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Feather mites of the genus *Zachvatkinia* Dubinin, 1949 (Astigmata: Analgoidea: Avenzoariidae) from Saudi Arabia: A new species and two new records

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Abstract

Feather mites of the family Avenzoariidae (Acari: Astigmata: Analgoidea) are recorded for the first time in Saudi Arabia. A new avenzoariid species, *Zachvatkinia* (*Zachvatkinia*) *repressae* **sp. n.** (Avenzoariidae: Bonnetellinae), is described from the White-cheeked Tern, *Sterna repressa* Hartert, 1916 (Charadriiformes: Sternidae). The new species belongs to the *sternae* group and is closely related to *Z.* (*Z.*) *chlidoniae* Mironov, 1989a. Two more species, *Z.* (*Z.*) *dromae* Mironov, 1992 and *Z.* (*Z.*) *sternae* (Canestrini & Fanzago, 1876), were collected from the Crab Plover *Dromas ardeola* Paykull, 1805 (Charadriiformes: Dromadidae) and the Sooty Gull *Ichthyaetus hemprichii* (Bruch, 1853) (Charadriiformes: Laridae), respectively. Among the 18 described species of *Zachvatkinia* Dubinin, 1949, including the new species, this is the fifth species recorded from a sternid host. The remaining 13 nominal species are associated with birds of the families Diomedeidae, Dromadidae, Hydrobatidae, Laridae, Pelecanoididae, Procellariidae and Stercorariidae. A checklist of world species of *Zachvatkinia* with data on their distribution and type hosts is also provided.

Key words: Astigmata, feather mites, Avenzoariidae, Bonnetellinae, new species, *Zachvatkinia*, Saudi Arabia

Introduction

The feather mite genus *Zachvatkinia* Dubinin, 1949 (Astigmata: Analgoidea: Avenzoariidae: Bonnetellinae) was originally established by Trouessart (1916) under the name *Giebelia* Trouessart, 1916. Since the latter name appeared preoccupied, Dubinin (1949) proposed a replaced name *Zachvatkinia*. This genus currently includes 18 nominal species (Buchholz 1869; Canestrini & Fanzago 1876; Bonnet 1924; Dubinin 1949; Chirov 1978; Mironov 1989a, b, 1991b, 1992; Mironov & Stefan 2013) (Table 1). Mironov (1989b) divided the genus into two subgenera, *Zachvatkinia* and *Rhinozachvatkinia*, on the basis of the structure of their gnathosoma and form of setae *mG* of genua I. The most extensive work on this genus has been done by Mironov (1989a, b, 1991a, b, 1992). Representatives of this genus occur on various avian families of the orders Charadriiformes (Dromadidae, Laridae, Stercorariidae and Sternidae) and Procellariiformes (Diomedeidae, Hydrobatidae, Pelecanoididae and Procellariidae) (Table 1).

Including mites, external parasites of wild birds are poorly studied in Saudi Arabia (El-Ahmed *et al.* 2012). Bafort and Fain (1984) reported endoparasitic hypopi of *Phalacrodectes* (*Peledectes*) *punctatissimus* Cerny, 1969 and *Pelecanectes apunctatus* Pence & Courtney, 1973 (Sarcoptiformes: Hypoderoidea: Hypoderidae) from the air sacs of the Great White Pelican, *Pelecanus onocrotalus* Linnaeus, 1758 (Pelecaniformes: Pelecanidae) in Dammam, Eastern province. The present study is a first step in surveying the ectoparasite fauna associated with marine birds in Saudi Arabia.

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This present work contributes to the knowledge of Asian feather mites by describing a new *Zachvatkinia* species from the White-cheeked Tern, *Sterna repressa* Hartert, 1916 (Charadriiformes: Sternidae). We also report for the first time two more species of the genus *Zachvatkinia* for Saudi Arabia.

TABLE 1. Checklist of *Zachvatkinia* subgenera and species with distribution and type hosts.

Mite species	Type host	Host family	Type locality	Reference
Zachvatkinia (*Rhinozachvatkinia*) *graciosa*	*Pachyptila desolata*	Procellariidae	South Georgia Island	Mironov, 1989b
Z. (*R.*) *pelecanoidi*	*Pelecanoides georgicus*	Pelecanoididae	South Georgia Island	Mironov, 1989b
Z. (*R.*) *zygoloba*	*Oceanodroma leucorhoa*	Hydrobatidae	South Georgia Island	Mironov, 1989b
Z. (*Zachvatkinia*) *caspica*	*Hydroprogne caspia*	Sternidae	Russia: Volga delta	Mironov, 1989a
Z. (*Z.*) *chlidoniae*	*Chlidonias niger*	Sternidae	Russia: Volga delta	Mironov, 1989a
Z. (*Z.*) *dromae*	*Dromas ardeola*	Dromadidae	Madagascar	Mironov, 1992
Z. (*Z.*) *hydrobatidii*	*Oceanites oceanicus*	Hydrobatidae	USA: Massachusetts	Dubinin, 1949
Z. (*Z.*) *isolata*	*Stercorarius parasiticus*	Stercorariidae	Russia: Ainovy Islands	Mironov, 1989a
Z. (*Z.*) *issykkulica*	*Sterna albifrons*	Sternidae	Kirghizia	Chirov, 1978
Z. (*Z.*) *larica*	*Larus ridibundus*	Laridae	Russia: Volga delta	Mironov, 1989a
Z. (*Z.*) *oceanodromae*	*Oceanodroma melania melania*	Hydrobatidae	Russia: Komandor Islands	Mironov, 1989a
Z. (*Z.*) *ovata*	*Calonectris diomedea borealis*	Procellariidae	North-East-Atlantic	Mironov, 1989a
Z. (*Z.*) *oxyloba*	*Dromas ardeola*	Dromadidae	Madagascar	Mironov, 1992
Zachvatkinia (*Z.*) *puffini*	*Procellaria cinerea*	Procellariidae	Madagascar	Buchholz, 1869
Z. (*Z.*) *stercorarii*	*Stercorarius pomarinus*	Stercorariidae	Russia: Wrangel Island	Dubinin, 1949
Z. (*Z.*) *sternae*	*Chlidonias niger*	Sternidae	Italy	Canestrini & Fanzago, 1876
Z. (*Z.*) *trouessarti*	*Thalassarche chlororhynchos*	Diomedeidae	Antarctica	Bonnet, 1924
Z. (*Z.*) *repressae*	*Sterna repressa*	Sternidae	Saudi Arabia	Present study

