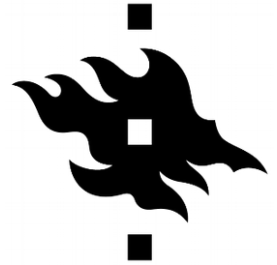


Морфологические и молекулярно-генетические
исследования филогеографии гарпактицид семейства
Canthocamptidae

Crustacea. Copepoda. Harpacticoida.



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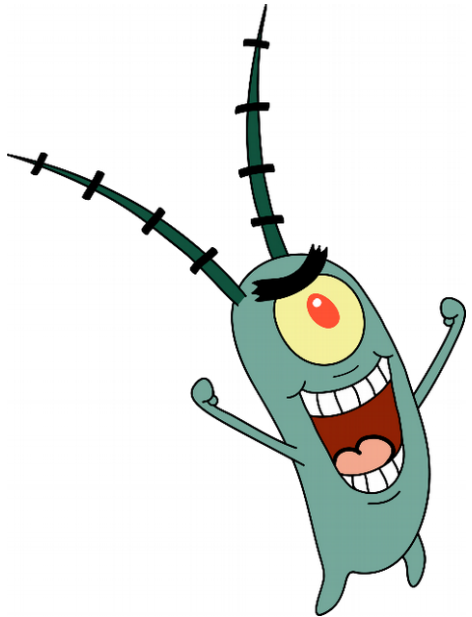
Harpacticoida

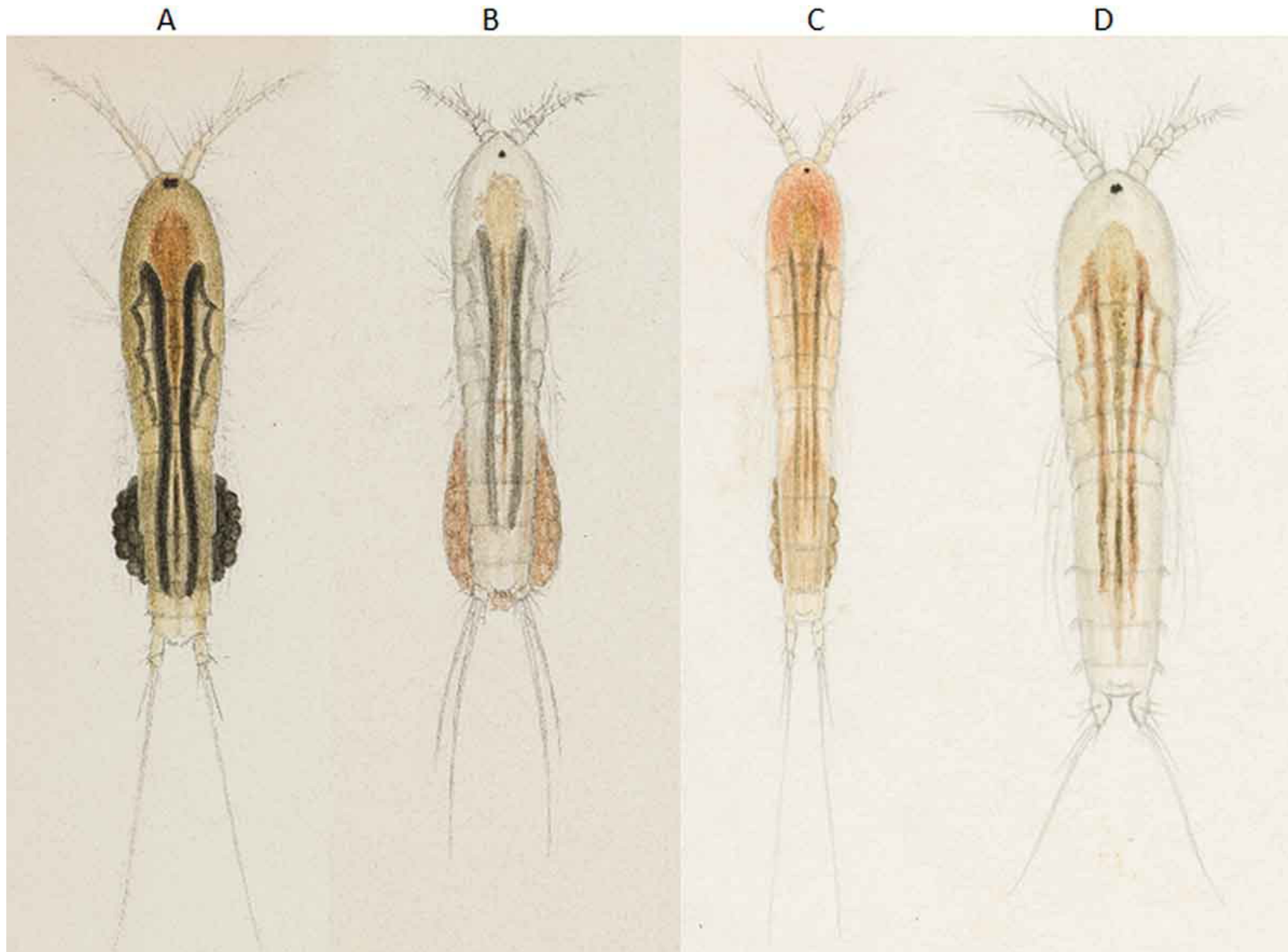
Small benthic copepods
from 0.2 to 2.5 mm

Common benthic invertebrate

Important in nutrient cycling

Food sources for fish larvae

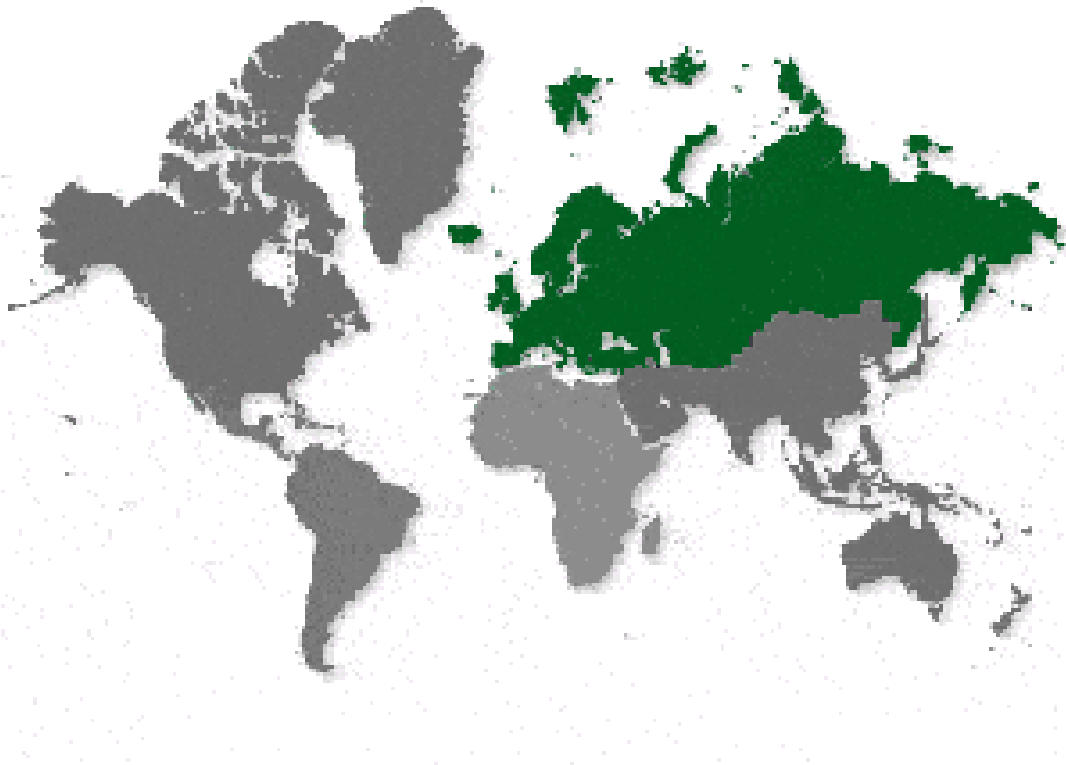




Drawings by G. O. Sars from the unpublished manuscript «Om de i Christiania's Omegn forekommende Ferskvandskrebsdyr», **1862**.

