

# Morphometric Snapshots Reveal no Effect of Latitude on Water Bears (*Tardigrada*) Body Size

Krzysztof Zawierucha\*, Paweł Podkowa, Piotr Gąsiorek, Martyna Marciniak, Lidia Szymkowiak, Maria Włodarska-Kowalczuk

\*corresponding author, Department of Animal Taxonomy and Ecology, Adam Mickiewicz University, Umultowska street 89, 61-614 Poznań, email: k.p.zawierucha@gmail.com

## I. Purpose

Climate warming is likely to effect the size of organisms. In the present study we explored the latitudinal variations in tardigrade length to understand the relationships between the temperature and the body size in this group. Additionally the effects of organic enrichment (produced by the seabird colonies in coastal areas) were tested.

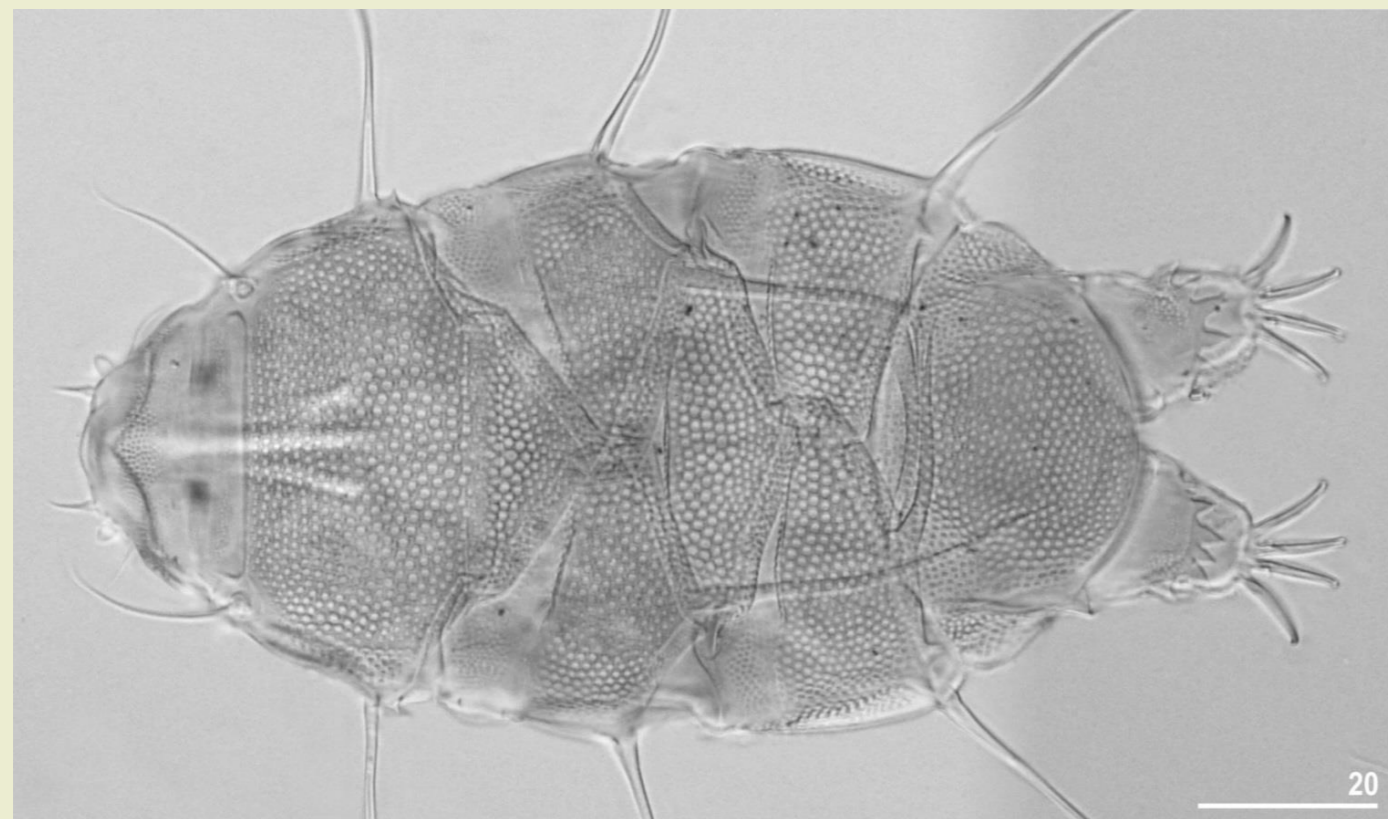


Fig. 1. *Testechiniscus spitsbergensis* (Scourfield, 1897) under differential interference contrast microscope.

