LE GUIDE VISUEL DES CHIRONOMIDES SUB-FOSSILES DU QUÉBEC À L'ÎLE D'ELLESMERE

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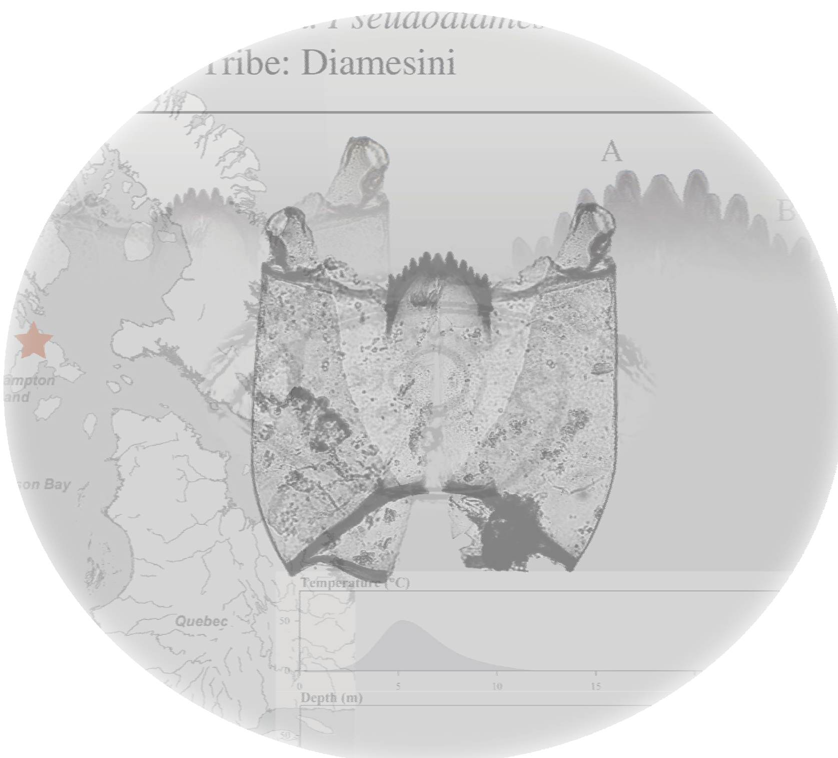

Le Guide Visuel des Chironomides sub-fossils du Québec à l'Île d'Ellesmere

Isabelle Larocque, Nicolas Rolland

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Université du Québec
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Eau, Terre et Environnement

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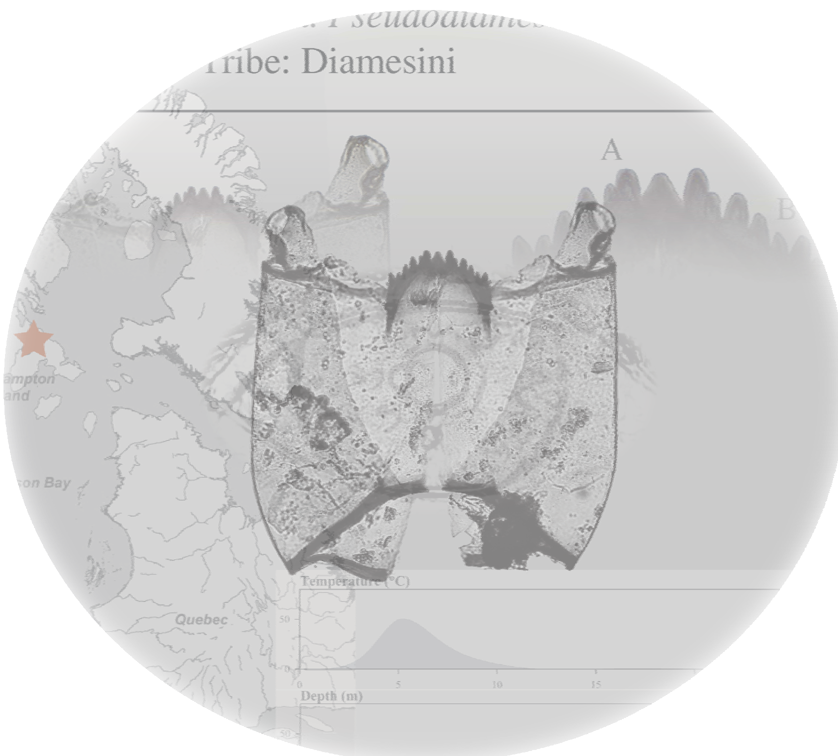
RÉSUMÉ

Ce guide a pour but d'illustrer les différents taxons de chironomides sub-fossiles extirpés de la surface des sédiments de plusieurs lacs entre Mont-Laurier (Québec) et l'île d'Ellesmere. 90 taxons sont représentés au chapitre 4. Le premier chapitre présente une courte introduction à l'analyse des chironomides, le chapitre 2 explique brièvement le concept de fonction de transfert et le chapitre 3 révise deux nouvelles techniques méthodologiques développées à notre laboratoire. Ce guide n'est pas complet, il concerne simplement les taxons retrouvés dans les lacs que nous avons échantillonnés. Plusieurs autres lacs devraient être échantillonnés dans les prochaines années, la partie taxonomie sera tenue à jour sur notre site internet www.chironomids.com.

Ce guide est destiné aux chercheurs internationaux en analyse des chironomides, et à ceux qui aimeraient s'initier à cette analyse. Il a donc été rédigé en anglais.



A Visual Guide to Sub-fossil Chironomids from Quebec to Ellesmere Island

Isabelle Larocque, Nicolas Rolland

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Contents

1. Introduction

Chironomids (Insecta : Diptera) are abundant aquatic insects. They can be found on all the continents, in an extremely diverse array of environments (reviewed in Armitage et al. 1997). While the adult stage is a terrestrial winged insect (Figure 1.1), the larvae develop in or on the surface of different substrates (sediments, plants, dead wood, other invertebrates), in aquatic, humid or semi-terrestrial environments (lakes, ponds, rivers, estuaries, bogs, marshes, etc). Most species go through four distinct larval stages, each leaving behind a molted head capsule with the potentiality of being preserved. Different species have specific ecological preferences and tolerances which make them useful indicators of various environmental variables.

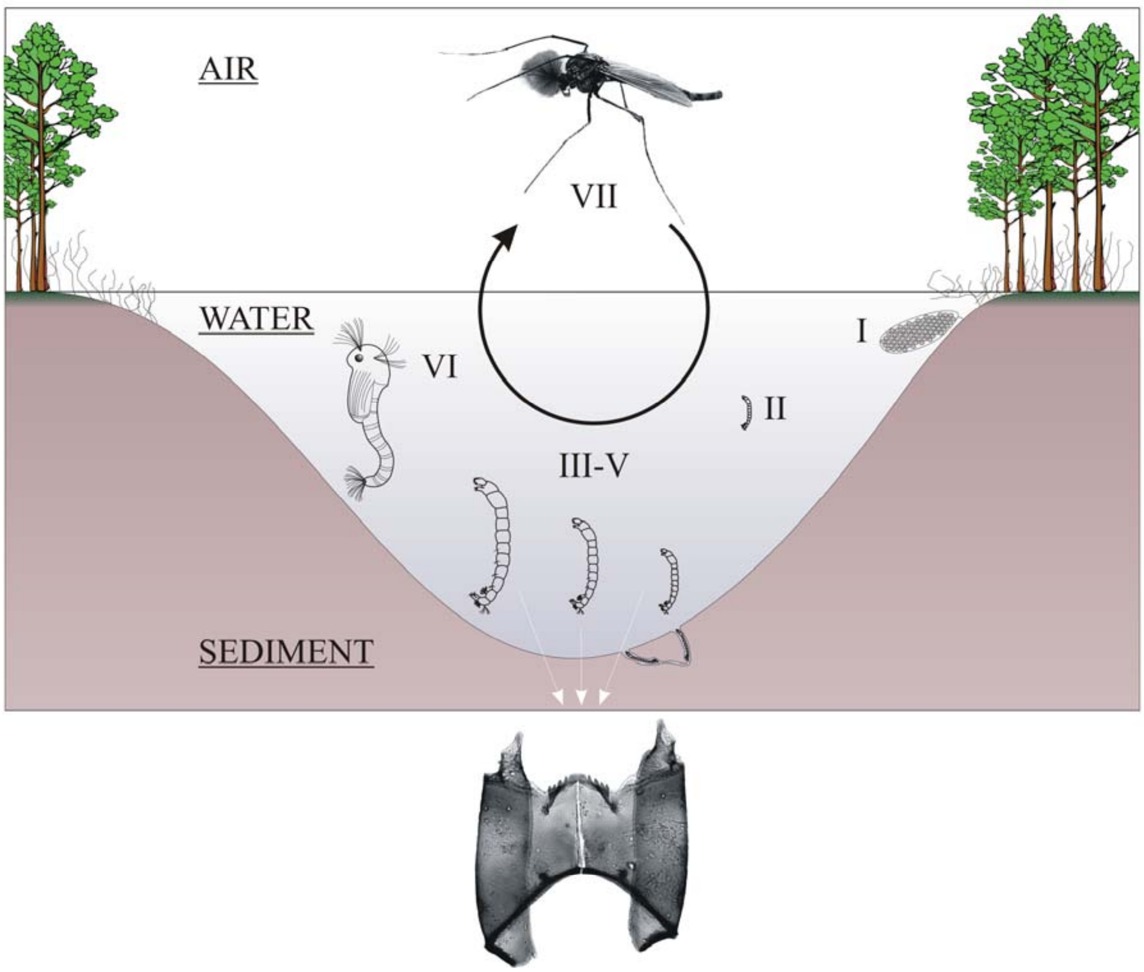

Figure 1.1. Life cycle of a chironomid: the chironomid goes through four larval stages (II-V), a pupa stage (VI) then emerge and start their adult (imago) stage (VII). Molted headcapsules are preserved in the sediment and are used in subfossil chironomid analysis (© Nicolas Rolland).

In lake sediments, the chitinous ($C_6H_{12}O_5N$) head capsules of chironomid larvae preserve well and can be identified to genus, even to species level in certain cases, making it possible to characterize past assemblages with a high degree of accuracy. This has made the use of subfossil chironomid assemblages a powerful paleoenvironmental tool used both qualitatively and quantitatively to infer various limnological variables such as trophic status (Lotter et al. 1998), oxygen level (Quinlan and Smol 2002), salinity (Heinrichs et al. 2001), depth (Korhola et al. 2000), lake size and acidification (Mousavi 2002), chlorophyll a (Brodersen and Lindegaard 1999) and especially air or water temperature (Walker et al. 1991; Lotter et al. 1997; Olander et al. 1997; Walker et al. 1997; Olander et al. 1999; Korhola et al. 2000; Brooks and Birks 2001; Larocque et al. 2001; Brodersen and Andersen 2002; Porinchu et al. 2002; Heiri et al. 2003; Larocque et al. 2006). The use of chironomid remains as paleolimnological indicators has been addressed and revised in length elsewhere (Frey 1964; Walker 1987; Hofmann 1988; Walker et al. 1991; Walker 1995). We especially recommend chapter 3 in DPER volume 4 by Walker (2001) which gives a good overview of the method.

The purpose of this book is not to repeat the information already presented in other sources but to gather and make available new information on the recent advances in methodology and taxonomy of the subfossil chironomid larvae. The major part of this book is dedicated to taxonomy and presents each of the ~100 taxa found in over 100 lakes located between southern Québec and Bylot Island, in northeastern Canada (Figure 1.2). A first transfer function was published recently (Larocque et al. 2006). It covers lakes from Matagami to Purvinituq in Quebec. Since then, lakes from Mont-Laurier to Matagami, in northern Quebec, on Southampton Island and on Cape Bounty have been added creating a new model with improved statistics

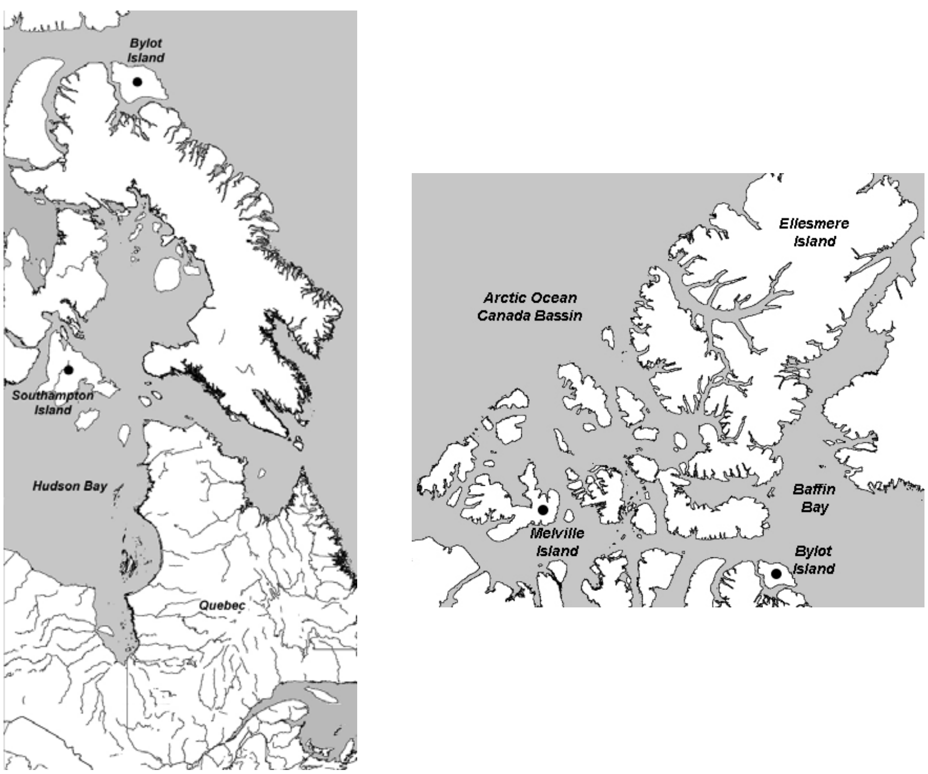

Figure 1.2. Studied areas

RMSEP=1.13°C). Recently, lakes were sampled on Bylot and Ellesmere islands, and the distribution of taxa in these lakes should be added in the following year. If new taxa are found, this guide will be updated on our website (www.chironomids.com).

To our knowledge, there is no single reference book for subfossil chironomid taxonomy relating to eastern Canada. The taxonomy of this group has greatly evolved since subfossil chironomid workshops started in 1997, but no specific guide reflecting this evolution has as of yet been published. The multiplication of paleolimnological investigations utilizing chironomid remains in Québec (Fallu et al. 2005; Swadling et al. submitted; Saulnier-Talbot et al. in prep) and in the eastern Canadian Arctic (Rolland et al. in prep) underscores the need for an overview of the diversity and distribution of the taxa encountered to date, and for a better taxonomic guide in order to compare reconstructions obtained from different sites, or in order to adequately use the transfer function recently developed in Québec (Larocque et al. 2006). To gather this information in one textbook is extremely helpful for researchers already working with chironomids in the area but also to any chironomist who wishes to establish work in Québec and/or the eastern Canadian Arctic, or who wants to compare the taxa found in the area with other areas around the world.

Apart from the taxonomic descriptions and considerations which make up the last chapter, other parts of this book concern a short description of the transfer function and different aspects of the advances in methodology and presents two new techniques that can be applied to the sediment for calculating concentrations of headcapsules (marker technique) and to extract chironomid headcapsules (floating technique).

We hope that this book will serve as a reference for anyone working with subfossil chironomids or who wishes to become familiar with the fascinating and challenging world of subfossil chironomid analysis

ACKOWLEDGEMENTS

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2. Transfer function

This study was made primarily to create a model (transfer function) to reconstruct air temperature. The transfer function is created by sampling many lakes in a large gradient of temperature. Those lakes are called the training set (T.S) lakes (Figure 2.1 1A). In each of these lakes, the surface sediment is taken (1B) and chironomid headcapsules are extracted and identified (1C). At the sampling time, physical (e.g. depth, surface, catchment area), chemical (nutrients, pH) and climatological (water temperature) parameters are measured (1D). Air temperature is extrapolated from existing climate stations (see Larocque et al. 2006). A detrended canonical analysis (DCA) is made with all measured parameters and the chironomid assemblages to determine which factors best explain the distribution of chironomids in the T.S. lakes. A model for reconstruction (transfer function) based on the temperature optimum for each taxa (2A) is then developed (2B) and will subsequently be applied to chironomid assemblages extracted from sediment cores (3A, 3B).

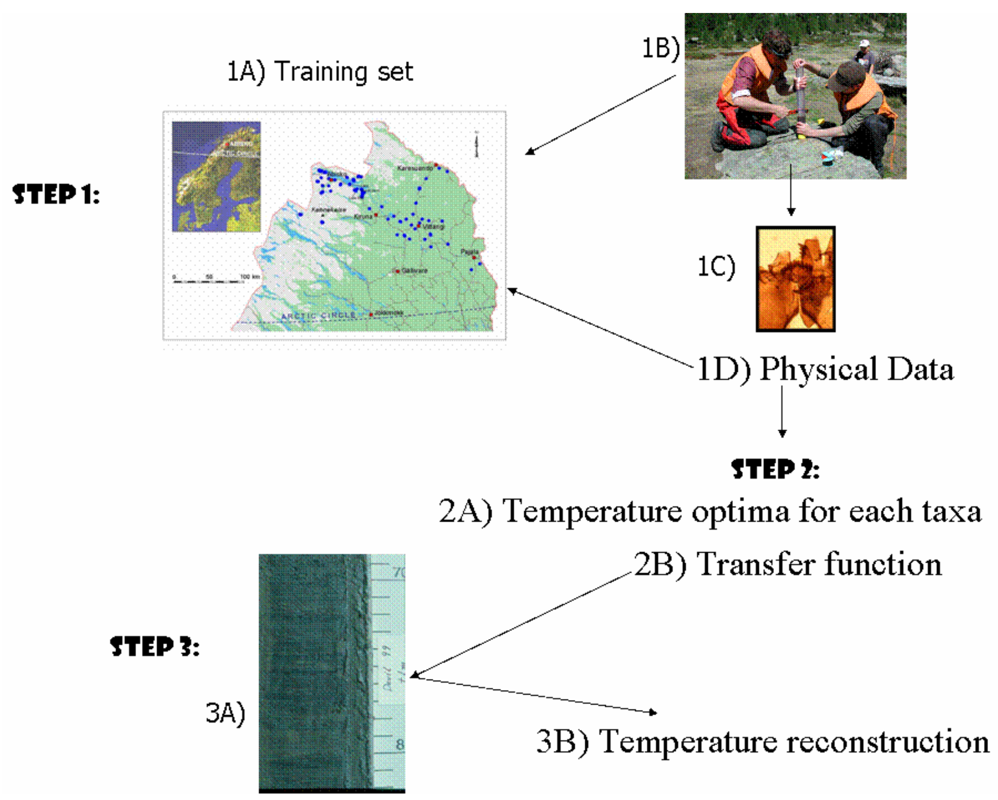

Figure 2.1. Development of a transfer function, example from Sweden (Larocque et al. 2001)

Such models (for air or water temperature) have been developed in many countries: western Canada (Barley et al. in press), eastern Canada (Walker et al. 1997), Finland (Olander et al. 1999), Norway (Brooks and Birks 2000), Sweden (Larocque et al. 2001), Switzerland (Lotter et al. 1997; Heiri et al. 2003) and USA (California) (Porinchu et al. 2002). Some of these transfer functions have been applied to reconstruct temperature from lakes in other countries (e.g. the Swiss transfer function to reconstruct temperature in France (Heiri and Millet 2005), a Swedish transfer function to reconstruct temperatures in Russia (e.g. Ilyashuk et al. 2005)). The transfer function presently being developed in Canada will be available to anyone wanting to reconstruct temperature in similar lakes. Although the model could be adjusted to fit a different taxonomy, the transfer function will have its maximum power if it is based on similar taxonomy. The purpose of this is to help determining which names we gave to different headcapsules, and to what level the taxonomy was separated.

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3. Advances in methodology

Probably the best way to avoid damage to headcapsules during extraction from the sediments would be to pick midges from untreated sediment (Velle 1998). Although this method is protective, the time to pick headcapsules is extremely high, and because the sediment is not deflocculated, there is a greater chance of missing some pale headcapsules during picking. A universal way of sample preparation has been established by Walker and is presented in Walker (2001). Although some variations to the method have been recently made, as using a sonic bath to increase deflocculation of the sediment (Lang et al. 2003), very few adjustments were brought to the method since its development. In general, the number of headcapsules extracted this way is sufficient (depending on the sediment type) and the number of “missed” headcapsules is low if the person who is picking is paying enough attention to its work. Only one aspect of this universally used method could be improved: the time needed to pick all chironomid headcapsules from one sample. The number of headcapsules hand-picked and individually mounted on a microscopic slide can be up to 800 (personal data) and the process can take up to two days. If the time needed to prepare samples was reduced, we could do higher resolution studies, or increase the number of sites to analyse. Recently, two studies (Velle and Larocque accepted; Rolland and Larocque submitted) proposed two ways of improving the universal method by proposing ways to greatly reduce the time used for picking and mounting the chironomid headcapsules. These new methodologies are summarised below.

CALCULATING CONCENTRATIONS WITH MARKERS

Relative abundances are often employed in chironomid reconstructions but the use of absolute abundances, such as concentrations or influx, may provide information overlooked by relative abundances (Heiri et al. 2003; Quinlan et al. 2005). For example, a reconstruction made at Lac du Sommet in Québec (Figure 3.1) shows variations in the interpretation of changes through time if relative abundances (as percentages) or concentrations (number of headcapsules per gram) are used. While *Microtendipes* percentages show few changes through the core, the concentrations indicate two zones (1 and 4) with an increase in the number of recorded *Microtendipes*. By looking at percentages, *Pagastiella* seems to disappear periodically during zones 2 and 3 but the concentrations indicate that the taxon is still present. *Tanytarsus* sp. B, *Pentaneurin*i and *Procladius* increase during zone 1 but these increases are masked when percentages are considered. These results enhance the need of presenting both the percentages and the concentration diagrams, when possible.

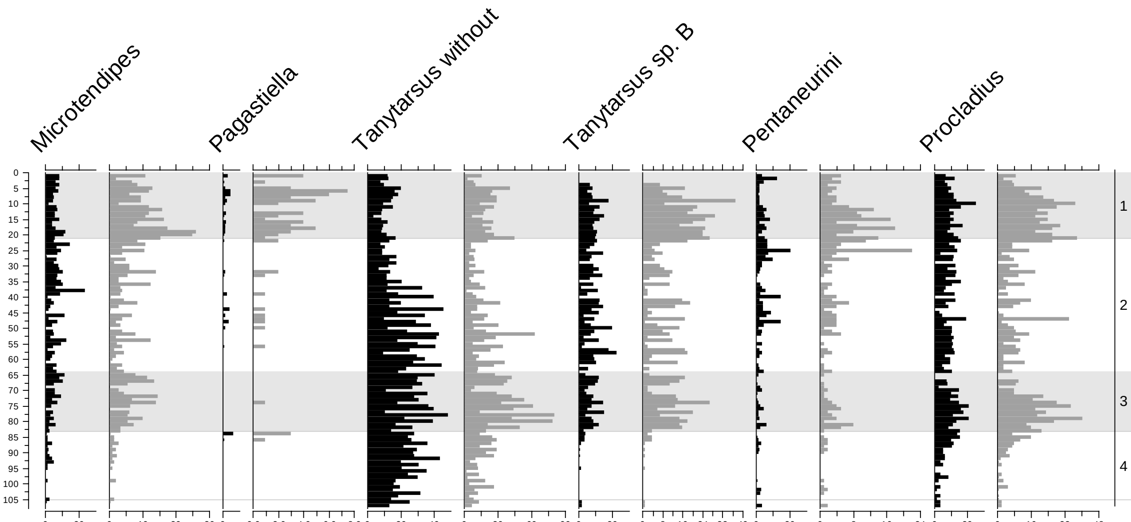

Figure 3.1. Percentages (black diagrams) and concentrations (gray diagrams) of chosen taxa in the sediment core of Lac Du Sommet, Charlevoix, Québec, Canada (Hausmann et al. in prep).

In the standard procedure developed by Walker (2001), to determine the concentration of head capsule involves counting every headcapsule in a pre-measured quantity of sediment. Densities can greatly vary in subsequent levels in a sediment cores, and there is no way to foresee these variations. In some cases, we end up mounting and counting 800 headcapsules for one level. Velle and Larocque (accepted) described a way to evaluate headcapsule concentrations while partially counting a subsample.