- A** *Canthocamptus staphylinus*,
- B** *Bryocamptus pygmaeus*,
- C** *Elaphoidella gracilis*,
- D** *Attheyella crassa*.

Distribution and ecology of *Canthocamptus staphylinus*



The Palearctic

Inhabits different water bodies:
from small ponds to deep and large lakes

Prefers cold seasons: fall to spring

During summertime exists in cysts



A PARTHENOGENETIC LIFE CYCLE IN A POPULATION OF CANTHOCAMPTUS STAPHYLINUS (COPEPODA, HARPACTICOIDA)

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Keywords: Life cycle, parthenogenesis, encystment, Copepoda

Abstract

The harpacticoid copepod *Canthocamptus staphylinus* (Jurine) was shown to reproduce parthenogenetically in an oligotrophic Finnish lake. The population was univoltine with peaks of egg production in winter and early spring. Young from both peaks became adults in spring and aestivated as cysts. Laboratory ex-

camptus staphylinus (Jurine). Both field and laboratory results are compared with earlier accounts of sexually reproducing populations.

Study area, methods and material

Canthocamptus staphylinus is geographically and ecologically variable species

Some scientists:

Canthocamptus staphylinus monardi;

Canthocamptus staphylinus neocomensis;

Canthocamptus staphylinus sinuus;

Canthocamptus staphylinus thallwitzii;

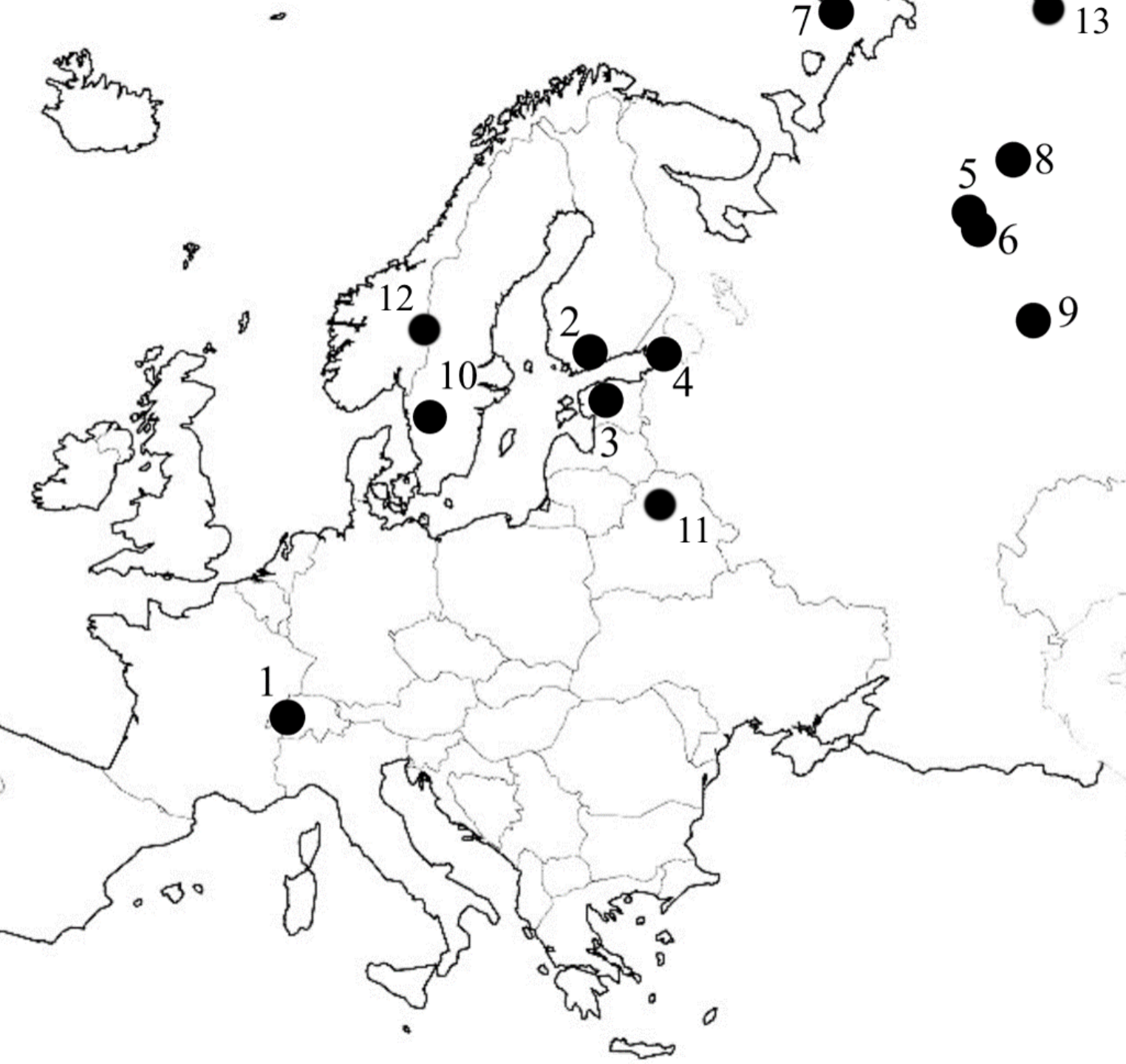
Canthocamptus staphylinus microstaphylinus.

Wolf (1905), Gurney (1932), Lang (1948), Sarvala (1977),
Roy (1927), Monard (1918), Coker (1934), Kessler (1913)

Other scientists:

It is one species with morphological
differences within-species variability

Borutzky (1952), Janetzky (1996), Fefilova (2009)



- 1 lake Geneva, Switzerland
- 2 lake Pääjärvi, Finland
- 3 lake Võrtsjärv, Estonia
- 4 Orlov pond, Saint Petersburg, Russia
- 5 pond in Botanical garden, Syktyvkar, Russia
- 6 Nyuvchim reservoir, Komi Republic Russia
- 7 lake on Vaygach island, Russia
- 8 river Unia, Komi Republic Russia
- 9 pond in Samara, Russia
- 10 lake Vänern, Sweden
- 11 lake Naroch, Belarus
- 12 Store Le, Norway
- 13 Delta of Pechora River, Russia

