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

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ABSTRACT Contrib. Nat. Hist. 12: 1415–1424.

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 banana-shaped 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) **2**

– Chelicera with 2 setae (Fig. 1d) **3**

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) **4**

– Subapical setae on tarsi II, III and IV flagellate (Fig. 2f) **5**

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 ..... ***Troglocheles aggerata*** Zacharda, 2000

5 Trichobothrium on propodosomal dorsum distinctly clavate (Fig. 1f). In the low nival zone (genus *Coccorhagidia* Sig Thor, 1934) ..... ***Coccorhagidia pittardi*** Strandtmann, 1971

– 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 *Poecilophysis* Cambridge, 1876) **7**

– Cheliceral shears relatively short, not elongated and attenuated (Figs. 1o, 1p, 1q, 1r). Ratio of length of movable digit to the total length of chelicera ranging from 0.25 to 0.40 ..... **11**

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 I reaching or overlapping tip of claws (Fig. 2f) **8**

8 Tarsus I with 1 erect spiniform dorsoproximal solenidion (Fig. 1k), 4 ciliated setae on coxisternal plate IV. Stellate famulus in rhagidial organ I positioned between 1st and 2nd, or 2nd and 3rd distal rhagidial solenidia antaxially (subgenus *Dentocheles* Zacharda, 1980) **9**

– No dorsoproximal spiniform solenidion on tarsus I, 3 ciliated setae on coxisternal plate IV, stellate famulus in rhagidial organ I positioned between 1st and 2nd proximal rhagidial solenidion antaxially (subgenus *Procerocheles* Zacharda, 1980) **10**