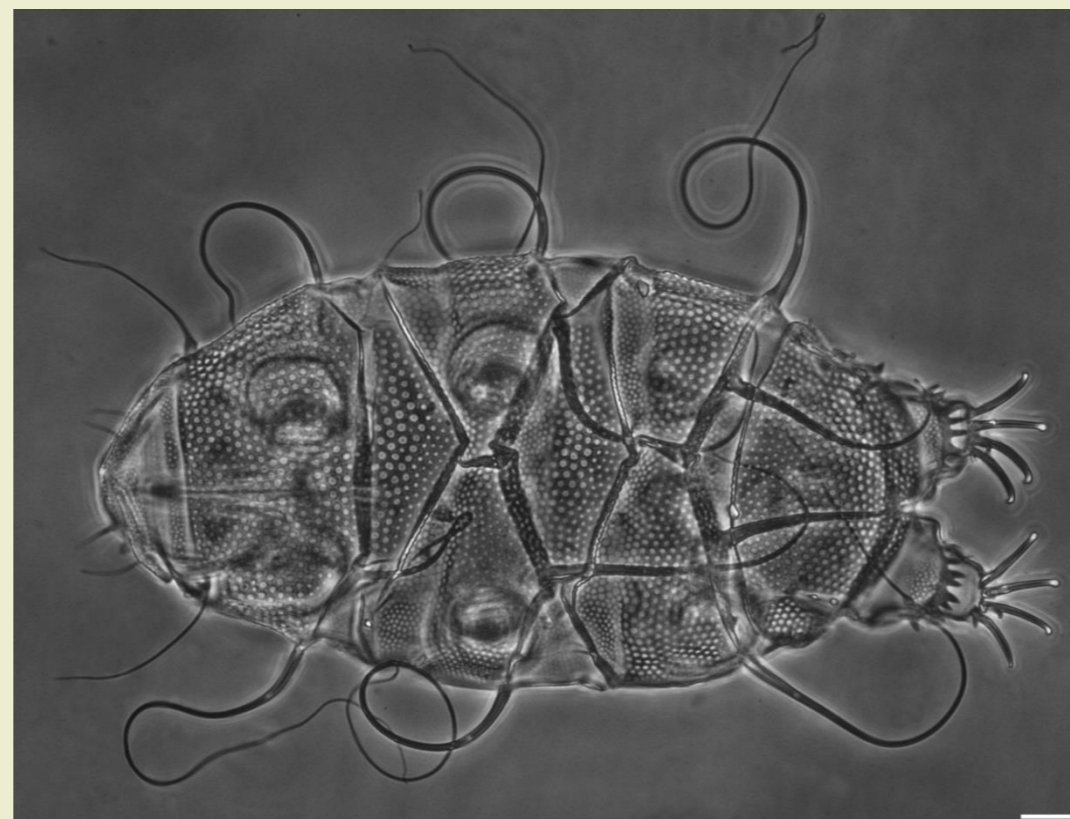


Fig. 2. *Testechiniscus spitsbergensis* (Scourfield, 1897) under phase contrast microscope.