The most variable morphological characters

Body length

Number of spinules on the anal operculum

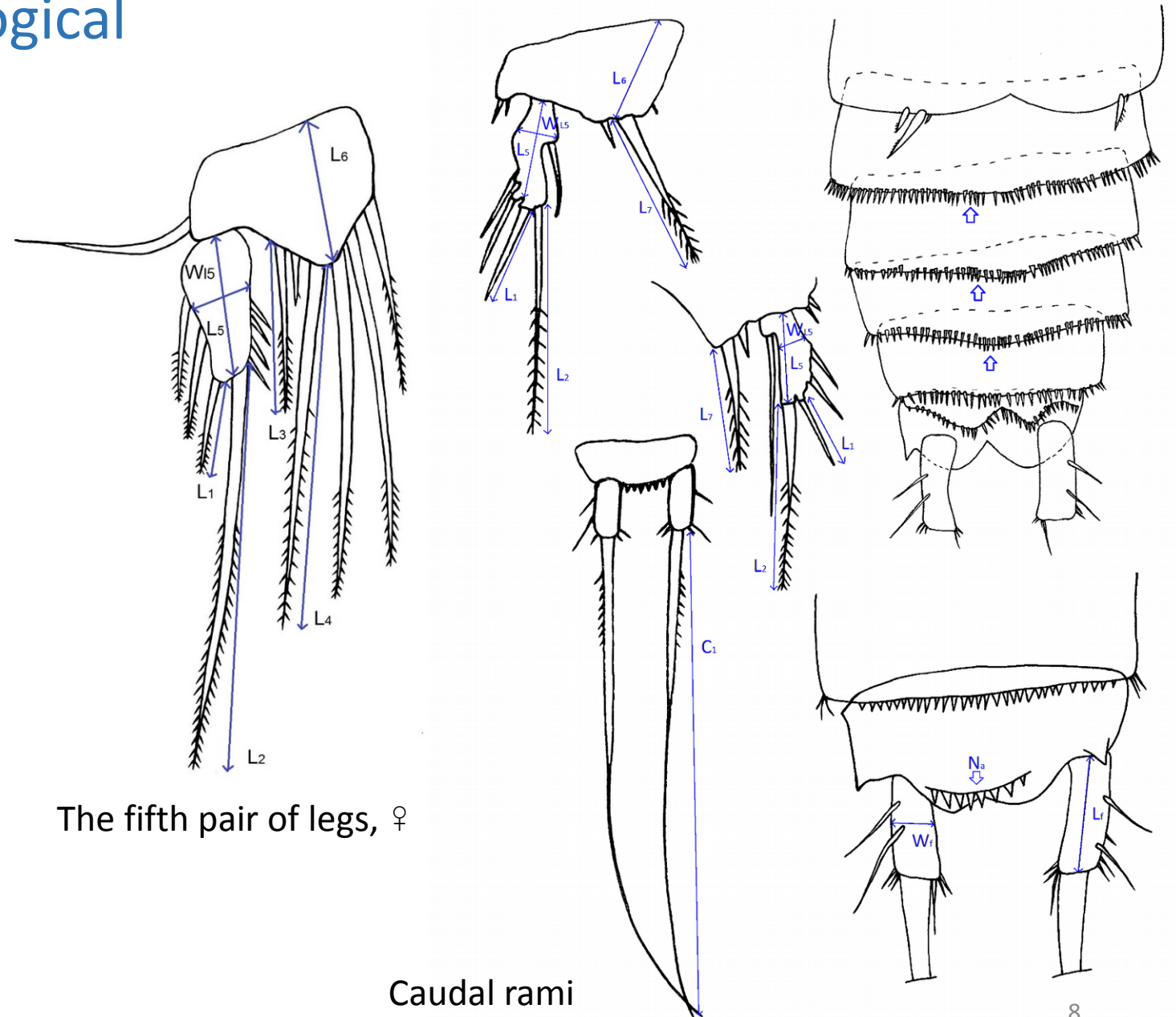
L_f/W_f — length to width ratio of caudal rami

L_2/L_1 — ratio of the 1st spine from external edge to 2nd of the 5th pair of legs exopodite

L_4/L_3 — ratio of the 2nd spine from internal edge to the 1st spike of the 5th pair of legs endopodite

L_2/L_4 — ratio of the 1st spine from external edge of exopodite to the 2nd spike from internal edge of endopodite

