

RESEARCH/REVIEW ARTICLE

High-Arctic gamasid mites (Acari, Mesostigmata): community composition on Spitsbergen, Svalbard

Dariusz J. Gwiazdowicz¹ & Stephen J. Coulson²
¹ Department of Forest Protection, University of Life Sciences, Wojska Polskiego 71c, PL-60625 Poznan, Poland

² University Centre in Svalbard, P.O. Box 156, NO-9171 Longyearbyen, Norway

Keywords

Mites; Acari; Mesostigmata; Arctoseius; Zercon; Spitsbergen.

Correspondence

Dariusz J. Gwiazdowicz, Department of Forest Protection, University of Life Sciences, Wojska Polskiego 71c, PL-60625 Poznan, Poland.
E-mail: dagwiazd@up.poznan.pl

Abstract

This study investigates assemblages of mesostigmatid mites on Spitsbergen, in the Arctic archipelago of Svalbard, Norway. Soil samples were collected from three areas with differing vegetational communities in Adventdalen. The greatest gamasid mite density and species diversity was observed at the location with the richest vegetation cover, *Dryas octopetala* heath, where 10 species were collected and there was a mean total gamasid mite density of 1000 individuals per m². The vegetation-poor saline meadow site revealed five species and had a mean total gamasid mite density of 130 individuals per m². The floristically more diverse *Luzula* tundra site yielded four species and had a density of 270 individuals per m². The most frequently found species were *Zercon forsslundi*, *Arctoseius haarlovi* and *A. weberi*. Results indicate that even in High-Arctic regions, where species diversity is less than at lower latitudes, there is specialization amongst the gamasid mite community depending on local environmental conditions. Apart from isolated checklists, only sporadic information concerning the ecology of High-Arctic gamasid mites is available. Many of the gamasid mites reported from Svalbard are relatively rare.

Mesostigmatid mites are predators forming the last link of the soil trophic chain. Because they may play an essential role in the functioning of soil mesofauna communities, this group of mites may be used as bioindicators of environmental changes (Karg & Freier 1995). Reflecting the low numbers of mesostigmatid mite specialists who have studied the fauna of Svalbard, research on the gamasid mite fauna of this High-Arctic archipelago has been limited (e.g., Thor 1930; Gwiazdowicz & Gulvik 2008; Gwiazdowicz & Coulson 2010). Twenty species of mites from the suborder Mesostigmata have been reported from Svalbard (Coulson & Refseth 2004; Coulson 2007; Gwiazdowicz & Gulvik 2008). Many of these are restricted to polar regions or are recorded only from Svalbard, e.g., *Amblyseius magnanalis*, *Antennoseius oudemansi* and *Proctolaelaps parvanalis* (Thor 1930; Gwiazdowicz & Rakowski 2009). Though it is recognized that in polar areas the acarofauna exhibit significant species diversity between plant communities (Haarløv 1942; Makarova 1999, 2002), factors having an impact

on the species diversity of these animals and their microhabitat selectivity in Svalbard have not been assessed.

This study presents results of research aimed at discovering variability in groupings of High-Arctic mesostigmatid mites at three locations on the island of Spitsbergen, in Svalbard Norway. The locations were within 2 km of one another but had greatly differing vegetation types.

Methods

Three undisturbed botanical communities in the vicinity of Longyearbyen, Spitsbergen, were selected. These sites lay on a transect ranging approximately 2 km from the banks of the Advent river into the Endalen valley and encompassing three distinct vegetation types: *Dryas octopetala* heath, *Luzula* tundra and *Puccinellia phryganodes* saline meadow. The sites have all been free from permanent ice cover for a significant period and it is

not believed that the three sites form a chronosequence, although the saline meadow site may be subject to disturbance as the river meanders. Hence, variations in mite communities are unlikely to be due to differences in stochastic colonization processes but rather the result of current physical characteristics.

***Dryas octopetala* heath site**

The *Dryas octopetala* heath site was located in the vicinity of the International Tundra Experiment site (78° 11' 13.3 N, 15° 45' 50.8 E) on the valley slope in Endalen. Vegetation cover was complete at this site, with deep organic soils up to 7 cm thick and early snow clearance (mid- to late May). The vegetation community was dominated by *D. octopetala* and *Cassiope tetragona* (Brattbakk 1984), with *Salix polaris*, *Saxifraga oppositifolia*, *Bistorta vivipara* and *Carex rupestris* also occurring in high frequency (Dollery et al. 2004).

