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CHIRONOMID FAUNA (DIPTERA, CHIRONOMIDAE) IN A FILTRATION PLANT IN JAPAN

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ABSTRACT. Massive flights of chironomid midges have been observed frequently, and they have caused some problems in the daily life of residents around water treatment works. The development of physical and biological control strategies against chironomid midges is urgently needed because chemical control is not feasible in slow sand filter beds. In this study, in order to collect basic biological data for controlling the massive flights of chironomid midges, seasonal changes in the abundance and species composition of chironomid midges and larvae were investigated in slow sand filter beds. We identified 21 genera and 49 species belonging to 3 subfamilies. In spring, *Cricotopus sylvestris* and *Rheopelopia maculipennis* were the dominant species, whereas *Polypedilum nubifer, Cricotopus trifasciatus, Chironomus kiiensis,* and *Procladius sagitalis* were dominant in summer. *Tanytarsus mendax* and *T. volgensis* were the dominant species in fall. *Polypedilum nubifer, C. sylvestris,* and *C. kiiensis* were the major pest species in Japan. The overall factors influencing the abundance pattern of chironomids supposedly are temperature and the quality and quantity of food in slow sand filter beds.

KEY WORDS Chironomid fauna, Chironomidae, filtration plant, seasonal change, slow sand filter bed

INTRODUCTION

Slow sand filter beds are water-filled enclosures used by municipalities to purify water for drinking purposes. The beds used in the water treatment works are almost all identical in size and in the homogeneity of their sand substratum (Brink and Parks 1996, Rachwal et al. 1996). Because of a continuous supply of particulate food passing through and becoming trapped at the filter surface, the macroinvertebrate fauna inhabiting the sand surface is dominated by oligochaetes and chironomid larvae (Diptera: Chironomidae) (Lodge 1979, Wotton et al. 1996). According to Hirabayashi and Wotton (1998) and Wotton and Hirabayashi (1999), chironomid larvae achieve high population densities in the filter beds and play an important role in the filtration process. On the other hand, according to Wotton et al. (1996), many water company managers are concerned by the huge numbers of midges swarming and flying around water treatment works, and local residents complain when midges cover washing and recently painted or cleaned surfaces, and cause allergic reactions (Ali 1995, Cranston 1995a). Furthermore, Ali (1995) reported that the constant high numbers of flying adults are a nuisance that is difficult to avoid.

Various midge control methods have been developed in the past several decades (Ali 1991). Studies in this area have focused on chemical control (Tabaru et al. 1987, Ali 1995). However, in slow sand filter beds, chemical control is not feasible because the beds are used to purify water for drinking purposes. Therefore, the development of physical and biological control strategies is urgently needed. Based on midge biology, physical control may be possible by manipulating adult behavior (Hirabayashi and Nakamoto 2001). No reports have been made previously on the seasonal change in chironomid communities on slow sand filter beds associated with the water temperature and the quality and quantity of food sources for chironomid larvae. In the present study, in order to collect basic data for controlling the massive flights of chironomid midges, seasonal changes in the abundance and species composition of chironomid midges and larvae were investigated in slow sand filter beds at the Someya filtration plant in an inland region (the plateau area) of Honshu Island, Japan.

MATERIALS AND METHODS

Description of slow sand filter beds: Slow sand filter beds are used to purify water passing from rivers or storage reservoirs into the drinking water supply (Graham 1988). Beds consist of enclosed rectangular ponds that have a concrete base overlain with gravel and then a thick layer of sand. The surface of the sand is a smooth, markedly homogeneous, level substratum. The depth of water also is uniform, varying from 1.0 to 2.0 m. With a continuous supply of particulate food passing to and becoming trapped at the filter surface, very large populations of animals accumulate. Of these, the oligochaetes, nematodes, and protozoans inhabiting the interstices of the sand grains have been studied by Duncan (1988). However, the chironomids living in and partly responsible for developing the organically rich coating of the sand surface have been little studied, despite being known to reach impressively high numbers (Wotton et al. 1992).