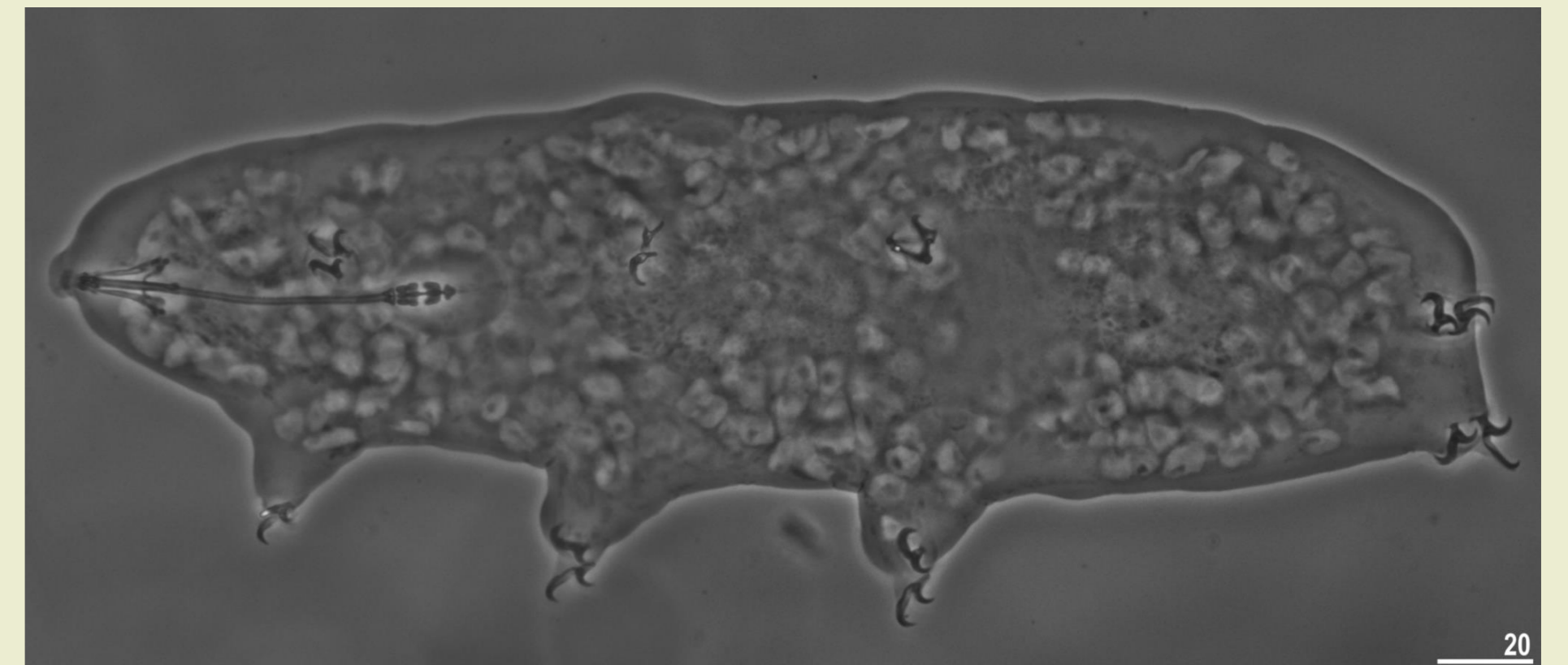
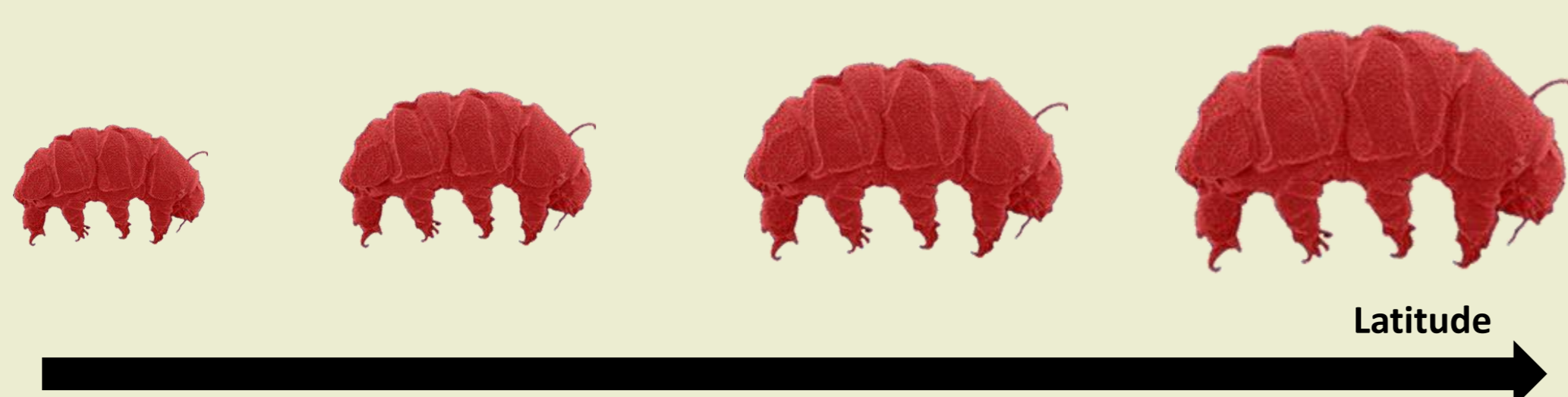


Fig. 3. *Pilatobius recamieri* (Richters, 1911) under phase contrast microscope.