***Luzula* tundra site**

The *Luzula* tundra site was a level area on the north side of the Endalen track (78° 11' 33.8 N, 15° 47' 33.3 E) at a place called Dammyra. *Luzula confusa* dominated the plant community. Vegetation cover was complete. Snow cover at the site has a maximum depth of ca. 50 cm and extends into late spring (early to mid-June).

Saline meadow site

This *Salix polaris*–*Polytrichum hyperboreum*-dominated (Brattbakk 1984) site, with *Puccinellia phryganodes* on mud flats along the river delta, was located on the silty saline soils near the Advent river, close to the old northern lights research station (Nordlysstasjon) (78° 12' 10.6 N, 15° 49' 46.8 E) in Adventdalen. Vegetation cover was incomplete. The site was well drained in the upper areas through loose gravel soils with only thin organic soil, whereas in the *P. phryganodes* delta the soil was damp gravel and silt. Maximum snow cover at the site is less than 50 cm. Snow clearance begins in early June.

Data collection

Summer soil temperatures were recorded between June and September 2010 using TGP-4020 Tinytag Data Loggers (Gemini, Chichester, West Sussex, UK) fitted with external thermister probes (PB-5009, Tinytag). Temperatures were measured in the surface layers of the organic soil at a depth of approximately 5 mm. Care

was taken to avoid direct sunlight impinging on the thermistor.

To conform to the requirements of the Svalbard Environmental Protection Act of 2001, which aims to minimize damage to sensitive tundra, sampling was restricted to 10 samples from each location. Each sample consisted of a block of soil turf 10 cm in length and 10 cm in width and extending in depth to the bottom of the organic soil, which ranged between 2 and 4 cm deep. The samples were collected on 30 June 2009. The soil samples were placed in Tullgren funnels at the University Centre in Svalbard (UNIS) and extracted for 72 hours until fully dry. The microarthropod fauna was extracted into and stored in 96% alcohol. After sorting, slides of the mesostigmatic mites were prepared using Hoyer's solution. The slide material is deposited at UNIS, in Longyearbyen, Svalbard.

Statistics

Differences in densities between sites were analysed using SigmaPlot (Release 11, Systat Software Inc.). Total densities of mites were assessed with one-way ANOVA tests with pairwise multiple comparisons using the Holm-Sidak method. Individual species comparisons were performed using Kruskal-Wallis, ANOVA, Mann-Whitney or Student's *T*-test, as appropriate. The similarity relationships between the species composition of the mesostigmatid fauna in the study sites is demonstrated by a cluster analysis of the Sorensen similarity index (So). The index was calculated as follows: $So = (A + B) / (2C \times 100)$, where A is the total number of species in site A, B is the total number of species in site B and C is the total number of species that occur in both sites.

Results

Soil temperatures

Soil temperatures were broadly similar at all sites. Daily mean temperatures peaked during late June and early July at almost 12 °C. Soil temperatures were generally several degrees higher than air temperature until mid-August, when air temperatures were sporadically higher than soil temperatures. Mean soil temperatures at the three sites during July were between 8.5 and 9 °C while air temperature during this period averaged 6.6 °C.

***D. octopetala* heath**

In total, 10 species and 100 specimens were collected at this site (Table 1). The dominant species—that is, the

Table 1 The mesostigmatid mites encountered in soil samples from the three vegetation communities examined in this study. Dominance refers to the proportion of total mite individuals comprised of each species. Frequency refers to the proportion of samples containing each species.