Sampling areas: The Someya filtration plant at Ueda City in the eastern part of Nagano Prefecture (36°24′N, 138°16′E) is located at the center of the main island of Honshu in an inland climate region (500 m above sea level). The plant consists of 13 filter beds arranged as shown in Fig. 1, onto which

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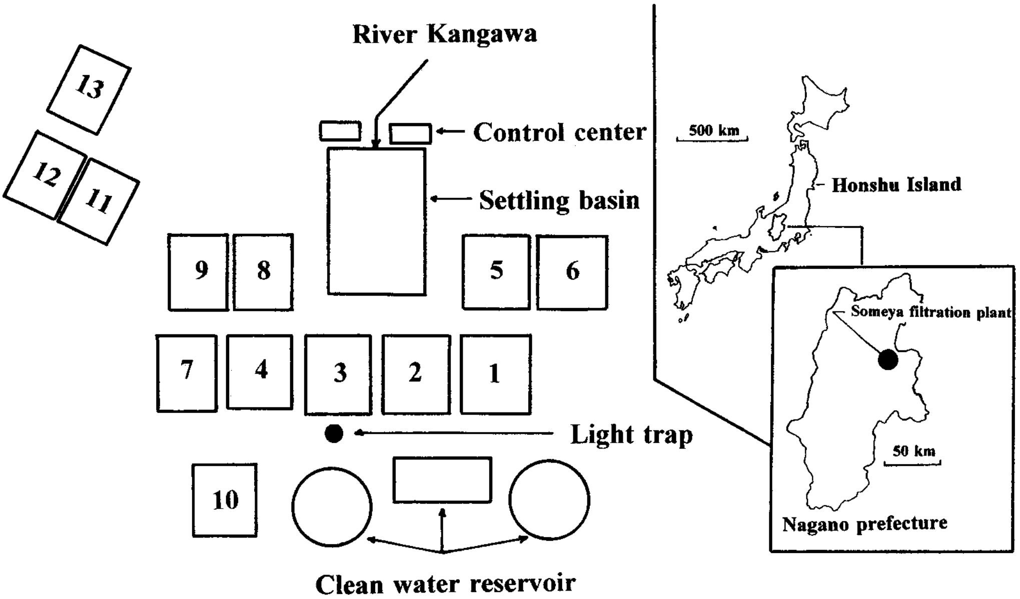

Fig. 1. Map of Someya filtration plant at Ueda City, Nagano Prefecture, Japan.

water is pumped for treatment from the Kangawa River. The distance between the plant and this river, the water source, is about 5 km. A culvert is used to draw water from the river. All beds receive water of a similar quality. At intervals, the sand filters lose efficiency because they become clogged with accumulated organic matter; water then is drained away and the surface of the sand layer is removed (these intervals are known as the bed run length). The pond is subsequently refilled. In the Someya plant, the run length ranged from 31 to 44 days, and mean values (± SD) were 39.0 ± 4.2 days.

Estimates of chironomid larval density on slow sand filter beds: Samples of chironomid larvae were collected every month from April through December 2001. They were taken from drained filter beds by pushing petri dishes (9 cm in diameter, 1 cm in depth) into the substratum, digging into the sand with a plasterer's trowel, and inverting the dishes upon removal. Seventy percent alcohol was added to kill larvae, each dish was covered with a companion dish, and the whole was sealed with insulating tape. On each occasion, 3 samples were taken in an apparently clean area of the sand and 3 samples where algal growth was present. Moreover, we measured the chlorophyll *a* content of the surface of the filter beds. Three substratum samples of equal area and volume were taken by pushing a metal frame (diameter 18 cm, height 3 cm) into the substratum and then, after careful removal, put into plastic bags. In the laboratory, dishes were unsealed and chironomid larvae were picked out and counted under a binocular microscope. All individuals were counted in the April samples but from the May samples onwards, a 25% subsample (sand in 1 quadrant) was used from each dish. This cut down the time taken in sorting. Larvae were identified to the generic level by using the keys provided by Wiederholm (1983), Sæther et al. (2000), and Kondo et al. (2001). Chlorophyll *a* content was measured by standard methods of the United Nations Educational, Scientific, and Cultural Organization. Moreover, the dominant algal genera in each chlorophyll sample were identified under a microscope by using the keys provided by Mizuno (1964) during the investigation period.

