[SHORT COMMUNICATION]

Summer Occurrence of *Tyrophagus similis* Volgin (Acari, Acaridae) in Hayfields in Northern Iceland May Include a Facultative Deutonymph

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INTRODUCTION

During a study of the field biology of the plant parasitic mite *Penthaleus major* in Iceland (Hallas and Gudleifsson, 2004), the astigmatid mite *Tyrophagus similis* was observed where it made up 13.9% of the mites captured. We took therefore the opportunity to study its occurrence and development in the same format as used for *Penthaleus*, to get information on its life cycle in the subarctic environment during the snow free period.

Tyrophagus similis Volgin 1948 is a cosmopolite species frequently reported from grassland, in soil or on plants, and it is regarded as a pest in greenhouses on spinach, lettuces and other crops (Nakao, 1989, 1991). *T. similis* is also known from Iceland (Hallas, 1981; Hallas and Gudleifsson, 2004; Hughes, 1961, 1976; Lindroth et al., 1973). Some authors (Bruehl, 1940; Hughes, 1961) have used the synonym *T. dimidiatus* Herm. *T. similis* is able to reproduce on a wide range of foods (Kasuga and Honda, 2006) but is probably primarily a fungal browser and its enzyme spectrum includes trehalase which is designed to digest trehalose in fungi, but being without chitinase and cellulase (Behan-Pelletier, 1999; Siepel and de Ruiter-Dijkman, 1993).

The biology of *T. similis* is known from laboratory cultures (Al-Safadi, 1987, 1990, 1991; Kasuga and Amano, 2000). It comprises egg, larva, protonymph, tritonymph and adult. No deutonymph has been observed and the male:female ratio has been 1:1. There seems to be no published reports of stage progression in the open nature for this species. Therefore we aim in this paper to show the phenology and biology of *T. similis* in one of its natural habitats, grass fields in the subarctic environment.

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MATERIALS AND METHODS

Pitfall traps were used to provide an indirect measure of the abundance of invertebrates in hayfields in northern Iceland. Traps were placed in the center of 21 field plots in 10 farms in Horgardalur and Svarfadardalur, Eyjafjordur, northern Iceland. In 1996 traps were placed in center of 3 hayfields in Modruvellir, in 1997 in two hayfields at Ingvarir, Tvera, Hofsa, Stori-Dunhagi, Brakandi and Barka and in 1998 in two hayfields at Sakka, Brautarholl and Atlastadir (Fig. 1). Traps consisted of 200 ml plastic beakers containing about 25 ml of water with one drop of detergent. Beakers were dug into the soil and placed with the edge at the level of the soil surface. Traps were emptied at 2 to 7 day intervals and samples were stored in 70% ethanol for later sorting and identification of invertebrates. Mites were counted on Petri dishes under stereo loupe and number of specimens was calculated daily. For identification mites were colored and cleared in lactic acid with the dye Lignin Pink, then washed with tap water on a suction filter and finally embedded into the mounting medium of Hoyer (Krantz, 1978) on slides and examined by normal phase contrast by x100 or more (x200, 400, 1000) for finer morphological details. From the proportions of *T. similis* on slides, the stereo loupe counting and number of trapping days, the average number of *T. similis* caught by the traps per day was calculated. Measurements including body lengths were done by mouse-marking at screen on video transmitted images (System Olympus Oylite). Eggs in mothers were measured inside the shape of chorion.

Temperature records for the collection periods were provided from the meteorological station at the Agricultural Research Institute, Modruvellir, which is nearest to the fields where collections took place. Soil temperatures were measured 5 cm below soil surface, while measurements of air temperature took place 2 m above ground.

RESULTS

An egg stage and a larval stage plus three nymphal stages and adult males and females were identified in *T. similis*. The male:female ratio was about 1:3 (44:124). About 80% of the female specimens carried 1 to 9 eggs. Sizes are shown in Table 1. The identity of the deutonymph stage as part of the life cycles of *T. similis* was confirmed by observation of specimens on the slides

Fig. 1. Location of sampling farms in northern Iceland 1996-1998. Temperatures were recorded at Modruvellir (65°46' N, 18°15' W). Scale bar is 10 km.

going from protonymphs to deutonymphs. The deutonymph (or hypopus) in this species (Fig. 2) is smaller than the protonymph and is of the phoretic *Acarus* type.

Results from the years 1996–1998 are shown in Fig. 3, and a comprehension is given in Table 2.

When the snow has melted in the last weeks of May the first larval stage appeared in the traps. A week or two later the deutonymphs occurred. Then there was a progression of protonymphs, deutonymphs, tritonymphs and adult males and females which culminate in the first part of July. The adults' produces eggs and the larvae, making up the midsummer generation, are seen in the traps between the first week of July and the first week of August. Then no larvae are seen the rest of the year, although the adults of the midsummer generation still produce eggs.

