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Chironomus fraternus sp. n. and *C. beljaninae* sp. n., sympatric sister species of the *aberratus* group in Fennoscandian reservoirs

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The karyotypes, larvae, pupae and adults of *Chironomus fraternus* sp. n. and *C. beljaninae* sp. n. are described. The chromosomes of the two species have almost identical banding patterns; the polymorphisms in at least five of the seven chromosome arms are also the same. However, the chromosome number is $2n=8$ in *C. fraternus* (AB, CD, EF, G), and $2n=6$ in *C. beljaninae* (GAB, CD, EF). No hybrid individuals between the two species have been found as yet. Only slight diagnostic differences could be shown between the adults, pupae and larvae of the two species. The sympatric occurrence of *C. fraternus* and *C. beljaninae* in lakes of central Finland and Sweden points to speciation due to chromosome fusion. The species are closely related to *C. aberratus*, *C. sororius* and *C. jonmartini*; the five species may therefore be regarded as forming the "*aberratus* group" of the *thummi* complex of *Chironomus*.

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1. Introduction

Recently, Belyanina & Sigareva (1987) and Belyanina (1989) reported two karyotypes, found in the Yamal peninsula, the polar Urals and Kamchatka, which were called *Chironomus* sp. and *C. aberratus*. The first species had the unknown chromosome arm combination GAB, CD, EF, representing a new cytocomplex.

I also found a species with GAB, CD, EF, apparently identical with that in the USSR, in some reservoir lakes in Sweden and Finland during two research excursions in 1980 and 1985. It also occurs together with a closely related species, which is different, however, from the second species of Belyanina. I was successful in rearing the adults of both Fennoscandian species and I am able to report both as new.

In the first part of the present paper, I shall give comparative descriptions of the karyotypes, larvae, pupae and adults of *C. fraternus* and *C. beljaninae*. In the second part, I shall compare them with the closely related species *C. aberratus* Keyl 1961, *C. sororius* Wülker 1973 and *C. jonmartini* Lindeberg & Wiederholm 1979 (syn. *C. neglectus* Lindeberg 1960). For the five species, I shall define an "*aberratus*-group" in the genus *Chironomus*.

2. Material and methods

I detected both species in the material from my research trip to Fennoscandia in May–June 1980. My stay in the Vaasa Water District water laboratory in May–June 1985 (by invitation of Pertti

Sevola and Esa Koskenniemi) offered an opportunity to complement these samples and to rear adults from larvae.

The *Chironomus* larvae were taken from the mud of bottom samples (Ekman-Birge grab) or of hand-net catches (in shallow areas). To rear adults I used plastic containers of about 500 cm^2, with a natural substrate and a water level of about 1 cm, kept at room temperature and without additional aeration.

An important condition of the correct description of closely related species is the clear association of the karyotypes with the adults. A larva used for the identification of its karyotype allows a description of larval characters, but of course cannot be reared further to the adult stage. If another larva of the same sample is reared to the adult stage, this may belong to another species; many incorrect associations have entered the literature in this way. One method which helps in this dilemma is rearing from egg masses, used for instance in the investigations of Strenzke (1959). But cultures of egg-reared larvae can become contaminated by larvae of other species (Geiger et al. 1978). If they are performed under different temperature conditions (e.g. those in the field and those in the laboratory) adults with statistically different characters may emerge (Wülker et al. 1981). Moreover, we cannot exclude the possibility of multiple insemination followed by a mixture of more than one karyotype in the descendants of one egg mass (Martin & Lee 1989). In the present investigation, I tried to rear egg masses of *C. beljaninae*, collected 10 June 1985 near the shore of Kyrkösjärvi, in the laboratory in Freiburg, but the larvae entered into diapause in the middle of the fourth larval instar and could not be brought to the adult stage by temperature shocks or other means.

If larvae with different karyotypes, but occurring in the same field sample, show clear morphological differences, a second method is to rear cultures of selected larvae. In the present investigation, the association of karyotypes and adult morphology is mainly based on rearings of larvae selected on the shape of the head stripes (see morphological section), from which different types of male adults emerged. However, karyological checks showed that the morphological identification could result in (rare) errors. Therefore, the associations of adults with karyotypes in the present paper are only approximative; the character decisive for the definition of the species is the karyotype. Single larvae can also be reared, but again this gives no information on the karyotype.

A third method is to use investigation of the chromosomes in the Malpighian tubules of adults to clarify the relation to the chromosomes in the salivary glands of larvae. Unfortunately, this method could not be applied under the field conditions of the present investigation.

The technique of chromosome preparation followed Keyl & Keyl 1959, the identification of chromosome arms and the standardization of banding patterns in arms A, E and F goes back to Keyl 1962, the standardization for arms B, C and D to Dévai et al. 1989. A satisfactory comparative evaluation of arms B, however, needs more experience with other species. The terminology is according to Saether 1980.

3. *Chironomus fraternus* sp. n. and *C. beljaninae* sp. n.

3.1. Type materials and localities

C. fraternus

Holotype: chromosome preparation No. V 14, Hirvijärvi (Finland), leg. W. Wülker, Mus. Hist. Nat. Helsinki; paratypes: Zoologische Staatssammlung München. The name of the species comes from the Latin *fraternus* = fraternal.

