

Northernmost *Chironomus* karyotypes

(Insecta, Diptera, Chironomidae)

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In the extremely high latitude of Ellesmere Island, the karyotypes of *Chironomus* spec. Le1 (sensu Kiknadze), *C. spec. w Martin**, and *C. hyperboreus* Staeger, 1845 could be identified. The first two species have relations to Alaska and the Russian Arctic, the third to Greenland.

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Introduction

Chironomus species from the High Arctic are scarcely known. Initially, expeditions to Greenland, Spitsbergen, Bear Islands, northern Canada etc. (data e.g. in Edwards 1935, Thienemann 1954, Brundin 1949, Oliver 1964) collected some adults, but not many of them were identified to species. Later on, data on metamorphoses were included in the investigations (e.g. Andersen 1937). Karyological studies (e.g. Kiknadze et al. 1996) have shown the presence of a large number of *Chironomus* species in the High Arctic. Zelentsov & Shilova (1996) estimated 15–20 *Chironomus* species to be expected just in the delta of the river Lena in Siberia.

Many of the species identified by chromosome investigations were new for science. Most of them have a salinarius larval type, i.e. lack tubuli ventrales and laterales. Many have remarkable heterochromatic blocks at the centromeres and show “basic” (Wülker 1980, 1991) chromosome banding patterns.

In the Nearctic, besides the investigations of Butler (1982) on *Chironomus prior* and *C. tardus* from arctic Alaska, material suitable for karyological studies was collected in Ellesmere Island, N.W.T., 81°49'N, by Corbet and Parker (for locality data see Oliver & Corbet 1966). This latter material was given to the second author who recognized the presence of five species on the basis of the karyotypes.

Comparison with larvae from Greenland and the Russian Arctic revealed three known karyotypes of the *thummi*-complex: spec. Le1 (Kiknadze et al. 1996), *C. spec. w Martin*, and *C. hyperboreus* Staeger, 1845. The other two karyotypes, one of them belonging to the *pseudothummi*-complex, are not clear enough for description.

In the present paper, we demonstrate and discuss our results on Ellesmere material, including some unpublished data on northern Alaska (leg. M. G. Butler). It should be considered that chromosomes in arctic species are often very much contracted, and conclusions on the banding pattern therefore sometimes approximations.

* See unpublished list of North American *Chironomus* species under internet URL: <http://www.genetics.unimelb.edu.au/Martin/NACytfiles/NACHiron.html>.
The species will soon be described by Shobanov, Wülker & Kiknadze.

Results

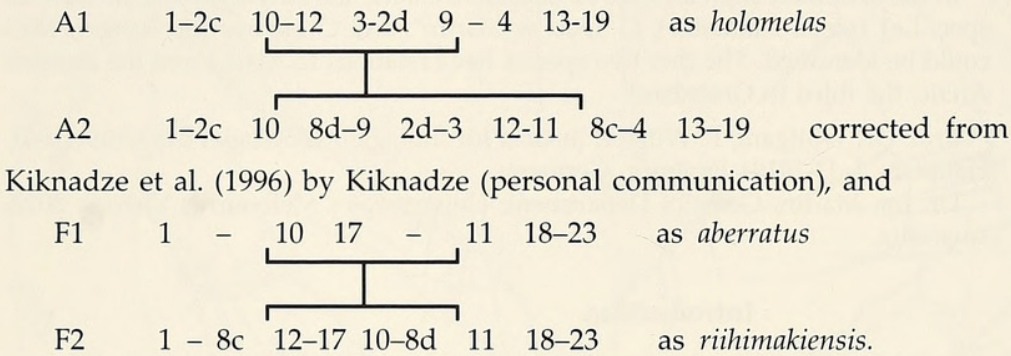
1. *Chironomus* spec. Le1 sensu Kiknadze et al. (1996)

Material used: Canada, N.W.T., Ellesmere Island, Hazen Camp, permanent pool no.78, leg. P. S. Corbet & J. Parkes, 14.vi.1988, 1 chrom. squ. – U.S.A., Alaska, Point Barrow, pond B.R., leg. M. G. Butler, 1.vii.1980, 5 chrom. squ. – Russia: delta of river Lena, leg. T. A. Salova, 5 chrom. squ.

