Feed, breed & die - the amazing life cycle of Svalbard aphids

Karina Wieczorek

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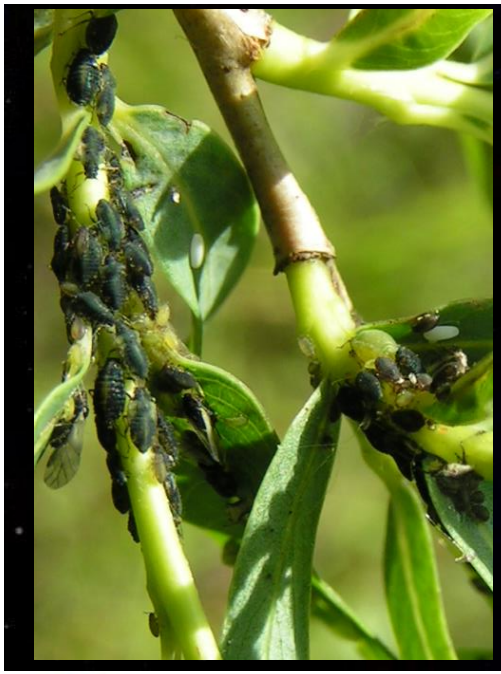
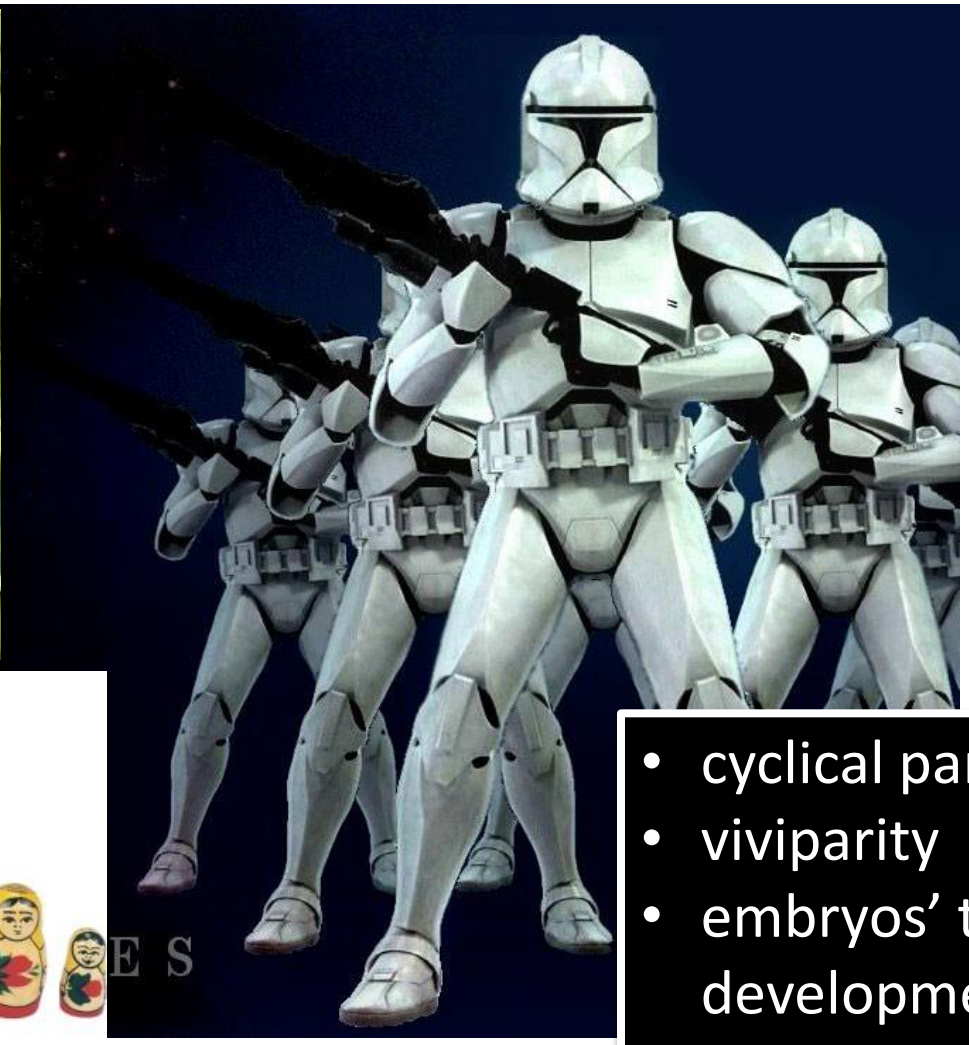
APHIDS (INSECTA, HEMIPTERA: APHIDIDAE)

About 5000 species, placed in 514 currently accepted genera and recorded from about 300 plant families

Fot. M. Kanturski

APHIDS – REPRODUCTIVE STRATEGY

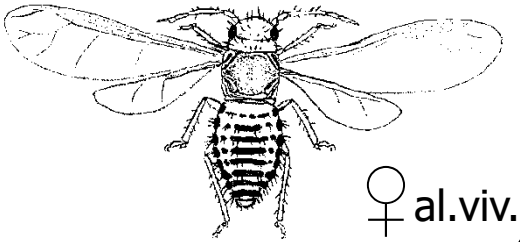




- cyclical parthenogenesis
- viviparity
- embryos' telescopic development
- clonal reproduction

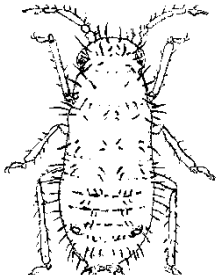
APHIDS – POLYMORPHISM

Hibernation

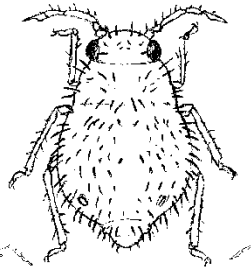


♀ al.viv.

