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Article

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A new species of the genus *Acarophenax* (Acari: Heterostigmatina: Acarophenacidae) associated with *Sphindus* sp. (Coleoptera: Sphindidae) from Iran

Vahid Rahiminejad and Hamidreza Hajiqanbar*

Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, 14115-336, Tehran, Iran; E-mail: hajiqanbar@modares.ac.ir

* Corresponding author

Abstract

The mite *Acarophenax sphindi* **sp. nov.** (Acari: Heterostigmata) collected under head of the host beetle, *Sphindus* sp. (Coleoptera: Sphindidae) is described and illustrated from Oak forests of Golestan Province, northern Iran. It is first record of the beetle family Sphindidae (Col.: Cucujoidea) as an acarophenacid host. Moreover, host range of the genus is reviewed and a key to world species of the genus *Acarophenax* Newstead and Duvall, 1918, is provided.

Key words: Cucujoidea; Gorgan city; mite;parasitoid; Prostigmata.

Introduction

The family Acarophenacidae (Acari: Prostigmata) includes 35 species in 7 genera (Walter *et al*. 2009). These mites are egg parasitoids of their insect hosts in several beetle families such as Cerambycidae, Cucujidae, Dermestidae, Nitidulidae, Curculionidae (Scolytinae) and Tenebrionidae (Goldarazena *et al.* 1999). One of the largest genera is *Acarophenax* Newstead & Duvall, 1918 whose members may be (speculatively) useful as biological control agents (Faroni *et al.* 2000), because they parasitizing graminivorous beetles of the genera *Tribolium* MacLeay, *Cryptolestes* Ganglbauer and *Alphitobius* Stephens (Kaliszewski *et al.* 1995).

Currently there are 11 species in the genus *Acarophenax* including the new species described here (see Table 1). It has to be mentioned that *A. makros*, was reported for the first time, as *A. mahunkai* by Gao and Zou (1994), but then renamed by Ostoja-Starzewski and Fleming (2003). There were three other species that previously were classified in the genus *Acarophenax*. The *A. bambergensis* Krczal collected from under elytra of nitidulid beetles (Col.: Nitidulidae) from Germany and *A. dermestidarum* Rack collected from *Dermestes* spp. (*D. frischii* Kugelann, *D. haemorrhoidalis* (Kuster), *D. carnivorus* Fabricius, *D. maculates* DeGeer, *D. ater* DeGeer, *D. peruvianus* Castelnau and *Necrobia rufipes* Fabricius (Cleridae) were transferred to the *Paracarophenax* by Cross (1965). Also, the *A. nicolae* Krczal, 1959 collected from lichens in Germany was transferred to *Adactylidium* by Cross (1965).

During a study of heterostigmatic mites associated with Coleoptera in Golestan province, northern Iran, we found a new species of the genus *Acarophenax* under the

head of *Sphindus* sp. (Coleoptera: Sphindidae). The main purpose of this paper is to describe the new species. In addition, host range of the genus is reviewed and a key to world species of the genus is provided.

Materials and methods

Host beetle was captured by light trap in Oak forest, Naharkhoran, Golestan province, northern Iran in 2010. Mite specimens were cleared in lactophenol and mounted in Hoyer's medium. The morphology of the mites was studied by a light microscope with phase contrast illumination (Olympus BX51, Tokyo. Japan). The terminology used in the description follows that of Lindquist (1986). All measurements in the description are given in micrometers (μm) for the holotype and one paratype (in parenthesis). Coordinates of geographical position were recorded using a global positioning system (GPS model: eTrex).

The holotype and paratype of the new species are deposited in the Acarological Collection, Department of Entomology, Faculty of Agriculture, Tarbiat Modares University, Tehran, Iran.

