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# A guide to the predatory soil mites of the family Rhagidiidae (Acari: Prostigmata) of the Ötztal Alps, North Tyrol, Austria

#### Miloslay Zacharda

#### **ABSTRACT**

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A guide to twenty-two species of predatory soil mites of the family Rhagidiidae (Acari: Prostigmata) that occur in various altitudinal niches in the Ötztal Alps, North Tyrol, Austria, is presented to facilitate their identification in studies focused on biodiversity and ecology of the alpine environment.

# Introduction

Spiders and mites are the dominant arachnid groups, both for their diversity and abundance, in the Austrian Alps (Thaler 1994, 2003). Among the mites, representatives of the predatory family Rhagidiidae frequently occur at high altitudes above the timberline in the uppermost parts of alpine, subnival and low nival zones with a prevailing severe climate. Here, they mostly live under stones and in wet stony debris in periodically occuring snow beds located in the shaded ground depressions that are frequently covered with snow up to mid- or late summer. These psychrophilic species are cool-adapted and they can frequently be observed active, running here and there and feeding mostly on springtails (Collembola) under stones covered with snow in the alpine nival zone. They are univoltine, with their active developmental stages (larvae, proto-, deuto-, tritonymphs and adults) appearing successively during the growing season.

Rhagidiid mites have frequently been collected in various habitats in the region of the Alps including caves, as it was reviewed by Zacharda & Kučera (2006). The previous lack of knowledge and confused taxonomic placements were the reasons that reliable identification of species was impossible until 1980 and most of the Rhagidiidae collected in the Alps were misidentified. To date 27 species are taxonomically well recognized and confirmed (Zacharda &

Kučera 2006). However, owing to lack of comprehensive, simple and reliable keys for the determination of taxa of generic and specific rank, also nowadays identification of most groups of soil inhabiting arthropods, including mites, still remains a domain of skilled specialists. Consequently a need for tools for the identification of soil-inhabiting arthropods for professional ecological studies or education of students of soil zoology is evident.

Thanks to enthusiastic personal support of Dr. Konrad Thaler and funding by the Institute of Zoology at the University of Innsbruck, I was enabled to collect numerous rhagidiid mites in stony debris habitats in various alpine zones (Reisigl & Keller 1987, Zacharda & Kučera 2006) in the vicinity of the Obergurgl Alpine Research Center, Ötztal Alps (Central Alps, Northern Tyrol, Austria) (http://www.uibk.ac.at/obergurgl/forschung/index.html.en) in 1992 and 1993. This field study resulted in descriptions of (i) newly discovered taxa (Zacharda 2000 a, b, c, d) and (ii) assessment of diversity of assemblages of these mites in different altitudinal niches (Zacharda & Kučera 2006).

In the vicinity of Obergurgl as well as elsewhere in the Ötztal Alps these mites occur in various alpine and altitudinal niches and may frequently be collected on occasion of various field studies focused on alpine soil biodiversity and ecology that are continuously carried out, for example, by research workers and students of the Institute of Ecology, University of Innsbruck (www.uibk. ac.at/ecology/).

The objective of this paper is to add to this series of papers a comprehensive guide to the predatory soil mites of the family Rhagidiidae (Acari: Prostigmata) occurring in the Ötztal Alps, to facilitate for students and researchers identification of these mites to species level.

# **Material and Methods**

Mites were collected in the vicinity of the Obergurgl Alpine Research Center (11° 02′ E, 46° 52′ N), in the silicate bedrock area of the Ötztal Alps, at various altitudes above the timberline ranging from ca 2000 m a.s.l. in the low alpine zone up to ca 3000 m a.s.l. in the low nival zone (Reisigl & Pitschmann 1958, Reisigl & Keller 1987, Meyer & Thaler 1995) in 1992 and 1993. Because for the most part only adult specimens of the rhagidiid mites can be reliably identified to species and because these occur in cool mountainous habitats at the end of the growing season, hand collections were timed from the end of August to the beginning of September when the alpine landscape was not yet covered with snow. Epigeic and hypolithic mites, i. e. living in voids under stones, were collected by way of hand sorting, using a small aspirator contain-

