FIRST RECORD AND REDESCRIPTION OF *PARACAROPHENAX BAMBERGENSIS* (ACARI: HETEROSTIGMATA: ACAROPHENACIDAE) ASSOCIATED WITH *AMPHOTIS MARGINATA* (COLEOPTERA: NITIDULIDAE) FROM EUROPEAN RUSSIA

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ABSTRACT: A rare species, *Paracarophenax bambergensis* (Krczal, 1959) (Acari: Acarophenacidae), is redescribed based on phoretic females collected under the elytra of a sap beetle *Amphotis marginata* (Fabricius, 1781) (Coleoptera: Nitidulidae) in European Russia.

KEY WORDS: Heterostigmata, Pyemotoidea, systematics, morphology, phoresy.

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INTRODUCTION

The family Acarophenacidae currently includes one fossil genus *Protophenax* Magowski, 1994, six extant genera, and about 38 described species. The extant genera include: *Acarophenax* Newstead and Duval, 1918; *Adactylidium* Cross, 1965; *Aegyptophenax* Rady, 1992; *Aethiophenax* Mahunka, 1981; *Paracarophenax* Cross, 1965; and *Paradactylidium* Mahunka, 1975 (Magowski 1994; Ardjomandi *et al.* 2017; Walter and Seeman 2017; Khaustov and Abramov 2018; Xu *et al.* 2018). Members of the family are parasitoids of eggs of various insects, including beetles belonging to the Cerambycidae, Tenebrionidae, Nitidulidae, Dermestidae, Curculionidae, Mycetophagidae, Erotylidae families, as well as thrips (Thysanoptera) (Goldarazena *et al.* 2001; Katlav *et al.* 2015; Ardjomandi *et al.* 2017; Walter and Seeman 2017; Khaustov and Abramov 2018; Xu *et al.* 2018). The genus *Paracarophenax* Cross, 1965 includes eight described species: *P. dybasi* Cross, 1965 from USA (Cross 1965); *P. bambergensis* (Krczal, 1959) from Germany (Krczal 1959); *P. undosus* Mahunka, 1975 from New Guinea (Mahunka 1975); *P. paucisetosus* Mahunka and Rack, 1977 from Hungary (Mahunka and Rack 1977); *P. scolysi* Khaustov, 1999 from Crimea (Khaustov 1999); *P. myzognathus* Walter and Seeman, 2017 from Canada (Walter and Seeman 1917); *P. triplaxophilus* Khaustov and Abramov, 2018 from European Russia (Khaustov and Abramov 2018); and *P. alternatus* Xu and Zhang, 2018 from China (Xu *et al.* 2018). Katlav *et al.* (2015) have discussed the distribution and the host range of *Paracarophenax* species, while Walter and Seeman (2017) have redefined the genus and described the phenomenon of pre-phoresy, when adult females of *P. myzognathus* attach to larvae of the host

beetle. Also, Xu *et al.* (2018) have provided the latest key to the species of all described *Paracarophenax*.

During the study of insect associated mites, a rare species *Paracarophenax bambergensis* was discovered in European Russia. This is the first record of this species from Russia and the second record in the world. Previously, it was known only from Germany, associated with an undetermined beetle of the Nitidulidae family.

The aim of this article is to redescribe *Paracarophenax bambergensis*, associated with the *Amphotis marginata* (Fabricius, 1781) sap beetle from European Russia.

MATERIAL AND METHODS

Mites were collected from under the elytra of a single specimen of *Amphotis marginata* that was captured by the junior author in Tula Region, Russia. The mites were mounted in Hoyer's medium. The terminology follows that of Lindquist (1986). The notation of gnathosomal setae follows Khaustov and Abramov (2018). All measurements are given in micrometers (μm). For leg chaetotaxy, the number of solenidia is given in parentheses. DIC micrographs were taken using the Carl Zeiss Axio Imager A2 compound microscope, as well as Hitachi KP-HD20A and AxioCam 506 color digital cameras. All materials have been deposited in the mite collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

SYSTEMATICS

Family **Acarophenacidae** Cross, 1965

Genus ***Paracarophenax*** Cross, 1965

Type species: *Paracarophenax dybasi* Cross, 1965

Fig. 1. *Paracarophenax bambergensis*, female: A—dorsum of the body, B—venter of the body. Legs omitted.