Other material. — Finland: Kyrkösjärvi near Seinäjoki, Central Finland 62°55′N, 22°48′E (for details see Koskenniemi & Paasivirta 1987), 2 chromosome squashes, one with larval head, 2 pupal exuviae, 4 reared male adults, 2 of them with pupal exuviae, VI. 1985, E. Koskenniemi, W. Wülker; Liikapuro, same area as Kyrkösjärvi, 6 chromosome squashes, 2 of them with larval head, 1 larval head, 1 pupa, 3 reared adult males, VI.1985, E. Koskenniemi, W. Wülker; Hirvijärvi, same area as Kyrkösjärvi, 2 chromosome squashes, 1 larval head with pupal exuvia and male hypopygium, VI.1985, E. Koskenniemi, W. Wülker; Siikaneva, 61°41′N, 24°06′E (for details see Paasivirta et al. 1988), 1 chromosome squash, 1 male pupa, 1 male adult with pupal exuvia, VI.1985, L. Paasivirta. — Sweden: Bussjön near Umeå, 4 chromosome squashes, 3 of them with larval head, 20.V.1980, obtained by colleagues of the University of Umeå and myself; Veittijärvi, Norrbotten, 66°30′N, 23°46′E (for details see Wiederholm et al. 1977), 4 chromosome squashes, 2 of them with larval head, 25.V.80, W. Wülker. — Norway: Christiansborgvatnet in Bergen/Norway, 1 chromosome squash, IV.1980, collected by the staff of the Zoological Museum Bergen; Prestvatnet near Tromsø, 2 chromosome squashes, 4.VI.1980, K. Aagaard and W. Wülker. The larvae from Norway have uncommon arms F, see description of this arm.

C. beljaninae

Holotype: chromosome preparation No. V 12, Hirvijärvi (Finland), leg. W. Wülker, 16.5.85., Mus. Hist. Nat. Helsinki; paratypes: Zoologische Staatssammlungen München.

Other material. — Finland: Kyrkösjärvi, 1 chromosome squash with larval head, 1 male adult with pupal exuvia, 2 male hypopygia with pupal exuviae, VI.1985, E. Koskenniemi, W. Wülker; Liikapuro, 6 chromosome squashes, 2 of them with larval heads, 1 male adult with pupal exuvia and larval skin, 2 male pupae, VI.1985, E. Koskenniemi, W. Wülker; Hirvijärvi, 11 chromosome squashes, 3 larval heads, VI.1985, E. Koskenniemi, W. Wülker; Venetjärvi, 63°30′N, 24°15′E (details Paasivirta & Koskenniemi 1980), 4 larvae 17.V.1980, L. Paasivirta, E. Koskenniemi and R. Palomäki, 4 chromosome squashes with larval heads, 23.V.1985, E. Koskenniemi, W. Wülker. — Sweden: Bussjön near Umeå, 3 chromosome squashes with larval head, 20.V.1980, members of the Institute of Limnology, University of Umeå and W. Wülker.

It is a pleasure for me to name the species after Prof. S. I. Belyanina, Saratov, who detected the new species in material collected from 1976 on in the Yamal peninsula, the polar Urals and Kamchatka. She confirmed the identity of her and my material of this species (personal communication)

3.2. Diagnoses

Karyosystematically, both species belong to the *thummi* complex. They have good chromosome structure, high inversion polymorphism and no heterochromatic blocks at the centromeres. The larvae belong to the *plumosus* type and have dark head stripes and gulae. The male adults are black and show broad anal points and remarkably short, curved volsellae. For differences from other species of the *aberratus* group, see the last section of the present paper.

C. fraternus is slightly larger than *C. beljaninae*. It has $2n=8$ chromosomes and the larvae have a straight narrow head stripe. The combs of segment VIII of the pupa mostly show 3 teeth. The male adult has a bearded fore-tarsus.

In *C. beljaninae*, the larva has $2n=6$ chromosomes and a more extended broad head stripe. The comb of segment VIII of the pupa shows more than 3 teeth, the bristles of the fore-tarsus of the male adult are short.

3.3. Karyotypes and inversion polymorphism

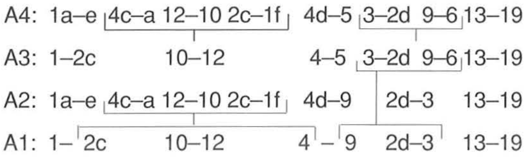
C. fraternus

One metacentric, 2 submetacentric, 1 acrocentric chromosomes, $2n=8$, arm combination AB, CD, EF, G (*thummi* complex). Nucleolus only in arm G (terminal). Centromeres not heterochromatinized.

C. beljaninae

One metacentric, 2 submetacentric chromosomes, $2n=6$, arm combination GAB, CD, EF, (modified *thummi* complex). Nucleolus only in arm G (terminal at place of connection with arm A). Centromeres only slightly heterochromatinized.

Arms A (Fig. 1a–c) The two species show the same four banding patterns:


A4: 1a–e 4c–a 12–10 2c–1f 4d–5 3–2d 9–6 13–19
A3: 1–2c 10–12 4–5 3–2d 9–6 13–19
A2: 1a–e 4c–a 12–10 2c–1f 4d–9 2d–3 13–19
A1: 1–2c 10–12 4–9 2d–3 13–19

Seen from A1, A2 and A3 have either a distal or a proximal inversion, A4 has both. A1 is identi-