The fifth pair of legs, ♂

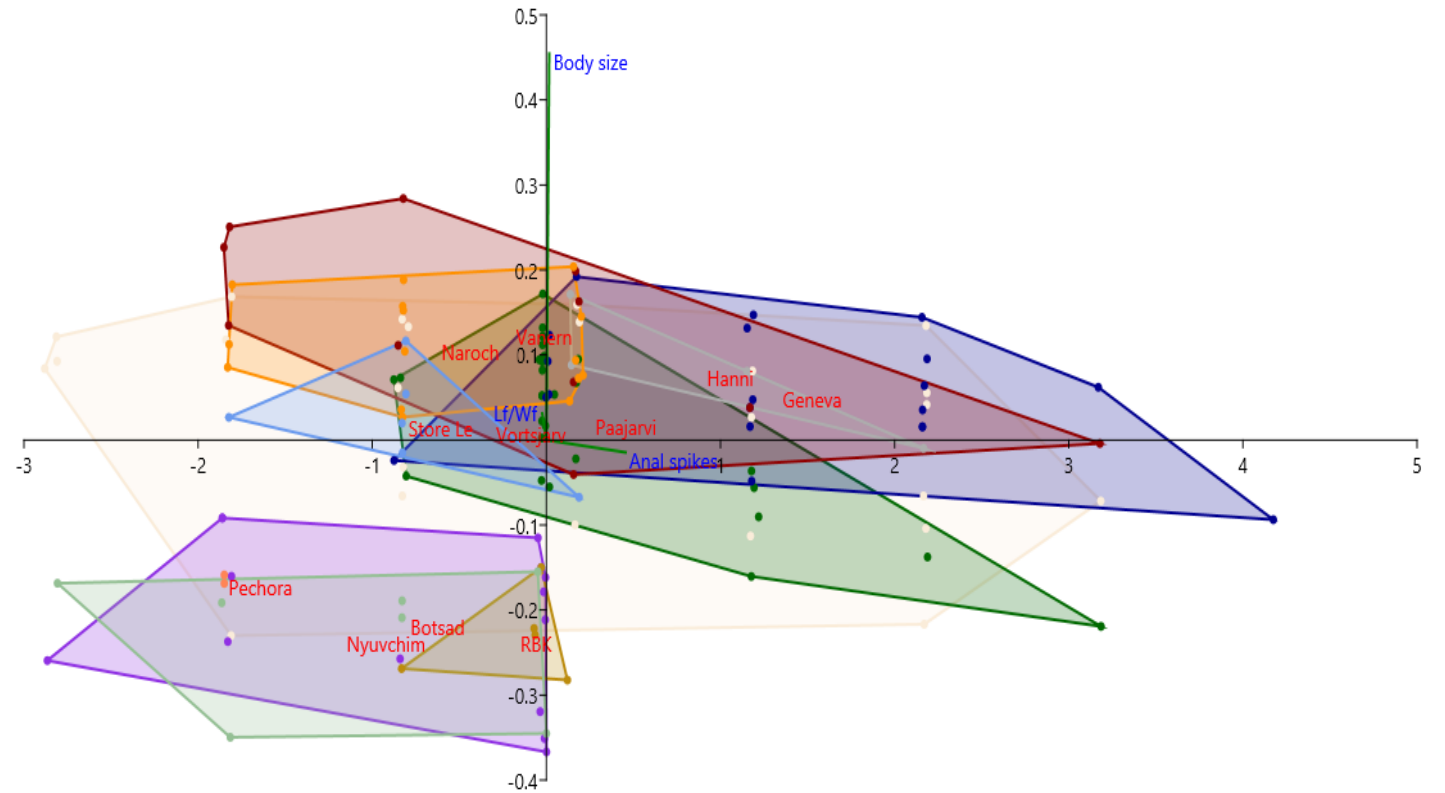


The fifth pair of legs, ♀

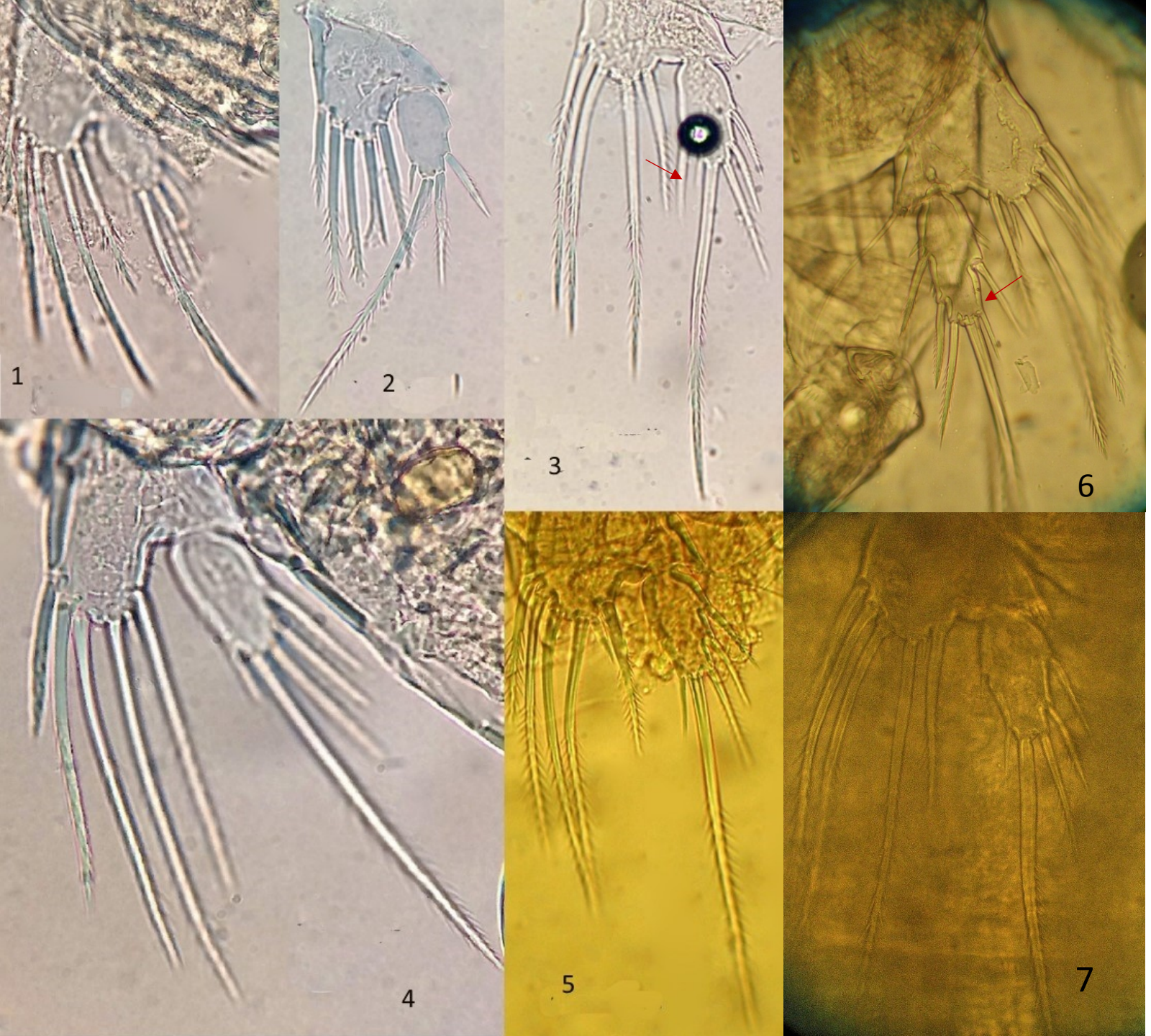
Caudal rami



Females of *Canthocamptus staphylinus* from lake Paajarvi, Finland (on the right) and from pond in botanical garden in Syktyvkar, Russia (on the left)

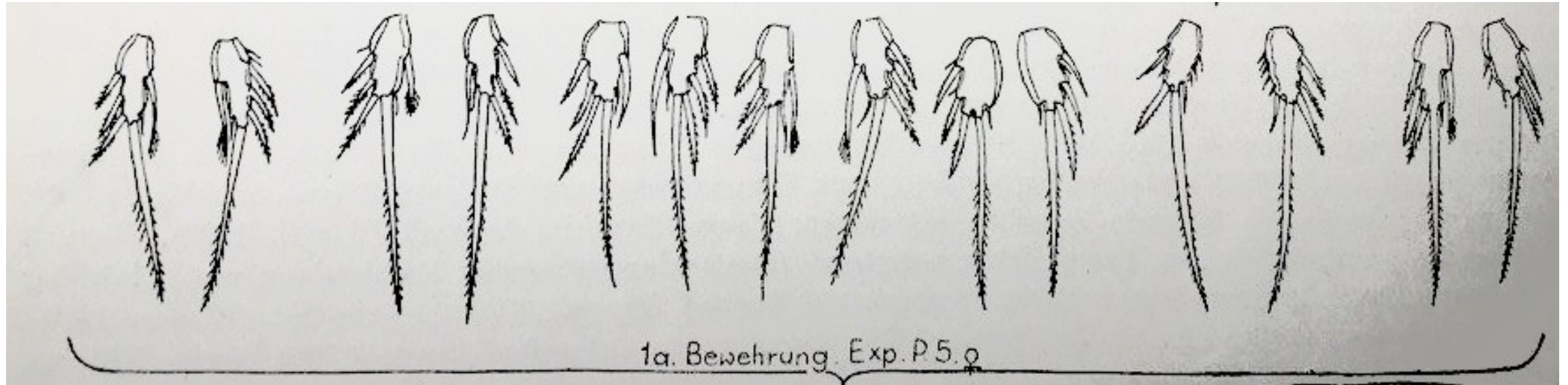


Principal Component Analysis (PCA) plot showing the **multivariate morphological variation** among populations of *Canthocamptus staphylinus*

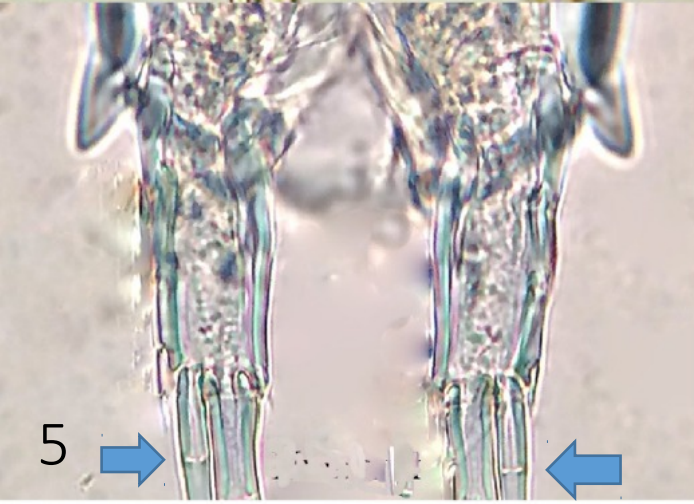
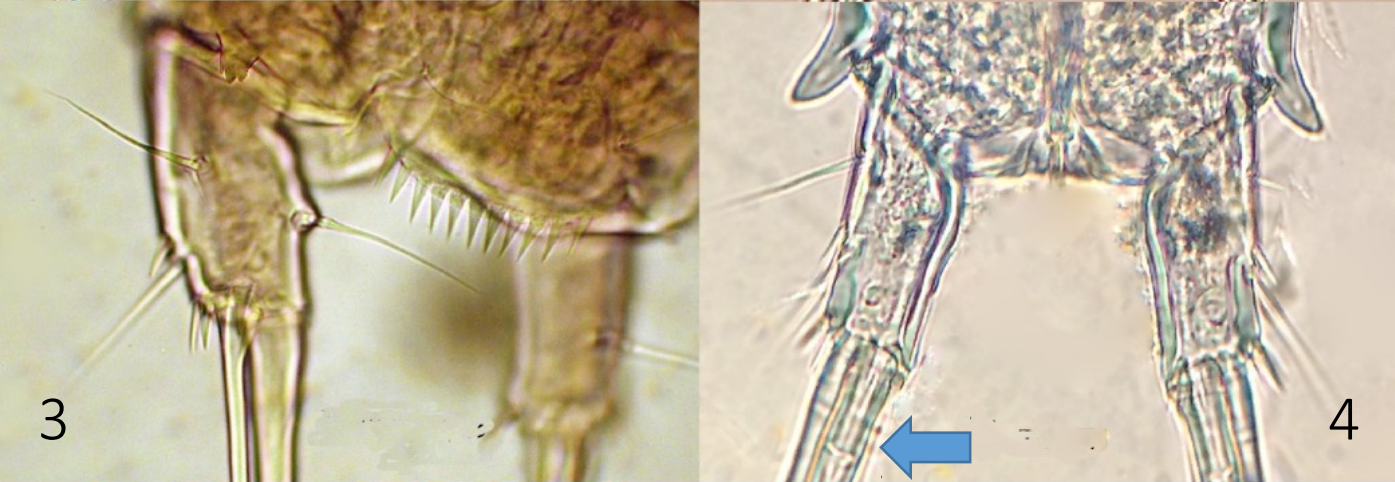
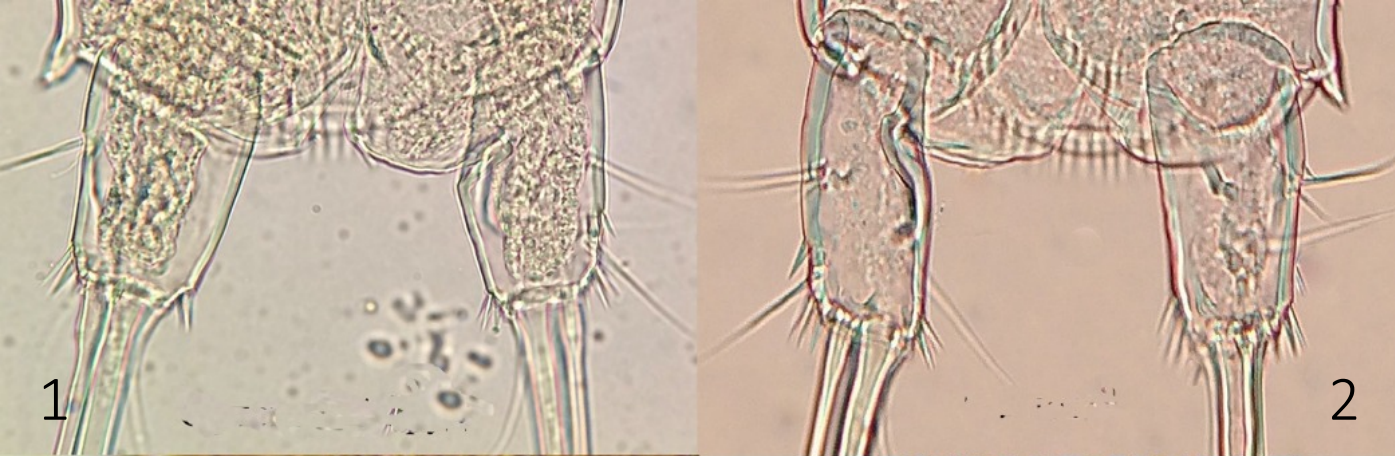