Adult midge collection: The abundance of adult chironomid midges from slow sand filter beds was monitored with a light trap (Nozawa NH-5, Tokyo AS Corporation, Tokyo, Japan) set up in the Someya plant near the beds during 4 days in the middle of every month from April to December 2001 (Fig. 1). The light trap was operated continuously during those 4 days and was equipped with a 6-W black fluorescent lamp. The cage was changed to a new one and insects were killed with insecticide spray every morning (about 10 a.m.). At the same time, the surface water temperature of the filter bed was recorded. Because the current is constant at 20 cm/h toward the bottom, the variation in surface water temperature is very small (about 2–3°C) throughout the day (Someya filtration plant staff, personal communication). After the chironomid midges were sorted, males and females were counted separately in the laboratory. Adults were identified according to species or to the generic level by using the keys provided by Pinder (1978), Wied-

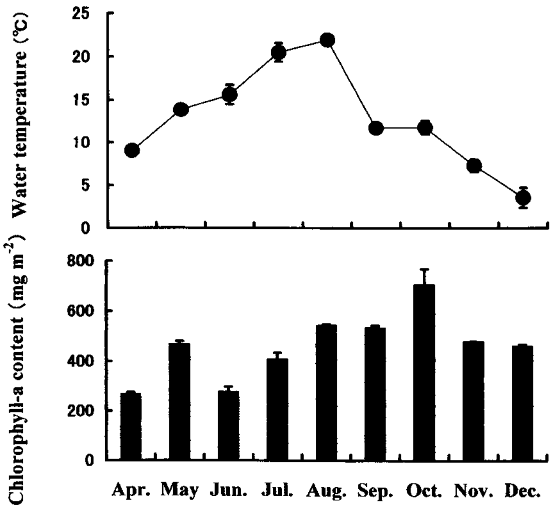

Fig. 2. Seasonal change of water temperature and chlorophyll *a* content on the slow sand filter beds. Vertical bars indicate standard deviations.

erholm (1989), Sasa and Kikuchi (1995), and Sæther et al. (2000).

RESULTS

Physical environmental factors in slow sand filter beds

Figure 2 shows the seasonal change in water temperature and chlorophyll *a* content on the filter beds at the Someya filtration plant. Water temperature (mean ± SD) ranged from 3.6 ± 1.2°C (December, $n = 4$) to 21.9 ± 0.5°C (August, $n = 4$), and the mean value (from April through December) was 13.0 ± 5.6°C ($n = 36$). Chlorophyll *a* content ranged from 267.7 ± 7.3 mg/ m^2 (April, $n = 3$) to 704±62.9 mg/m^2 (October, $n = 3$), and the mean value was 460.0 ± 127.1 mg/m^2 ($n = 27$). These chlorophyll *a* levels reflected algal growth on the filter bed and the accumulation of plankton on the filter surface. A significant difference was found in the chlorophyll *a* content, depending on the month (F = 91.4; df = 8,18; $P < 0.001$ in analysis of variance [ANOVA]), and it peaked in October. Although no significant difference was found between April and June, these months differed markedly from the other months ($P < 0.05$, Tukey's test). In April, small single-cell diatoms such as *Cymbella* and *Navicula* and a filamentous diatom (*Melosira*) were the dominant algal genera on the sand filter beds, whereas *Melosira* dominated from May through December. *Spirogyra* appeared on some beds from August to December.