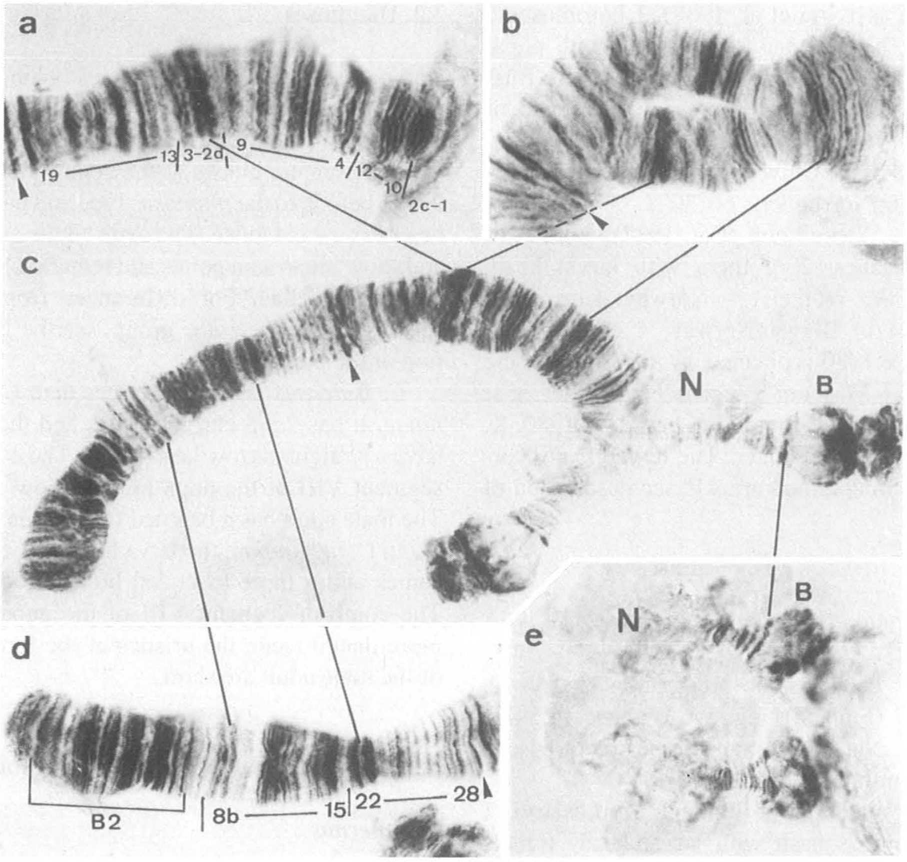


Fig. 1. — a: *C. fraternus*, chromosome arm A11. — b: *C. fraternus*, heterozygous chromosome arm A24. — c: *C. beljaninae*, chromosome B11 A22 G. — d: *C. fraternus*, chromosome arm B11. Bracket: limits of inversion to B2. — e: *C. fraternus*, chromosome arm G (homologous chromosomes unpaired). N = nucleolus, B = Balbiani ring, arrow-head = centromere. Some homologous bands connected by lines.

cal with that in *C. aberratus* (Keyl 1961, 1962), *C. sororius* (Wülker 1973) and *C. jonmartini* (Fig. 7a). A short pericentric inversion was observed in two larvae of *C. beljaninae*.

Arms B (Fig. 1c, d): The two species show the same banding pattern in B1. Groups 8–15 and 22–28 in the proximal part of this arm are in the same position in many *Chironomus* species (e.g. *aberratus, sororius, jonmartini*). The differences in the distal part are difficult to clarify at the moment. Two slides of *C. fraternus* are heterozygous. The inversion lies in the distal part of the arm (Fig. 1d) and is not identical with the more proximal inversion in arm B of *C. aberratus* (Wülker 1973).

Arms G (Fig. 1c, e): The chromosome arm is unpaired in both species, it has a nucleolus at one end, followed by a typical constriction. More distally, a Balbiani ring and a couple of dark bands can be seen. In the area of connection of arms G and A, it is difficult to say whether or not the banding pattern of *C. beljaninae* is identical with that of *C. fraternus*. But identity of *C. fraternus* with *C. aberratus* (Keyl 1961: plate 5) is very probable.

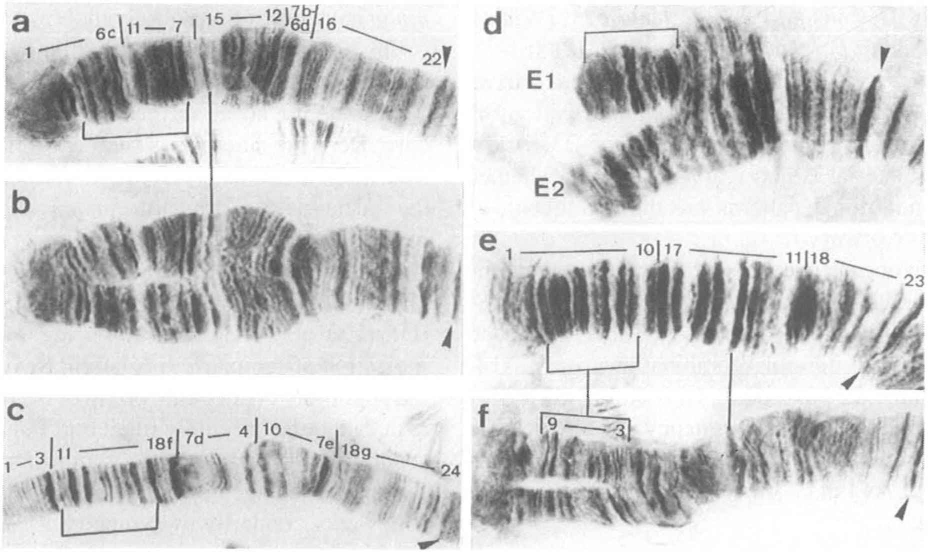


Fig.2. — a: *C. fraternus,* chromosome arm C11. Bracket = limits of inversion to C2. — b: *C. beljaninae,* heterozygous arm C12. — c: *C. fraternus*, chromosome arm D11. Bracket = limits of inversion to D2. — d: *C. beljaninae*, chromosome arm E12. Bracket = limits of inversion to E2. — e: *C. beljaninae*, chromosome arm F11. Bracket = limits of inversion to F2. — f: *C. beljaninae*, heterozygous arm F12.

