〔Med. Entomol. Zool. Vol. 54 No. 4 p. 389–394 2003〕

Research Note

Newly identified chironomids at Fuji Five Lakes in the fall season

Kimio HIRABAYASHI[1], Masaru YAMAMOTO[2], Norihiko YOSHIDA[3] and Manabu SASA[4]

[1] *Department of Applied Biology, Shinshu University, 3–15–1, Tokida, Ueda, Nagano, 386–8567 Japan*
[2] *Kankyou-kagaku Kabushiki-gaisha, 2–21–7, Nakasakurazaka, Osaka, 560–0881 Japan*
[3] *Yamanashi Women's Junior Collage, 5–11–1, Iida, Kofu, Yamanashi, 400–0035 Japan*
[4] *Institute for Environment and Social Welfare Research, 135–3, Aza Sunaba, Aramata, Kurobe, Toyama, 938–0001 Japan*

(Received: 6 June 2003; Accepted: 6 August 2003)

Abstract: This is the first report on chironomid communities captured by light traps at the Fuji Five Lakes in the fall season. A comparison of the chironomid communities was made among these lakes in relation to the eutrophic level. We identified a total of 33 species belonging to three subfamilies, i.e., 16 species of Orthocladiinae, 16 species of Chironominae and 1 species of Tanypodinae. We recorded a total of 24 newly recorded species around these lakes. In Lake Yamanaka, *Tanytarsus takahashii*, *Stictochironomus sticticus* and *Tanytarsus yunosecundus* were the dominant species, whereas *Propsilocerus akamusi* was dominant in Lake Kawaguchi and *Smittia insignis* in Lake Motosu. Only *Smittia aterrima* was a common species in the Fuji Five Lakes. Shannon–Wiener diversity index (H′) was highest at 2.63 in Lake Shoji and lowest at 0.99 in Lake Kawaguchi. Our results suggest remarkable differences in chironomid communities between rather oligotrophic lakes such as Lakes Motosu and Sai, and the more eutrophicated ones such as Lakes Shoji and Kawaguchi. Although Lake Yamanaka was classified as a mesotrophic lake in previous studies, this lake seems to be undergoing progressive eutrophication.

Key words: chironomid community, fall season, Fuji Five Lakes, index of diversity, light trap, littoral region

INTRODUCTION

The Fuji Five Lakes, Lake Kawaguchi, Lake Motosu, Lake Sai, Lake Shoji and Lake Yamanaka, are especially famous for their beautiful scenery among the Japanese people. More than 22,000,000 tourists visit these lakes and Mt. Fuji annually (Yamanashi Prefecture, 2002). The water supply of the Fuji Five Lakes comes mostly from the permeable volcanic substratum of Mt. Fuji. There are no streamlets on the side of Mt. Fuji like on the slopes of the Misaka mountains, with their small influent streams most of which are dry except on rainy days.

These lakes provide a good field for a comparative study of the composition of the biota in relation to the water quality criteria for the trophic status of these lakes, because they have similar geological and climatic conditions. Yamanashi Prefectural government (1993) has classified these lakes as follows: Lakes Motosu and Sai, oligotrophic; Lake Yamanaka, mesotrophic; and Lakes Kawaguchi and Shoji, eutrophic. The classification is

Table 1. Mean transparency, COD, total nitrogen, total phosphorus and chlorophyll-a at the surface water during 21 years (from June 1971 to March 1992) in Fuji Five Lakes.

Lake's name	Transparency (m)	COD (mg/l)	Total nitrogen (mg/l)	Total phosphorus (μg/l)	Chlorophyll-a (μg/l)
L. Motosu	13.2	0.9	0.15	5	1
L. Sai	8.2	1.6	0.23	6	2
L. Yamanaka	4.0	2.3	0.17	10	4
L. Kawaguchi	3.5	2.8	0.37	11	5
L. Shoji	2.4	3.2	0.35	21	11

Data source from Yamanashi Prefecure (1993)

