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A comparative study of adults and immature stages of nine Japanese species of the genus *Chironomus* (Diptera, Chironomidae)

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* Studies on Chironomidae of Japan, Part 3, from NIES.

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I. INTRODUCTION

The insect family Chironomidae (=Tendipedidae) includes a large number of species whose larvae develop in the bottom sediment of rivers, lakes, ponds and artificial containers (in some species in tide pools or in terrestial environments). Because of their enormous numbers and fast growth in the bottom sediment, they obviously play an important role in the disposal and fixation of nutrients introduced into the waters and in the prevention of various adverse effects of eutrophication of rivers and lakes. Some species have been a serious nuisance to people residing near lakes or rivers during the mass breeding season of the adult flies. However, because of the absence of their medical or agricultural importance, they have attracted little interest in applied entomology, especially in Japan and the Oriental countries.

Our studies in taxonomy and biology of chironomid midges at NIES were begun in April, 1976, as a part of the Special Programme on Eutrophication of Water. Extensive collections of adults and immature stages of chironomids have been made in our study areas. In the first report of this series compiled by Sasa and Yamamoto (1977), an annotated check list of Chironomidae recorded from Japan was compiled. In the second report by Sasa (1978d), morphological and biological accounts were made on an important species of this family, *Tokunagayusurika akamusi* (Tokunaga, 1936). In the present paper, we report the results of comparative studies on the external structure of nine species of the genus *Chironomus* (in the strict sense), whose life histories from larva, pupa and adult have only poorly been elucidated until now.

As reported by Sasa (1978a), a total of 169 species of Chironomidae have been recorded from Japan, among which males are known from 152 species, females from 130 species, pupae from 36 species, and larvae from 31 species. The majority were identified and described by Professor Masaaki Tokunaga during the period from 1933 to 1965. However, the materials studied by him were from limited areas in Japan (mainly from the vicinity of Kyoto, especially from mountain streams), and it is obvious that these 170 species represent only a small fraction of the chironomid fauna of Japan. Many of the species important to the eutrophication of rivers and lakes are considered still unknown.

Before 1977, a total of 12 species of *Chironomus* (s. str.) were reported from Japan (not including Taiwan and Karafuto); males were described for 12 species, females for 8 species, pupae for only 4 species, and larvae for 4 species. Martin and Sublette (1972) proposed a new name, *Chironomus yoshimatsui*, for the most common species occurring in Japan which had been called *Chironomus dorsalis* Meigen by the Japanese workers. More recently, Hashimoto (1977a) made a review of Japanese *Chironomus* in a popular biological science magazine 'Iden' and gave brief morphological accounts on eight species (*yoshimatsui, samoensis, plumosus, nipponensis, kiiensis, circumdatus, tainanus*); of these, five species were new records from Japan. Hashimoto (1977b) further made notes on the larvae of seven species (*yoshimatsui, samoensis, kiiensis, circumdatus, plumosus, nipponensis, tendens*), among which the last one was a new record from Japan.

The present paper deals with the results of comparative studies on the external structure of adults, pupae, and mature larvae of nine species of genus *Chironomus* s. str., i.e., *acerbiphilus, circumdatus, flaviplumus, kiiensis, nipponensis, plumosus, salinarius, strenzkei*, and *yoshimatsui*. Two species among them, namely *strenzkei* (*dorsalis* in the

sense of Strenzke, 1959) and *salinarius*, are newly recorded from Japan. Both pupae and larvae of *acerbiphilus, strenzkei* and *salinarius*, as well as pupae of the other species are newly described with the Japanese specimens. These species can be differentiated rather easily with the male specimens, especially by the difference in the structure of the hypopygium and the coloration of thorax, abdomen and legs; but they are so closely related that it is sometimes difficult to separate the species with females, pupae, or larvae. It has also become clear that a population of common chironomids, conventionally called *'dorsalis'* by the classical workers in Japan, or *'yoshimatsui'* by recent workers, probably include several different species, such as identified in the present paper by the scientific names of *circumdatus, strenzkei, flaviplumus* and *yoshimatsui*. For example, the species recorded by the name of *Chironomus dorsalis* Meigen by Esaki (1932, 1950) obviously refers to the form called in this paper *"yoshimatsui"*, because the male illustrated here has a transversal band on each of abdominal tergites II to V. On the other hand, the larva illustrated by Tokunaga (1959, 1973) by the name of *dorsalis* probably represents either of the other three species because it has a caudolateral process on the 7th abdominal segment, which is absent in *yoshimatsui*.

II. MATERIALS AND METHODS

Methods of collection

The adults were collected by light traps set all through the seasons on the roof of the Suigoso Hotel near the beach of Lake Kasumigaura, in the yard of a house near rice paddies at Hanamuro (Tsukuba Science City), and on the grounds of our Institute (NIES). Collections of adults were made with insect nets or sucking tubes also all through the season in the Tsukuba area (Ibaraki) and occasionally in other regions of Japan. Larvae and pupae were collected from the bottom sediment of lakes, ponds, concrete tanks, artificial water containers, river beds, and sewage ditches, using an Eckman-Birge sediment collector when the water was deep, or with screen filters when it was shallow.

Method of individual rearing

Most chironomid species in Japan were known only by the adults (especially by males), and thus the morphological characteristics in the larval and pupal stages of these species could be elucidated only when adults were successfully reared from the individual specimens. The information obtained by mass rearing of many specimens in a container is often misleading because in many instances more than one species of larvae and pupae coexist in samples collected from the same habitats. Test tubes 18 mm in diameter have usually been used as the containers, and mature larvae collected in the fields were transferred individually into the tubes after their morphological characters were thoroughly examined under a stereomicroscope, such as for the presence or absence of caudolateral processes on 7th abdominal segment, shape of blood gills on the 8th abdominal segment, length of anal gills, etc. This procedure is especially important for identification of *Chironomus* larvae, because these structures are difficult to examine with the larval exuviae. A few ml of water containing green algae were added to each tube as nutrient and nest material for the larva, and the mouths of the tubes were stoppered

with a cotton plug. When adult flies were successfully reared, they were transferred individually into another tubes, and the skin casts of larvae and pupae were picked up with a pipette and mounted on a microscopic slide. The same code number was given to the adult specimen and skin casts of the immature stages.

Methods for preservation and mounting the specimens

Various methods have been proposed by previous workers for preservation and mounting of chironomid specimens. In our laboratory, adult specimens were either preserved in 70% ethanol or kept dry in airtight boxes together with p-dichlorobenzol crystals. The adults for comparison of the color patterns and wing venation were fixed individually on an insect pin with a piece of trinagular paper. Pupae and larvae were preserved in 70% ethanol or 5% formalin solution in water.

In order to prepare specimens of adults, pupae and larvae for microscopic examination, they were first treated with a hot sodium hydroxide solution for a few minutes, and after rinsed with diluted acetic acid, mounted in canada balsam (after dehydration with a series of ethanol concentration) or in a gum-chloral solution (directly, without dehydration). The gum-chloral solution is prepared by dissolving 8 g of gum arabic, 30 g of chloral hydrate, 1 ml of acetic acid glacial and 3 ml of glycerin in 10 ml of distilled water. This is a medium commonly used by acarologists for mounting small mites, and is excellent for preparation of microscopic slides of larval and pupal skin casts (exuviae) and of male genitalia.

III. MORPHOLOGICAL CHARACTERISTICS AND NOMENCLATURE

A. *Structure of adults*

The nine species investigated in the present study all belong to the genus *Chironomus* in the most strict sense, or to Series 1 of Group B, subgenus *Chironomus* s. str. of Edwards (1929). In the male, this group is characterized by the dorsal appendage being strongly chitinised and quite bare except for the basal part, the ventral appendage long and straight, provided with numerous long recurved bristles apically, but devoid of the long and straight terminal bristle such as seen in *Polypedilum*, and with the 9th tergite and anal point well developed and simple. In both males and females, all of these species have a pair of frontal tubercles, the pronotum is complete and not divided in the middle, the wing membrane is bare (devoid of macrotrichia), and r-m is more or less pigmented, the front tarsus I is longer than front tibia (LR larger than 1), and the two comb scales on the distal end of middle and hind tibiae are separated and each has a spur. Antenna is 12 segmented in males and 6 segmented in females.

In the adults, the following points are considered as being important key characters for identification of species within this group.

Coloration: The color patterns of the thorax, abdominal tergites, and legs are characteristic to each species, and are often most useful for rapid identification under a stereomicroscope. Of the nine species discussed in this report, *acerbiphilus* and *salinarius* are almost uniformly dark, while the other species have dark patches on yellowish pale backgrounds. The body color is shining black in *acerbiphilus*, while it is dusty and dark

brown in *salinarius*. In the other species with more or less conspicuous color contrasts, the difference in color between the scutal stripes (vittae) and the ground color is very useful especially for differentiation among species like *circumdatus, flaviplumus, kiiensis, strenzkei,* and *yoshimatsui*. In the males these species also have peculiar color patterns on the abdominal tergites; for example, *strenzkei, flaviplumus* and *yoshimatsui* can be differentiated by the shape of dark partches on tergites II, III and IV. However, such differences are inconspicuous in the females as the dark parts on each abdominal tergites in the females are much larger, and occupies nearly the entire surface of the segment.

Coloration of the legs is also an important character of each species. It may be classified into various types, such as, (1) the *acerbiphilus* type, in which all leg segments are almost uniformly dark, (2) the *kiiensis* type, in which the legs are generally pale yellow but have dark bands on the knee joint (on the distal end of femur and on the proximal end of tibia; this band is most conspicuous on the front leg), on the distal ends of tibiae, and tarsi I to IV of all legs, while tarsi V are entirely dark, and (3) the *strenzkei* type, in which the tarsi are almost uniformly dark and there are no apical dark bands on the tarsal segments, while the large parts of the front, middle and hind femora, as well as middle and hind tibiae are paler in color than the more apical segments. The coloration of the legs of *salinarius* is similar to *acerbiphilus,* and *yoshimatsui* is similar to *strenzkei*, while *circumdatus, nipponensis, plumosus*, and *flaviplumus* have the knee spots and the apical dark bands on the tarsi, and apparently belong to the *kiiensis* type.

In the adults, the following structures were also found to be especially useful for species identification of this group of chironomids.

Antennal ratio (AR): The value obtained by dividing the length of the last segment of male antenna with the combined length of the remaining segments of the flagellum, not including the large doughnut-shaped basal segment called pedicellus. This value is usually higher than 2 in *Chironomus*, and among the nine species examined in this study the largest was 5.4 in *plumosus*, the next being 4.0 of *flaviplumus*, and the smallest was about 3.0 of *acerbiphilus, strenzkei* and *yoshimatsui.*

Leg ratio (LR): This is the ratio of front tarsus I to the front tibia. It is almost unexceptionally larger than 1 in species of the subfamily Chironomidae, while the value is less than 1 in those of other subfamilies of Chironomidae. Among the nine species studied here, this ratio is about 1.3 in *acerbiphilus, plumosus* and *salinarius*, but is significantly larger, 1.6 or more, in *circumdatus, flaviplumus, kiiensis, nipponensis, strenzkei* and *yoshimatsui.*

Beard ratio (BR): This is the value obtained by dividing the length of the longest hairs (beards) on front tarsus I with the diameter of this leg segment, and is considered as to be 'bearded' when the value exceeds 3 or 5 (Strenzke, 1959, p.5). Among the nine species studied here, only *kiiensis, plumosus*, and *salinarius* were found to have long beards with the BR value above 4, and in the other species the bristles on front tarsus I were only about 2.0 times as long as the diameter of the segment, as shown in Table 1.

Besides the above discussed ratios conventionally used by previous workers in the identification of chironomid species, the following measurements were found also to be useful in the taxonomy of this group of insect.

Relative length of fore tarsus V (TR): The relative length of tarsus V to the tibia of the front leg is characteristic in some species. As shown in column TV/Ti of Table 1, this value is as high as 0.4 in *flaviplumus*, 0.35 in *circumdatus*, but is much smaller in other species, thus showing that the first two species have unusually long front tarsi V.

Standard measurements of the wing: The size and the structure of the wings are important characters for identification of chironomid group and species. A simple biometric method is proposed here for quantitative comparison of the wing venation, as shown in Table 2.

A male or female specimen mounted on a pin is placed under a stereomicroscope with its wing held horizontally to the optic field. The length and the width of the wing as well as the relative position of the end-point of each wing vein is recorded by values read with ocular micrometer. The length of wing as expressed in mm is a useful index for comparsion of the body size because other measurements such as the body length is quite variable according to the methods and conditions. The relative value of the width as compared with the length of the wing differ greatly between the two sexes, being about 22% in the male and nearly 30% in the female in all the species examined.

The percentage of the end-point of each vein on the wing margin in relation to the total wing length is measured as shown in Table 2. For example, the relative position of the end-points of R(1), R(2+3) and R(4+5) are important taxonomic characters. In some species, R(2+3) is closely set to R(1), while in other, it ends nearly at the mid-point between the tips of R(1) and R(4+5). The relative positions of the cross veins r-m and m-cu (this is absent in Chironomidae) and the fork point, called fCu, are also important characters for identification of groups and species and can be expressed quantitatively by this method.

Structure of the male hypopygium: This body part represents the most important and reliable character for identification of chironomids and the species studied in this report can be classified into different groups according to the following characters.

Anal point. This structure is sometimes absent in other subfamilies, but is always well developed in this group. When present, it may be classified into three types, namely, (1) X-type, in which the anal point is expanded apically and wider here than in the middle, (2) V-type, in which it is widest at base and becomes gradually narrower towards the apex, and (3) Y-type, in which the anal point is slender and almost the same width all along the shaft. Of nine species studied, *nipponensis* is V-type, while all the others belong to X-type in the structure of the anal point.

Dorsal appendage. Members of the genus *Chironomus* in the most strict sense have a broad and flat base and a highly chitinized, bare apical process. The apical process may be classified into groups as proposed by Strenzke (1959), such as S-type (expanded apically like a shoe), D-type (with almost the same width, like a band), and E-type (slender and curved, like a horn or elephant tusk). Of the species studied here, *acerbiphilus, flaviplumus* and *yoshimatsui* have S-type dorsal appendage, among which *flaviplumus* has more angulate lateral edge than the others; *strenzkei* is different from all the others in having the D-type dorsal appendage; the other species belong to E-type, but the dorsal appendage of *plumosus* differs from the others in that it is almost straight and has a small apical knob, while in the other species it is curved like a fishing hook.

Ventral appendage. In all the species studies here, the ventral appendage is well developed, only slightly expanded apically, and devoid of the long apical seta but has numerous recurved bristles. These bristles are either simple, or have a branch from the distal part; these branches are especially conspicuous in *nipponensis*.

Coxite and Style. The shape and structure of the coxite (basistyle) and style (dististyle) are very useful characters for differentiating *Chironomus* from other

Table 1.
Measurement data of legs of chironomid adults

Species	Sex	Leg	Ratio		Length in 0.01 mm unit						
			TI/Ti	TV/Ti	Fe	Ti	T-1	T-2	T-3	T-4	T-5
acerbiphilus	M	I	1.25	0.224	128	116	145	68	53	43	26
AR=3.0		II	0.51	0.140	133	121	62	36	29	19	17
BR=2.2		III	0.65	0.135	151	141	91	52	41	24	19
	F	I	1.30	0.227	154	128	167	72	62	47	29
		II	0.49	0.143	160	140	68	36	29	21	20
		III	0.61	0.133	172	165	101	56	48	29	22
circumdatus	M	I	1.67	0.352	124	105	176	98	85	71	37
AR=3.8		II	0.65	0.134	115	112	73	43	32	18	15
BR=1.9		III	0.81	0.122	144	139	112	61	40	27	17
	F	I	1.79	0.356	144	115	205	100	93	88	41
		II	0.60	0.112	163	134	81	41	29	18	15
		III	0.77	0.121	149	149	115	56	46	27	18
flaviplumus	M	I	1.63	0.403	139	124	203	102	93	88	50
AR=4.0		II	0.62	0.116	146	129	81	46	34	21	15
BR=2.1		III	0.75	0.120	166	166	124	66	49	32	20
	F	I	1.76	0.418	151	122	215	117	110	110	51
		II	0.61	0.102	154	137	83	44	29	20	14
		III	0.76	0.124	166	161	122	66	50	29	20
kiiensis	M	I	1.76	0.290	110	93	163	93	66	53	27
AR=3.4		II	0.53	0.118	112	110	59	39	32	20	13
BR=5.4		III	0.78	0.127	132	134	105	63	49	28	17
	F	I	1.65	0.327	117	98	161	88	71	66	32
		II	0.56	0.128	120	117	66	38	27	20	15
		III	0.76	0.139	137	144	110	66	54	32	20
nipponensis	M	I	1.53	0.249	205	185	283	139	102	93	46
AR=3.8		II	0.52	0.107	222	224	117	95	49	32	24
BR=2.1		III	0.70	0.103	254	261	183	137	73	46	27
	F	I	1.61	0.265	163	151	244	127	97	89	40
		II	0.58	0.094	181	173	100	59	42	25	17
		III	0.84	0.104	215	212	178	90	63	38	22

Species	Sex	Leg	Ratio		Length in 0.01 mm unit						
			TI/Ti	TV/Ti	Fe	Ti	T-1	T-2	T-3	T-4	T-5
plumosus	M	I	1.28	0202	190	203	259	156	96	86	41
AR=5.4		II	0.61	0.145	203	200	122	83	56	37	29
BR=6.5		III	0.77	0.132	249	256	198	120	81	51	34
	F	I	1.25	0.189	205	224	281	154	95	90	46
		II	0.59	0.150	220	239	142	83	59	39	33
		III	0.77	0.126	285	285	220	122	88	54	36
salinarius	M	I	1.29	0.214	156	159	205	117	92	76	34
AR=3.4		II	0.57	0.135	176	171	98	63	46	32	23
BR=4.6		III	0.75	0.123	195	203	151	90	68	41	25
	F	I	1.36	0230	166	161	220	110	88	76	37
		II	0.55	0.126	188	183	100	59	44	30	23
		III	0.70	0.129	203	210	146	88	66	39	27
strenzkei	M	I	1.76	0283	142	120	210	100	85	71	34
AR=3.1		II	0.60	0.112	149	134	81	46	32	20	15
BR=2.0		III	0.72	0.096	171	166	120	63	49	28	16
	F	I	1.92	0.313	183	144	276	142	132	127	45
		II	0.58	0.110	181	173	100	54	39	22	19
		III	0.71	0.103	203	203	144	81	63	37	21
yoshimatsui	M	I	1.60	0.263	151	129	207	107	90	76	34
AR=3.1		II	0.60	0.120	159	142	85	49	32	22	15
BR=2.1		III	0.72	0.113	178	168	122	71	51	31	19
	F	I	1.79	0289	176	142	254	117	102	95	41
		II	0.55	0.112	178	161	88	46	34	22	18
		III	0.68	0.109	195	193	132	73	59	34	21

AR: antennal ratio (the ratio obtained by dividing the length of the last segment with the combined length of the basal segments, not including the large first segment of antenna); BR: beard ratio (the ratio obtained by dividing the length of the longest bristle on the front tarsus I with the diameter of the segment; M: male; F: female; TI/Ti: the ratio obtained by dividing the length of tarsus I with the length of tibia of the same leg; TV/Ti: the ratio obtained by dividing the length of tarsus V with the length of tibia of the same leg; Fe: the length of femur in 0.01mm unit; Ti: the length of tibia; T-1 to T-5: length of tarsus I to tarsus V, respectively, all in unit of 0.01mm.

Table 2.
Standard measurements of the wing of chironomid midges

Species	Sex	Wing Length (mm)	Percentage to the wing length of the fixed points											
			WW	Sc	R 1	R 2+3	R 4+5	Cs	M	Cu 1	Cu 2	An	r-m	fCu
acerbiphilus	M	3.5	21	65	82	85	99	99	99	89	69	66	53	58
	F	3.7	28	61	80	83	99	99	98	89	69	62	50	54
circumdatus	M	3.2	22	65	84	86	99	99	99	91	70	62	54	57
	F	3.6	28	60	80	82	99	99	99	89	69	58	49	52
flaviplumus	M	3.3	26	65	83	85	99	99	99	88	67	59	52	52
	F	3.5	30	59	80	82	99	99	99	86	69	61	48	49
kiiensis	M	2.9	25	65	82	85	99	99	99	90	71	58	54	56
	F	2.8	29	61	80	83	99	99	99	89	67	56	50	53
nipponensis	M	4.8	25	67	83	88	98	98	98	88	69	60	51	51
	F	4.1	28	60	79	84	98	98	98	87	69	57	50	50
plumosus	M	7.0	22	67	83	92	98	98	97	87	69	63	52	55
	F	6.3	27	63	84	91	99	99	98	86	66	60	51	54
salinarius	M	4.5	21	54	77	83	97	97	98	90	71	64	49	53
	F	5.4	25	62	79	84	99	99	99	89	69	63	48	51
strenzkei	M	3.4	25	61	79	82	99	99	99	88	68	61	49	51
	F	3.6	30	60	78	81	99	99	98	87	66	55	48	51
yoshimatsui	M	3.4	24	67	82	88	99	99	99	88	69	62	54	56
	F	3.8	28	61	81	86	99	99	98	87	68	58	51	54

Note. M: male; F: female; WW: the ratio in percentage of the wing width to the wing length; Sc: relative position of the end-point of Sc (a wing vein subcosta) in percentage to the wing length; Cs: same value for Cs (a wing vein costa); for detail, see Fig. 4.

taxonomic groups, but are usually quite similar among members of this genus. The style has some 7 simple setae near the apex, and their length (in mm), and the ratio of length to the diameter of the style when measured at the base of the most proximal seta among the apical group (ASR), are sometimes useful for species identification.

B. *Structure of pupae*

The pupae of this group are very closely related, and are often difficult to be separated by morphological characters. The thoracic respiratory organ is divided into

numerous fine branches. The abdominal segments bear three kinds of appendages, i.e. the spines, the simple hairs, and the swimming hairs, as shown in Fig. 3. The arangements of these appendages are characteristic to this genus but quite similar among the species of this group.

Pupae of the genus *Chironomus* (s. str.) have a pair of caudolateral scales on the 8th abdominal segment, and these provide the most important information for the species identification. In *plumosus*, the scales differ from those of all the other species in having numerous spines, while in the other species these scales are rather simple in structure and are apically pointed to a simple tip, or forked into two or more branches. The frequency distribution of the numbers of branches on these scales is as shown in Table 3.