Material and methods

During a field survey of the chewing lice fauna of birds of Saudi Arabia, one of us (M.G. Nasser) had the opportunity to examine three species of marine birds for mites. Breeding sites of these birds were located at three different islands: Farasan Archipelago (16º50'4"N, 42º1'38"E) for the crab plover; Umm Al-Malik Island, Red Sea (25º13'48"N, 37º8'37"E) for the sooty gull and Jana Island, Arabian Gulf (27º22'10"N, 49º53'53"E) for white-cheeked tern. The host species were identified using two different field guides to birds of the Middle East (Cottridge 2006; Porter & Aspinall 2010).

Birds were caught using two methods: a standard mist-net (mesh, 1.8cm × 0.12mm; size, 2m × 15m) for catching sooty gulls and crab plovers while ground traps were used to catch white-cheecked terns. Visual inspection was used to determine the presence of mites. Feather mites were visible along the shaft and/or between the barbs of the infested primary feathers. Mites were collected either by using a fine forceps or by cutting a part of the infested feather(s). The collected mites were preserved in 70% ethanol, and then brought to the Acarology Laboratory at King Saud University for identification. Mite specimens were mounted in Hoyer's medium and examined under a phase-contrast microscope (DM2500, Leica®, Germany). Drawings were made using a drawing tube (Olympus®, Japan) attached to the microscope. Images of mites were taken with an Auto-Montage software

system (Syncroscopy®, Cambridge, UK) with the aid of a camera (Q-Imaging, MicroPublisher 0.5 RTV) controlled by AcQuis image capture software. All measurements are presented in microns (μm).

The holotype and most of the paratypes are deposited at King Saud Museum of Arthropods, Riyadh, Saudi Arabia (KSMA) while a paratype male and female will be deposited at the Acarology Laboratory, Museum of Biological Diversity, The Ohio State University, 1315 Kinnear Road, Columbus, Ohio 43212, USA.

Family Avenzoariidae Oudemans, 1905

Subfamily Bonnetellinae Atyeo & Gaud, 1981

Genus *Zachvatkinia* Dubinin, 1949

Zachvatkinia (*Zachvatkinia*) *repressae* Negm & Alatawi sp. n.

(Figs. 1–9)

Type material. Male holotype (KSMA), 8 male and 18 female paratypes ex *Sterna repressa* Hartert, 1916 (Charadriiformes: Sternidae), Jana Island, Arabian Gulf, Saudi Arabia, 27º22'10"N, 49º53'53"E, 11 July 2012, leg. M.G. Nasser. Holotype, most male and female paratypes—KSMA; a paratype female and male—The Acarology Laboratory, Museum of Biological Diversity, The Ohio State University.

Description. *Male* (Figs. 1–5) (holotype, range for 4 paratypes in parentheses): gnathosoma length 100 (90–105), maximum width 80 (80–85). Idiosoma length 710 (650–720) from anterior end of propodosomal shield to level of bases of setae *h3* posteriorly, greatest width 340 (322–348) (Fig. 1). Propodosomal shield: subtriangular, posterolateral angles rounded, posterior margin straight or slightly convex and with a pair of small transversely directed extensions, surface of shield without ornamentation, length along midline 180 (166–180), maximum width 210 (200–228), lengths of scapular setae *si* 26 (24–26) and *se* 125 (122–126), distance between setae *se-se* 180 (173–180) (Fig. 3). Humeral shields well developed, setae *c2* 35 (32–36) situated on their anterior ends, lanceolate setae *c3* 45 (44–46) long and macrosetae *cp* 125 (122–128) long. Hysteronotal shield: anterior margin straight or slightly concave, anterior angles acute, length from anterior margin to the bases of setae *h3* 530 (515–542), width at anterior margin 300 (288–305). Openings of opisthosomal glands situated anterolateral to setae *e1*. Terminal cleft narrow, subtriangular, anterior end extending beyond level of setae *e2*, length of cleft from anterior end to bases of setae *h3* 250 (248–253). Setae *ps1* 60 (57–62) long, situated on lateral margins of supranal concavity, their tips almost extending to bases of setae *h3*. Macrosetae *h2* and *h3* with noticeably thickened basal part and with long filiform distal part. Distances between hysteronotal setae: *c2:d2* 165 (161–172), *d2:e2* 135 (134–143), *e2:f2* 132 (132–145), *f2:h2* 33 (25–33), *c1:d1* 82 (80–86), *d1:e1* 112 (100–114), *e1:h1* 188 (178–190), *h1:h3* 120 (116–122), *ps2:ps1* 45 (45–50).