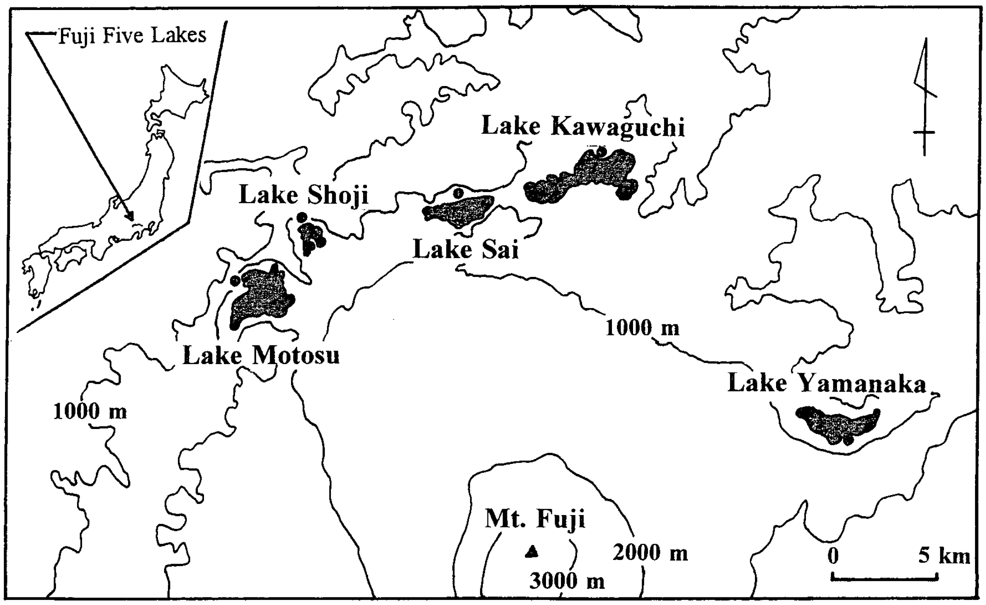

Fig. 1. Maps showing location of Fuji Five Lakes and sampling stations (●) around the lake.

based on the modified Carlson's trophic state index (TSI) using chlorophyll-a, total phosphorus, and transparency (Aizaki et al., 1981). Table 1 gives the mean values of transparency, COD, total nitrogen, total phosphorus and chlorophyll-a at the surface water of each lake during 21 years (from June 1971 to March 1992) (Yamanashi Prefecture, 1993).

Limnological studies of these lakes were carried out by Kofuji (1883). However, studies of the macrobenthic fauna, especially chironomid fauna, have been very few (Miyadi, 1932; Kitagawa 1973). In addition, most of them focused on profundal and/or sublittoral regions. In this paper, chironomids in the littoral regions of the Fuji Five Lakes were investigated by light traps during the fall season, and a comparison of chironomid communities was made among these lakes in relation to the eutrophic level.

Materials and Methods

According to Yamagishi and Fukuhara (1971), the emergence period of *Spaniotoma akamusi* (=*Propsilocerus akamusi*) and *Chironomus plumosus*, which are bioindicators of a eutrophic lake (Iwakuma et al., 1988), occurs in fall. Therefore, we consider fall to be the most effective time to investigate chironomid fauna including these species. Chironomid midges were collected from October 31 to November 1 in 1994 using five light traps equipped with a 6-W black fluorescent lamp (Nozawa Co., NH-5 type) set up on the shore of each of the Five Lakes (Fig. 1). Each trap was hung from a pole about 2.5

m above ground level and activated at 15:00 with an automatic timer. The trapped insects were recovered the next morning (about 10:00 a.m.). No visible sources of artificial light were noticed at each light trap location during the nocturnal study period. Insects that entered the cage of the traps were killed with insecticide spray. After the chironomid midges were sorted out from the other insects, the numbers of males and females were counted separately in the laboratory. They were then mounted on slides in the laboratory and identified according to the keys of Pinder (1978), Sasa and Kikuchi (1995), and Wiederholm (1989).

In order to compare the chironomid fauna among the Fuji Five Lakes, we calculated the index of diversity, i.e., Shannon–Wiener diversity index H′.

