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Draconizercon punctatus gen. et sp. nov., a peculiar zerconid mite (Acari: Mesostigmata: Zerconidae) from Taiwan

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Abstract. A new genus and species, *Draconizercon punctatus* gen. et sp. nov. is described from low and high elevation areas of Taiwan. The classification problems within the family Zerconidae are discussed.

Keywords. Zerconidae, new genus, new species, Taiwan, rainforest.

INTRODUCTION

Zerconid mites were thought to be distributed in the Holarctic region, inhabiting the cold and temperate climate zones only, however several records of the last two years show that Zerconidae were able to disperse southwards through the high mountain zone, reaching and expanding beyond the Tropic of Cancer (Ujvári, 2010, 2011a, b, c; Ma *et al.,* 2011). According to our present knowledge, altogether eight species of five genera are known from Taiwan, seven of the species are endemic on the island, besides one genus (*Rotundozercon* Ujvári, 2011) and two subgenera (*Parazercon (Formosella)* Ujvári, 2011 and *Zercon (Zercorientalia)* Ujvári, 2011)) seem also to be endemic.

The present paper contributes to the knowledge of the Zerconidae fauna of Taiwan reporting on a remarkable species which, because of the special character-combination necessitated establishing a new genus.

It should be remarked that all previously recorded specimens were found between 1500–3100 meters a.s.l. and were missing from the lowland rainforests of the island. However two specimens of the species described herein were found on 585 meters elevation and inhabit the latter vegetation type.

MATERIAL AND METHODS

Mites were extracted using Berlese funnels, then cleared with lactic acid and mounted in glycerine. Preparates were examined using a light microscope; drawings were made with the aid of a drawing tube. Mites are deposited in the Collection of Soil Zoology of Hungarian Natural History Museum (HNHM), and the National Museum of Natural Sciences, Taichung, Taiwan (NMNS), in 70% ethanol. The terminology of idiosomal setae follows Lindquist & Evans (1965), with modifications for the caudal region as given by Lindquist & Moraza (1998). The system of notation for dermal glands and lyrifissures follows Johnston & Moraza (1991). The description of gnathosomal structures is in accordance with Ujvári (2011d). All measurements including scale bars of the figures are given in micrometres.

TAXONOMY

Draconizercon gen. nov.

Diagnosis. Podonotal shield carapace-like, expanded anteroventrally and lateroventrally, setae j1 situated ventrally. The slit between peritrematal shields and dorsal shields not conspicuous, posterolateral tips of peritrematal shields expanded posteriorly. Peritremes of general size, expanded to anterior half of coxae III, straight or slightly bent. Setae r1 and r3 shifted ventrally to peritrematal shields, both short, bristle-like. A single opening of glands *gv2* present. Ventrianal shield bearing 19 setae, setae Zv1 absent. Setae z1 absent. Glands *gv3* situated posterolaterally to adanal setae. Third pair of opisthonotal pores associated with the Z-series (*gdZ4*). Margin of opis-

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thonotum generally with 7–8 pairs of R-setae. Opisthomarginal setae of distinctive shape, bent, apically tapering and serrate.

Remarks. The new genus is similar to the genera *Aleksozercon* Petrova, 1978, *Blaszakzercon* Kemal & Koçak, 2009, *Cosmozercon* Błaszak, 1981, *Krantzas* Błaszak, 1981 and *Prozercon* Sellnick, 1943 on the basis of the following features: carapace-like podonotal shield; two short peritrematal setae; posteriorly expanded peritrematal shield; peritremes expanded to anterior half of coxae III; third pair of podonotal glands situated medial to the s-series; third pair of opisthonotal glands associated to the Z-series. The six genera can be distinguished by the combination of characters listed in Table 1.

Etymology. The name of the new genus is composed of the Latin '*draco*', means dragon, and the name *Zercon*.

Gender. Male.

Type species. *Draconizercon punctatus* sp. nov.

***Draconizercon punctatus* sp. nov.**

Diagnosis. Central setae of podonotum smooth, submarginal and marginal setae pilose. Opisthonotal J-setae, Z1–4 and S2 elongate, apically tapering, densely covered by short pili; Z5 pointed, smooth or finely serrate; S3–5 brush-like, apically plumose; marginal setae bent, serrate. Glands *gdZ4* (Po3) situated medially to Z4. Dorsal cavities small, well-sclerotized. The area between J-series covered by large alveolar pits. Sternal setae st2 situated in the central area of the shield, near each other.

Material examined. Holotype. Taiwan, Hualien County, Jhuosi Township, Wa-la-mi, 585 m a.s.l., from leaf-litter, 05 May 2006, leg. Huang, K-W (deposited in HNHM). Paratypes. One female: locality and date as for the holotype (deposited in HNHM). Three females: Taiwan, Tseuhun lake, 1890 m a.s.l., from leaf-litter 21 October 2004, leg. Huang, K-W (deposited in HNHM). One female: Taiwan, Dabachinshan, 2120 m a.s.l., from soil, 25 March 2004, leg. Huang, K-W (deposited in NMNS).

Measurements. Female. Length of idiosoma: 317–328 μm; width: 269–285 μm (*n*=6). Holotype: length: 323 μm; width: 280 μm.