Table 3.
Frequency distribution of the number of caudolateral scales on the 8th abdominal segment of *Chironomus* pupae according to te number of apical branches.

Species	Number of pupae examined	Frequency according to the number of branches					
		1	2	3	4	5+	mean
acerbiphilus	21	14	21	7	0	0	1.83
circumdatus	26	18	24	7	2	1	1.94
flaviplumus	14	2	5	13	8	0	2.96
kiiensis	16	26	6	0	0	0	1.19
nipponensis	2	0	1	1	2	0	3.25
salinarius	2	0	1	2	1	0	3.00
strenzkei	14	0	2	18	7	1	3.29
yoshimatsui	19	14	15	7	2	0	1.92

C. *Structure of larvae*

The larvae of *Chironomus* species examined in this study are all blood-red or pink in color, and the structure of head capsules, mouth parts, hooks, and spines on the anterior and the posterior pseudopods are quite similar. They may be classified further into the following groups by the presence or absence of the appendages on the 7th and 8th abdominal segments.

1) The *salinarius*-group: both the caudolateral process and the blood gill are absent.
2) The *yoshimatsui*-group: the caudolateral process is absent on the 7th abdominal segment, but has two pairs of long blood gills on the 8th abdominal segment.
3) The *plumosus*-group: the larvae have a pair of caudolateral processes on the 7th abdominal segment, and two pairs of blood gills on the 8th abdominal segment; *acerbiphilus, circumdatus, flaviplumus, kiiensis, nipponensis, plumosus,* and *strenzkei,* all belong to this group.

IV. DESCRIPTION OF EACH SPECIES

(1) *Chironomus acerbiphilus* Tokunaga, 1939

References. This interesting species was described by Tokunaga (1939, p.336) based on males and females collected by Fujimatsu from Lake Katanuma, near Naruko Spa, Miyagi Prefecture. In this report, only a brief account was made on the adult morphology (73 words for male and 51 words for female), and the structure of the larva and pupa has remained undescribed since then. Prior to this, Fujimatsu (1938) reported on results of a limnological survey of this lake, and stated that the water was highly acidic (pH 1.4), no fish was breeding, and that larvae of this *Chironomus* were found breeding very abundantly in the bottom sediment feeding on a diatome *Pinnularia* sp.

Materials studied. Large numbers of larvae, pupae, their exuviae, and the adults were collected by Dr. M. Yasuno and his associates from Katanuma on 8 October 1976.

Key characters. The adults differ from all the other *Chironomus* studied here in coloration, the body being almost entirely shining black and even the scutal vittae are inconspicuous. The structure of the male genitalia is closely related to *C. flaviplumus* or *C. yoshimatsui*, and the dorsal appendage is expanded apically like a shoe. The larva is most closely related to those of *C. flaviplumus* and has a pair of caudolateral processes on the 7th abdominal segment and two pairs of long blood gills on the 8th abdominal segment.

Male. Medium sized species as a member of *Chironomus* s. str., with the body length of 4.6 - 5.3 mm and the wing length of 3.3 - 3.6 mm. Body almost uniformly black; ground color of scutum black and pruinose, scutal stripes (vittae) black and inconspicuous; scutellum and postscutellum almost uniformly black and pruinose; tergites of abdominal segments I to VII each with a narrow pale band along the posterior margin, abdomen otherwise uniformly black; leg segments entirely black; halteres dark brown.

Antennae 12 segmented, all black; AR relatively small, 2.88 - 3.03 (2.94 in the average of 10 specimens). Frontal tubercle 0.030 mm long and 0.013 mm wide. Relative length of leg segments as in Table 2; tarsus I/tibia ratio of front leg (leg ratio, or LR of previous author) is 1.25 in our standard specimen, a relatively small value as a member of *Chironomus*; tarsus V/tibia ratio (TR) of front leg is also small, 0.224 in our specimen.

Wing venation as in Fig. 4 and Table 1; costa, stems of R and M, R(1) and R(4+5), as well as the cross vein r-m are stout and dark brown; R(2+3) ending much closer to the end of R(1) than to the end of R(4+5); fCu located definitely beyond r-m. Wing membrane slighly brown and without clouds.

Male hypopygium closely related in structure to *C. flaviplumus*; anal point narrow and slender, slightly expanded near the apex; style constricted near the apex, with seven apical setae which are all longer than in the related species (0.056 - 0.059 mm in length and about 2.2 times as long as the width of the style at the position of the most proximal one among the apical setae); dorsal appendage similar in shape to that of *C. flaviplumus*; apically expanded and sickle-like, with irregularly serrulate apical margin; base of dorsal appendage with five long bristles which reach beyond the tip of the dorsal appendage; ventral appendage comparatively long and slender, extending beyond anal point, with about 20 long, recurved setae on the dorsal surface.

Female. Body coloration as in male, almost entirely black. Antenna 6 segmented, (0.14, 0.10, 0.10, 0.11, 0.28 mm); palpus 4 segmented; (0.05, 0.20, 0.20, 0.25 mm), frontal tubercle 0.038 mm long and 0.024 mm wide. Wing wider than in the male (width/length ratio 0.28 in female and 0.21 in male); venation similar to the male wing, as in Fig. 4 and Table 1; R(2+3) ending close to the end of R(1), and fCu is located definitely beyond r-m. Legs almost uniformly black; LR is 1.30 and relatively small as in the male. Spermathecae two, oval, 0.137 mm long and 0.059 mm wide in our standard specimen. Cercus as in Fig. 8

Pupa. Typical in structure as a *Chironomus.* Caudolateral scales of 8th abdominal segment with 2 or 3 relatively short spurs.

Larva. Blood-red in color. Seventh abdominal segment with a pair of caudolateral processes (clp), which are usually curved rectangularly towards the ventral side (this is probably a diagnostic character of this species). Eighth abdominal segment with two pairs of long blood gills (blg), the anterior pair nearly straight and the posterior pair coiled. Anal gills (ang) subequal in length, and about two-thirds as long as the posterior pseudopods. Labial plate, (lbp), paralabial plate (plp), mandible (mnd), antenna (ant), hooks of posterior pseudopods (hpp), and hooks of the anterior pseudopods (hap) are as in the figure.

(2) *Chironomus circumdatus* (Kieffer, 1916)

References. Described by Kieffer (1916, p. 110-111) by male and female collected at Tainan, Yentempo and Takao, Taiwan. Tokunaga (1940) redescribed male and female collected at Taihoku, Taiwan. Asahina (1975) recorded its occurrence in Kandagawa River, Tokyo. Hashimoto (1977a) gave morphological account of male collected in Japan, and Hashimot (1977b) gave a brief description of larva.

Materials studied. Larvae, pupae, males and females, collected or reared from concrete pools of the Aquatron, NIES, July and August, 1977; males and females collected on light at Hanamuro, Tsukuba; males and females collected by insect net from bush on a beach of Lake Kasumigaura.

Key characters. In males and females the three thoracic stripes are orange-yellow in color and their lateral margins are conspicuously darker; with dark apical tarsal bands; dorsal appendage of male hypopygium E-type. In pupae, the caudolateral scales of 8th abdominal segment usually with two (occasionally three) spurs. Larvae with two pairs of extremely long blood gills on the 8th abdominal segment, the posterior pair being usually coiled, and with a pair of caudolateral processes on the 7th abdominal segment.

Male. Wing length about 3.2 mm. Ground color yellow to pale green, with brown and dark brown markings.

Head: Eyes dark brown. Antenna 12 segmented, antennal hairs yellow; AR=3.8. Palpus 4 segmented (0.06, 0.22, 0.22, 0.37 mm). Frontal tubercles short and stout, 0.026 mm long and 0.017 mm wide.

Thorax: Pronotum well developed and complete. Scutum greenish yellow in ground color, scutal stripes conspicuous, with dark brown margins as in Fig. 11. Wing transparent and colorless, r-m slightly pigmented, fCu almost on the same level as r-m. Halteres yellow except for the extreme tip which is dark brown. Scutellum pale yellow. Postnotum dark brown. Legs generally yellow, with dark brown bands on the distal end of all femora,

tibiae, tarsi I, II and III, as well as on the proximal end of front tibiae; distal half of tarsi IV and the entire length of tarsi V of all legs are also dark brown. Length and ratios of leg segments are as in Table 1. Hairs on front tarsus I are about twice as long as the diameter of the segment; LR=1.67; front tarsus V is 0.037 mm long and 0.35 times as long as front tibia (the ratio is longest among the species examined by us except for *flaviplumus*).

Abdomen: Abdominal tergite I entirely pale; tergites II, III and IV each with a central oval dark patch surrounded by pale areas; proximal half of tergite V and nearly all surface of tergites VI, VII and VIII are dark brown.

Hypopygium: Anal point slender, narrower near base than near apex and swollen distally (X-type), darker than 9th tergite. Style with the distal half attenuated, with six terminal setae which is relatively stout and long (about 0.012 mm long and 1.5 times as long as the diameter of the style); dorsal appendage E-type, with the distal process horn-shaped (this process is stouter than that of *kiiensis* or *plumosus*); ventral appendage as usual, the recurved bristles are conspicuously branched as in *nipponensis*.

Female. Coloration similar to the male, though generally darker.

Antenna 6 segmented (0.08, 0.19, 0.12, 0.12, 0.13, 0.28 mm). Pulpus 4 segmented (0.06, 0.24, 0.25, 0.54 mm). Frontal tubercle short and stout, 0.024 mm long and 0.017mm wide. Thorax pruinose, ground color grey, the median vittae almost entirely dark brown, the lateral vittae with the anterior and lateral margins conspicuously darker than the rest parts. Scutellum grey. Postnotum dark brown. Abdominal tergites almost entirely dark brown, with narrow apical pale bands on tergites I to VII. Halteres pale yellow except for the extreme tip, which is dark brown. Legs with apical dark bands on all femora, tibiae, tarsi I, II and III; tarsi IV and V almost entirely dark brown, as in the male.

Pupa. The caudolateral scale on 8th abdominal segment apically tapers into a long, whip-like tail, and usually has one or two branches from near the apex.

Larva. Seventh abdominal segment with a pair of caudolateral processes. Eighth abdominal segment with two pairs of very long blood gills, the posterior pair usually coiled. Anal gills are nearly as long as the posterior pseudopods, and constricted at about one third from the base.

(3) *Chironomus flaviplumus* Tokunaga, 1940

References. This species was described as new by Tokunaga (1940, p. 294) by males collected at Saga (Kyoto) in August, 1937. The description was very brief, and no figure was given, but it was pointed out in this paper that the tergal side of abdominal segments II to IV each with a small, oval, dark central spot, antennal ratio is about 3.5 and larger than 2.9 of *C. dorsalis*, and hypopygium is very closely resembling that in *C. dorsalis* (this is presumably the species now called *C. yoshimatsui*).

On the other hand, Hashimoto (1977a, b) recorded a species from Japan with the scientific name of *C. samoensis* Edwards, and stated that its adult fits morphologically quite well with that described in detail by Tokunaga (1964) from various localities of Micronesia. However, it should be noted here that the antennal ratio of *C. samoensis* is only 2.7 - 2.09 according to Tokunaga (1964), and although this author regarded

C. dorsalis of Tokunaga (1940a, p.220) collected from Truk and Kusale (Micronesia) as well as *C. eximius* Johannsen (1946, p.193) collected from Indonesia as synonyms of *C. samoensis*, he did not mention the synonymy of *C. flaviplumus* with *C. samoensis*.

The population collected by us from the Tsukuba and Tokyo areas and discussed in the present paper under the scientific name of *C. flaviplumus* is probably the same as that reported by Hashimoto (1977a, b) as *C. samoensis*. However, our specimens fits better to the description of *C. flaviplumus* of Tokunaga (1940b) than to *C. samoensis* of Tokunaga (1964), so far as the antennal ratio is concerned. It is of course possible that *C. flaviplumus* is a synonym of *C. samoensis*, but I consider that this name should be retained until the relationship between the Japanese and the Micronesian populations are clarified by future studies.

Materials studied. Larvae, pupae and adults collected or reared from concrete pools at NIES, Tsukuba, through all the seasons of 1976 and 1977. Larvae, pupae and adults collected or reared from plastic tanks containing rain water at the Institute of Medical Science, Minatoku (Tokyo), from May through September, 1977. Males and females collected by light at Hanamuro (Tsukuba).

Key characters. Adults of this species closely resemble those of *C. yoshimatsui* (*C. dorsalis* of former Japanese workers) and the two species have probably been mixed up by most previous workers in Japan. However, the males are rather easily differentiated by the shape of the dark patches on abdominal tergites II, III and IV (oval in this species, a narrow transverse band in *yoshimatsui*), and by the lateral margin of dorsal appendage of male hypopygium which is more angulate in this species. In the females these two species are rather difficult to differentiate, but the relative length of front tarsus V to the length of the front tibia is probably a discriminating character as it is in the males (about 0.42 in *flaviplumus*, and about 0.29 in *yoshimatsui*). There is also a significant difference in the antennal ratio (4.0 in the former, and 3.1 in the latter). In the pupa, the tip of the caudolateral scales of 8th abdominal segment is forked into 2 to 4 filamentous branches in this species, while the branches are stouter and shorter in *yoshimatsui*. In the larva, they are rather easily differentiated by the presence of a pair of caudolateral processes on the 7th abdominal segment in *flaviplumus* and their absence in *yoshimatsui*; larvae of *yoshimatsui* are found usually in the bottom mud of sewage ditches (running water), while those of *flaviplumus* breed exclusively in stagnant waters.

Male.

Head: Antenna 12 segmented, hairs yellow; antennal ratio relatively high (AR=4.0). Palpus 4 segmented (0.07, 0.25, 0.28, 0.40 mm). Frontal tubercle 0.02 mm long and 0.013 mm wide.

Thorax: Ground color of scutum pale yellow, shoulder areas yellowish green. Scutal stripes orange-yellow (this coloration of scutum is quite similar to *C. yoshimatsui* and the two species are easily confused if examination of other key characters is neglected, especially the shape of dark areas on abdominal tergites). Scutellum pale yellow, with some greenish tint. Postnotum orange yellow (darker in the middle in some specimens). Halteres greenish yellow.

Wing: Length 3.3mm (medium sized as a *Chironomus* species), width about 0.6mm. Wing membrane almost uniformly milky white and semi-transparent, area around r-m dark. R(2+3) is very closely set to R(1); end-points of these two veins on the anterior wing margin as expressed by the ratio to the wing length are 85% and 83%, respectively,

as in Table 2 (in *C. yoshimatsui*, these two veins are well separated, 88% and 82%, respectively). fCu is situated on almost the same level as r-m (both 52% level of the wing length; in *C. yoshimatsui*, fCu is slightly distal to r-m, 56% and 53%, respectively).

Legs: Leg segments are largely yellowish brown, with rather inconspicuous dark areas on the distal end of tibiae, tarsi I, II, and III; tarsi IV dark on distal two-thirds, and tarsi V are almost entirely dark. Front tarsus I without long beards (BR=2.1, same as in *C. yoshimatsui*). The relative length of leg segments are as in Table 2; leg ratio is relatively high (LR=1.63); especially noteworthy is the length of front tarsus V, which is 0.40 times as long as front tibia (this ratio is highest among the *Chironomus* species studied here, 0.26 in *C. yoshimatsui*).

Abdomen: Ground color of abdominal tergites is yellow or greenish yellow. *Tergite I is entirely pale. Tergites II, III and IV each with a large oval dark spot in the* middle (this is characteristic to this species, and most important in differential diagnosis with other species). Tergites V to VIII and hypopygium are almost uniformly dark brown.

Hypopygium: Anal point is expanded apically when examined from dorsal side (X-type), but roughly triangular in its lateral aspect, as in Fig. 23. Apical one-third of style is conspicuously narrower than the basal two-thirds; apical bristles 0.036 mm long, and 2.1 times as long as the diameter of style on the same level. Dorsal appendage is S-type, expanded distally, and the lateral margin is more conspicuously angulate than in the related species with S-type dorsal appendage (such as *yoshimatsui* and *acerbiphilus*). Ventral appendage as usual.

Female.

Head: Antenna six segmented, the flagellomeres 0.18, 0.13, 0.14, 0.14, 0.25 mm long, respectively. Palpus 4 segmented (0.06, 0.25, 0.25, 0.37 mm). Frontal tubercle 0.026 mm long and 0.012 mm wide.

Thorax: Coloration as in the male. Scutum pale yellow or greenish yellow in ground color, scutal stripes orange-yellow. Scutellum pale yellow. Postnotum orange-yellow, darker in the middle. Halteres pale yellow.

Wing: 3.5 mm long and 1.1 mm wide. Venation as in the male.

Legs: Coloration and relative length of individual segments similar to the male. Relative length of front tarsus I to front tibia (leg ratio) is 1.76, and that of front tarsus V is 0.42 (much higher than in the related species).

Abdomen: Coloration of abdominal tergites is quite different from that in the male, and there is no characteristic pattern for species diagnosis. The tergites are largely black, tergites II to VI with a narrow pale band along the caudal margin, and with white scales in the basal portion of the segments.

Pupa. Caudolateral scales on 8th abdominal segment are apically forked into 2 to 4 long and slender spurs in most specimens examined.

Larva. Seventh abdominal segment with a pair of long caudolateral processes, which *are pointed apically. Eighth abdominal segment has two pairs of blood gills, which are* relatively shorter than in *C. circumdatus* but similar in relative length to *kiiensis* and *strenzkei*. Anal gills are as long as the posterior pseudopods, and longer than those of the related species.

(4) *Chironomus kiiensis* Tokunaga, 1936

References. Described by Tokunaga (1936, p.76) by male and female as commonly found at Seto (Wakayama). Hashimoto (1977a) reported that this species is very common in Japan, west of Kanto, especially during the summer. Hashimoto (1977b) gave a brief account on the structure of larva.

Materials studied. Larvae, pupae and adults collected and/or reared from concrete pools and oxidation ponds at NIES; adults collected at Hanamuro and Tsuchiura (Ibaraki) during March to November, 1977.

Key characters. This species is smallest among the known *Chironomus* of Japan, with the wing length of about 2.9 mm in males. Adults of this species are characteristic in having several cloudy patches on the wing membrane (a character often seen in *Polypedilum* spp. but not in other *Chironomus* spp. known from Japan); legs are largely yellow but with dark brown bands on the knee joint, on the distal parts of tibiae and tarsi I to IV, while tarsi V are entirely dark. Dorsal appendage of male hypopygium is E-type. In pupae, the tip of caudolateral scales on the 8th abdominal segment is mostly simple and sharply pointed, but rarely forked into two branches. The larva has both the caudolateral process on the 7th abdominal segment and two pairs of long blood gills on the 8th abdominal segment (*plumosus* type), but is usually paler in color (pink) and smaller in size than mature larvae of other *Chironomus* spp.

Male.

Coloration generally yellow, with dark brown or brown markings on scutum, abdominal tergites, and legs.

Head: Antenna 12 segmented, hairs brown; AR = 3.4. Palpus four segmented (0.05, 0.16, 0.16, 0.22 mm). Frontal tubercle relatively conspicuous, 0.040 mm long and 0.019 mm wide.

Thorax: Ground color of scutum yellowish white (paler than related species). Scutal vittae yellowish brown, and their margins are darker than the central portions (this difference is not so conspicuous as in *circumdatus*). Scutellum yellow. Postnotum yellowish brown. Halteres pale yellow.

Wing: Membrane with milky white patches (clouds) in the distal and posterior parts, one between R(4+5) and M, one between M and Cu(1), one between Cu(1) and Cu(2), and three between Cu and the posterior edge of the wing (these three patches are contiguous along the posterior margin). Wing venation as in Fig.31 and Table 1. Cross vein r-m is conspicuously pigmented. fCu is definitely distal to r-m. R(2+3) is closer to R(1) than to R(4+5).

Legs: Coloration of legs is characteristic to this species both in males and females. The ground color is pale yellow, with narrow dark bands on tarsal segments. On front leg, there is a faint "knee spot" (dark band on distal end of femur as well as on proximal end of tibia); tarsi I to III with a narrow apical dark band; tarsus IV pale on basal one third and dark on distal two thirds; tarsus V entirely dark. On middle and hind legs, there are faint dark bands on distal end of femur and tibia, and more conspicuous dark bands on distal ends of tarsi I to III; tarsi IV and V are entirely dark. The length and ratio of leg segments are as in Table 2; the leg ratio is relatively large (AR = 1.76); tarsus V of front leg is about 0.3 times as long as the front tibia. All tibiae and tarsi I bear numerous long bristles, and the length of the longest bristles on front tarsus I are more than 5 times the diameter of the segment (BR = 5.4 in the standard specimen).

Abdomen: In contrast to the pale yellow ground color of thorax and legs, the abdominal tergites are almost uniformly dark brown except for very narrow apical pale bands seen on tergites I to VII. In this point, male of *kiiensis* differs from most other related species which usually have conspicuous pale areas on most abdominal tergites.

Hypopygium: Anal point is slender, slightly expanded distally and narrower in the middle than near the apex (X-type). Distal process of dorsal appendage bare, slender and slightly curved inward (E-type). Ventral appendage relatively long, slightly expanded distally and reaches beyond the apex of anal point, with nearly 20 long, recurved bristles. Style with relatively long apical bristles (more than twice as long as the diameter of the apical part of the style).

Female. Body size smallest among the *Chironomus* species known from Japan, with the wing length of about 2.8 mm. Coloration as in the male, with dark brown markings on pale yellow ground color. Antenna six segmented (0.08, 0.15, 0.11, 0.10, 0.09, 0.17mm). Palpus four segmented (0.04, 0.13, 0.10, 0.23 mm). Frontal tubercle 0.043 mm long and 0.022 mm wide. Scutum with brown stripes on pale yellow ground color. Scutellum pale yellow. Postnotum with a pale basal and a brown distal band. Abdominal tergites almost uniformly dark brown except for the narrow and inconspicuous apical pale bands seen on segments I to VII. Legs have dark bands the same as in the male, among which the apical dark bands on tarsi I, II and III are very conspicuous, tarsi IV are partly or largely dark, and tarsi V of all legs are entirely dark. Wing with cloudy patches on the membrane, the same as in the male wing.

Pupa. Caudolateral scales of 8th abdominal segment with a whip-like terminal spur, usually simple but occasionally forked into two branches.