This karyotype belongs to the *riihimakiensis*-group (Kiknadze et al. 1994), but it cannot yet be decided whether it is a separate species or simply a northern variant of *C. riihimakiensis* Wülker 1973.

Kiknadze et al. (1996) described the larval morphology (“*bathophilus*-type” = short tubuli ventrales, no tubuli laterales) and karyotype, the latter with a photographic plate. The karyotype shows four chromosomes ($2n=8$) with arm combination AB, CD, EF, G (*thummi*-complex), large heterochromatic blocks at centromeres, frequent lack of pairing of homologues even in the homozygous state. There are nucleoli in arms C and D as is typical for the group (Fig. 1b), as well as Balbiani rings in arms F and B. The short chromosome G has a typical spindle form with a subterminal nucleolus and one Balbiani ring.

The arms are said to be monomorphic, but we found polymorphism in A and F. In A, the pattern shown by Kiknadze et al. is supplemented by the basic *holomelas* 1 pattern. In F, the pattern of *aberratus* is supplemented by the same second pattern as in *C. riihimakiensis*:



The polymorphism in A was present in the material of Ust Lena Natural Reserve in Russia and in Alaska, while the single slide from Ellesmere is a homozygote A1.1 (Fig. 1a).

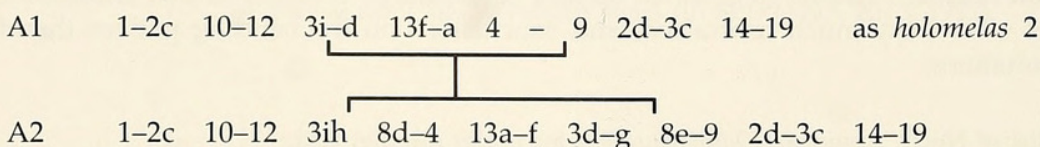
The distribution of spec. Le1 seems to be circumpolar: Novaja Semlya, Dikson (det. I. I. Kiknadze), Lena delta in Russia, Alaska and Ellesmere Island in North America.

2. *Chironomus* spec. w Martin

Material used: Canada, N.W.T., Ellesmere Island, Hazen, inland marsh of Skeleton Lake, leg. P. Corbet & J. Parker, 15.vi.1966, 1 chrom. squ. – U.S.A., Alaska, west shore of Prudhoe Bay, EWD1, tundra pond east of West Doc pad, 70°23'N, 148°31'W, leg. M. G. Butler, 7.vii.1980, 2 chrom. squ. – Russia: delta of river Lena, leg. N. A. Shobanov, 1990, 4 chrom. squ.

This species has larvae of the *salinarius*-type (= no tubuli ventrales and laterales). It has 4 chromosomes ($2n=8$) with chromosome arm combination AB, CD, EF, G (*thummi*-complex), no heterochromatic blocks at centromeres; nucleoli in arms A and D.

Arm A of the single slide from Ellesmere Island has the pattern of *C. holomelas* 2 (Keyl 1962). The Lena delta specimens have an arm A differing by one inversion from *holomelas* 2, but this karyotype occurs also in Alaska, where it shows heterozygosity between both patterns (Fig. 2a), with the typical nucleolus in region 14.