## Expected pattern



## II. Material and methods

Material (moss, moss/lichen, moss/soil samples) were collected in latitudinal gradient (sites: Tat – Poland, Tatra Mountains; Sc – United Kingdom, Scotland; Tro – Norway, Tromso; SvB – Norway, Svalbard, Bjørnøya; SvH - Norway, Svalbard, Hornsund, SvF - Norway, Svalbard, Fuglesangen; SvN - Norway, Svalbard, Nordaustlandet). Subsequently tardigrades were isolated from samples under stereomicroscope mounted in the slides and then measured.

Body length as a dependent variable was explained first by a seabird colony presence/absence within the study location, and then by latitude. We performed General Linear Models (GLMs) for each tardigrade species separately. Differences in the body length between sites affected and not affected by seabirds were tested in the localities SvH and SvB for *T. spitsbergensis*, and SvH and SvP for *P. recamieri*. We used "Locality" as an additional fixed factor in these analyses. Additionally we tested differences in body size of *T. spitsbergensis* between Arctic islands and continental Europe (including UK).

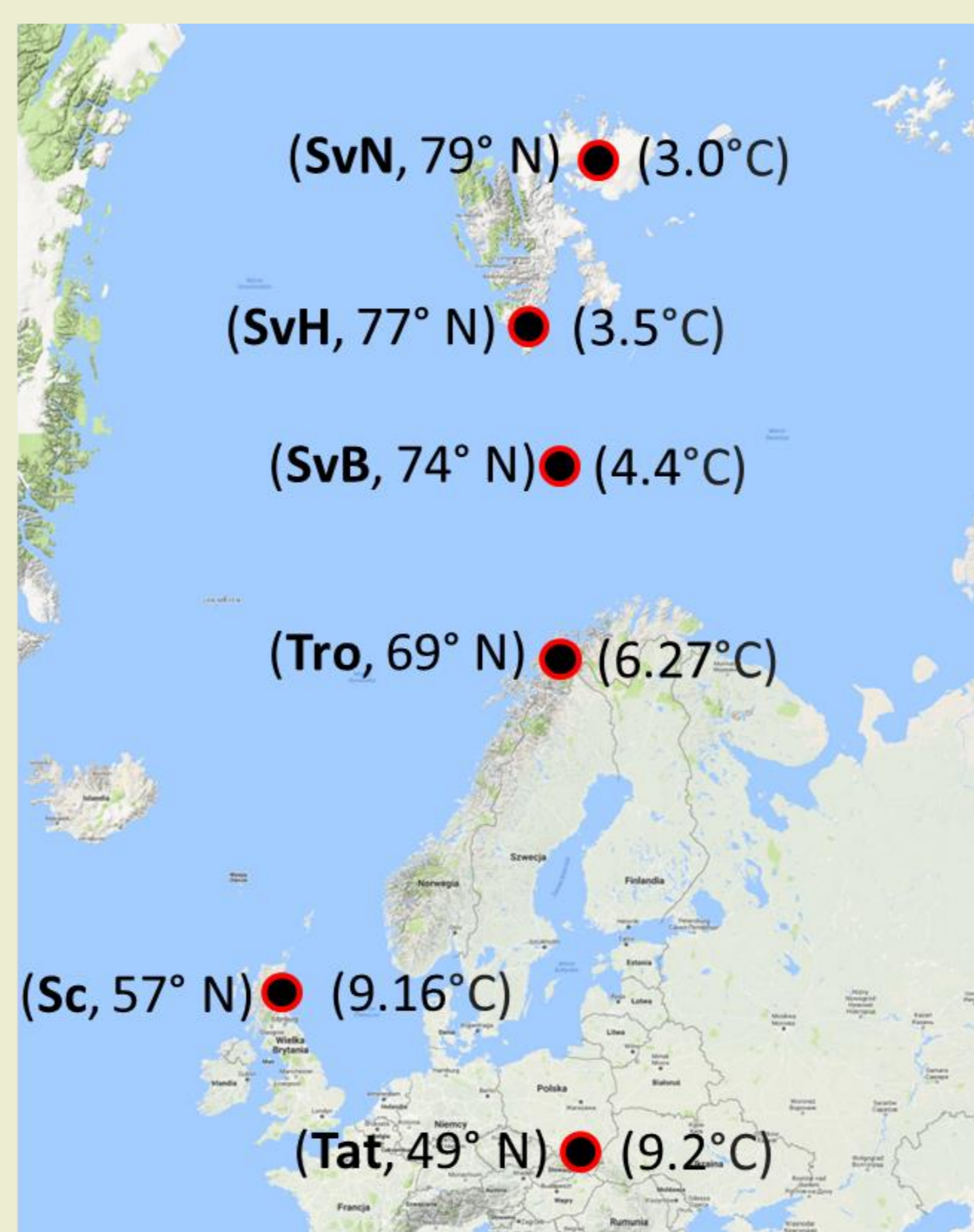


Fig. 4. Sampling points for *T. spitsbergensis*. In the left brackets latitude and in the right brackets average temperatures for sampling period are provided.