The fifth pair of legs of *C. staphylinus* from different populations

- 1 Pond in Botanical garden in Syktyvkar, Komi Republic, Russia
- 2 Nuyvchim reservoir, Komi Republic, Russia
- 3 Saint Petersburg, Russia
- 4 Lake Paajarvi, Finland
- 5 Lake Vortjarv, Estonia
- 6 Lake Geneva, Switzerland
- 7 Lake Vanern, Sweden

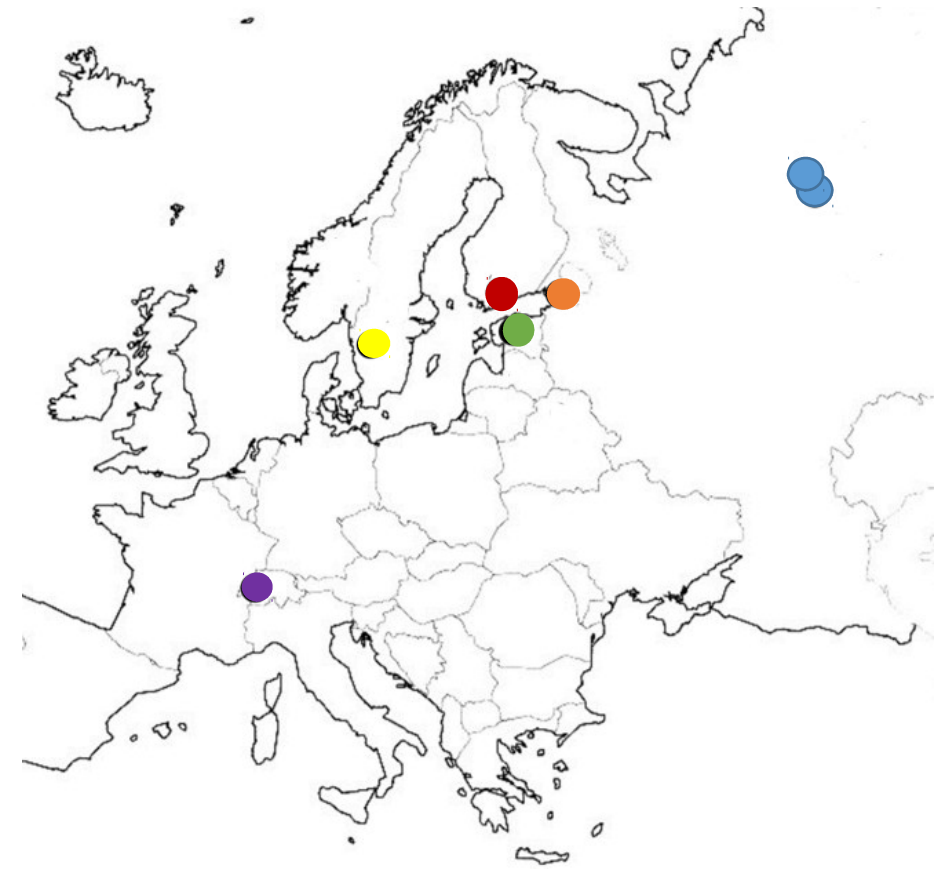
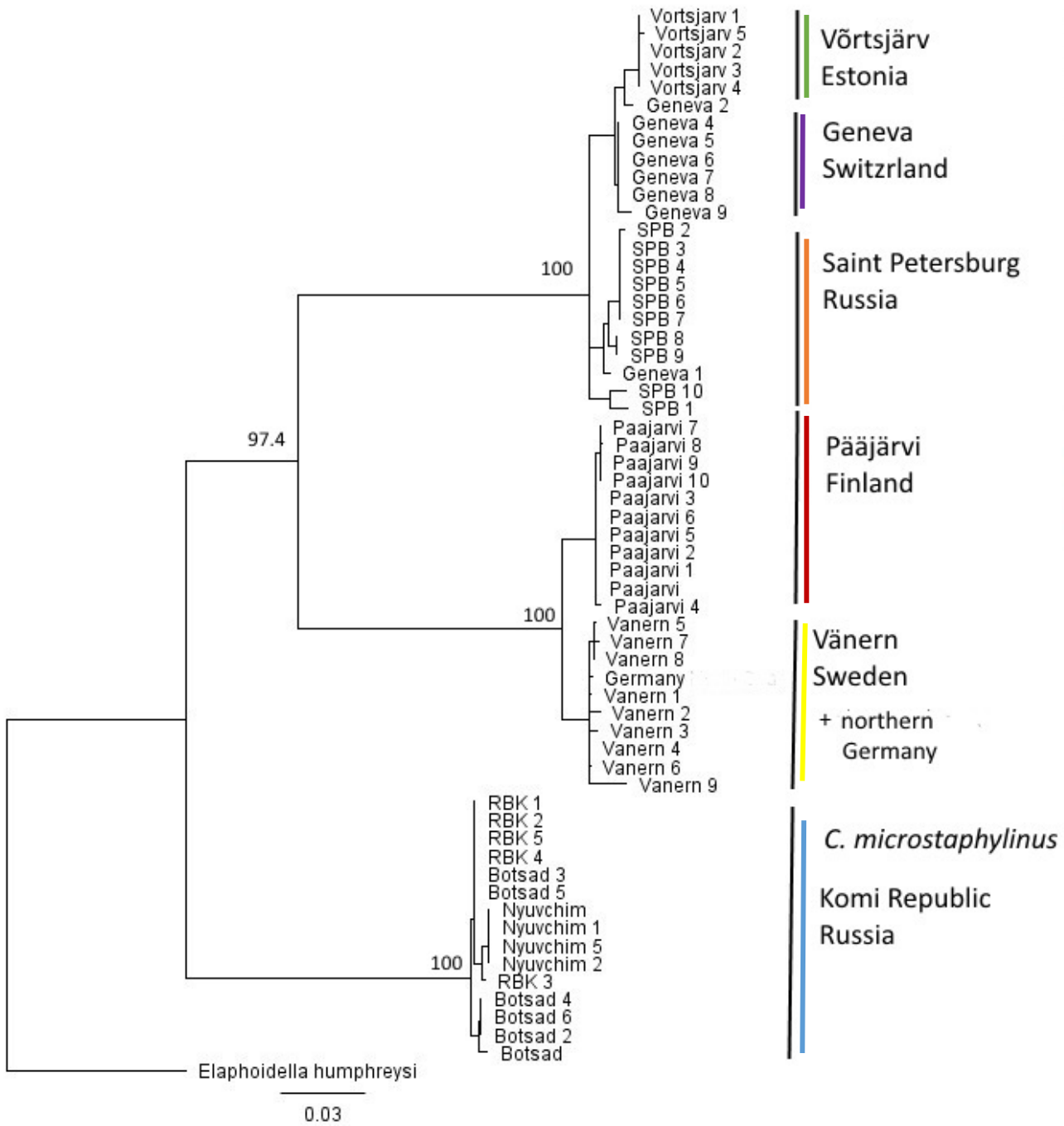