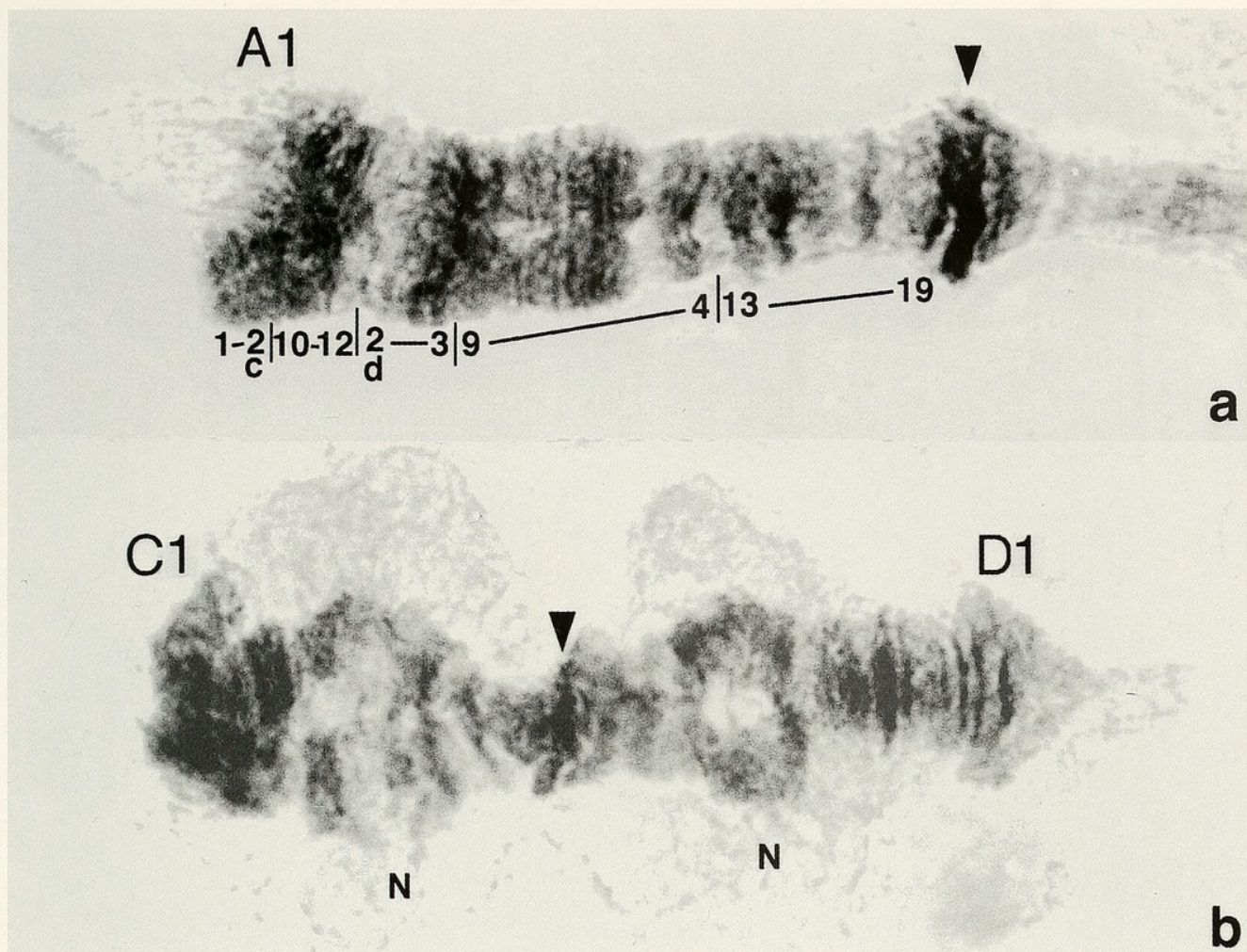


Fig. 1. *Chironomus* spec. Le1. Chromosome arms. a. A1. b. C1 and D1. N = nucleolus; arrowhead = centromere.

Arm B: with the typical position of groups 8-9 in the middle of the arm, flanked distally by dark band groups. The Ellesmere specimen has B1.1.

Arm C: shows the typical group 6b-2 in the middle of the arm and group 15 far distal.

Arm D: can be identified by the nucleolus in the middle of the arm flanked proximally by groups 4-8d.

Arm E: has the typical insertion of group 2d-1d in the middle of the arm.

Arm F (Fig. 2b): is one inversion from *C. aberratus*:

1 - 10 17 - 11 18-23 as *aberratus*

1 - 9 11h-i 12 - 17 10d-a 11g-a 18 - 23

Arm G: (Fig. 2c) is the most problematic in the Ellesmere slide. It is much shorter than in the material from the Lena delta, but shows the typical 3 Balbiani rings. The individuals from Alaska vary in the length of arm G.

The distribution of *C. spec. w* Martin seems to be circumpolar: Archangelsk, Dikson (det. I. I. Kiknadze) and Lena delta in Russia, Alaska and Ellesmere Island in North America.

3. *Chironomus hyperboreus* Staeger, 1845

Material used: Canada, N.W.T., Ellesmere Island, Hazen, Hazen Camp pond, 2 chrom. squ.; permanent pond No. 33, 1 chrom. squ.; inlet marsh of Skeleton Lake, 1 chrom. squ.; Skeleton Lake, 2 chrom. squ., all leg. J. Corbet, 1966. - Denmark, Greenland, Lake 517 Stoe Kvaneso, leg. J. Skriver, 11.viii.81, 4 chrom. squ.