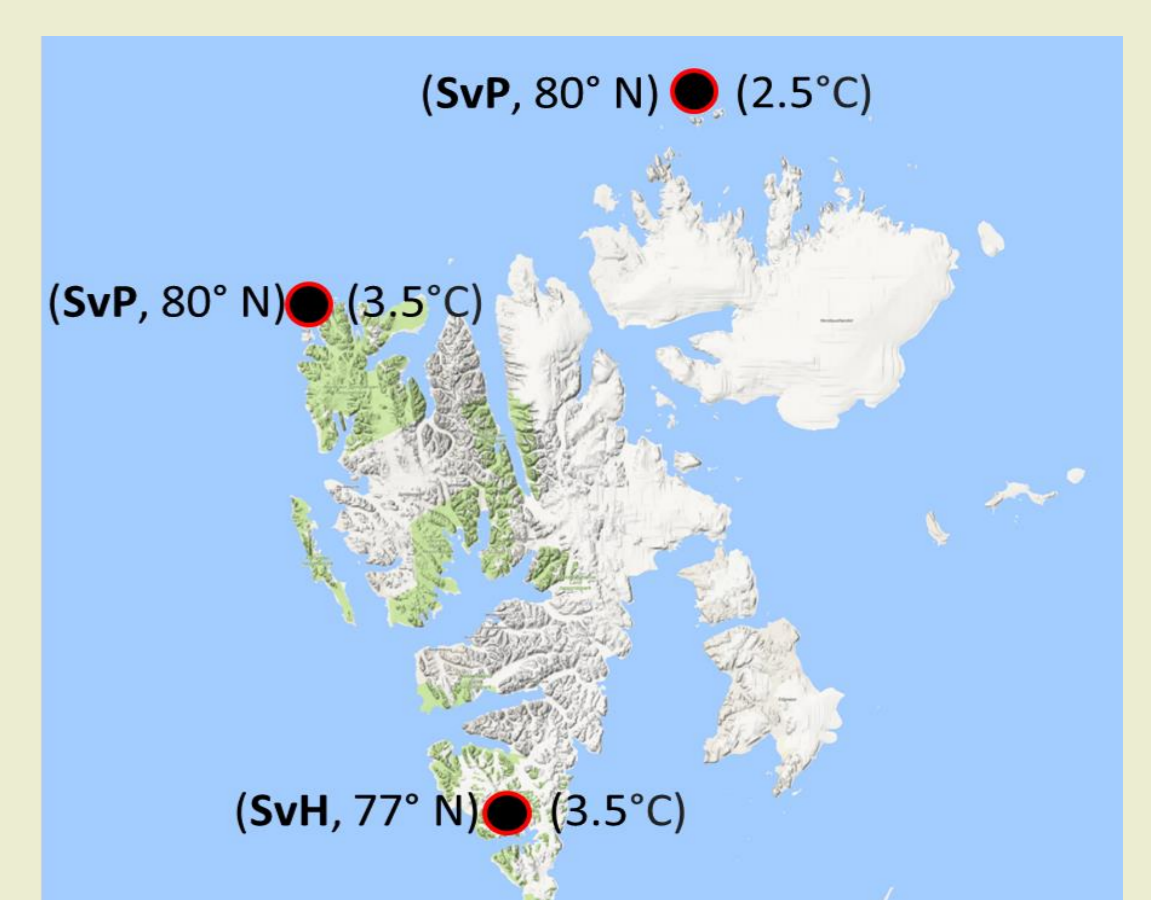


Fig. 5. Sampling points for *P. recamieri*. In the left brackets latitude and in the right brackets average temperatures for sampling period are provided.



Fig. 6. *Alle alle* – colony fertilising tundra.