9 Masticatory surface of cheliceral movable digit with 2 large cusps, other-

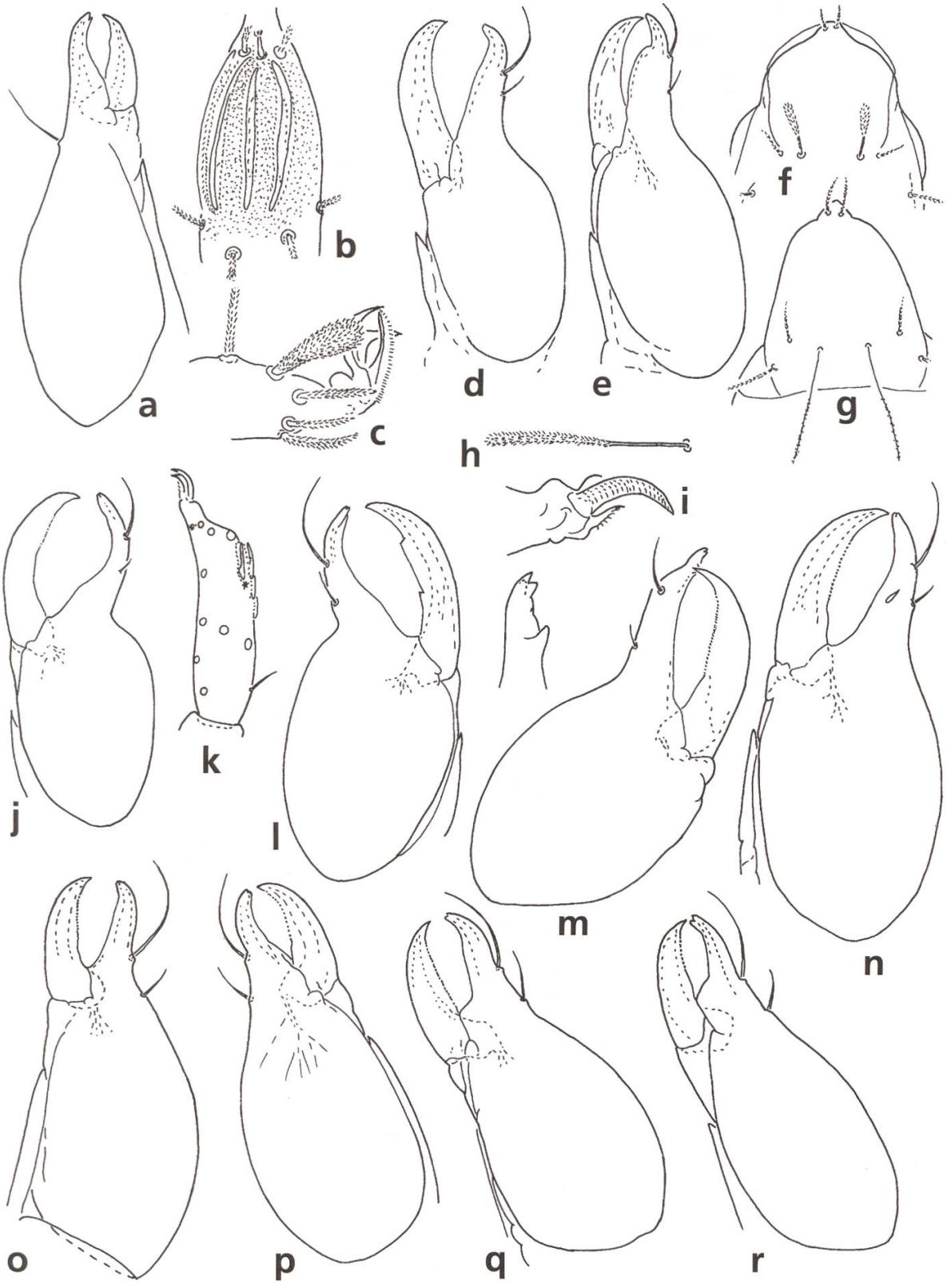

Fig. 1. – a, b: *Shibaia longisensilla*, chelicera and rhagidial organ I, respectively; – c: *Troglocheles* sp., apex of tarsus II with the paddle-shaped seta; – d: *Troglocheles archetypica*, chelicera; – e: *Troglocheles aggerata*, chelicera; – f: *Coccorhagidia* sp., clavate trichobothria on propodosomal 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-dorsomedial. In the low alpine zone ..... ***Poecilophysis pratensis*** (C. L. KOCH, 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 ..... ***Poecilophysis wankeli*** (ZACHARDA, 1978)

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 ..... ***Poecilophysis spelaea*** (WANKEL, 1861)

– Masticatory surface of cheliceral fixed digit smooth, apex of movable digit opposite to apex of fixed digit (Fig. 1n). The most abundant species occurring from the mid-alpine to the low nival zone ..... ***Poecilophysis pseudoreflexa*** ZACHARDA, 1980

11 Both proximal and distal cheliceral setae inserted on cheliceral fixed digit dorsally (Figs. 1o, 1p, 1q, 1r). Fixed digit with no dorsal ridge (seen in lateral aspect). Rhagidial solenidia in rhagidial organ I oblique (genus *Rhagidia* THORELL, 1872) **12**

– 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 μm, tips of dorsal opisthosomal setae c_1 and d_1 almost reaching insertions of the successive seta. Masticatory 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 ..... ***Rhagidia longiseta*** ZACHARDA, 2000

– Large species, length of idiosoma ca 900–1600 μm. Tips of opisthosomal setae c_1 and d_1 far from insertions of the successive seta. Masticatory surface 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 rhagidial solenidion **13**

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**

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 ..... ***Rhagidia parvilobata*** ZACHARDA, 1995

– Masticatory surface of cheliceral fixed digit with large, distinct prebasal lobe (Figs. 1q, 1r). Tarsus II with 3 rhagidial solenidia lying in separate