Species	Distribution	Dryas heath			Luzula tundra			Saline meadow		
		Number of specimens	Dominance (%)	Frequency (%)	Number of specimens	Dominance (%)	Frequency (%)	Number of specimens	Dominance (%)	Frequency (%)
<i>Amblyseius magnanalis</i> (Thor 1930)	Spitsbergen	1	1.00	10.00						
<i>Antennoseius oudemansi</i> (Thor 1930)	Spitsbergen	3	3.00	20.00	5	18.52	30.00			
<i>Arctoseius haarlovi</i> Lindquist 1963	NE Greenland, Spitsbergen, Novaya Zemlya, Wrangel Island	13	13.00	60.00	11	40.74	50.00	2	15.38	20.00
<i>Arctoseius multidentatus</i> Evans 1955	Alaska (Barrow), Svalbard, Novaya Zemlya, Severnaya Zemlya, Wrangel Island	5	5.00	20.00				2	15.38	20.00
<i>Arctoseius tschernovi</i> Makarova 2000	Franz Josef Land, Severnaya Zemlya, N coast Taimyr Peninsula, Wrangel Island Svalbard	1	1.00	10.00						
<i>Arctoseius weberi</i> Evans 1955	Alaska (Barrow), Spitsbergen, Novaya Zemlya, Severnaya Zemlya, Novosibirskiye Islands, Wrangel Islands	10	10.00	60.00	4	14.81	30.00	5	38.46	40.00
<i>Haemogamasus ambulans</i> (Thorel 1872)	Greenland, N Canada, N Russia, Alaska, Spitsbergen	2	2.00	10.00						
<i>Proctolaelaps parvanalis</i> (Thor 1930)	Spitsbergen	4	4.00	30.00	7	25.93	20.00			
<i>Zercon forsslundi</i> Sellnick 1958	Northern mainland Europe, Latvia, Lithuania, Svalbard	53	53.00	70.00				3	23.08	10.00
<i>Zercon solenites</i> Haarløv 1942	Greenland, Svalbard	8	8.00	30.00				1	7.69	10.00
Total number of species		10			4			5		
Total individuals		100			27			13		

species with the most number of individuals—was *Zercon forsslundi* (dominance = 53%), followed by *A. haarlovi* (13%) and *A. weberi* (10%). *Z. forsslundi* was present in 70% of samples, while *A. haarlovi* and *A. weberi* were each present in 60% of samples. There were more females (59% of individuals) than males (27%), deutonymphs (13%) and protonymphs (1%). Only *Z. forsslundi* was represented by almost all developmental stages: females (29 specimens), males (12), deutonymphs (11) and one protonymph.

Luzula tundra

Gamasid mites were found in 9 of the 10 samples from the *Luzula* tundra site. Six samples contained only one species. In the nine samples containing gamasid mites, there were between one and seven specimens per sample, yielding densities ranging from 100 to 700 specimens per 1 m² and a density of 270 individuals per m² as the average for all nine samples.

In total, four species and 27 specimens were found (Table 1). Fifty percent of samples contained *A. haarlovi*, 30% contained *Antennoseius oudemansi* and 30% contained *A. weberi*. Over 40% of individuals found in samples from this site were *A. haarlovi*, while *Proctolaelaps parvanalis* comprised nearly 26% of specimens found. There were 20 females and 7 males in the collected material. Nymphal stages were not detected. The lack of *Z. forsslundi* is notable given the dominance of this species in the *Dryas* heath samples and its occurrence in samples from the saline meadow location.

Saline meadow

There were gamasid mites in just 5 of the 10 samples taken from the saline meadow. In samples containing gamasid mites, between one to five individuals were found, equating to densities of 100 to 500 individuals per m² and 130 m² on average.

Five species and 13 specimens were detected in the samples from this site (Table 1). *A. weberi* comprised 38.46% of individuals collected at this site and was found in 40% of the samples. Eleven females and two males were collected.

Gamasid mite communities

Applying an ANOVA, numbers of mites sampled varied significantly between sites ($p = 0.032$, $F = 3.917$, 2 *df*). Post hoc testing using Student's *T*-test indicated that the

Dryas heath site had significantly greater densities of mites compared to the saline meadow site ($t = 2.606$, $p = 0.017$) but other comparisons were non-significant.

Alpha diversity varied between the sampling sites. Ten species of gamasid mite were found in samples from the *Dryas* heath site (Table 1). Of these 10, only 2—*Arctoseius haarlovi* and *A. weberi*—were also found at both the saline meadow site and the *Luzula* tundra site (Table 1). Perhaps surprisingly, the saline meadow had a greater number of species (five species) than the more floristically diverse *Luzula* tundra (four species).

Applying a Mann–Whitney *U*-test, there was no significant difference in densities of these species between sites ($p > 0.05$), with the single exception of *Zercon forsslundi*, which was found in samples from the *Dryas* heath site but was absent in samples from the *Luzula* tundra site ($U = 21.0$, $p = 0.015$). *Zercon forsslundi* was the species with the greatest number of individuals collected (56), comprising 40% of all individuals collected and accounting for the significantly greater total densities of gamasid mites observed at the *Dryas* heath location.