Larva. So far as our specimens are concerned, the color is pink and paler than the larvae of related species, which are mostly blood-red. The size is smallest among the mature larvae of *Chironomus* species. Abdominal segment VII with a pair of caudolateral processes, which are apically rounded (not pointed as in *C. flaviplumus*); abdominal segment VIII with two pairs of blood gills, which are about twice as long as the diameter of the body segment. Anal gills are about half as long as the posterior pseudopods, and thus relatively shorter than those of *C. flaviplumus.*

(5) *Chironomus nipponensis* Tokunaga, 1940

References. Described by Tokunaga (1940, p.293) by male and female collected at Sikuka (Karahuto) in August. Reported by Hashimto (1977a) as being commonly found in Japan, west of Kanto. Hashimto (1977b) gave a brief account on the morphology of larva.

Materials studied. Adults have been collected occasionally resting in the woods and bushes at NIES (Tsukuba, Ibaraki) in all through the seasons except for winter. Adults were also collected at Tsuchiura, near Lake Kasumigaura (Ibaraki), in June 1977. Larvae and pupae were collected from the bottom sediment of Lake Chuzenji, Nikko (Tochigi) by Dr. Yasuno and Mr. Sugaya in June 1977, from these adults were reared in the laboratory.

Key characters. Adults are large black midges and largest among the species studied here, with the exception of *C. plumosus*; The coloration is somewhat similar to

C. plumosus, but may be differentiated in both sexes by the contrast between the dark basal bands and the pale apical bands on abdominal tergites which are more conspicuous in this species than in *C. plumosus*. They are more precisely differentiated by the shape of the anal point of male hypopygium (V-type in this species, X-type in *plumosus*), by the higher leg ratio in both sexes of this species, and by the absence of long beards on tarsus I of the male of this species. The dorsal appendage of male hypopygium is E-type in both species. In pupa, the caudolateral scales on the 8th abdominal segment are forked into two to several sharply pointed branches. Larva has a very small caudolateral process on the 10th segment, and two pairs of relatively long blood gills on the 11th segment.

Male.

Head: Antenna 12 segmented; antennal hairs brown; antennal ratio relatively large (AR = 3.8). Palpus 4 segmented (0.11, 0.29, 0.32, 0.44 mm). Frontal tubercle 0.050 mm in length and 0.021 mm in diameter.

Thorax: Ground color of scutum silvery white, scutal stripes brown and pruinose. Scutellum brownish yellow. Postnotum dark brown. Halteres yellow.

Wing: Wing membrane uniformly transparent and colorless. Cross vein r-m slightly pigmented. Wing venation as in Table 1. fCu is nearly on the same level as r-m.

Legs: Coloration is largely yellow, with dark bands on the knee joint and on the distal ends of tarsi. On the front leg, dark bands are on the distal end of femur, on proximal one-fourth and distal end of tibia, on distal ends of tarsi I to IV; tarsus V is entirely dark. On the middle and hind legs, dark bands are on the distal end of femur, on the proximal and distal ends of tibia,on the distal ends of tarsi I to IV, while tarsi V are entirely or largely dark. Proportions of leg segments are as in Table 2; LR = 1.5, TR = 2.5.

Abdomen: Abdominal tergites are largely black (or dark brown) but most segments have a conspicuous white band as shown in the figure (this is the most useful character for naked-eye identification of this species).

Hypopygium: Anal point broad, wider at base than apex (V-type). Apical bristles of style about 0.053 mm long, and 1.9 times as long as the diameter of the style. Dorsal appendage E-type. The recurved bristles on the ventral appendage each with a long branch.

Female.

Head: Length of antennal flagellomeres 0.22, 0.17, 0.17, 0.15 and 0.31 mm. Palpus 4 segmented (0.11, 0.31, 0.35, 0.54 mm). Frontal tubercle 0.053 mm long and 0.026 mm wide.

Thorax: Ground color of scutum yellowish white, scutal stripes dark brown. Scutellum yellow, with brown basal band. Postnotum dark brown. Halteres pale yellow. Wing venation as in Table 1. fCu just under r-m. Legs with coloration as in the male; on all legs, coxa and trochanter as well as most parts of femur, tibia, tarsus I, II, III and IV are yellow; distal end of femur, basal and distal ends of tibia, distal ends of tarsi I, II, III and IV are dark brown, while tarsus V is entirely dark. Leg ratio is about 1.6.

Abdomen: Tergites are largely black, and segments I to VII each have a white band along the caudal margin.

Pupa. In the materials examined by us, the caudolateral scales of 8th abdominal segment were forked into two to several spurs.

Larva. The specimens examined by us (from Lake Chuzenji) had short caudolateral processes on the 7th abdominal segment, two pairs of medium sized blood gills on the 8th

abdominal segment, and two pairs of anal gills which were about half as long as posterior pseudopods and not constricted in the middle.

(6) *Chironomus plumosus* (Linnaeus, 1758)

References. This species was recorded by Esaki (1932) in the first edition of "Konchu Zukan" (Hokuryukan). In its 1950 edition, Esaki used a scientific name of *Chironomus plumosus prasinus* Meigen. Yamagishi & Fukuhara (1971) studied the seasonal distribution of this species and *Spanitoma akamusi* in Lake Suwa. Hashimoto (1977a, b) gave brief accounts on the morphology of adults and larvae, and discussed variation in color of adults according to the season and the age.

Materials studied. Large numbers of adults and immature stages were collected from Lake Kasumigaura, and also from an oxidation pond at NIES, all through the seasons of 1976 and 1977.

Key characters. The largest species among the known chironomids, with the wing length of about 7 mm in the male. Coloration of adults is highly variable (pale form, dark form and various intermediate forms), but is an important key for differentiation from related species. (For example, the contrast between the dark parts and the pale parts is less conspicuous in this species than in *nipponensis*.) In the male, the antennal ratio is high (AP = 5.4), the front tarsus I has long beards (BR = 6.5), but the leg ratio is small (LR = 1.3). Dorsal appendage of male hypopygium is characteristic in that its distal process is long and slender (E-type), nearly uniform in width, hardly curved, and has an apical knob. Anal point is slender and expanded apically (X-type). In the pupa, it differs from all other Japanese chironomids in that the caudolateral scales of the 8th abdominal segment have numerous sharply pointed spurs. The mature larva is also largest among the chironomids; it has a pair of caudolateral process on the 7th abdominal segment, and two pairs of long blood gills on the ventral side of the 8th abdominal segment. Anal gills are nearly as long as the posterior pseudopods, and constricted in the middle.

Note: As discussed by Edwards (1929, p.384), various names have been proposed for the color variants. In the typical form, the scutal stripes are dark grey, abdomen largely dark; var. *ferrugineovittatus* Zett. has scutal stripes reddish brown, ground color of thorax and abdomen lighter; var. *prasinus* Mg. has the abdomen green, with small dark dorsal spots.

Male.

Head: Antenna 12 segmented, AR = 5.4 (largest among Japanese *Chironomus*), antennal hairs yellow. Palpus 4 segmented (0.12, 0.31, 0.26, 0.41 mm). Frontal tubercle oval in shape, 0.045 mm long and 0.029 mm in diameter.

Thorax: In the dark form (typical form), the scutal stripes are dark grey and the ground color is grey; in the pale form, the scutal stripes are brown and the ground color is yellow. (In *nipponensis*, the color contrast between the stripes and other parts of scutum is more conspicuous.) Scutellum brown and pruinose. Postnotum dark brown. Halteres largely yellow, apically brown.

Wing length about 7.0 mm, the longest among Japanese *Chironomus*. Venation as in Table 1 and Fig. 52. The distance between the end-points of R(1) and R(2+3) is almost the same as that between those of R(2+3) and R(4+5); in most other *Chironomus*, end-point of R(2+3) is closer to R(1) than to R(4+5). The posterior margin of wing is

markedly concave at the end-point of Cu(2); fCu is slightly distal to r-m. Wing membrane is uniform in color; r-m is conspicuously pigmented.

Legs: Leg coloration is the *kiiensis*-type; namely, leg segments are generally yellow, and dark bands are on the knee joint (distal end of femur and proximal end of tibia; this band is more conspicuous and larger in front leg than in the middle and hind legs), on the distal end of tibia, tarsus I, II and III; tarsus IV dark on distal 4/5; tarsus V is entirely dark. Front tarsus I has long beards (BR = 6.5). The relative length of leg segments is as shown in Table 2. Leg ratio is smallest among the Japanese *Chironomus* (LR = 1.2 - 1.3). Front tarsus V is relatively short, and about 0.2 times the length of front tibia.

Abdomen: Abdominal coloration is variable according to the poplulations. In the dark form (*plumosus*-type, Fig. 50b), abdominal tergites are largely black or dark brown, with narrow caudal pale bands on tergites I to VII; the black areas on tergites II, III and IV have a median projection into the pale caudal band; tergites IV and V have a pale band also along the proximal margin. In the pale form (Fig. 50c) the dark areas on abdominal tergites II, III and IV are largely yellow, and has a diamond shaped central dark area; tergites V to VIII are largely pale yellow in color.

Hypopygium: Posterior edge of the 9th tergite forms a very sharp angle as compared with that of the rather wide angles in other *Chironomus* species. Anal point is slender, apically expanded (X-type). The distal process of dorsal appendage is peculiar to this species in that it is long and slender, nearly uniform in width and hardly curved, and has a recurved apical knob. Ventral appendage is also long and slender, not expanded apically, and bears some 30 stout and recurved bristles.

Female.

Coloration is also variable, and in the pale or summer form the ground color of thorax is lighter, and the apical pale areas on the abdominal tergites are larger than in the dark form. In the pale form, especially conspicuous are the pale bands along the posterior margins of tergites II, III and IV.

Antenna 6 segmented (0.11, 0.23, 0.14, 0.18, 0.15, 0.31 mm). Palpus 4 segmented (0.11, 0.28, 0.29, 0.34 mm). Frontal tubercle 0.045 mm long and 0.026 mm in diameter.

Wing venation and coloration of legs as in the male; legs with knee spots, and distal dark bands on tarsi I to IV; tarsi V are entirely dark.

Pupa. This is differentiated from all other *Chironomus* pupae by the structure of the caudolateral scales on the 8th abdominal segment, which have numerous short spines instead of one to several apical spurs as in other species.

Larva. When fully mature, larvae of this species can be easily differentiated from those of the related species by the large body size, as the body length reaches 20 mm or longer. They can be easily differentiated from those of *Tokunagayusurika akamusi* by the presence of two pairs of blood gills on the 8th abdominal segment. The anl gills are nearly as long as the posterior pseudopods, and are constricted in the middle.

(7) *Chironomus salinarius* (Kieffer, 1921)

References. This species is a new record from Japan. The morphological characters of adults generally fit the description of European specimens of *C. salinarius* by Strenzke (1959, p.29), and those of larvae and pupae coincide with that described by Lenz (1937, p. 161).

Materials studied. Adults, pupae, and mature larvae collected and/or reared from a brackish water swamp at Okinosu (Tokushima), on April 5, 1977. One male and one female were reared from larvae kept individually in test tubes.

Key characters. Adults are almost entirely dark brown, and even the scutal stripes are inconspicuous (coloration is similar to *acerbiphilus*, but the latter is shining black, dorsal appendage is S-type). In the male, both antennal ratio and leg ratio are relatively small (AR = 3.4, LR = 1.3), but front tarsus I bears long bristles (BR = 4.6). Anal point is expanded distally (X-type), and dorsal appendage is long and slender (E-type), and strongly curved like a fishing hook. In pupa, the caudolateral scale of the 8th abdominal segment usually has several spurs. Larva of this species has neither the caudolateral process on the 7th abdominal segment nor blood gills on the 8th segment.

Male.

Head: Antenna 12 segmented; hairs brown; AR = 3.4. Palpus 4 segmented (0.09, 0.25, 0.25, 0.32 mm). Frontal tubercle 0.050 mm long and 0.019 mm wide.

Thorax: Scutum with the ground color dark grey and highly pruinose, scutal stripes black and poorly differentiated. Scutellum dark grey. Postnotum black. Halteres apically yellow and basally dark brown.

Wing: Length about 4.5 mm (medium in size as a *Chironomus* species). Wing membrane uniformly milky white and semi-transparent, r-m conspicuously pigmented; fCu slightly distal to r-m; R(2+3) is well-separated from R(1).

Legs: Legs are almost uniformly dark brown. Front tarsus I with long beards (RB = 4.6). Leg ratio relatively small (LR = 1.3). Front tarsus V is also relatively short, and its ratio to front tibia is about 0.21.

Abdomen: Abdominal tergites are almost entirely black, tergites III to VI each with a faint pale band along the caudal margin.

Hypopygium: Anal point expanded more apically than in the middle (X-type). Style conspicuously narrowed on apical one-third; apical bristles long, about 0.055 mm long and 2.2 times as long as the diameter of the style. Dorsal appendage highly chitinized, dark brown, the apical process long, slender and curved like a fishing hook (E-type). Ventral appendage well developed, hardly expanded apically, and reaches far beyond the tip of the anal point; the recurved bristles have conspicuous branches.

Female. Coloration similar to the male, body almost entirely black (slightly brownish, and can be differentiated by color from *acerbiphilus*, which is shining black).

Head: Antenna six segmented (0.06, 0.15, 0.11, 0.11, 0.21 mm). Palpus 4 segmented(0.08, 0.25, 0.25, 0.38 mm). Frontal tubercle 0.045 mm long and 0.019 mm wide.

Thorax: Scutal ground color dark grey, scutal stripes black and pruinose. Scutellum and postnotum dark grey. Halteres yellow.

Wing: Length 5.4 mm, width 1.35 mm. Wing membrane milky white and semi-transparent, with dark area around cross vein r-m. fCu slightly distal to r-m.

Legs: Coloration almost uniformly dark brown, and without tarsal bands; distal end of femur and both distal and apical ends of tibia are darker than the remaining parts of the segments. Leg ratio relatively small (LR = 1.36).

Abdomen: Abdominal tergites largely black; tergites I, II and III with inconspicuous apical pale bands.

Pupa. The specimens examined are peculiar in that the caudolateral scales of the 8th abdominal segment have several very short but pointed spurs.

Larva. The specimens collected and examined by us were blood-red in color, but differ from all the other species in that they have neither the caudolateral process on the 7th abdominal segment, nor the blood gills on the 8th abdominal segment. Anal gills are short, and less than one-half of the length of posterior pseudopods.

(8) *Chironomus strenzkei*, **sp. n.**

References. The species described here as new is morphologically closely related to the form reported by Strenzke (1959, p.23) as *Chironomus dorsalis* Meig. and I consider that the present species found in Japan and Strenzke's '*dorsalis*' in northern Europe may be the same species, though further studies are needed in order to confirm this possibility. In my previous reports, I tentatively listed this species under the name *Chironomus dorsalis* Meigen. However, this species is not the same as *C. dorsalis* referred by previous Japanese workers to the most common form found in sewage ditches in Japan (Esaki, 1932, 1950; Shirota, 1969), which is now called *Chironomus yoshimatsui* Martin et Sublette, 1972.

There has been a lot of confusion about the identity of *C. dorsalis* Meigen. The original description is in Meigen's monograph of European Diprera (System. Beschr. europ. zweifl. Ins. 1:25; 1818), and the type specimen is preserved in Musée l'Histoire Naturelle in Paris. According to Edwards (1929, p.385), "the specimen in Meigen's collection labelled *dorsalis* is *Chironomus (Einfeldia) longipes* Staeg. but is probably not the type as the description agrees better with the species usually determined so." In the same paper (p.384), he described *C. dorsalis* as "hypopygium with appendage 1 short, broadened apically and blackened, as in *C. riparius*; differs from that species and also from all the others of the group in the somewhat higher L.R., which is at least 1.5, and may reach 1.7. Abdomen greenish or yellowish with dark bands on segments, variable in width. Common." The description of *C. dorsalis* by Goetghebuer (1937, p.25) agrees with that of Edwards (1929), in that it has the dorsal appendage expanded apically into a triangular shape, and a high leg ratio; his drawing of the male hypopygium (Fig. 84, Taf 6) indicate that it has a S-type dorsal appendage. On the other hand, the adults described and illustrated in detail by Strenzke (1959) have a D-type dorsal appendage, i.e., almost the same width throughout its length.

There has been a striking difference in opinion between the above European and some American workers. Towns (1945, p.112), in his review of Nearctic Tendipedini (=Chironomini), proposed a new combination *Tendipes* (*Einfeldia*) *dorsalis* (Meigen) and designated *Chironomus longipes* as its synonym. Martin and Sublette (1972, p.1) reported that "Dr. Wolfgang Wülker, Albert-Ludwigs-Universitat, Freiburg (personal communication) has recently examined the type specimens in the Musée l'Histoire in Paris and reports it to be an *Einfeldia*. The species referred to by Edwards, Strenzke, and Keyl is a

Chironomus in the strict sense, the identity of which is uncertain at this time. It probably should be described as a new species."

The species recorded by Esaki (1932, 1950) as *Chironomus dorsalis* Meigen fits well in morphological character to *C. dorsalis* of Edwards (1929) and Goetghebuer (1937) but is obviously different from *C. dorsalis* of Strenzke (1959). This form, common in Japan and breeding in running water of sewage ditches, was named by Martin and Sublette (1972) as *Chironomus yoshimatsui*. On the other hand, the species described here as new is similar in coloration to *C. yoshimatsui* and *C. flaviplumus*, but is quite distinct in the structure of male hypopygium and in the color pattern of abdominal tergites. It seems that these three species, as well as *C. circumdatus*, have been mixed up by most previous workers in Japan.

Materials studied: Larvae, pupae and adults collected or reared from a plastic tank containing rainwater, at the Institute of Medical Science, Minatoku, Tokyo, June 1976; those collected or reared from concrete tanks at NIES, Tsukuba, Ibaraki, June to September, 1977; adults collected by light at Hanamuro, Tsukuba, May through September, 1977. Holotype: a male (dry mounted on a pin, with hypopygium mounted on a slide in gum-chloral solution), reared from larva collected from a concrete pool at NIES, Ibaraki, on 23 May, 1976. Paratypes: seven males and three females, reared from larvae collected at the same habitat, with associated larval and pupal exuviae, May-June, 1976.

Key characters: Most characteristic are the shape of dorsal appendage (D-type) of male hypopygium, shape of dark area on abdominal tergite II of male, color of scutum and vittae of both male and female, and the color pattern of legs of male and female. In pupa, the tip of caudolateral scale of the 8th abdominal segment is slender and usually forked into 3 or 4 sharply pointed branches. The larva is blood-red in color, and provided with a pair of caudolateral processes on the 7th abdominal segment, and two pairs of long blood gills on the 8th abdominal segment (*kiiensis*-group), and the anal gills are a little more than half as long as the posterior pseudopods.

Male. Coloration generally brown to yellow, with dark brown markings on thorax and abdomen.

Head: Antenna 12 segmented, AR = 3.1; antennal hair brown. Palpus 4 segmented (0.09, 0.25, 0.26, 0.39 mm). Frontal tubercle 0.024 mm long and 0.010 mm wide.

Thorax: Ground color brownish yellow and pruinose, vittae almost uniformly dark brown (this coloration is characteristic to this species and is an important point for differentiating this species from allied ones, such as *flaviplumus, circumdatus* and *yoshimatsui*). Scutellum yellowish brown. Postnotum dark brown. Halteres yellow. Wing venation as in Fig. 65 and Table 2; fCu is almost on the same level or only slightly distal of r-m; R(2+3) much closer to R(1) than to R(4+5); wing membrance colorless and transparent; r-m slightly pigmented. Leg coloration also typical to this species; in the front leg, basal four-fifth of femur is pale yellow, and distal one-fifth of femur as well as tibia and all tarsi are almost uniformly dark brown; in the middle and hind legs, femur has a distal dark band, tibia has both a distal and a basal dark band, tarsus I is pale on the basal half and dark brown on the distal half, while tarsi II to V are all dark brown. Tarsus I without long beards (BR = 2.0). Leg ratio is relatively high (LR = 1.8).

Abdomen: Coloration of abdominal tergites is an important key character of this species (Fig. 64); the ground color is yellow or slightly greenish yellow, and each segment

has a dark brown band; tergite I has a pale proximal band and a large distal dark area which covers almost two thirds of the segment (this segment is entirely pale in *flaviplumus* and *yoshimatsui*); tergites II and III has a wide basal dark band whose posterior margin is V-shaped (produced posteriorly in the middle); tergites IV, V and VI are largely dark except for the narrow pale bands on the proximal and distal margin; tergite VIII and IX as well as hypopygium are entirely dark brown.

Hypopygium: Anal point is slender and expanded distally into a hyaline knob. Distal process of dorsal appendage is bare, highly chitinized, almost the same in width from the base to near the distal end (D-type), and not distally expanded as in *flaviplumus* and *yoshimatsui*. Ventral appendage as usual, with some 13 recurved bristles which are almost simple (not conspicuously branched as in *nipponensis*). Style slender, the distal half being attenuated, with seven apical bristles which are all relatively long and strong.

Female. Coloration generally as in the male, except for that abdominal tergites are devoid of the conspicuous pale bands seeen in the male. Antenna 6 segmented (0.04, 0.11, 0.11, 0.13, 0.13, 0.24 mm). Palpus 4 segmented (0.06, 0.22, 0.24, 0.35 mm). Frontal tubercle small, 0.015 mm long and 0.013 mm wide.

Thoracic ground color grey and highly pruinose. Median and lateral vittae are uniformly black or dark brown. Scutellum brown. Postnotum nearly black. Halteres pale yellow. Leg coloration as in the male; in the front leg, femur is largely pale except for the distal one-fifth which is brown, while tibiae and all tarsi are dark brown; in the middle and hind legs, distal part of femur, both distal and basal parts of tibia, and basal half of tarsus I are pale, and the other parts of these segments as well as tarsi II to V are dark brown. Leg ratio is about 1.9 (largest among the *Chironomus* species examined in this study). Wing about 3.6 mm long and 1.1 mm wide; wing membrane uniformly milky white; r-m not pigmented; R(2+3) is much closer to R(1) than to R(4+5); fCu slightly distal to r-m.

Abdominal tergites are almost entirely black or dark brown, but tergites II to VII have a narrow apical pale band.

Pupa. Caudolateral scales of the 8th abdominal segment are forked near the tip to 3 or 4 long and slender spurs.