## III. Results

We did not find any statistically significant differences in body length of *T. spitsbergensis* or *P. recamieri* between the localities affected and not affected by a seabird colony ( $p=0.2$  and  $p=0.06$ , respectively). For *P. recamieri* there were no significant differences in body length between individuals collected from three localities ( $F(2,67)=2.19$ ,  $p=0.12$ , Fig. 9). For *T. spitsbergensis* effect of latitude was statistically significant ( $F(5,194)=5.64$ ,  $p<0.05$ , Fig. 7). Differences in body length explained by the locality (Arctic islands vs. UK and continental Europe) for *T. spitsbergensis* were statistically significant ( $t=-1.99$ ,  $p=0.05$ , Fig. 8).

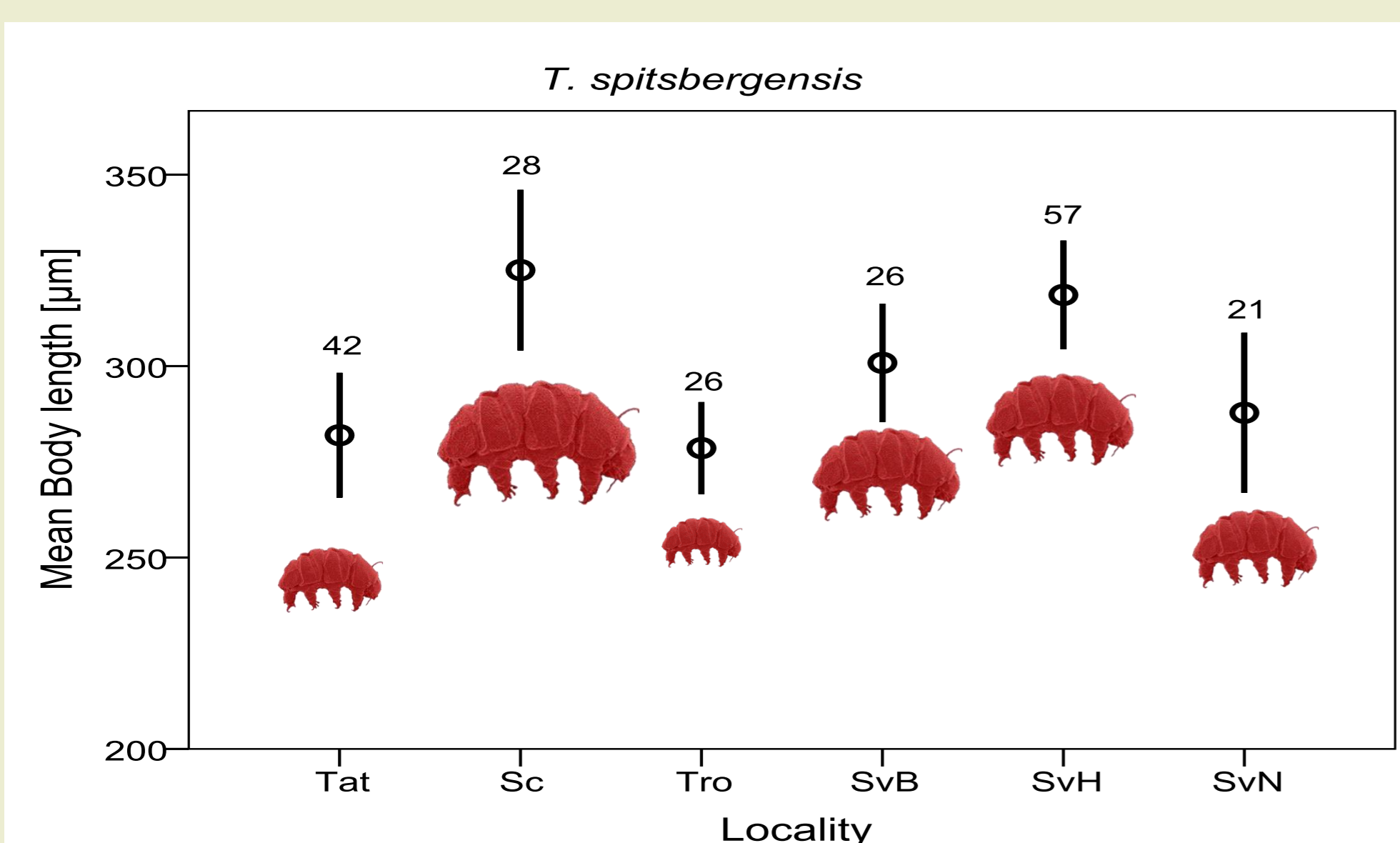


Fig. 7. Mean ( $\pm 0.95$  CI) body length of *T. spitsbergensis* in six localities. Sample size indicated over the bars.