ing ethanol as a preservative. Rhagidiid mites inhabiting deep underground voids in scree slopes were collected by using large pitfall traps made of rigid plastic, about 13 cm high and 10.5 cm in diameter (Růžička 1988) which were positioned ca 50–100 cm under the surface of the scree slopes. The traps contained an aqueous mixture of 7% formalin and 20% glycerol, plus a few drops of detergent. They were left in place for 1 year, from June 4, 1991 to June 26, 1992, after which they were removed and the catch was processed in the laboratory. Mites, initially preserved in ethanol, were transferred to lactic acid in temporary slide preparations (Krantz 1978), examined under a standard light microscope under a bright field and identified to species (Zacharda 1980, 1995a, b, 1996, 2000 a, b, c, d).

# Results

A total of 242 specimens of collected rhagidiid mites belonging to 6 genera were examined and twenty-two species were distinguished. They can be identified reliably according to specific diagnostic morphological characters and their combinations as presented in the following key for identification of adults of the collected taxa. The morphological terminology is taken from Lindquist and Zacharda (1987) and Baker (1990).

Key to adults of genera and species of the rhagidiid mites occurring in various altitudinal niches in the vicinity of Obergurgl, Ötztal Alps, North Tyrol, Austria.

Because for the most part only adult specimens of the rhagidiid mites can be reliably identified to species, this should be examined first whether the specimens under study are adults or subadults. To distinguish adult specimens, examine the genital region on the opisthosomal venter. The large ventral genital opening is located subterminally and is covered with two bananashaped genital valves while the anal pore is terminal. In the adult specimen a number of 5 to 6 pubescent setae on each genital valve is usual. Also numerous pubescent internal eugenital setae on the retracted ovipositor in the female or a longitudinally oval club-shaped sperm sac showing through the opisthosomal integument in the male are typical for adults. In contrast, only one, two or three setae on each genital valve and no internal genital setae under the genital valves are typical for the protonymph, deutonymph and tritonymph, respectively.

1	Chelicera with 1 seta (Fig. 1a)
_	Chelicera with 2 setae (Fig. 1d)
2	Solenidia in rhagidial organ I arranged in tandem axially (genus Thoria
	ZACHARDA, 1980) (Not collected in Obergurgl till now.)
_	Solenidia in rhagidial organ I parallel (Fig. 1b) (genus Shibaia ZACHARDA
	1980) (Not collected in Obergurgl till now.)
3	Tarsi II, III and IV with subapical paddle-shaped setae (Fig. 1c) (genus
	Troglocheles Zacharda, 1980)
_	Subapical setae on tarsi II, III and IV flagellate (Fig. 2f)
4	Fixed digit of chelicera slender (Fig. 1d). Epigean and hypolithic in the high
	alpine to the low nival zone Troglocheles archetypica ZACHARDA, 2000
_	Fixed digit of chelicera strikingly robust, flattened laterally (Fig. 1e). In
	underground compartments on talus slopes in the low alpine zone
5	Trichobothrium on propodosomal dorsum distinctly clavate (Fig. 1f). In the
	low nival zone (genus <i>Coccorhagidia</i> SIG THOR, 1934)
-	Trichobothrium filiform, exceptionally slightly swollen (Figs. 1g, 1h) 6
6	Cheliceral shears large and narrow with elongated and attenuated arched
	digits (Figs. 1j, 1l, 1m, 1n). Ratio of length of movable digit to the total
	length of chelicera ranging from 0.42 to 0.52 (genus <i>Poecilophysis</i> CAM
	BRIDGE, 1876)
-	Cheliceral shears relatively short, not elongated and attenuated (Figs. 10
	1p, 1q, 1r). Ratio of length of movable digit to the total length of chelicera
200	ranging from 0.25 to 0.40
7	Trichobothrium distinctly swollen, but not clavate (Fig. 1h) (subgenus
	Soprocheles Zacharda, 1980). Empodium on tarsus I short, rudimentary
	not reaching tip of claws (Fig. 1i). In the low alpine zone
	Poecilophysis saxonica (WILLMANN, 1934)
-	Trichobothrium finely filiform, thread-like (Fig. 1g). Empodium on tarsus-like (Fig. 2f).
_	reaching or overlapping tip of claws (Fig. 2f)
8	Tarsus I with 1 erect spiniform dorsoproximal solenidion (Fig. 1k), 4 cili
	ated setae on coxisternal plate IV. Stellate famulus in rhagidial organ I
	positioned between 1 <sup>st</sup> and 2 <sup>nd</sup> , or 2 <sup>nd</sup> and 3 <sup>rd</sup> distal rhagidial solenidia
	antaxially (subgenus Dentocheles ZACHARDA, 1980)
-	No dorsoproximal spiniform solenidion on tarsus I, 3 ciliated setae on coxi
	sternal plate IV, stellate famulus in rhagidial organ I positioned between 1 <sup>st</sup>
	and 2 <sup>nd</sup> proximal rhagidial solenidion antaxially (subgenus <i>Procerocheles</i>
_	ZACHARDA, 1980)
9	Masticatory surface of cheliceral movable digit with 2 large cusps, other