Lang. 1948. Monographie der Harpacticiden. Lund: Håkan Ohlsson. Bd.1-2. 1682 pp.

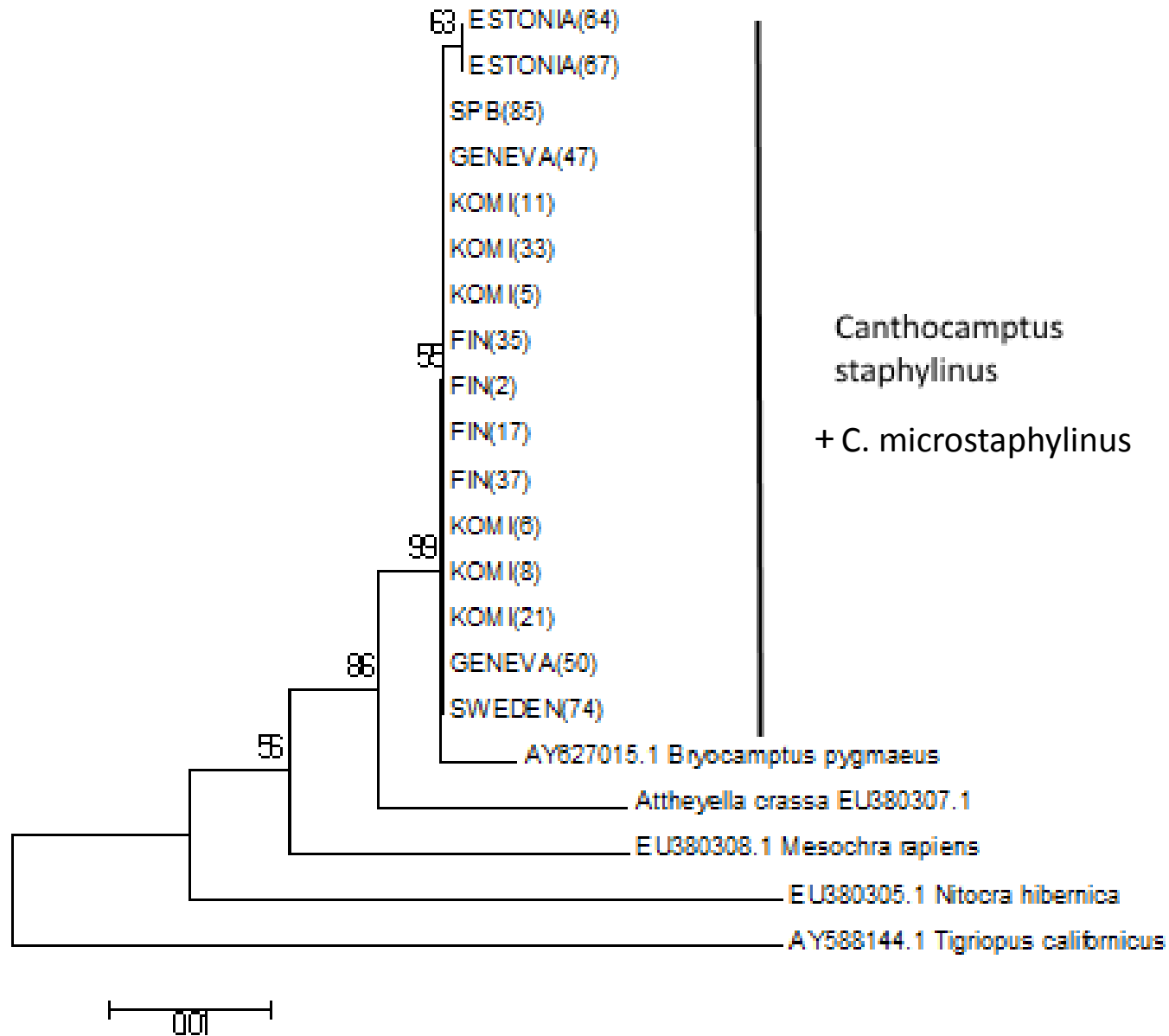


A definite break in the seta marked by «helle Stelle»

- 1 Orlov pond, Saint Petersburg, Russia
- 2 Paajarvi Lake, Finland
- 3 Vortsjarv Lake, Estonia
- 4 Pond in Syktyvkar, Komi Republic, Russia
- 5 Nyuvchim Reservoir, Komi Republic, Russia



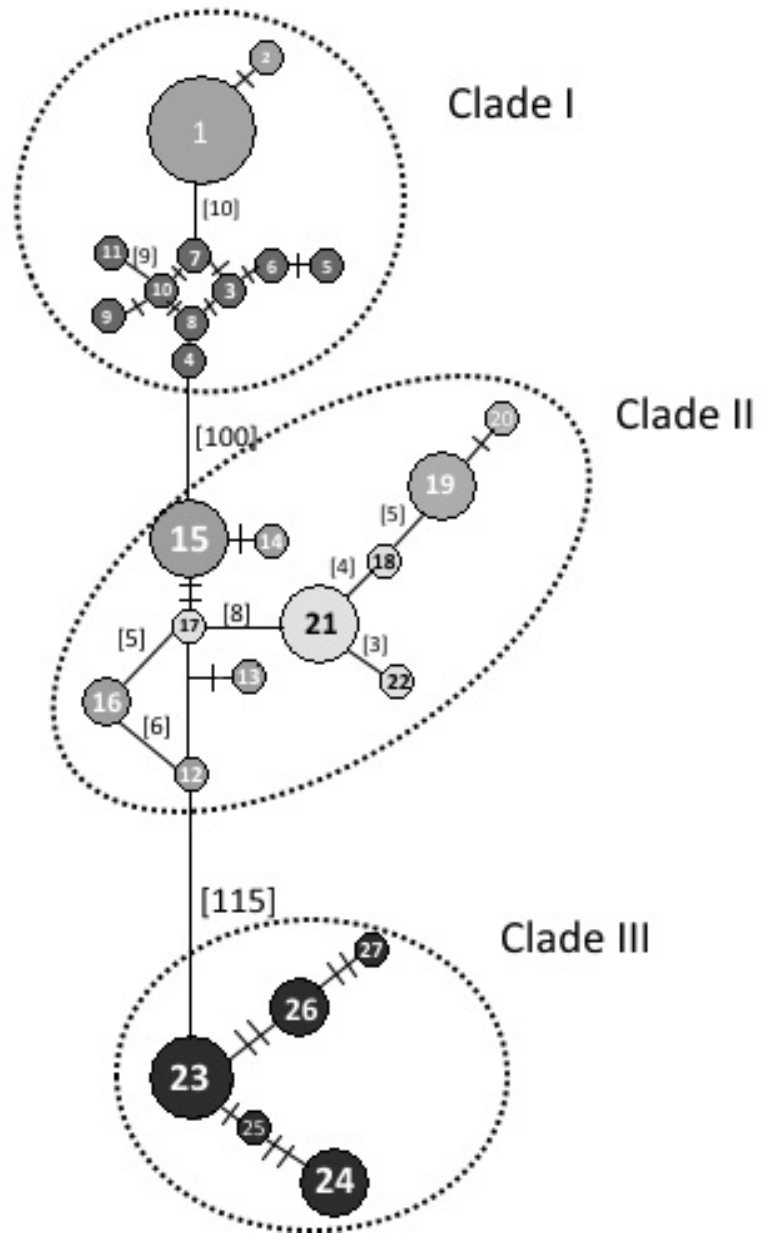
Phylogenetic relationships among *Canthocamptus staphylinus* and *C. microstaphylinus* populations based on COI mtDNA sequences