Cluster analysis (Fig. 1) indicates that the *Dryas* heath and saline meadow were the most similar in terms of

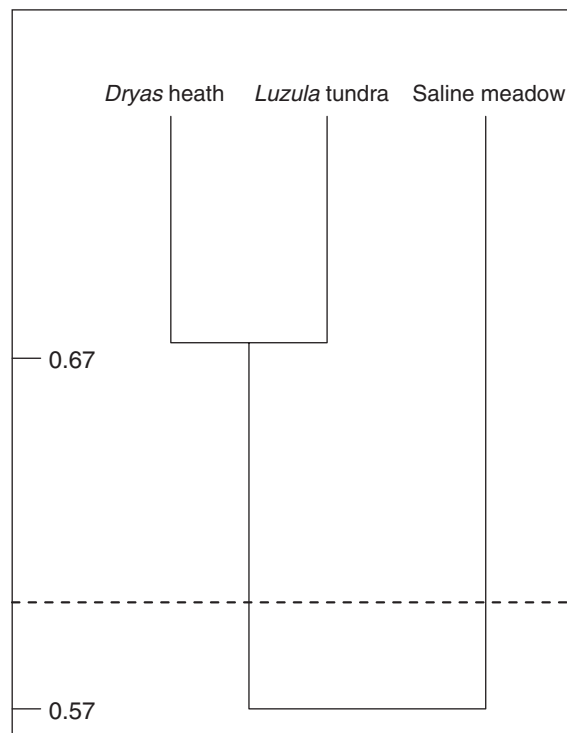


Fig. 1 Cluster analysis (Sorensen's index of similarity) of mesostigmatid mites collected in the research area.

species diversity, with the *Luzula* tundra site forming an outlier. The similarity in terms of species diversity between the *Dryas* heath and *Luzula* tundra was 0.57%, 0.67% between *Dryas* heath and saline meadow and 0.44% between *Luzula* tundra and saline meadow.

Discussion

Of the 10 species of gamasid mites collected during this study, three (*A. magnanalis*, *A. oudemansi* and *P. parvanalis*) have been reported exclusively on Spitsbergen (Thor 1930). However, it is difficult to say whether these are endemic species. Arctacarids in general appear to have a circumberingian distribution and their occurrence at high latitudes, with the logistical difficulties these regions impose, means that they have been seldom collected (Krantz & Walter 2009). The other seven species have been reported from many northern lands including Greenland, Franz Josef Land, Novaya Zemlya, Severnaya Zemlya, the Novosibirskiye Islands and Wrangel Island and we are preparing a publication documenting the collection of these—and other species of gamasid mites—from other islands of the Svalbard Archipelago. Some of these species have also been reported in northern Russia (e.g., northern coast of the Taimyr Peninsula), northern Canada and Alaska. However, two species are found at more southerly latitudes: *Z. forsslundi* from Latvia and Lithuania (Petrova 1977) and *H. ambulans* from central Europe (Mašán & Fenda 2010).

The mite communities featured distinct variability. Nonetheless, similarities between the acarofauna in the three sampled habitat types were relatively high, as a result of the low number of species. It should, however, be appreciated that many of the mites collected from the *Dryas* heath site were present at low densities: three species were represented by only one or two individuals. Given the potentially lower densities at the saline meadow and *Luzula* tundra sites, the apparent absence of some species may be due to lack of sufficient sampling effort rather than a genuine absence.

The relative sparsity of the mite fauna at the *Luzula* tundra site was unexpected, going against the expectation that richer vegetation cover would be associated with greater density of individual mites and a larger number of species. The *Luzula* tundra site had complete vegetation cover and high botanical diversity, yet only four species were detected in samples from this site, whereas five were observed at the saline meadow site. Low sampling replication or some unmeasured physical characteristic of the *Luzula* tundra site may account for this unexpected result. Although this site is in a snow-lie

area with a late snowmelt (early to mid-June) and generally cool, moist conditions until mid-summer, after snowmelt the temperatures at all sites were similar even though the *Dryas* heath site displayed slightly greater temperature fluctuations as well as the highest temperatures. The summer in Svalbard begins at the onset of the thaw of the upper soil surface layers, usually in late May to mid-June. Soil surface can be expected to refreeze in mid-September, making the summer season a short period of some 12 weeks (Coulson et al. 1995). It seems unlikely that the differences in the gamasid mite communities between the sites were due to temperature differences at these locations. It is clear that there is potential bias in the data arising from sampling on just one date. As has been demonstrated previously in the High Arctic, densities of mites can vary dramatically throughout the summer season (Coulson et al. 1996; Høye & Forchhammer 2008). Normal demographic processes will also be exacerbated by differences in timing of snow clearance between the sites. With sampling at only one point, our data represent a snapshot of the demographic situation early in the summer. Sampling on additional dates would probably have revealed fluctuating population densities. Moreover, it is not possible to exclude the possibility that additional species of gamasid mite would have been identified.