Arms C (Fig. 2a, b): The pattern of both species is:

1–6c 11–7c 15–12 7b–6d 16–22

(For the relations of the patterns in arms C and D to those in *C. piger*, see Wülker 1991). An inversion distal to the dark band of group 15 leads to C2 (Fig. 2b). C1 is identical with that in *C. anthracinus* (Keyl & Keyl 1959), *C. aberratus* (Wülker 1973), *C. jonmartini* (Fig. 7c), *C. neocorax* (Wülker & Butler 1983), *C. longistylus* and C. *tenuistylus* (Wülker 1980 and 1991), *C. riihimakiensis* (Wülker 1973), *C. staegeri* (Wülker et al. 1971) and *C. whitseli* (Wülker & Martin 1974)

Arms D (Fig. 2c): The pattern of both species is:

1–3 11–18f 7d–4 10–7e 18g–24

A short inversion in the distal quarter of the arm leads to D2. This brings the most distal dark bands to a more proximal position. The pattern of D1 is also known in *C. aberratus, C. sororius* (Wülker1973), *C. jonmartini* (Fig. 7d), *C. islandicus, C. tardus, C. cucini* (Wülker & Butler 1983) *C. riihimakiensis* (Wülker 1973), *C. longistylus* (Wülker 1991) and *C. pilicornis* (Wülker, unpublished).

Arms E (Fig. 2d): The pattern is identical in the two species. An inversion in the distal part of the arm leads to E2:

E2: 1–2 7–5 3–2 8–10b 4–3f 10c–13
E1: 1–3e 5–10b 4–3f 10c–13

E1 is identical with many other species of the *thummi* complex (Wülker 1980).

Arms F (Fig. 2e, f): Both species show the following two banding patterns:

F2: 1–2 9–3 10 17–11 18–23
F1: 1–10 17–11 18–23

F1 is identical with that in *C. aberratus, C. sororius, C. jonmartini* (Wülker 1973), *C. tardus, C.*

major, *C. cucini* (Wülker & Butler 1983), *C. balatonicus* (Dévai et al. 1983), *C. tenuistylus* (Wülker 1991) and *C. borokiensis* (Kerkis et al. 1988).

Moreover, of the three *C. fraternus* larvae from Norway, two have the standard pattern of arm F (1–23), one has 1–2 9–3 10–23. Additional material is necessary to find out whether these additional patterns are more frequent, at least in Norway.

The occurrence of the different zygotic combinations in different reservoirs in central Sweden and Finland is shown in Table 1. Of the theoretically possible combinations, only A14, A33 and D22 have not been found. Differences are apparent in the frequency of the zygotic combinations in the two species (e.g. the prevalence of A44 in *C. fraternus*, of A24 in *C. beljaninae*).

Hybrids between *C. fraternus* and *C. beljaninae* have never been observed.

In conclusion, all the data reported on the karyotypes indicate that *C. fraternus* and *C. beljaninae* are sister species with sympatric occurrence. This situation is frequent in the genus *Chironomus* and has been found, for example, in the species pairs *C. riparius(thummi)-piger* (Keyl & Strenzke 1956), *C. aberratus-sororius* (Wülker 1973), *C. plumosus-muratensis-nudiventris* (Ryser et al. 1983) and *C. plumosus-balatonicus* (Dévai et al. 1983). It may be regarded as an indication of sympatric speciation. Nevertheless, the possibility of allopatric origin of the respective taxa cannot be definitely ruled out. For instance, separation of populations of northern species during the ice age could have led to speciation, followed secondarily by sympatry.

Table 1. Zygotic combinations in chromosome arms A–F, found in 18 larvae of *C. fraternus* and 25 larvae of *C. beljaninae*. K = Kyrkösjärvi, L = Liikapuro, H = Hirvijärvi, S = Siikaneva, B = Bussjön, Vt = Veittijärvi, Vn = Venetjärvii.

Chromosome arm	Zygotic combination	*C. fraternus* K	L	H	S	B	Vt	Total	*C. beljaninae* K	L	H	Vn	B	Total
A	11	2	1					3		1				1
	12		1					1			1			1
	13		2					2		1				1
	14							–						–
	22							–		1	2	1		4
	23							–		1				1
	24		1	1		1	1	4	1	2	8	3	2	16
	33							–						–
	34				1			1					1	1
	44			1		3	3	7						
B	11		3	2	1	4	4	14	1	6	11	4	3	25
	12		2					2						–
	22	2						2						–
C	11	2	3	2	1	3	2	13	1	4	3	1	2	11
	12		2				2	4		2	6	2	1	11
	22					1		1			2	1		3
D	11	2	5	2	1	4	1	15		4	9	4	3	20
	12						3	3	1	2	2			5
E	11	2	4		1			7			1			1
	12			1		1	1	3	1	4	8	4	3	20
	22		1	1		3	3	8		2	2			4
F	11	1	1	2		4	3	11	1	6	6	2	1	16
	12	1	2				1	4			5	1	2	8
	22		2		1			3				1		1

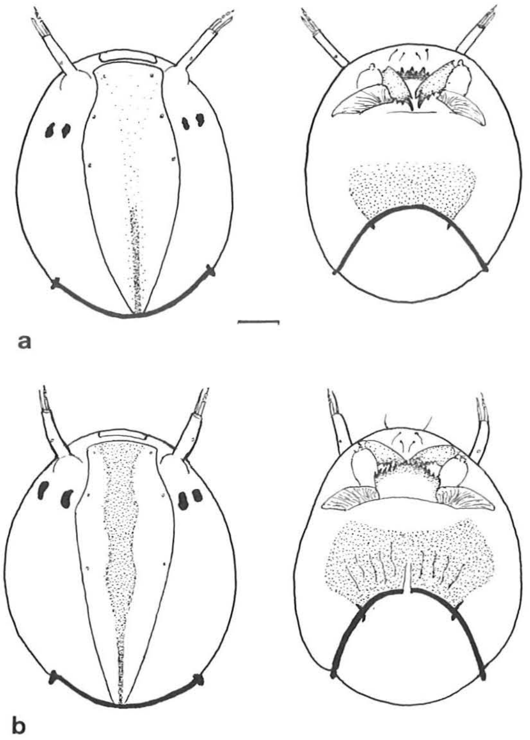


Fig. 3. Larval heads in dorsal and ventral view. — a: *C. fraternus*; b: *C. beljaninae*. Bar = 100 µm.