Systematics

Family Acarophenacidae Cross, 1965
Genus *Acarophenax* Newstead and Duvall, 1918

Acarophenax sphindi sp. nov. (Figs. 1–7)

Differential diagnosis

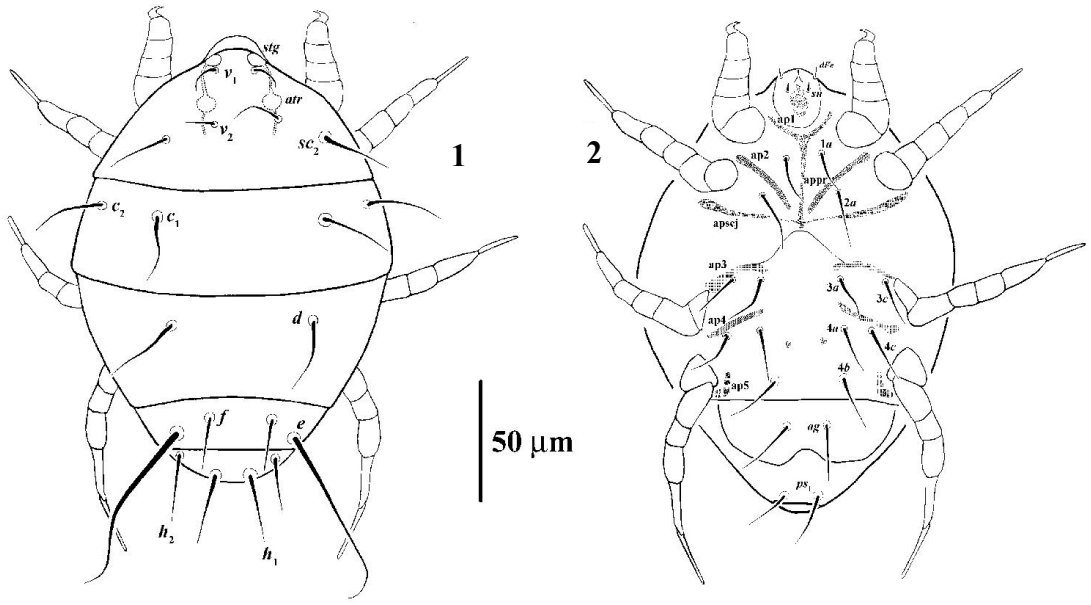
The new species is similar to three species of the *Acarophenax* i.e. *A. rackae*, *A. tribolii* and *A. meropsi* by having setae *e* at least 3 times longer than *f*. The new species differs from *A. rackae* by setae *e* more than two times longer than sc_2, c_1, c_2 and *d* (setae *e* subequal to sc_2, c_1, c_2 and *d* in *A. rackae*); setae *d* not extending to posterior border of tergite D (setae *d* extending to posterior border of tergite D in *A. rackae*); all setae on tarsus II seta-like (two strongly dilated setae on tarsus II in *A. rackae*). The new species differs from *A. tribolii* Newstead & Duvall, 1918 (sensu Cross, 1965) by setae c_1, c_2 and *d* thin (setae c_1, c_2 and *d* robust in *A. tribolii*); setae *e* at least two times longer than *d* (setae *e* shorter than *d* in *A. tribolii*). The new species also differs from *A. meropsi* Rakha & Kandeel by setae *e* at least two times longer than setae *d* (setae *e* nearly as long as setae *d* in *A. meropsi*); tarsus I solenidion ω_1 short (tarsus I solenidion ω_1 very long and thin in *A. meropsi*).

Female - Length of idiosoma 180 (173), width 125 (119).