Dispersion



fundatrix ♀



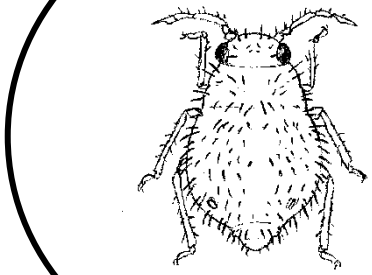
apterous viviparous female

♀

larva

Periphyllus testudinaceus

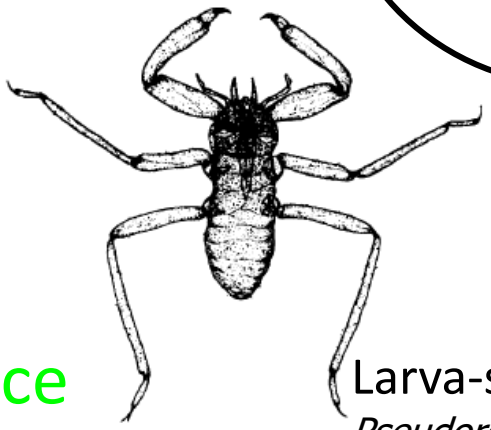
(Fernie)



♀

♀ apterous viviparous females

Estivation

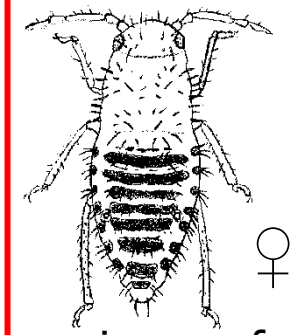


Defence

Larva-soldier

Pseudoregma bambulicola

Takahashi



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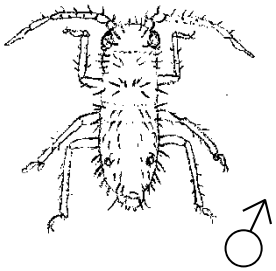
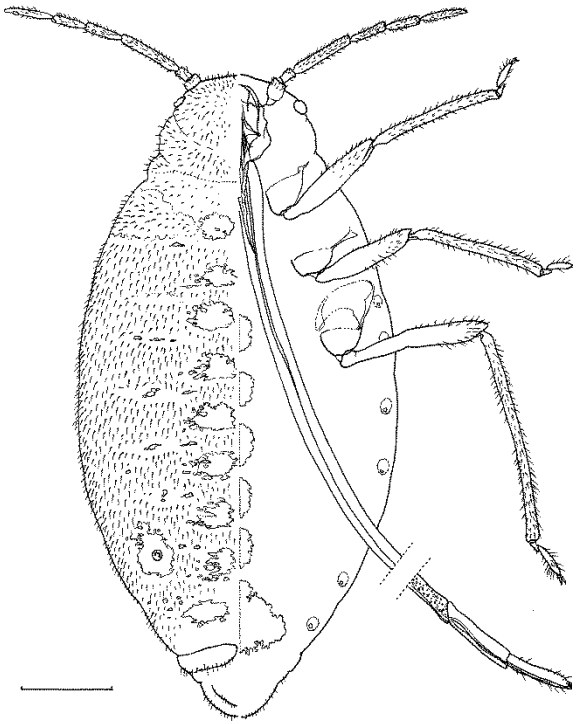