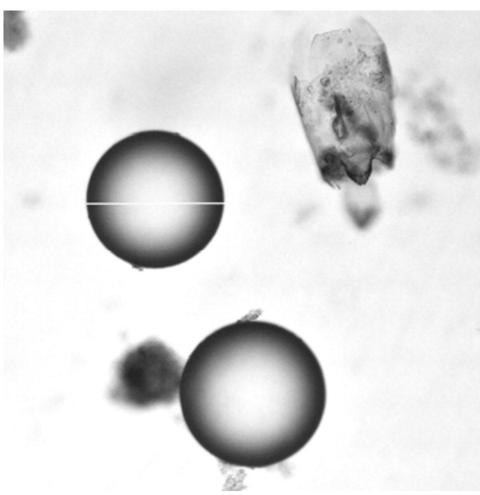

Figure 3.2. Two spheres and a chironomid headcapsule. The white scale in the first micro-sphere represents 150 µm.

Markers can be used in chironomid analysis as is done in pollen (Moore et al. 1991) and diatom (Battarbee and Kneen 1982) analyses. A known number of microspheres (Figure 3.2) (generally about 200) are added to a known volume or weight of sediment during the 10 % KOH process.

A short stay in an ultrasonic bath (Lang et al. 2003) can be added to the Walker (2001) universal method. The sonic bath did not seem to affect the spheres. The solution is then sieved in a 90 µm mesh, placed in a Bogorov counting tray and looked at under a stereozoom microscope. Headcapsules are handpicked and mounted on a microscopic slide while microspheres are enumerated using a counter (Figure 3.3).

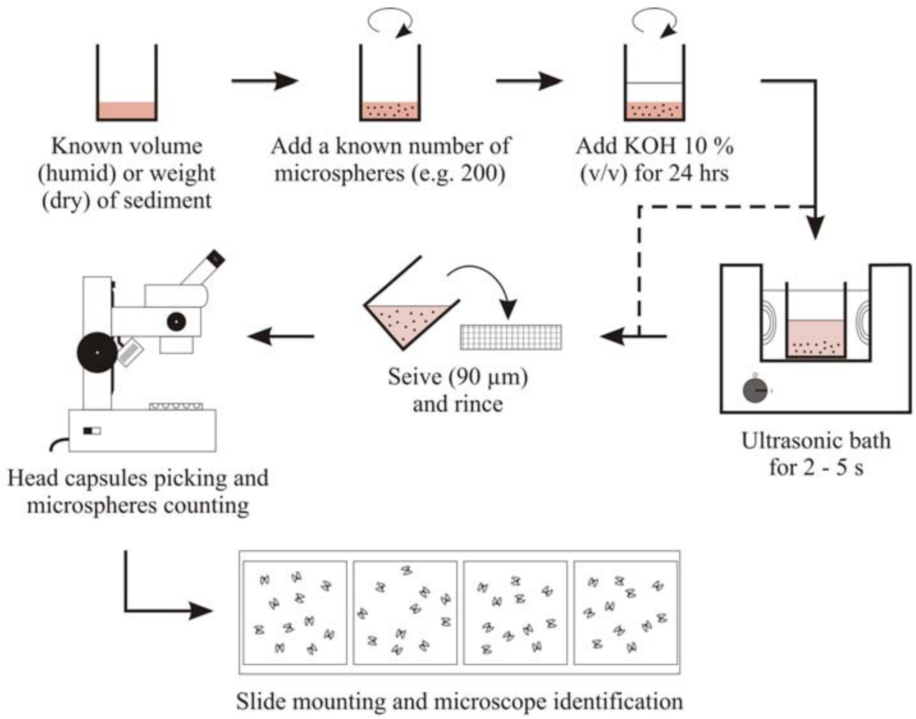

Figure 3.3. Sample preparation with microspheres

The chironomid analyst can decide on a number of headcapsules to be picked in the sample. Various studies have shown that at least 50 headcapsules should be counted per sample for accurate statistical analyses (Quinlan and Smol 2000; Heiri and Lotter 2001; Larocque 2001). Velle and Larocque (accepted) have shown that, with the use of markers, at least 50 headcapsules should be counted, but better results were obtained with at least 85 headcapsules.

Concentrations can then be calculated using this formula:

$$N = (n\ S_a) / Sf / W$$

where N is the total number of headcapsules per weight or volume

n is the number of headcapsules retrieved

S_a is the number of spheres added

Sr is the number of spheres retrieved

W is the sediment volume or weight

The concentrations calculated might be dependant on sediment characteristics (sedimentation rate, sediment focusing and sediment density). If an age-depth model is available, we suggest using influx (number per annum per cm^2) instead of only concentration. This number obtain comprises a concentration that is relative to the sediment characteristics which may highly fluctuate in sediment cores. To calculate influxes, the following formula can be used:

$$Y = N_d \, (W_d^- / W_p) \, (1/dr)$$

Where Y = influx

N_d = number of fossil per gram

W_d = dry weight of the sample

W_p = the percentage dry weight

d = the sediment density

r = sedimentation rate

FLOATING TECHNIQUE USING KEROSENE

Another way to decrease the time for picking and to know the chironomid head capsules concentration is to use a floating technique which is generally used for insects (Coope 1986) such as Coleoptera (Elias 2001) and aquatic mites (Proctor 2001). This technique started to be applied for chironomid analysis (e.g., Gandouin et al. 2005; Ruiz et al. 2006) but, to our knowledge, the technique was never tested before the study of Rolland and Larocque 2006. The technique is rather simple (Figure 3.4) and is based on a) the affinity between chitin and kerosene and b) the difference in densities of headcapsule, kerosene and ethanol.

First, 10 % KOH is added to a known amount of dry or wet sediment. The solution can be left overnight or heated for 5-10 minutes to deflocculate the sediment. The solution is filtered in a 100 µm mesh. The sediment left in the mesh is placed in an Erlenmeyer using distilled water. Ethanol is added to bring the volume to 100 ml. We then add 50 ml of kerosene, cap the Erlenmeyer and shake gently to mix the sediment, the ethanol and the kerosene. The Erlenmeyer is left to stand until the separation of ethanol and kerosene. The hadcapsules, being attracted by the kerosene but having densities between kerosene and ethanol, will float to the line of separation between the two solutions. A pipette is then used to extract the headcapsules and the kerosene. A second floatation can be made by adding again 50 ml of kerosene, shaking gently the solutions and letting the two solutions separate. Headcapsules are again retrieved with a pipette. Rolland and Larocque (submitted) found that one floating was enough to remove at least 85 % of the headcapsules but two floats are generally used to ensure the capture of most headcapsules.

Various sediment types were tested with this technique, from clay sediment to peat samples. The floating responded very well to all sediment types between inorganic (Loss on ignition (LOI

= 2 %) to organic (LOI = 68 %) (Rolland and Larocque, submitted). The method has then become a standard in our laboratory and all long cores are treated this way. We routinely verify samples to be sure that most headcapsules are floating and in all cases very few (2 %) to no headcapsule were found in the sediment remaining after the float.

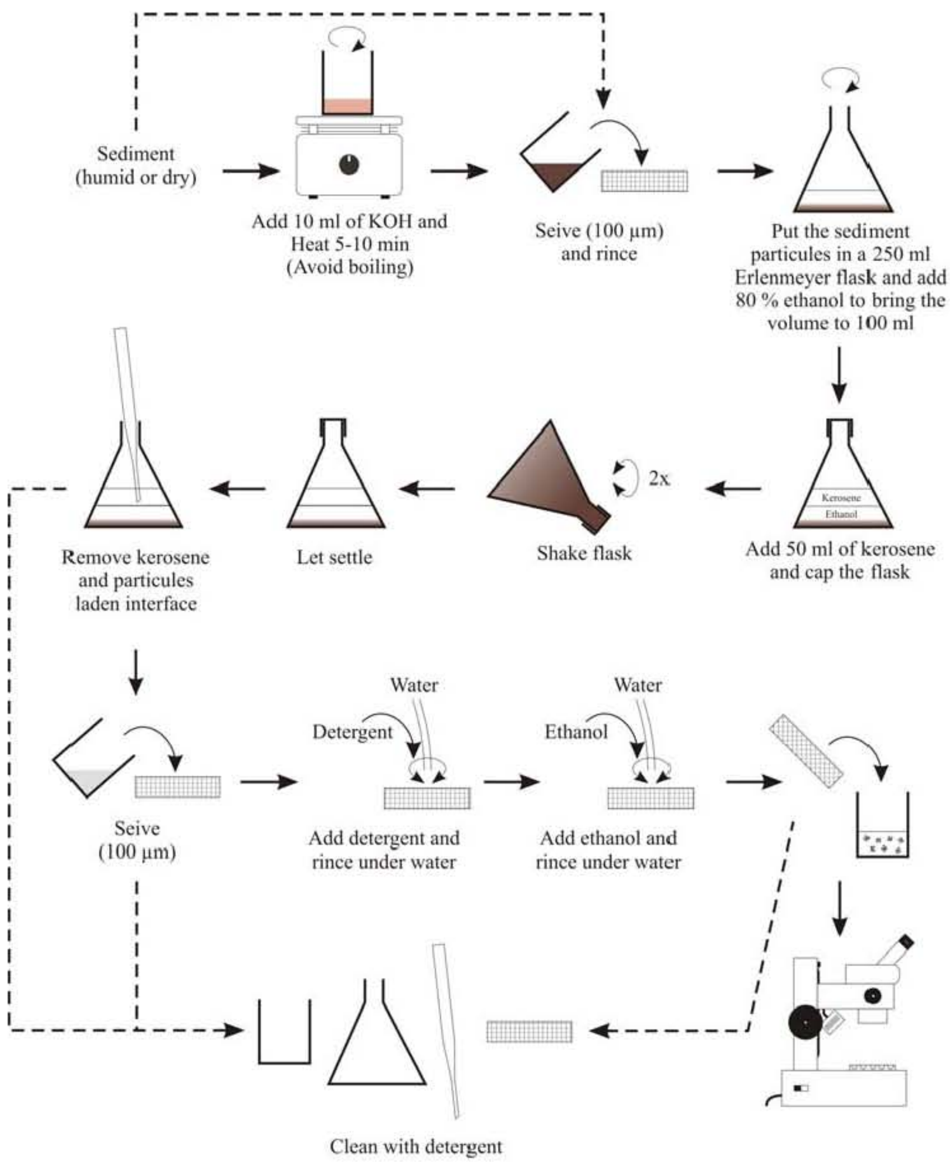

Figure 3.4. Sample preparation for kerosene floating

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4. Taxonomy

INTRODUCTION

The taxonomy presented here is based on various sources including published keys (e.g., Wiederholm 1983; Oliver and Roussel 1983; Moller Pilot 1984 a,b, Epler 1995; Rieradevall and Brooks 2001), information gathered at various workshops attended in Europe and North America (e.g., unpublished keys developed by Steve Brooks on Tanytarsini), Oliver Heiri's website on Tanytarsisni (www.bio.uu.nl/~palaeo/Chironomids /Tanytarsini/intro.htm) and personal observations and classifications of different taxa.

This guide is not complete, it only concerns the taxa found in the training set lakes. For complete guides, please consult the sources enumerated above. A complete guide for subfossil taxonomy by Brooks, Langdon and Heiri should be soon available. The taxonomy part of this guide is separated into Tribe and subtribes, based primarily on parts that are preserved and are present in sub-fossils: the mentum and the ventromental plates.

The Chironominae have elongated ventromental plates. They are divided into two subtribes: the Chironomini, with wide ventromental plates (Figure 4.1) and the Tanytarsisni, with thin ventromental plates (Figure 4.2). The shape of the ventromental plates and the shape of the teeth on the mentum are used to differentiate the taxa.

Figure 4.1 ventromental plates of Chironomini

The taxonomy of Tanytarsini is based on Steve Brooks' unpublished key. The presence and shape of the spur on the antenna, the number of teeth on the mandible and the shape of the occipital plates are characteristics used to separate the different taxa.

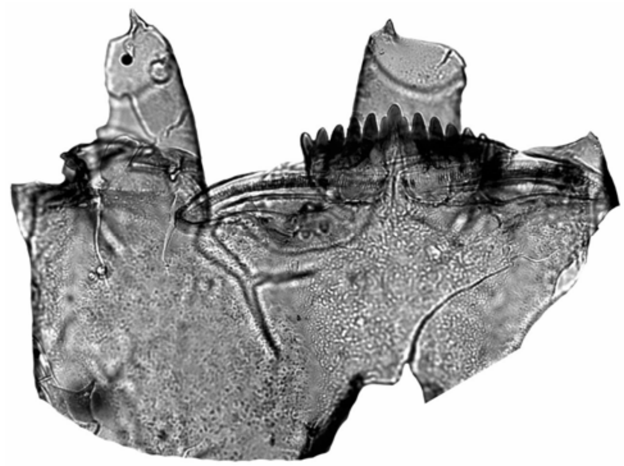


Figure 4.2 Ventromental plates of Tanytarsini

The Orthocladinae have thin ventromental plates which follow the mentum and are often hard to see (Figure 4.3). The shape of the ventromental plates, the shape of the median, the shape and number of the lateral teeth are characteristics used to differentiate the taxa.

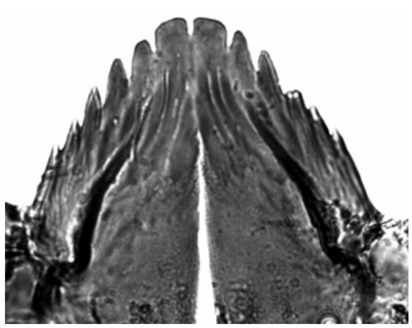


Figure 4.3. Ventromental plates of Orthocladinae

The Diamesinae are distinguished by a high number (>6) of lateral teeth on the mentum. The shape and number of teeth on the mentum are used to differentiate the taxa (Figure 4.4).

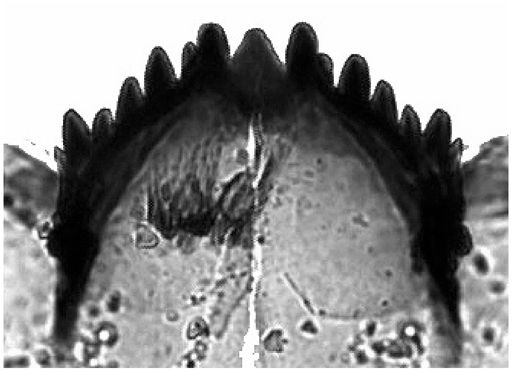


Figure 4.4. Pseudodiamesa

The Tanypodinae have elongated headcapsules, they do not have a mentum but a ligula. Taxonomy is based on Rieradevall and Brooks (2001) where seta pores are used. The ventromental pore is oval (A), the setae pores are round and look double-lined (B-C) (Figure 4.5).

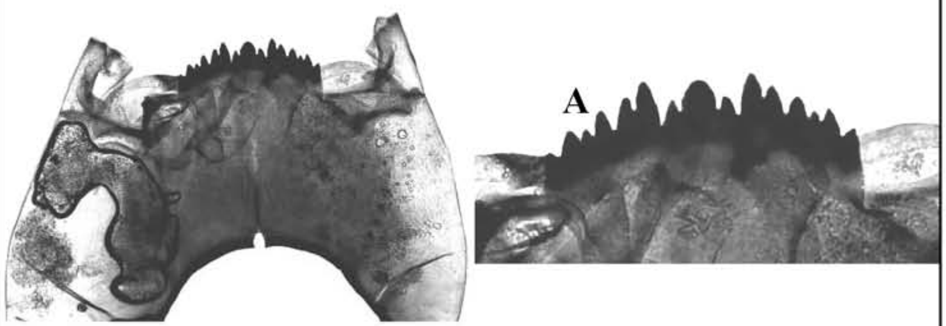
Figure 4.5 Telopelopia headcapsule

CHIRONOMINAE

CHIRONOMINI

The visual guide to subfossil chironomid analysis

Genera: Chironomus anthracinus-type
Tribe: Chironominae

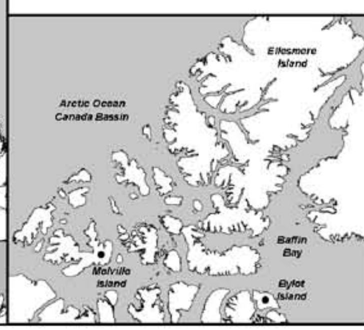


Description:

Differentiated from C. plumosus-type by a shorter lateral tooth (A)

Ecology:

Found in productive lakes (1), in the profundal zone (2, 3)

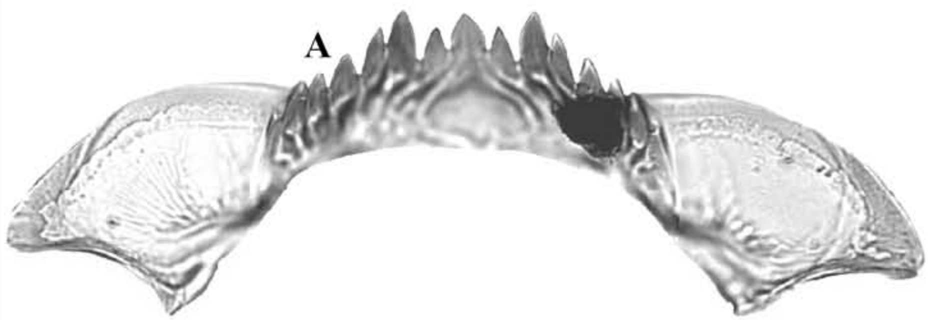


Temperature optimum (°C):

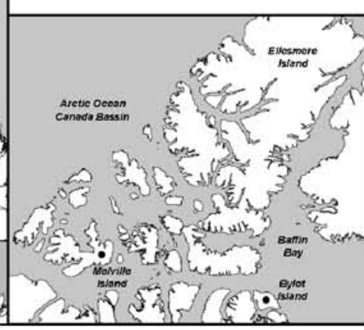
11.0

The visual guide to subfossil chironomid analysis

Genera: Chironomus plumosus-type
Tribe: Chironominae

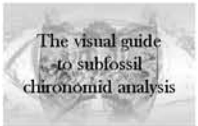


Description:
Lateral teeth as long as the others (A)
Ecology:
Found in productive lakes, with low pH, in the profundal zone and increase with eutrophication (4). Found in warm and humic waters (5,6), in eutrophic lakes (7,8) and in the profundal zone of lakes with low oxygen (8).

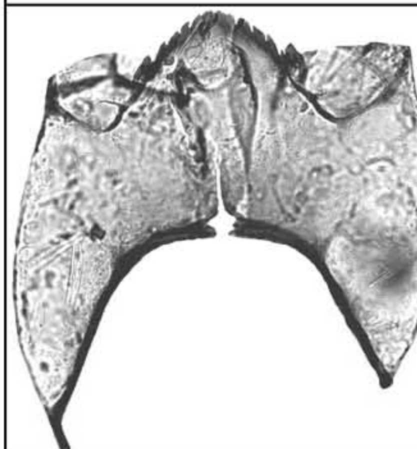


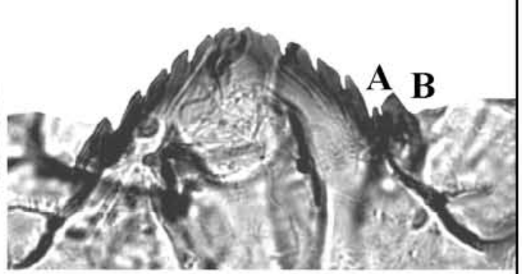
Temperature optimum (°C):

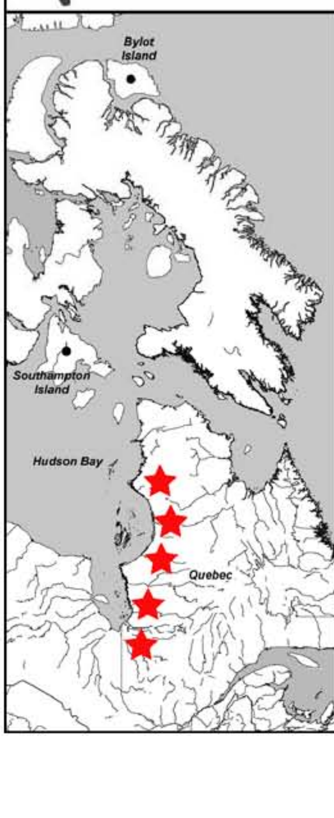
11.6



Genera: Cladopelma
Tribe: Chironominae, Chironomini

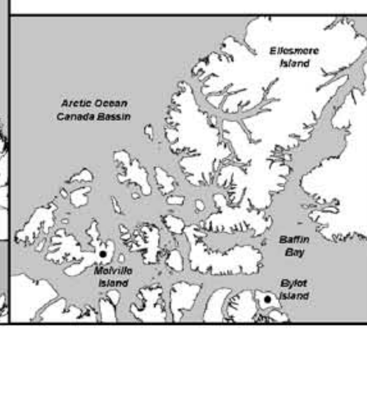






Description:
Second last lateral extremely short (A), last lateral prominent (B).

Ecology:
Restricted to shallow lakes (9), on on in the bottom sediments (10), in mud of gravel substrate (11). Prefers warm water (12,13).

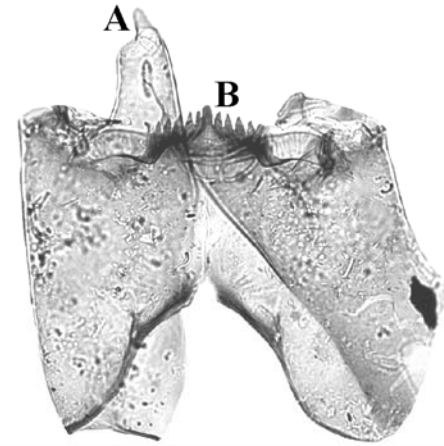


Temperature optimum (°C):

9.5

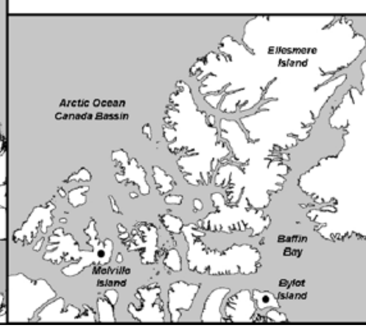
The visual guide to subfossil chironomid analysis

Genera: Constempellina
Tribe: Chironominae, Chironomini



Description:
Spur on the antenna (A). Spur shorter than Stempellinella. Lateral teeth (B) are thin and curved compared to Stempel-linella

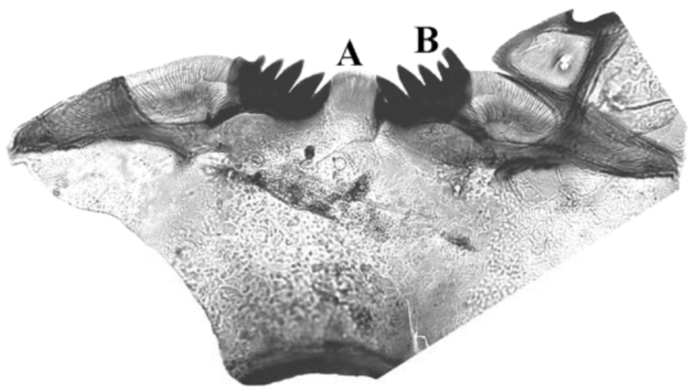
Ecology:
Stream dwellers (10)



Temperature optimum (°C):

21.2

Genera: Cryptochironomus
Tribe: Chironominae, Chironomini

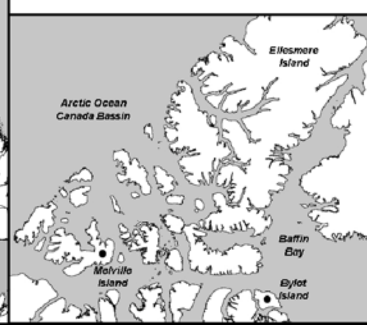


Description:

Characteristic mentum with very large median (A) and dark lateral teeth (B).

Ecology:

Larvae are mostly benthic on sandy substrata (10).

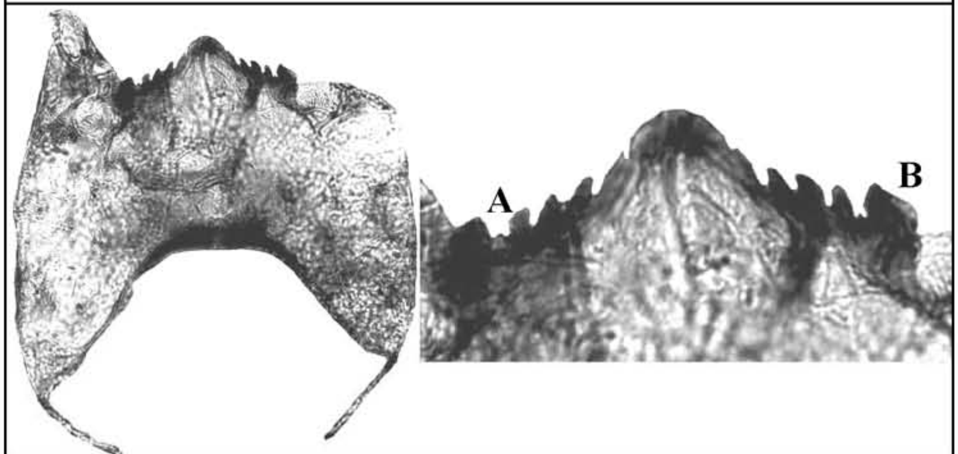


Temperature optimum (°C):

21.6

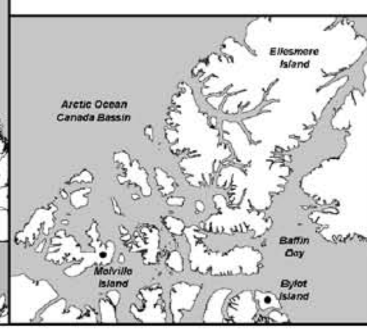
The visual guide to subfossil chironomid analysis

Genera: Cryptotendipes
Tribe: Chironominae, Chironomini



Description:
Fifth lateral suppressed (A), 6th lateral prominent (B).