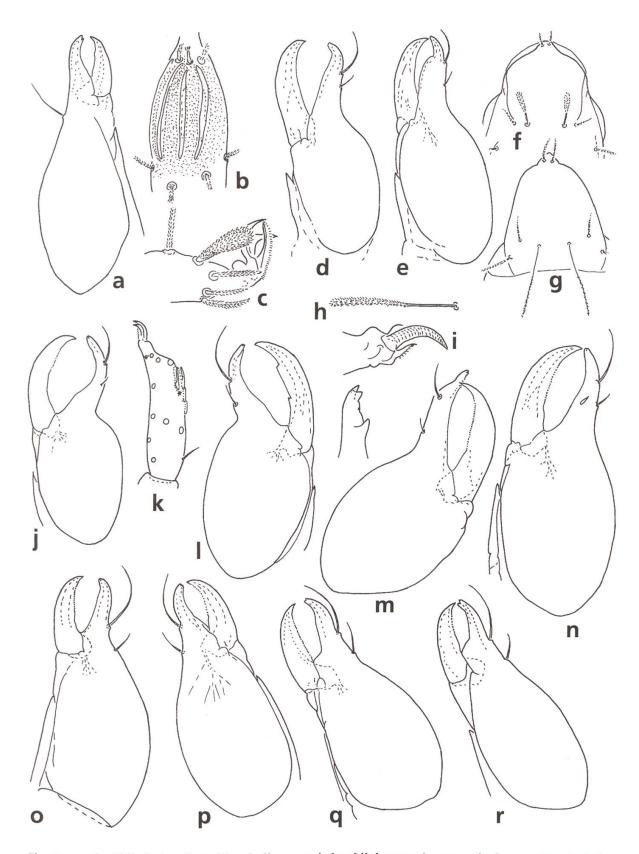


Fig. 1. – a, b: Shibaia longisensilla, chelicera and rhagidial organ I, respectively; – c: Troglocheles sp., apex of tarsus II with the paddle-shaped seta; – d: Troglocheles archetypica, chelicera; – e: Troglocheles aggerata, chelicera; – f: Coccorhagidia sp., clavate trichobothria on propodosomal dorsum; – g: Rhagidia sp., filiform trichobothria on propodosomal dorsum: – h, i: Poecilophysis saxonica, swollen trichobothrium and rudimentary empodium on tarsus I, respectively; – j: Poecilophysis wankeli, chelicera – k, l: Poecilophysis pratensis, tarsus I with spiniform solenidion and chelicera, respectively; – m: Poecilophysis spelaea, chelicera; – n: Poecilophysis pseudoreflexa, chelicera; – o: Rhagidia longiseta, chelicera; – p: Rhagidia parvilobata, chelicera; – q: Rhagidia gigas, chelicera; – r: Rhagidia diversicolor, chelicera.