Larva. With a pair of relatively long caudolateral processes on the 7th abdominal segment, and two pairs of relatively long blood gills of the 8th abdominal segment. Anal gills somewhat longer than half the length of posterior pseudopods.

(9) *Chironomus yoshimatsui* Martin et Sublette, 1972

References. This scientific name was attributed, by Martin and Sublette (1972, p.1), to the most common species regarded by previous Japanese workers as *Chironomus dorsalis*, or 'Sesujiyusurika' in Japanese common name. Detailed descriptions were given for male, female, larva and pupa as well as the chromosomal patterns. The materials studied were from Yamaguchi and Shizuoka, Japan.

Prior to this report, Esaki (1932, p.164) and Esaki (1950, p.1564) recorded *Chironomus dorsalis* Meigen as a most common species found in Japan; the figures given in the text indicate that he probably dealt with the species now called *'yoshimatsui'* because the second abdominal tergite bears a narrow transverse dark band; he also stated that the larvae are abundant in ditches and small streams.

Larva and pupa of "*Tendipes dorsalis*" were described and illustrated by Tokunaga (1959, 1973, p.644). He stated "the larva has two pairs of long blood gills on the 8th abdominal segment, and occasionally also has a pair of short blood gills on the caudolateral parts of the 7th segment." The larva illustrated in this text is a *plumosus*-type and not the *yoshimatsui*-type.

Materials studied. Specimens of larvae, pupae and adults showing typical key characters of *C. yoshimatsui* were collected very abundantly from Kandagawa River (Tokyo), at Hase, Kamakura (Kanagawa), Arakawaoki (Ibaraki), Tsuchiura (Ibaraki), and Kamisuwa (Nagano). The breeding places were all highly polluted running waters in sewage ditches.

Key characters. Adult is quite similar in coloration to *C. flaviplumus*, hardly distinguishable in the female. In the male this species is characterized by possessing a narrow transverse dark band on abdominal tergites II, III and IV. Dorsal appendage of male hypopygium is S-type, but less angulate than in *C. flaviplumus*. In both sexes, the relative length of front tarsus V is smaller than in *C. flaviplums*. In the pupa, the caudolateral scale on the 8th abdominal segment has rather stout and short apical spurs. The larva breed in running water of sewage ditches, and distinguishable from all the other species studies here by the absence of caudolateral process on the 7th abdominal segment, while the 8th abdominal segment has two pairs of long blood gills.

Male.

Head: Antenna 12 segmented, hairs brown, antennal ratio around 3.0 (smaller than *C. flaviplumus*). Palpus 4 segmented (0.08, 0.26, 0.27, 0.37 mm). Frontal tubercle 0.029 mm long and 0.012 mm wide.

Thorax: Scutal ground color greenish yellow; scutal stripes orange yellow. Scutellum greenish yellow. Postnotum orange yellow as in the scutal stripes. Halteres pale yellow, with a dark area along the apical margin. Wing length 3.4 mm (medium as a *Chironomus*); wing membrane uniformly colorless and semi-transparent; r-m slightly pigmented; R(2+3) not so closely set to R(1) as in *C. flaviplumus*; fCu slightly distal to r-m.

Legs: Coloration rather uniform, femora and tibiae are largely pale brown, while tarsal segments are generally darker, and the apical tarsal dark bands are less conspicuous than in *C. flaviplumus*. The ratio of front tarsus I to front tibia (leg ratio) is relatively high (1.6), but that of front tarsus V to front tibia is about 0.26, and thus smaller than *C. flaviplumus*, in which the value is about 0.40.

Abdomen: Ground color of abdominal tergites pale yellow or greenish yellow. Tergite I largely pale and without a dark patch. Tergite II, III and IV each with a transversal dark band in the middle portion, which is narrowest in tergite II and widest in tergite IV (these dark patches are oval in *C. flaviplumus*). Tergites V and VI largely dark brown, each with an inconspicuous pale area along the basal margin. Tergites VII, VIII and IX as well as hypopygium entirely black.

Hypopygium: Similar to *C. flaviplumus*; the dorsal appendage is S-type, conspicuously expanded apically, and with a rounded lateral margin. Ventral appendage as usual.

Female. Coloration similar to the male, but the dark areas on abdominal tergites are expanded to cover nearly the entire dorsal surface of abdomen, and thus closely resembling the female of *C. flaviplumus*.

Head: Antenna 6 segmented, the flagellomeres 0.19, 0.14, 0.15, 0.14, 0.21 mm long, respectively. Palpus 4 segmented, 0.06, 0.31, 0.27, 0.47 mm long, respectively (the last

segment is significantly longer than in *C. flaviplumus*).. Frontal tubercle 0.036 mm long and 0.014 mm wide.

Thorax: Coloration of scutum as in the male, and practically indistinguishable from the female of *C. flaviplumus*. Wing 3.8 mm long and 1.1 mm wide; venation as in the male. Legs with coloration as in the male; femora and tibiae pale brown, tarsal segments largely brown, and distal ends of tarsus I, II and III as well as the entire segments of tarsus IV and V are slightly darker than the rest parts of tarsi.

Abdomen: Nearly the entire surface of abdominal tergites are dark brown or black; tergites I to V each with an inconspicuous narrow pale band along the caudal margin.

Pupa. Caudolateral scales on the 8th abdominal segment have stout, short, but apically pointed spurs.

Larva. Differs from all the other species by the absence of caudolateral process on the 7th abdominal segment (a minute process was found in one of the specimens examined, as illustrated in Fig. 79), while the 8th abdominal segment bears two pairs of blood gills, whose sizes are quite variable, as reported by Matsuzaki et at. (1977). Anal gills are about half as long as the posterior pseudopods.

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Note. References with * are described only in Japanese, and the titles were translated into English by the present author.

EXPLANATION OF FIGURES

1. Schematic drawing of a male, *Chironomus kiiensis* (hairs are omitted)
2. Abdominal segments of a pupa, *Chironomus kiiensis*
3. Schematic drawing of a chironomid larva, *Chironomus kiiensis*

Chironomus acerbiphilus **Tokunaga**

4. Wing venation (male and female)
5. Male hypopygium
6. Tips of caudolateral scales on the 8th abdominal segment of pupa
7. Appendages on male hypopygium (anal point, dorsal appendage, ventral appendage, tip of style)
8. Organs of female (cercus, palp, antenna, hind tarsus V)
9. Caudal part of larva
10. External appendages of larva (antenna, labial plate and paralabial plate, mandible, hooks on anterior pseudopod, hooks on posterior pseudopod)

Chironomus circumdatus **(Kieffer)**

11. Coloration of thorax and abdominal tergites (male and female)
12. Wing venation (male and female)
13. Coloration of leg segments (male)
14. Male hypopygium (left half)
15. Appendages of male hypopygium
16. Variation of the tip of caudolateral process of the 8th abdominal segment of pupa.
17. Caudal part of larva
18. External appendages of larva

Chironomus flaviplumus **Tokunaga**

19. Coloration of thorax and abdominal tergites (male and female)
20. Wing venation (male and female)
21. Apical comb scales of hind tibia
22. Size and coloration of leg segments
23. Male hypopygium (right half)
24. Anal point (lateral aspect)
25. Appendages of male hypopygium (tip of style, dorsal appendage, ventral appendage)
26. Caudolateral scales on the 8th abdominal segment of pupa
27. Caudal part of larva (ventral aspect)
28. Caudal part of larva (lateral aspect)
29. External appendages of larva

Chironomus kiiensis **Tokunaga**

30. Coloration of thorax and abdominal tergites (male and female)
31. Wing venation (male and female)
32. Relative size and coloraton of leg segments
33. Caudolateral scales of 8th abdominal segment (pupa)
34. Male hypopygium (right half)
35. Anal point (dorsal aspect)
36. Appendages of male hypopygium (tip of style, dorsal appendage, ventral appendage)
37. Caudal part of larva (ventral aspect)
38. Caudal part of larva (lateral aspect)
39. External appendages of larva

Chironomus nipponensis **Tokunaga**

40. Coloration of thorax and abdominal tergites (male and female)
41. Wing venation (male and female)
42. Relative size and coloration of leg segments (male)
43. Caudolateral scales on the 8th abdominal segment (pupa)
44. Male hypopygium (right half)
45. Appendages of male hypopygium
46. Caudal part of larva (ventral aspect)
47. Caudal part of larva (lateral aspect)
48. External organs of larva

Chironomus plumosus **(Linnaeus)**

49. Coloration of thorax and abdominal segments (a: female, dark form; b: male, dark form; c: male, pale form)
50. Relative size and coloration of leg segments (male)
51. Caudaolateral scale of the 8th abdominal segment of pupa (V: ventral aspect; D: dorsal aspect)
52. Wing venation (male and female)
53. Male hypopygium

54. Appendages of male hypopygium (anal point, tip of style, dorsal appendage, ventral appendage)
55. Caudal part of larva (lateral aspect)
56. External appendages of larva

Chironomus salinarius **(Kieffer)**

57. Wing venation (male and female)
58. Relative size and coloration of legs (male)
59. Male hypopygium
60. Appendages of male hypopygium (anal point, dorsal appendage, ventral appendage)
61. Caudolateral scales of 8th abdominal segment of pupa
62. Caudal part of larva (lateral aspect)
63. External appendages of larva and pupa

Chironomus strenzkei, **n. sp.**

64. Coloration of thorax and abdomen (male and female)
65. Wing venation (male and female)
66. Relative size and coloration of legs (male)
67. Male hypopygium (right half)
68. Appendages of male hypopygium (tip of style, dorsal appendage, ventral appendage)
69. Caudolateral scales of the 8th abdominal segment of pupa
70. Caudal part of larva
71. External appendages of larva

Chironomus yoshimatsui
Martin et Sublette

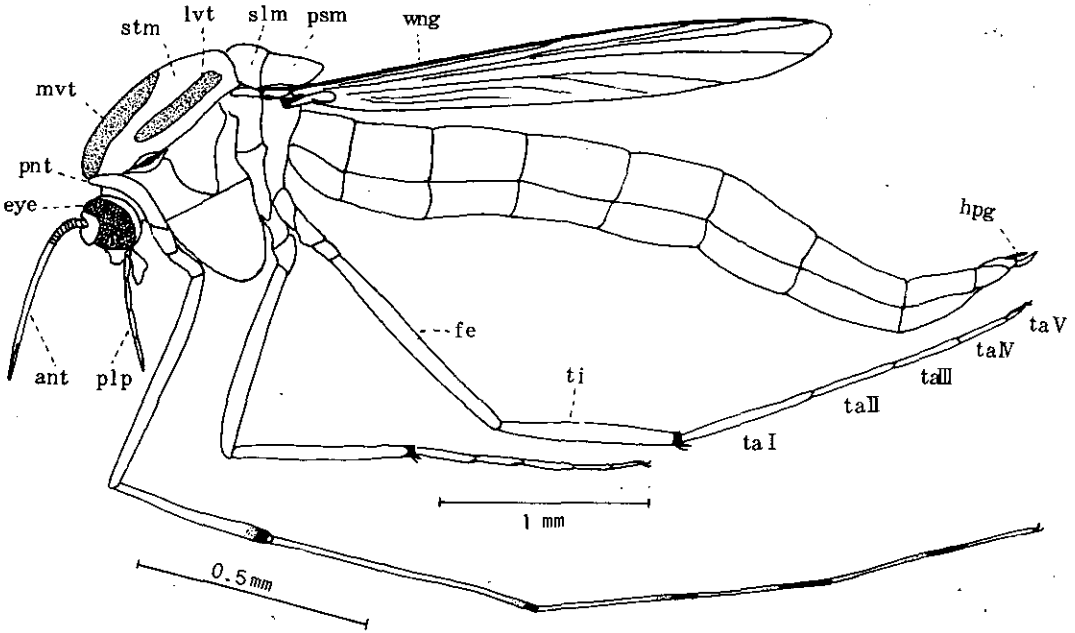
72. Coloration of thorax and abdominal tergites (male and female)
73. Wing venation (male and female)
74. Relative size and coloration of legs (male)
75. Caudolateral scales of the 8th abdominal segment of pupa
76. Male hypopygium (right half)
77. Appendages of male hypopygium
78. Caudal part of larva (ventral aspect)
79. Caudal part of larva (lateral aspect)
80. External appendages of larva

ABBREVIATIONS

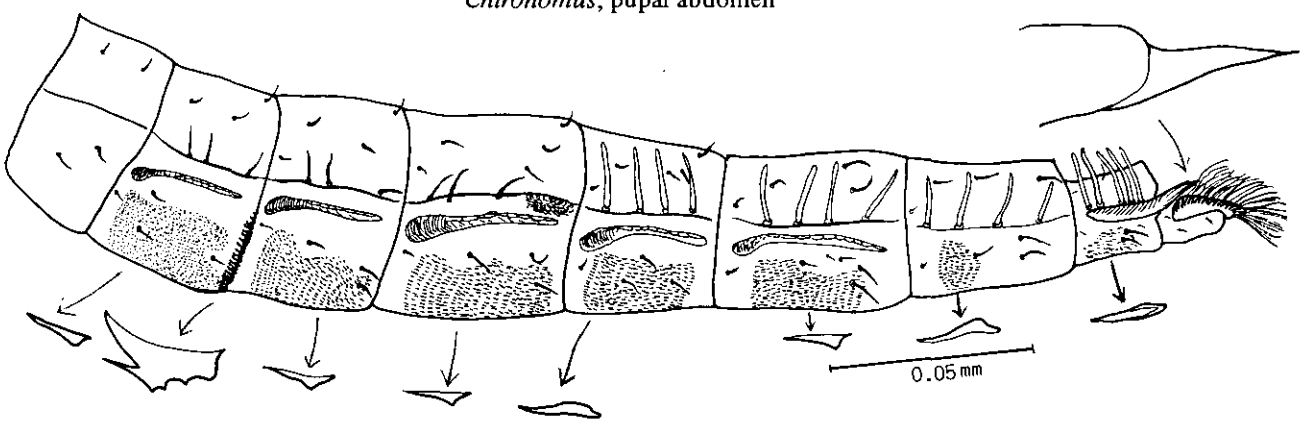
abd (abdomen); *abs* (abdominal sternite); *abt* (abdominal tergite); *anf* (anal fin of pupa); *ang* (anal gill of larva); *anp* (anal point of male hypopygium); *ant* (antenna of adult or larva); *blg* (blood gill on the 8th abdominal segment of larva); *cer* (cercus of female genitalia); *clp* (caudolateral process on the 7th abdominal segment of larva); *cls* (caudolateral scale on the 8th abdominal segment of pupa); *clw* (claw of leg); *Cs* (a wing vein costa); *ctb* (cephalic tubercle of pupa); *Cu* (a wing vein); *cx* (coxa of leg); *dap* (dorsal appendage of coxite, male hypopygium); *emp* (empodium of leg); *emr* (epimeron of thorax); *est* (episternal suture of thorax); *eye* (eye of adult or larva); *fcl* (frontoclypeus of head); *fe* (femur of leg); *hap* (hooks on anterior pseudopods of larva); *HD* (head); *hpp* (hooks on posterior pseudopods of larva); *hpg* (hypopygium); L-I (the first leg, or front leg); L-II (the second leg, or middle leg); L-III (third leg, or hind leg); *lbp* (labial plate, or mental plate, of larval mouth); *lvt* (lateral vitta, or lateral stripe, on scutum of thorax); *M* (a wing vein); *mnd* (mandible); *msg* (mesothoracic stigma); *mvt* (median vitta, or median stripe, of scutum); *nes* (notoepisternum of thorax); *nsg* (notothoracic stigma); *pah* (preanal hair tuft of larva); *pap* (preanal papilla); *pbc* (proboscis); *plb* (paralabial plate of larva); *plp* (palp, or maxillary palp); *Plv* (pulvillus of leg); *ppp* (posterior pseudopod, or posterior proleg); *prm* (premandible of larva); *prt* (pronotum of thorax); *psm* (postscutellum, or postnotum); *Sc* (a wing vein subcosta); *ses* (sternepisternum); *slm* (scutellum of thorax); *stl* (style, or dististyle, of male hypopygium); *stm* (scutum of thorax); t-1, t-2, t-3, t-4, t-5 (the first, second, third, fourth and fifth tarsal segments of leg); THX (thorax); *ti* (tibia of leg); *tic* (tibial comb); *tr* (trochanter of leg); *tro* (thoracic respiratory organ of pupa); *vap* (ventral appendage of male hypopygium); *wng* (wing).

1

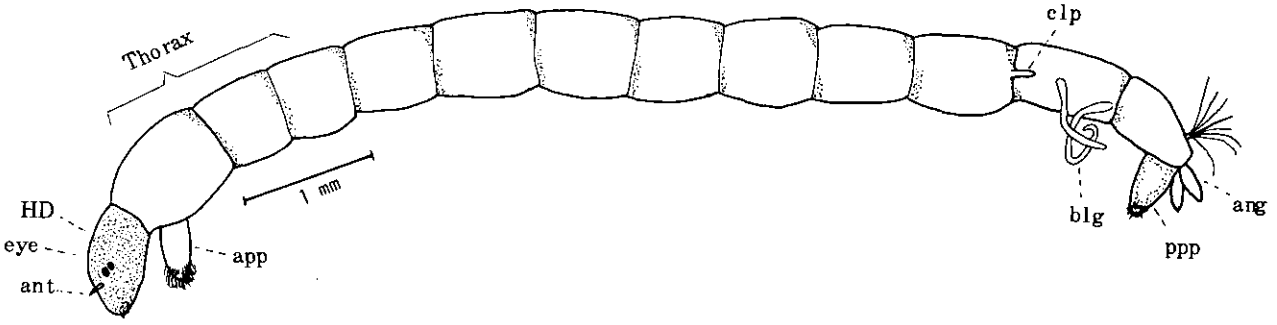
Chironomus, adult



2 *Chironomus*, pupal abdomen



Chironomus, larva



Chironomus acerbiphilus Tokunaga

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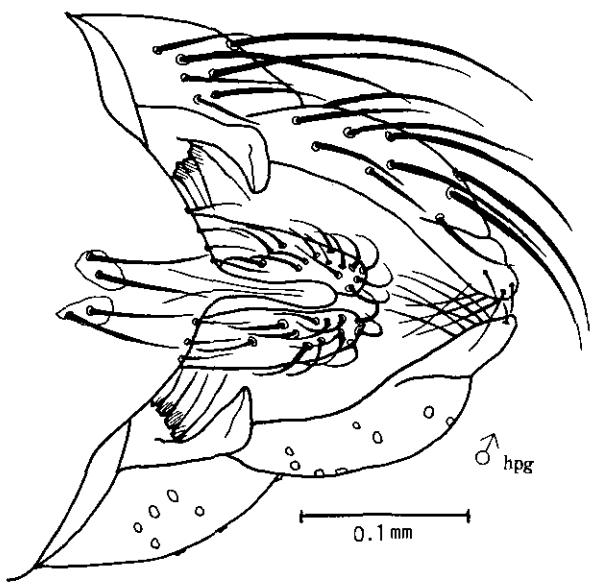

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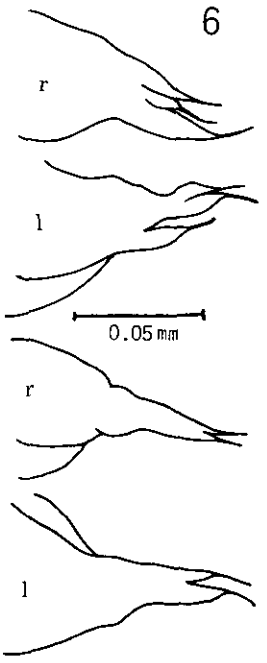

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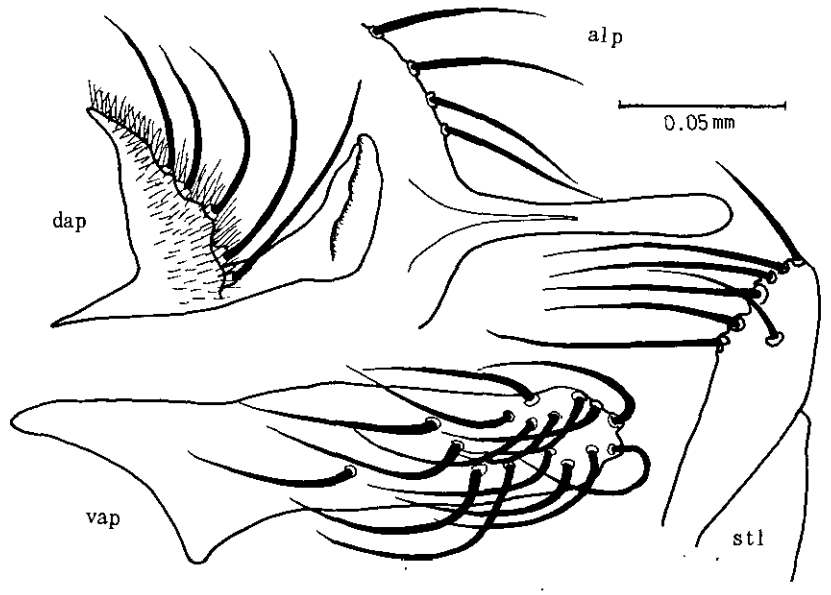