Ecology:
Lotic or lentic taxa, benthic and tolerate enriched lakes (10), oligo to mesothrophic (32).

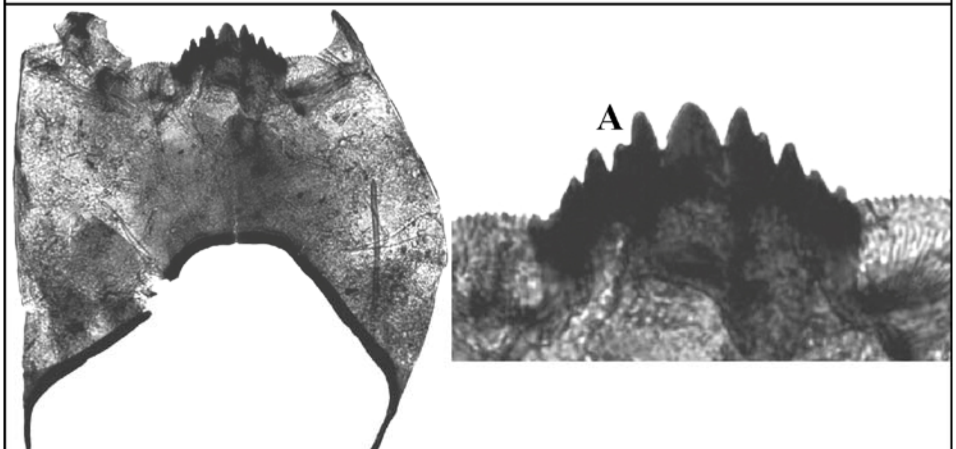


Temperature optimum (°C):

24.0

The visual guide to subfossil chironomid analysis

Genera: Dicrotendipes
Tribe: Chironominae, Chironomini

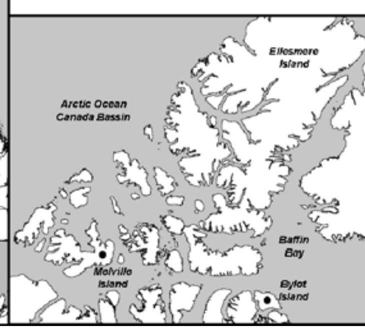


Description:

1st and second lateral fused (A).

Ecology:

Eutrophic taxa (14, 15) in vegetated ponds (11, 16, 17), on vegetation (10), decrease with deforestation (14).

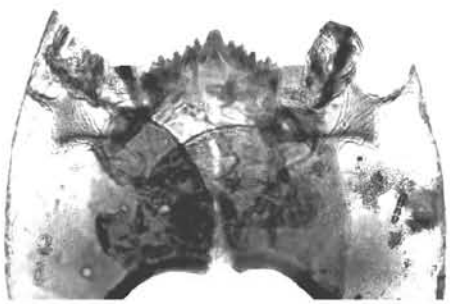


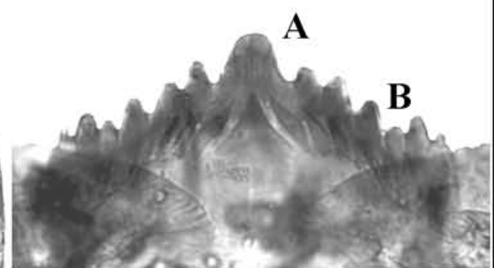
Temperature optimum (°C):

16.0

The visual guide to subfossil chironomid analysis

Genera: Einfeldia
Tribe: Chironominae, Chironomini



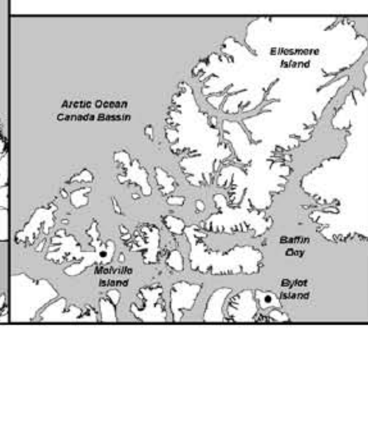


Description:

Round and prominent median (A), 4th lateral smaller (B).

Ecology:

In eutrophic (10) and/or small lakes (4).

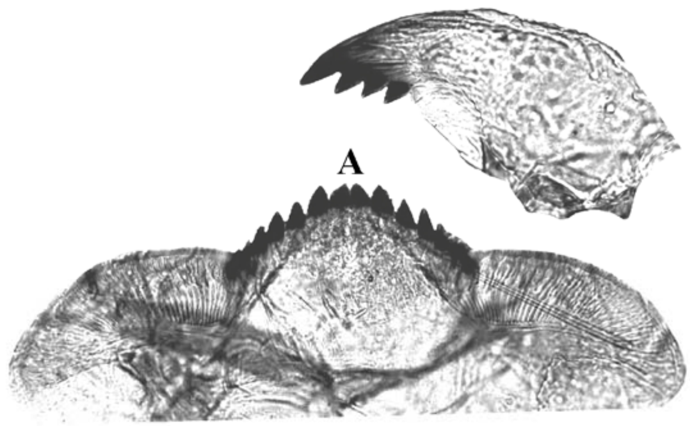


Temperature optimum (°C):

16.1

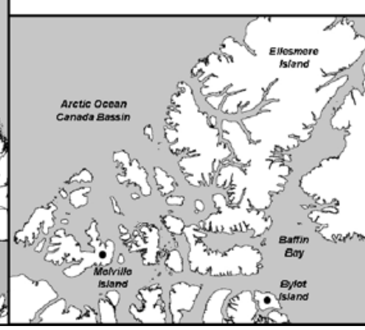
The visual guide to subfossil chironomid analysis

Genera: Endochironomus albipennis
Tribe: Chironominae, Chironomini



Description:
Named following Wiederholm (1983) *fig*. 10.24
First two median are close together (A).

Ecology:
Moderate to eutrophic lakes (10), on vegetation (4).



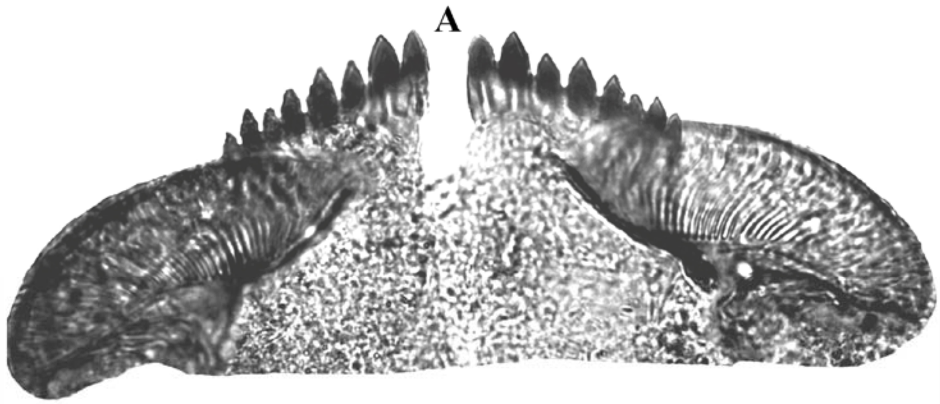
Temperature optimum (°C):

13.2

The visual guide to subfossil chironomid analysis

Genera: Endochironomus impar
Tribe: Chironominae, Chironomini

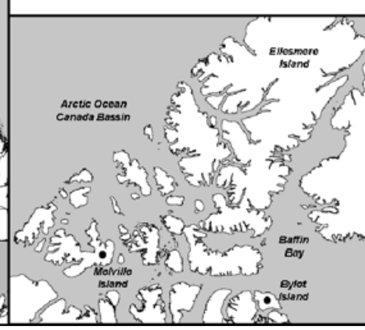
A



Description:

Named following Wiederholm (1983) *fig*. 10.26B.
Four Median (A).
Same as Endochironomus dispar ?

Ecology:

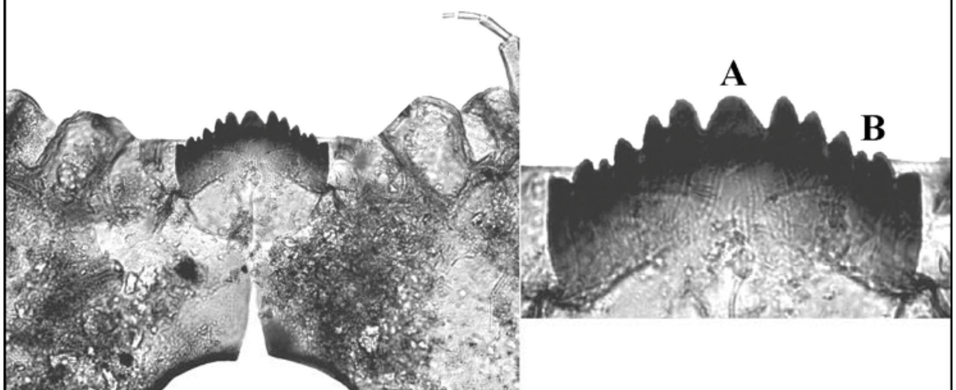


Temperature optimum (°C):

28.6

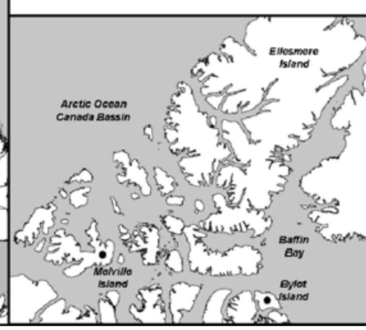
The visual guide to subfossil chironomid analysis

Genera: Glyptotendipes
Tribe: Chironominae, Chironomini



Description:
Round median with a notch (A), 4th lateral smaller (B)

Ecology:
In eutrophic lakes (10, 14), on plants (4, 10), exclusively in littoral zone (2), decrease with deforestation (14).

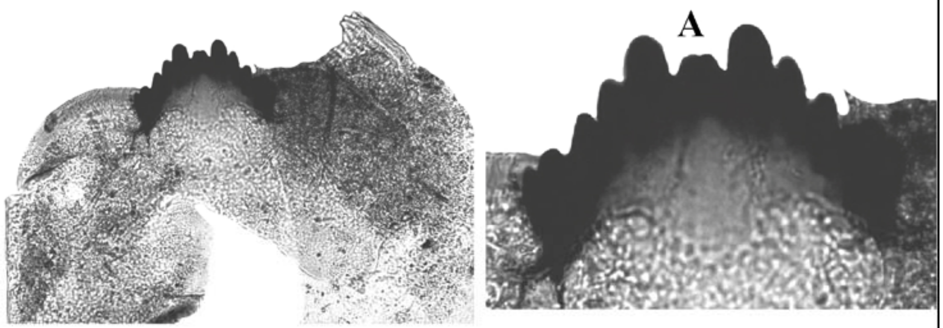


Temperature optimum (°C):

17.1

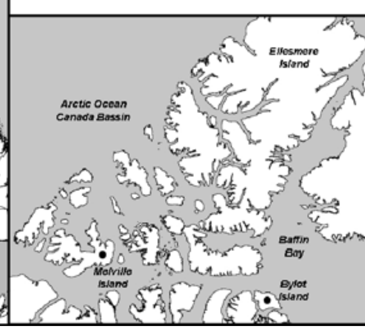
The visual guide to subfossil chironomid analysis

Genera: Glyptotendipes type 2
Tribe: Chironominae, Chironomini



Description:
Named following Wiederholm (1983) *fig*.10.30.
Glyptotendipes II (severini ?)
Three median elevated with the middle tooth smaller (A) and a dark mentum.

Ecology:

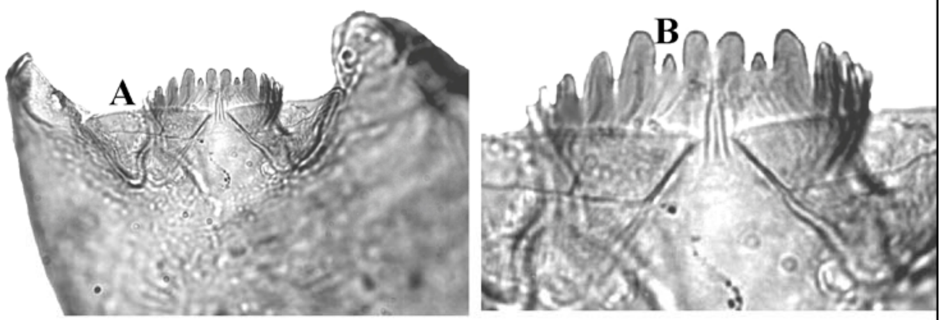


Temperature optimum (°C):

34.7

The visual guide to subfossil chironomid analysis

Genera: Lauterborniella
Tribe: Chironominae, Chironomini

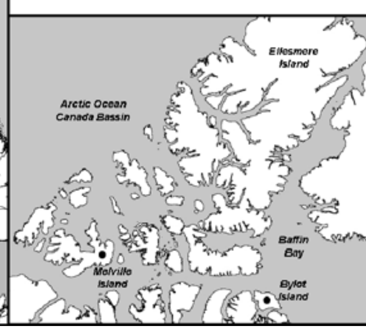


Description:

Ventromental plates are triangular (A).
The first lateral teeth are smaller (B).

Ecology:

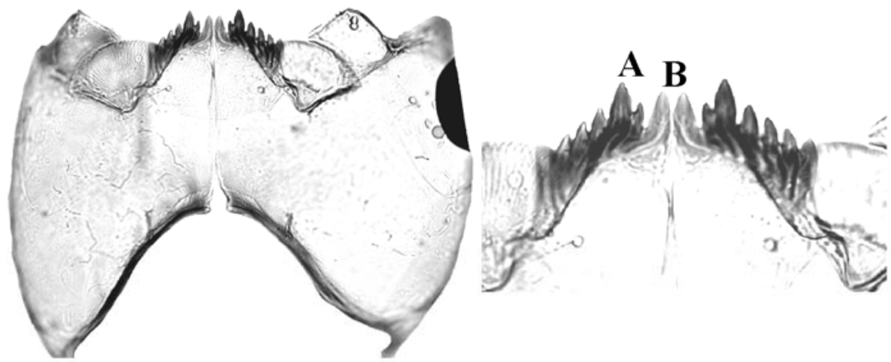
Among vegetation in ponds (10).
Note: Found only in one lake in the T.S.



Temperature optimum (°C):

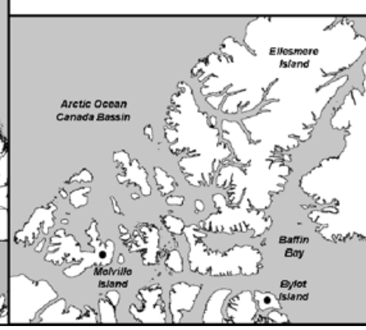
n.a

Genera: Microtendipes
Tribe: Chironominae, Chironomini



Description:
Second lateral and third are fused. The second is smaller (A). The median are often paler (B) than other teeth.

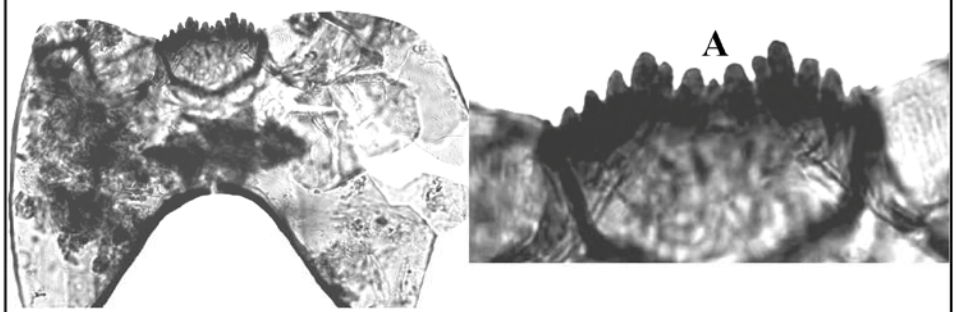
Ecology:
In warm and humic waters (5), small, shallow lakes (9), low to mid-elevation (18).



Temperature optimum (°C):

12.6

Genera: Microtendipes rydalensis
Tribe: Chironominae, Chironomini

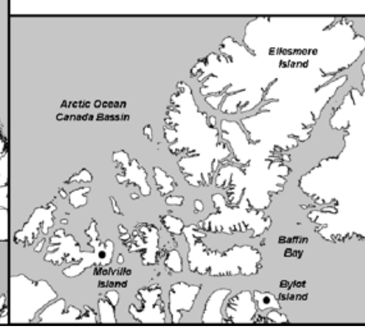


Description:

Three median teeth (A).

Ecology:

Not included in the T.S.

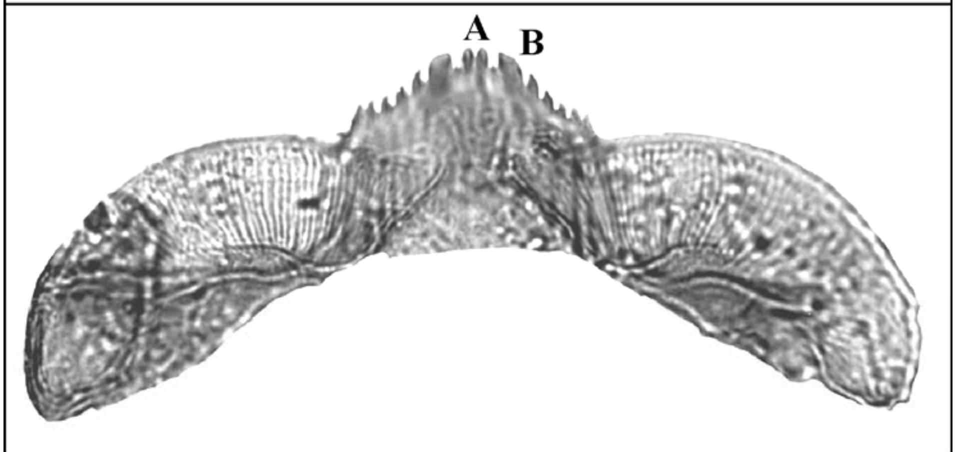


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Pagastiella
Tribe: Chironominae, Chironomini

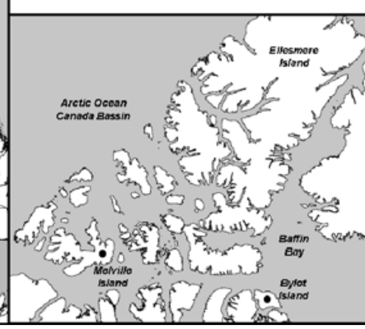


Description:

Two thin median (A) followed by small lateral. The third lateral is wider (B).

Ecology:

In littoral zone (10), oligotrophic (34), acid-sensitive (35).

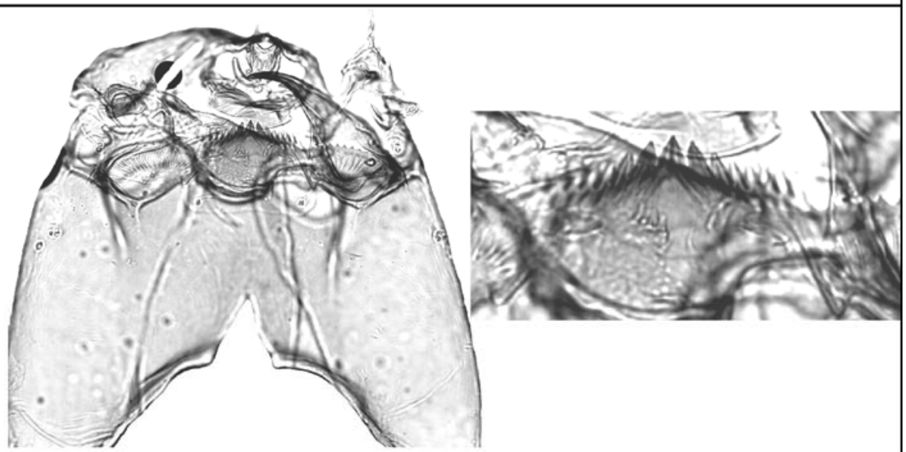


Temperature optimum (°C):

17.8

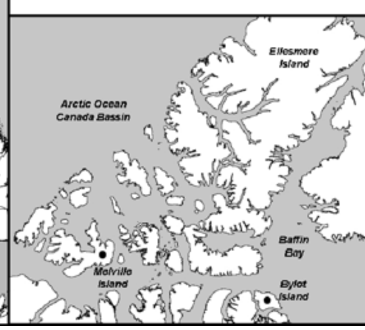
The visual guide to subfossil chironomid analysis

Genera: Parachironomus
Tribe: Chironominae, Chironomini



Description:
Type C in Wiederholm (1983) *fig.* 10.51
Triangular teeth, short ventromental plates with large crenulations.

Ecology:
Ponds, lakes and slow flowing waters (4).

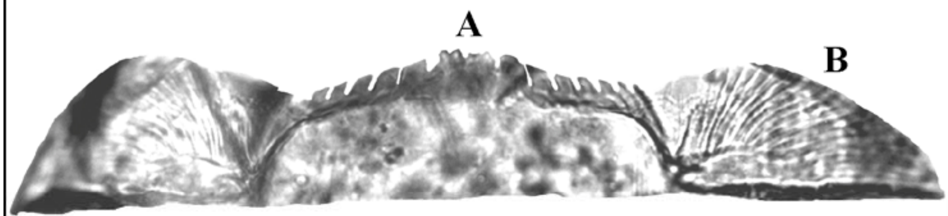


Temperature optimum (°C):

5.7

The visual guide to subfossil chironomid analysis

Genera: Paracladopelma
Tribe: Chironominae, Chironomini

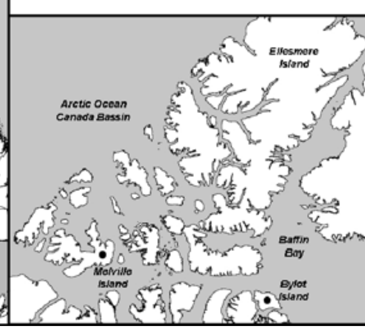


Description:

Square teeth (A), ventromental plates with wide crenulations (B).

Ecology:

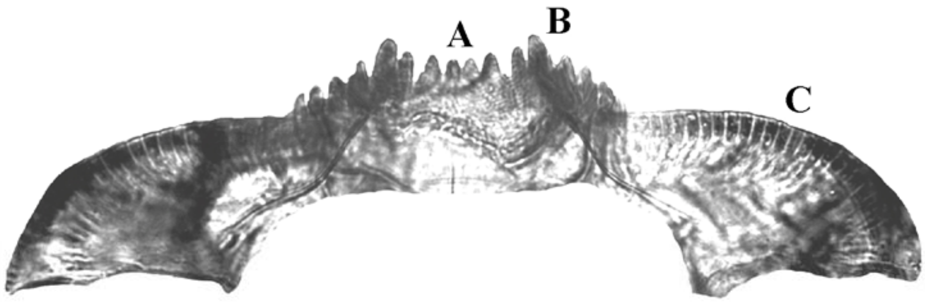
In oligotrophic (8, 32) and profundal (32) lakes.



Temperature optimum (°C):

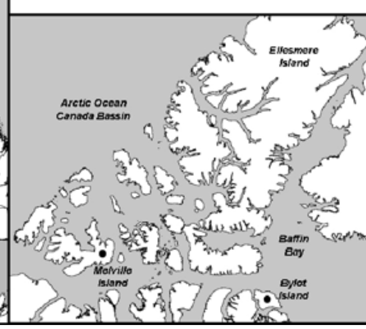
18.1

Genera: Paratendipes albimanus
Tribe: Chironominae, Chironomini



Description:
Four median (A), the first two lateral are fused (B). Crenulations on plates well defined (C).

Ecology:
Stream detritivore (36), large deep lakes with high pH (37).