Epimerites I fused into a Y, sternum without lateral extensions (Fig. 2). Setae *1a* 40 (38–41) long, situated on coxal fields I close to epimerites II. Coxal field II open. Epimerites III and IIIa fused, coxal field III closed, setae *3b* 50 (45–52) long. Setae *3a* 37 (35–38) long, situated approximately at same level with setae *3b*. Setae *4a* 37 (37–42) long, situated at same level with genital papillae. Distances between ventral setae: *1a:1a* 105 (102–110), *3b:3b* 205 (202–212), *4a:4a* 97 (95–99), *3a:3a* 45 (44–50), *g:g* 37 (36–42), *ps3:ps3* 48 (48–50). Distance from genital arch apex to level of setae *ps1* 230 (212–241). Genital arch shaped as inverted bowl, free ends of its branches directed outward (Fig. 4). Length of genital arch 37 (35–38), width 50 (47–54). Genital shields represented by small and narrow longitudinal strips widely separated from each other, setae *g* situated on posterior ends of genital shields. Adanal shields fused and form acute median extensions with two small lateral ledges. One pair of additional adanal sclerites shaped as inverted cups present, closely adjacent or poorly connected to adanal apodemes. Bases of setae *g* and *ps3* in subrectangular arrangement. Anal suckers rounded, 35 (32–37) in diameter. Legs III extend beyond lobar apices by full tarsus. Tarsus III with seta *s* thick, spine-like and tridentate apically (Fig. 5A). Tarsus IV with two dorsobasal spines and with one apical spine-like extension at base of modified seta *e* (Fig. 5B).

Female (Figs. 6–9) (range for 5 paratypes): gnathosoma length 80–90, width 70–80. Idiosoma: length 440–466 from anterior end of propodosomal shield to level of bases of setae *h3*, maximum width 280–310 (Fig. 6). Propodosomal shield: subtriangular in shape as in males, posterior margin conspicuously convex, without extensions, lateral angles with small notches posterior to bases of setae *se*, length along midline 122–130, width at

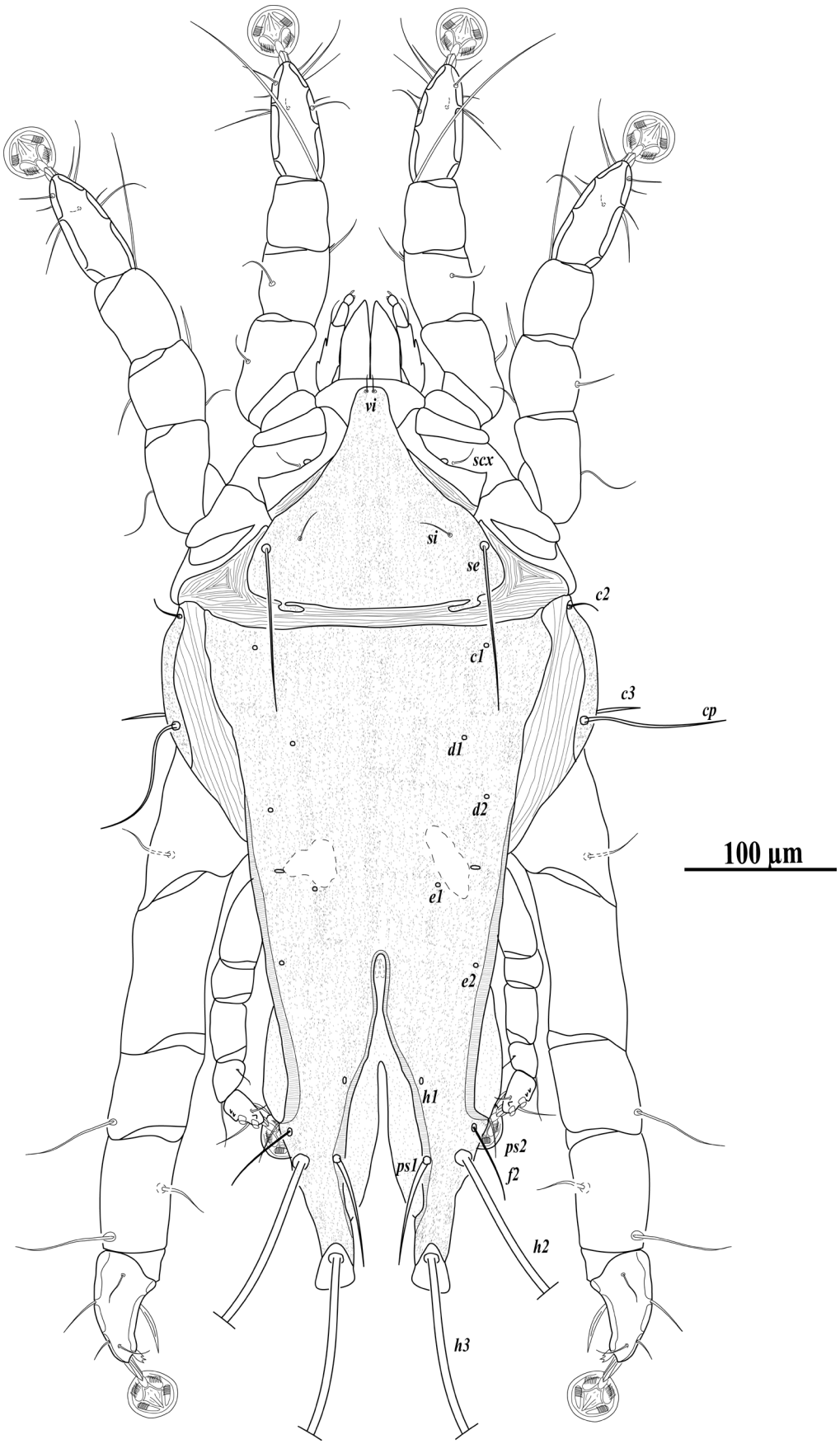


FIGURE 1. *Zachvatkinia repressae* **sp. n.**, male—dorsum.