♂

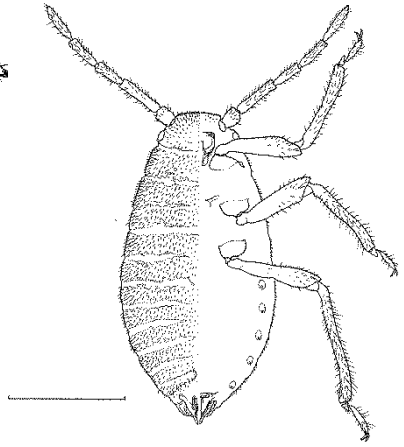
oviparous female male

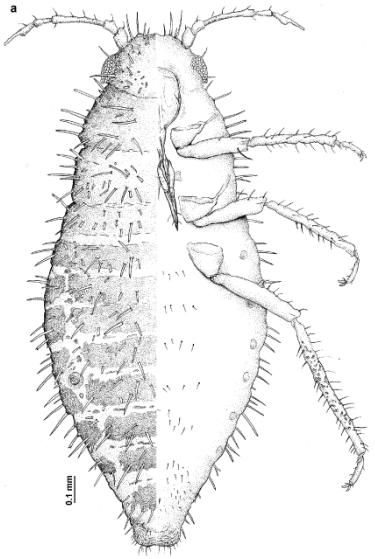
Reproduction

APHIDS – SEXUAL DIMORPHISM AND MATING SYSTEM

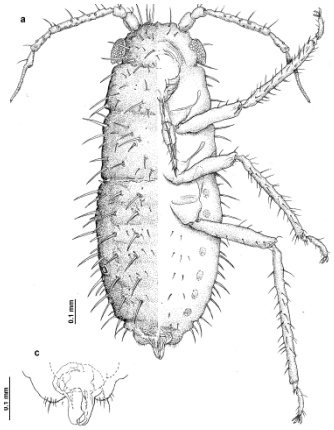


Stomaphis quercus





Chaetosiphella stipae

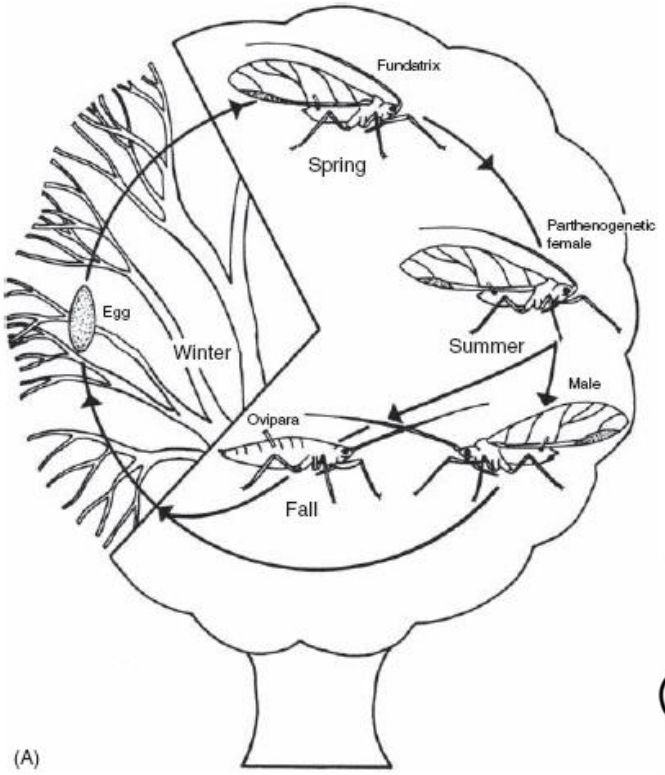


Chaitophorus populialbae

APHIDS – LIFE CYCLE

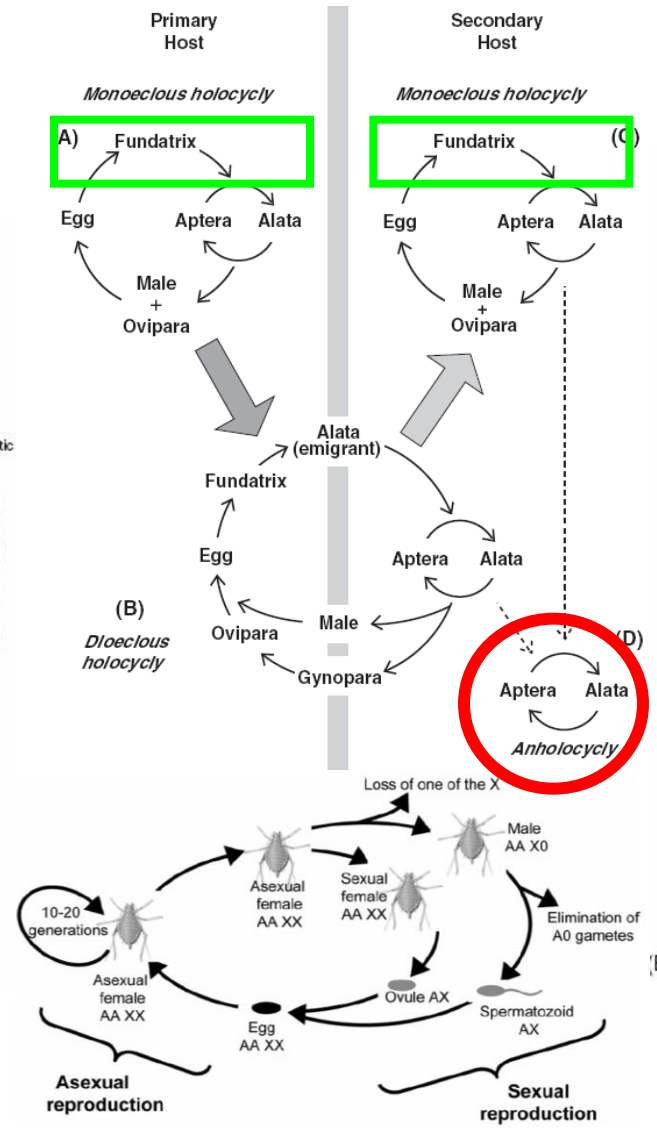
Holocycly

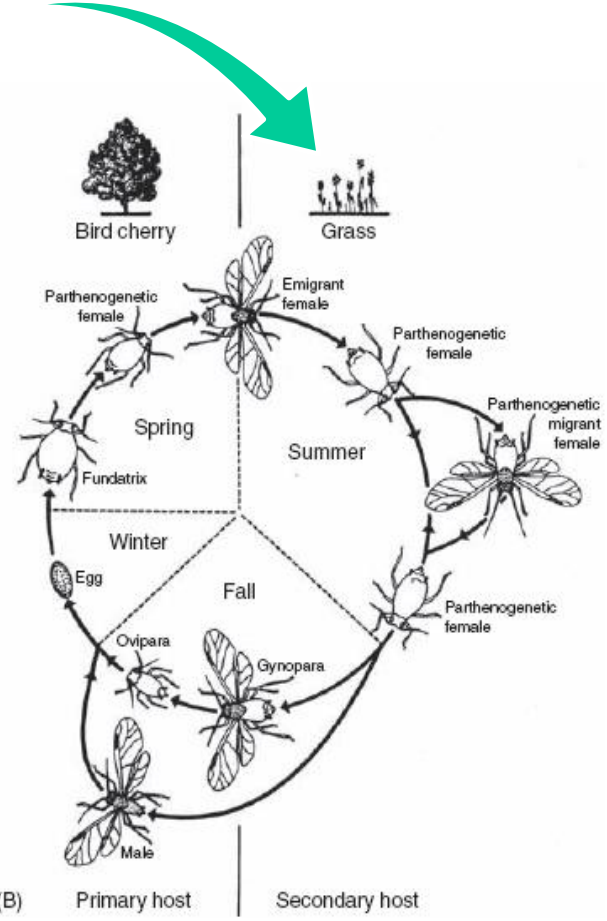
Monoecious



Rys. Blackman & Eastop 1994

Dioecious



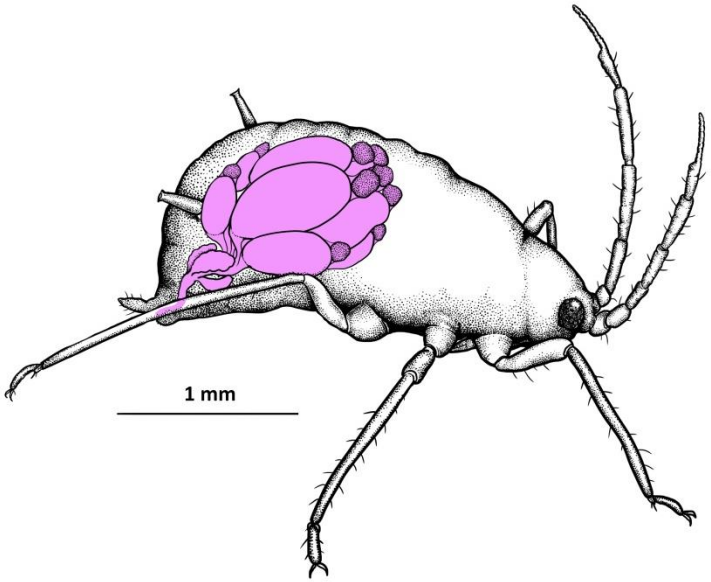


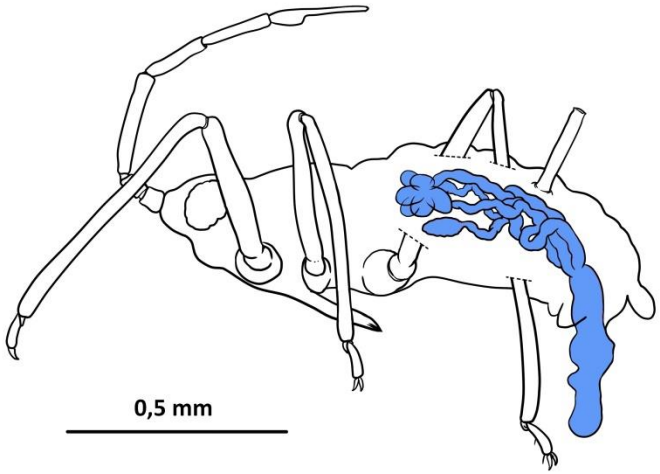
Rys. Blackman & Eastop 1994

FIG. 1. Annual life cycle of the pea aphid and ploidy levels for autosomes (A) and sexual chromosome (X). Overwintering eggs, diploid for both types of chromosomes (AA and XX), give birth to an asexual female. After 10–20 generations of apomictic parthenogenesis, asexual females produce (by parthenogenesis) sexual females and males. Males inherit the same autosomal genome as asexual females but receive only one of the female Xs: hence, they are diploid for the autosomes and haploid for the X (represented as AAX0). Ovules (haploid for both the autosomes and the X) are generated by a normal meiosis, but males produce only X-bearing sperm (AX). The fusion of male and female gametes restores the diploid level at both the X and the autosomes and generates asexual females.