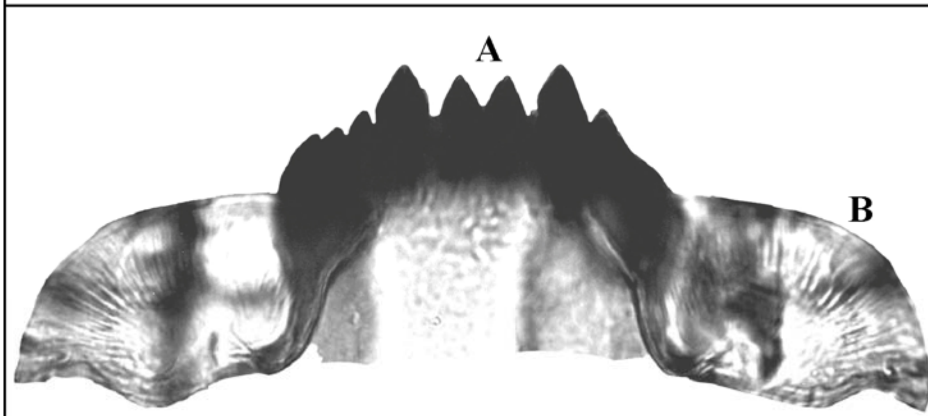


Temperature optimum (°C):

n.a

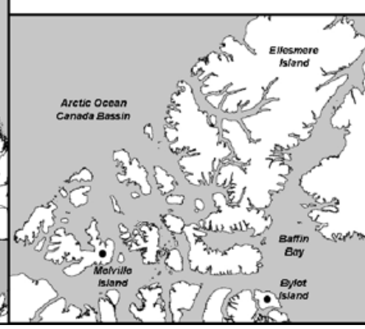
The visual guide to subfossil chironomid analysis

Genera: Phaenopsectra
Tribe: Chironominae, Chironomini



Description:
Four median teeth prominent (A), dark mentum, small crenulation on the margin of the ventromental plates (B).

Ecology:
Either in streams (10) or in the profundal of cold lakes (4).

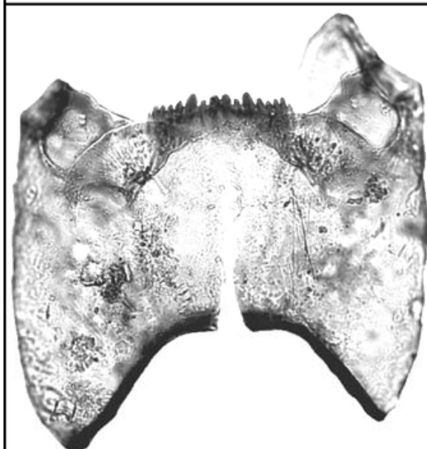


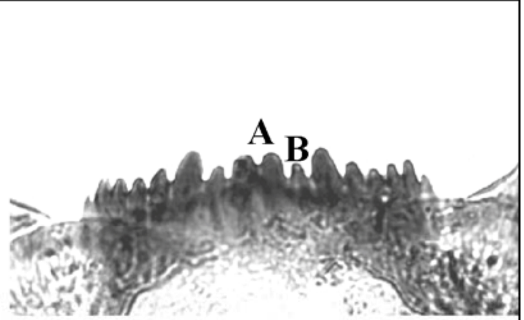
Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

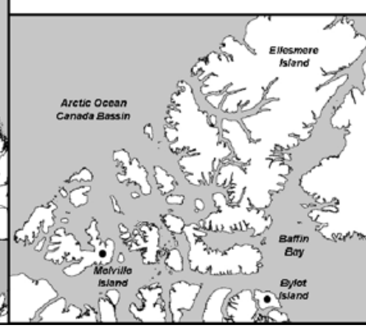
Genera: Polypedilum nubeculosum
Tribe: Chironominae, Chironomini





Description:
Follows Wiederholm (1983) *Fig*. 10.59. Two median fused (A), 1st lateral small (B), the teeth on the mentum are round.

Ecology:
In eutrophic waters (13, 15), increase with deforestation (14), decrease with oxygen depletion (19).

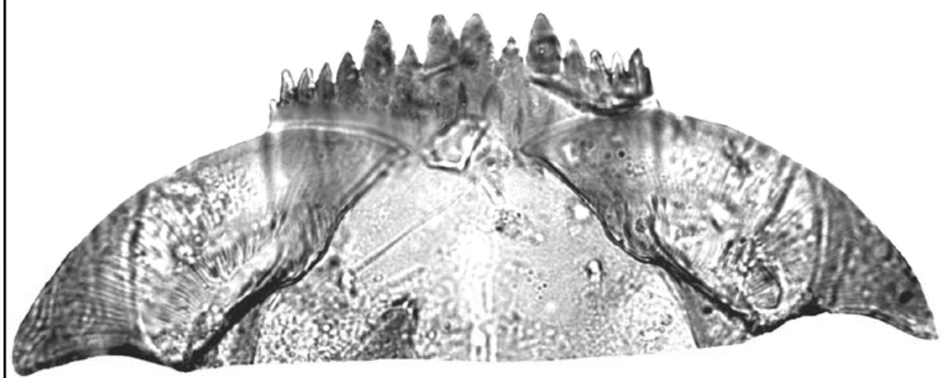


Temperature optimum (°C):

15.1

The visual guide to subfossil chironomid analysis

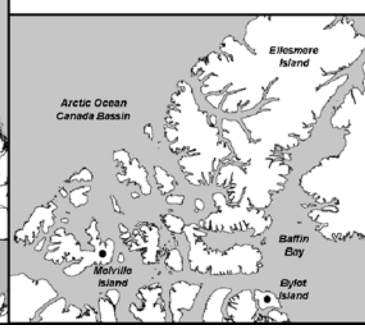
Genera: Polypedilum type IIIc
Tribe: Chironominae, Chironomini



Description:

Follows Wiederholm (1983) *Fig.* 10.61c. Teeth on the mentum are triangular not round like P. nebeculosum.

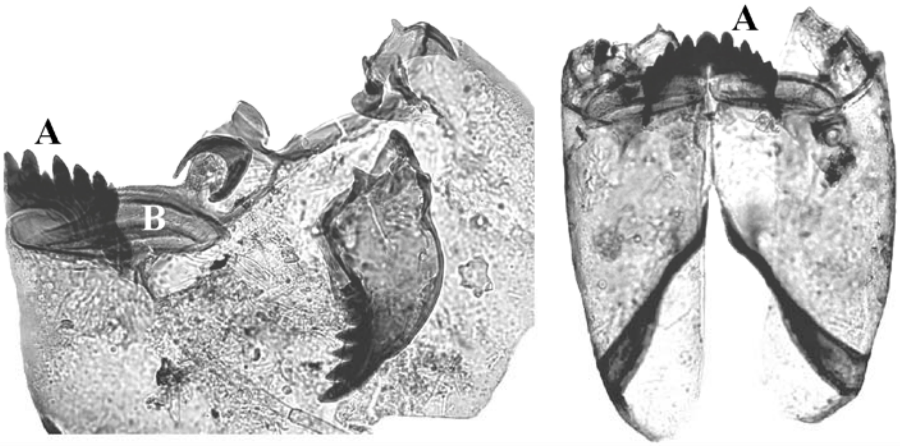
Ecology:



Temperature optimum (°C):

15.4

Genera: Pseudochironomus
Tribe: Chironominae, Chironomini

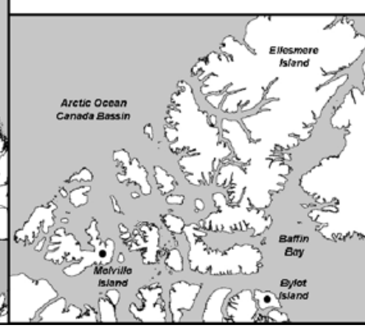


Description:

Small second lateral (A), plates with a similar shape as Tanytarsini but wider (B).

Ecology:

On sandy substrate (10).

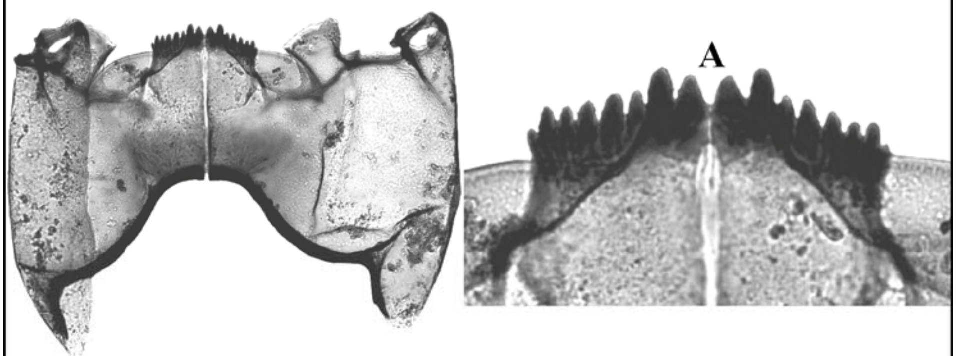


Temperature optimum (°C):

5.3

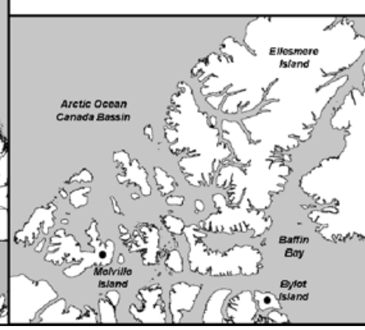
The visual guide to subfossil chironomid analysis

Genera: Sergentia coracina-type
Tribe: Chironominae, Chironomini



Description:
Four median (A), the ventromental plate starts at the fourth median, the crenulations are weaker than on S. longiventris.

Ecology:
Mesotrophic (8), profundal (20).

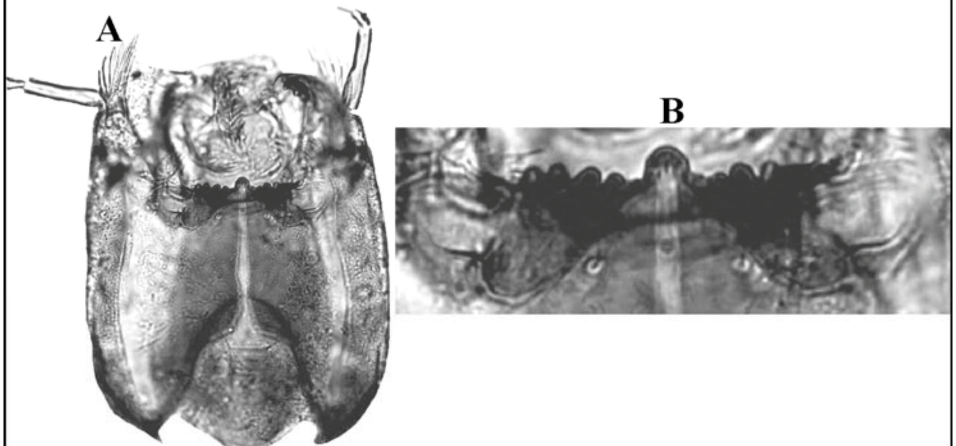


Temperature optimum (°C):

1.1

The visual guide to subfossil chironomid analysis

Genera: Stempellina
Tribe: Chironominae, Chironomini

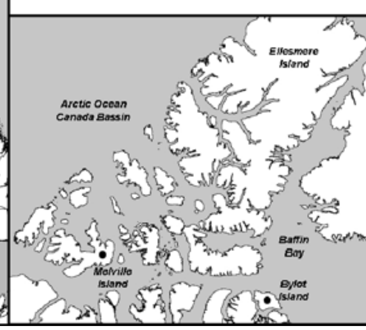


Description:

Many projections on the antenna (A), round median (B).

Ecology:

Lotic and lentic situations (10).

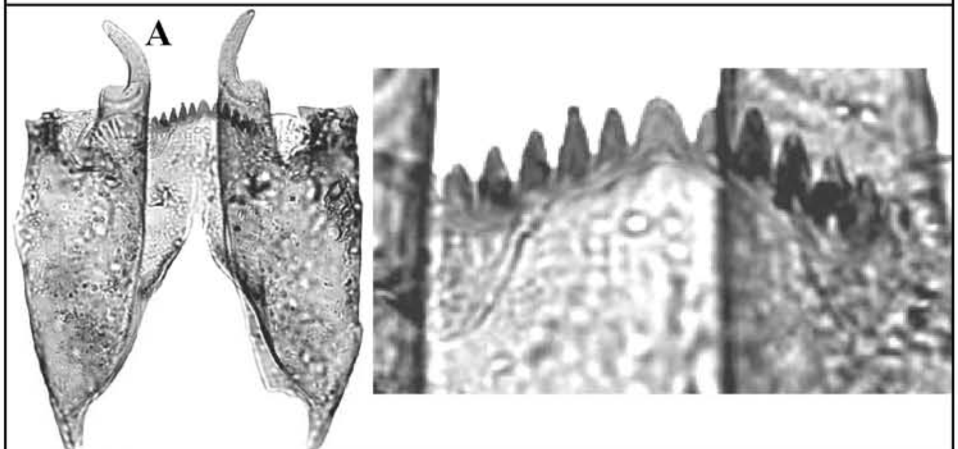


Temperature optimum (°C):

17.9

The visual guide to subfossil chironomid analysis

Genera: Stempellinella
Tribe: Chironominae, Chironomini

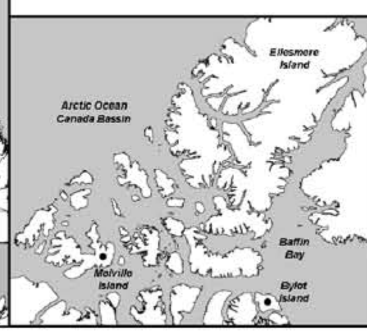


Description:

Long spur on the antenna (A).

Ecology:

Spring, streams and river but also in lakes (10).

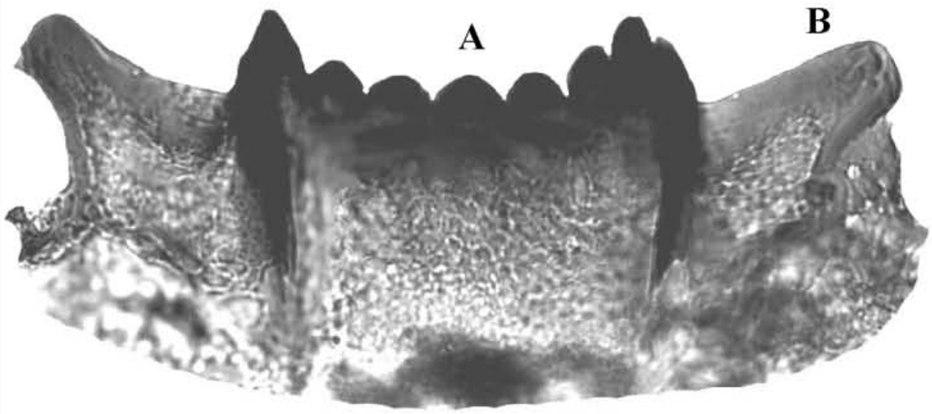


Temperature optimum (°C):

13.8

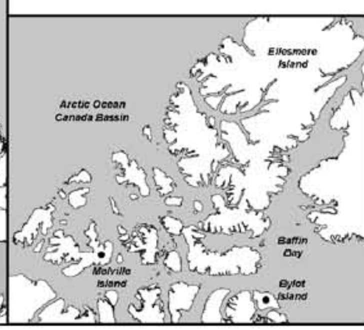
The visual guide to subfossil chironomid analysis

Genera: Stenochironomus
Tribe: Chironominae, Chironomini



Description:
Median teeth are lower than other teeth (A), the ventromental plates are large (B).

Ecology:
In dead submerged leaves or wood (10).
Note: One specimen in one lake in the T.S.



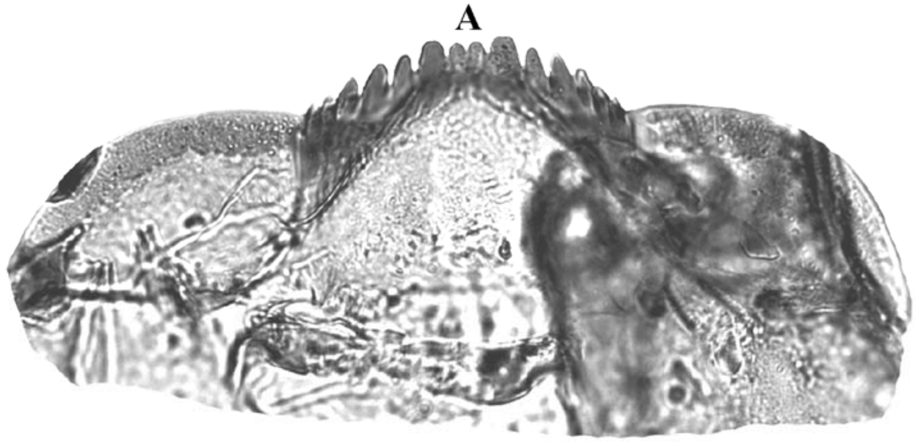
Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Stictochironomus
Tribe: Chironominae, Chironomini

A

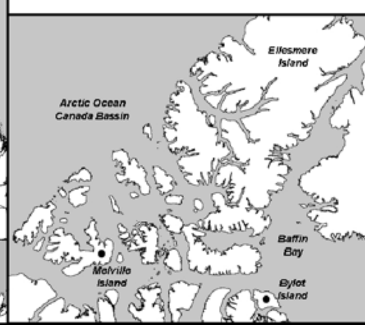


Description:

Four median, the middle ones are small (A).

Ecology:

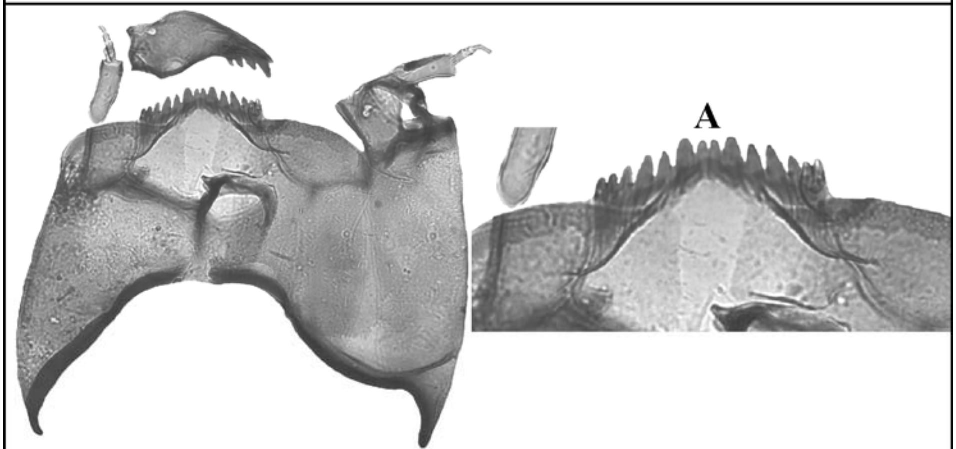
Profundal taxa (20), sandy sediment of streams, rivers and lakes (10).



Temperature optimum (°C):

9.4

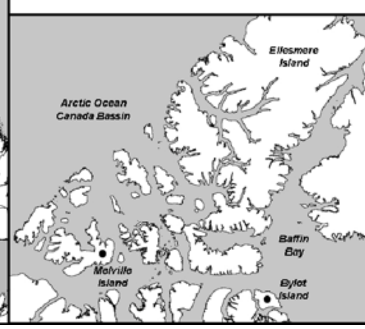
Genera: Stictochironomus type B
Tribe: Chironominae, Chironomini



Description:

Four median, the middle ones are small (A). Wiederholm (1983) *Fig.* 10.74 B

Ecology:



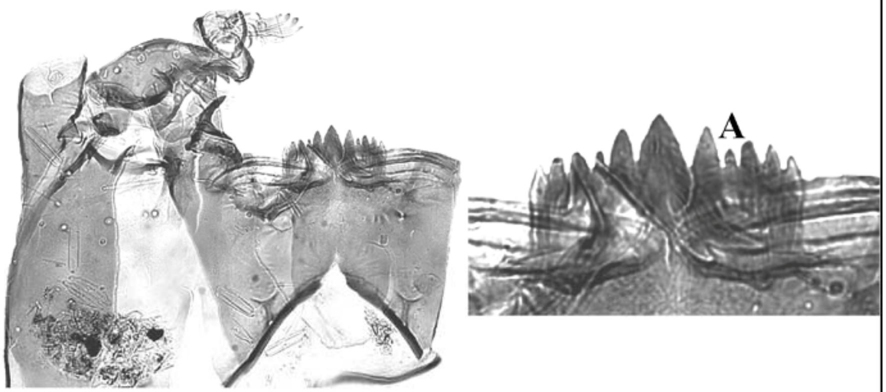
Temperature optimum (°C):

n.a

CHIRONOMINAE

TANYTASINI

Genera: Cladotanytarsus mancus-type
Tribe: Chironominae, Tanytarsini

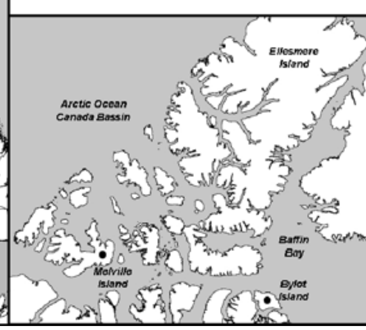


Description:

Second lateral shorter than other teeth (A).

Ecology:

Exclusively littoral (2), in warm and humic waters (4)

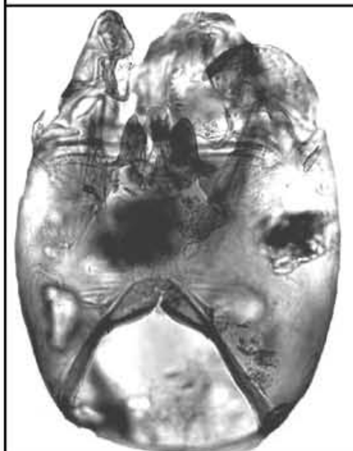


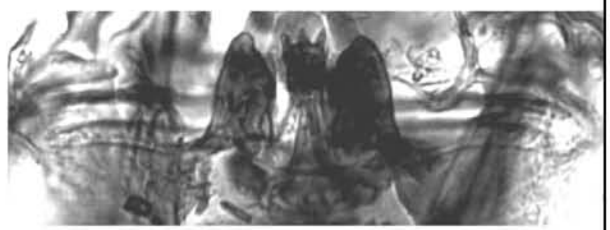
Temperature optimum (°C):

17.9

The visual guide to subfossil chironomid analysis

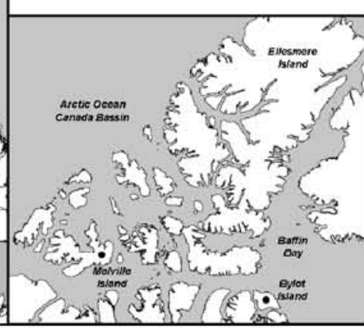
Genera: Corynocera ambigua
Tribe: Chironominae, Tanytarsini





Description:
Three pale teeth on the back and two very dark ones on front.

Ecology:
In shallow tundra lakes (9), oligothrophic, associated with Chara sp. (40).

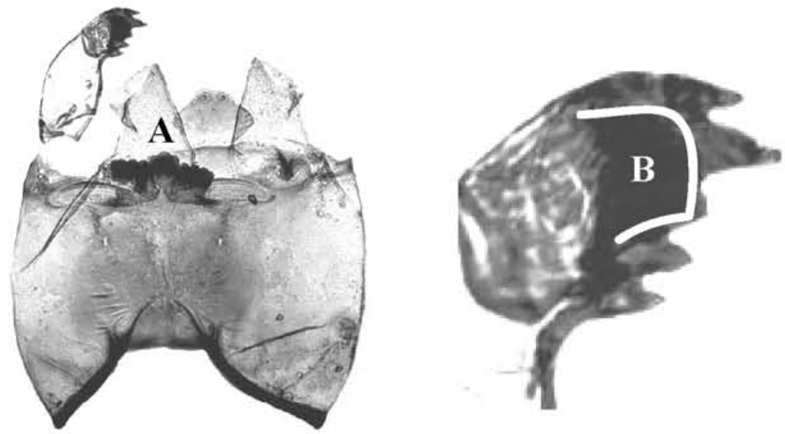


Temperature optimum (°C):

1.2

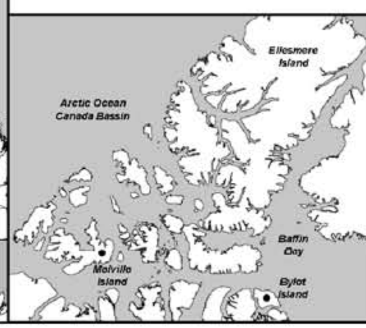
The visual guide to subfossil chironomid analysis

Genera: Corynocera oliveri
Tribe: Chironominae, Tanytarsini



Description:
Median teeth (A) are higher than the lateral teeth. One large surface tooth covering the inner teeth on the mandible (B).

Ecology:
In cold water (5), in the littoral zone (2).