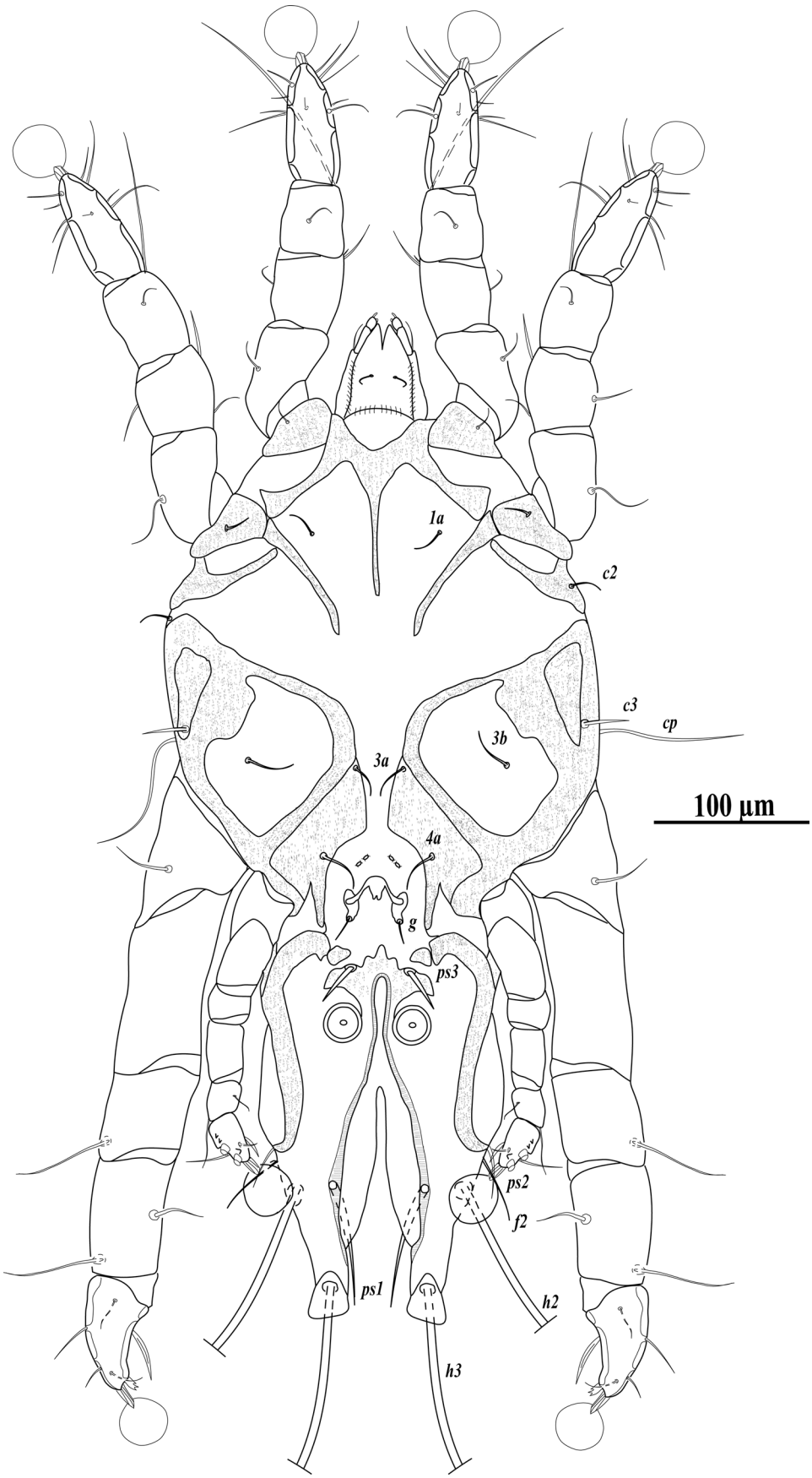
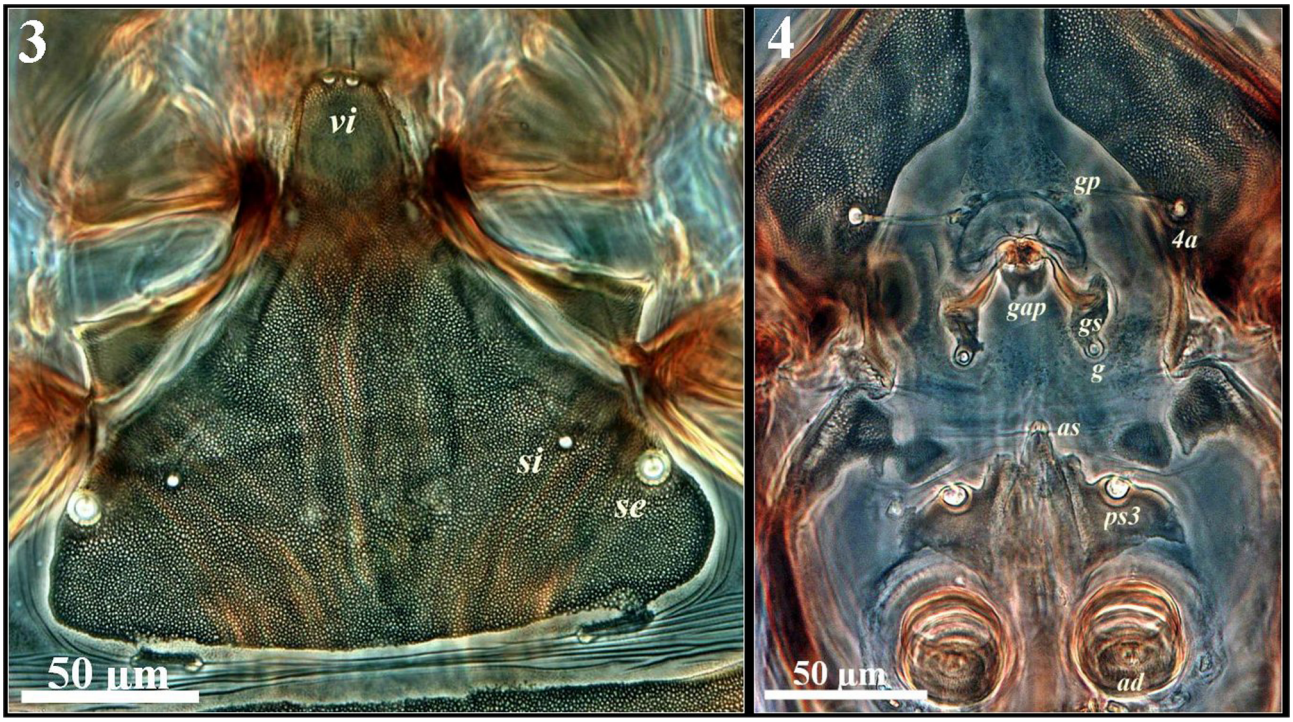