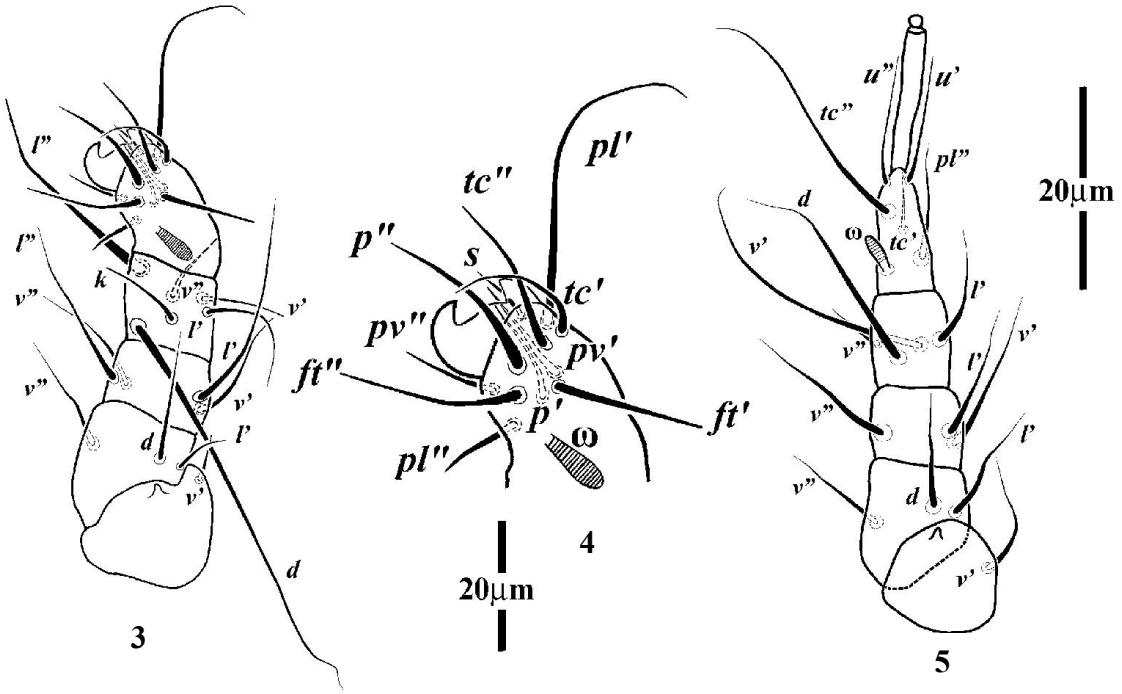
Gnathosoma (Figs. 1, 2) - Gnathosomal capsule dorsally fused with idiosoma and weakly separate from ventral surface, and ventrally with one pair of needle-like subcapitular seta *su* 4 (3); each palpi dorsally with one needle-like seta *dFe* 4 (3); chelicerae indiscernible; pharynx oval.

Idiosomal dorsum (Fig. 1) - Body wide, approximately ovoid; rounded stigmata and atria visible in anterior part of prodorsal shield; all dorsal setae smooth and pointed; prodorsal shield with three pairs of setae v_1 12 (12), v_2 15 (16) and sc_2 20 (22); all tergites smooth, tergite C with two pairs of setae c_1 27 (27) and c_2 28 (27), setae c_2 as long as c_1, and setae c_1 placed more posteriorly than c_2, setae c_1 and c_2 not extending the posterior border of tergite C, posterior border of tergite C rounded; tergite D with setae *d* 32 (33), setae *d* not extending posterior border of tergite D; tergite EF with two pairs

of setae *e* 70 (73) and *f* 17 (18), setae *e* more than three times longer than setae *f*; tergite H with two pairs of setae h_1 27 (26) and h_2 26 (26); distances between dorsal idiosomal setae: v_1–v_1 26 (27), v_2-v_2 32 (32), sc_2- sc_2 61 (62), c_1–c_1 60 (62), c_2–c_2 103 (104), *d*–*d* 57 (59), *e*–*e* 58 (58), *e*–*f* 15 (15), *f*–*f* 33 (34), h_1–h_1 19 (19), h_1–h_2 18 (19), h_2–h_2 46 (48).