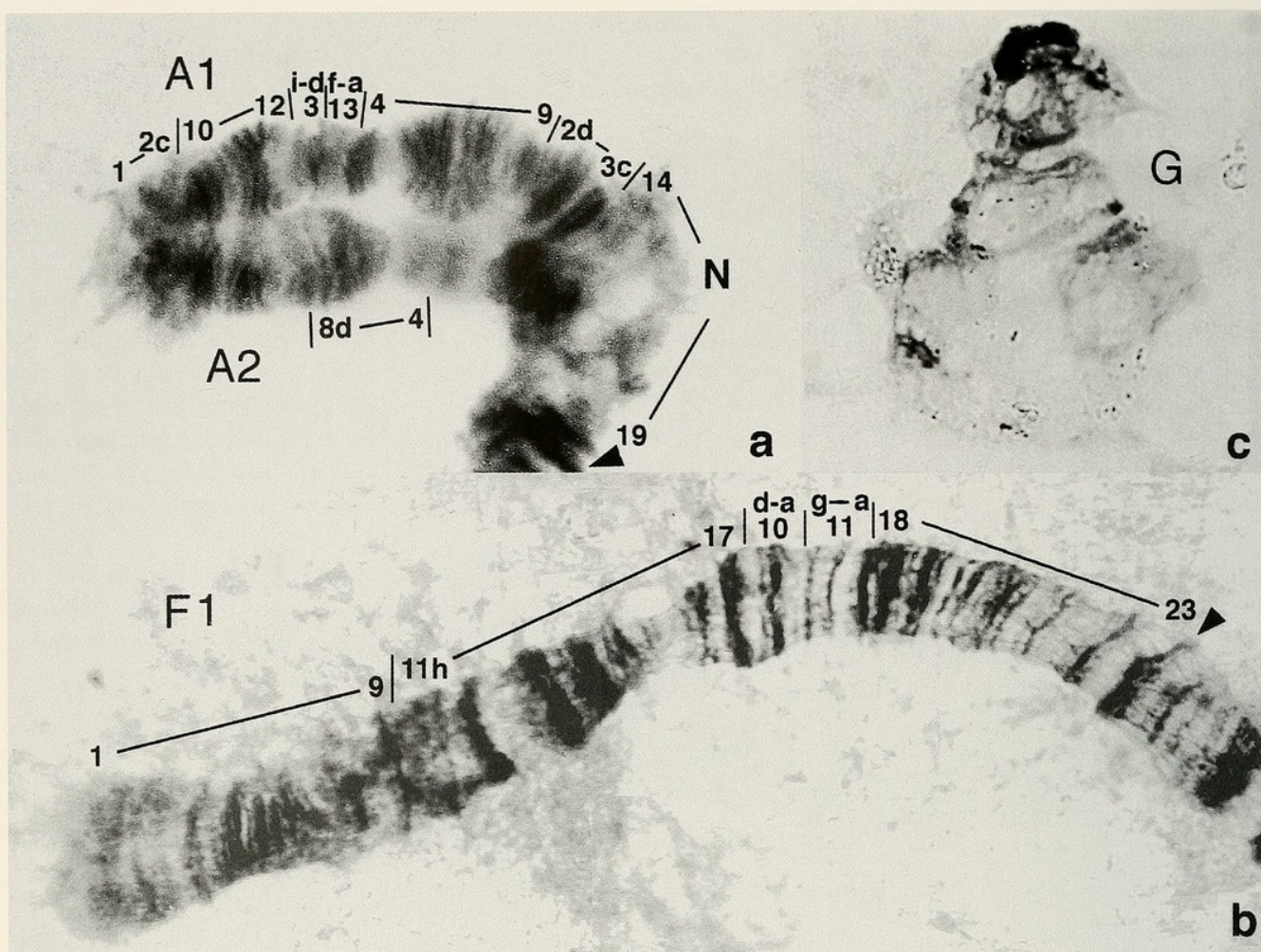




Fig. 2. *Chironomus* spec. w. Chromosome arms. a. A1.2. b. F1. c. G. Symbols as in Fig. 1.