While the saline meadow had a greater species diversity than at *Luzula* tundra, this latter site did possess a greater density of mites, with 27 individuals being collected there compared to 13 at the saline meadow. The diet of these gamasid mites is not well known but it is generally considered that they are predators of other invertebrates. There is a strong relationship between botanical diversity and the densities of Collembola and oribatid mite in Svalbard (Coulson et al. 1996; Coulson et al. 2003; Hodkinson et al. 2004) and the likely greater prey density in the *Luzula* tundra may explain the greater individual mite density here than at the saline meadow. The *Dryas* heath site, situated on the slopes of Endalen valley, is well drained with relatively deep organic soil with a diverse soil fauna (Dollery et al. 2004) and, hence, suitable to a varied predatory gamasid mite community.

Unfortunately, our knowledge about their diet and ways of obtaining food is poor. For instance, the diet of free-living mites of the genus *Arctoseius*, which is numerous in Svalbard, remains unknown. Lindquist (1961) considers that they are predators of small arthropods. These conclusions have been confirmed in part by laboratory research. It has been observed that mites of the genus *Arctoseius* are predators, e.g., on sciarid eggs and first instar larvae (Binns 1972, 1974; Rudzińska 1998).

Haemogamasus ambulans is an ectoparasite associated with such small mammals as *Microtus* spp. and lemmings (*Lemmus lemmus*) as well as birds (Bregetova 1956; Makarova 1999; Mašán & Fenda 2010).

In summary, soil samples taken from three distinct plant communities along a 2-km transect revealed gamasid mite communities that differed from one another also showed strong similarities. These results demonstrate that even in the High Arctic, with a reduced species diversity compared to lower latitudes, there is specialization amongst the gamasid mite community depending on local environmental conditions. A more detailed investigation into the ecology and role of these mites in Arctic regions is required. This is especially important considering that many species are Arctic specialists and do not occur in ecosystems for which more detailed information is available.

Acknowledgements

The authors thank European Union's Erasmus Exchange programme, UNIS, the University of Bergen and Dr Torstein Solhøy for financial support to DJG.