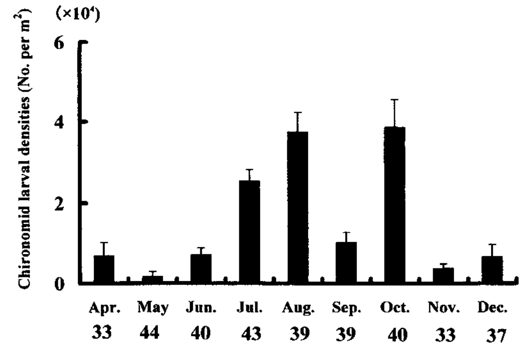

Fig. 3. Seasonal change of chironomid larval density on the slow sand filter beds. Vertical bars indicate standard deviations. Number indicates bed run length (days).

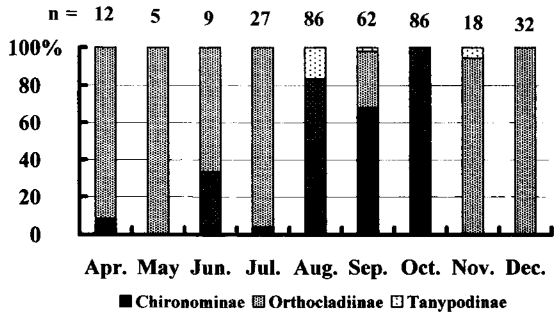

Fig. 4. Seasonal change of chironomid communities at the subfamily level (*n*, number of individual chironomid larvae).

Seasonal change in chironomid larval density on slow sand filter beds

The density of chironomid larvae ranged from 1,622.6 ± 1,330.2 individuals/m^2 (May, $n = 3$) to 38,589.1 ± 6,944.1 individuals/m^2 (October, $n = 3$), and the mean value was 15,066.0 ± 14,675.7 individuals/m^2 ($n = 25$; Fig. 3). A significant difference was found in the density, depending on the month (F = 46.3; df = 8,16; $P < 0.001$, ANOVA). Larval density peaked in August and October, and although no significant difference was found between these 2 months, they differed substantially from the other months ($P < 0.05$, Tukey's test).

Figure 4 shows the seasonal change in chironomid communities at the subfamily level. During the investigation period, 60.8% of the larvae were Chironominae, 34.4% were Orthocladiinae, and 4.7% were Tanypodinae. Orthocladiinae was the dominant subfamily in the filter beds from April to July. The most abundant genus was *Cricotopus*. Chironominae dominated from August to October, during which the most abundant genera were *Polypedilum* and *Tanytarsus*. In winter, Orthocladiinae (mainly *Orthocladius*) was again dominant. Tanypodinae (mainly *Procladius* and *Rheopelopia*) appeared from August to November. The fauna in the Someya filter beds was mainly dominated by the 3 genera (in order of abundance) *Polypedilum, Cricotopus,* and *Tanytarsus.*

Adult midges collected at the Someya filtration plant

Table 1 shows the list of monthly catches of chironomid midges collected by a light trap near the slow sand filter beds from April to December, 2001. A total of 48,944 adults were collected. Their numbers ranged from 1.0 ± 0.1 individuals/day (December, $n = 4$) to 8,251.5 ± 4,748.1 individuals/day (August, $n = 4$), and the mean number was 1,350.0 ± 2,492.7 individuals/day ($n = 36$). A significant difference was found in the number of trapped midges, depending on the month ($F = 10.7$; df = 8, 27; $P < 0.001$ in ANOVA). The numbers peaked in August, which was significantly different from the other months ($P < 0.05$, Tukey's test). Although the trapped midges were almost all males (average 71.5%), the percentage of females rose from April to July.