FIGURE 2. *Zachvatkinia repressae* **sp. n.**, male—venter.



FIGURES 3-4. *Zachvatkinia repressae* **sp. n.**, male—3, propodosomal shield. 4, genital area. Abbreviations: gp—genital papillae, gap—genital apparatus, gs—genital shield, as—adanal shield, ad—anal disk.

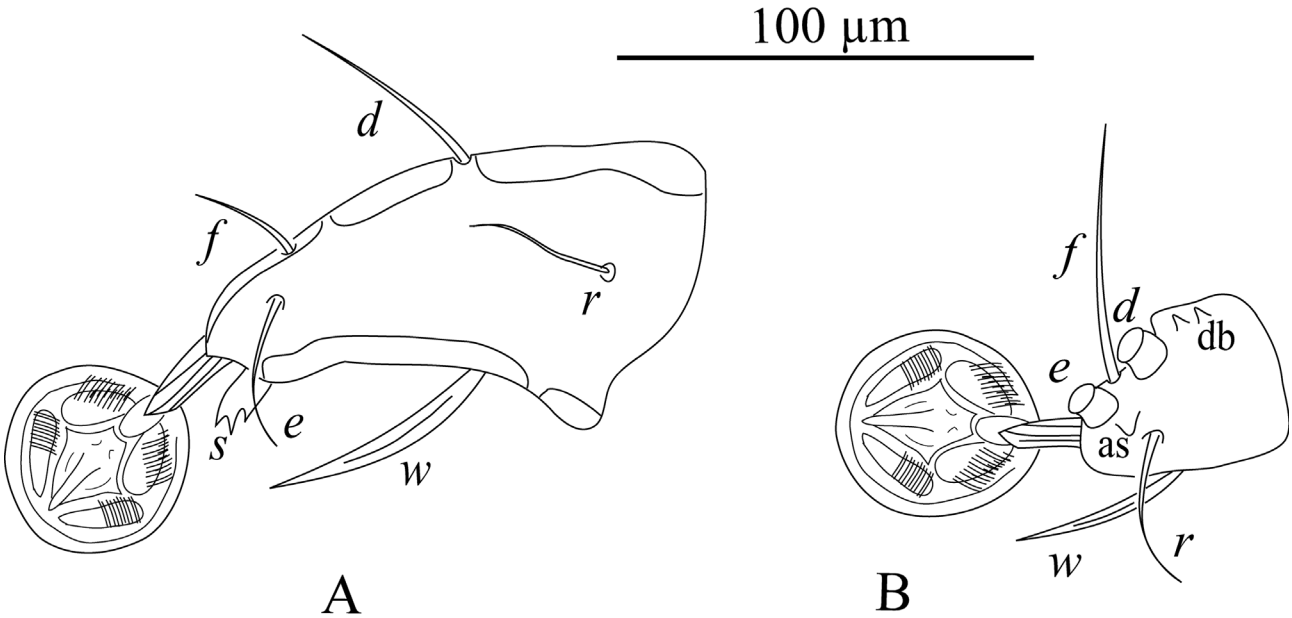


FIGURE 5. *Zachvatkinia repressae* **sp. n.**, male, A—tarsus III, B—tarsus IV. Abbreviations: as—apical spine-like extension, db—dorsobasal spine-like extensions.

the level of scapular setae *se* 144–150, distance between scapular setae *si-si* 92–100 (Fig. 8). One pair of small transverse sclerites situated between propodosomal shield and transverse row of setae *c1*, *c2*. Humeral shields narrow, not developed dorsally and not extending beyond anterior ends of hysteronotal shields. Setae *c2* situated off humeral shields. Humeral setae *cp* filiform, 80–88 long, subhumeral setae *c3* spiculiform, 33–37 long. Hysteronotal shields: one pair of large longitudinal shields along lateral body margins, separated by wide longitudinally striated area. Setae *d1* situated on median striated integument of hysterosoma, close to inner margins of hysteronotal shields. Pygidial shield present, length 21-25, width 70–76. Distances between hysteronotal setae: *c2:d2* 128–135, *d2:e2* 110–116, *c1:d1* 73–77, *d1:e1* 115–122.