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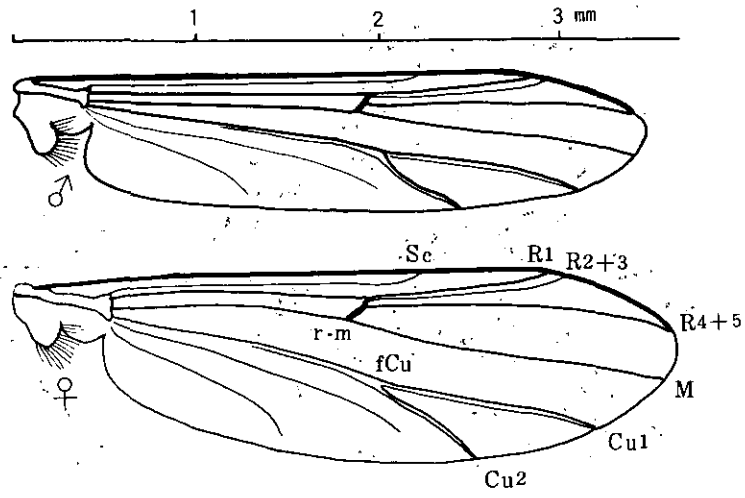
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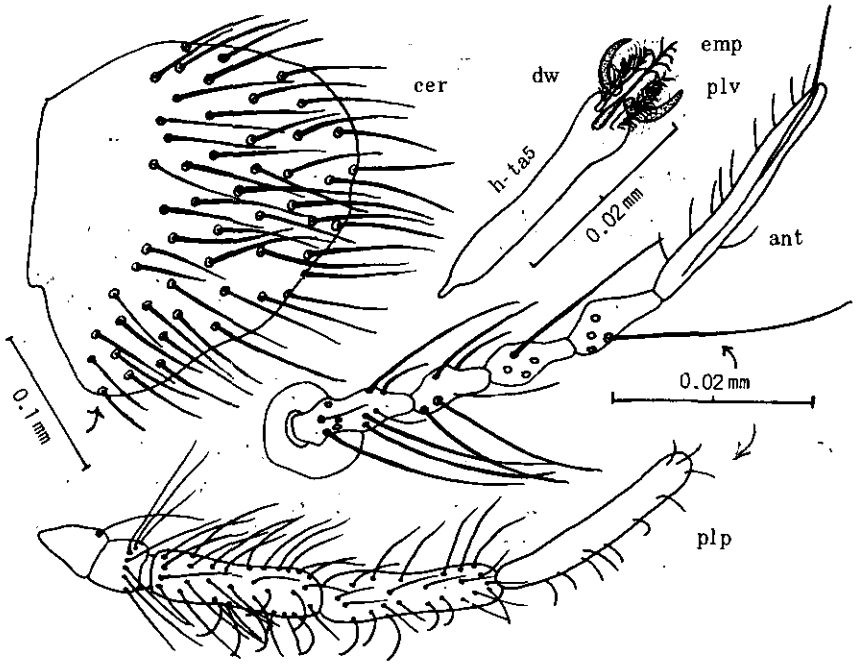
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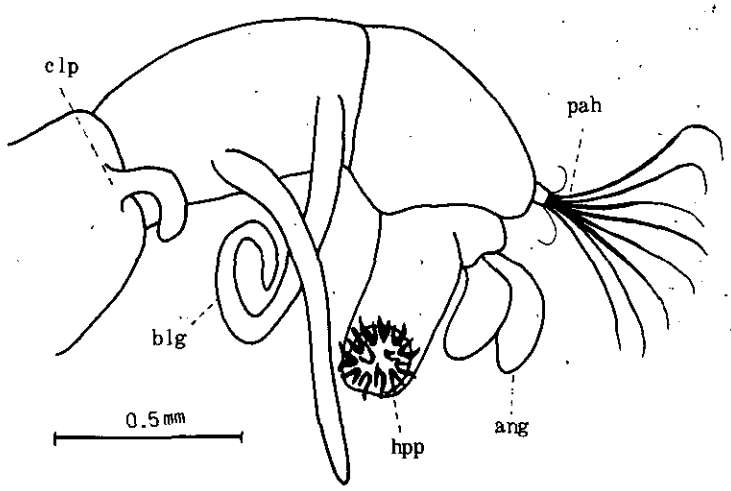

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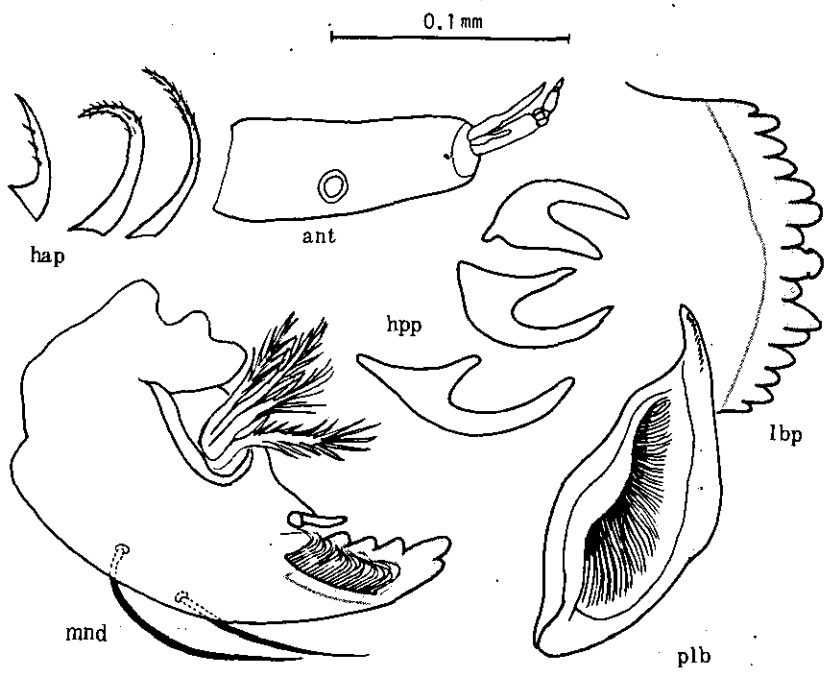

Chironomus circumdatus (Kieffer)

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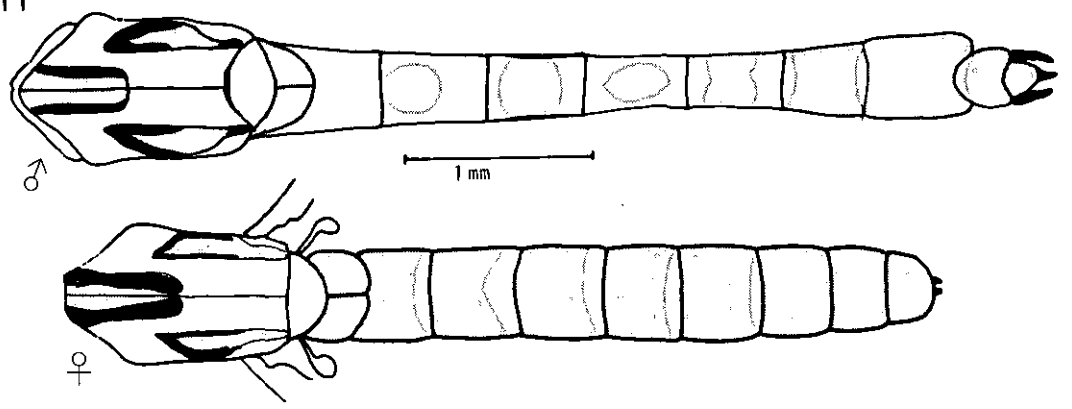

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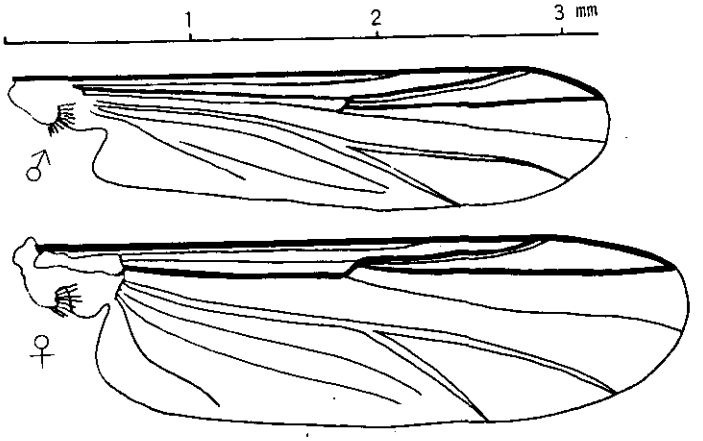

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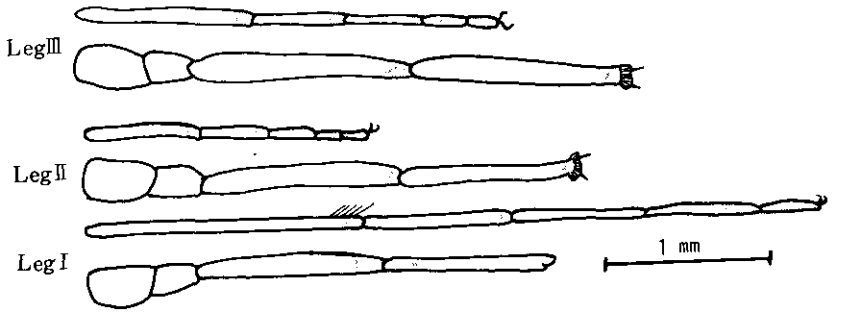

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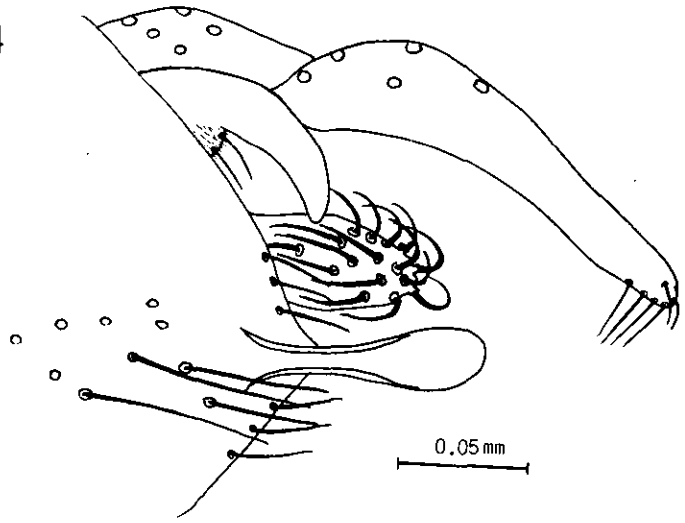

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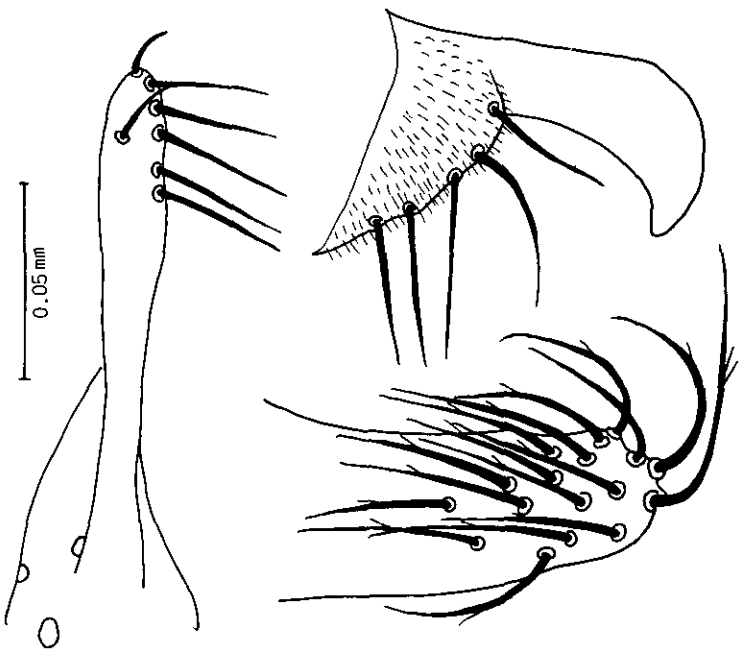

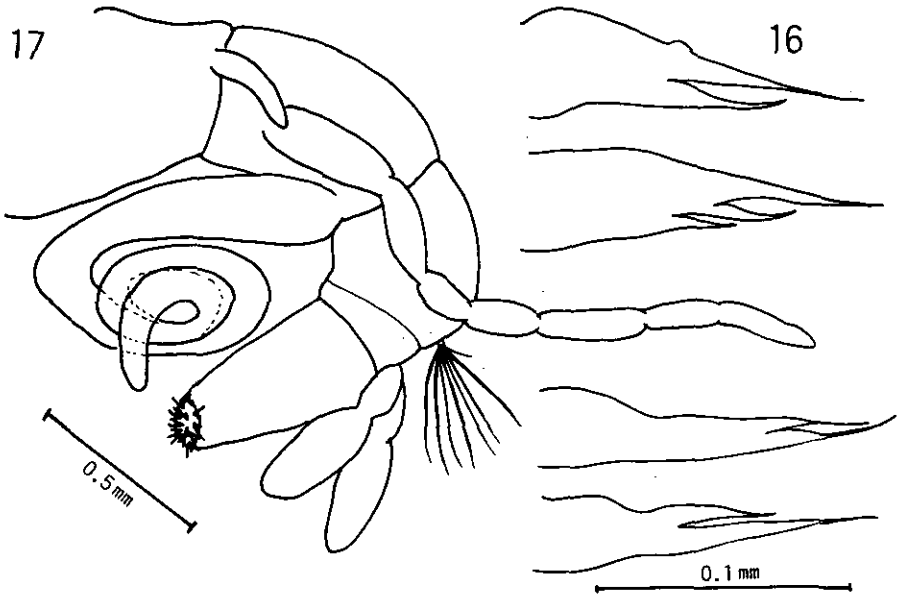
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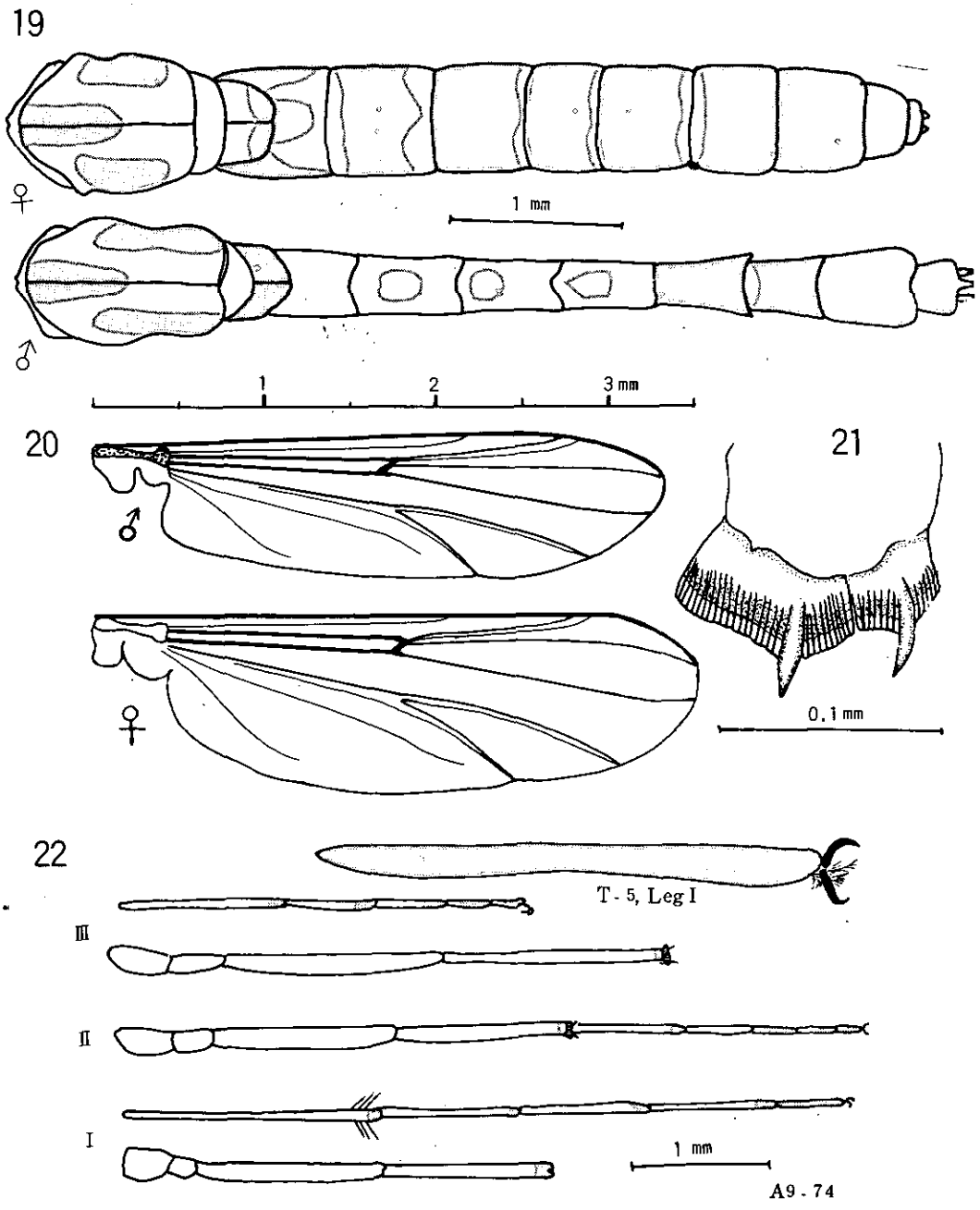
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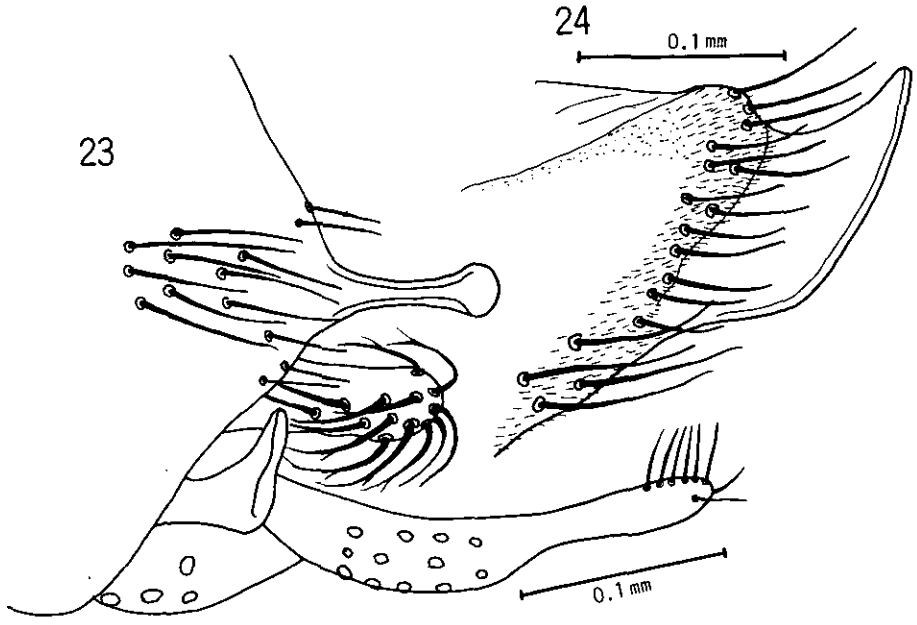
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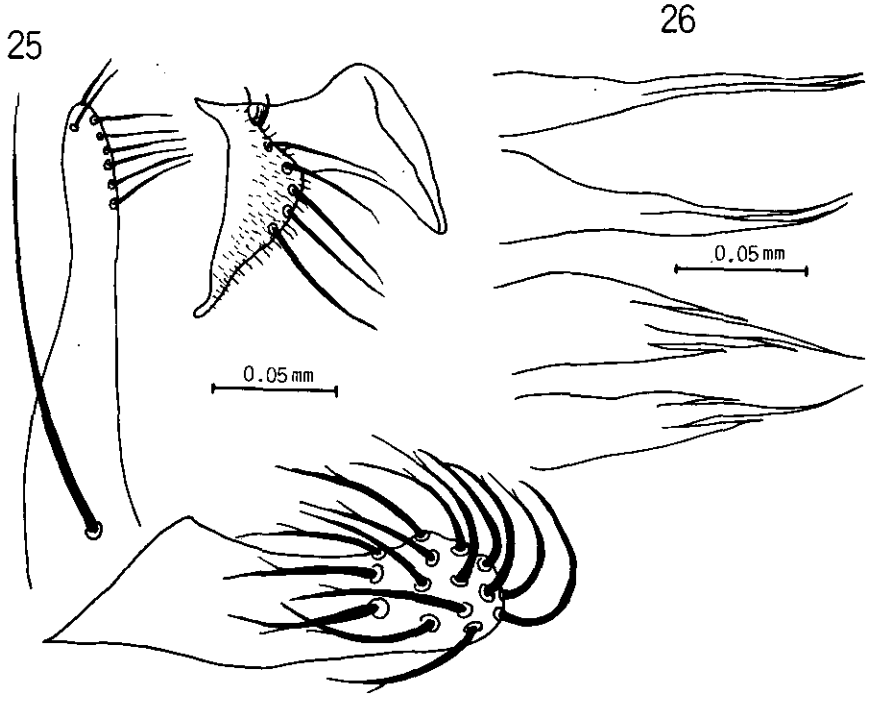
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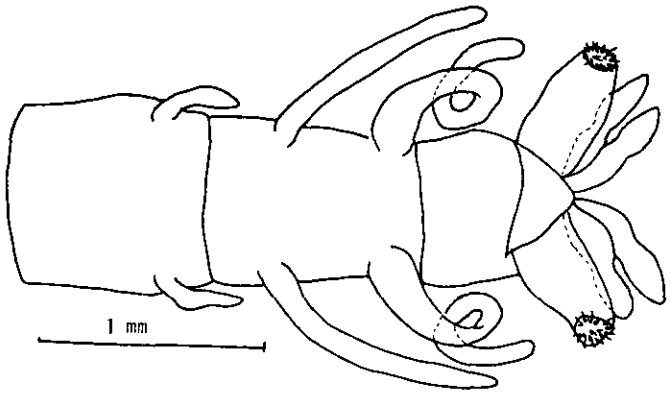

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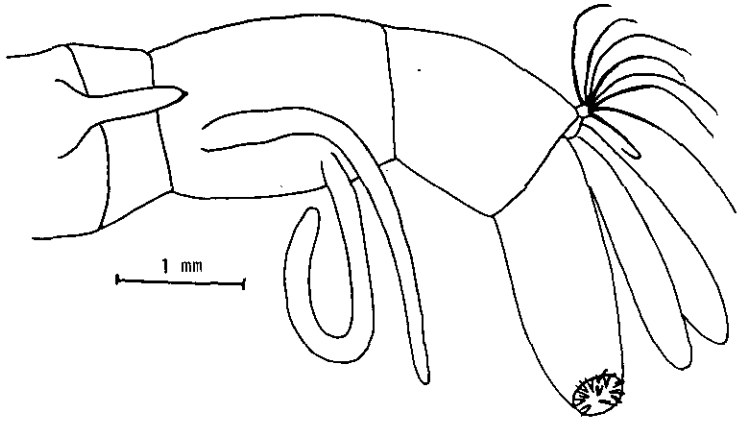