References

- Binns E.S. 1972. *Arctoseius cetratus* (Sellnick) (Acarina: Ascidae) phoretic on mushroom sciarid flies. *Acarologia* 14, 350–356.
- Binns E.S. 1974. Notes on the biology of *Arctoseius cetratus* (Sellnick) (Mesostigmata: Ascidae). *Acarologia* 16, 577–582.
- Brattbakk I. 1984. *Vegetasjonskart Adventdalen, Svalbard 1:50,000. (Vegetation map of Adventdalen, Svalbard 1:50,000.)* Trondheim: Royal Norwegian Scientific Society, Botanical Department, Museum.
- Bregetova N.G. 1956. *Gamasovyie klešči (Gamasoidea). Kratkij opredelitel'. Gamasid mites [Gamasoidea]. A short key.* Moscow: Izdatel'stvo Akademii Nauk.
- Coulson S.J. 2007. The terrestrial and freshwater invertebrate fauna of the High Arctic Archipelago of Svalbard. *Zootaxa* 1448, 41–58.
- Coulson S.J., Hodkinson I.D., Strathdee A.T., Block W., Webb N.R., Bale J.S. & Worland M.R. 1995. Thermal environments of Arctic soil organisms during winter. *Arctic Antarctic and Alpine Research* 27, 364–370.
- Coulson S.J., Hodkinson I.D. & Webb N.R. 2003. Microscale distribution patterns in High Arctic microarthropod communities: the influence of plant species within the vegetation mosaic. *Ecography* 26, 801–809.
- Coulson J.J., Hodkinson I.D., Webb N.R., Block W., Bale J.S., Strathdee A.T., Worland M.R. & Wooley C. 1996. Effects of experimental temperature elevation on High-Arctic soil microarthropods. *Polar Biology* 16, 147–153.
- Coulson S.J. & Refseth D. 2004. The terrestrial and freshwater invertebrate fauna of Svalbard and Jan Mayen. In P. Prestrud et al (eds.): *A catalogue of the terrestrial and marine animals of Svalbard. Skrifter* 201. Pp. 57–122. Tromsø: Norwegian Polar Institute.
- Dollery R., Hodkinson I.D. & Jónsdóttir I.S. 2004. Impact of warming and timing of snow melt on soil microarthropod assemblages associated with *Dryas*-dominated plant communities on Svalbard. *Ecography* 29, 111–119.
- Gwiazdowicz D.J. & Coulson S.J. 2010. First record of *Thinoseius spinosus* (Acari, Eviphididae) from the High Arctic island of Spitsbergen (Svalbard) including a key to deutonymphs of genus *Thinoseius*. *International Journal of Acarology* 36, 233–236.
- Gwiazdowicz D.J. & Gulvik M.E. 2008. Mesostigmatid mites (Acari, Mesostigmata) in Svalbard. Paper presented at the 32nd International Polar Symposium. 23–24 May, Wrocław, Poland.
- Gwiazdowicz D.J. & Rakowski R. 2009. Redescription of *Proctolaelaps parvanalis* (Thor, 1930) (Acari: Ascidae) from Spitsbergen. *Entomologica Fennica* 20, 281–286.
- Haarløv N. 1942. *A morphologic-systematic-ecological investigation of Acarina and other representatives of the microfauna of the soil around Mørkefjord, northeast Greenland. Meddelelser om Grønland* 128. Copenhagen: C.A. Reitzel.
- Hodkinson I.D., Coulson S.J. & Webb N.R. 2004. Invertebrate community assembly along proglacial chronosequences in the High Arctic. *Journal of Animal Ecology* 73, 556–568.
- Høye T.T. & Forchhammer M.C. 2008. Phenology of High Arctic arthropods: effects of climate on spatial, seasonal and inter-annual variation. *Advances in Ecological Research* 40, 299–324.
- Karg W. & Freier B. 1995. *Parasitiforme Milben als Indikatoren für den ökologischen Zustand von Ökosystemen. (Parasitiformes mites as ecological factors of state of ecosystems.)* Berlin: Federal Biological Research Centre for Agriculture and Forestry.
- Krantz G.W. & Walter D.E. 2009. *A manual of acarology.* Lubbock, TX: Tech University Press.
- Lindquist E.E. 1961. Taxonomic and biological studies of mites of the genus *Arctoseius* Thor from Barrow, Alaska (Acarina: Aceosejidae). *Hilgardia* 30, 301–350.
- Makarova O.L. 1999. Mezostigmatičeskie klešči (Parasitiformes, Mesostigmata) poljarnyh pustyn Severnoj Zemli. (Mesostigmatic mites [Parasitiformes, Mesostigmata] of polar deserts in Severnaya Zemlya.) *Zoologičeskij Žurnal* 78, 1059–1067.
- Makarova O.L. 2002. Akarocenozy (Acariformes, Parasitiformes) poljarnyh pustyn. 1. Soobščestvo kleščej Severnoj Zemli. Struktura fauny i čislennost'. (Acarocenoses [Acariformes, Parasitiformes] in polar deserts: 1. Mite assemblages of the Severnaya Zemlya Archipelago: structure of fauna and abundance.) *Zoologičeskij Žurnal* 81, 165–181.
- Mašán P. & Fenda P. 2010. A review of the laelapid mites associated with terrestrial mammals in Slovakia, with a key to the European species (Acari: Mesostigmata):

- Dermanyssoidea). Bratislava: Institute of Zoology, Slovak Academy of Sciences.
- Petrova A.D. 1977. Family Zerconidae Canestrini, 1891. In M.S. Giljarov & N.G. Bregetova (eds.): *Opređitel' obitajuščih v počve kleščej (Mesostigmata). (Key to mites living in soil [Mesostigmata].)* Pp. 577–621. Leningrad: Nauka.
- Rudzińska M. 1998. Life history of the phoretic predatory mite *Arctoseius semiscissus* (Acari: Ascidae) on a diet of sciariid fly eggs. *Experimental and Applied Acarology* 22, 643–648.
- Thor S. 1930. *Beiträge zur Kenntnis der invertebraten Fauna von Svalbard. (Introduction to knowledge of the invertebrate fauna of Svalbard.) Skrifter om Svalbard og Ishavet* 27. Oslo: Norway's Svalbard and Arctic Ocean Research Survey (Norwegian Polar Institute).