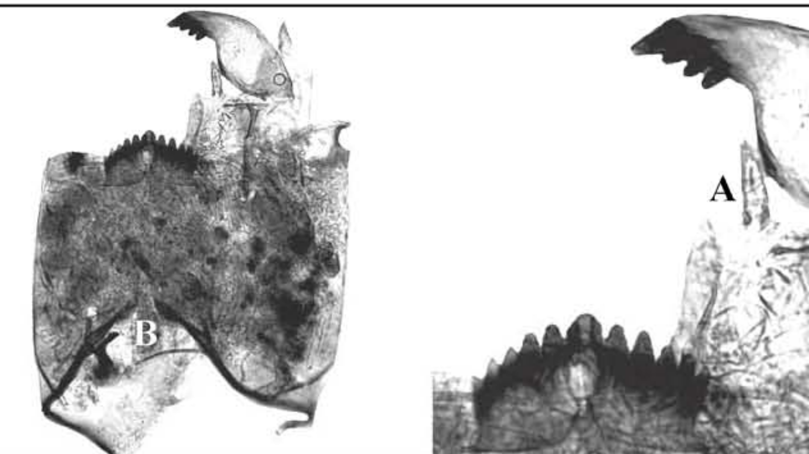


Temperature optimum (°C):

5.9

The visual guide to subfossil chironomid analysis

Genera: Micropsectra bidentata-type
Tribe: Chironominae, Tanytarsini

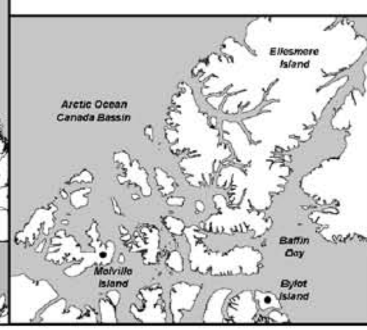


Description:

Long spur on the antenna (A). The spur is wider than on T. chinyensis. Large occipital plates (B).

Ecology:

In streams (41), temporary pools (42).

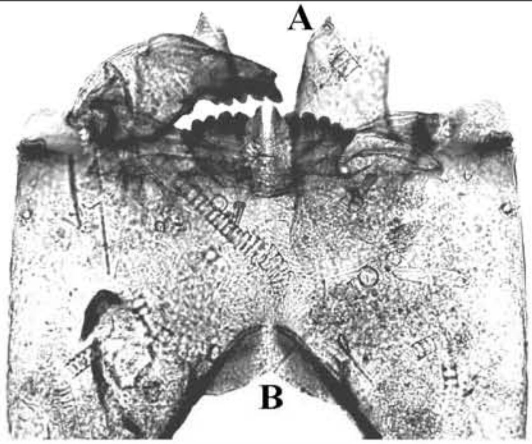


Temperature optimum (°C):

9.9

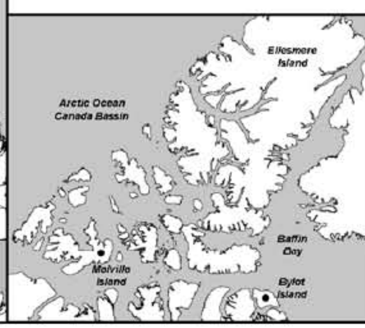
The visual guide to subfossil chironomid analysis

Genera: Micropsectra insignilobus-type
Tribe: Chironominae, Tanytarsini



Description:
Short sharp spur on the antenna (A). One side of the spur is rounder than on M. radialis. Large occipital plates (B).

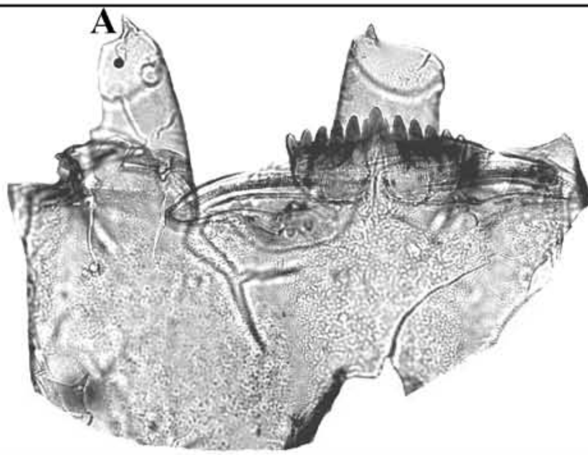
Ecology:
Oligotrophic taxon (21), cold and acidophilic (43).



Temperature optimum (°C):

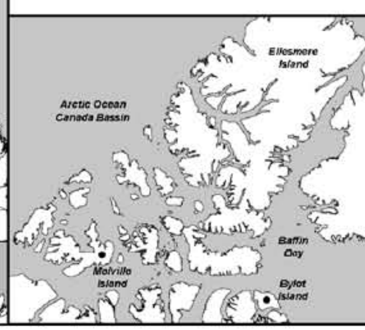
9.5

Genera: Micropsectra radialis-type
Tribe: Chironominae, Tanytarsini



Description:
Short and pointy spur on the antenna (A). The spur is sharper than on M. radialis.

Ecology:
High alpine lakes (22), cold indicator (44).

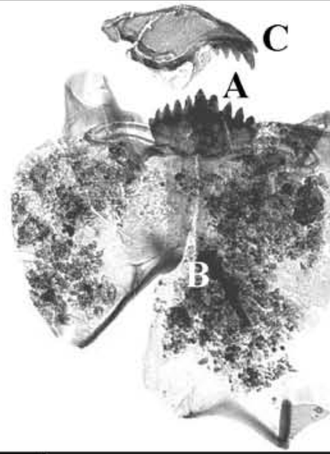


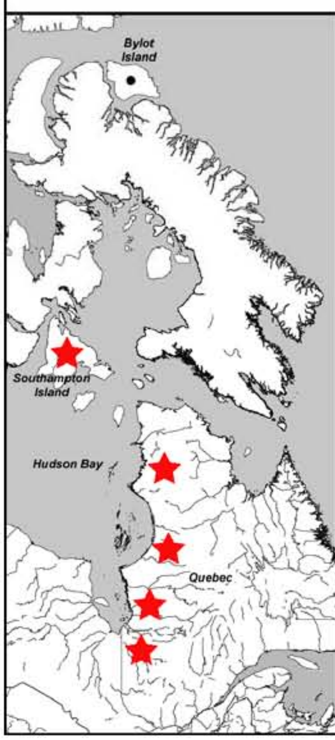
Temperature optimum (°C):

4.4

The visual guide to subfossil chironomid analysis

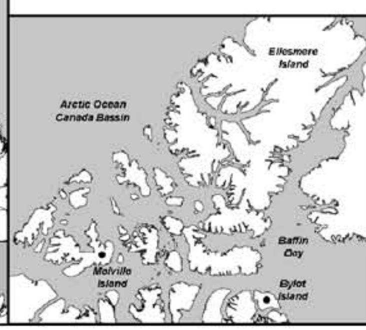
Genera: Paratanytarsus austriacus-type
Tribe: Chironominae, Tanytarsini





Description:
Median teeth prominent giving an arched mentum (A). No occipital plate present, the head capsule looks incised (B). Three inner teeth on the mandibule (C).

Ecology:
Most ubiquitous and abundant taxa in the Alps (45).

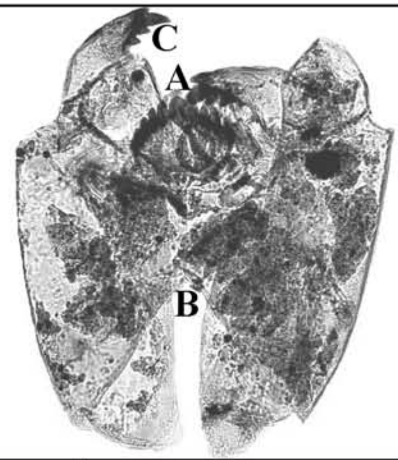


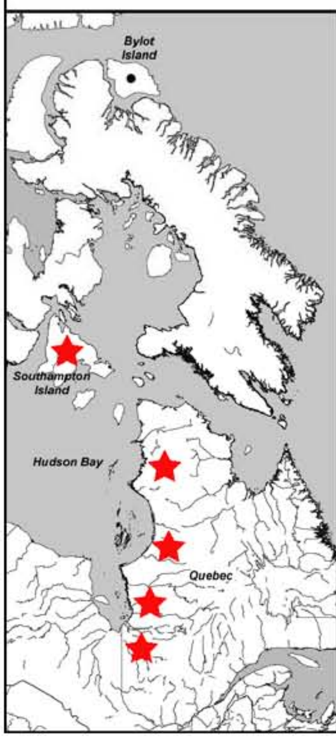
Temperature optimum (°C):

10.0

The visual guide to subfossil chironomid analysis

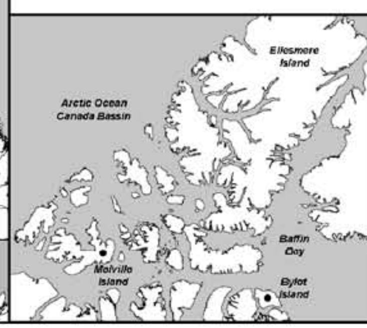
Genera: Paratanytarsus penicillatus-type
Tribe: Chironominae, Tanytarsini





Description:
Median teeth prominent giving an arched mentum (A). No occipital plate present, the head capsule looks incised (B). Two inner teeth on the mandibule (C).

Ecology:
Oligotrophic (21), cool and clean water lakes (46).



Temperature optimum (°C):

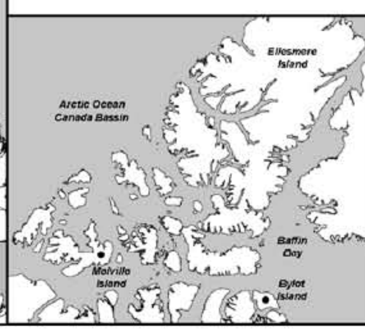
10.0

The visual guide to subfossil chironomid analysis

Genera: Tanytarsus chinyensis-type
Tribe: Chironominae, Tanytarsini

Description:
Very long spur on the antenna (A). They are thin and often broken.

Ecology:

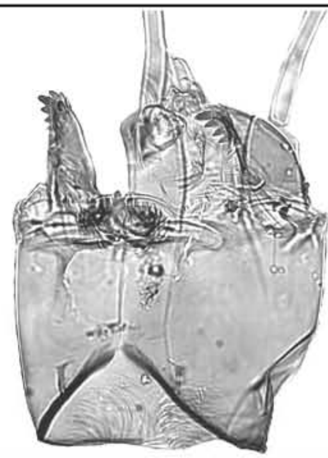


Temperature optimum (°C):

23.8

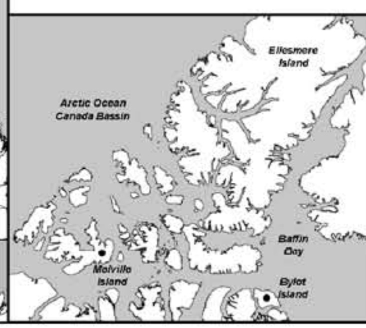
The visual guide to subfossil chironomid analysis

Genera: Tanytarsus lugens-type
Tribe: Chironominae, Tanytarsini



Description:
One large surface tooth on the mandible (A).

Ecology:
Cold stenotherm (13), in shallow lakes (22), increase following human impact (1).

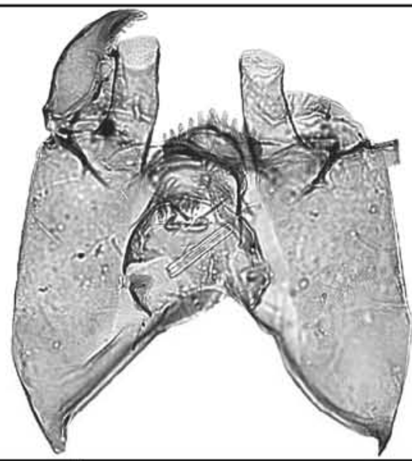


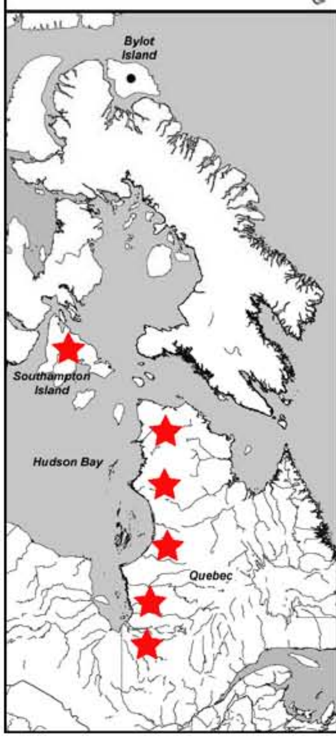
Temperature optimum (°C):

9.5

The visual guide to subfossil chironomid analysis

Genera: Tanytarsus sp. B.
Tribe: Chironominae, Tanytarsini

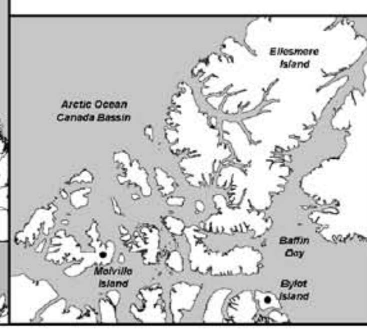




Description:

No specific characteristic.

Ecology:



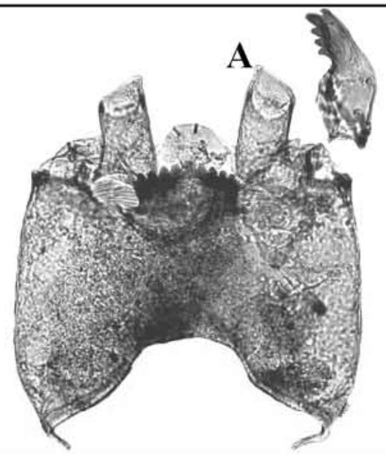
Temperature optimum (°C):

11.9

The visual guide to subfossil chironomid analysis

Genera: Tanytarsus pallidicornis-type

Tribe: Chironominae, Tanytarsini

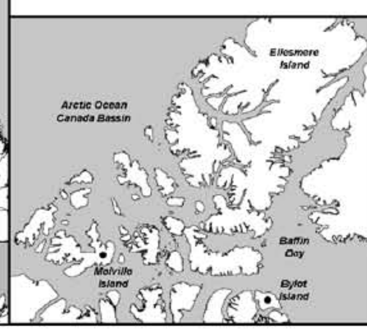


Description:

Small blunt spur on the antenna (A).

Ecology:

Temperate lowland lakes (47, 48).



Temperature optimum (°C):

8.6

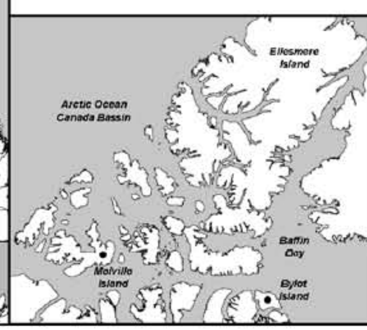
The visual guide to subfossil chironomid analysis

Genera: Tanytarsus sp. C.
Tribe: Chironominae, Tanytarsini

Description:

Short spur on the antenna (A). Two surface teeth on the mandible (B).

Ecology:



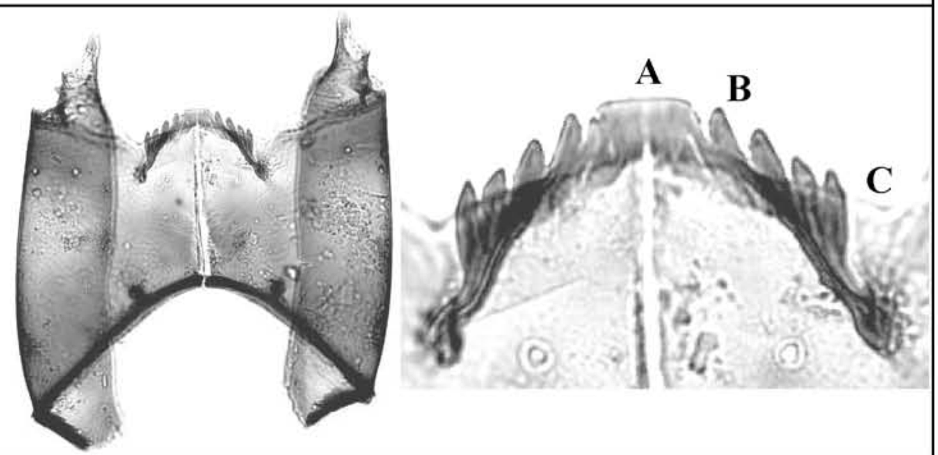
Temperature optimum (°C):

19.0

ORTHOCLADINAE

The visual guide to subfossil chironomid analysis

Genera: Abiskomya
Tribe: Orthocladinae



Description:
Median teeth plate-like (A), four lateral, the 1st one is long and thin (B). Ventromental plates larges (C).

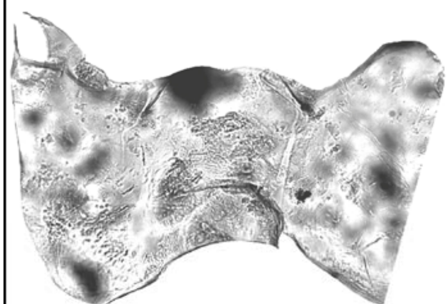
Ecology:
Cold-adapted, in shallow arctic lakes (4, 5).

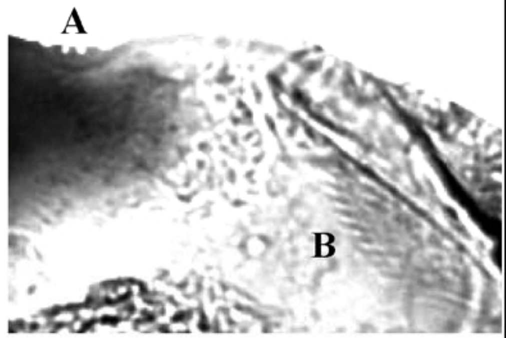
Temperature optimum (°C):

5.9

The visual guide to subfossil chironomid analysis

Genera: Acamptocladius
Tribe: Orthocladinae

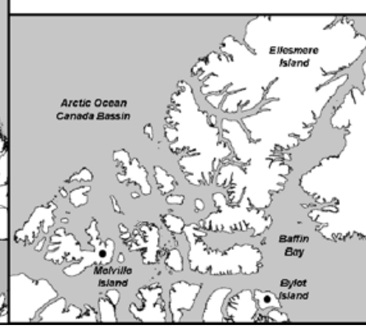




Description:

Small teeth in the middle of the mentum (A), plates with sharp teeth (B).

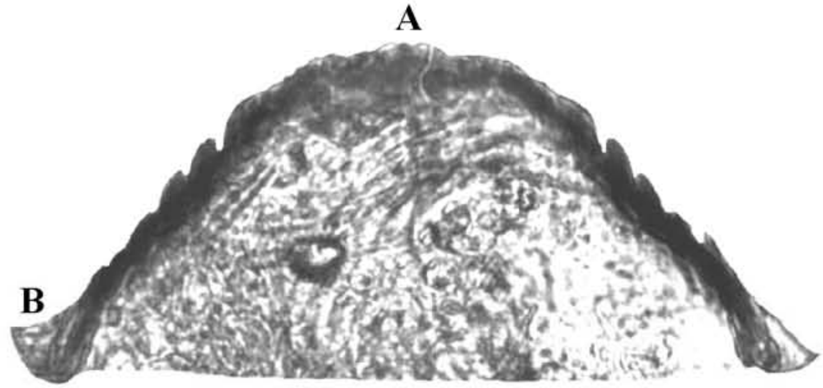
Ecology:



Temperature optimum (°C):

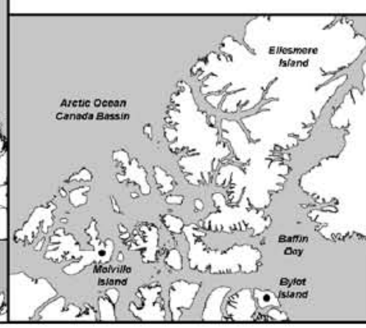
n.a

Genera: Allopsectrocladius-group
Tribe: Orthocladinae



Description:
Two large median, plate-like (A). Round plate (B).
Wiederholm (1983) *Fig.* 9.61 A, B.

Ecology:
In high oxygenated ponds (52), in shallow lakes (53), temperate taxa (54).

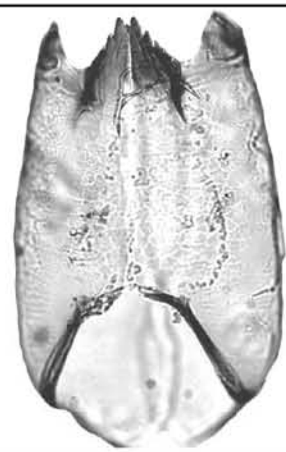


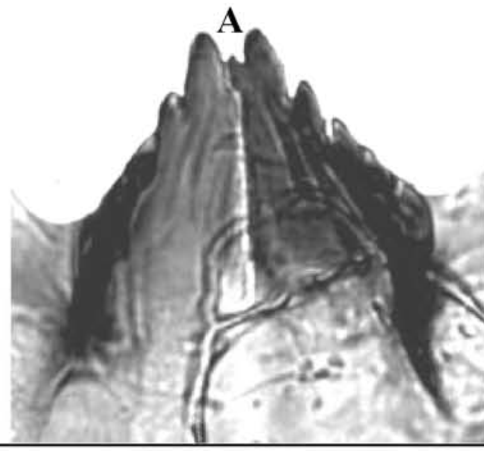
Temperature optimum (°C):

15.4

The visual guide to subfossil chironomid analysis

Genera: Brillia
Tribe: Orthocladinae



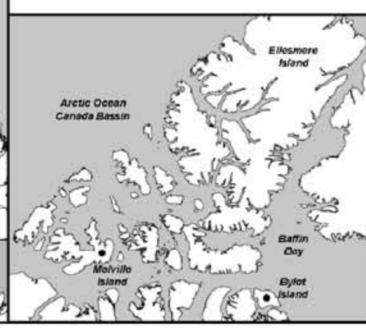


Description:

Three elevated median, one is very small (A). Five lateral teeth, the last two are compressed together.

Ecology:

Flowing waters (23, 24).

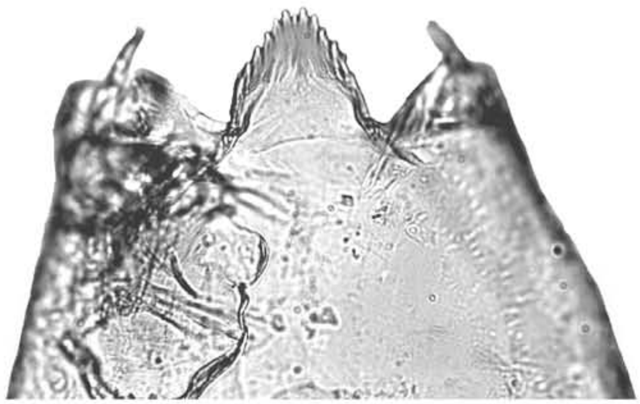


Temperature optimum (°C):

27.6

The visual guide to subfossil chironomid analysis

Genera: Corynoneura
Tribe: Orthocladinae

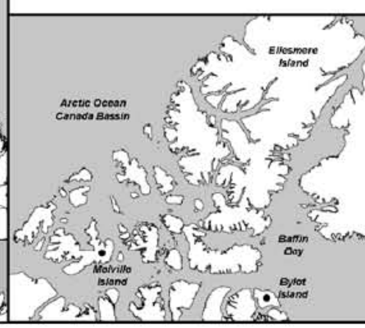


Description:

Triangular mentum.

Ecology:

Standing water on aquatic plants (4), littoral (2), increase with deforestation (14).

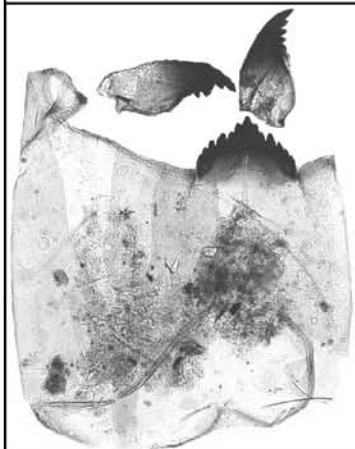


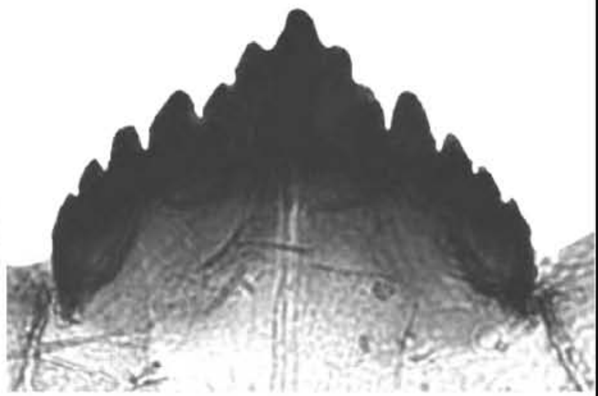
Temperature optimum (°C):

1.0

The visual guide to subfossil chironomid analysis

Genera: Cricotopus 285
Tribe: Orthocladinae

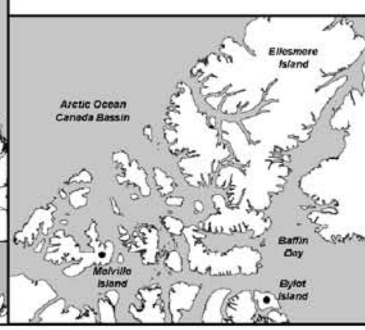




Description:

Named following picture 285 in Oliver and Roussel (1983).