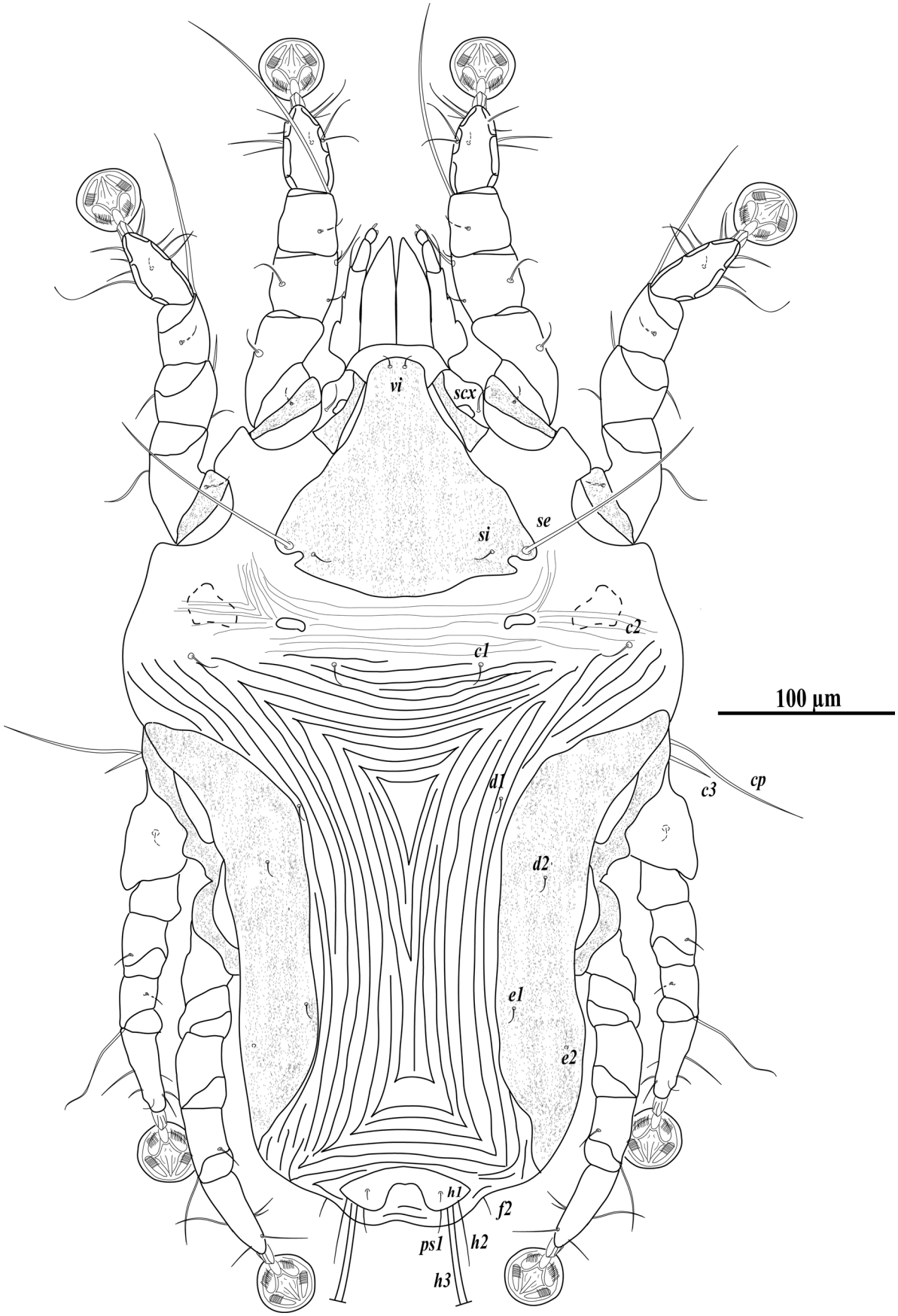


FIGURE 6. *Zachvatkinia repressae* **sp. n.**, female—dorsum.