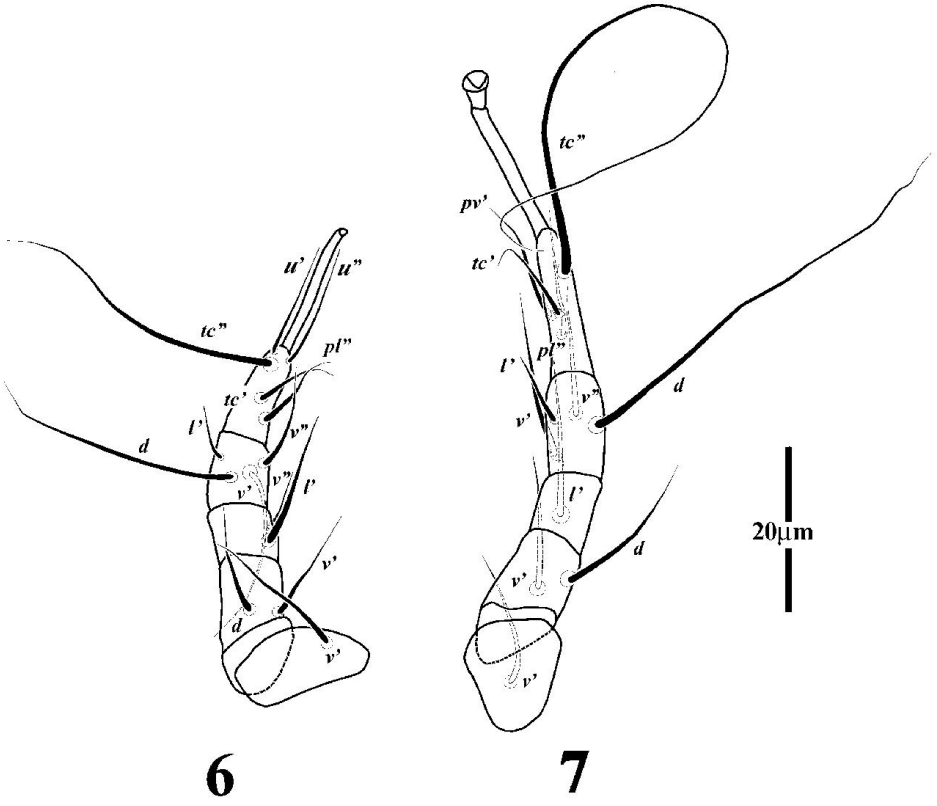
Figures 1–2. *Acarophenax sphindi* **sp. nov.** - 1. Dorsal view of body; 2. Ventral view of body.



Figures 3–5. *Acarophenax sphindi* **sp. nov.** – 3. Leg I; 4. Tarsus of Leg I; 5. Leg II.

Idiosomal venter (Fig. 2) - Ventral plates smooth; all ventral setae smooth and pointed; apodeme 1 reaching to prosternal apodeme (appr), apodeme 2 not reaching to prosternal apodeme, sejugal apodeme (apsej) extending and reaching to appr, apodemes

3, 4 and 5 vestigial and not reaching to center, poststernal apodeme (appo) absent; anterior border of poststernal plate with a distinct projection, its posterior border straight; coxal fields I with one pair of setae 1*a* 27 (26); coxal fields II with one pair of setae 2*a* 29 (29), setae 1*a* and 2*a* subequal; coxal fields III with two pairs of setae 3*a* 26 (25) and 3*c* 25 (25), 3*a* and 3*c* subequal; coxal fields IV with three pair of setae 4*a* 31(31), 4*b* 31 (31) and 4*c* 29 (30); aggenital plate with one pair of setae *ag* 35 (36), and with a medial incision; plate PS with only one pair of setae ps_1 25 (24), ps_1 shorter than *ag*.



Figures 6-7. *Acarophenax sphindi* **sp. nov.** – 6. Leg III; 7. Leg IV.

Figure 8. *Sphindus* sp. (Col.: Sphindidae), the host beetle of *Acarophenax sphindi* **sp. nov.**

Table 1. Host/habitat and distribution of species of the genus *Acarophenax*.

Species	Host/Habitat	Distribution	Reference
A. tribolii	*Tribolium* spp., *Gnathocerus cornutus* (F.), *Latheticus oryzae* Waterhouse, *Palorus ratzeburgi* (Wissmannn) (Col.: Tenebrionidae); *Sciara hirtilineata* Brunetti (Dip.: Sciaridae)	Worldwide	Krczal (1959), Wadhi and Kishore (1975), Oliveira *et al*. (2007)
A. traegardhi	*Macrotermes natalensis* (Haviland) (Isoptera: Termitidae)	Africa	Krczal (1959)
A. nidicolus	*Cryptolestes ferrugineus* (Stephens) (Col.: Laemophloeidae)	USA	Cross and Krantz (1964)
A. lacunatus	Debris in nest of *Colaptes cafer* (L.) (Aves: Picidae); *Rhyzopertha dominica* (F.) (Col.: Bostrichidae); *Tribolium castaneum* (Herbst) (Tenebrionidae); *Cryptolestes ferrugineus* (Stephens) (Laemophloeidae)	USA, Morocco	Cross and Krantz (1964) Ostoja-Starzewski and Fleming (2003), Oliveira *et al*. (2003)
A. assanovi	*Rhizopertha dominica* (Fabricius) (Bostrichidae)	Uzbekistan	Livshitz and Mitrofanov (1974)
A. meropsi	*Merops apiaster* (L.) (Aves: Meropidae)	Egypt	Rakha and Kandeel (1983)
A. lukoschusi	Guano of *Taphozous nudiventris* (Cretzschmar) (Chiroptera: Emballonuridae); a sphecid wasp (Hym.: Sphecidae)	Cameron	Mahunka and Fain (1989) Walter *et al*. 2009
A. rackae	sheep dung; *Tribolium confusum* (Jacquelin du Val) (Col.: Tenebrionidae)	Egypt, Iran	Mahunka and Zaki (1990) Hajiqanbar *et al*. (2011)
A. mahunkai	*Alphitobius diaperinus* (Panzer), *Tenebrio molitor* (L.) (Tenebrionidae); *Helicoverpa zea* (Boddie), *Pseudoplusia includens* (Walker), *Anticarsia gemmatalis* (Hubner), *Heliothis virescens* (F.) (Lep.: Noctuidae); *Epilachna varivestis* (Mulsant) (Col.: Coccinellidae); *Cotinis nitida* (L.) (Scarabaeidae); *Galleria mellonella* (L.) (Lep.: Pyralidae)	USA, Iran	Steinkraus and Cross (1993) Hajiqanbar (2010)
A. makros	Chicken manure heap	China	Gao and Zou (1994)
A. sphindi	*Sphindus* sp. (Col.: Sphindidae)	Iran	Present study