	wise smooth (Fig. 1l). Erect spiniform solenidion on tibia I latero-dorsomed-
	ial. In the low alpine zone <i>Poecilophysis pratensis</i> (С. L. Косн, 1835)
_	Masticatory surface of cheliceral movable digit finely serrate (Fig. 1j). Erect
	spiniform solenidion on tibia I dorsodistal. In the mid- and high alpine zone
10	Masticatory surface of cheliceral fixed digit with large subterminal cusp
	lying opposite to tip of movable digit (Fig. 1m). Hypolithic in the mid-alpine
	zone
-	Masticatory surface of cheliceral fixed digit smooth, apex of movable digit
	opposite to apex of fixed digit (Fig. 1n). The most abundant species occur-
	ring from the mid-alpine to the low nival zone
11	Both proximal and distal cheliceral setae inserted on cheliceral fixed digit
	dorsally (Figs. 10, 1p, 1q, 1r). Fixed digit with no dorsal ridge (seen in lat-
	eral aspect). Rhagidial solenidia in rhagidial organ I oblique (genus <i>Rhagidia</i>
	Thorell, 1872)
_	Distal cheliceral seta dorsolateral, inserted in proximally open depression
	below soft sharp dorsal ridge (seen in lateral aspect) (Figs. 2a, 2d, 2g, 2i).
	Rhagidial solenidia in rhagidial organ I oblique or parallel 16
12	Smaller species, length of idiosoma ca 800 $\mu\text{m}\text{,}$ tips of dorsal opisthosomal
	setae $c_1$ and $d_1$ almost reaching insertions of the successive seta. Mas-
	ticatory surface of fixed digit of chelicera without prebasal lobe (Fig. 1o).
	Tarsus II with 3 rhagidial solenidia in separate oblique depressions, small
	spiniform famulus inserted laterad of proximal solenidion antaxially. In the
	high alpine zone
_	Large species, length of idiosoma ca 900–1600 $\mu m$ . Tips of opisthosomal
	setae $c_1$ and $d_1$ far from insertions of the successive seta. Masticatory sur-
	face of fixed digit of chelicera with distinct prebasal lobe (Figs. 1q, 1r).
	Tarsus II with 3 rhagidial solenidia, in separate depressions axially or lying
	in tandem in confluent depression, spiniform famulus subtending proximal
40	rhagidial solenidion
13	Spiniform solenidion on tibia I and II dorsodistal. In the low alpine zone
	Rhagidia distisolenidiata Zacharda, 1995
-	Spiniform solenidion on tibia I and II dorsoproximal
14	Masticatory surface of cheliceral fixed digit with minute, indistinct prebasal
	lobe (Fig. 1p). Tarsus II with 3 rhagidial solenidia lying axially in confluent
	depression. In the low to mid-alpine zone
	Masticatory surface of shalicaral fixed digit with large distinct probasal
_	Masticatory surface of cheliceral fixed digit with large, distinct prebasal
	lobe (Figs. 1q, 1r). Tarsus II with 3 rhagidial solenidia lying in separate