Ecology:

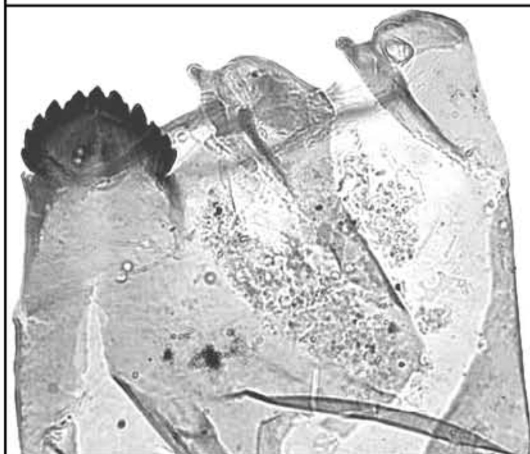


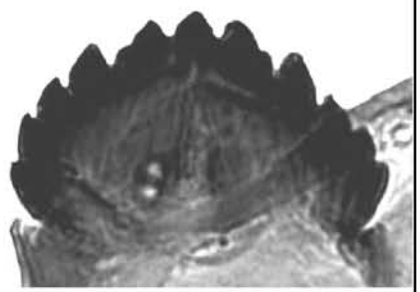
Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Cricotopus 289
Tribe: Orthocladinae

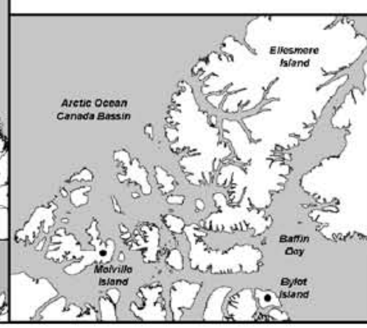




Description:

Named following picture 289 in Oliver and Roussel (1983).

Ecology:

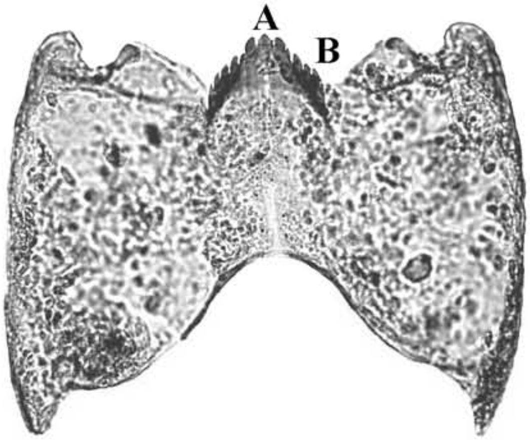


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

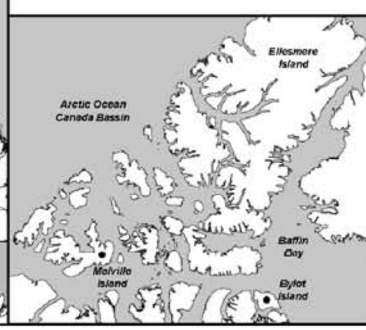
Genera: Cricotopus B
Tribe: Orthocladinae



Description:

Described by Steve Brooks.
Three median are round and of equal length (A). The lateral are round and decreased in size (B).

Ecology:

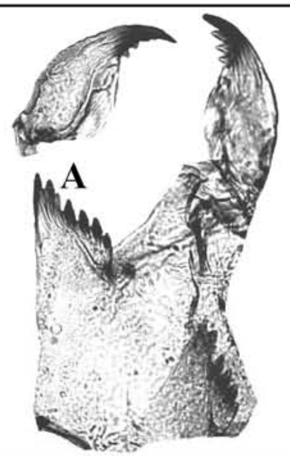


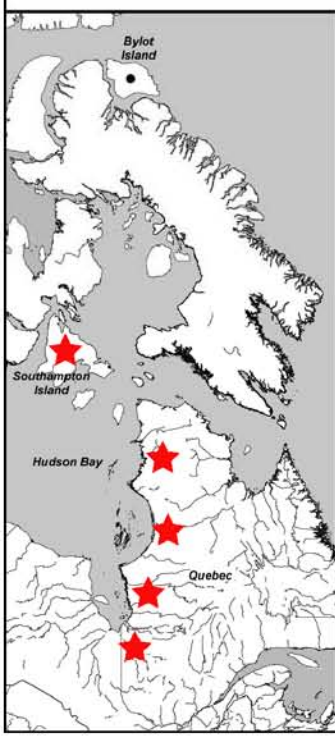
Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Cricotopus laricomalis
Tribe: Orthocladinae

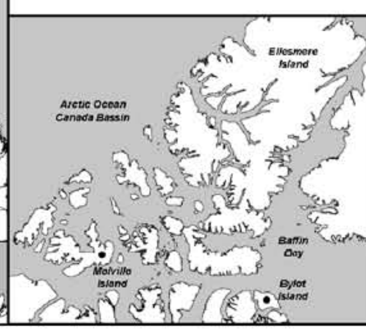




Description:

Accessory tooth on the 1st lateral (A).

Ecology:

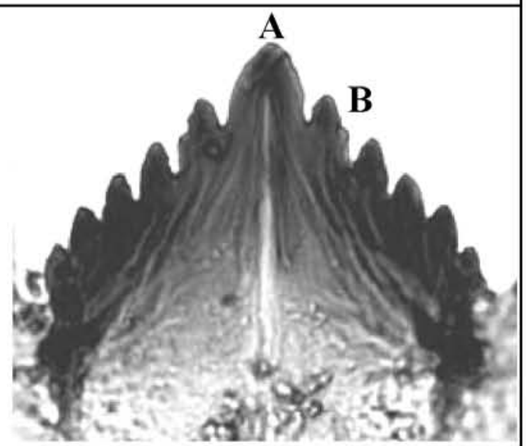


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

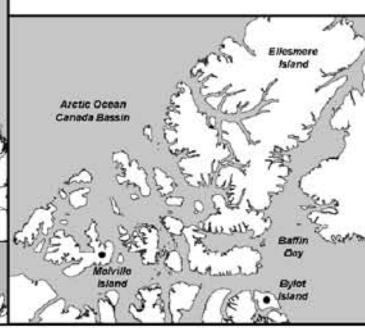
Genera: Cricotopus sylvestris-type
Tribe: Orthocladinae



Description:

Long rounded median (A), small accessory tooth on 1st lateral (B).

Ecology:

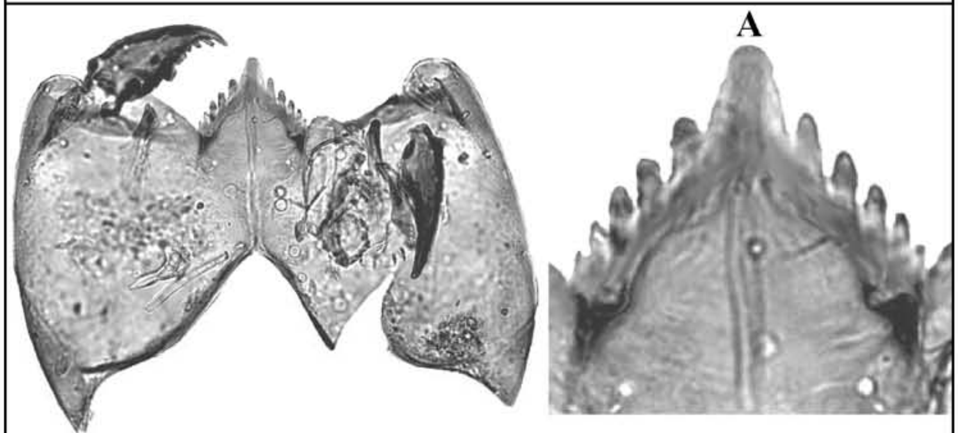


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

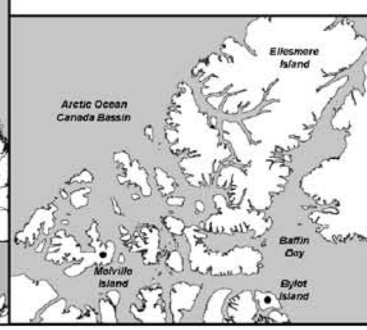
Genera: Cricotopus mlm
Tribe: Orthocladinae



Description:

Looks like C. sylvestris but median is longer (A) and no accessory tooth on the 1st lateral.

Ecology:

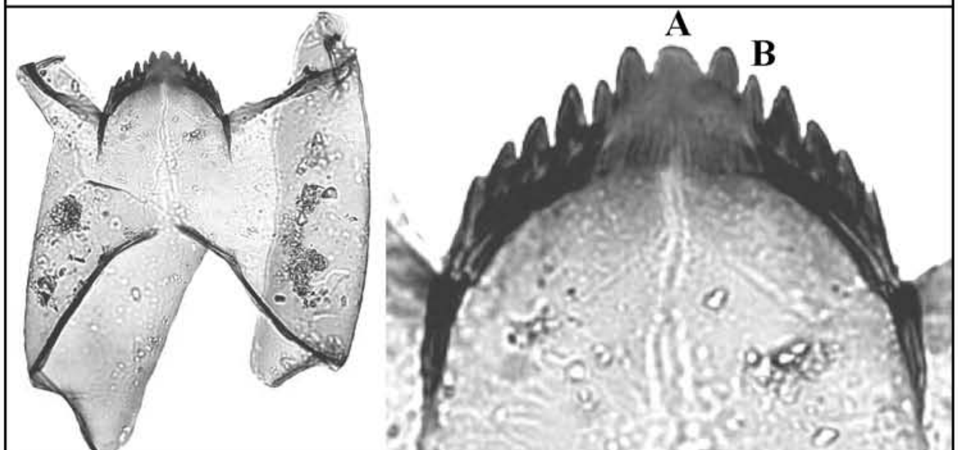


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

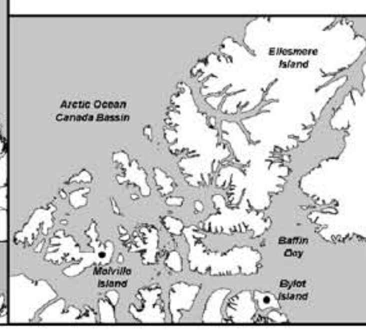
Genera: Cricotopus tremulus-type
Tribe: Orthocladinae



Description:

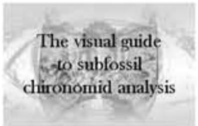
First three teeth (median) are the same lenght (A). Second latera is smaller (B).

Ecology:

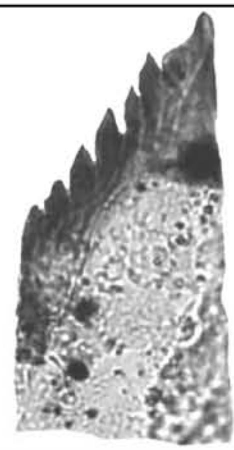


Temperature optimum (°C):

n.a



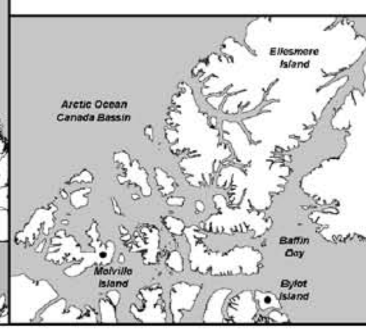
Genera: Cricotopus trifasciata-type
Tribe: Orthocladinae



Description:

Oliver and Roussel (1983) Fig. 277.

Ecology:

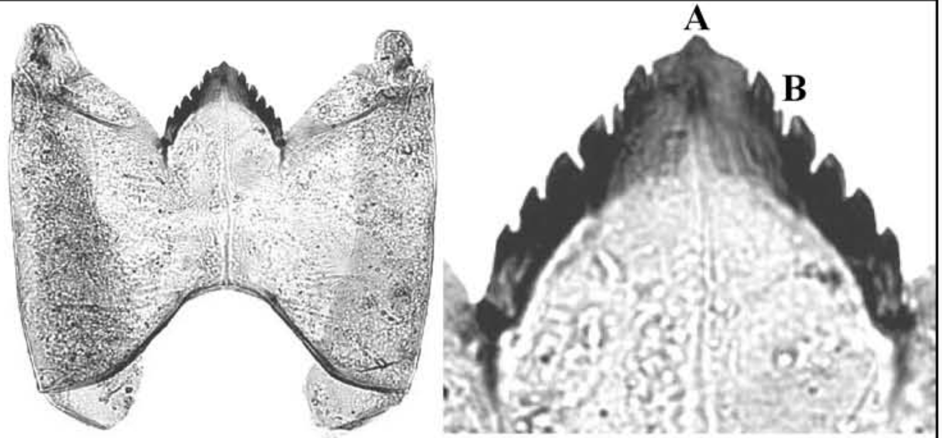


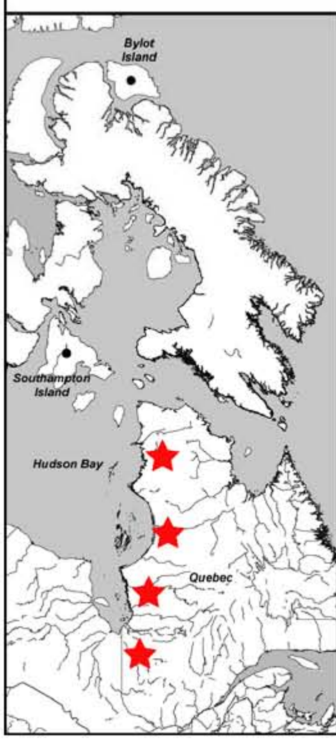
Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Cricotopus cylindraceus-type
Tribe: Orthocladinae

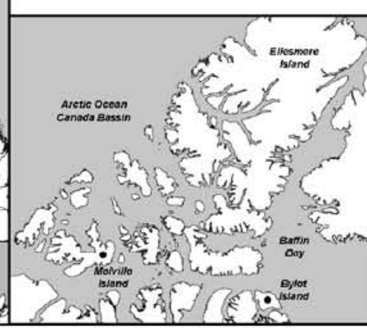




Description:

Median with a "nipple" (A), small accessory tooth after first lateral (B).

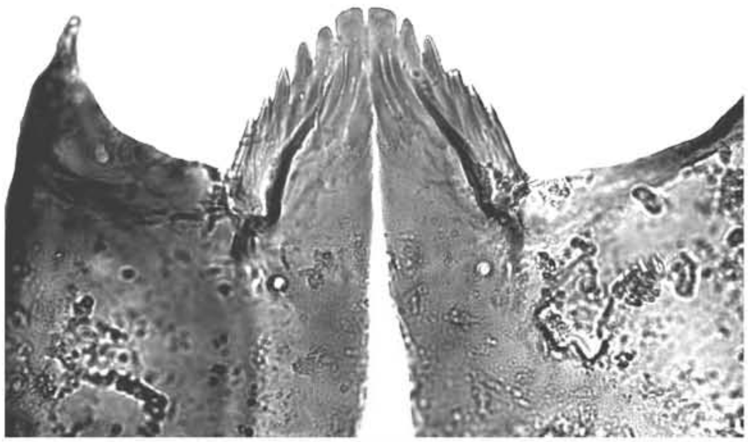
Ecology:



Temperature optimum (°C):

n.a

Genera: Eukieferiella
Tribe: Orthocladinae

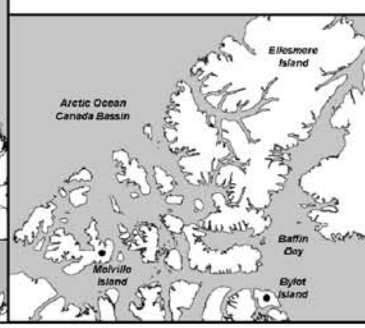


Description:

The mentum har large lines (A).

Ecology:

North of treeline (4), in running and polluted waters (10).

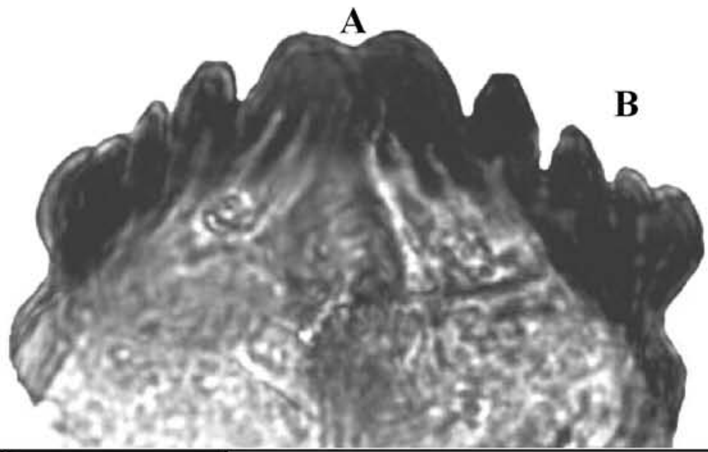


Temperature optimum (°C):

1.0

The visual guide to subfossil chironomid analysis

Genera: Georthocladius
Tribe: Orthocladinae

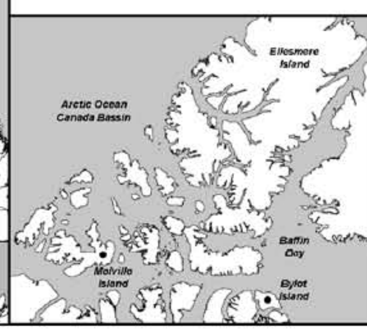


Description:

Two median (A), four lateral teeth (B).

Ecology:

Semi-terrestrial (63).

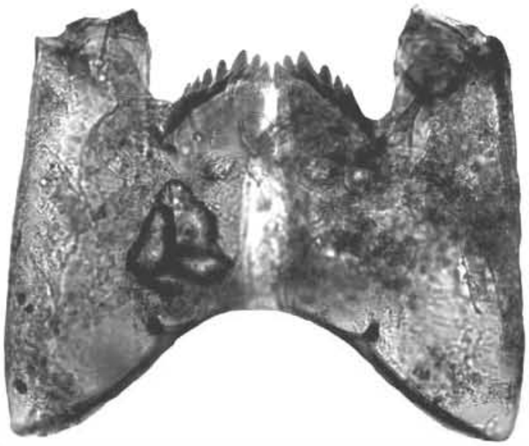


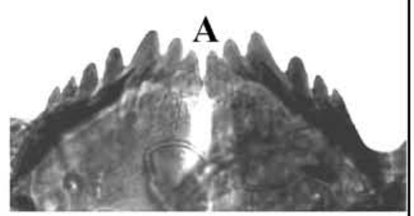
Temperature optimum (°C):

17.7

The visual guide to subfossil chironomid analysis

Genera: Heterotanytarsus
Tribe: Orthocladinae



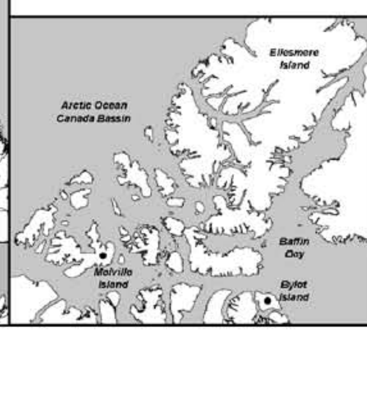


Description:

Median teeth are lower than the lateral teeth (A).

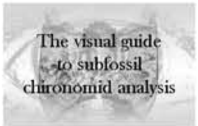
Ecology:

In humic waters (13), small lakes (4), littoral taxon (55).

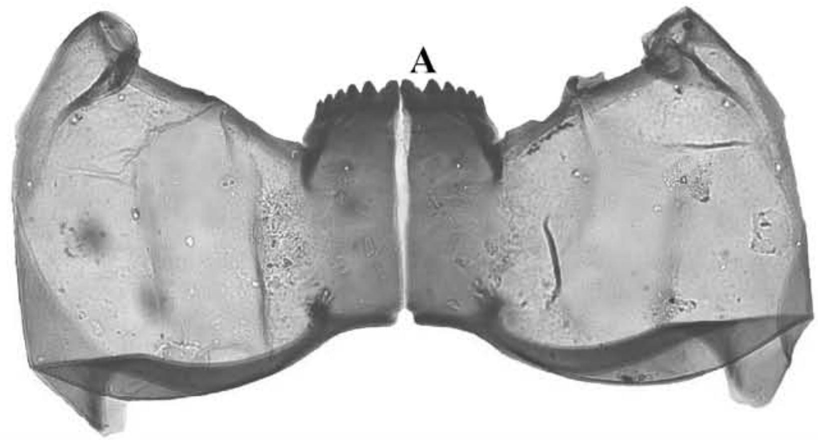


Temperature optimum (°C):

19.1



Genera: Heterotrissocladius brundini-type
Tribe: Orthocladinae

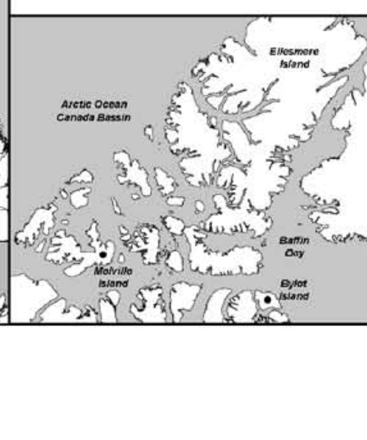


Description:

Large gap between the median and the 1st lateral (A). Post mentum dark.

Ecology:

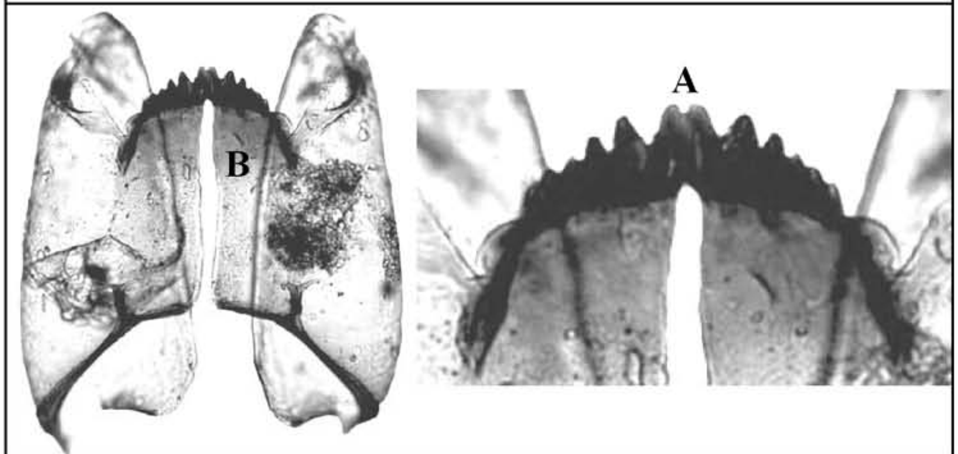
Strickly profundal (3), cold stenothermic oligotroph (43).



Temperature optimum (°C):

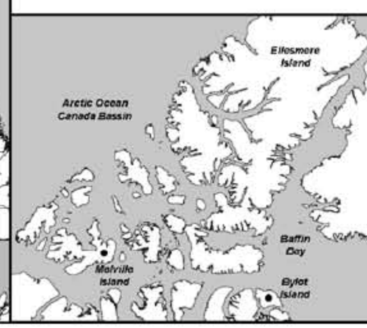
12.2

Genera: Heterotrissocladius grimshawi-type
Tribe: Orthocladinae



Description:
The median teeth are parallel (A). Headcapsule is dark under the mentum (B) but not until the end of the capsule as in H. marcidus.

Ecology:
Cold-stenotherm (15), acidophilic (26), oligotrophic (27), high alpine lakes (22).