DISCUSSION

Tyrophagus species to form a deutonymph stage is already known from *Tyrophagus formicetorum* Volgin, 1948 (Fain and Chmielewski, 1987). It is associated with the nest of the ant *Formica rufa* in Poland and USSR. The present observation of a facultative deutonymph stage in *Tyrophagus similis* is the second to be found in this genus and details of morphological description are still in demand. *T. similis* in Iceland cannot be connected with ant nests, as ants are absent from this country. However, its presence in a *Bombus ionellus* nest (Hughes, 1961) and in the nest of an eider duck (*Somateria mollissima*) in Iceland (Hughes, 1976) opens the possibility of a nidicolous behavior. Here the phoretic deutonymph may play a role in the dispersal, by clinging to feathers or hairs of animals which may carry them to their nests. There were no eider duck nests in the proximity of our collection sites however, and a simple interpretation of the finding of the deutonymphs in the trapping fluid might be that the deutonymphs have arrived to the pitfall traps as passengers on other captured arthropods. A list of possible candidates may be found in Gudleifsson and Bjarnadottir (2002). *Bombus jonellus* has been captured, but so far no deutonymphs have been connected to carriers in the present study. The observation, that *T. similis* may form the deutonymphal stage, is new and may add some explanation to the dispersal behavior of this species. The eggs produced by adults from the midsummer generation may overwinter and hatch as winter generation eggs next spring. It appears that the deutonymphal formation takes place in the cold winter, whereas the summer generation does not develop this stage. It is noted that that the Icelandic adults had a male:female ratio of 1:3. This could be a consequence of the pitfall trapping method, where differences in life lengths and activity of the two sexes will influence the sex ratio in trapped specimens. However, as material from pitfall traps are not usually examined for the presence of acarid mites, the formation of deutonymphs in *T. similis* might be widespread, but unrecognized.

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Table 1. Idiosomal lengths (μ) in *Tyrophagus similis* in northern Iceland.

Category	Mean	SD	Min.	Max.	N
Eggs	82.6	9.4	51	116	308
Larvae	110.3	36.7	72	167	8
Protonymphs	154.5	28.9	99	205	37
Moult N1/N2	141.4	4.5	136	145	5
Deutonymphs	122.7	14.3	92	211	123
Tritonymphs	246.6	33.6	186	338	57
Males	262.3	31.7	207	344	44
Females	331.4	35.3	254	413	124

Fig. 2. Deutonymph of *Tyrophagus similis*. Scale bar is 50 μ . The figure has been drawn from a low-resolution image and therefore the many setae, solenoids etc. essential for a proper identification, could not be shown.

Table 2. Daily captures (number of specimens/day) of *Tyrophagus similis* in pitfall traps in hayfields and the average temperatures in the trapping area (mean 1996-1998).

	Temperature °C		Development stages				Adults	Sum
	Soil	Air	Larvae	Proto-nymph	Deuto-nymph	Trito-nymph	Males, females	
01 May	0.3	2.2	—	—	—	—	—	—
20 May	3.3	6.0	—	—	—	—	—	—
24 May	5.3	7.8	—	—	—	—	—	—
30 May	5.3	8.3	3	—	—	—	—	3
05 June	3.2	5.5	—	—	—	—	—	—
12 June	5.5	7.3	5	—	3	—	—	8
19 June	7.7	9.2	—	—	11	—	—	11
26 June	7.0	9.6	—	11	10	3	1	25
03 July	7.7	9.9	—	33	61	8	17	119
10 July	8.7	11.4	40	—	10	4	33	87
16 July	8.9	10.9	2	—	1	6	9	18
22 July	9.0	11.2	4	2	1	7	3	17
31 July	10.3	12.1	18	16	—	—	9	44
07 Aug	9.1	11.1	27	7	—	39	8	81
14 Aug	8.2	10.6	—	28	—	30	8	65
21 Aug	7.1	8.6	—	2	1	2	5	10
29 Aug	8.8	10.7	—	—	—	1	5	7
06 Sept	7.0	9.6	—	—	—	—	1	1
11 Sept	4.8	7.0	—	1	—	—	1	2
16 Sept	4.6	6.9	—	—	—	1	—	1
25 Sept	6.4	8.2	—	—	—	—	—	—
30 Sept	2.3	4.2	—	—	—	—	—	—

Fig. 3. Specimens of *Tyrophagus similis* caught in pitfall traps between May 24 and September 17 in each of the years 1996 (3 sites), 1997 (6 sites) and 1998 (3 sites). Traps were harvested 17 times in the period. The deutonymph stage was present also in 1996, but in very low number.

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