18S gene is too conservative for study of intrapopulational diversity

Works for families separation

Phylogenetic relationships among *Canthocamptus staphylinus* and *C. microstaphylinus* populations based on 18S sequences

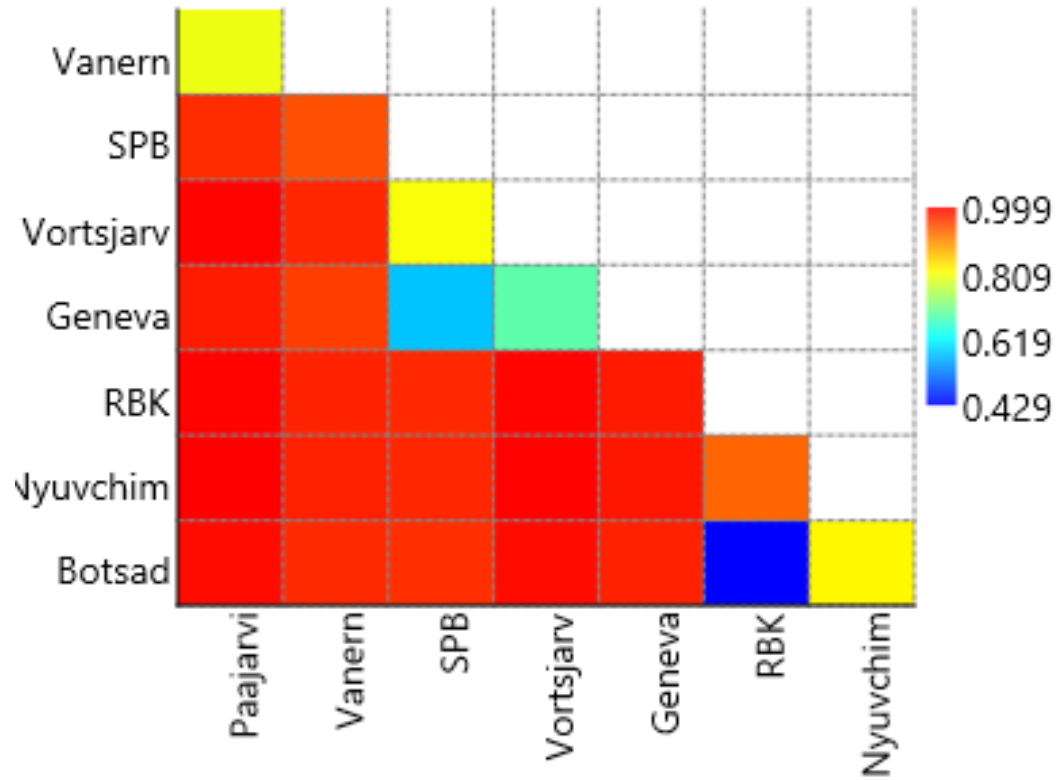


Genealogical relationships between COI haplotypes in populations of *Canthocamptus staphylinus* and *C. microstaphylinus*.

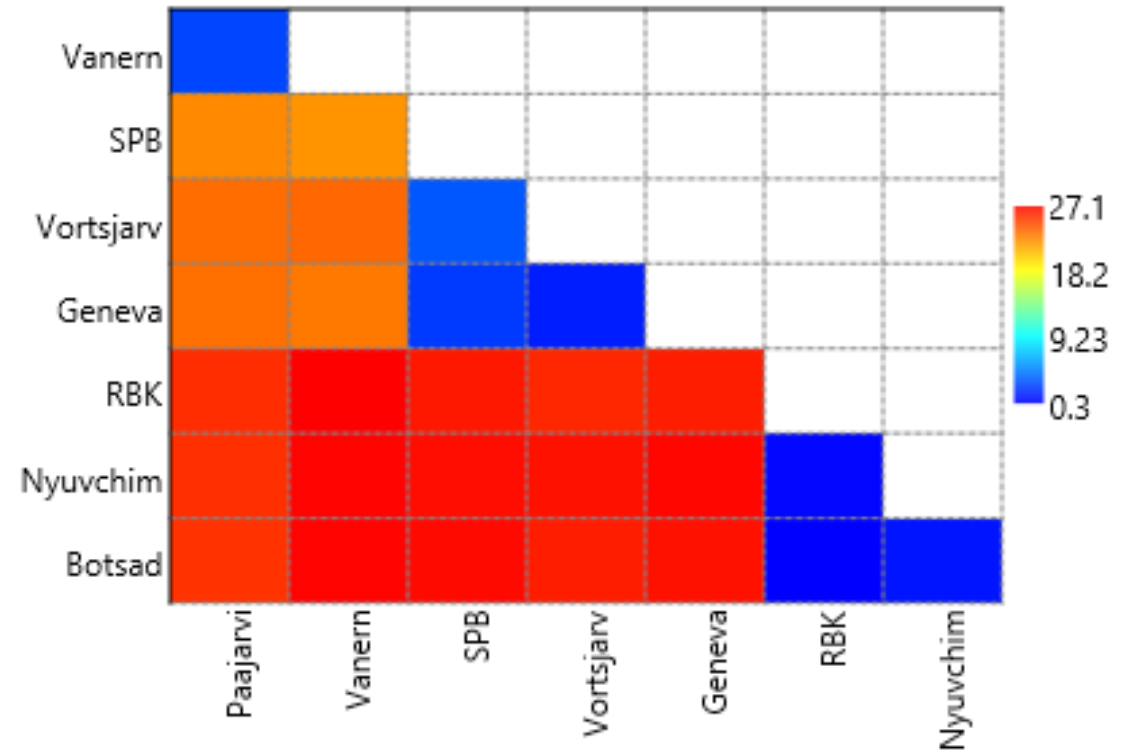
Haplotype network based on statistical parsimony.

Numbers in square brackets and black lines represent mutations between haplotypes.