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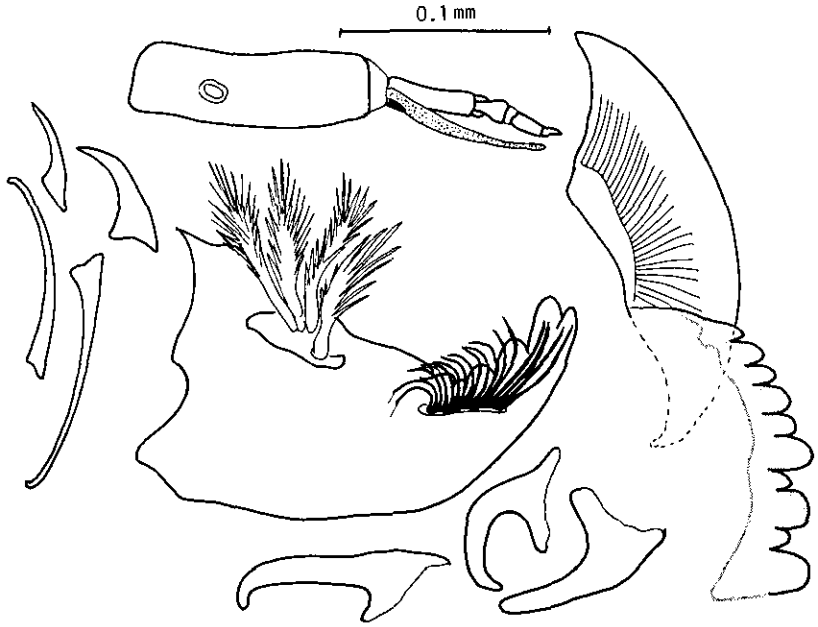

Chironomus kiiensis Tokunaga

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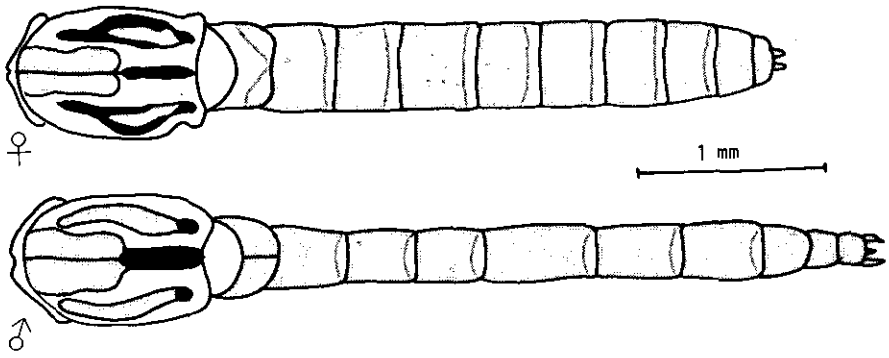

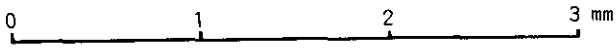

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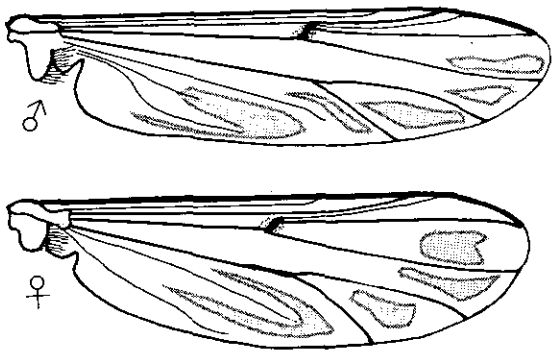

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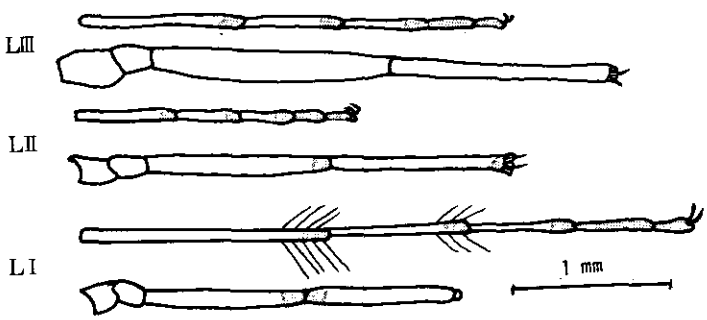

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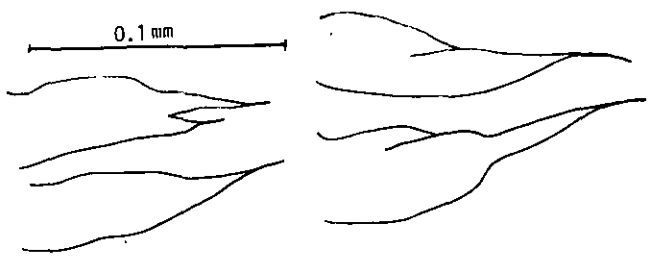

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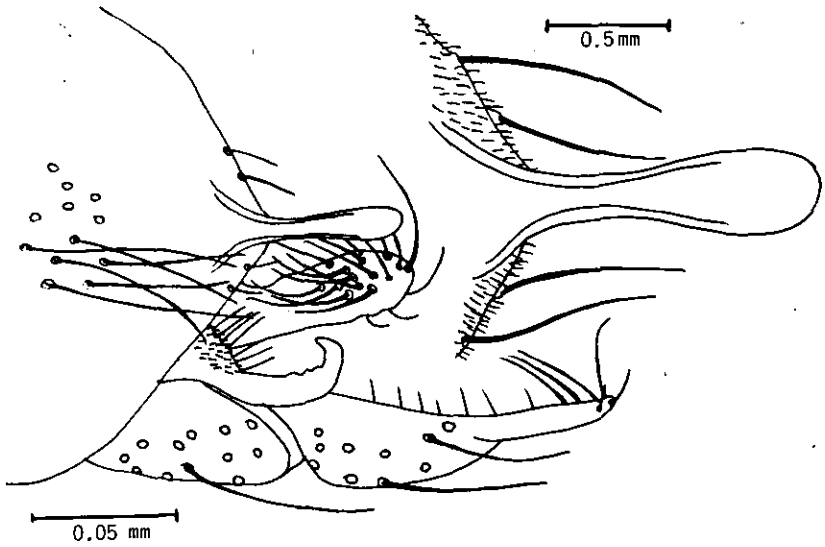

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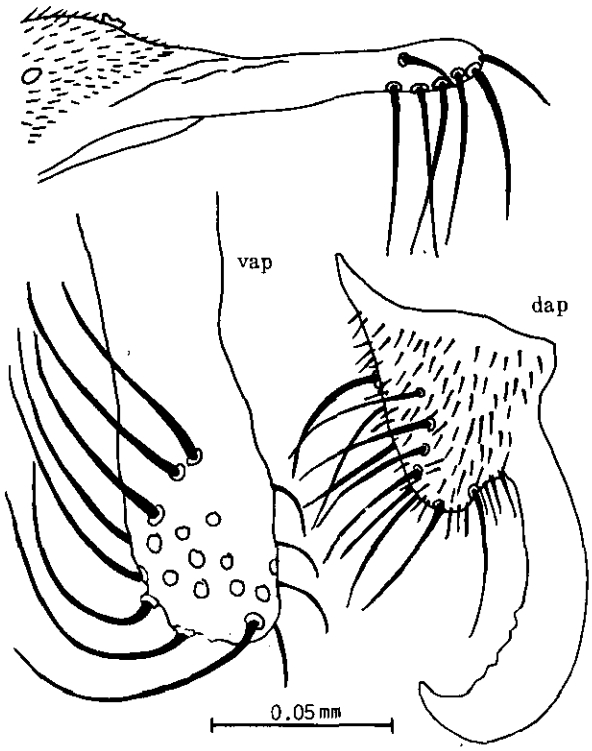

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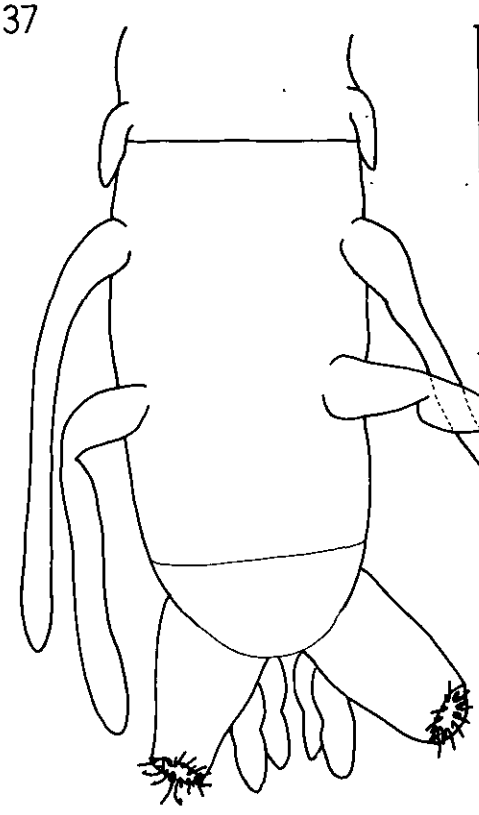

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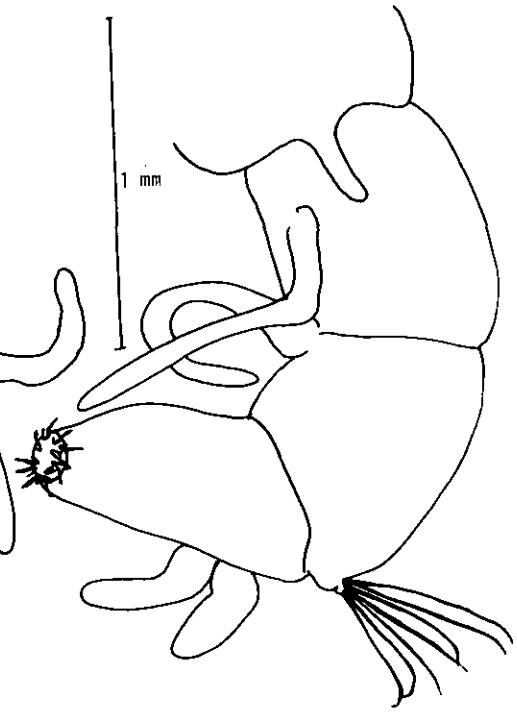

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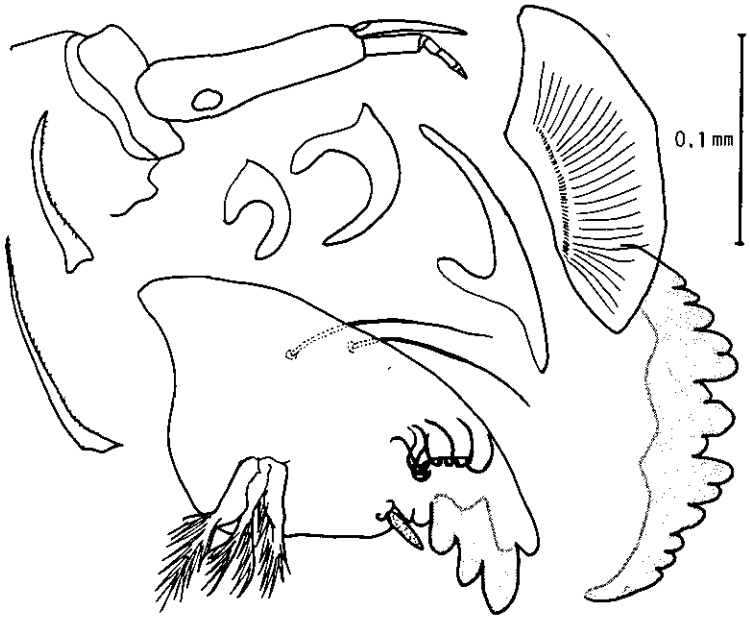

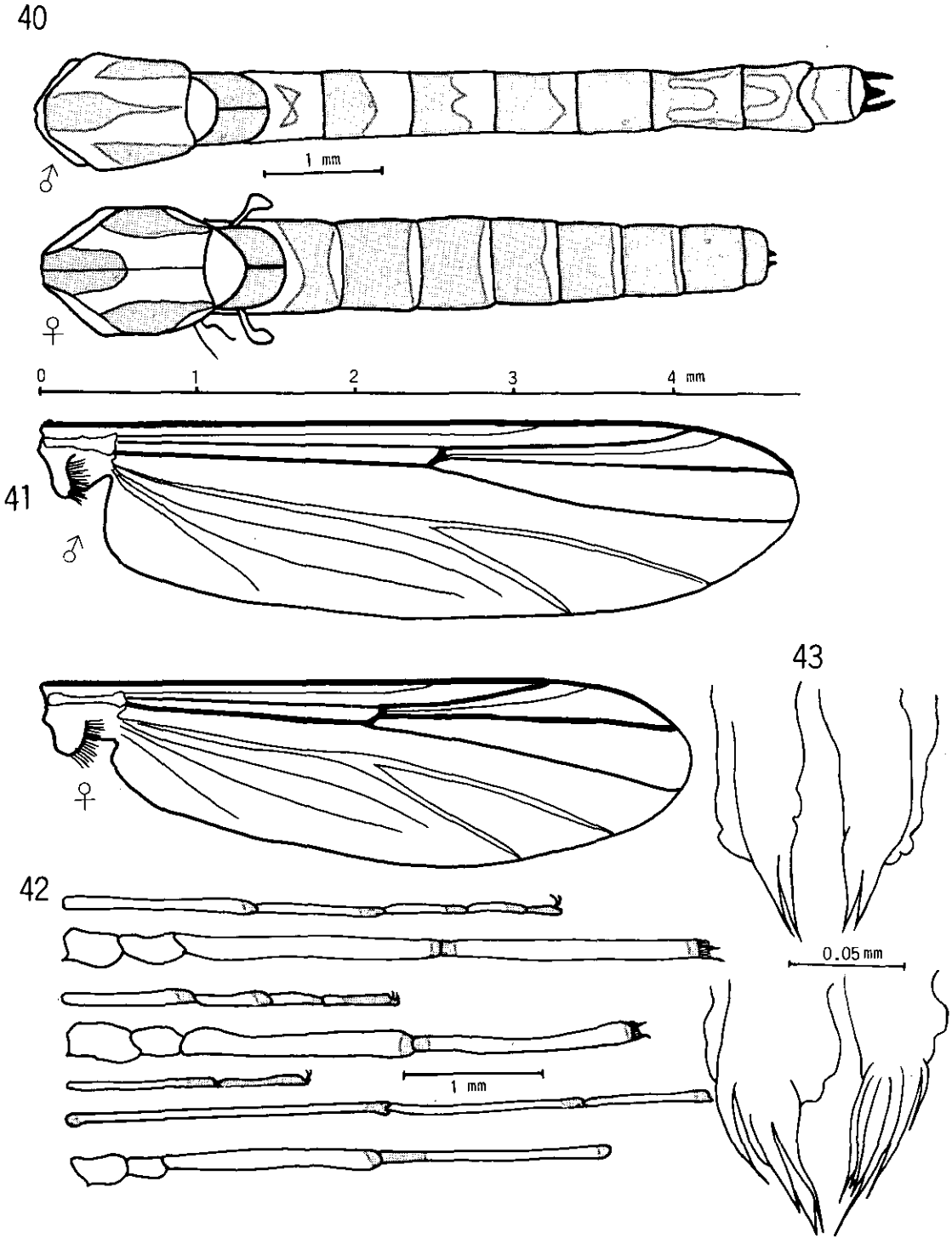
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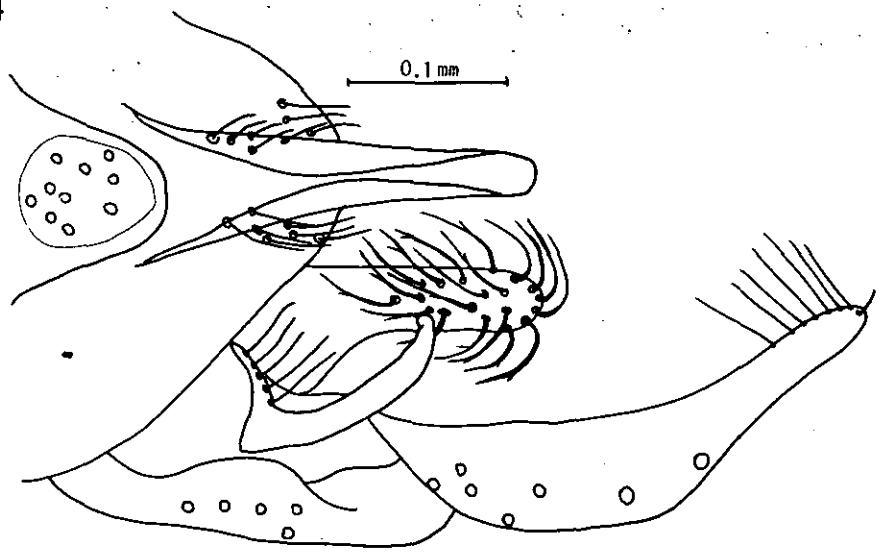
44



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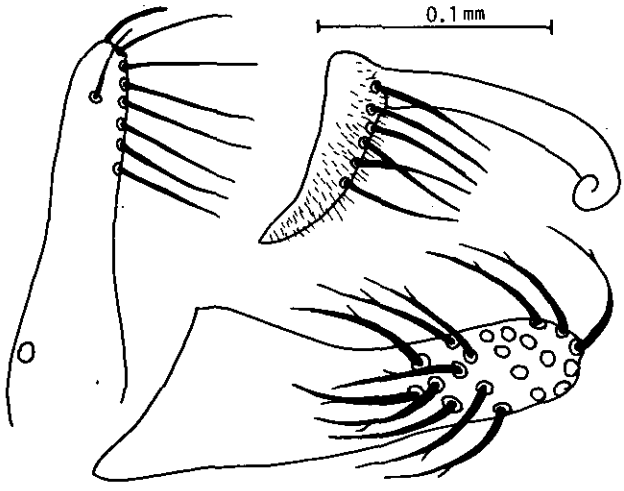

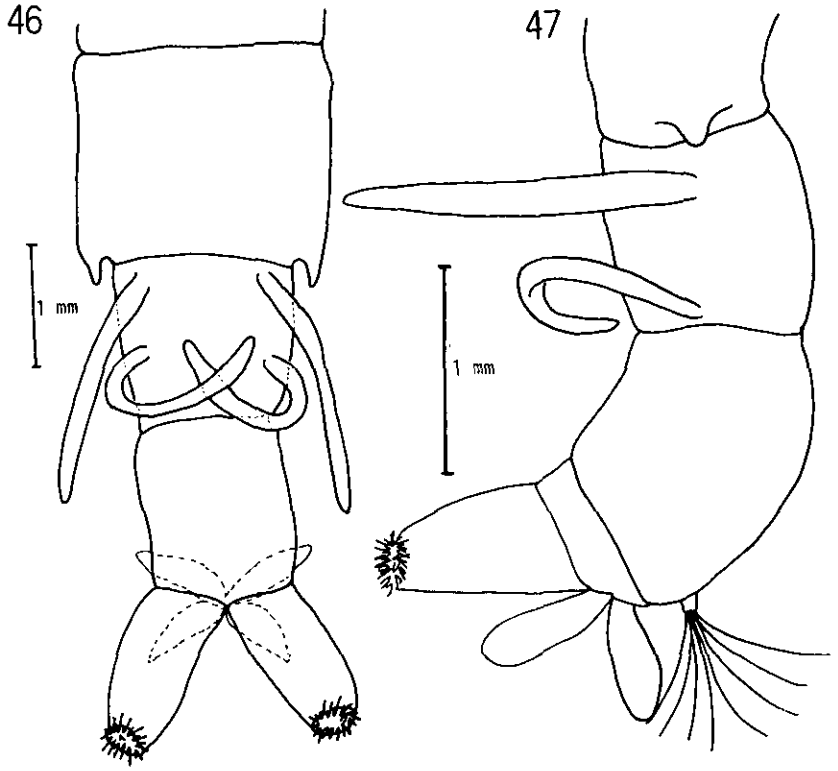
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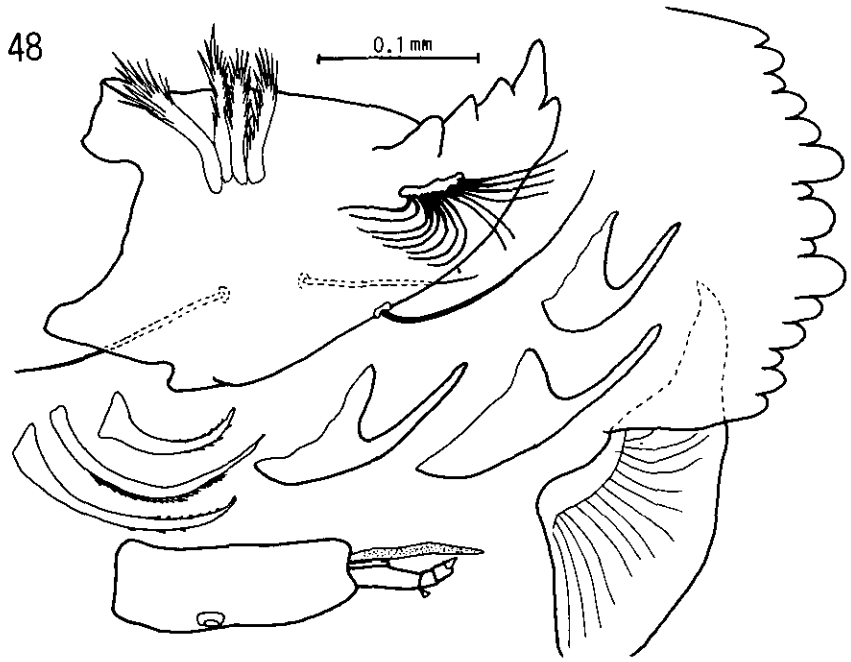
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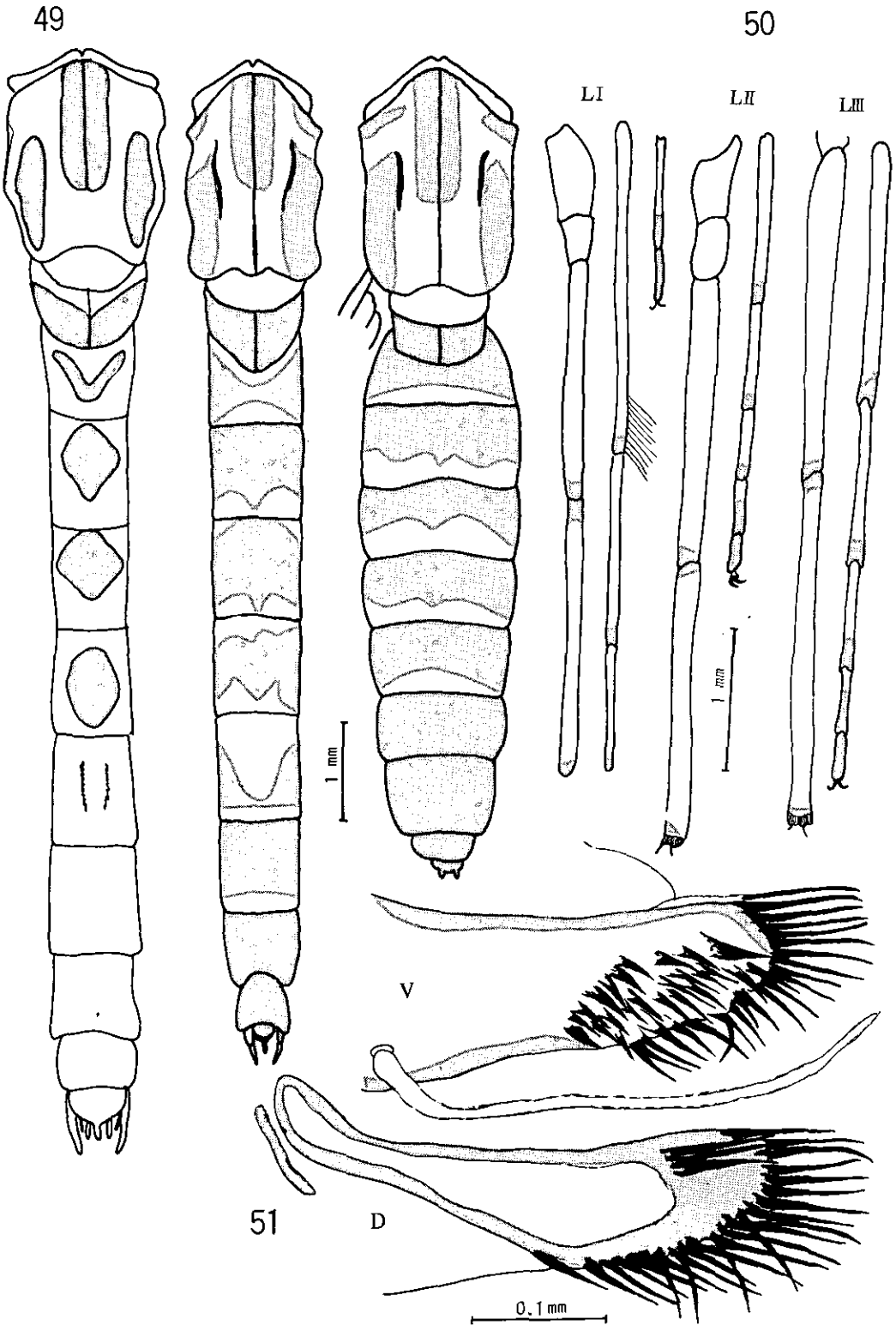
Chironomus plumosus (Linnaeus)