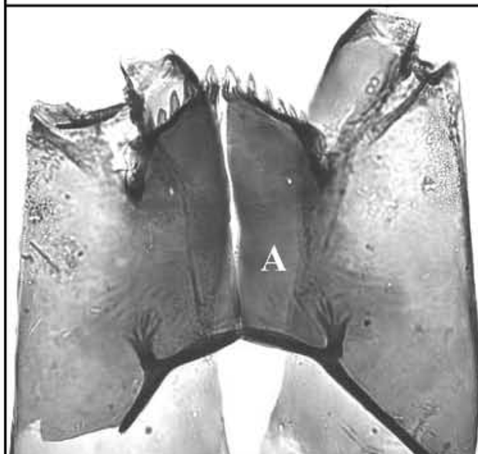


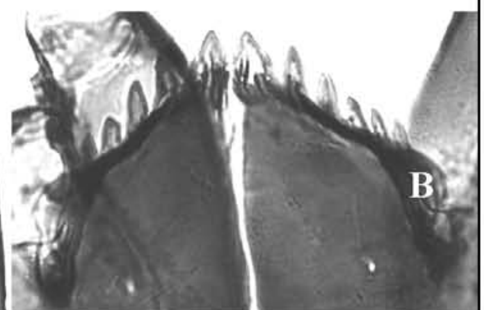
Temperature optimum (°C):

9.9

The visual guide to subfossil chironomid analysis

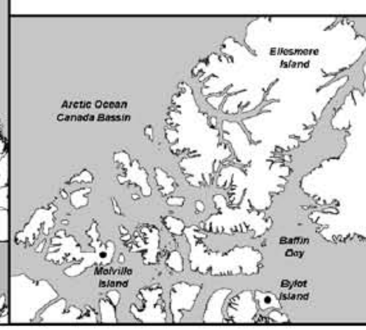
Genera: Heterotrissocladius marcidus-type
Tribe: Orthocladinae





Description:
Post mentum dark until the end of the headcapsule (A).
Ventromental plate has large shoulders (B).

Ecology:
Oligotrophic (21), mesotrophic (32).

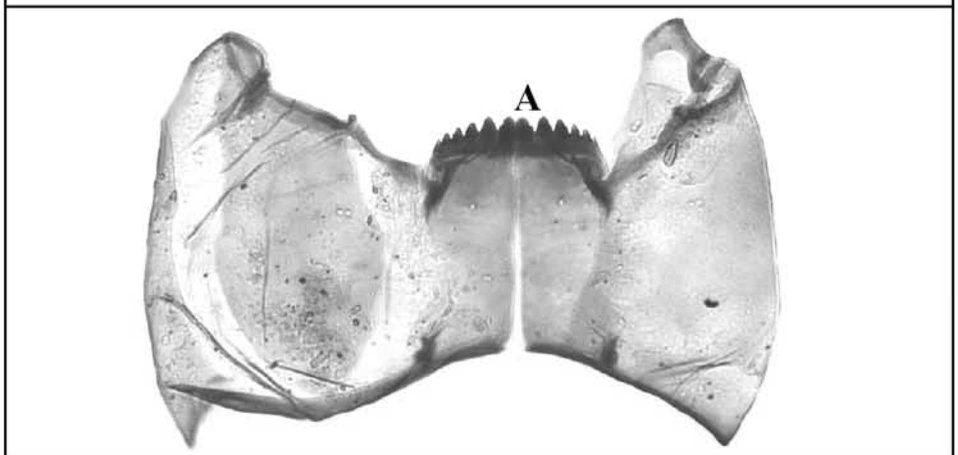


Temperature optimum (°C):

12.2

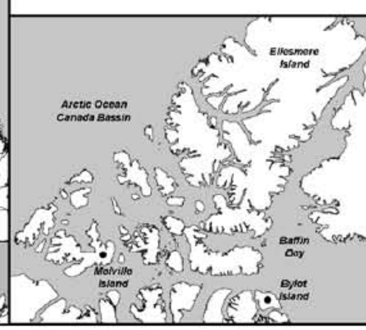
The visual guide to subfossil chironomid analysis

Genera: Heterotrissocladius subpilosus-type
Tribe: Orthocladinae



Description:
One accessory tooth on the median (A). Dark teeth, clear post mentum.

Ecology:
Cold and oligotrophic (18),large deep lakes (9), ultraoligotrophic and well oxygenated lakes (8).

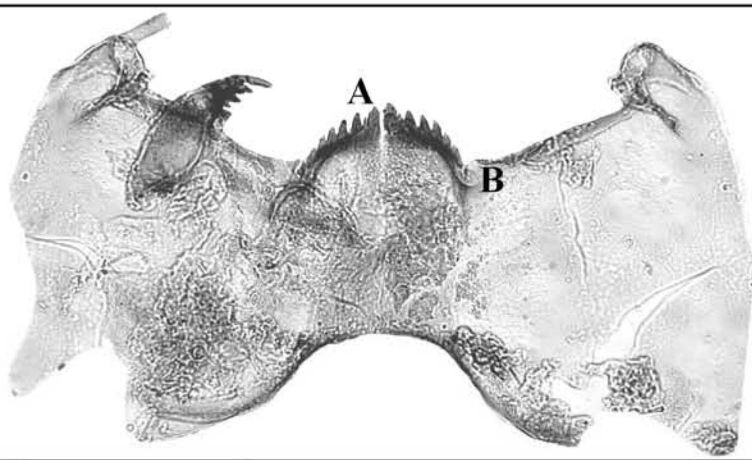


Temperature optimum (°C):

4.2

The visual guide to subfossil chironomid analysis

Genera: Hydrobaenus
Tribe: Orthocladinae

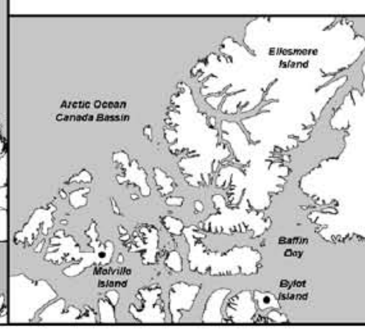


Description:

Small accessory tooth (A), large plate round at the end (B).

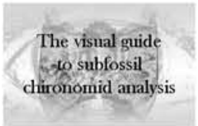
Ecology:

Cold adapted, littoral (25).

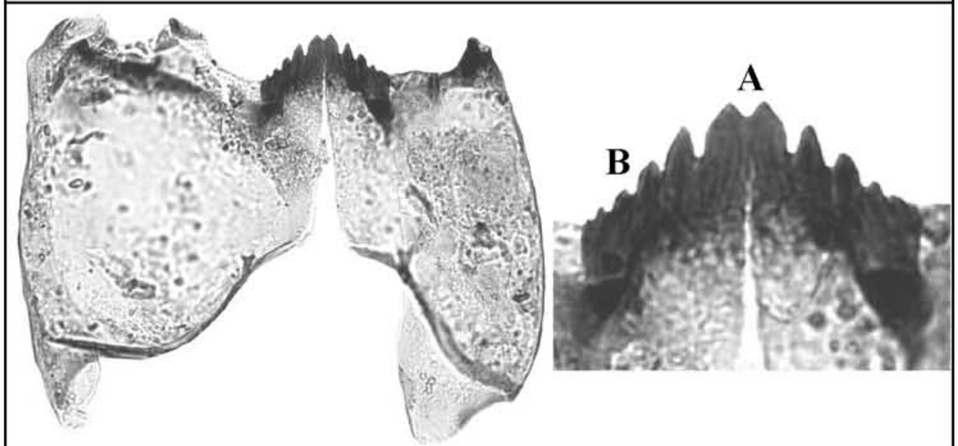


Temperature optimum (°C):

n.a

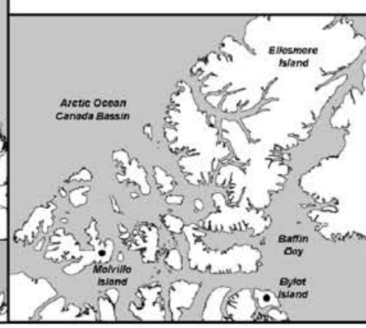


Genera: Limnophyes
Tribe: Orthocladinae



Description:
Two median (A), five lateral teeth (B).

Ecology:
At margins of shallow lakes, on aquatic plants (4), edge-of-lake, semi-terrestrial or stream habitants (1), running waters (28).

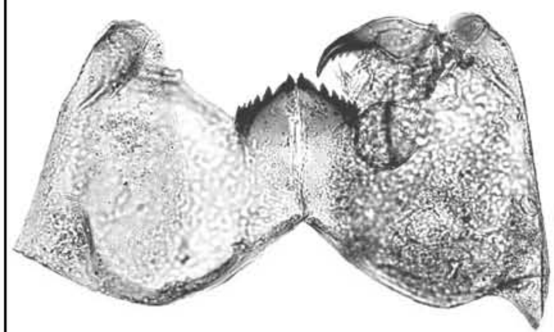


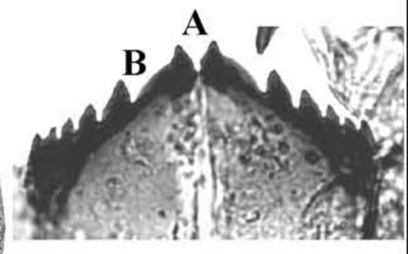
Temperature optimum (°C):

11.1

The visual guide to subfossil chironomid analysis

Genera: Mesocricotopus
Tribe: Orthocladinae



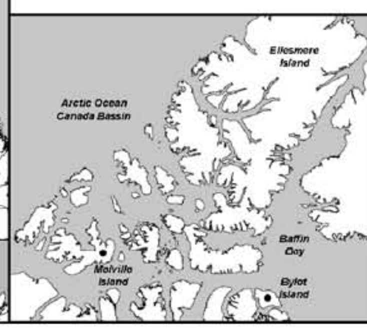


Description:

Median curved outwards (A). Gap between median and 1st lateral (B).

Ecology:

Cold-stenotherm (60), oligotrophic and cold (61).

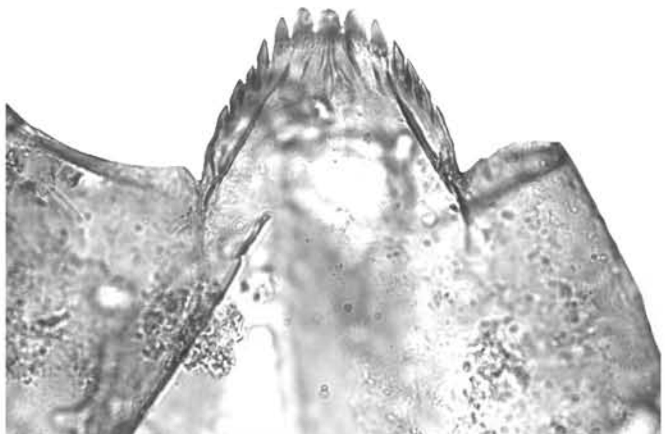


Temperature optimum (°C):

16.6

The visual guide to subfossil chironomid analysis

Genera: Orthocladius
Tribe: Orthocladinae

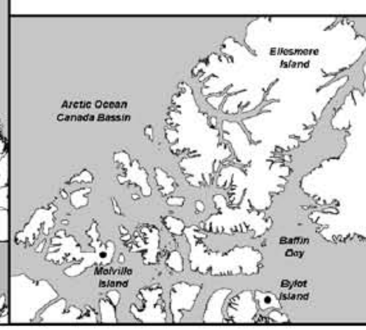


Description:

6 lateral teeth.

Ecology:

Medium to large arctic lakes (4).



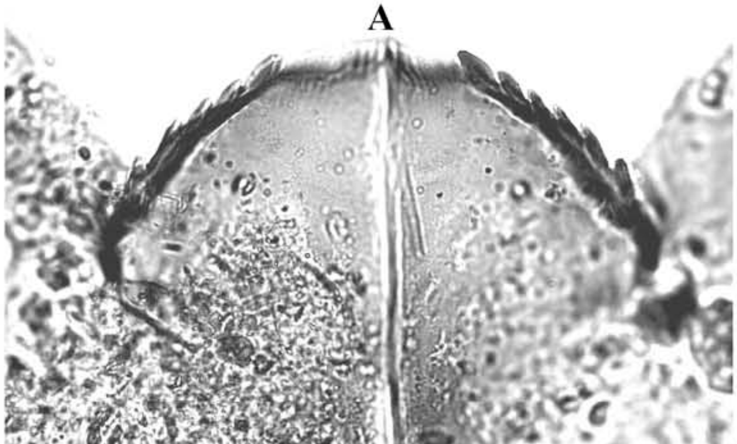
Temperature optimum (°C):

9.9

The visual guide to subfossil chironomid analysis

Genera: Paracladius
Tribe: Orthocladinae

A

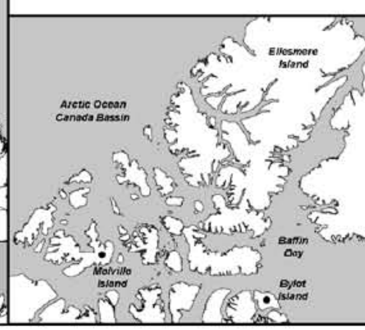


Description:

Large median, plate-like (A).

Ecology:

Strongly cold-stenotherm (17, 29, 30).

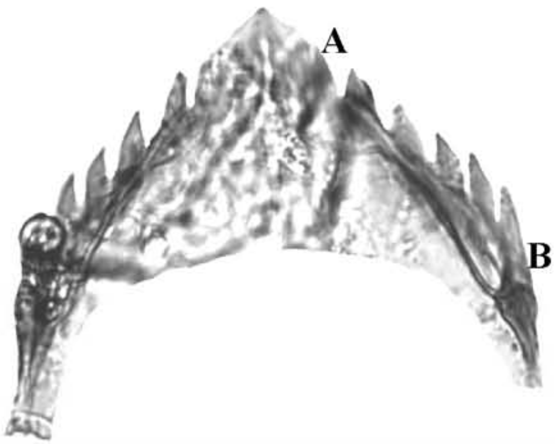


Temperature optimum (°C):

4.4

The visual guide to subfossil chironomid analysis

Genera: Parakieferiella
Tribe: Orthocladinae

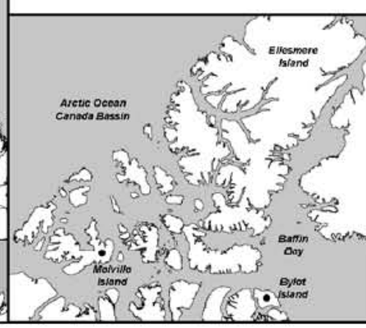


Description:

Small lateral tooth compressed to median (A), end of ventromental plate round (B).

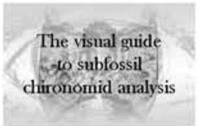
Ecology:

Still water, some in flowing waters (4).

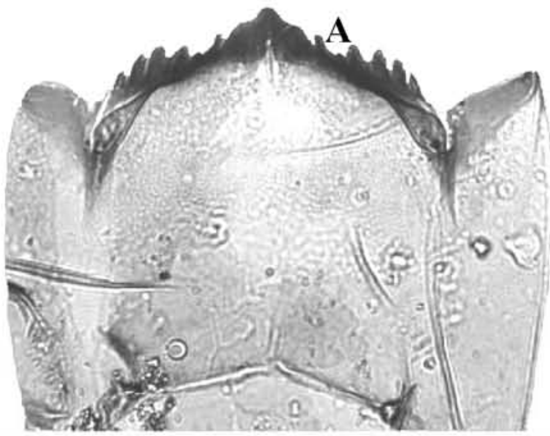


Temperature optimum (°C):

12.5



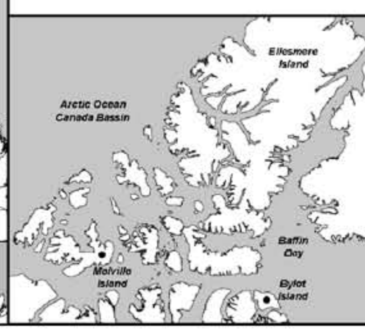
Genera: Parakieferiella sp 368
Tribe: Orthocladinae



Description:

Oliver and Roussel (1983) *Fig.* 368.
Small lateral tooth (A), median with "nipple".

Ecology:

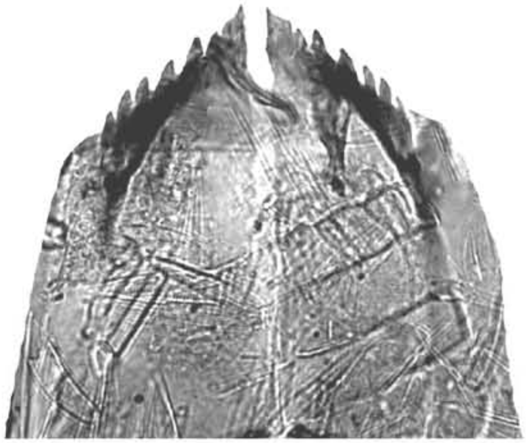


Temperature optimum (°C):

n.a

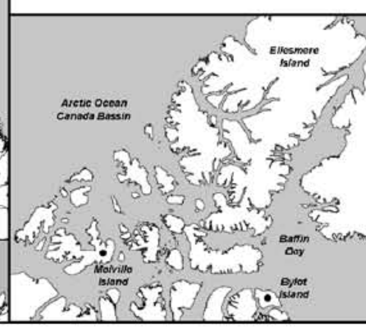
The visual guide to subfossil chironomid analysis

Genera: Parakieferiella bathophila
Tribe: Orthocladinae



Description:

Ecology:

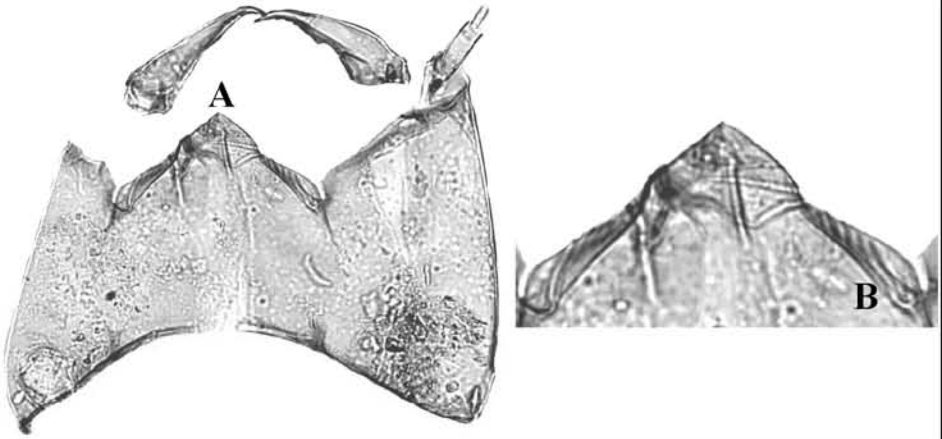


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

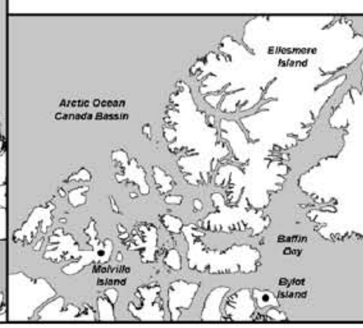
Genera: Parakieferiella fennica
Tribe: Orthocladinae



Description:

Large triangular median (A), large plates (B).

Ecology:

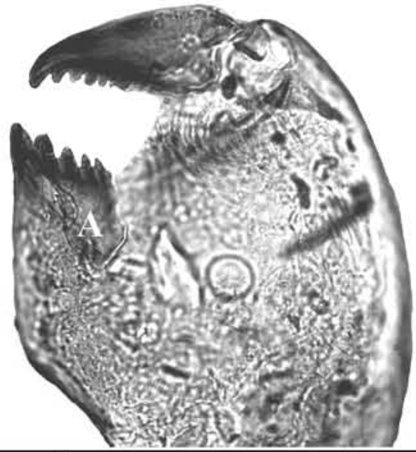


Temperature optimum (°C):

16.0

The visual guide to subfossil chironomid analysis

Genera: Paraphaenocladius
Tribe: Orthocladinae

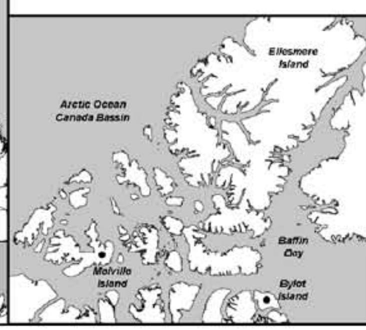


Description:

Round plate with an extension inwards (A).

Ecology:

North of treeline (4), terrestrial or semi-terrestrial (59).

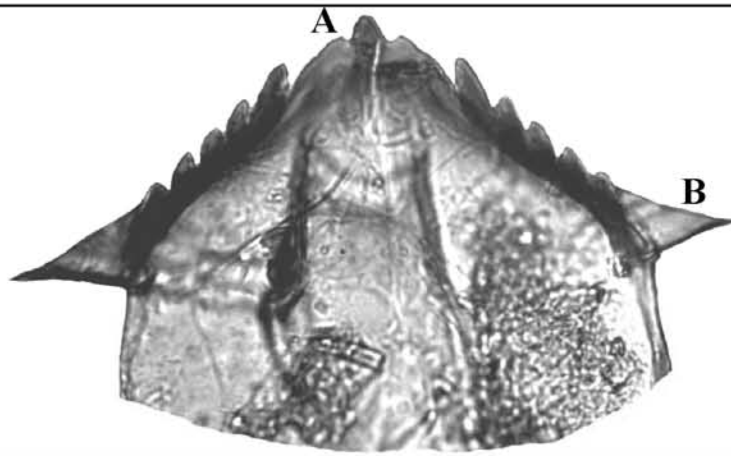


Temperature optimum (°C):

20.6

The visual guide to subfossil chironomid analysis

Genera: Psectrocladius septentrionalis-gr
Tribe: Orthocladinae

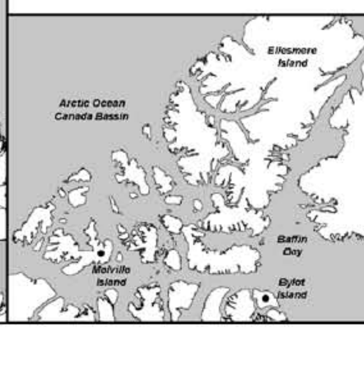


Description:

Median large with a "nipple" (A). Plates are triangular and extended (B). Wiederholm (1983) *Fig.* 9.61 C,D.

Ecology:

Temperate (16, 50, 51), cold taxa (49).

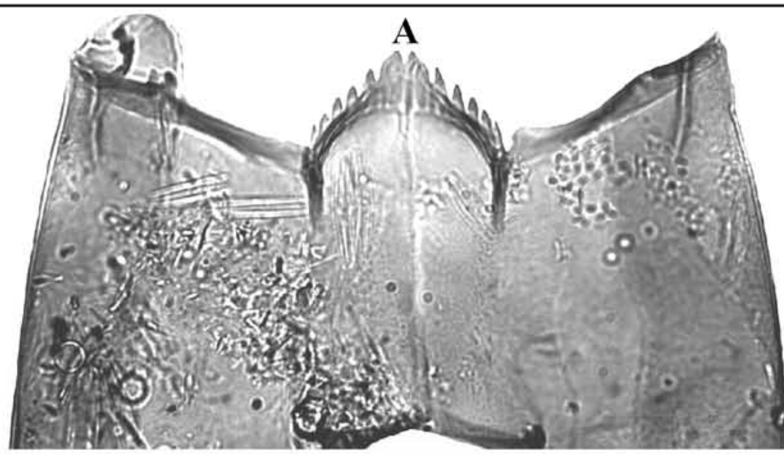


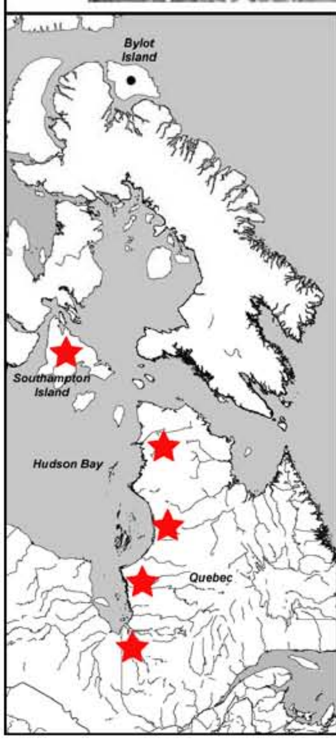
Temperature optimum (°C):

14.0

The visual guide to subfossil chironomid analysis

Genera: Psectrocladius sordidellus-gr
Tribe: Orthocladinae



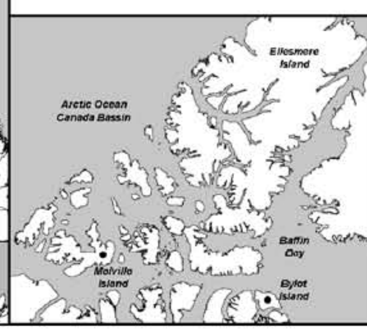


Description:

Two median (A).
Wiederholm (1983) *Fig.* 10.64 E, F.

Ecology:

In acidophilic and humic material (13).