- I Pääjärvi and Vänern
- II SPB, Vörtsjärv and Geneva
- III RBK, Nyuvchim and Botsad (*C. microstaphylinus*)

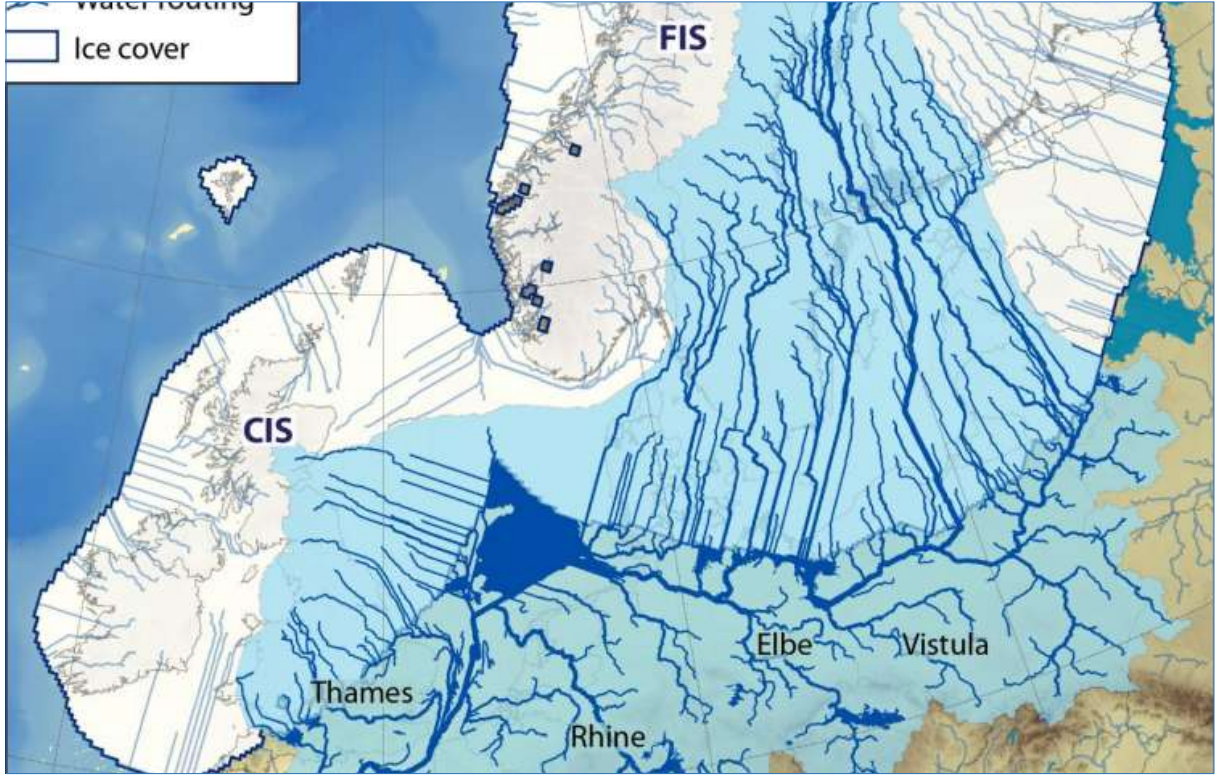
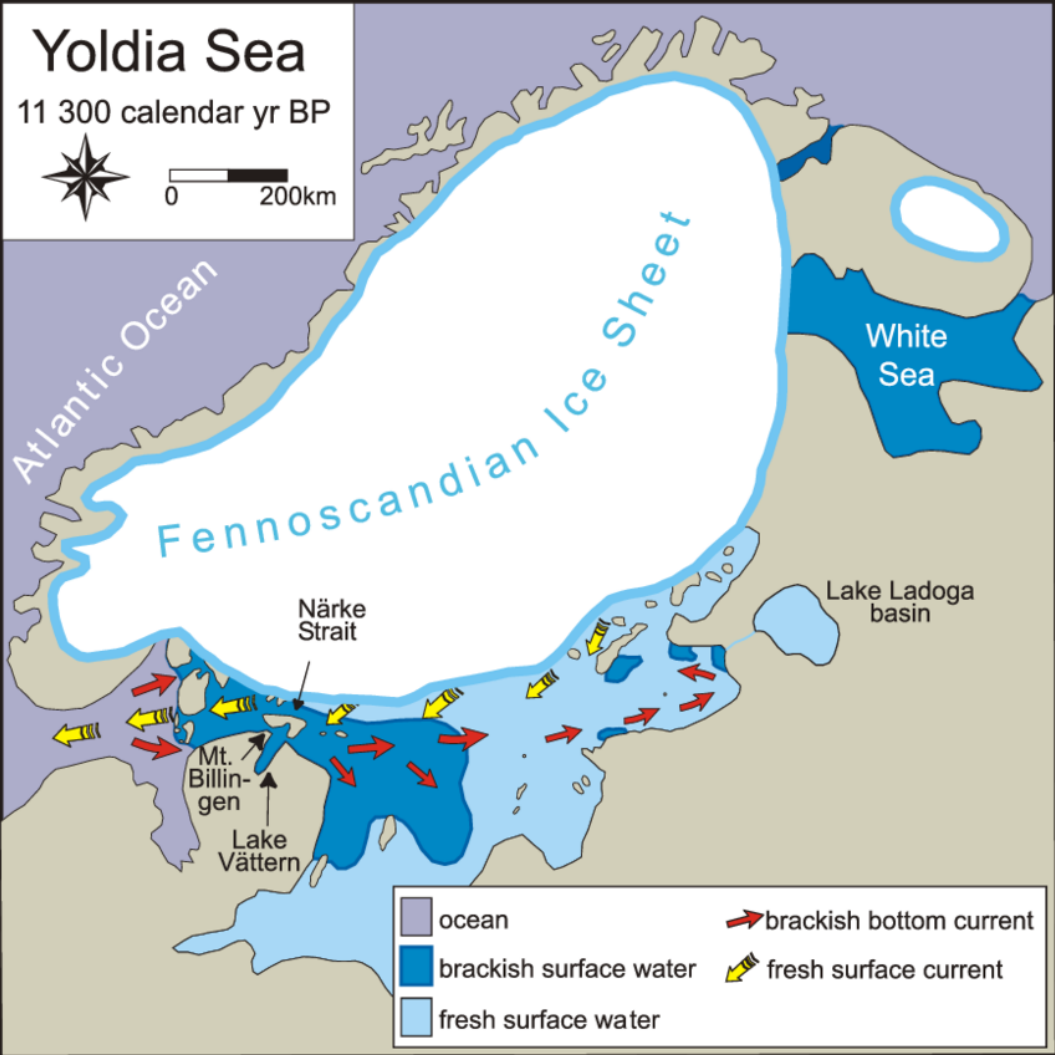


Fst matrix of genetic divergence among populations of *Canthocamptus*
Total Fst 0,97493



The matrix of genetic distances (in %) for the 8 populations of *Canthocamptus* based on CO1 sequences

Paleogeographic patterns of population structure



Polymorphism of the COI gene

Population	n	N	H	Hd	L	Pi	S	Eta
Pääjärvi	11	2	1, 2	0.182	611	0.00033	1	1
Vänern	9	9	3–11	1.000	611	0.00884	18	18
SPB	10	5	12–16	0.756	611	0.01118	20	20
Vörtsjärv	5	2	19, 20	0.400	611	0.00066	1	1
Geneva	8	4	17, 18, 21, 22	0.643	611	0.00702	17	17

The parthenogenetic population is indicated in bold.

n — number of sequences, N — Number of haplotypes, H — Haplotypes, Hd — Haplotype diversity, L — length of sequences, Pi — Nucleotide diversity, S — Number of polymorphic (segregating) sites, Eta — number of mutations.

Some conclusions

C. staphylinus

The harpacticoid species *C. staphylinus* shows a high level of genetic and morphological divergence between populations, possibly due to complex patterns of dispersal after glaciation.

The «northern» and «continental» clades of *C. staphylinus* can likely be considered as a complex of cryptic species.

The parthenogenetic population showed the smallest nucleotide and haplotype diversity, suggesting a clonal genetic structure in the population through the line of maternal inheritance of mitochondrial DNA

C. microstaphylinus

Population from Komi Republic is morphologically (smaller body sizes) and genetically (big genetic distances) distant from others.