Results

A list of chironomid midges collected in the Fuji Five Lakes from October 31 to November 1 in 1994 is presented in Table 2. A total of 2,694 (♂ 1,631, ♀ 1,063) adults were collected by light traps, 66.1% of which were trapped at Lake Yamanaka (1,780 individuals per trap; ♂ 852, ♀ 928). The least number was trapped at Lake Shoji (18 individuals per trap; ♂ 15, ♀ 3, 0.7%), which is approximately a ratio of 1:100. The sex ratio was different in each lake, i.e., there was a high ratio of males in Lakes Kawaguchi (90.6%) and Shoji (83.3%), whereas Lakes Sai and Yamanaka had almost the same ratio. We identified a total of 19 genera and 33 species belonging to three subfamilies, i.e., 16 species of Orthocladiinae (48.5%), 16 species of Chironominae (48.5%) and 1 species of Tanypodinae (3.0%). The most abundant genus was *Smittia* and *Chironomus* (4 species), followed by *Polypedilum* (3 species). In this study, the midges in the Fuji Five Lakes were dominated by three species (in order of abundance); *Tanytarsus takahashii* (1,134 individuals; 42.1%), *P. akamusi* (647 individuals; 24.0%) and *Stictochironomus sticticus* (487 individuals; 18.1%). These three species accounted for 84.2% of the overall total. 19 species were described in Lake Yamanaka, making it the lake with the highest number of species, against 9 species in Lakes Sai and Shoji. In Lake Yamanaka, *T. takahashii* (1,119 individuals; 62.9%), *S. sticticus* (480 individuals; 27.0%) and *T. yunosecundus* (115 individuals; 6.5%) were the dominant species while *P. akamusi* (639 individuals; 86.0%) was dominant in Lake Kawaguchi, and *Smittia insignis* (75 individuals; 64.7%) in Lake Motosu. Only *Smittia aterrima* was common to all of the Fuji Five Lakes. Shannon–Wiener's H′ (index of diversity) was highest at 2.63 in Lake Shoji and lowest at 0.99 in Lake Kawaguchi.

Discussion

Several researchers have reported on the benthic macroinvertebrates including chironomid larvae, in the profundal region of the Fuji Five Lakes (Miyadi, 1932; Kitagawa, 1973; Yasuno et al., 1983), but the numbers of species identified were much fewer than in the present study, and their species names were rather ambiguous, because they were all examined by the chironomid larvae. Moreover, the chironomid fauna in the littoral and hydrophyte zone is also little known in the Fuji Five Lakes (Sasa, 1985). Until now, quantitative data on chironomid fauna have not been reported in these lakes. Sasa (1985) reported 45 species collected around these lakes on 9–10 July 1981 and on 13–14 May 1983 with a sweeping net. According to his reports, 16 species of Orthocladiinae (35.6%) and 29 species of Chironominae (64.4%) were collected, but Tanypodinae were not. Moreover, the number of species was 16 from Lakes Shoji, Kawaguchi and Motosu, 24 from Lake Yamanaka and 7 from Lake Sai. In addition, Hirabayashi (2001) reported 66 species around Lake Kawaguchi through the year. This is the first report on chironomid fauna in the fall season around the Fuji Five Lakes using quanti-

Table 2. List of chironomid midges collected in Fuji Five Lakes from October 31 to November 1 in 1994.