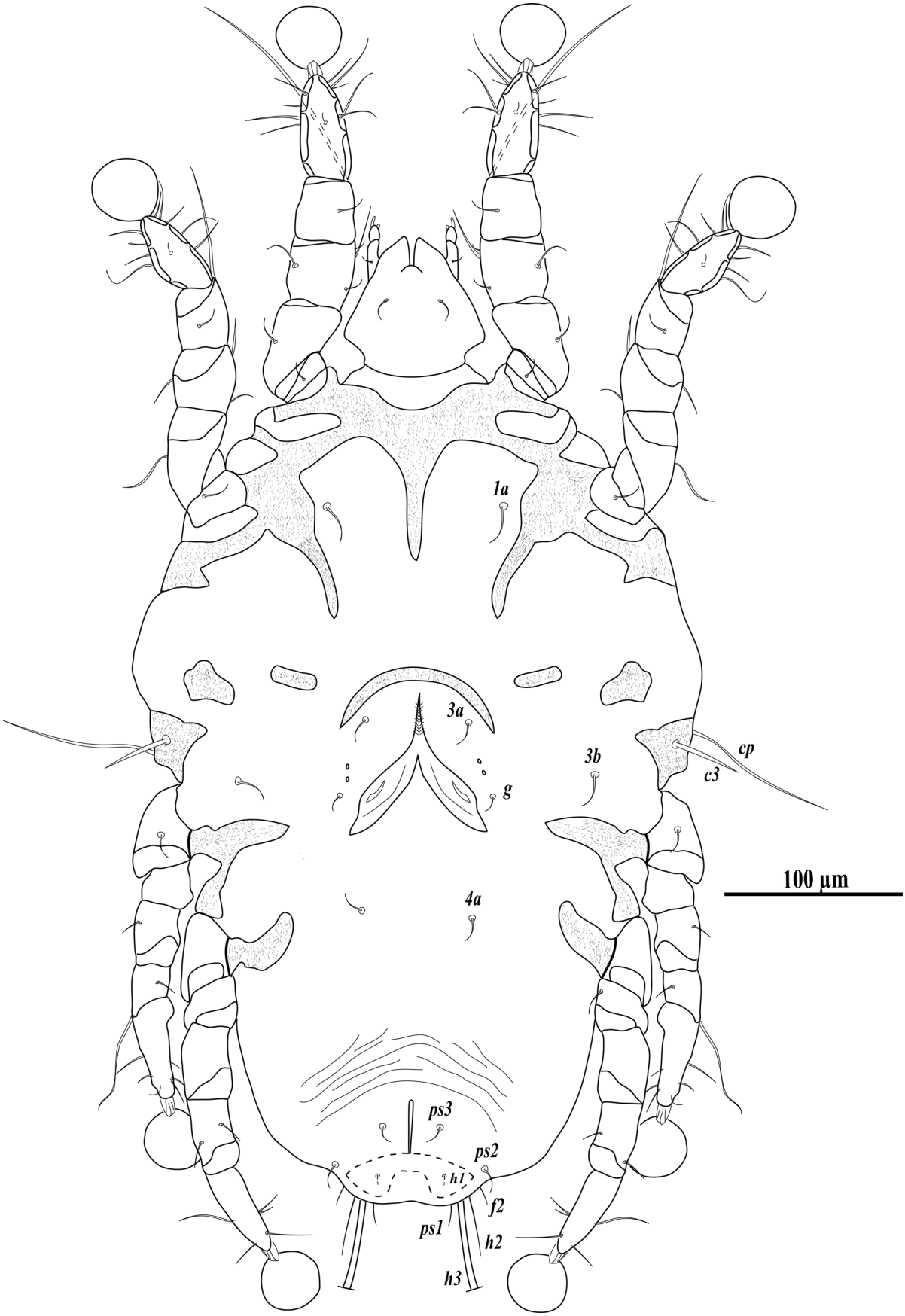
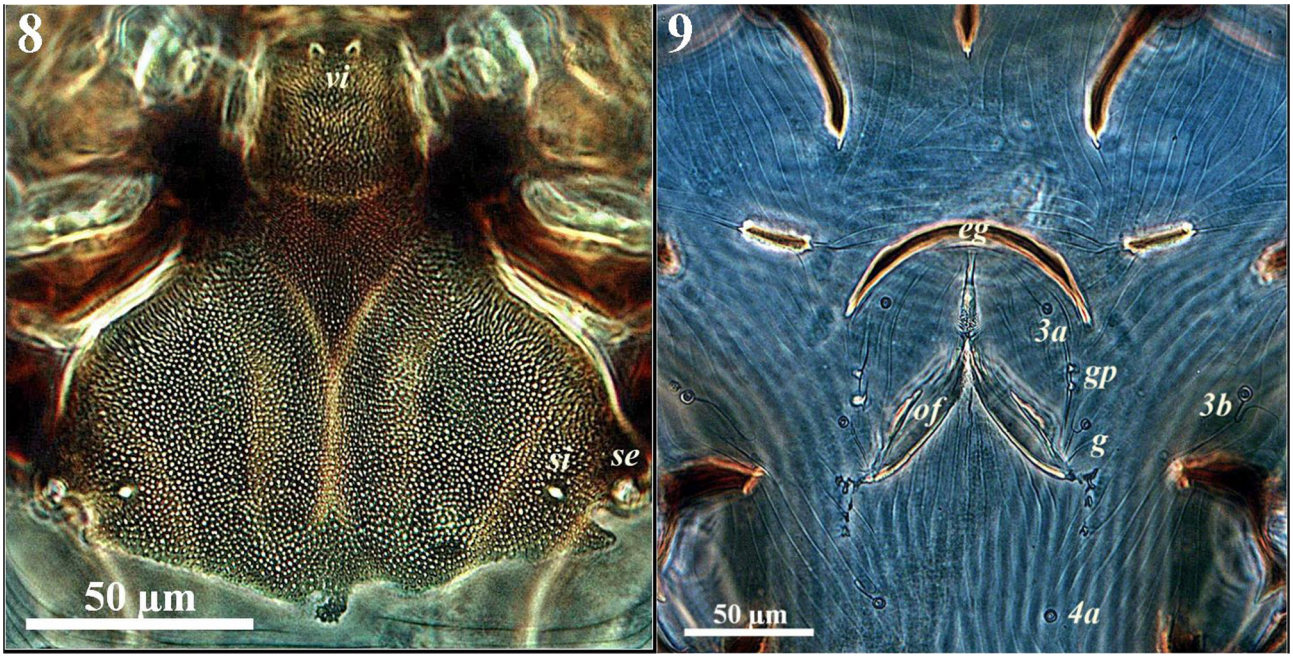


FIGURE 7. *Zachvatkinia repressae* **sp. n.**, female—venter.



FIGURES 8–9. *Zachvatkinia repressae* **sp. n.**, female—8, propodosomal shield. 9, genital area. Abbreviations: eg—epigynum, gp—genital papillae, of—oviporus fold.

Epimerites I fused into a Y (Fig. 7). Length of setae *1a* 16–18. Epimerites II free, with pointed tips. Remnants of epimerites IIa not fused with humeral shields. Transverse sclerites situated much anterior to the level of epimerites III, not fused to epigynum. Epimerites III and IVa short. Length of setae *3b* 25–30. Setae *3a* 14–17 situated anteriorly to level of setae *3b*, while setae *g* slightly posterior to them. Distances between ventral setae: *1a:1a* 92–105, *3b:3b* 180–205, *3a:3a* 51–55, *g:g* 72–85, *4a:4a* 48–56. Epigynum semicircular, bow-shaped, length 35–37, width 75–90, its tips extending slightly beyond level of setae *3a* but not reaching level of genital papillae (Fig. 8). Oviporus folds moderate in size and extend to level of epimerites IIIa tips. Tarsi, tibiae, genua and femora of legs I– IV longer than wide. Legs IV extend beyond posterior margin of opisthosoma by distal half of tarsus. Tarsus IV twice as long as corresponding tibia.