We identified 21 genera and 49 species belonging to 3 subfamilies, that is, 31 species of Chironominae (63.3%), 12 species of Orthocladiinae (24.5%), and 6 species of Tanypodinae (12.2%) during the investigation period. This composition ratio was the same as for larva (Fig. 4). The most abundant genus was *Polypedilum* (8 species), followed by *Chironomus* (7 species) and *Tanytarsus* (6 species). The midge fauna in the filter beds in Someya was dominated by the 3 species (in order of abundance) *Polypedilum nubifer* (Skuze) (35,169 individuals, 71.9%), *Cricotopus sylvestris* (Fabricius) (3,617 individuals, 7.4%), and *Tanytarsus mendax* Kieffer (2,671 individuals, 5.5%). Forty-four species were described in July, the month with the highest number of species. In spring, *C. sylvestris* and *Rheopelopia maculipennis* (Zetterstedt) were the dominant species, whereas *P. nubifer, Cricotopus trifasciatus* (Panzer), *Chironomus kiiensis* Tokunaga, and *Procladius sagitalis* Kieffer were dominant in summer. *Tanytarsus mendax* and *Tanytarsus volgensis* Miseiko were the dominant species in fall.

DISCUSSION

The filter beds, consisting of rectangular concrete enclosures filled with water, have a substratum of sand on which a rich coating of organic particles (*schmutzdecke* layer) accumulates during the passage of water through the bed. Research into the ecology of slow sand filter beds has been limited (Duncan 1988). In particular, the invertebrates (nematodes, oligochaetes, and larvae of caddisflies, mayflies, and chironomids) associated with the *schmutzdecke* layer have either been ignored or no relevant studies have been published (Brook 1954; Duncan 1988; Sladeckova 1991; Chaloner and Wotton 1996a, b). Chironomids were mentioned in a brief review by Sladeckova (1991) of the biota associated with water supply systems and in a study of the algal flora of filter beds by Brook (1954). However, Duncan (1988), in her review of the ecology of interstitial meiofauna and flora, made no reference to chironomids. Recently, research on slow sand filter systems has focused on chironomid larvae because they feed on detritus and algae and egest fecal pellets that are well consolidated and of large particle size (Wotton et al. 1992, Wotton and Hirabayashi 1999). Chironomid larvae influence the functioning of filter beds by processing organic matter in the course of tube building and feeding (Hirabayashi and Wotton 1998).

Numerous studies of the distribution and seasonal abundance of chironomids in relation to environmental factors (water temperature, dissolved oxygen concentration, and food abundance) have been conducted in lentic and lotic habitats (e.g., see literature reviews by Pinder [1995]). In this study, seasonal change occurred in chironomid communities on the slow sand filter beds at Someya (Fig. 4 and Table 1). Moreover, seasonal changes in chironomid larvae (Fig. 4) and midges (Table 1) showed similar patterns. In natural condition, especially in lentic habitats (lakes and ponds), dissolved oxygen concentration has been reported to be a key factor controlling the distribution and seasonal abundance of chironomids (e.g., Jonasson 1965, Lindegaard 1995). However, in slow sand filter beds at Someya, dissolved oxygen was always sufficient in water through the year (Nakamoto et al. 1996, 2000). According to Nakamoto et al. (1996), clear diurnal changes of dissolved oxygen concentration were observed during the summer. Oxygen is the by-product of photosynthesis during the daytime by algae. As a result, the dissolved oxygen concentration ranged from approximately 5 mg/liter (8 a.m.) to 15 mg/liter (2 p.m.) (the saturation of dissolved oxygen was ca. 60% to more than 180%). Moreover, active formation of bubbles occurred on the sand bed under conditions of dissolved oxygen supersaturation, and the oxygen in the bubbles on the bottom maintained aerobic conditions in the sand layer even at night (Nakamoto et al. 2000). In addition, because of a constant downward current of about 20 cm/h in the filter beds, the bottom of the beds did not reach the anaerobic condition. Thus, the apparent oxygen concentration did not have as much influence on the seasonal abundance of chironomid community on slow sand filter beds as oxygen concentration would have in natural conditions. One reason for the seasonal change in the chironomid community, from one dominated by Orthocladiinae to one dominated by Chironominae, and then back to Orthocladiinae again, could be water temperature. According to Cranston (1995b), the ratios of taxon richness between subfamilies of chironomids reflect the variation in the proportions of cold stenothermic taxa (Diamesinae and Orthocladiinae) in relation to warm eurytherms (Chironominae), that is, members of the Diamesinae and Orthocladiinae prefer cold water, whereas members of the Chironominae prefer warmer water (except in Australia and much

Table 1. List of monthly catches of chironomid midges collected by light trap near slow sand filter beds.