Legs - Leg I - thicker and shorter than other legs (Figs. 3 & 4); setal formula: Tr1-Fe3-Ge4-Ti6-Ta11(ω) (number of solenidia in parenthesis). Tarsus (Figs. 3, 4) with solenidion ω 8 (8) finger shaped, with six blunt-ended eupathidial setae (*p'*, *p"*, *ft'*, *ft"*, *tc'*, *tc"*), seta *pl'* whip-like and longest on tarsus, seta *pv'* as long as *pv"*; tibia with one eupathidium *k*, seta *d* longest on leg I, setae *v"* and *v'* subequal, seta *l"* longer than *l'*; genu with setae *l"* and *l'* subaqual and longer than *v'* and *v"*; femur with setae *d* and *v"* subequal and longer than *l'*; trochanter with seta *v'*.

Leg II (Fig. 5) - Setal formula: Tr1-Fe3-Ge3-Ti4-Ta5(ω). Tarsus with solenidion ω 6 (6) prominent and finger shaped, seta *tc"* whip-like and longest on leg II; tibia with setae *d* and *v'* longer than *l'*, *v"* shorter than length of the segment; genu with setae *v'* and *v"* subequal, both longer than *l'*; femur with three setae *l'*, *d* and *v"* subequal; trochanter with seta *v'*.

Leg III (Fig. 6). Setal formula: Tr1-Fe2-Ge2-Ti4-Ta5. Tarsus with seta *tc"* whip-like and longest on TaIII; tibia with seta *d* whip-like and longer than seta *v'*, seta *v'* two times longer than seta *l'*; genu with setae *l'* longer than *v"*; femur with two subequal setae *v'* and *d*; seta *v'* on trochanter longer than femoral setae.

Leg IV (Fig. 7). setal formula: Tr1-Fe2-Ge1-Ti4-Ta4. Tarsus with seta *tc"* whip-like and long; tibia with seta *d* longer than other tibial setae, seta *l'* shortest and half as long as *v"*; genu with only seta *l'* as long as tibial seta *v'*; femur with two subequal setae *d* and *v'*; trochanter with seta *v'* as long as femoral seta *v'*.

Male and larva unknown.

Type material - Holotype female (VR2010-1) and one paratype detached from under head of *Sphindus* sp. (Coleoptera: Sphindidae). The host beetle (Fig. 8) was collected by light trap from Oak trees in the Naharkhoran forest, Golestan province, northern Iran, 36.46°N, 54.27°E, and altitude 450 m, coll. V. Rahiminejad, 6 July 2010.

Etymology

The name of the new species, "*sphindi*" refers to generic name of the host beetle, *Sphindus*.