	L. Kawaguchi	L. Yamanaka	L. Sai	L. Motosu	L. Shoji	Total
Total No. (%)	743 (100)	1780 (100)	37 (100)	116 (100)	18 (100)	2694 (100)
♂, ♀	673, 70	852, 928	16, 21	75, 41	15, 3	1631, 1063
Orthocladiinae	664 (89.4)	27 (1.5)	13 (35.1)	85 (73.3)	15 (83.3)	804 (29.8)
	628, 36	23, 4	7, 6	60, 25	14, 1	732, 72
Chaetocladius sp.					1, 0	1, 0
Cricotopus trifasciatus (Panzer, 1809)		1, 1	0, 2			1, 3
C. bicinctus (Meigen, 1818)		1, 0	0, 1			1, 1
Limnophyes minimus (Meigen, 1818)	1, 0			1, 0		2, 0
Neobrillia longistyla Kawai, 1991					0, 1	0, 1
Orthocladius sp.				1, 1		1, 1
O. frigidus (Zetterstedt, 1852)					1, 0	1, 0
Parakiefferiella bathophila (Kieffer, 1912)		4, 0				4, 0
Paraphaenocladius impensus (Walker, 1856)		1, 0		2, 0		3, 0
Propsilocerus akamusi (Tokunaga, 1938)	619, 20	7, 0			1, 0	627, 20
Psectrocladius sordidellus (Zetterstedt, 1838)	1, 2	8, 1	1, 0			10, 3
P. sp.		0, 1				0, 1
Smittia aterrima (Meigen, 1818)	7, 14	1, 0	6, 3	3, 1	7, 0	24, 18
S. insignis Brundin, 1947				52, 23	4, 0	56, 23
S. pratora (Goetghebuer, 1926)				1, 0		1, 0
S. sp.		0, 1				0, 1
Chironominae	78 (10.5)	1749 (98.3)	23 (62.2)	30 (25.9)	3 (16.7)	1883 (70.0)
	45, 33	826, 923	8, 15	14, 16	1, 2	894, 989
Chironomus flaviplumus Tokunaga, 1940	0, 1	0, 5				0, 6
C. nipponensis Tokunaga, 1940	4, 1					4, 1
C. plumosus (Linnaeus, 1758)	2, 2	0, 1				2, 3
C. yoshimatsui Martin et Sublette, 1972		0, 1				0, 1
Micropsectra contracta Reiss, 1965				6, 9		6, 9
M. sp.			0, 3			0, 3
Neozavrelia bicoliocula (Tokunaga, 1938)					1, 0	1, 0
Parachironomus arcuatus Goetghebuer, 1921	27, 8					27, 8
Paratanytarsus sp.	0, 1					0, 1
Polypedilum nubeculosum (Meigen, 1804)	4, 2	11, 6	7, 10	3, 4		25, 22
P. cultellatum Goetghebuer, 1931		5, 4				5, 4
P. sp.			0, 2		0, 1	0, 3
Stictochironomus akizukii (Tokunaga, 1940)	1, 3	1, 1		5, 3	0, 1	7, 8
S. sticticus (Fabricius, 1781)	5, 2	361, 119				366, 121
Tanytarsus takahashii Kawai et Sasa, 1985	2, 13	415, 704				417, 717
T. yunosecundus Sasa, 1984		33, 82	1, 0			34, 82
Tanypodinae	1 (0.1)	4 (0.2)	1 (2.7)	1 (0.9)	0 (0.0)	7 (0.2)
	0, 1	3, 1	1, 0	1, 0	0, 0	5, 2
Ablabesmyia moniliformis Fittkau, 1962	0, 1	3, 1	1, 0	1, 0	0, 0	5, 2
No. of species	14	19	9	10	9	33
Index of diversity	0.99	1.49	2.32	1.85	2.63	

tative data. We describe a total of 24 newly recorded species around these lakes in this study, including one Tanypodinae species, *Ablabesmyia moniliformis*.

Sasa (1985) suggested remarkable differences in the chironomid fauna between rather oligotrophic lakes such as Lakes Motosu and Sai, and the more eutrophicated ones such as Lakes Shoji and Kawaguchi. The results of the present study are in agreement with his results (Sasa, 1985). Thus, we collected *P. akamusi* in Lakes Kawaguchi, Shoji and Yamanaka, and *C. plumosus* in Lakes Kawaguchi and

Yamanaka. Both species are bioindicators of a eutrophic lake (Iwakuma et al., 1988), so these lakes would seem to be eutrophic lakes according to the chironomid communities in this study. Kawai et al. (1999) reported that species compositions of a genus of *Tanytarsus* in littoral communities can be applied in the biological judgement of the eutrophication levels of lakes, and *T. takahashii* occurred in the largest numbers at the middle eutrophication level. Consequently, although Lake Yamanaka was classified as a mesotrophic lake in previous studies (Aizaki et al., 1981; Yamanashi Prefecture, 1993 and others), this lake seems to be undergoing progressive eutrophication.

However, since the present study was carried out over only one night, further follow-up field investigations are necessary to collect more adult midges by other collecting methods, e.g., sweeping net, sticky traps. Such studies should be conducted during different seasons to further improve our understanding of the chironomid fauna of the Fuji Five Lakes.