Species	No. individuals/4 days									Total no.	%
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Chironominae											
Chironomus nipponesis Tokunaga			9	25						34	0.07
C. kiiensis Tokunaga			1	537	370	41				949	1.94
C. nippodorsalis Sasa				4						4	0.01
C. circumdatus (Kieffer)				1						1	0.00
C. flaviplumus Tokunaga		7	4	257	71	3				342	0.70
C. dissidens (Walker)				2						2	0.00
Chironomus sp.				1						1	0.00
Cladopelma edwardsi (Kruseman)				9						9	0.02
C. onogawaproma Sasa				1						1	0.00
Cryptochironomus albofasciatus (Staeger)		35	1		12	38				86	0.18
Cryptochironous sp.			22	27						49	0.10
Paratanytarsus stagnarius Tokunaga				2	32	43	6			83	0.17
Polypedilum nubifer (Skuze)		6	7	2,981	31,318	851	5	1		35,169	71.86
P. convictum (Walker)		2	1	27			3			33	0.07
P. aviceps Townes				1						1	0.00
P. nubeculosum (Meigen)				128	5					133	0.27
P. kyotoense (Tokunaga)			4	30						34	0.07
P. parviacumen Kawai and Sasa		7	4	10						21	0.04
P. cultellatum Goetghebuer		1	1	8	1	1				12	0.02
Polypedilum sp.				8						8	0.02
Parachironomus arcuatus Goetghebuer				3						3	0.01
Micropsectra sp.			1	18						19	0.04
Microchironomus tener (Kieffer)				9						9	0.02
Microchironomus sp.				68						68	0.14
Microtendipes shounagasaki Sasa		2		8	6	7	3			26	0.05
Tanytarsus oyamia Sasa		17	4	27	320	233		2		603	1.23
T. angulatus Kawai				2						2	0.00
T. mendax Kieffer		214	149	132	333	1,843				2,671	5.46
T. volgensis Miseiko					166	3	500	4		673	1.38
T. formosanus Kieffer			1	5						6	0.01
Tanytarsus sp.			2	80	1	2	336	4		425	0.87
Orthocladiinae											
Cardiocladius fuscus Kieffer		15	13	54	1	1				84	0.17
Cricotopus trifasciatus (Panzer)				1,155						1,155	2.36
C. bicinctus (Meigen)				22						22	0.04
C. sylvestris (Fabricius)	108	2,858	627		3	5	16			3,617	7.39
Cricotopus sp.		3	20		3	4	3	2		35	0.07
Eukiefferiella sp.			1	1						2	0.00

Table 1. Continued.

Species	No. individuals/4 days									Total no.	%
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.		
Orthocladius obumbratus Johannsen	1	34					17	4		56	0.11
Orthocladius sp.	4	13	11	15			8	3	4	58	0.12
Parametriocnemus stylatus (Kieffer)		1	1	7			15			24	0.05
Paratrichocladius rufiventri (Meigen)		1	121	5	28	26	1			182	0.37
Psectrocladius sordidellus (Zetterstedt)			7	5	147	75	5			239	0.49
Psectrocladius sp.				1						1	0.00
Tanypodinae											
Ablabesmya moniliformis Fittkau		1		11	57	55	8			132	0.27
Procladius sagitalis Kieffer		3	1	449	28	26	1			508	1.04
Rheopelopia maculipennis (Zetterstedt)		831	124	137	147	75	5			1,319	2.69
Rheopelopia sp.				1						1	0.00
Tanypus formosanus Kieffer				7						7	0.01
Tanypodinae, genus unknown				2						2	0.00
Unknown	1	10	3		7	2				23	0.05
Total no.	114	4,061	1,140	6,283	33,056	3,334	932	20	4	48,944	100.00
No. of species	3	19	25	44	20	19	16	7	1	49	
Percentage of Chironomidae (%)	0	7.2	18.5	70.2	98.7	92	91.5	55	0		
Percentage of Orthocladiinae (%)	100	72	70.3	20.1	0.6	3.3	7	45	100		
Percentage of Tanypodinae (%)	0	20.8	11.2	9.7	0.7	4.7	1.5	0	0		
Total no. male	6	93	219	841	31,089	2,331	396	12	4	34,991	
Percentage of male (%)	5.3	2.3	19.2	13.4	94.1	69.9	42.5	60	100	71.5	