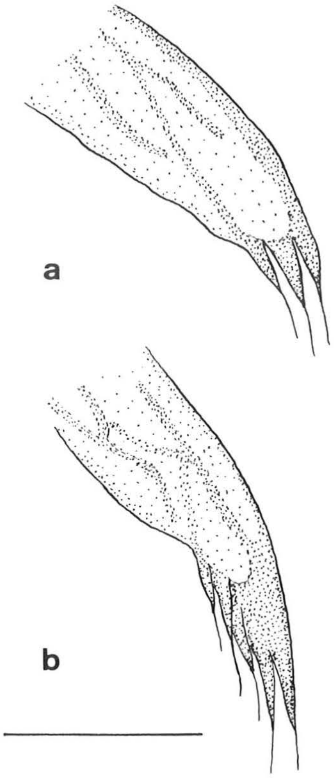


Fig. 4. Combs of segment VIII of pupal exuvia. — a: *C. fraternus*; b: *C. beljaninae*. Bar = 100 µm.

The connection of arms G and A in *C. beljaninae* is a rare event, in contrast to the much more frequent combination of G and E in 3-chromosome species in different complexes of the genus. In the case of *C. fraternus* and *C. beljaninae*, tandem fusion of arm G to arm A in the long chromosome AB may be supposed (Belyanina 1989). A discussion of the fusion GA can be found in Wülker et al. 1989.

3.4. Morphology

Larvae

Both species have *plumosus*-type larvae (presence of tubuli in segment VIII as well as segment VII). The most important character of the larvae is the head stripe (used for the establishment of cultures of selected larvae, see Material and methods), which is smaller, parallel-sided and often confined to the hind part of the frontoclypeal apotome in *C. fraternus*, but more irregular and more extended in *C. beljaninae* (Fig. 3), a difference similar to that figured by Geiger et al. 1978 for *C. sororius* and *C. aberratus*. Also, the dark part of the gula is not very extended in *C. fraternus*, but more extended, sometimes troughlike, in *C. beljaninae*. However a certain variability of head stripes and gulae has to be considered.

As shown by Table 2, there are no other remarkable morphological differences between the larvae of *C. fraternus* and *C. beljaninae*; for instance none are evident in the values and indices used by Webb & Scholl 1985. In the key of Webb & Scholl, due to the combination of dark head stripe and *plumosus*-type larvae, both species would place near to *C. dorsalis*, but this is a clearly different species of the *pseudothummi* complex.

Table 2. Larval morphology. Colour characters and measurements (mean values and ranges). Measurements in µm. MS = distance of first lateral teeth in the mentum; L1, L2 = length of the antennal segments 1 and 2; W = width of antennal segment 1; CW = clypeus width; MW = mandibular width.

	C. fraternus (N=5)		*C. beljaninae* (N=8)		*C. aberratus* (N=10)		*C. sororius* (N=10)		*C. jonmartini* (N=10)	
L1	130	115–143	133	121–145.5	123.8	117–129	122.0	120–129	152	144–156
L2	37.8	35.2–43.5	41.5	34.5–49.5	39	36–42	38.8	36–42	43.6	42–45
W1	38.9	36–42	48	40.5–46.5	41.6	33–48	42.4	36–51	46.8	45–51
MS	68.1	57–72	72.75	66–79.5	65.8	60–72	67.5	63–72	79.5	69–84
L1/W1	3.43	2.85–3.60	3.04	2.82–3.34	2.90	2.68–3.23	2.91	2.41–3.23	3.26	3.05–3.46
L1/MS	1.91	1.66–2.04	1.82	1.62–1.92	1.84	1.74–1.95	1.81	1.66–1.90	1.92	1.85–2.17
L2/MS	0.55	0.48–0.63	0.57	0.43–0.63	0.58	0.51–0.70	0.57	0.52–0.61	0.54	0.51–0.60
W1/MS	0.57	0.52–0.63	0.59	0.54–0.68	0.62	0.55–0.70	0.62	0.54–0.75	0.58	0.55–0.65
CW	245.8	217–262.5	252.9	232–292	237.5	232.5–247.5	197.0	187.5–217.5	268.1	240–300
MW	277.4	228–303	290.3	255–315	261.9	232.5–292.5	246.7	225–277.5	314.5	277.5–345

Pupae

Pupal exuviae from my material were investigated by P. Langton / Huntingdon and their descriptions were included in a new key (Langton 1991) as Pe 15 (*C. beljaninae*) and Pe 16 (*C. fraternus*). The most remarkable differences are the shagreen of sternite III (lateral shagreen bands without an anterior transverse band in *C. fraternus*, but broadly joined anteriorly across the sternite in *C. beljaninae*) and the number of teeth in the comb of segment VIII (3 in *C. fraternus*, 4–5 in *C. beljaninae*, Fig. 4). In my experience, unfixed exuviae of *C. fraternus* are always darker than the very transparent exuviae of *C. beljaninae*.