Preliminary data on the karyotype and larva were given in Wülker & Butler (1983). Larva of *salinarius*-type. 4 chromosomes ($2n=8$), chromosome arm combination AB, CD, EF, G (*thummi*-complex), heterochromatin blocks at centromeres. Inversion polymorphism in arms A and F, one pattern as in *holomelas* A1, arm C with dumbbell structure at distal end, and in arm F one pattern is standard *C. piger*.

In Arm A (Fig. 3a) the basic pattern of *C. holomelas* occurs in the heterozygous condition with a different alternative pattern on Greenland (A2) and on Ellesmere (A3):

A1	1-2c	10-12	3-2d	9	-	4	13-19	as <i>holomelas</i>
								
A2	1-2c	10-12	7-9	2d-3	6-4	13-19	Greenland	
								
A3	1-2c	3-2d	9-7	12-10	6-4	13-19	Ellesmere	

Arm B: Identical with *C. riihimakiensis* (Wülker 1973), also having the same polymorphism in the most distal part of the arm.

Arm C: has the "basic" pattern (= pattern present in at least 14 *Chironomus* species (Wülker 1980, 1991): 1-6c 11-7c 15-12 7b-6d 16-22.

Kiknadze et al. (1996, e.g. photo 13, *C. spec.* A11), have suggested another preferable version of the same pattern: 1-6b 11c-8 15-11d 6gh 17a 16h-a 7d-a 6f-c 17b-22.

Arm D: has also a "basic" pattern, present in at least 10 *Chironomus* species (Wülker 1980, 1991): 1-3 11-18f 7d-4 10-7e 18g-24.

Arm E (Fig. 3b): is 1-3e 7-5 8-10b 4-3f 10c-13, one inversion from *aberratus*.

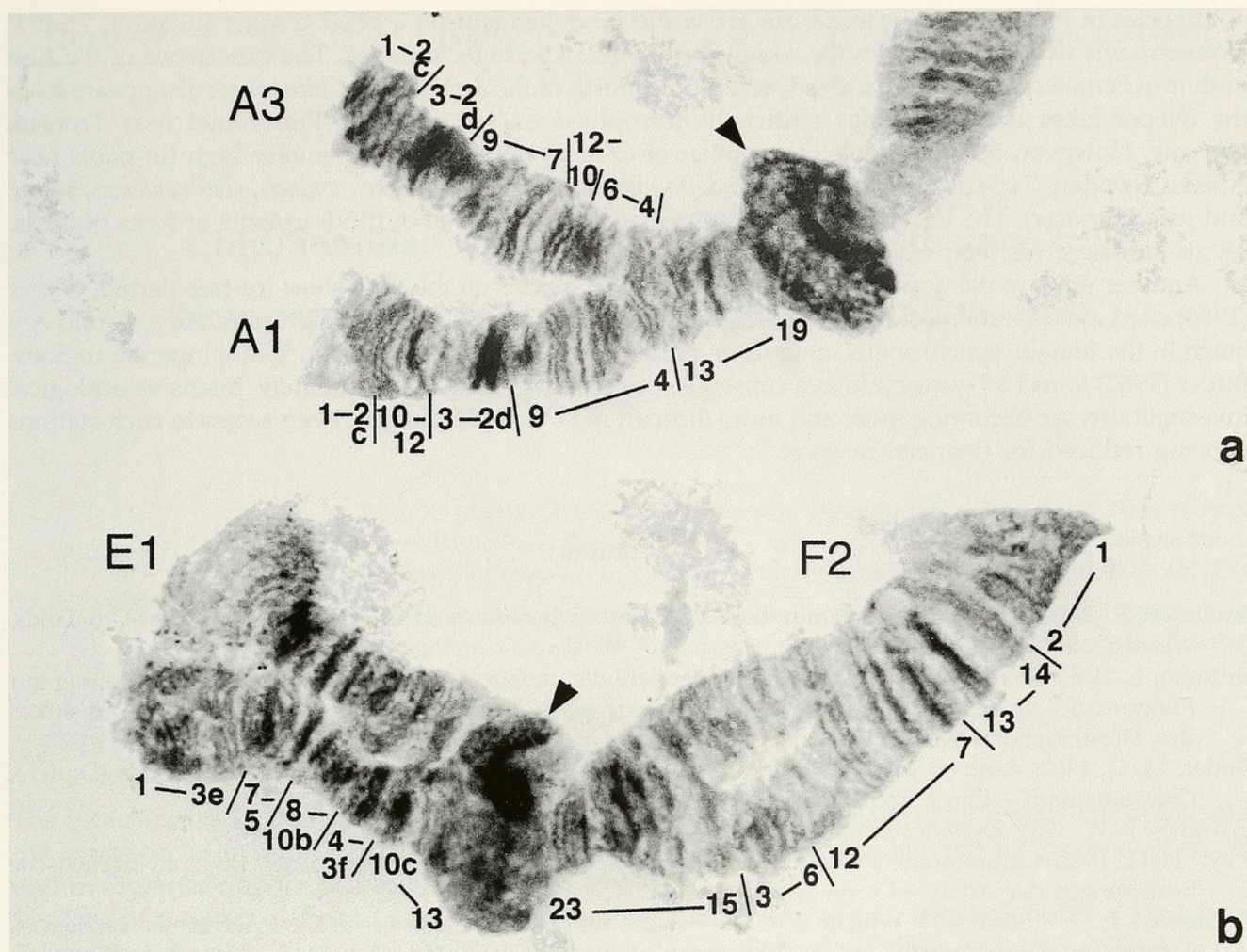
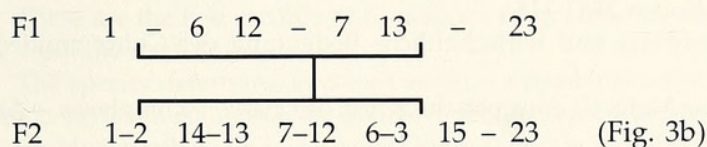