Discussion

Heretofore, there was no record of association between acarophenacid mites and sphindid beetles (see Table 1). The only record of association between mites of the genus *Acarophenax* and beetles of the superfamily Cucujoidea was reported by Cross and Krantz (1964) for *A. nidicolus* exploiting *Cryptolestes ferrugineus* (Stephens) (Col.: Cucujidae). The newly described species have extended the host range of the *Acarophenax* and Acarophenacidae to the family Sphindidae. The Sphindidae is a primitive family of the superfamily Cucujoidea that occurs worldwide, with 61 species representing nine genera. All sphindid beetles are myxomycophagous, and all stages normally occur on or inside slime mold sporocarps, where adults and larvae feed on the spores and supporting structures (Arnett *et al*. 2002).

Key to world species of the genus *Acarophenax* (females)

1. Apodemes with strong form; apodemes 4 reaches the anterior edge of metapodosoma ……..……. *A. traegardhi* (Trägårdh)
- Apodemes with no strong form; apodemes 4 do not reach the anterior edge of metapodosoma……... 2
2. Setae *e* and *f* nearly equal in length or setae *f* less than two times longer than *e* 3
- Setae *e* at least three times longer than *f* ……..…..……... 8
3. Trochanters I-IV without setae ……..….. *A. lacunatus* Cross and Krantz
- Trochanters I-IV with one seta each ……..… 4
4. Posterior margin of tergites waved; setae *f* slightly longer than *e*…… ……..……. *A. assanovi* Livshitz and Mitrofanov

- Posterior margin of tergites straight; setae *e* and *f* equal in length, or setae *e* slightly longer than *f* …… 5
5. All setae on tarsus II simple and thin ……. *A. nidicolus* Cross and Krantz
- At least one seta on tarsus II strongly thickened ……..…… 6
6. Two setae (*pl″* and *pv″*) on tarsus II strongly thickened ……..…… ……...…….. *A. lukoschusi* Mahunka and Fain
- One seta (*pv″*) on tarsus II strongly thickened …….. 7
7. All setae on genu I simple and thin ..……. *A. makros* (Gao and Zou)
- Genu I with stout, blunt and spiculate seta *v″* …. *A. mahunkai* Steinkraus and Cross
8. Setae *e* longer than *d* …… *A. sphindi* **sp. nov.**
- Setae *e* and *d* subequal, or setae *e* shorter than *d* ……..……..…..…. 9
9. Setae c_1, c_2 and *d* robust; *e*, *f*, h_1 and h_2 fine; setae *e* distinctly shorter than setae *d* ……..…… *A. tribolii* Newstead and Duvall (sensu Cross, 1965)
- Setae c_1, c_2, *d, e* and *f* fine and identical in form and thickness; setae *e* nearly as long as *d* ……..…… 10
10. Solenidion ω of tarsus I very long, thin, much longer than lanceolate seta *k*; all setae on tarsus II normal, setiform …….…... *A. meropsi* Rakha and Kandeel
- Solenidion ω of tarsus I short, spindle-shaped, much shorter than seta *k*; two strongly dilated setae (*pl″* and *pv″*) on tarsus II …...… *A. rackae* Mahunka and Zaki

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گونهٔ جدیدی از کنه‌های جنس *Acarophenax* (Acari: Heterostigmatina: Acarophenacidae) در ارتباط با سوسک *Sphindus* sp. (Coleoptera: Sphindidae) از ایران

وحید رحیمی نژاد و حمیدرضا حاجی‌قنبر*

گروه حشره‌شناسی، دانشکده کشاورزی، دانشگاه تربیت‌مدرس، تهران، ایران؛ رایانامه: hajiqanbar@modares.ac.ir

* نویسندهٔ مسئول

چکیده

کنه *Acarophenax sphindi* **sp. nov.** (Acari: Heterostigmata) از قسمت زیرین سر سوسک میزبان، *Sphindus* sp. (Coleoptera: Sphindidae) از جنگل‌های بلوط استان گلستان، شمال ایران، جمع آوری و توصیف شد. این نخستین گزارش میزبانی سوسک‌های خانواده Sphindidae (Col.: Cucujoidea) به عنوان میزبان کنه‌های Acarophenacidae است. همچنین، دامنهٔ میزبانی این جنس مورد بازبینی قرار گرفته و کلیدی برای تمامی گونه‌های جنس *Acarophenax* Newstead and Duvall, 1918 فراهم شده است.

واژگان کلیدی: Cucujoidea، شهر گرگان، کنه، پارازیتوئید، پیش‌استیگمایان.

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