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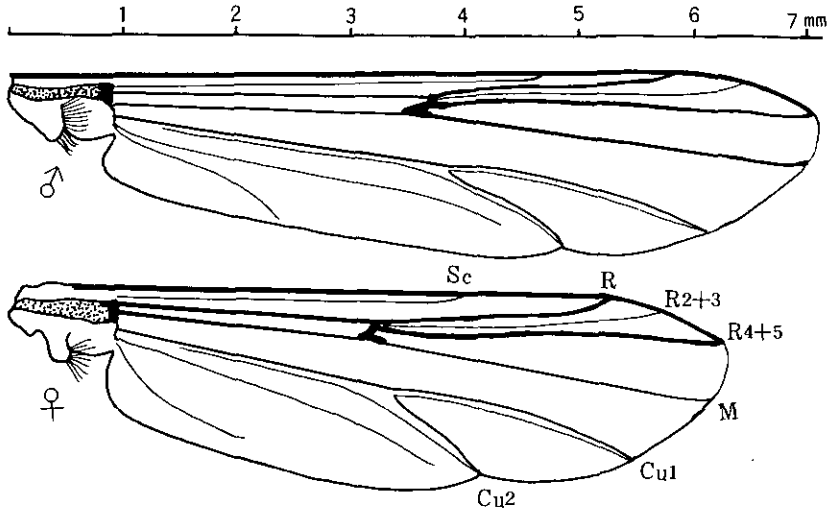

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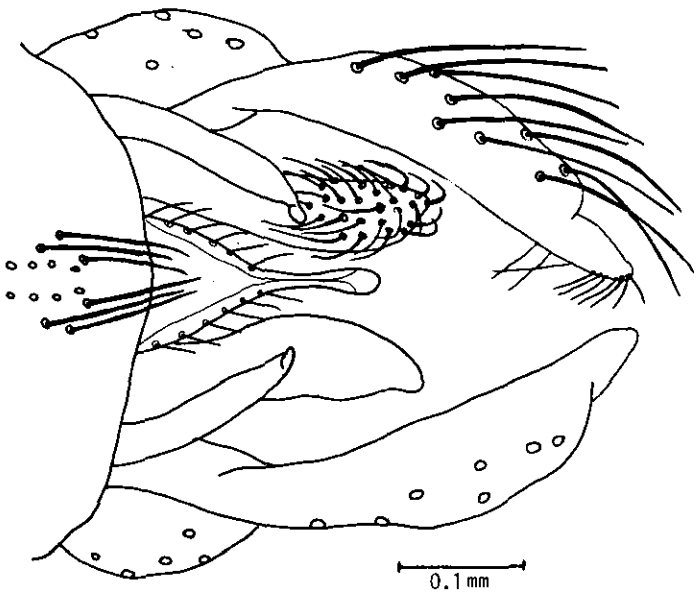

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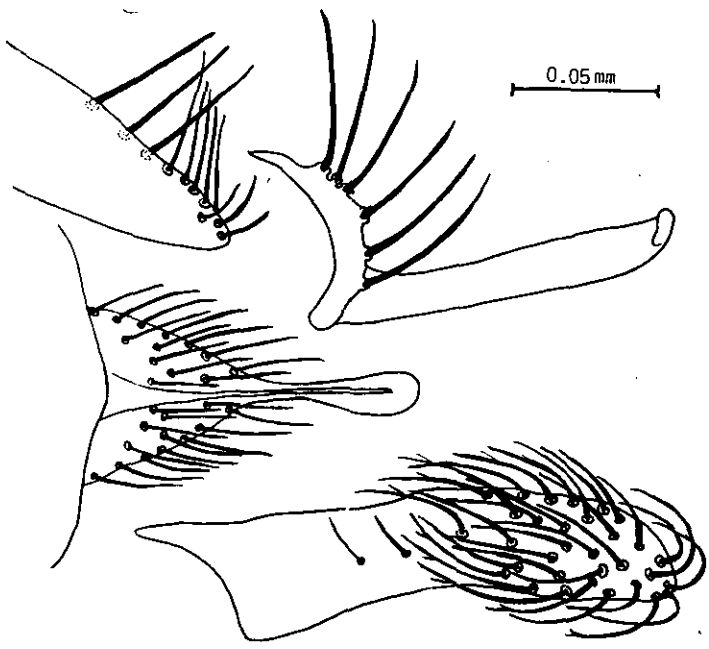

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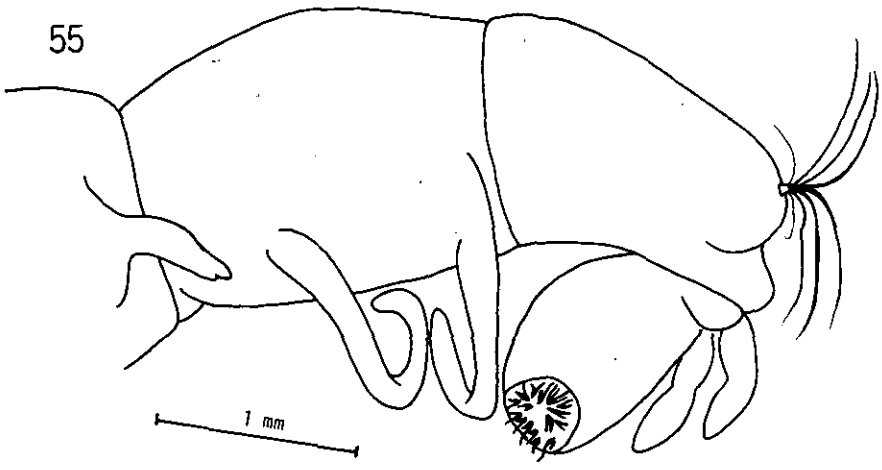

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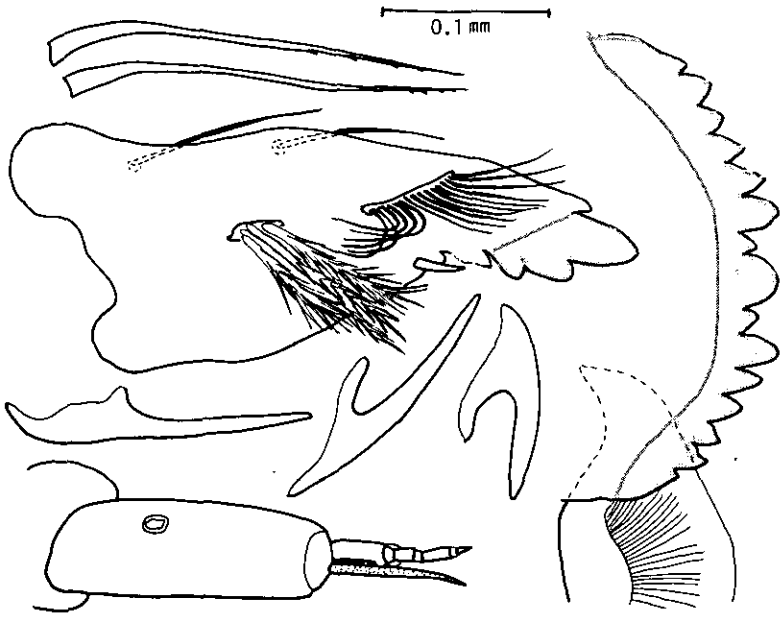

Chironomus salinarius (Kieffer)

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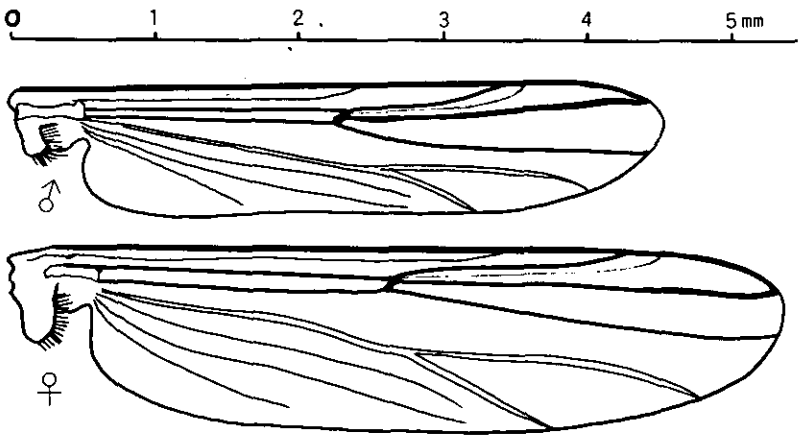

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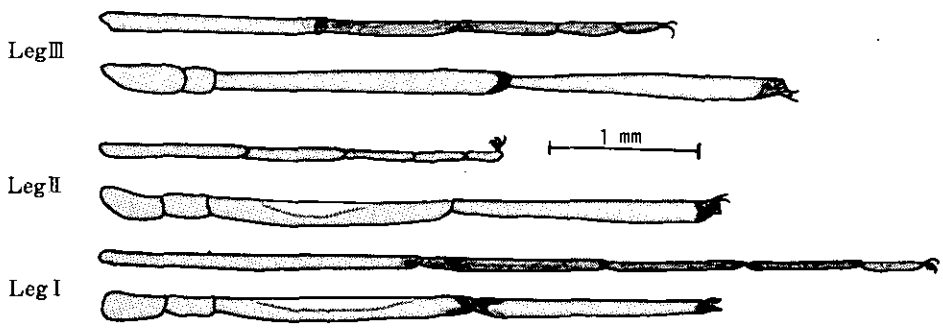

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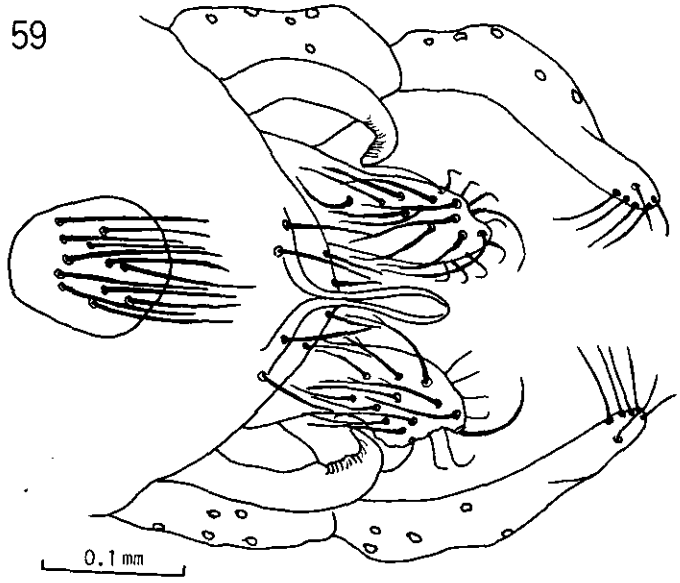

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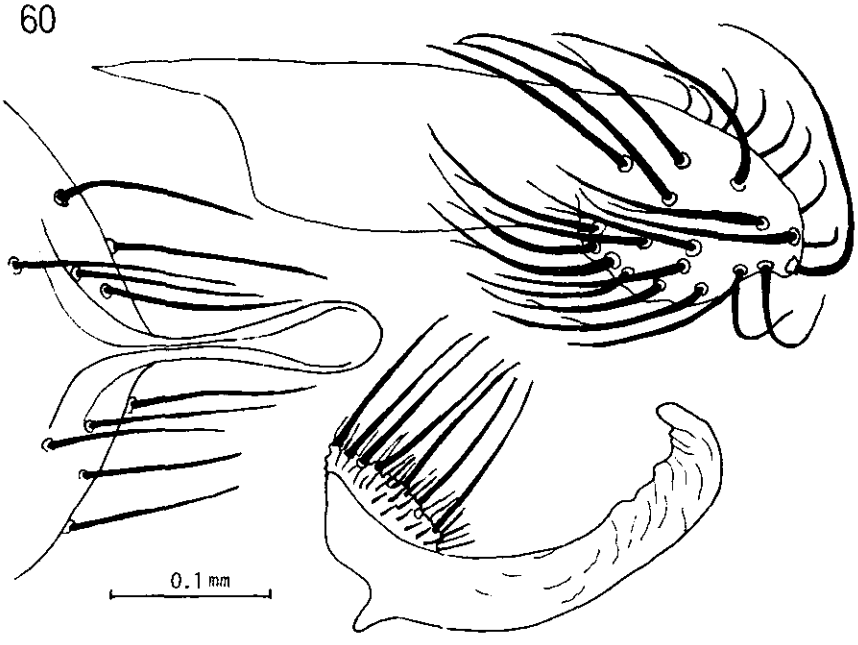

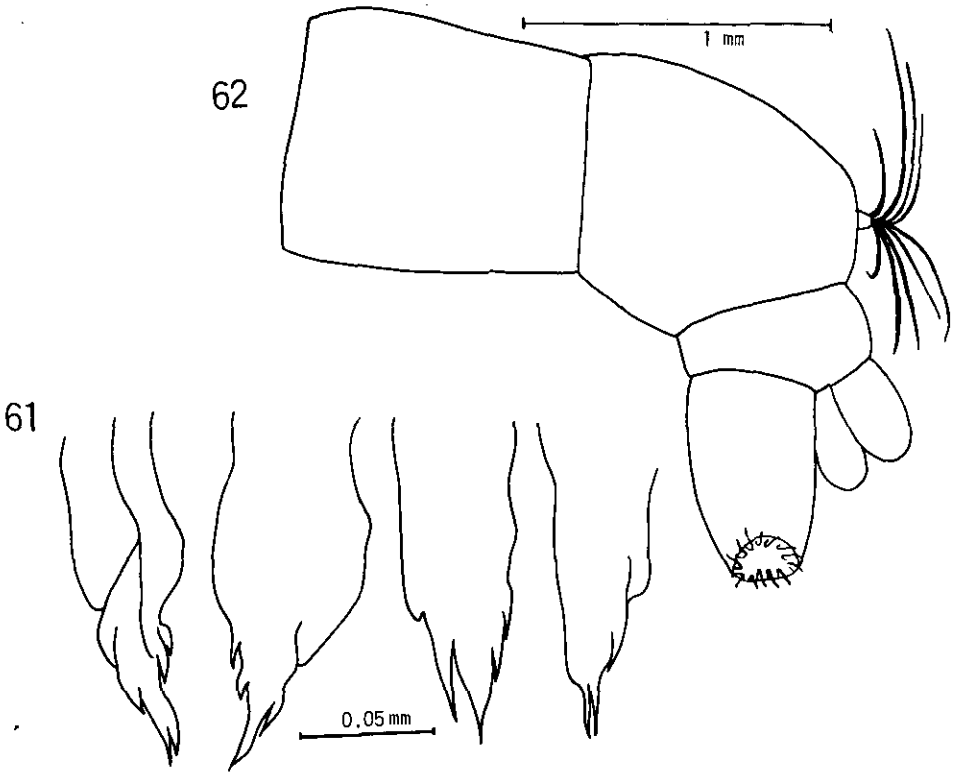
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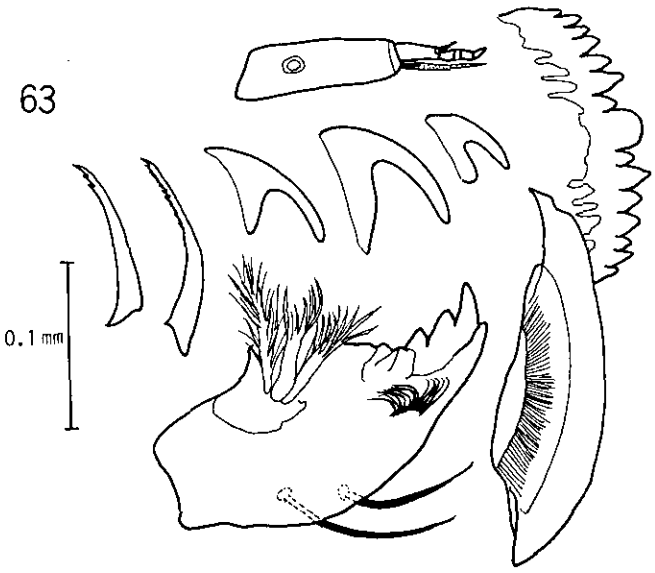
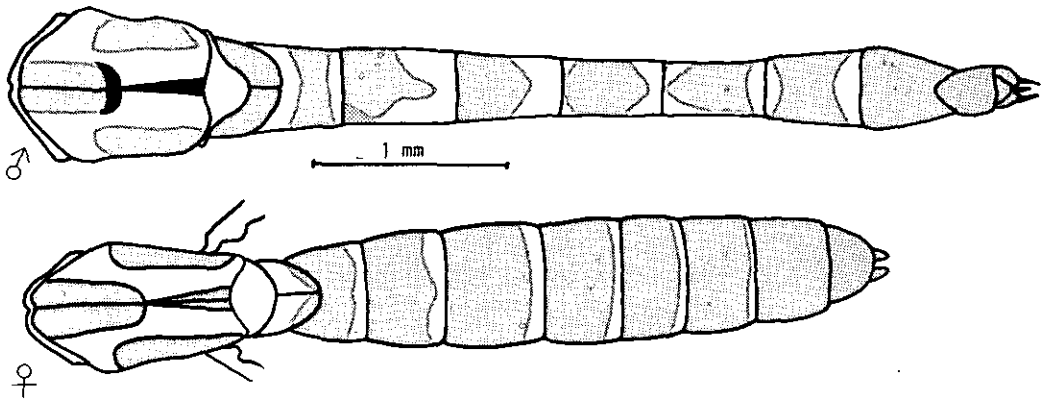
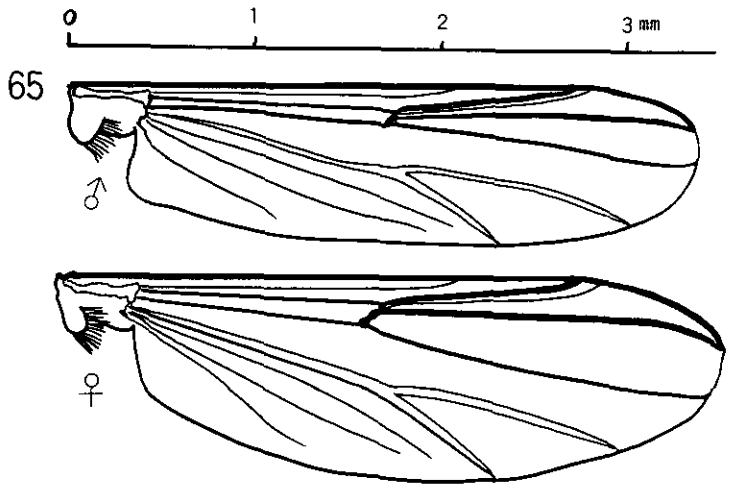
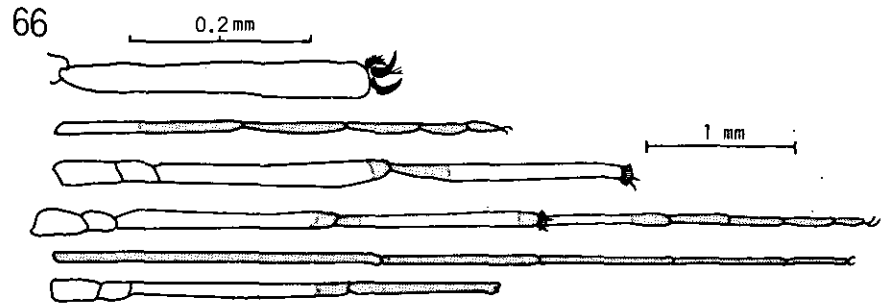
61
0.05 mm