Differential diagnosis. The new species *Z. repressae* **sp. n.** can be differentiated from the morphologically most similar species, *Zachvatkinia chlidoniae* Mironov, 1989, by the following characters: In males of *Z. repressae* **sp. n.**, the branches of the genital arch are slightly curved, so that their free ends are directed outward while the anterior end of the arch forms an acute angle, the anterior end of the adanal shield forms an acute angle (Fig. 4), and the posterior margin of propodosomal shield has a pair of small transversely directed extensions (Fig. 3). In males of *Z. chlidoniae*, the branches of the genital arch are strongly S-shaped, so that their free ends are bent forward, the front end of the adanal shield forms an obtuse angle, the posterior margin of propodosomal shield is slightly convex and has no extensions. In females of *Z. repressae* **sp. n.** the epigynum is 75–90 in width, while in *Z. chlidoniae* it is shorter (64-72) (Mironov, 1989a).

Etymology. The new species epithet *repressae* derives from the specific name of the type host.

Remarks. In Saudi Arabia, *Sterna repressa* occurs during the breeding season in summer in many islands of the Arabian Gulf and Red Sea, where it nests. *Sterna repressa* is distributed through Bahrain, Djibouti, Egypt, Eritrea, India, Iran, Iraq, Israel, Jordan, Kenya, Kuwait, Maldives, Oman, Pakistan, Qatar, Saudi Arabia, Seychelles, Somalia, South Africa, Sudan, Tanzania, United Arab Emirates and Yemen (Porter & Aspinall 2010).

In his review of the genus *Zachvatkinia*, Mironov (1989a) largely revised material previously investigated from host species in the Procellariiformes and Charadriiformes in the USSR, resulting in 12 species, of which six were new. Procellariiformes are assumed to be primary hosts for feather mites of the genus *Zachvatkinia*. The study of host-parasite associations revealed some features of co-evolution both with procellariiform and charadriiform hosts (Mironov, 1991a).

Zachvatkinia (*Zachvatkinia*) *dromae* Mironov, 1992

Zachvatkinia (*Zachvatkinia*) *dromae* Mironov, 1992: 497.

Specimens examined. Many males, females and nymphs, from the crab plover, *Dromas ardeola* Paykull, 1805 (Charadriiformes: Dromadidae), Farasan Archipelago, Jazan province, Saudi Arabia, 16º50'4"N, 42º1'38"E, 17 July 2012, leg. M.G. Nasser.

Remarks. In Saudi Arabia, the crab plover breeds during summer in some Red Sea islands including Farasan Archipelago and Umm Al-Qamarie Island and are usually never seen in the mainland. It is distributed through the East African coast, Red Sea, Arabian Gulf and Southern coast of Iran, India, Pakistan and Sri Lanka (Baker 1929; Porter & Aspinall 2010).

The type specimens of *Z. dromae* were collected from *D. ardeola* captured on Providence Island, Madagascar (Mironov 1992: 499). The Saudi specimens are very similar to the description done by Mironov, 1992 who illustrated the propodosomal shield of female without notches at the posterolateral angles; however, some of the Saudi specimens have small notches posterior to scapular setae *se*. This is the first record of this species in Saudi Arabia. Up to now, *Z. dromae* is known from just two countries, Madagascar (Mironov 1992) and Saudi Arabia (present study).

Zachvatkinia (*Zachvatkinia*) *sternae* (Canestrini & Fanzago, 1876)

Dermaleichus sternae Canestrini & Fanzago, 1876: 109.

Specimen examined. One male ex sooty gull, *Ichthyaetus hemprichii* (Bruch, 1853) (Charadriiformes: Laridae), Umm Al-Malik Island, Red Sea, Tabuk province, Saudi Arabia, 25º13'48"N, 37º8'37"E, 12 November 2011, leg. M. Shobrak.

Remarks. In Saudi Arabia, the sooty gull is considered as a coastal gull found throughout the year in the Red Sea and Arabian Gulf, especially around fishing ports. It is distributed through Bahrain, Djibouti, Egypt, Eritrea, India, Iran, Israel, Jordan, Kenya, Lebanon, Maldives, Mozambique, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sri Lanka, Sudan, Tanzania, United Arab Emirates and Yemen (Pons *et al*. 2005; Cottridge 2006; Porter & Aspinall 2010).

The type specimens of *Z. sternae* were collected from *Chlidonias niger* (Linnaeus, 1978) in Italy (Canestrini & Fanzago 1876) and further it was recorded by these authors also from *Sterna hirundo* Linnaeus, 1758 (Canestrini & Fanzago 1877). We consider the collection of *Z. sternae* from *I. hemprichii* to represent a new host record for this species although we collected only one specimen of it. The Saudi male specimen is very similar to the redescription done by Mironov (1989a: 97) who depicted the ventral setae cx_3 (=*3b*) and c_1 (=*3a*) at one level. However, *3b* are distinctly posterior to the level of *3a* in the Saudi specimen. We consider this difference to represent intraspecific variation. This is the first record of this species in Saudi Arabia. *Z. sternae* occurs in Italy (Canestrini & Fanzago 1876, 1877), Russia (Mironov, 1989a) and Saudi Arabia (present study).

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