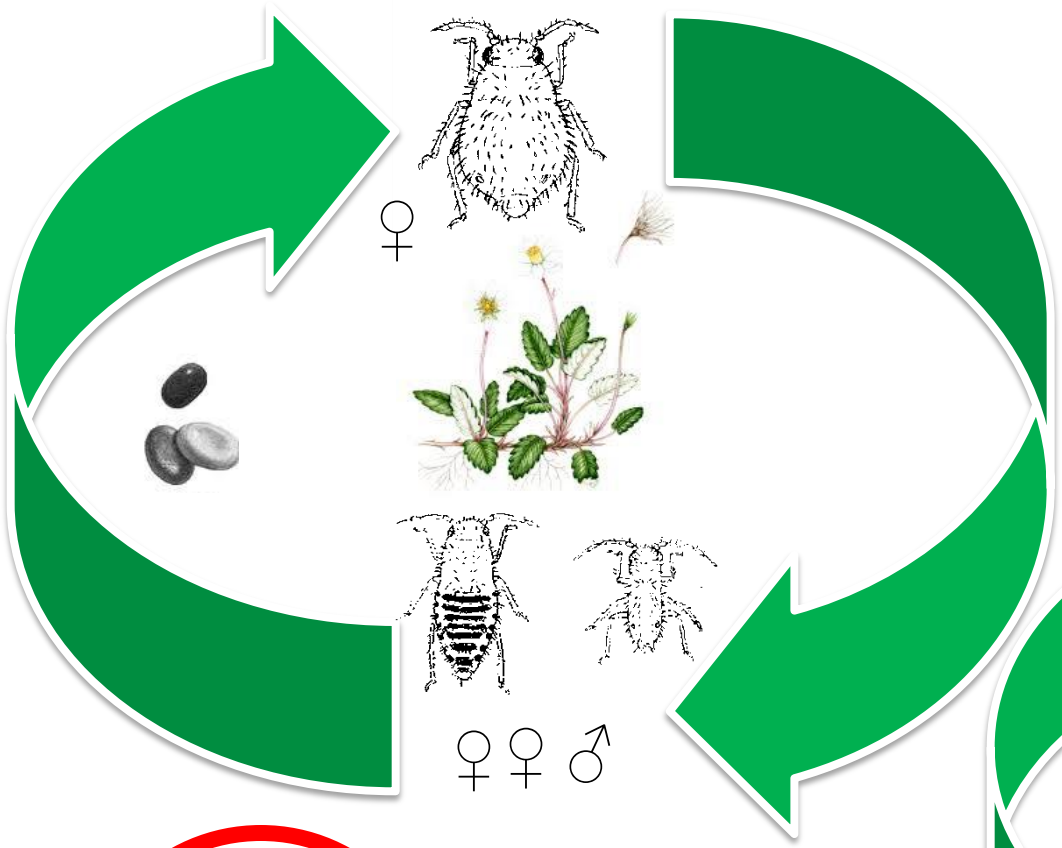
Rys. Jaquiéry et al. 2014

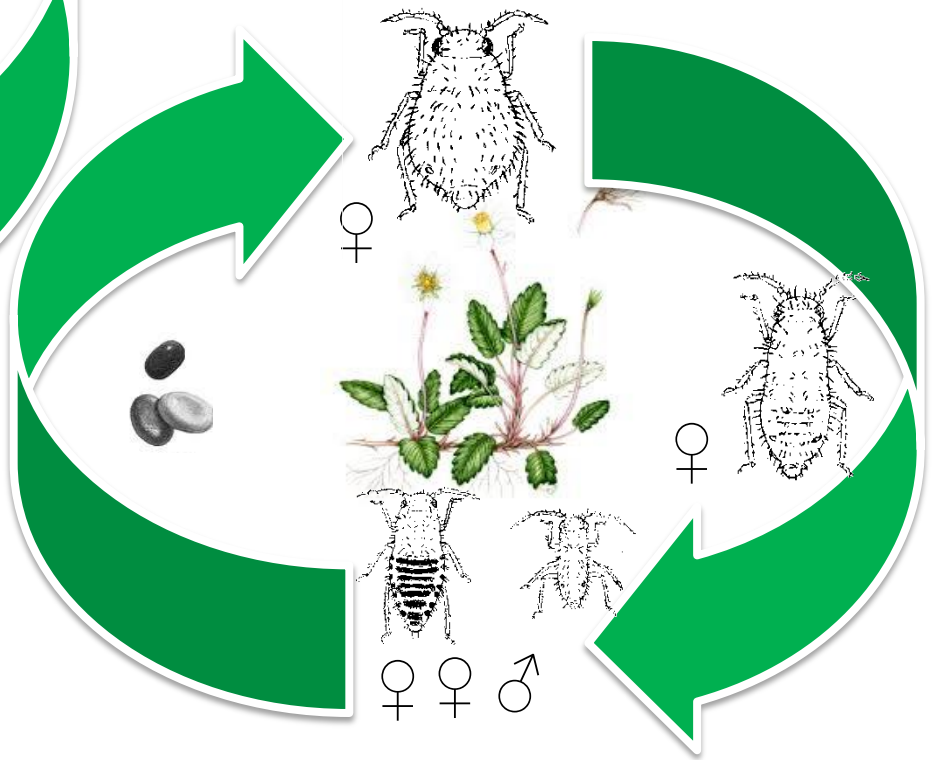
WHY THE LIFE CYCLE OF SVALBARD APHIDS IS SO AMAZING COMPARE TO THEIR TEMPERATE COUNTERPARTS?