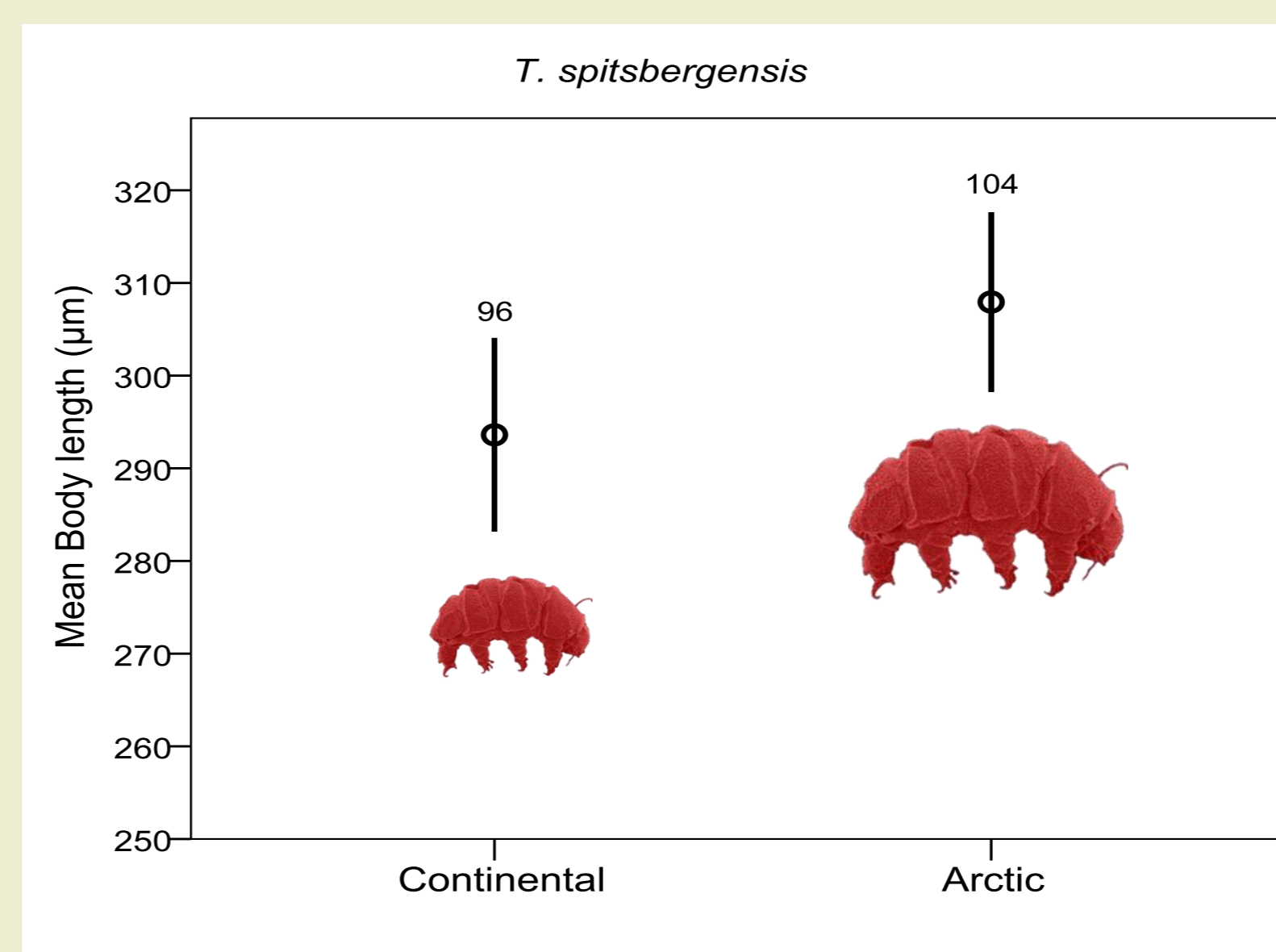


Fig. 8. Mean ( $\pm 0.95$  CI) body length of *T. spitsbergensis* in continental and Arctic localities. Sample size indicated over the bars.