of the Southern Hemisphere). In this study, Orthocladiinae was dominant in spring and late fall, whereas Chironominae was dominant in summer, because of different species, resulting in a different growth rate for each. However, in September and October, Chironominae was dominant on slow sand filter beds, even though the water temperature was low (September, 11.7 ± 0.3°C; October, 11.8 ± 0.8°C). The phenomenon thus could not be explained by water temperature alone. Changes in species composition might also be due to a change in the particle regime; specifically, the development of an organic coating on the surface of the substratum, that is, quality of the *schmutzdecke.* According to Brook (1954) and Chaloner (1995), the *schmutzdecke* is organic in nature with algae as an important component. Chironomid larvae eat the *schmutzdecke* accumulated at the sand surface and egest fecal pellets (Wotton and Hirabayashi 1999). According to Hirabayashi and Wotton (1998), ingested matter passed through the gut rapidly. Furthermore, of the pellets produced were reingested. Pellets became diffuse after conditioning by microorganisms. Thus, chironomid larvae recycle organic matter, resulting in its mineralization on filter beds. One way to demonstrate this for the filter beds at Someya was to measure the level of chlorophyll *a.* In the present study, we found that chlorophyll *a* peaked in October, and that a large quantity of organic matter was present on the filter beds during the investigation period (Fig. 2). We also noted seasonal changes in algal flora on beds, that is, in April, small single-cell diatoms such as *Cymbella* and *Navicula* were the dominant algal genera, whereas from May through December, the filamentous diatom *Melosira* dominated. Additionally, *Spirogyra* appeared from August to December. According to Lindegaard (1995), the importance of food is clearly correlated to the ratio of Orthocladiinae to Chironominae. Members of the Orthocladiinae often are scrapers preferring periphyton, whereas members of the Chironominae are suggested to be merely gatherers of detritus and algae (substrate feeders and filtrators). In any case, detritus and living algae such as *Melosira* and *Spirogyra* are important components of the *schmutzdecke,* which also was suitable as food and material for tube-building for chironomid larvae (Hirabayashi and Wotton 1998). Thus, in October, the supply of organic matter was good enough to serve as food for chironomid larvae. The overall factors controlling the abundance pattern of chironomids are temperature and the quality and quantity of *schmutzdecke.* Consequently, conditions over the substratum allow development of high population densities of chironomid larvae (Fig. 3).

Until now, few reports have been made of chironomid fauna in slow sand filter beds. Wotton et al. (1996) reported 19 genera and 23 species belonging to 3 subfamilies, that is, 11 genera and 13 species of Chironominae (56.5%), 4 genera and 6 species of Orthocladiinae (26.1%), and 4 genera and 4 species of Tanypodinae (17.4%), recorded at the slow sand filter beds of the Ashford Common Water Treatment Works, where Thames Water PLC. purifies some of the domestic water supplied to London, United Kingdom. In the present study, 21 genera and 49 species were described in the Someya filtration plant (Table 1). Previously, Hirabayashi et al. (2001) found 13 genera and 20 species in filtration plants in Japan, although the investigation was carried out only in summer. To these we added the 11 genera and 36 species found during this study. Consequently, a total of 24 genera and 56 species have been described in slow sand filter beds in Japan. Table 2 shows a comparison between the genera of chironomid midges collected from slow sand filter beds in Ashford Common and those from the Someya filtration plant. The number of genera in Someya was similar to that collected in Ashford Common, although twice as many members of the Orthocladiinae were collected in Someya. Only 2 species were common to both filter beds (*Parachironomus arcuatus* Goetghebuer and *C. sylvestris*), although the Ashford Common filter beds and the Someya beds had 12 genera in common (42.9%). Moreover, *C. sylvestris* was dominant species in the both filter beds. *Cricotopus sylvestris* is well suited to what is a temporary habitat, because this species has a relatively short life cycle (LeSage and Harrison 1980, Wotton et al. 1996). Wotton et al. (1996) reported that *C. sylvestris* was able to complete development in a mean period of about 20 days in the conditions provided by slow sand filter beds. In the Someya plant, the run length (time interval between removals of the sand surface layer) ranged from 31 to 44 days, and mean values were about 40 days. Therefore, a significant proportion of the larvae emerges as adult midges before the filter bed is drained for cleaning (Wotton et al. 1992, Wotton and Armitage 1995).