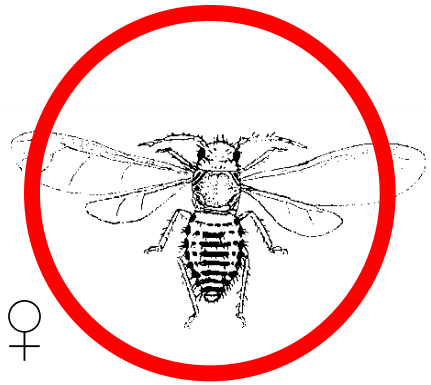




SVALBARD APHIDS – LIFE CYCLE



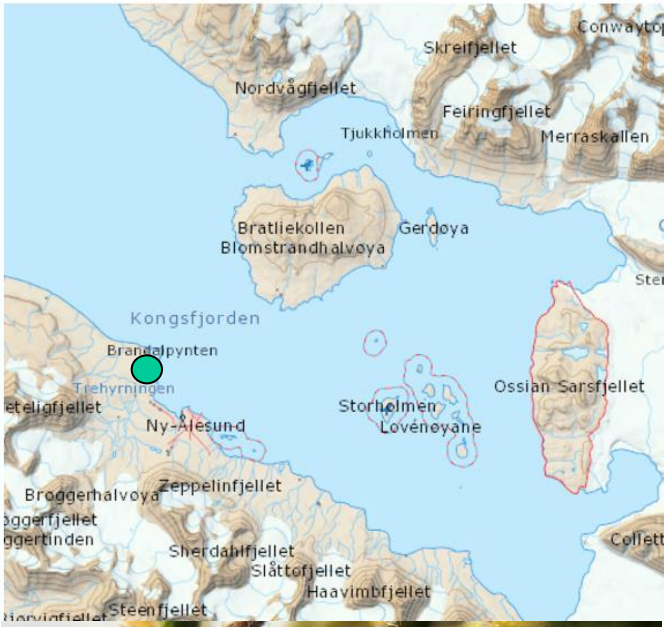


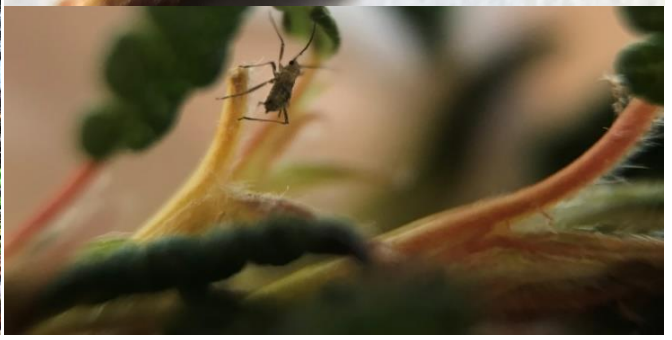


Ny-Alesund

June : *Dryas octopetala* flower bud occupied by the aphid *A. svalbardicum* Fot. S. Coulson