Fig. 2. *Paracarophenax bambergensis*, female: A—left leg I in dorsal view, B—left leg II in dorsal view.

Fig. 3. *Paracarophenax bambergensis*, female: A—left leg III in dorsal view, B—left leg IV in dorsal view.

***Paracarophenax bambergensis* (Krczal, 1959)**

Acarophenax bambergensis Krczal, 1959, p. 551, Figs 71-72

Paracarophenax bambergensis; Cross 1965, p. 132.

(Figs. 1–6)

Diagnosis. Gnathosoma ventrally with pair of smooth membranous areas. Alveolar pits of setae sc_1 absent. Setae e and ps present. Setae h_2 present.

Aggenital setae present. Trochanters I and II with one seta each. Apodemes 1 and 3 absent. Poststernal apodeme present. Femora III and IV with two setae. Genua II and III with three setae each. Seta pl'' of tarsus II spine-like.

Description. *Female.* Length of idiosoma 235–255, width 170–195.

Gnathosoma (Figs. 1B, 5A, 6A, B). Concealed dorsally by prodorsum, indistinguishable ventrally from idiosoma; palps absent. One pair of smooth and

Fig. 4. DIC micrographs of *Paracarophenax bambergensis* female: A—general view dorsally, B—general view ventrally.

weakly blunt-ended postpalpal setae *pp* 6–8 laterally. Venter with mouth flanked by paired, semi-ovular smooth membranous area (Fig. 5A); one pair of very short cuticular projections, probably of non-setal origin, situated laterad mouth. Pharynx large, narrowly oval, thin walled (Fig. 6A). Gnathosomal apodeme (*ap gn*) weakly sclerotized and thin in central part and well sclerotized and thick laterally (Fig. 6B). Cheliceral stylets long and curved, their tips protruding through mouth. Levers of cheliceral stylets weakly sclerotized, subtrapezoid.

Idiosomal dorsum (Figs. 1A, 4A, 5B, D). Ovate. Prodorsal shield not delineated into primary plate and prodorsal projection encapsulating gnathosoma. Stigmata oval, with tiny pore-like openings; tracheal trunks broad, expanding into cylindrical atrium, becoming obsolete posteriorly (Fig. 6B). Prodorsal shield and plates C, D, EF, H weakly punctate (Figures 5B, D); area between stigmata (Fig. 5B) and pair of oval areas anterior to setae *e* (Fig. 5D) more strongly punctate. Alveolar pits *sc*₁ absent. Setae *e* present. All dorsal setae weakly barbed and blunt-ended (Figs 5B, D). Cupules small, round; *ia* situated anterolaterad bases of setae *d*; cupules *im* situated anterior to setae *e*, and cupules *ih* situated anterolaterad bases of setae *h*₁. Posterior parts of tergites C, D, EF, and prodorsal shield with fine longitudinal striation. Lengths of dorsal setae: *v*₂ 17–18, *sc*₂ 17–18, *c*₁ 16–20, *c*₂

17–19, *d* 17–20, *e* 18–20, *f* 17–18, *h*₁ 14–17, *h*₂ 19–29. Distances between setae: *v*₂–*v*₂ 35–37, *v*₂–*sc*₂ 25–31, *c*₁–*c*₁ 43–45, *c*₁–*c*₂ 50–52, *d*–*d* 81–90, *e*–*f* 21–24, *f*–*f* 18–21, *h*₁–*h*₁ 18–22, *h*₁–*h*₂ 9–10.

Idiosomal venter (Figs 1B, 4B, 5A, C, 6C). Ventral plates weakly punctate (Figs 5A–C). Ventral setae *ps* barbed and blunt-ended; other ventral setae smooth and pointed. Setae *2a*, *3a*, *3c*, *4a*, *4b* and *4c* with thickened base (Figs 5A, C). Apodemes 1 absent, apodemes 2 (*ap2*) well developed, just reaching prosternal apodeme (*appr*); sejugal apodeme (*apsej*) well developed laterally and indistinct in central part; apodemes 3 absent; apodemes 4 (*ap4*) well developed, but not joining each other medially; apodemes 5 (*ap5*) short, located near bases of trochanters IV; poststernal apodeme (*appo*) present, very short. Anterior part of poststernal plate with fine striation. Lengths of ventral setae: *1a* 9–13, *2a* 26–31, *3a* 25–26, *3c* 25–26, *4a* 24–26, *4b* 20–23, *4c* 23–25, *ag* 20–26, *ps* 15–17. One specimen with additional abnormal seta *ps* (Fig. 6C).