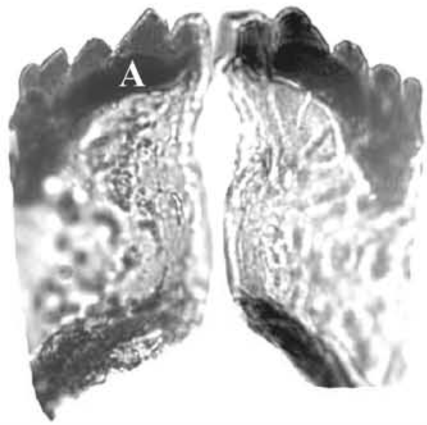


Temperature optimum (°C):

8.1

The visual guide to subfossil chironomid analysis

Genera: Pseudosmittia
Tribe: Orthocladinae

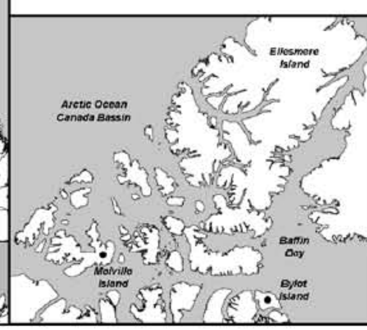


Description:

Ventromental plate large, short and dark like a cat nail (A).

Ecology:

Terrestrial, semi-aquatic habitats, associated with wetland areas (4).

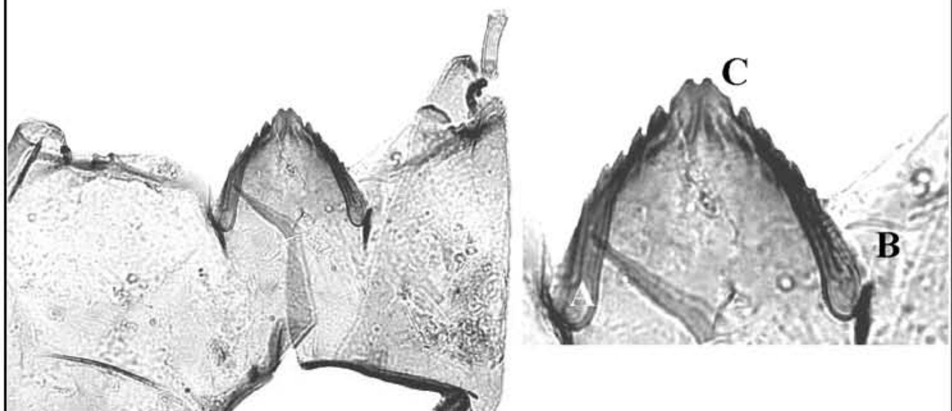


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Rheocricotopus
Tribe: Orthocladinae

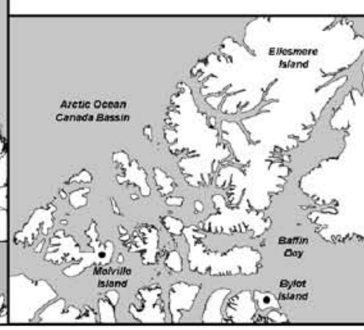


Description:

Large rounded plates (A), with hair (B), accessory tooth on the median (C).

Ecology:

North ot treeline (4).

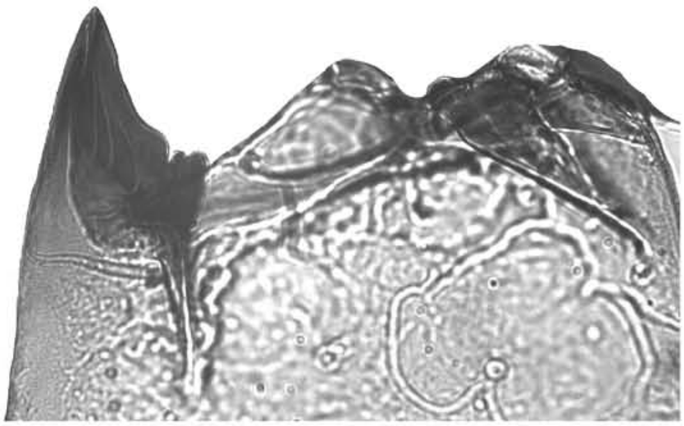


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Symbiocladius
Tribe: Orthocladinae



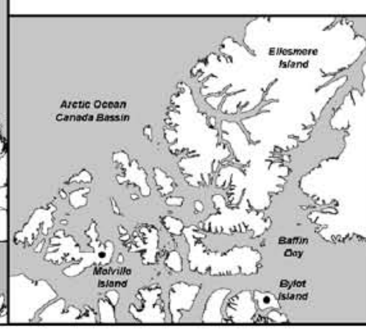
Description:

Extremely long median.

Ecology:

Parasitic on mayfly nymphs (4).

Note: only found in one lake.

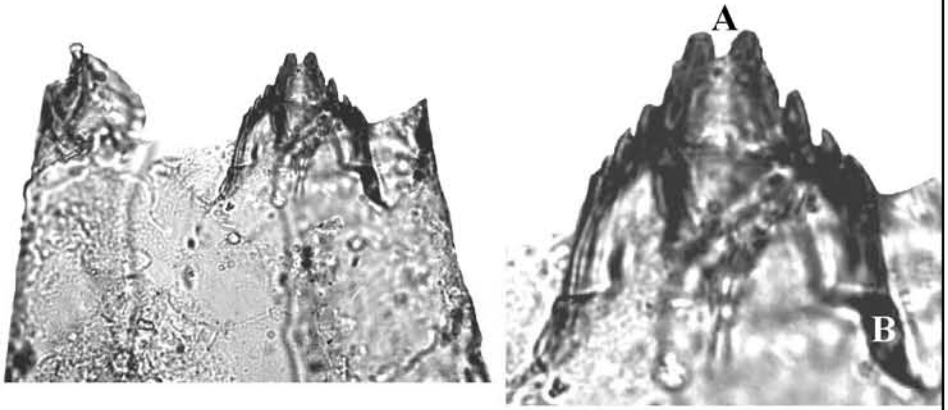


Temperature optimum (°C):

n.a

The visual guide to subfossil chironomid analysis

Genera: Synorthocladius
Tribe: Orthocladinae

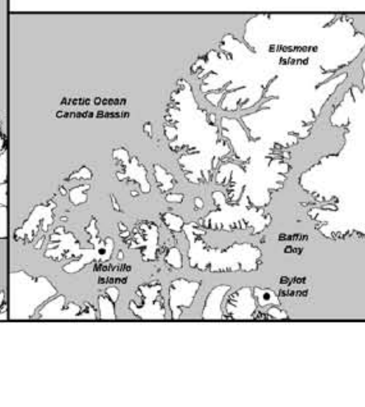


Description:

Two long median (A).
Long and thin plates (B).

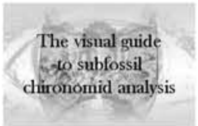
Ecology:

Flowing waters (4).

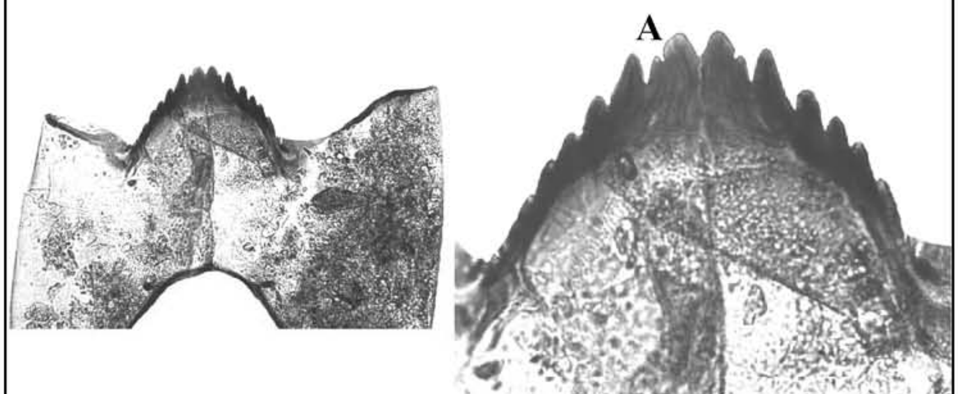


Temperature optimum (°C):

n.a



Genera: Zalutschia lingulata pauca
Tribe: Orthocladinae

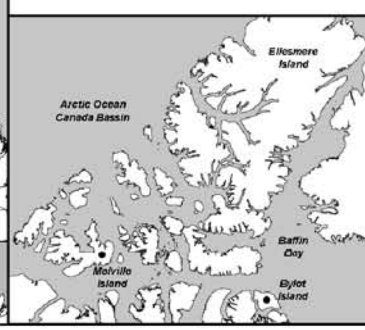


Description:

One small accessory tooth after the median (A).

Ecology:

Productive and anoxic conditions (56).

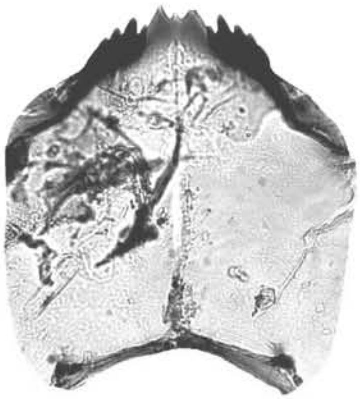


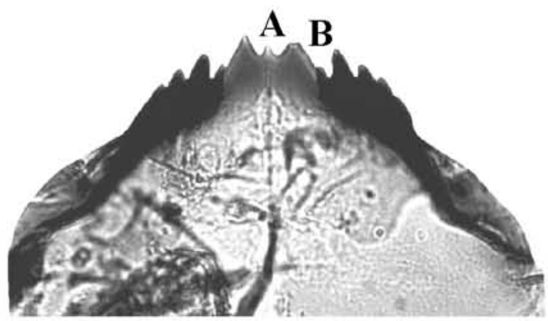
Temperature optimum (°C):

12.9

The visual guide to subfossil chironomid analysis

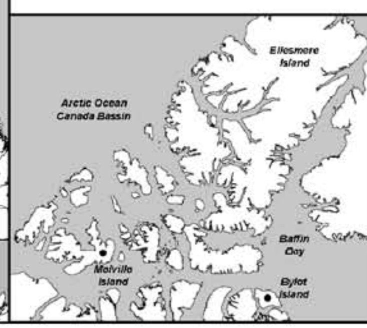
Genera: Zalutschia zalutschicola
Tribe: Orthocladinae





Description:
Gap between the median and the lateral (A). Small lateral (B). The median are pale and the rest of the mentum is dark.

Ecology:
Forest tundra, forested lakes (57), humic and acidic conditions (58).

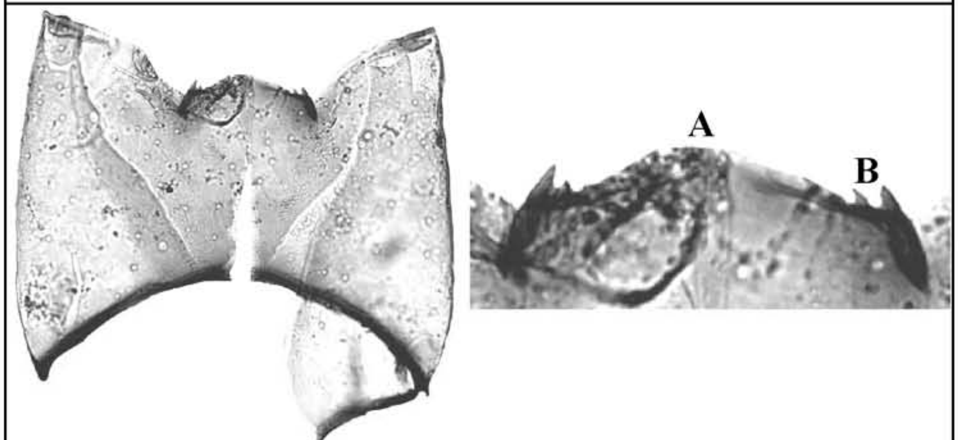


Temperature optimum (°C):

20.1

DIAMESINAE

Genera: Protanypus
Tribe: Diamesinae

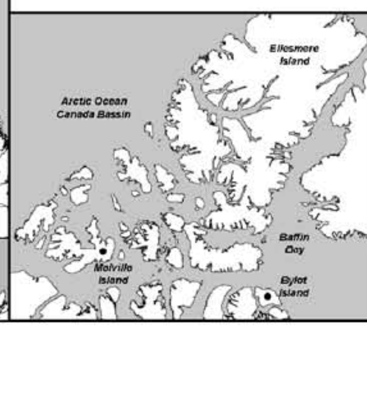


Description:

Large median, plate-like (A). Pointy last laterals (B).

Ecology:

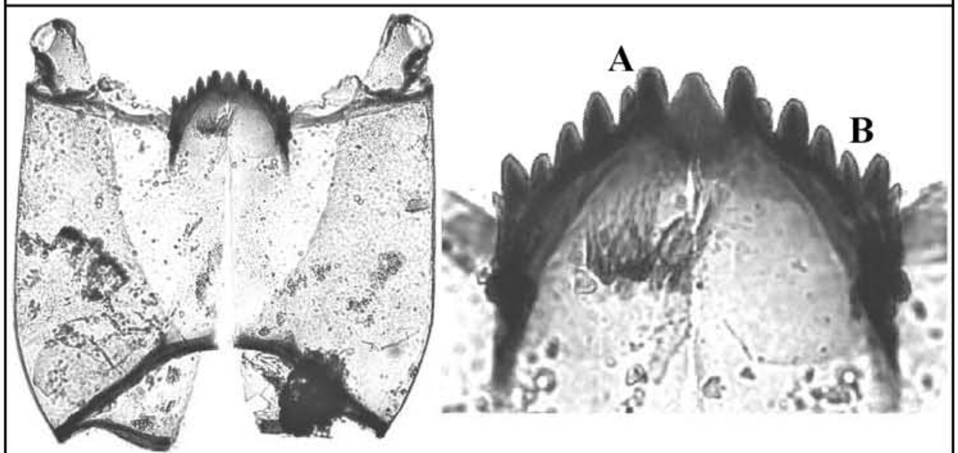
Deep, cold lakes (4).



Temperature optimum (°C):

13.3

Genera: Pseudodiamesa
Tribe: Diamesinae

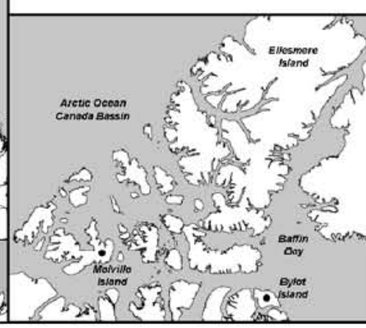


Description:

Second lateral (A) and second last lateral (B) short.

Ecology:

Flowing water and deep still lakes (4).

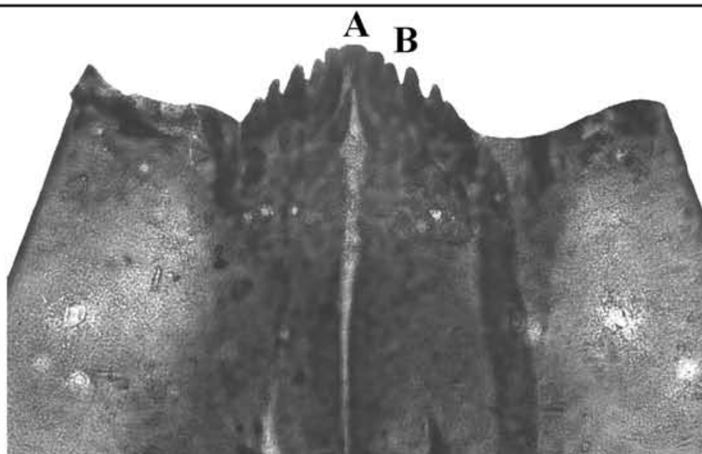


Temperature optimum (°C):

4.9

The visual guide to subfossil chironomid analysis

Genera: Pseudokieferiella
Tribe: Diamesinae

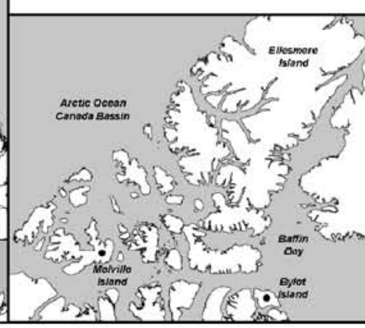


Description:

Plate-like median (A), smaller lateral tooth (B).

Ecology:

Associated with "glacial" conditions (62).



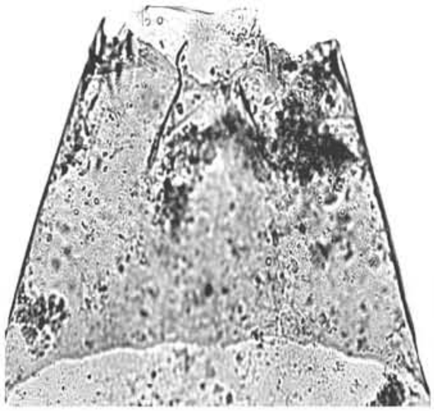
Temperature optimum (°C):

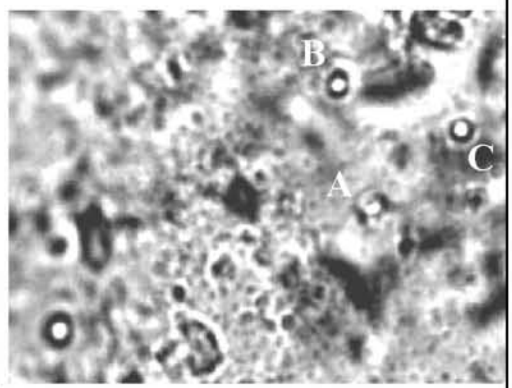
n.a

TANYPODINAE

The visual guide to subfossil chironomid analysis

Genera: Ablabesmiyia
Tribe: Tanypodinae, Pentaneurini



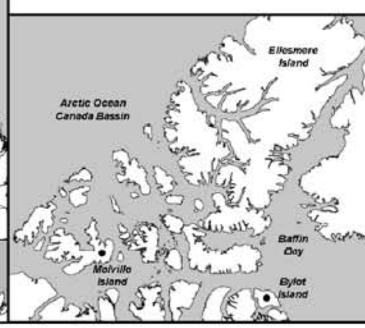


Description:

Pores are in a diagonal.

Ecology:

Warm, shallow lakes, on soft substrate (4)

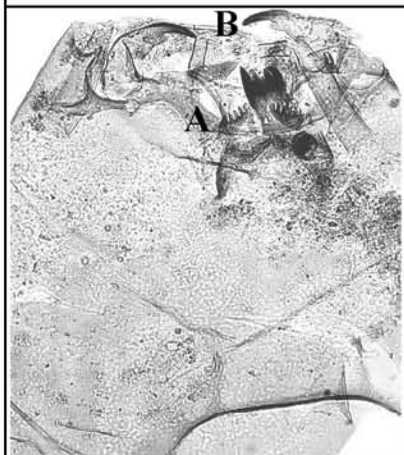


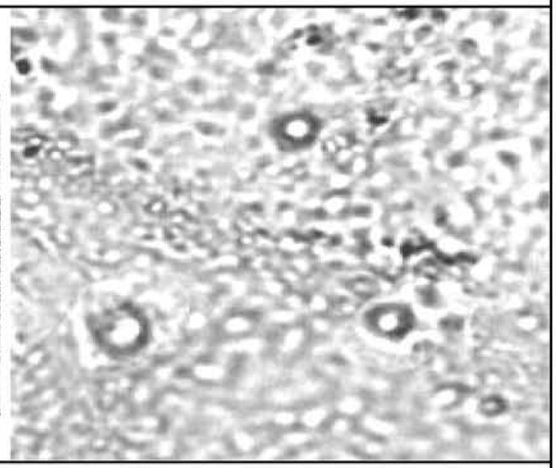
Temperature optimum (°C):

12.4

The visual guide to subfossil chironomid analysis

Genera: Procladius
Tribe: Tanypodinae



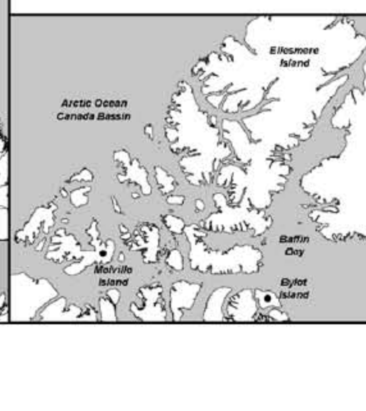


Description:

Paralabial teeth present (A), tip of the mandible is dark (B). note: pores are from the left side of the headcapsule.

Ecology:

Profundal (14), low abundance in fish

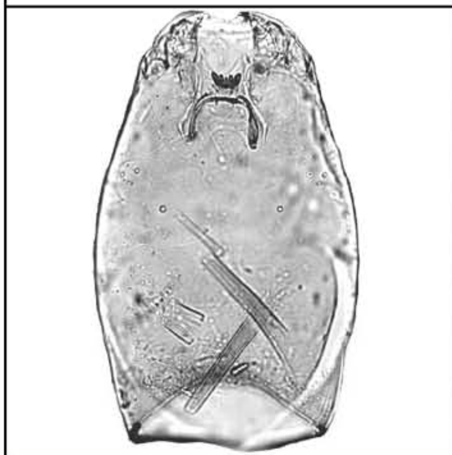


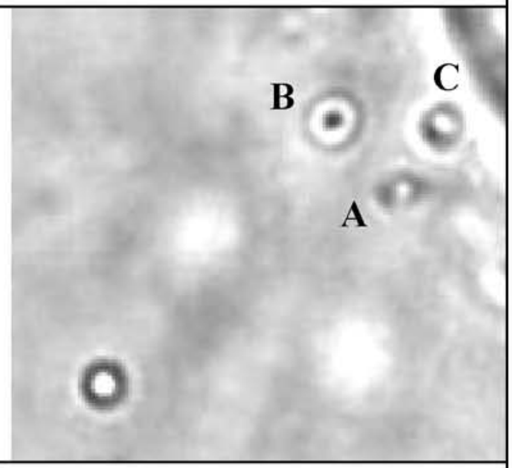
Temperature optimum (°C):

14.9

The visual guide to subfossil chironomid analysis

Genera: Telopelopia
Tribe: Tanypodinae, Pentaneurini

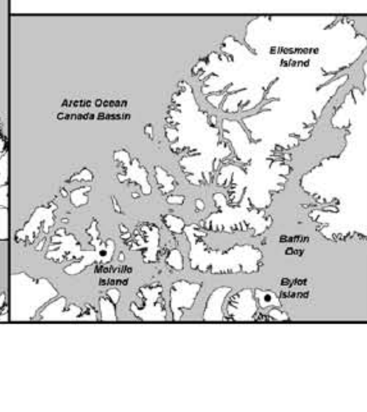




Description:

The two pores are on the same line (B - C)

Ecology:

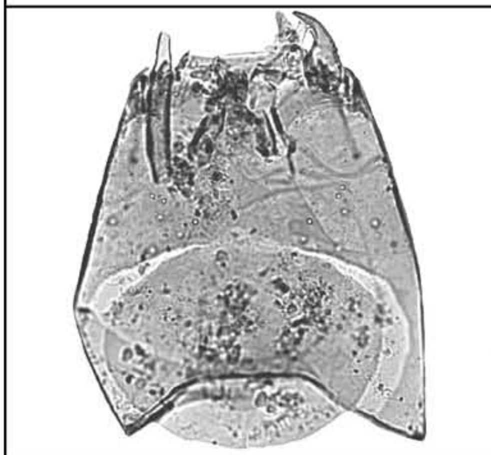


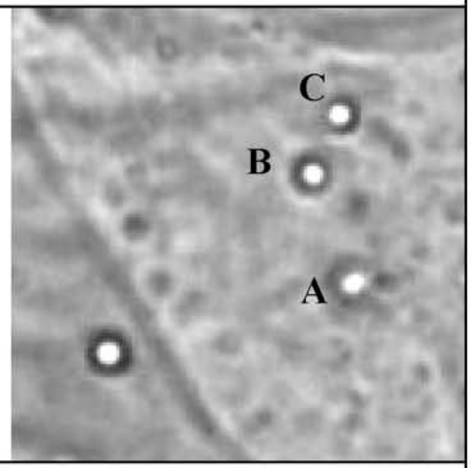
Temperature optimum (°C):

11.3

The visual guide to subfossil chironomid analysis

Genera: Thiennemanimyia
Tribe: Tanypodinae, Pentaneurini



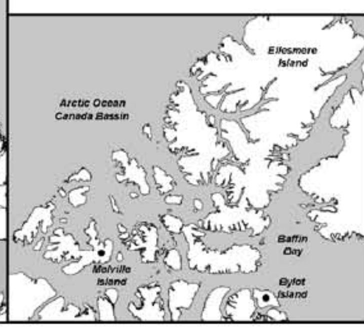


Description:

Two pores are close but in diagonal (B-C)

Ecology:

Cool-adapted, well oxygenated habitats (4), in rivers (28)



Temperature optimum (°C):

1.0

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