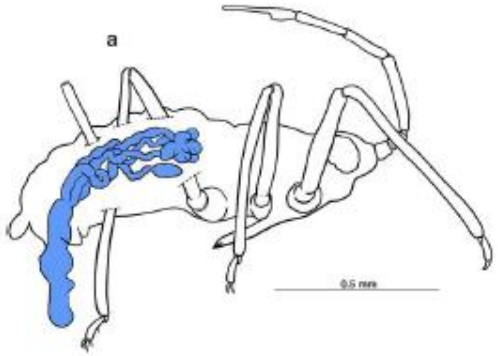
August: *Dryas octopetala*

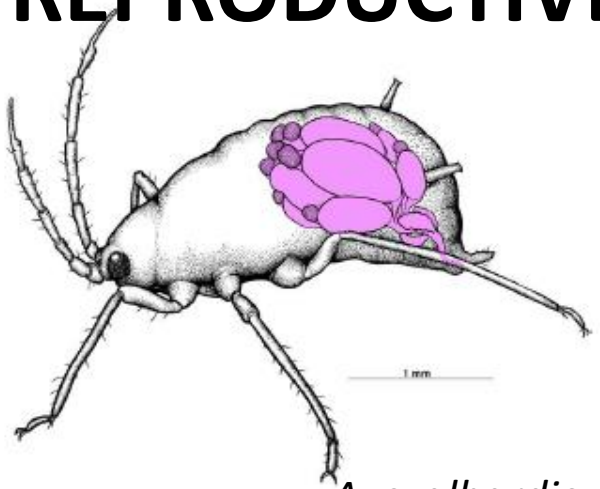




August: *A. svalbardicum* hidden in *Dryas octopetala* Wieczorek & Chłond 2019

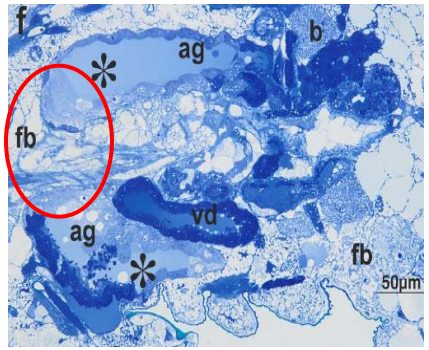
SVALBARD APHIDS – REPRODUCTIVE SYSTEM

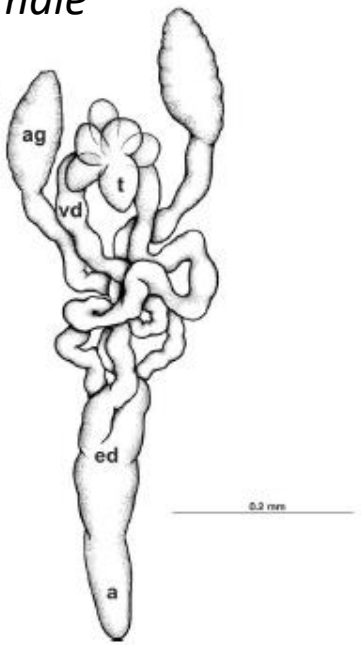


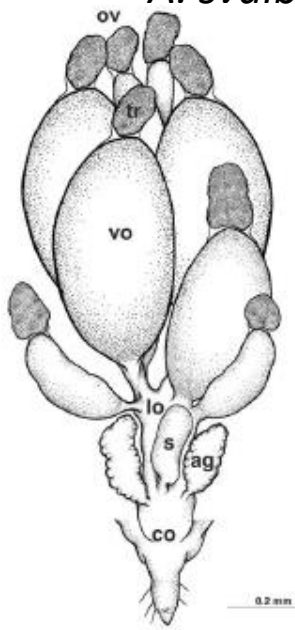


A. svalbardicum - male

A. svalbardicum – oviparous female







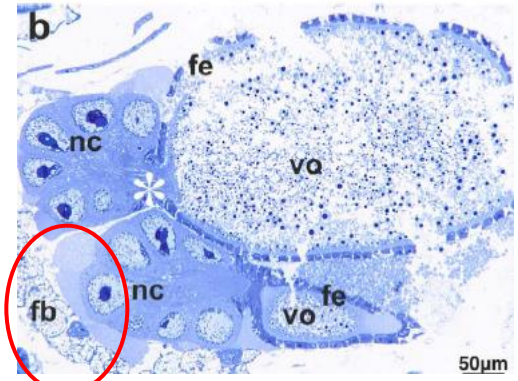
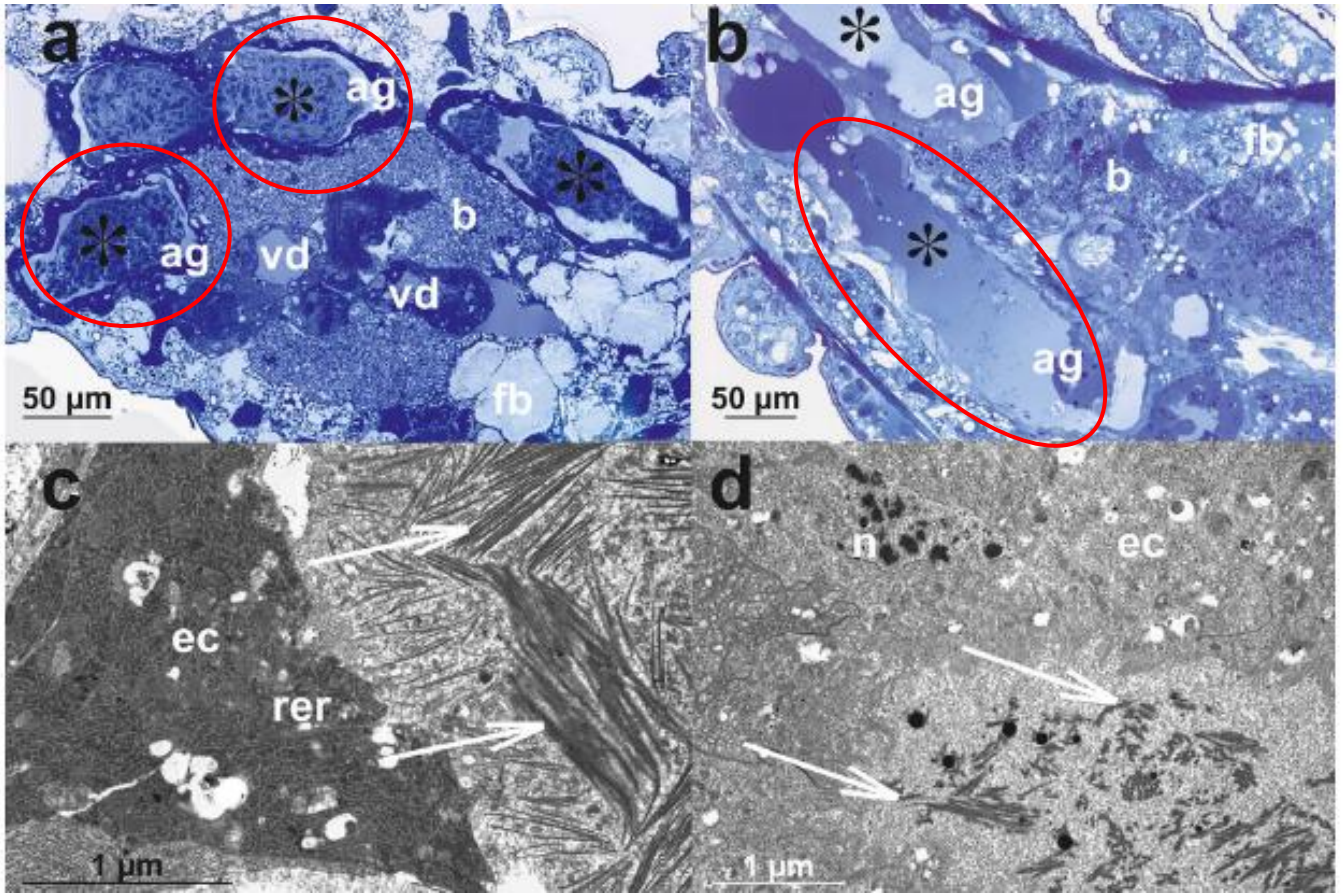


Figure 2. Schematic drawings presenting the localization (**a** and **c**) and morphology (**b** and **d**) of the reproductive system of male and oviparous female, respectively. ag, accessory glands; co, common oviduct; ed, ejaculatory duct; lo, lateral oviduct; ov, ovarioles; a, aedeagus; s, spermatheca; t, testes; tr, tropharia; vd, vasa deferentia; vo, vitellogenic oocyte.