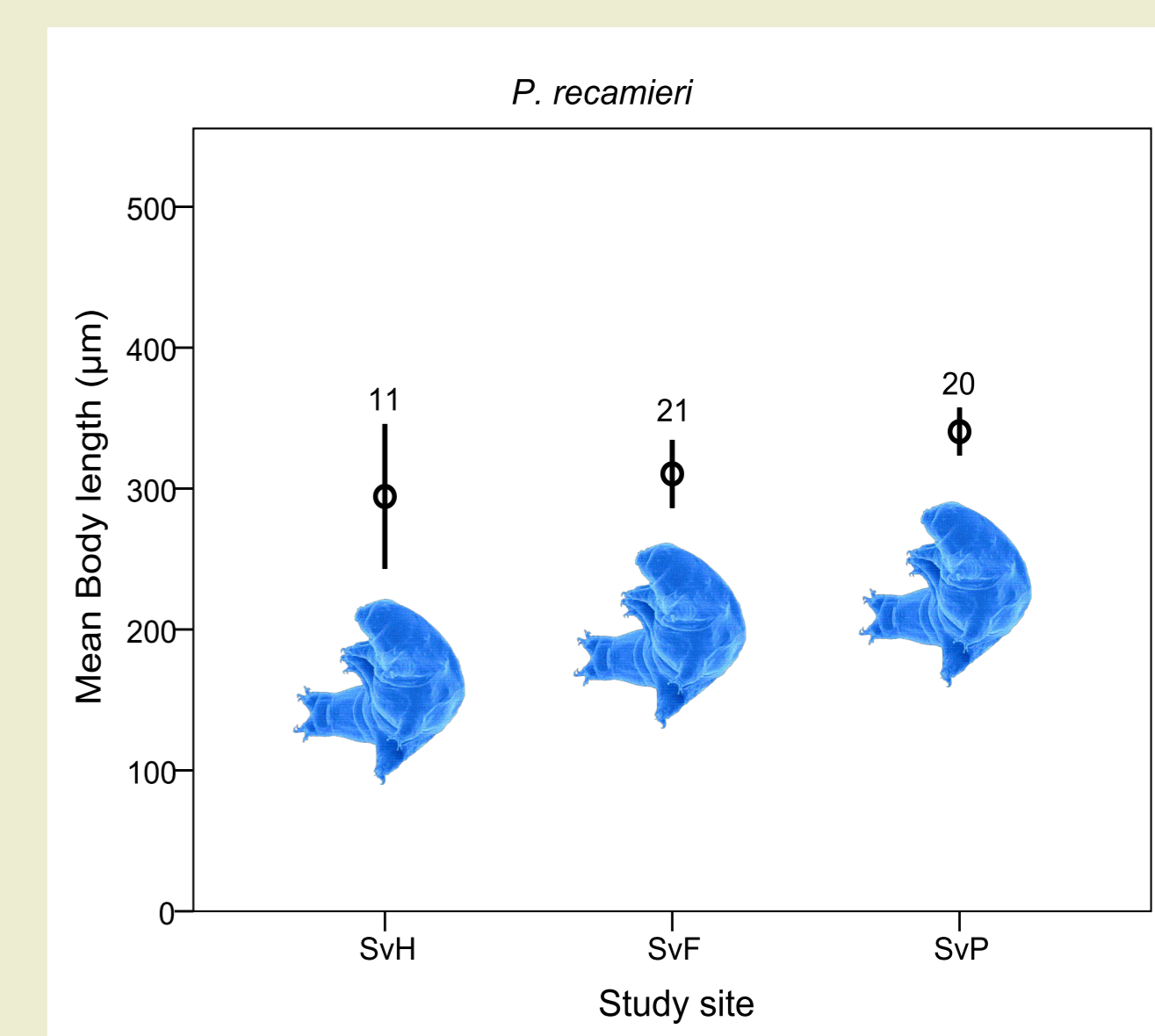


Fig. 9. Mean ( $\pm 0.95$  CI) body length of *P. recamieri* in three localities on Svalbard. Sample size indicated over the bars.

## V. Conclusions

Tardigrada is group of poorly known metazoans where data on life histories, phenotypic plasticity and ecological relations in natural environments are scarce. Thus, our results are important insights in the knowledge about these animals. Lack of expected pattern - gradual changes in tardigrade body size with increasing latitude, proves that latitude and temperatures are not factors influencing *T. spitsbergensis* and *P. recamieri* body size. Probably other factors like prey selection by predators or competition for food may affect tardigrade body size.