Adults

Table 3 shows some data on the male adult characters of *C. fraternus* and *C. beljaninae*. It is evident that they are almost identical in common indices such as the antennal ratio and leg ratio. Differences between the two species are present in the length of the fore tarsus setae (B.R.), the shape of the anal point and volsellae and the number of am setae on the hypopygium (Fig. 5), and the length of the frontal tubercles. With the key of Lindeberg & Wiederholm (1979), *C. fraternus* comes near to *C. staegeri*, a species which is well defined karyosystematically in North America (Wülker et al. 1971) and the adult of which was identified there with the use of the type material from Greenland; its karyotype however has never been found in Europe. Thus, the earlier reports of *C. staegeri* in Europe may have concerned *C. fraternus*.

Table 3. Adult morphology of male (mean, range, and number of individuals). AR = ratio length segment 12 / segments 2–11 of antenna; LR = ratio length tarsal segment 1 / tibia in front leg; BR = ratio length longest bristle of tarsal segment 1 / width of this segment (front leg); am = setae of anal tergite IX; TL = frontal tubercular length (µm); WL = wing length (mm).

	C. fraternus			*C. beljaninae*		
AR	4.33	3.82–4.57	(8)	3.74	3.58-3.88	(4)
LR	1.26	1.19–1.32	(7)	1.41	1.36–1.45	(3)
BR	5.08	3.25–6.96	(5)	2.18	2.10–2.30	(3)
am	4.10	2–8	(7)	11	8–15	(4)
TL	28	24–34	(4)	35	34–36	(3)
WL	4.06	3.84–4.18	(6)	3.88		(1)

C. beljaninae falls into the collective of species around *C. aberratus*, *C. sororius*, *C. striatus*, *C. melanotus*, *C. lacunarius*, *C. riihimakiensis*, which Lindeberg & Wiederholm could not divide further. It has some similarities with the species *C. nigricans* Goetgh. and *C. nigrifrons* Linevich & Erbaeva, 1971, collected near Irkutsk. I had an opportunity to examine the original material of the latter species in the laboratories of Prof. Linevich in 1989. The adults of both species

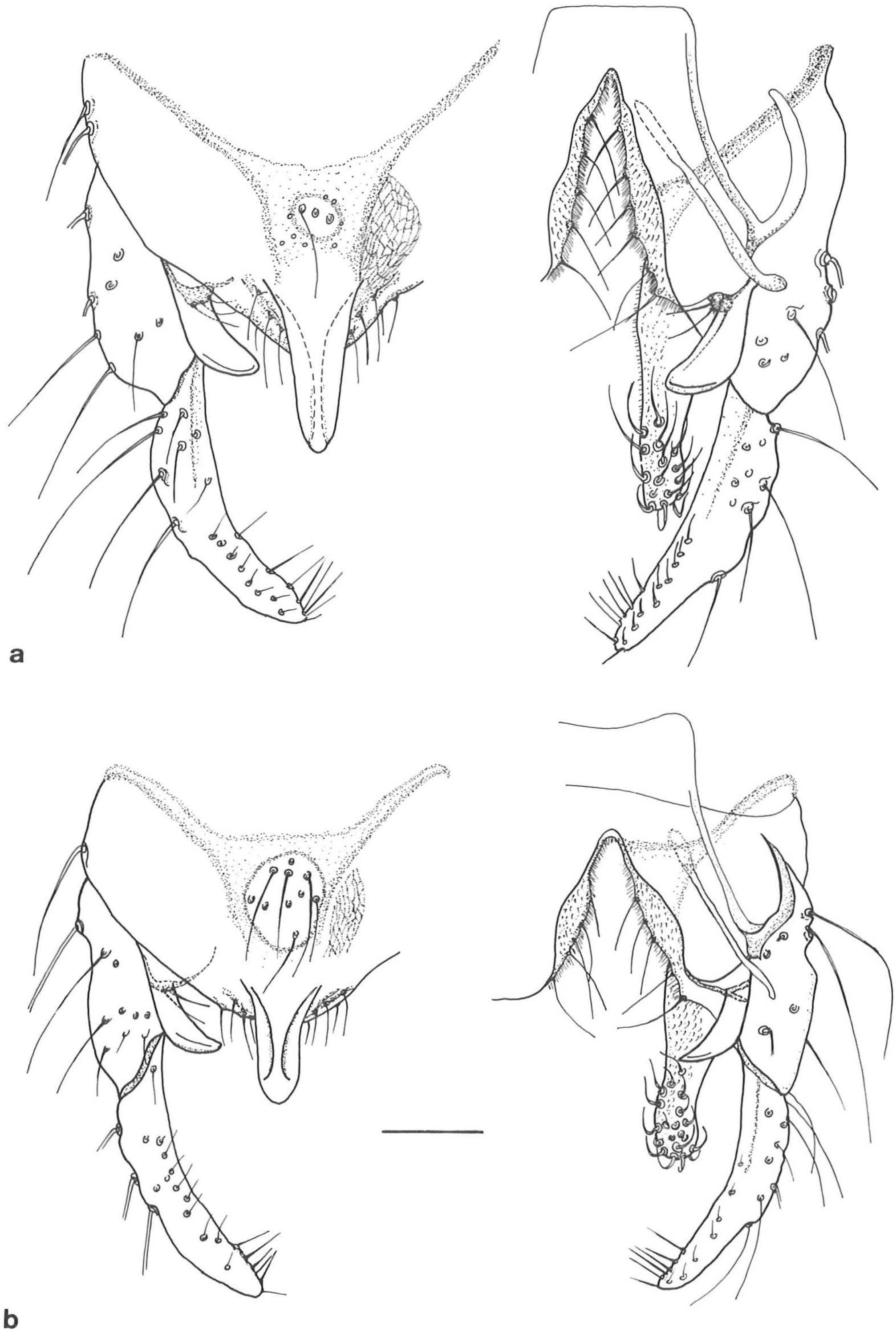


Fig. 5. Hypopygia of adult males. — a: *Chironomus fraternus*; b: *C. beljaninae*. Bar = 100 µm.