SVALBARD APHIDS – REPRODUCTIVE SYSTEM

A. svalbardicum male

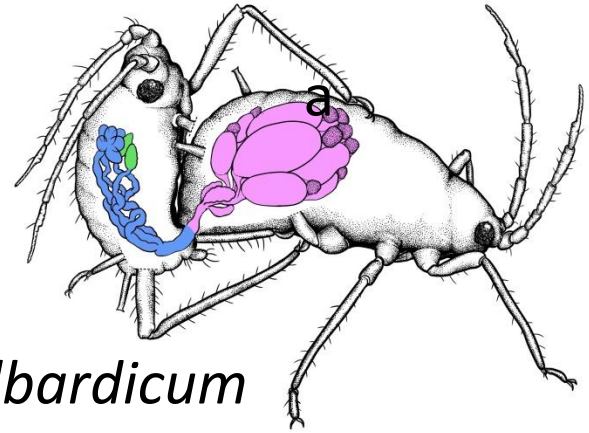


A. pisum male

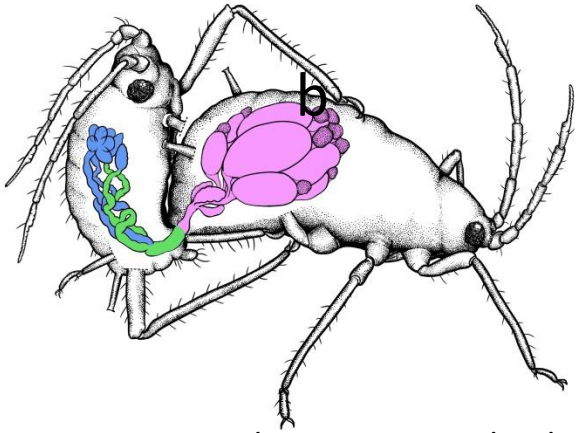
The comparison of selected histological and ultrastructural characters of male reproductive systems of *A. svalbardicum* (**a, c**) and *A. pisum (***b, d)**. Accessory glands of males before copulation with huge aggregations of secretion with *A. svalbardicum* glands (asterisks in **a**), whereas accessory glands of *A. pisum* (asterisks in **b**) contain liquid secretion differently stained with methylene blue. **C and d** Ultrastructural details of accessory glands in males before copulation. In *A. svalbardicum* accessory gland lumen, bunches of secretion in form of spicule-like inclusions embedded in granular material can be seen (arrows in **c**), whereas in *A. pisum*, the gland lumen is filled mainly with granular material in which some more electron-dense filaments are embedded (arrows in **d**).

K. Wieczorek et al., 2020, Vol. 103, No. 5

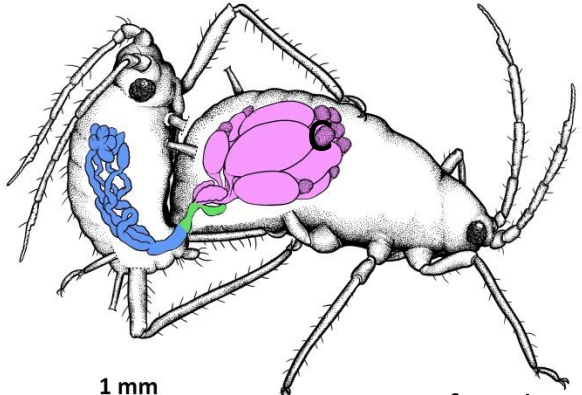
A. svalbardicum



Male – accessory glands before copulation

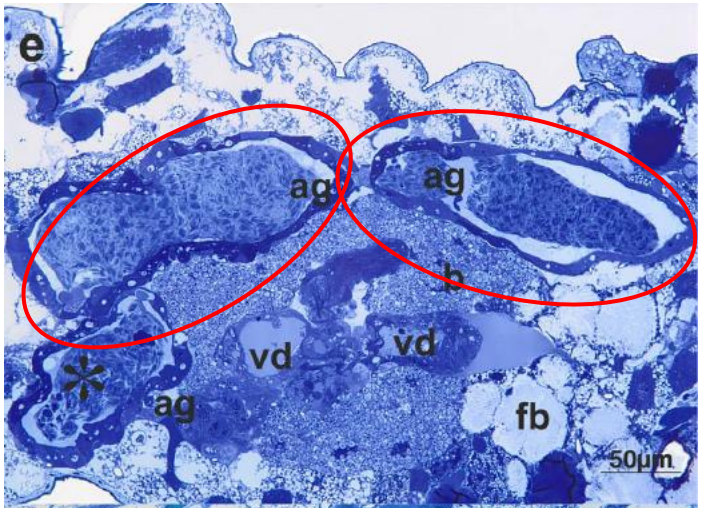


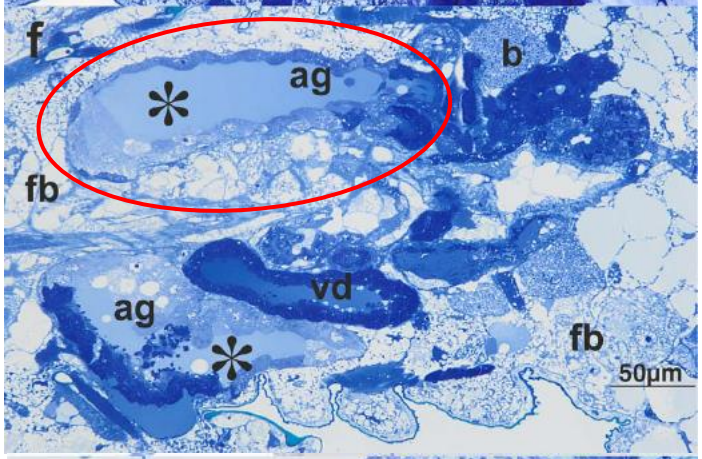
Male – accessory glands after copulation

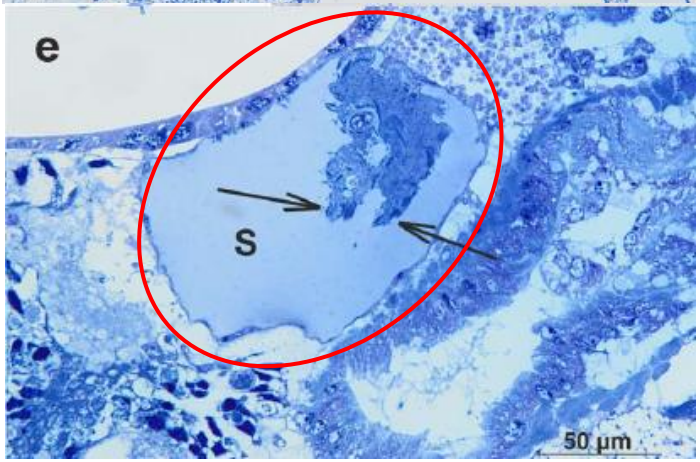


Oviparous female – spermatheca after copulation

Wieczorek et al. 2020







Dryas octopetala in late August

A. svalbardicum

CONCLUSIONS

- *A. svalbardicum* and *S. calvulum* occur in a few locations in Svalbard and is believed to be endemic. This makes them probably one of the rarest insects in the world

- *A. svalbardicum* could probably not establish populations beyond 79°12, which constitutes its northernmost limit, and at the same time the most north location for any aphid

- two (rarely three) generations in the life cycle, which obligatory is holocyclic

- fundatrix gives birth directly to sexual morphs

- the life-cycle is shown to be genetically determined and sexual forms are produced when 24 h photoperiod (in temperate aphids is controlled by photoperiod and shortened days)

- viviparous wingless or winged females, the dominant generation in temperate aphids, appear in a small number

