		1	2	1.0
Mean	3.3	23.9	0.5	3.3	12.1	0.4	1.9	11.6	0.8	1.3	2.7	0.8	1.4	3.4	0.6	0.8	2.2	0.9
Median	3	17	0.5	4	10	0.4	2	8	0.8	1	2	1.0	1	2	0.6	1	1	1.0
Mean	3.2	42.8	0.5	3.2	14.2	0.5	2.0	12.5	0.7	1.7	3.6	0.7	1.5	12.6	0.8	0.7	2.4	0.9
Median	3.0	13.5	0.4	3.5	10.5	0.4	2	10	0.7	1	2	0.5	1	2	0.9	1	1	1.0

— No Data

hydrophytes in August and November. *Cricotopus bicinctus* also emerged mainly from hydrophytes. *Cricotopus bimaculatus* emerged exclusively from hydrophytes. Only one *Cricotopus tricinctus* emerged from each substratum.

Chironomid species associated with hydrophytes at Sta. 6, where cattails predominated in the hydrophyte community, did not differ from other stations with reed vegetation. *D. pelochloris* and *G. tokunagai* were abundant in May, while *H. pilipes* and *L. tamakitanoides* abounded

Table 4. Numbers of individuals (converted in m⁻²) emerged from four types of sediments.

Species	May				August				November			
	Sand (n=17)	Mud (n=2)	Plant debris (n=3)	Cobble (n=1)	Sand (n=17)	Mud (n=2)	Plant debris (n=3)	Cobble (n=1)	Sand (n=17)	Mud (n=2)	Plant debris (n=3)	Cobble (n=1)
Tanypodinae												
<i>Ablabesmyia monilis</i>							4					
Orthocladiinae												
<i>Cricotopus bicinctus</i>		4							2			
<i>Cricotopus sylvestris</i>	1			150								
<i>Cricotopus tricinctus</i>				10								
<i>Hydrobaenus pilipes</i>									13	4	53	
Chironominae : Chironomini												
<i>Chironomus circumdatus</i>							2					
<i>Chironomus kiiensis</i>		4		10			13					
<i>Chironomus samoensis</i>							4					
<i>Chironomus yoshimatsui</i>			4	10			102					
<i>Cladopelma viridula</i>	1											
<i>Cryptochironomus</i> sp.	4				6		2		2	8		
<i>Dicrotendipes nervosus</i>	2				1							
<i>Dicrotendipes pelochloris</i>	5	34	4	10	3							
<i>Glyptotendipes tokunagai</i>	5		3	80	1		1					
<i>Pentapedilum shirokanense</i>							9					
<i>Polypedilum cultellatum</i>			2	10								
<i>Polypedilum japonicum</i>	1	6										
<i>Polypedilum nubeculosum</i>					2							
<i>Polypedilum nubifer</i>					85	2	1				4	
Chironominae : Tanytarsini												
<i>Cladotanytarsus vanderwulpi</i>	4				3							
<i>Tanytarsus oyamai</i>	1				40	32						
<i>Tanytarsus unagiseptimus</i>		8			4							

in November at Sta. 6.

Sediment types at sampling stations could be classified into four categories: sand, mud, plant debris and cobble (Fig. 1). Table 4 shows the list of chironomid species recovered from

sediment in terms of the substratum type.

Sediment was sandy at most (17) stations. *Polypedilum nubifer* emerged mainly from these sandy sediments. Although the remaining sediment types were low in number of replicates,

Table 5. A comparison of chironomid midges collected from Lake Kasumigaura in relation to substrates and methods of sampling

Species	Pelagic	zone ^a	Littoral	zone ^b	Shoreside ^c
	Emergence trap sample	Light trap sample	Sediment sample (rearing)	Plant sample (rearing)	Net sweeping sample
<i>Clinotanytus sugiyamai</i> TOKUNAGA	○	○			
<i>Procladius culiciformis</i> (LINNAEUS)	○	○			
<i>Tokunagayusurika akamusi</i> (TOKUNAGA)	○	○			○
<i>Chironomus plumosus</i> (LINNAEUS)	○	○			○
<i>Harnischia</i> complex sp.	○				
<i>Glyptotendipes fujisecondus</i>	○			○	
<i>Chironomus yoshimatsui</i>	○	○	○	○	
<i>Dicrotendipes pelochloris</i>	○	○	○	○	
<i>Cricotopus sylvestris</i>	○	○	○	○	
<i>Polypedilum nubeculosum</i>	○		○		
<i>Tanytarsini</i> spp.		○			
<i>Cricotopus</i> spp.		○			
<i>Chironomus nipodorsalis</i> SASA		○			
<i>Chironomus circumdatus</i>		○	○		○
<i>Tanytarsus oyamai</i>		○	○		○
<i>Chironomus kiiensis</i>		○	○	○	
<i>Glyptotendipes tokunagai</i>		○	○	○	
<i>Pentapedilum shirokanense</i>		○	○	○	
<i>Polypedilum nubifer</i>		○	○	○	
<i>Cricotopus tricinctus</i>		○	○	○	
<i>Cryptochironomus</i> sp.			○		
<i>Ablabesmyia monilis</i>			○		
<i>Chironomus samoensis</i>			○		
<i>Polypedilum japonicum</i>			○		
<i>Cricotopus bicinctus</i>			○	○	
<i>Hydrobaenus pilipes</i>			○	○	
<i>Cladopelma viridula</i>			○	○	
<i>Dicrotendipes nervosus</i>			○	○	
<i>Polypedilum cultellatum</i>			○	○	
<i>Cladotanytarsus vanderwulpi</i>			○	○	
<i>Tanytarsus unagiseptimus</i>			○	○	
<i>Potthastia gaedii</i>				○	
<i>Cricotopus bimaculatus</i>				○	
<i>Limnophyes immucronatus</i>				○	
<i>Limnophyes tamakitanoides</i>				○	
<i>Orthocladius glabripennis</i>				○	
<i>Paratrichocladius rufiventris</i>				○	
<i>Stenochironomus membranifer</i>				○	
<i>Rheotanytarsus aestuarius</i>				○	