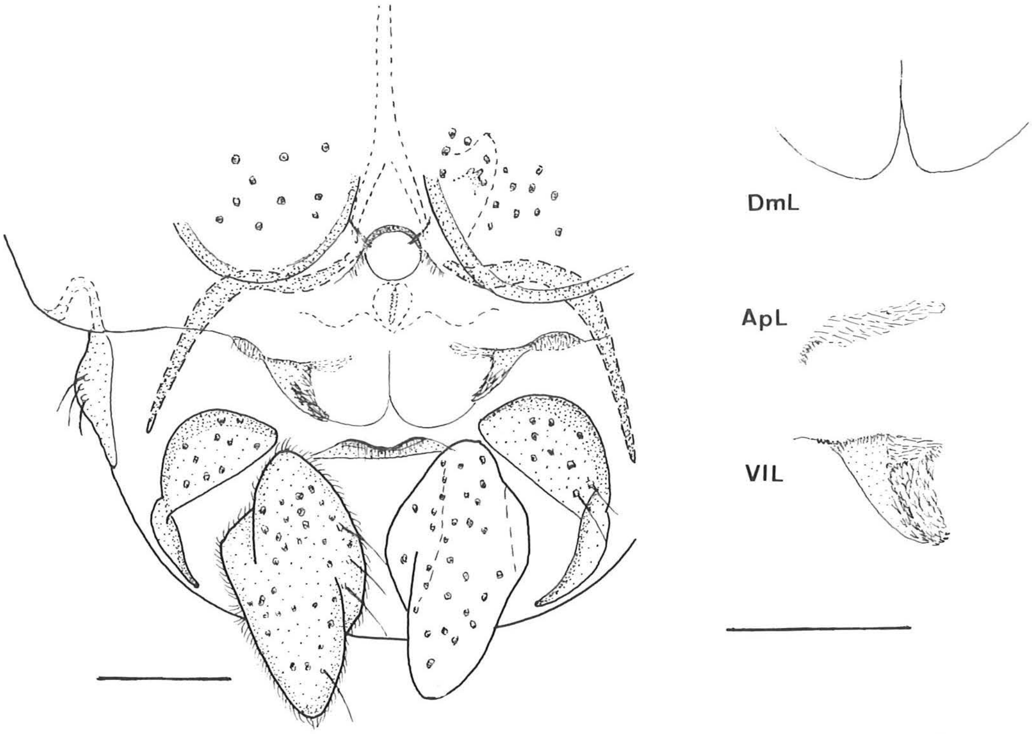


Fig. 6. Genitalia of a female adult of *Chironomus fraternus*. — Gonapophysis VIII: ApL = apodeme lobe, DmL = dorsomesal lobe, VIL = ventrolateral lobe. Bars = 100 µm.

have dark volsellae on the hypopygia and a low BR (< 2). *C. nigrifrons* was found to have more than 10 am setae and the larvae have a dark head stripe as in *C. fraternus* and *C. beljaninae*. But the gonostylus is much smaller than in these species and the larva is said to be of the bathophilus type. *C. nigricans* differs clearly, having a low number of am setae and a lower AR. It does not seem justified to associate *C. beljaninae* with one or the other species, because:

Without karyotype investigation, species of this collective group cannot be expected to be convincingly distinguished. The Russian species could also be, for example, *C. longistylus* Goetgh. (Wülker 1991).

The place of collection is much farther south than those of *C. beljaninae*.

Only one clearly associated female adult could be investigated. It shows the following characters:

Head: Antennal flagellomere proportions (µm) 220:120:150:128:265. Frontal tubercles length:breadth 20:20 µm. Ocular ratio 0.16. Temporal setae 38. — Thorax: Dorsocentral setae 54, acrostichal setae 19, prealar setae 9, scutellar setae 56. — Wing length 3.6 mm, squama with ca. 16 marginal setae. — Legs: sensilla chaetica PII not measurable, PIII 121. Leg ratios PI 1.44, PII 0.55, PIII 0.62. — Genitalia: Gonapopysis VIII: dorsomesal lobe broad, but with only scarce lateral chagrin, for apodeme lobe and ventrolateral lobe see Fig. 6.

3.5. Distribution, ecology, and phenology

In Scandinavia,the two species described here live in *Drepanocladus* mosses, sometimes on organic bottoms, most frequently in a depth of less than 1 m. They were observed to emerge in May and are known from reservoir lakes plus the bog pond Siikaneva.

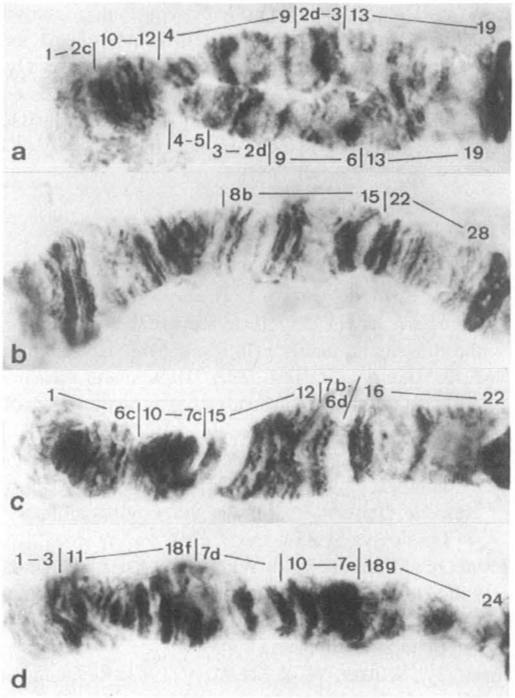


Fig. 7. *C. jonmartini.* — a: chromosome arm A13. — b: chromosome arm B. — c: chromosome arm C. — d: chromosome arm D. Besides arm A, arm B was very occasionally found to be heterozygotic for a paracentric inversion. Arms CD had a pericentric inversion in one individual.