- the flexibility of the life cycle - in favourable conditions viviparous generation respond rapidly and positively to increased summer temperature; thus this species may benefit from global warming

- in these conditions the additional generation of wingless viviparous females results in the extra sexual generation and a higher number of overwintering eggs

CONCLUSIONS

- overwintering eggs of *A. svalbardicum* are extremely cold tolerant, with a mean super-cooling point (SCP) of between −36.2◦C and −38.2◦C, dependent on acclimation temperature
- in sexual morphs an enormous layer of the fat body, adhering to the structures of the internal reproductive system is present
- the greatly enlarged accessory glands of male accumulate bunches of spicule-like structures of unknown role, transferred to the spermathecal of an oviparous female during mating
- sex ratios are induced by local mate competition and is strongly female biased
- the breeding period is about half the length (30–40 days, from late July to the end of August) compared with their temperate counterparts (60–70 days, from mid September to the end of November)

Therefore the Svalbard aphids really have to feed and breed quickly to survive!

The first detection of the alien species: green-peach aphid Myzus (Nectarosiphon) persicae *(Insecta, Hemiptera, Aphididae) in the Svalbard archipelago*

Karina Wieczorek & Dominik Chłond

Polar Biology
ISSN 0722-4060
Polar Biol
DOI 10.1007/s00300-019-02562-9

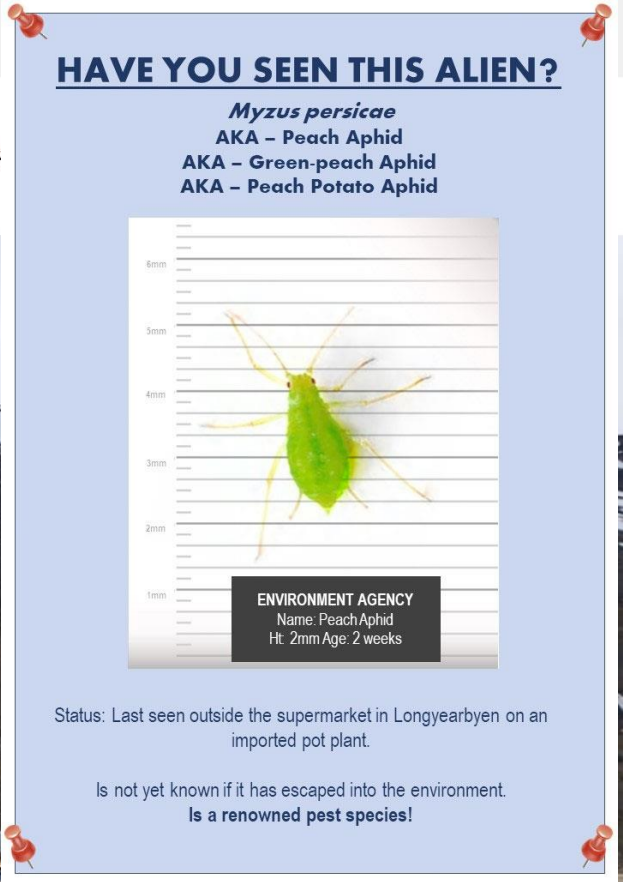
Springer

Myzus (*Nectarosiphon*) *persicae*

A survey of imported pot plants that were outside the only supermarket in Svalbard during summer 2018, when temperatures are above freezing, found the green-peach aphid *Myzus persicae* to be happily occupying three different ornamental plants. This aphid is a known pest species, with cold-tolerance physiology that may just allow it to colonise the area.
Whether or not it has managed to do so remains to be seen.

CONTRIBUTE Support Barents Observer

The Barents Observer



Fram Centre

Arctic Aliens: A rising threat

By **Fram Centre**

11

March 25, 2020

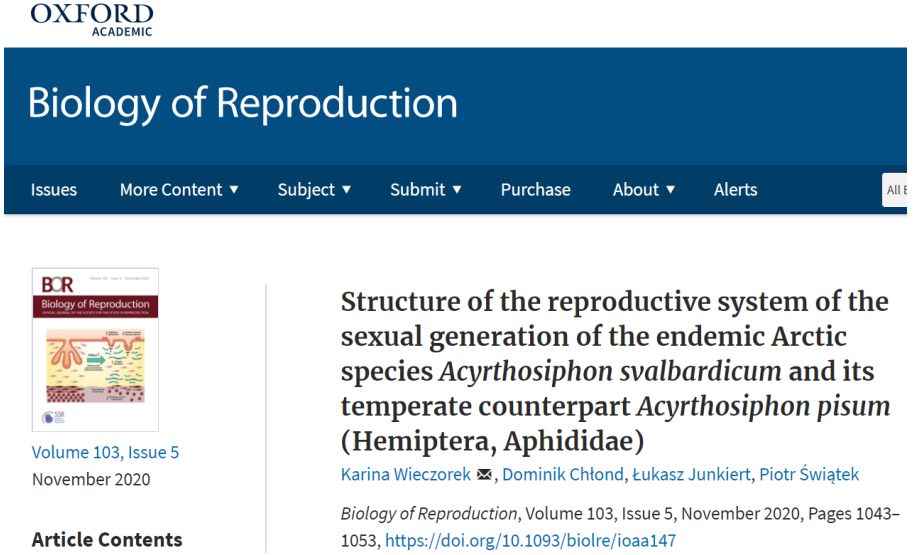
The Arctic is the fastest-warming region on Earth: ice is melting faster than ever, exposing land that is ripe for colonisation and occupation by both native and invading species. But it is not only flora and fauna that are traveling north: so are we. Homo sapiens, the greatest invader of them all.

Read in Russian | Читать по-русски

By: Jesamine Bartlett and Kristine Bakke Westergaard // Norwegian Institute for Nature Research, Trondheim

As climate change makes the harsh winters and cool summers of the Arctic increasingly favorable to any hitchhiking species, as the retreat of ice opens up more soils for colonisation, and as human activities fertilise the barren ground, ***we can no longer turn a blind eye to the issue of alien species in even the most inhospitable areas of our planet.***

Acknowledgements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Biology of Reproduction

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Article Contents

Structure of the reproductive system of the sexual generation of the endemic Arctic species *Acyrthosiphon svalbardicum* and its temperate counterpart *Acyrthosiphon pisum* (Hemiptera, Aphididae)

Karina Wieczorek, Dominik Chłond, Łukasz Junkiert, Piotr Świątek

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