Acknowledgements

We are grateful to Dr. K. Yoshizawa and Mr. M. Horiuchi of the Environmental Studies Division, Yamanashi Institute for Public Health, for their helpful suggestions. We also wish to express our thanks to the Tozawa Center (Lake Kawaguchi), Boat House Shyusuiya (Lake Yamanaka), Kouan (Lake Motosu) and Marumi (Lake Sai) for their assistance in our research. This study was partly supported by a Grant-in-Aid for Scientific Research from the Zenrousai Foundation. We would like to acknowledge here the generosity of this foundation.

References

Aizaki, M., Otsuki, A., Fukushima, T., Kawai, T., Hosomi, M., Muraoka, K. 1981. Application of modified Carlson's trophic state index to Japanese lakes and its relationships to other parameters related to the trophic state. *Res. Rep. Natl. Inst. Environ. Stud. Jpn.*, 23: 13–31 (In Japanese with English summary).

Hirabayashi, K. 2001. Chironomid fauna in Lake Kawaguchi. *In*: The World of Chironomidae (ed. Kondo, S., Hirabayashi, K., Iwakuma, T. and Ueno, R.), pp. 21–28. Baifukan, Tokyo (In Japanese).

Iwakuma, T., Yasuno, M., Sugaya, Y., Sasa, M. 1988. Three large species of Chironomidae (Diptera) as biological indicators of lake eutrophication. *In*: Biological Monitoring of Environmental Pollution (ed. Yasuno, M. and Whitton, B.A.), pp. 101–113. Tokai University Press, Tokyo.

Kawai, K., Inoue, E. and Imabayashi, H. 1999. Difference in occurrence in relation to the eutrophication level among chironomid species of the genus, *Tanytarsus*, in littoral of lakes. *Med. Entomol. Zool.*, 50: 65–70.

Kitagawa, N. 1973. Studies on the bottom fauna of Lakes Fujigo-ko and Ashino-ko. *Rikusui fueiyouka no kisotekikenkyu*, 2: 32–37 (In Japanese).

Kofuji, B. 1883. Water quality of Lake Kawaguchi. *J. Toyogakugei*, 61: 39–42 (In Japanese).

Miyadi, D. 1932. Studies on the bottom fauna of Japanese lakes. 5. Five lakes at the north foot of Mt. Hudi and Lake Asi. *Jpn. J. Zool.*, 4: 81–125.

Pinder, L. C. V. 1978. A key to adult males of British Chironomidae, pp. 1–169 with figs. Freshwater Biological Assoc. Publ. No. 37, Windermere Laboratory, The Ferry House, Ambleside, Cumbria, England.

Sasa, M. 1985. Studies on the chironomids collected from Lakes in the Mount Fuji Area (Diptera, Chironomidae). *Res. Rep. Natl. Inst. Environ. Stud.*, 83: 101–160.

Sasa, M. and Kikuchi M. 1995. Chironomidae (Diptera) of Japan. 334 pp. University of Tokyo Press, Tokyo.

Wiederholm, T. 1989. Chironomidae of the Holarctic region keys and diagnoses. Part 3 adult males. *Entomol. Scand. Suppl.*, 34: 1–532.

Yamagishi, H. and Fukuhara, H. 1971. Ecological studies on chironomids in Lake Suwa, 1. Population dynamics of two large chironomids, *Chironomus plumosus* L. and *Spaniotoma akamusi* Tokunaga. *Oecologia*, 7: 309–327.

Yamanashi Prefecture. 1993. The water quality of Fuji Five Lakes during 21 years. Yamanashi Prefecture, Kofu (In Japanese).

Yamanashi Prefecture. 2002. Yamanashi prefecture statistical year book 2000. Yamanashi Prefecture, Kofu (In Japanese).

Yasuno, M., Iwakuma, T., Sugaya, Y., Sasa, M. 1983. Zoobenthos of Japanese lakes of different trophic status, with special reference to Chironomidae. *Res. Rep. Spec. Res. Proj. Environ. Sci.*, B182–R12-17: 21–48 (In Japanese).