Wotton et al. (1992, 1996) found a distinct chironomid community at the Ashford filter beds, with samples of its adult midges and larvae dominated by 3 species, *C. sylvestris, Psectrocladius limbatellus* (Holm.), and *Tanytarsus fimbriatus* Reiss and Fittk. In summer, *C. sylvestris* usually was dominant. The midge fauna in the Someya filter beds was dominated throughout the investigation period by 3 species, *P. nubifer, C. sylvestris,* and *T. mendax.* During the spring, *C. sylvestris* and *R. maculipennis* were dominant, whereas *P. nubifer, C. trifasciatus, C. kiiensis,* and *P. sagitalis* dominated in summer. In fall, *T. mendax* and *T. volgensis* were the dominant species (Table 1). According to Kondo (2001), these species, especially, *P. nubifer, C. sylvestris,* and *C. kiiensis,* were the major pest species in Japan. In recent years, Hirabayashi and Ogawa (1999) reported that swarming males of chironomid midges were caught by sound–light field traps, which attracted many males. This combination method was based on midge biology and on

Table 2. Genera chironomids collected from slow sand filter beds in London, United Kingdom, and Nagano Prefecture, Japan.[1]

	Honshu Island, Nagano Prefecture (present study)	London (Wotton et al. 1996)
Chironominae (14 genera; 50.0%)	10 genera; 47.6%	11 genera; 57.9%
Chironomus	C	C
Cladopelma	C	
Cladotanytarsus		C
Cryptochironomus	C	C
Dicrotendipes		C
Endochironomus		C
Glyptotendipes		C
Microchironomus	C	
Micropsectra	C	C
Microtendipes	C	C
Parachironomus	C	C
Paratanytarsus	C	
Polypedilum	D	C
Tanytarsus	S	S
Orthocladiinae (8 genera; 28.6%)	7 genera; 33.3%	4 genera; 21.1%
Cardiocladius	C	
Cricotopus	S	D
Eukiefferiella	C	
Orthocladius	C	C
Parametriocnemus	C	
Paratrichocladius	C	
Psectrocladius	C	S
Tvetenia		C
Tanypodinae (6 genera; 21.4%)	4 genera; 19.0%	4 genera; 21.1%
Ablabesmyia	C	C
Apsectrotanypus		C
Macropelopia		C
Procladius	C	C
Rheopelopia	C	
Tanypus	C	
Total (28 genera; 100%)	21 genera; 100%	19 genera; 100%

[1] D, dominant genus; S, subdominant genus; C, collected.

the manipulation of their adult behavior. Thus, the application of audio-frequency sound plus light to control chironomid midges around slow sand filter beds seems to be quite feasible, assuming a suitable collecting device.

This is the 1st report on the seasonal change in the chironomid fauna of slow sand filter beds. However, because the present study was carried out at only one filtration plant, further follow-up field investigations of other filtration plants are necessary. Such studies should be conducted in a different climate area for a more precise understanding of the chironomid fauna of slow sand filter beds. In a study presently underway, we are attempting to compare the chironomid fauna in inland climate areas with those in subtropical areas for a more precise understanding of such fauna in slow sand filter beds.

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