Fig. 3. *Chironomus hyperboreus* Staeger. Chromosome arms. a. A.1.3. b. E1 and F2. Symbols as in Fig. 1.

Arm F: the statement of a standard pattern like *piger* by Wülker & Butler (1983) was wrong. The two existing patterns are two and three inversion steps from that pattern:



Only in Greenland have heterozygotes for F1.2 been found, all Ellesmere specimens are F2.2.

Arm G: unpaired, cone-shaped, homologues often connected at their ends by a heterochromatic block.

The species seems to be dominant on Ellesmere Island (4 sampling stations).

Beside the cytotaxonomically proven occurrence on Ellesmere and Greenland, *C. hyperboreus* has been reported from Bear Island, Spitsbergen, and northern Fennoscandia on the basis of male adults. However, the first author could not find any *C. hyperboreus* karyotype in northern Fennoscandia. Instead, in some lakes a very closely related karyotype occurs, but without heterochromatic blocks at the centromeres. This form will be compared with *C. hyperboreus* in a separate paper. The Fennoscandian occurrence of *C. hyperboreus* has to be reexamined.

Discussion

Ellesmere Island is at an extremely high latitude, comparable with the north of Spitsbergen or with Franz Josef Land (Russia), but from these places no karyotypes of *Chironomus* have ever been investigated.

Species of the genus *Chironomus* are known to be dependent on a good trophic situation. Thus it is remarkable that they occur in the rough conditions of so high latitudes. The experience of the first author in Fennoscandia is that, indeed, at latitudes north of the arctic circle *Chironomus* disappears from the deeper lakes if they are not artificially eutrophied as, for example, Prestvatnet near Tromsø, Norway. However, in small pools the number of *Chironomus* species can be very high (in pools near Abisko, Sweden, 7 species were found: *pseudothummi*, *acidophilus*, *fundatus*, *wulkeri*, *riihimakiensis*, *storai*, and *pseudomendax*). The input of allochthonous material, e.g. leaves of tundra plants or feces of birds, seems sufficient for their existence.

Another point is the dependence of the high arctic species on the very short ice-free period. Oliver (1964) cited as adaptations: flexibility of the length of larval stages, possible maturation of a second egg batch in the female, synchronous emergence pattern as in the spring emergence in temperate regions. Butler (1982) found a 7-year cycle as a consequence of slow growth. Unfortunately, intensive ecological investigations are becoming more and more difficult in arctic field stations, even access to such stations is being reduced for financial reasons.

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