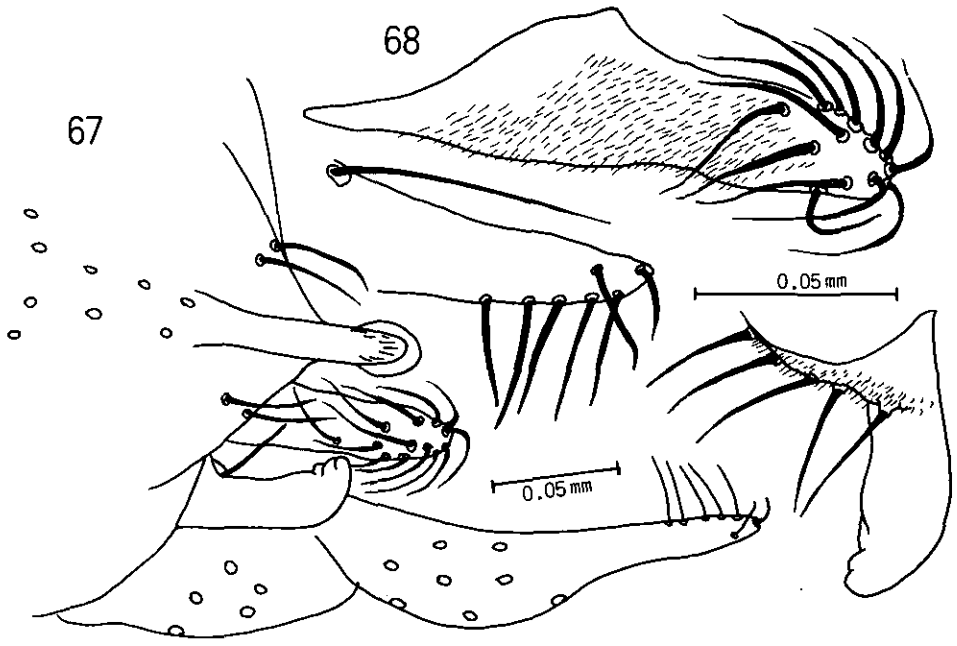

63
0.1 mm

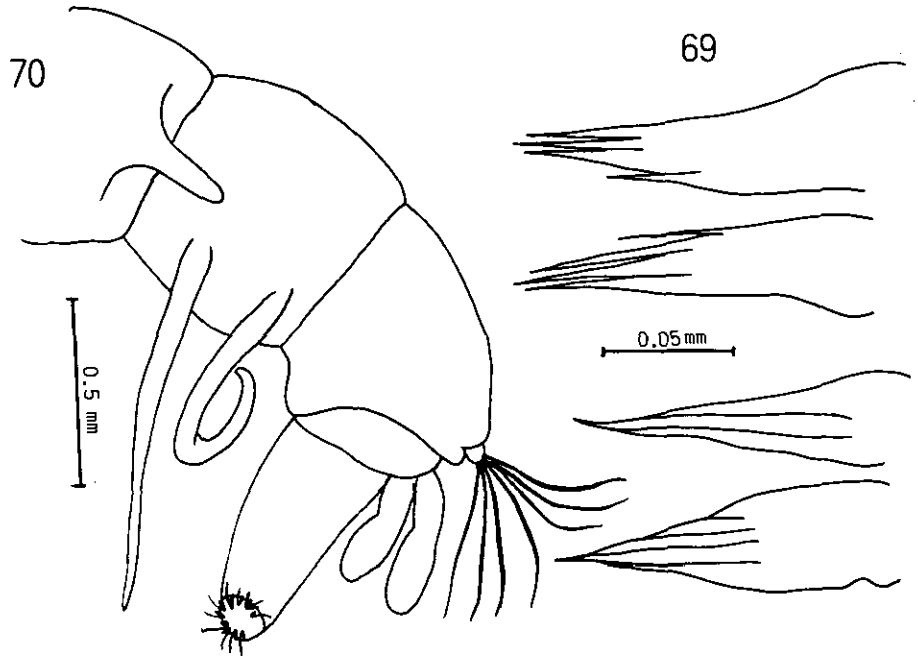
64 *Chironomus strenzkei*, n. sp.

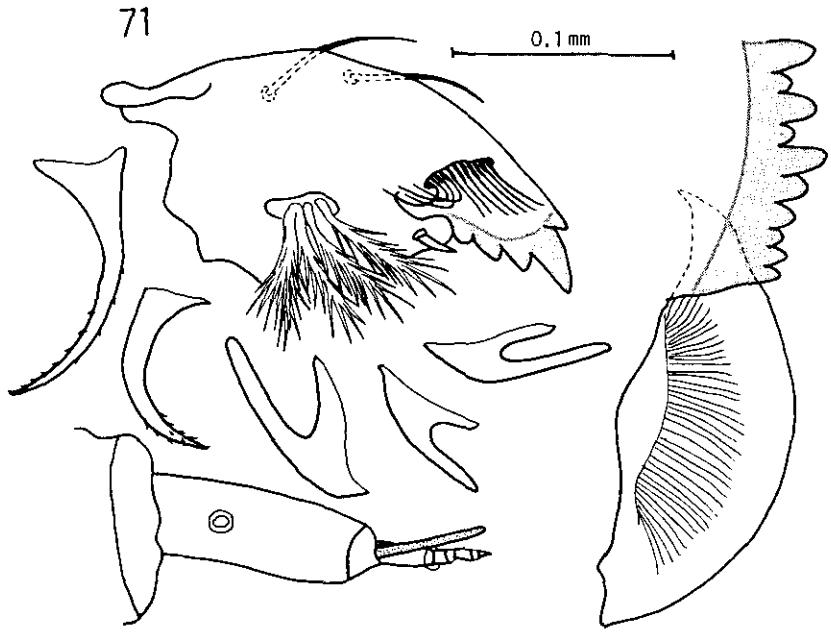




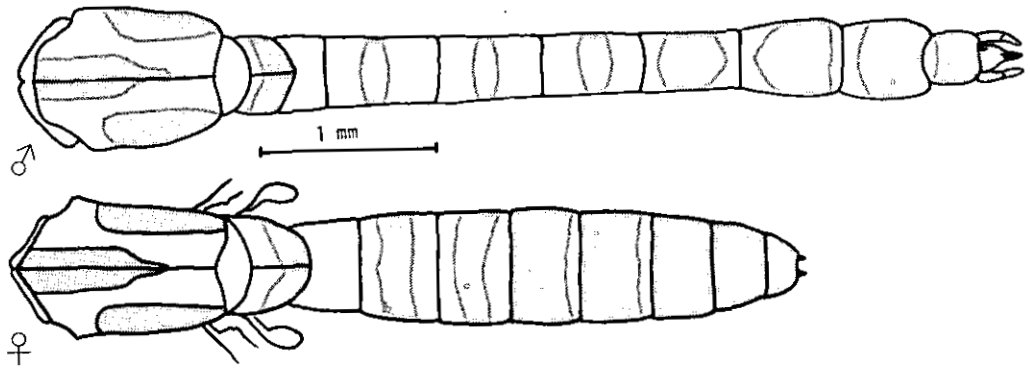



68
67
0.05 mm
0.05 mm

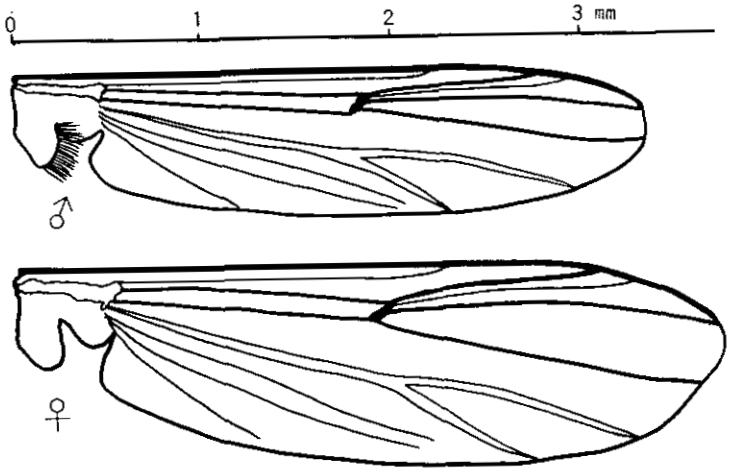

70
69
0.5 mm
0.05 mm


71
0.1 mm

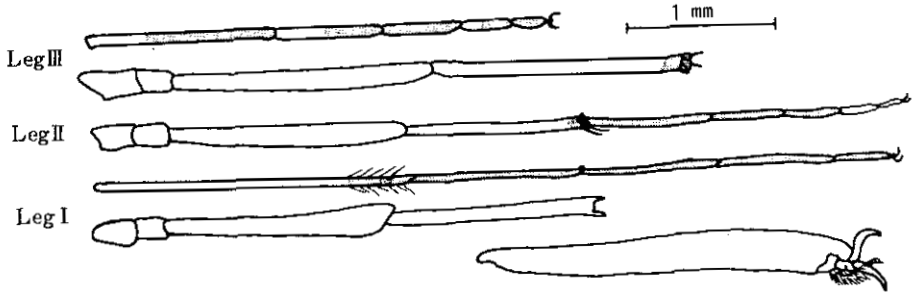
72



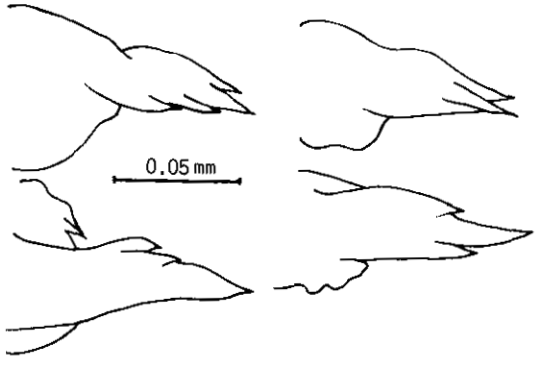
73



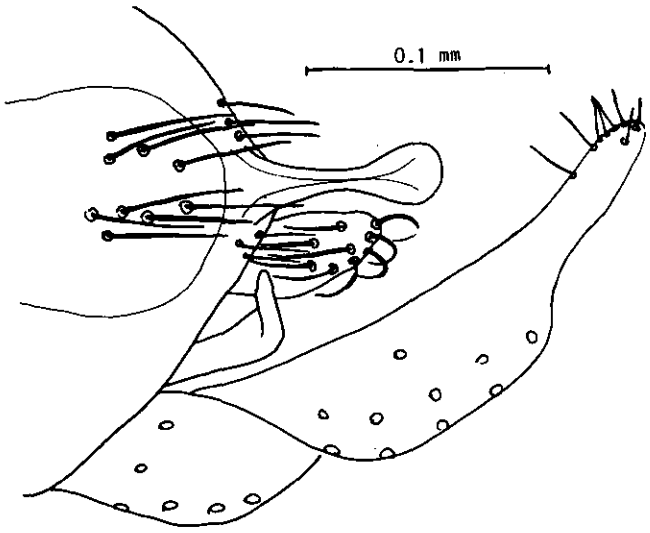
74



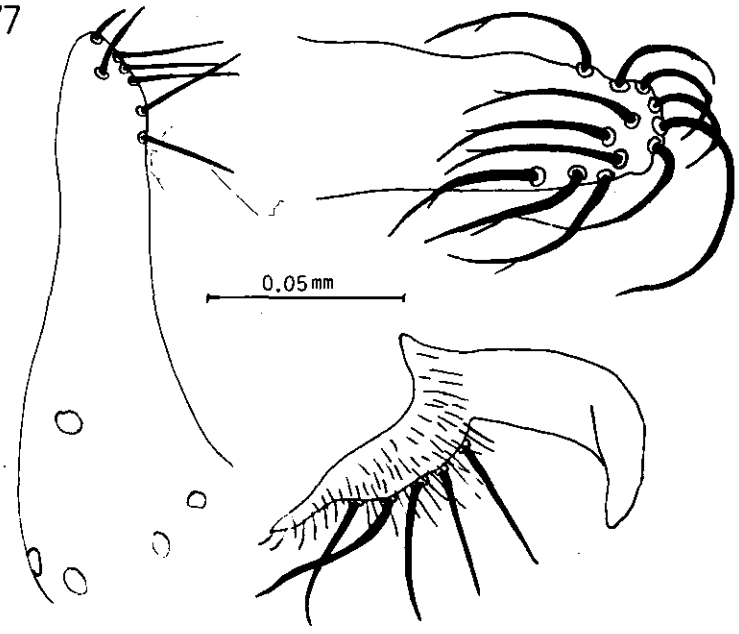
75

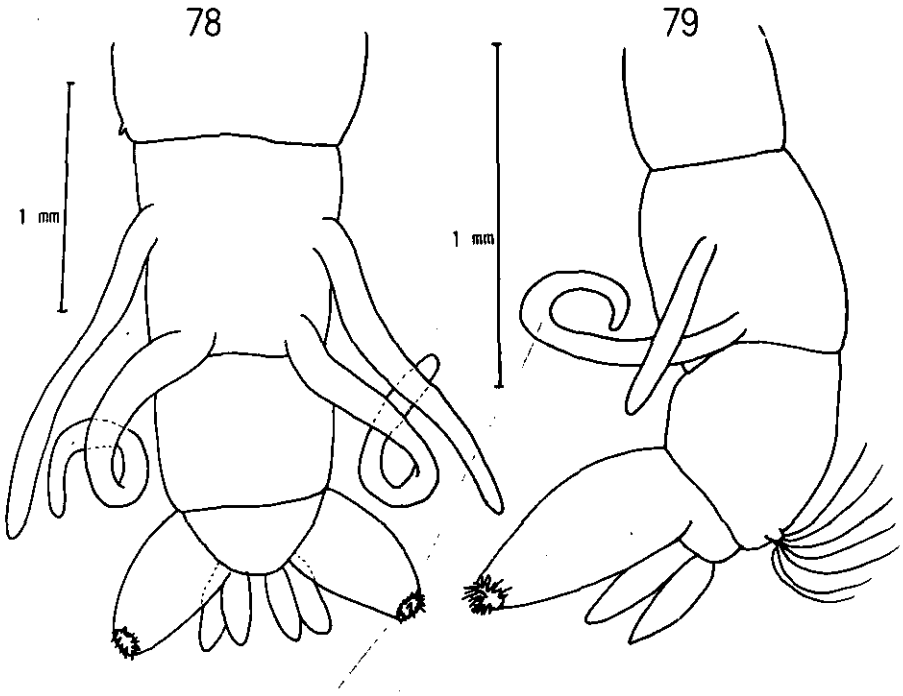


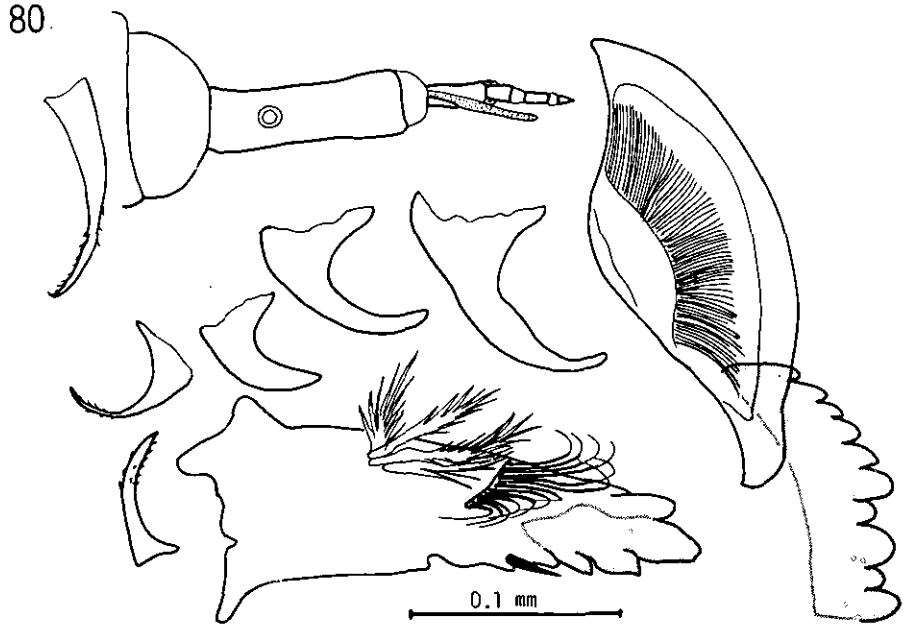
76



77




78
1 mm
79
1 mm


80
0.1 mm

日本産ユスリカ科*Chironomus* 属9種の成虫、サナギ、幼虫の形態の比較

国立公害研究所　佐々　学

ユスリカ科の昆虫は全世界に数千種が記録され、その多くは幼虫が湖沼、池、河川などの底質中に発育し、水質汚染の指標生物として重要であるのみならず、湖沼、河川などの水質改善に大きな役割を果たしていると考えられる。しかし、日本産ユスリカ類に関してはこのような環境科学的な見地からの研究は未だ少なく、各水域に発生するユスリカ類の種の同定に必要な文献もきわめて貧弱な現状である。

筆者らは筑波・霞ヶ浦地方を中心にした水域の富栄養化に関する総合研究の一部としてユスリカ類の分類と同定の基礎研究を開始した。その第1報は“日本産ユスリカ科の既知種の目録”(佐々学・山本優・１９７７）として発表され、第2報は“アカムシユスリカ各期の形態とその分類学上の位置について”として1977年10月に“衛生動物”に寄稿した。佐々（1978a)がまとめたところでは、それまでに日本から 169種のユスリカ科昆虫が正式な学名をもって報告されているが、そのうち雄成虫は 152種、雌成虫は、 130種、サナギは36種、幼虫は31種について記載されている。狭義の*Chironomus*属に関しては、1977年以前には12種が記録されていたが、その幼虫、サナギは4種しか分っていなかった。最近になって橋本（1977a、b）は広義の*Chironomus*属について成虫で8種、幼虫で7種の形態の特徴を雑誌“遺伝”にきわめて簡単に記載している。

私の今回の論文は主として筑波地方に普通に見出された種類を中心に狭義の*Chironomus*属9種の成虫、サナギ、幼虫の形態的特徴を記載したものである。それらはいずれも幼虫を池や水たまりなどの底泥から採集し、個別にその形態的特徴を実体顕微鏡下で記録した上で一疋づつ試験管内に飼育し、それがサナギとなり、さらに成虫が羽化したあと、幼虫とサナギの脱皮殻をガムクロラール液

封入標本とし、成虫も全部または一部（とくに雄の外部生殖器）をガムクロラール封入標本とし、あるいは三角台紙に固定したピンにとめた乾燥標本にしてそれらの形態をくわしく観察した。

これら*Chironomus*属のユスリカは成虫では雄外部生殖器の形態に最も顕著な種としての特徴が見出される。ここにあげた9種のうち、尾針 anal point については *nipponensis* がV型(基部が太く先端に向ってV字形に細くなる)、他はX型（中央部が最も細く、先端部がややふくれる)，背方突起はS型（先が靴状にふくらんで曲っている）が *acerbiphilus flaviplumus*, *yoshimatsui*, D型(全長にわたりほぼ同じ幅の板状)が *strenzkei*, E型（象牙状に細長く先がとがる）が *circumdatus*, *kiiensis*, *plumosus*, *salinarius* である。これらの種はさらに胸部背面と、腹部各節背面の色彩、および脚の各節の明色部と暗色部の区分によっても鑑別される。また、雄の触角比AR、脚剛毛比BR、脚比LR、などの計測値も種によって異なっている。この論文では、新たにハネの各脈の終末部の位置をハネの全長に対する%であらわすことにより比較したり(第2表)、脚の各節の長さを脛節の長さに対する比（第1表）で現わして比較する方法が種の区別に役立つことも提案した。

日本産ユスリカ類の分類にはこれまでいろいろな混乱がみられたが、このような方式で観察すればそれをすっきりさせることができる。ただし、雌成虫については雄成虫より区別が困難なことが多いが、胸背、腹背、および脚の各節の色彩が種により異なるし、ハネの各脈と、脚の各節の長さの比較も雄の場合と同じく種の特徴をあらわす。

サナギについては狭義の*Chironomus*属ではその構造が似ていて、わずかに第8腹節の後偶角にあるウロコ状の突起の先が単純か、何本に分岐しているかに差があるが、それも同一種内で変異があって種の確実な区別点にはならない。ただし、*plumosus*だけはこの突起に多数の小棘を生じているので他種と容易に区別できる。各種類ごとにその分岐数の度数分布を示したものが第3表である。しかし狭義の*Chironomus*属と他の属のサナギについては胸背の呼吸角の分岐数、

腹部の棘の形と分布、第８腹節後偶角の突起の形、腹部末端の游泳片の形とその縁毛の形状などで明確に区別できる場合が多い。

成熟幼虫はすべて血赤色（*kiiensis*はピンクで小さい)、頭部の口器や触角の形状に属としての特徴がある。本属の９種については、第７腹節後側縁に１対の突起と、第８腹節腹面に２対の長い血鰓を生ずる*plumosus*群､前者を欠く群（*yoshimatsui*)､両方とも欠く群（*salinarius*）の３群に区別される。各群については、血鰓や肛鰓の長さに差があったりするが、第１群の各種は幼虫においては確実な区別がむづかしい場合が多い。

以上のような研究の結果、ユスリカ科のうちで最も普通の水の富栄養化に関して重要な意義をもつ狭義の*Chironomus*属の各種についてその各期の分類上の特徴が明らかにされ、これまでセスジユスリカなどの名で何種類かが混同されていた面も指摘され、今後の湖沼、池、河川の底質動物の調査に有用な指針が作られたといえよう。