Legs (Figs 2, 3). Leg I (Fig. 2A) much thicker than other legs. Leg setation: Tr 1, Fe 3, Ge 4, TiTa 17(2). Tibiotarsus with massive claw and bifurcate structure opposing to claw. Solenidia ω 8–9 and ϕ 9–10 weakly clavate. Seta *k* thickened and flattened in middle part. Setae (*tc*), (*ft*) and *p'* eupathidium-like; seta *p''* thin, smooth, pointed and apparently not eupathidium-like. Setae *pl'*, *d* and *v''* of

Fig. 5. DIC micrographs of *Paracarophenax bambergensis* female: A—prosoma in ventral view, B—prosoma in dorsal view, C—metapodosoma in ventral view, D—tergites D, EF, and H.

tibiotarsus very long, whip-like; seta *l'* of femur, *pl'*, *k*, *p''* and *v''* of tibiotarsus smooth; other leg setae (except eupathidia) weakly barbed. Setae *d*, *l'v''* of femur, (*l*), (*v*) of genu and *k* of tibiotarsus blunt-ended; other leg setae (except eupathidia) pointed. Leg II (Fig. 2B). Leg setation: Tr 1, Fe 3,

Ge 3, Ti 4(1), Ta 7(1). Solenidia ω 7–8 and ϕ 8–9 weakly clavate. Tarsus with pair of simple claws and tongue-like empodium. Setae *pl''* and *p''v''* spine-like, smooth; setae *tc''* and (*u*) smooth; other leg setae weakly barbed. Setae *d*, *v''* of femur, *l''* of genu, and *l'* of tibia blunt-ended; other leg setae

Fig. 6. DIC micrographs of *Paracarophenax bambergensis* female: A—pharynx, B—gnathosomal apodeme and tracheae, C—aggenital and pseudanal plates in ventral view. Arrow points to abnormal seta *ps*.

pointed. Leg III (Fig. 3A). Leg setation: Tr 1, Fe 2, Ge 3, Ti 4, Ta 7. Claws and empodium as on tarsus II. Seta *pv*'' spine-like, smooth; setae *tc*'' and *pl*'' and *(u)* smooth; other leg setae weakly barbed. Setae *v*' of trochanter, *d* of femur, and *l*'' of genu blunt-ended; other leg setae pointed. Leg IV (Fig. 3B). Leg setation: Tr 1, Fe 2, Ge 2, Ti 4, Ta 6. Claws and empodium as on tarsus II. Seta *pv*'' spine-like, smooth; setae *tc*'' and *(u)* smooth; other leg setae weakly barbed. Setae *v*' of trochanter, *d*, *v*' of femur and *l*'' of genu blunt-ended; other leg setae pointed.

Male unknown.

Material examined. Eight females, Tula Region, vicinity of Suvorov town, 54°07'13.1"N, 36°30'03.4"E, 30 July 2018, under elytra of *Amphotis marginata* (Coleoptera: Nitidulidae), coll. V.V. Abramov.

DISCUSSION

Among all described *Paracarophenax* species, *P. bambergensis* possesses the most complete set of plesiomorphic characters such as: 1) aggenital setae present, 2) pseudanal setae present, 3) setae *e* present, 4) setae *h*₂ present, short poststernal apodeme present, 5) trochanters I and II with seta, 6) genu I with four setae, 7) seta *p*'' not eupathidium-like, 8) femur II with three setae, 9) genu II with three setae, 10) femur III with two setae, 11) genu III with three setae, 12) tarsi II and III with seven setae, 13) femur IV with two setae, 14) genu IV with two setae, tarsus IV with six setae. Similar characters are found only in type species *P. dybasi*. However, the type species is more derived in having apodemes 1 and in poststernal apodeme being absent.

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