References

^aIWAKUMA (1992); ^bPresent study; ^cSASA (1979)

i.e. one to three stations, several species seemed to be specific with specified substrates: *Dicrotendipes pelochloris* was associated with mud, *Chironomus yoshimatsui* with plant debris. *Cricotopus sylvestris* and *Glyptotendipes tokunagai* were primarily associated with cobbles, though they were rather more abundant on plant surfaces than in sediments. *Tanytarsus oyamai* emerged exclusively from sandy or muddy sediments rather than from attached material on hydrophytes.

5. Discussion

Species composition differed between hydrophyte and sediment at each station. Three species of *Cricotopus*, *L. tamakitanoides*, two species of *Dicrotendipes* and *P. cultellatum* were clearly abundant in hydrophyte samples, while *Chironomus*, *Cryptochironomus*, *P. nubifer*, and *T. oyamai* clearly abounded in sediments.

C. sylvestris uses emergent plants as the substrata for algal grazing (MENZIE, 1981), or in some cases as food (FROST, 1924 cited in BERG, 1950; DARBY, 1962). A congener, *Cricotopus trifasciatus*, feeds on rice in Japan (NODA *et al.*, 1986), and there may be similar reasons why *C. sylvestris* was attracted to emergent plants in Lake Kasumigaura.

IWAKUMA (1992) caught chironomid midges with emergence and light traps from May 1982 to December 1983 in Takahamairi Bay, the most eutrophic locale in Lake Kasumigaura. He recorded 17 chironomid species, 10 of which were also recorded in the present study. The chironomid fauna of Lake Kasumigaura is summarized in Table 5. The number of species in the pelagic zone of Takahamairi Bay was smaller than that of the littoral hydrophyte zones. This difference between two zones is due to the variations in some environmental conditions. The most important difference between littoral and pelagic zones is the existence of hydrophyte stands in the littoral zone. Some authors reported the ecological significance of hydrophytes for chironomids, i.e. species composition of chironomids in vegetation differs from that in plain sediment; removal of aquatic weeds caused low diversity

and high midge production (JOHNSON and MULLA, 1983); and the number of chironomid species correlated with the number of hydrophyte species among 14 ponds (DRIVER, 1977). BERG (1950) wrote that some species of *Cricotopus*, including *C. sylvestris* and *Polypedilum*, mine and feed on the tissues of hydrophytes, and some species of *Glyptotendipes*, *Polypedilum*, *Microtendipes* and *Tanytarsus* live in burrows beneath the epidermis of stems or leaves. We also observed *G. tokunagai* larvae beneath the epidermis of *Typha* stems or gathered on the cut ends of *Phragmites* in the laboratory. Emergent plants, therefore, might have supplied food for chironomid larvae in Lake Kasumigaura, though further studies are necessary to confirm the possibility of phytophagy on emergent plants by chironomid larvae in this lake.

As above, a higher diversity in chironomid fauna was observed in the hydrophyte zones than in the pelagic zones, although the pelagic chironomid fauna was not a subset of littoral chironomid fauna: the highly dominant species in the pelagic zone, *Tokunagayusurika akamusi* and *Chironomus plumosus* (IWAKUMA, 1987, 1992), were not recovered from the littoral zone at all.

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摘 要

霞ヶ浦抽水植物帯のユスリカ相

霞ヶ浦水草帯のユスリカ相を明らかにするため、1986年5月、8月、11月に各1回ヨシ植生内より採取した水草及び底質から実験室内で羽化したユスリカ成虫の種構成を調べた。5月と8月の種構成はほぼ同じで優占種は10種であった。主に水草から羽化する種は5月に最も多く得られた。これは水草表面の付着物中のクロロフィルa現存量が5月に最も高く、8月に減少したことと一致した。また、主に底質から羽化する種は8月に

多かった。11月の優占種は2種で5月および8月とは異なっていた。水草と水草周辺の底質とでは種構成が異なっており、水草及び付着物から、種数、個体数ともにより多くのユスリカ成虫が羽化した。底質の種類とそこに生息するユスリカの種類には関連がある可能性が示唆された。水草帯の種構成はすでに報告されている沖帯の種構成とは異なっており、種数は水草帯の方が多かった。

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