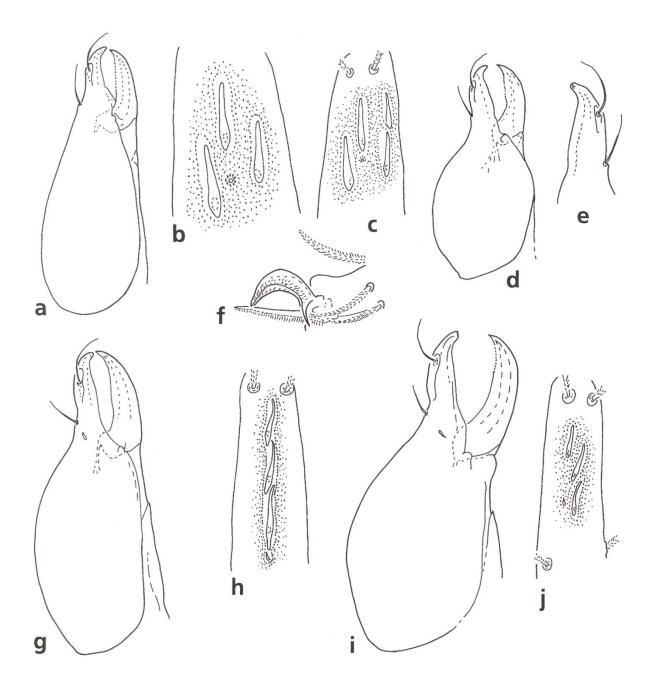


Fig. 2. – a, b: Evadorhagidia bezdezensis, chelicera and rhagidial organ I, respectively; – c: Evadorhagidia oblikensis, rhagidial organ I; – d, e and f: Foveacheles unguiculata, chelicera and apex of tarsus II with large ventrobasal clawlets on claws, respectively; – g, h: Foveacheles halltalensis, chelicera and rhagidial organ II, respectively; – i, j: Foveacheles proxima, chelicera and rhagidial organ II, respectively.

_	Rhagidial solenidia in rhagidial organ I parallel (Fig. 2b, 2c) (genus Evado-
	rhagidia Zacharda, 1980)
17	Rhagidial organ I consists of 3 rhagidial solenidia (in adults!) 18
-	Rhagidial organ I consists of 4 rhagidial solenidia 19
18	4 setae on epimeral plate IV; tibia I with 2 spiniform solenidia: 1 dorso-
	lateral proximal and 1 dorsodistal spiniform solenidion. In the low nival
	zone Evadorhagidia bezdezensis Zacharda, 1980
_	3 setae on epimeral plate IV; tibia I with 1 dorsolateral proximal and 1 dorso-
	lateral medial spiniform solenidion. In the low nival zone
	<i>Evadorhagidia janetscheki</i> (Willmann, 1953)
19	Rhagidial organ II consists of 2 (exceptionally 3: check both tarsi) rhagidial
	solenidia; 4 genital setae on each genital valve; tibia II with 1 dorsodistal
	spiniform solenidion; ratio of tarsus I length to width: 3.60-4.20. In the
	low alpine zone <i>Evadorhagidia oblikensis</i> ZACHARDA, 1980
-	Rhagidial organ II consists of 3 or 4 rhagidial solenidia; 5 genital setae on
	each genital valve; tibia II with 2 spiniform solenidia, 1 dorsoproximal (this
	can be absent: check both tibiae) and 1 dorsodistal solenidion; ratio of tar-
	sus I length to width: 4.30–4.50. In the mid-alpine zone
	<i>Evadorhagidia corcontica</i> Zacharda, 1993
20	Rhagidial organ II consists of 4 rhagidial solenidia 21
-	Rhagidial organ II consists of 3 rhagidial solenidia 22
21	Small species, ca 700-950 $\mu m\text{, } rhagidial \ solenidia \ in \ rhagidial \ organ \ II$
	strikingly short, arranged in separate depressions axially. In the high alpine
	zone <i>Foveacheles brevichelae</i> Zacharda, 1980
-	Large species, ca 970-1150 $\mu m$ , rhagidial solenidia in rhagidial organ II
	long and slender, arranged in separate depressions obliquely. In the low
	nival zone <i>Foveacheles cegetensis</i> ZACHARDA, 1983
22	Rhagidial solenidia in rhagidial organ II arranged axially in confluent
	depression, spiniform famulus subtending proximal rhagidial solenidion
	(Fig. 2h). Spiniform solenidion on genu I dorsodistal. In the mid-alpine to
	low nival zone Foveacheles halltalensis Zacharda, 2000
_	Rhagidial solenidia in rhagidial organ II in separate, slightly oblique depres-
	sions, spiniform famulus laterad of the proximal rhagidial solenidion ant-
	axially (Fig. 2j). Spiniform solenidion on tibia I laterodorsal, proximal 23
23	Tip of proximal cheliceral seta reaching insertion of distal seta (Figs. 2d,
	2e). Tarsal claws each with strikingly large, saber-shaped ventrobasal
	clawlet (Fig. 2f). Tibia IV with 1 erect spiniform laterodorsal medioproximal
	solenidion. In the mid-alpine to low nival zone
	Foveacheles unguiculata Zacharda, 1994
_	Tip of proximal cheliceral seta not reaching insertion of distal seta (Fig. 2i).

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