Zoogeographically, *C. beljaninae* is known only from the northernmost USSR and central Fennoscandia, *C. fraternus* from Fennoscandia.

4. *Aberratus* group of the genus *Chironomus*

The karyotypes of *C. fraternus* and *C. beljaninae* are very similar to those of *C. aberratus*, *C. sororius* and *C. jonmartini* (syn. *C. neglectus* Lindeberg, 1960). However, the karyotype of the latter species was insufficiently known (Wülker 1973) and needed additional descriptions (Fig. 7). For the five species, I define an "*aberratus* group" in the genus *Chironomus*. This group is not identical with the five species which Lindeberg & Wiederholm (1979) placed together with *C. aberratus* in couplet 15 of their key, based on the great similarity of the male adults.

For this part of the paper, I used the following additional materials: — Germany: Falkau, Black Forest (loc. typ.) several chromosome squashes and larvae of *C. aberratus* and *sororius*; pool at "Schwabenschanze", near "Zuflucht" Northern Black Forest, 8 chromosome squashes and larvae of *C. aberratus* and 2 of *C. sororius*, 22.X.1979, R. Rössler, W. Wülker. — Czechoslovakia: Weidetümpel Mlynarovice, 8 chromosome squashes of *C. sororius*, 1 of *C. aberratus*, 8.IX.1989, J. Matěna. — Sweden: pool in Hallen Haga forest near Uppsala, 1 chromosome squash of *C. sororius*, V. 1977, B. Nagell.; rock pools 90 km east of Uppsala near the shore of the Baltic Sea, Forsland Östhammar, 12 chromosome squashes of *C. jonmartini*, 14.V.1980, W. Wülker. — Norway: Christiansborgvatnet in Bergen, 1 chromosome squash of *C. sororius*, IV 1980, material collected by staff of Zoological Museum Bergen. — Finland: Tvärminne (locus typicus) 4 chromosome squashes of *C. jonmartini*, VIII 1967, W. Wülker.

The banding patterns of arms A, D, E and F are identical in the five species of the aberratus group, arm B is different in all species, arms C and G of *C. sororius* are different from those of the other species. The main characters used to differentiate the species have been the chromosome number, amount of heterochromatin at the centromeres, chromosome quality, inversion polymorphism, larval types, and tarsal beard of the adults. These can be expressed in the following key:

1. Karyotype with $2n=6$ chromosomes ...... *C. beljaninae*
— Karyotype with $2n=8$ chromosomes 2
2. Without heterochromatic blocks at centromeres, good chromosome quality, high inversion polymorphism .... *C. fraternus*
— Centromeres with heterochromatic blocks, poor chromosome quality, low inversion polymorphism 3
3. Larvae of *plumosus* type, male adult with tarsal beard .... *C. jonmartini*
— Larvae of *thummi*-type, male adult without tarsal beard 4
4. Chromosome arm C as in other species .. *C. aberratus*
— Chromosome arm C different .... *C. sororius*

The remarkable similarities in the banding patterns of species of the *aberratus* group to those of *Chironomus* species regarded as "basic" indicate that the group has a systematic position not far from this base. Inside the group, I am inclined to regard the species with good chromosome quality and high inversion polymorphism as derived (see discussion in Wülker & Butler 1983).

The larvae of the *aberratus* group (Table 2) are characterized by the head stripe on the frontoclypeus and a dark gula. The larvae of *C. fraternus* and *C. beljaninae* can be distinguished morphologically from the *thummi*-type larvae of *C. aberratus* and *C. sororius*. From *C. jonmartini* they can best be distinguished on the basis of the special biotope (see below). Table 2, which contains new measurements of the larvae of *C. aberratus*, *C. sororius* and *C. jonmartini*, shows that no clear morphometric differences exist between the species of the *aberratus* group. It may finally be mentioned that Wülker et al. (1969) could distinguish the larvae of *C. aberratus* and *C. sororius* (the latter sub *C.* sp. n.) by gel-electrophoresis of their hemolymph proteins.

The adults in the *aberratus* group are black. The males have a hypopygium with a broad anal point (Fig. 5) and a short, curved, more or less parallel-sided volsella. The sides of the 9th abdominal notum have a remarkable reticulate structure, which is also present in *C. melanotus, C. lacunarius, C. riihimakiensis, C. striatus* (Lindeberg & Wiederholm 1979) and *C. inermifrons* (Pinder 1978: fig. 143A). Only *C. fraternus* and *C. jonmartini* have a tarsal beard.

Ecologically and zoogeographically, *C. fraternus and C. beljaninae* are lake species in Fennoscandia, *C. beljaninae* also in the northern USSR. *C. aberratus* is known from small ponds or pools in the alpine region, the High Black Forest and Czechoslovakia. The validity of reports of *C. aberratus* in Belyanina 1989 from the northern USSR and in Michailova 1989 from Bulgaria is not clear from their photographs. *C. sororius* also occurs in small ponds and pools and seems to have an arcto-alpine distribution. *C. jonmartini* lives in Fennoscandia and seems to be adapted to the very unstable conditions of rock pools (reports of this species in Lake Kyrkösjärvi, Koskenniemi & Paasivirta 1987, and the pond Siikaneva, Paasivirta et al. 1988, may have concerned the closely related *C. fraternus*).

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