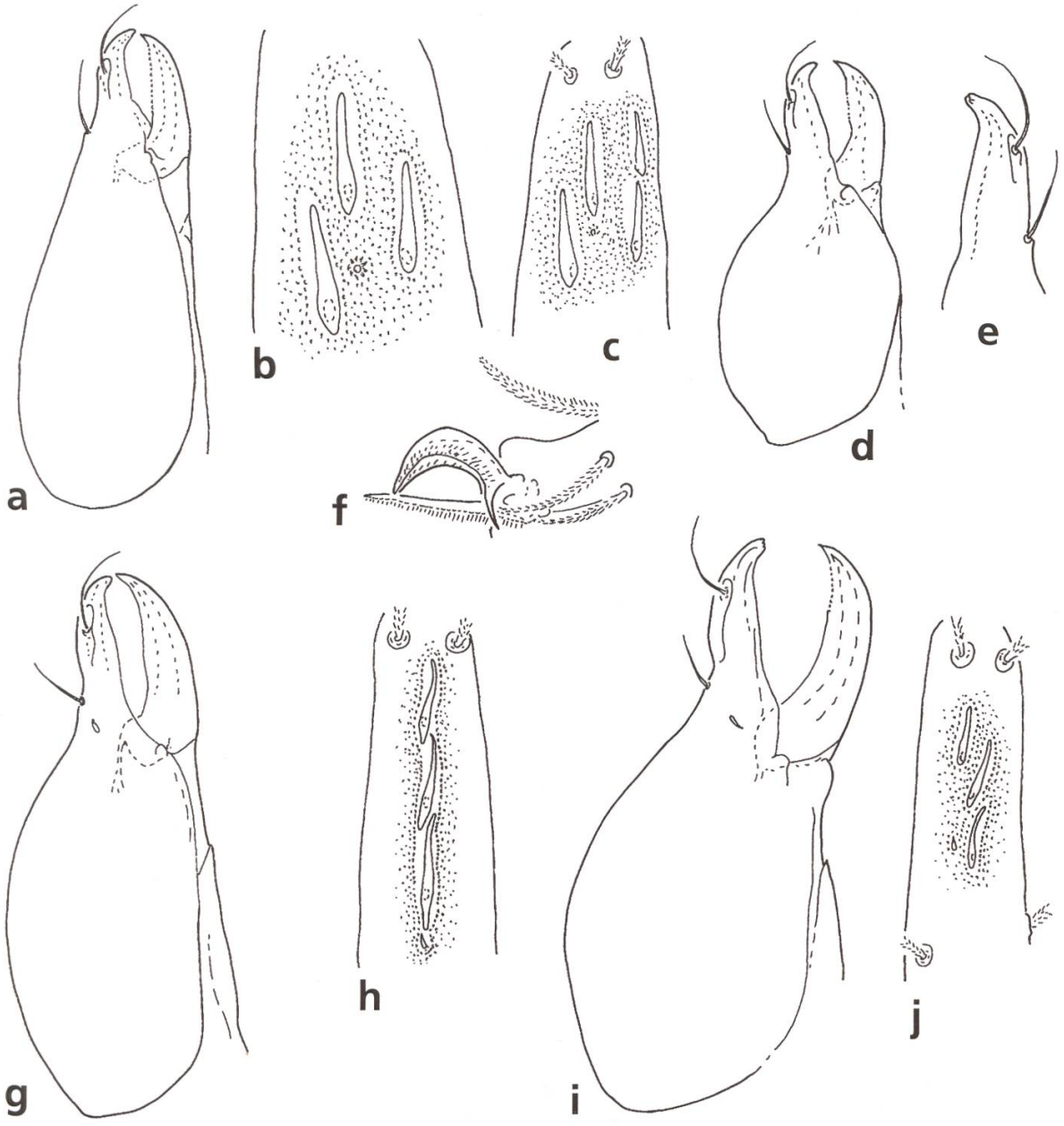

Fig. 2. – a, b: *Evadorhagidia bezdezensis*, chelicera and rhagidial organ I, respectively; – c: *Evadorhagidia oblikensis*, rhagidial organ I; – d, e and f: *Foveacheles unguiculata*, chelicera and apex of tarsus II with large ventrobasal clawlets on claws, respectively; – g, h: *Foveacheles halltalensis*,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

depressions axially **15**

15 Distal cheliceral seta inserted distad of prebasal lobe on masticatory surface of fixed digit of chelicera (Fig. 1q). Large species, 1100–1600 μm. In the low to mid-alpine zone ..... ***Rhagidia gigas*** (CANESTRINI, 1886)

– Distal cheliceral seta inserted opposite to prebasal lobe on masticatory surface of fixed digit of chelicera (Fig. 1r). Smaller species, 930–1100 μm. In the high alpine zone ..... ***Rhagidia diversicolor*** (C. L. KOCH, 1838)

16 Rhagidial solenidia in rhagidial organ I oblique (genus *Foveacheles* ZACHARDA, 1980) **20**

– Rhagidial solenidia in rhagidial organ I parallel (Fig. 2b, 2c) (genus *Evadorhagidia* ZACHARDA, 1980) **17**

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 dorsolateral 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 dorsolateral medial spiniform solenidion. In the low nival zone ..... ***Evadorhagidia janetscheki*** (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 ..... ***Evadorhagidia oblikensis*** 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 tarsus I length to width: 4.30–4.50. In the mid-alpine zone ..... ***Evadorhagidia corcontica*** 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 μm, rhagidial solenidia in rhagidial organ II strikingly short, arranged in separate depressions axially. In the high alpine zone ..... ***Foveacheles brevichelae*** ZACHARDA, 1980

– Large species, ca 970–1150 μm, rhagidial solenidia in rhagidial organ II long and slender, arranged in separate depressions obliquely. In the low nival zone ..... ***Foveacheles cegetensis*** 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 depressions, spiniform famulus laterad of the proximal rhagidial solenidion antaxially (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).

Tarsal claws each with only small clawlet ventrobasally. Tibia IV with 1 erect spiniform lateroventral medioproximal solenidion. In the high alpine zone ..... ***Foveacheles proxima*** ZACHARDA, 2000

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