Dorsal side (Fig. 1). Podonotum with 22 pairs of setae (j2–6, z2–6, s1–6, r2 and r4–5 inserted dorsally, setae j1 shifted ventrally, r1 and r3 inserted on peritrematal shields). Setae j3–5 and z5 smooth and needle-like, z4, z6 and s4–5 basally pilose. Among marginal setae s1, z2, s2, r2 and r4 serrate and pointed, others brush-like, plumose. Glands *gds1* (po1) situated posterior to insertions of s1; *gdj4* (po2) positioned on line connecting j5 and z4, equidistantly; *gds4* (po3) lying medial to s5. Podonotal shield covered by reticulate pattern, posterior surface with a few small, alveolar pits.

Opisthonotum with 22–23 pairs of setae (J1–5, Z1–5, S1–5, marginal R-series with 7–8 pairs of setae). Setae J1–5 (Fig. 6) elongate, apically tapering, pointed, provided with short pili, each reaching far beyond bases of the following one in the series. Setae Z1–4 (Fig. 8) and S2 similar in shape to J-setae, but shorter; each reaching bases of the following one in the series. Setae Z5 straight, pointed, smooth or finely serrate. Setae S3–5 (Fig. 7) elongate, brush-like, distally pilose, expanding beyond margin of idiosoma. Marginal setae (Fig. 9) bent, apically tapering and serrate. Size of opisthonotal setae and distances between their insertions as in Table 2. Glands *gdZ1* (Po1) anteromedial to Z1; *gdS2* (Po2) on line connecting Z2 and S3; *gdZ4* (Po3) medial to insertions of Z4; *gdS5* (Po4) anterior to insertions of R7 (or R8, if present). Marginal serration deep, several spines can be found between setae Z5 (Fig. 5). The area between J-series covered by large alveolar pits, other parts of opisthonotal shield smooth. Dorsal cavities small, well-sclerotized, with finely undulate inner margin. Axes of cavities slightly converging anteriorly.

Ventral side (Fig. 2). The slit between peritrematal and dorsal shields not conspicuous. Posterolateral tips of peritrematal shield reaching level of R6, surface of the shield covered by longitudinal

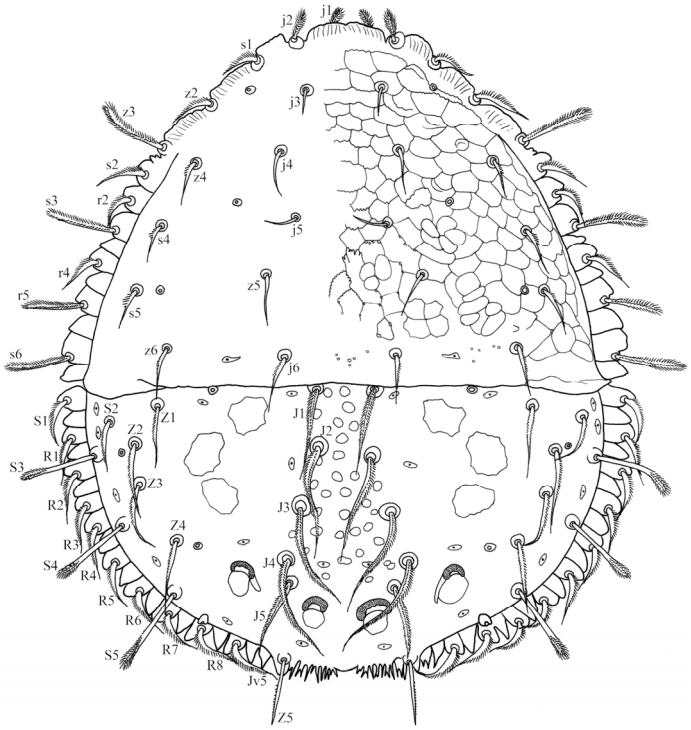


Figure 1. Dorsal view of *Draconizercon punctatus* sp. nov.

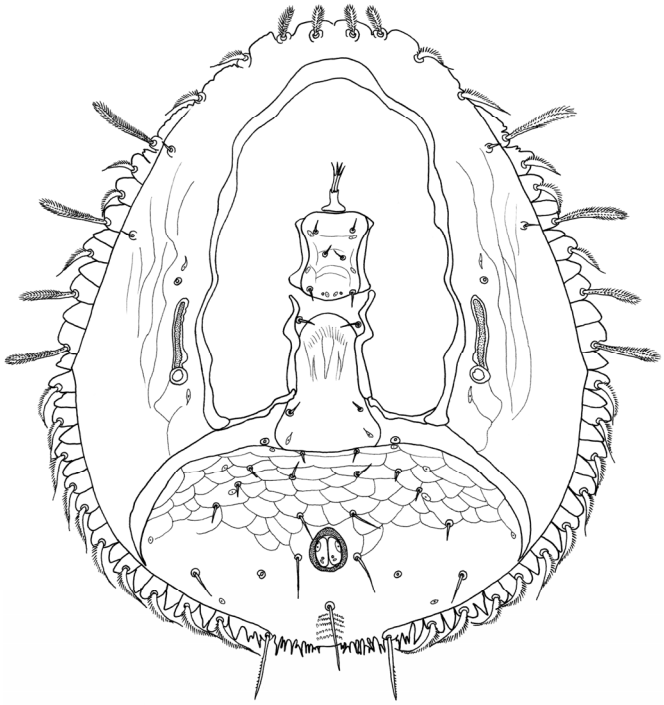
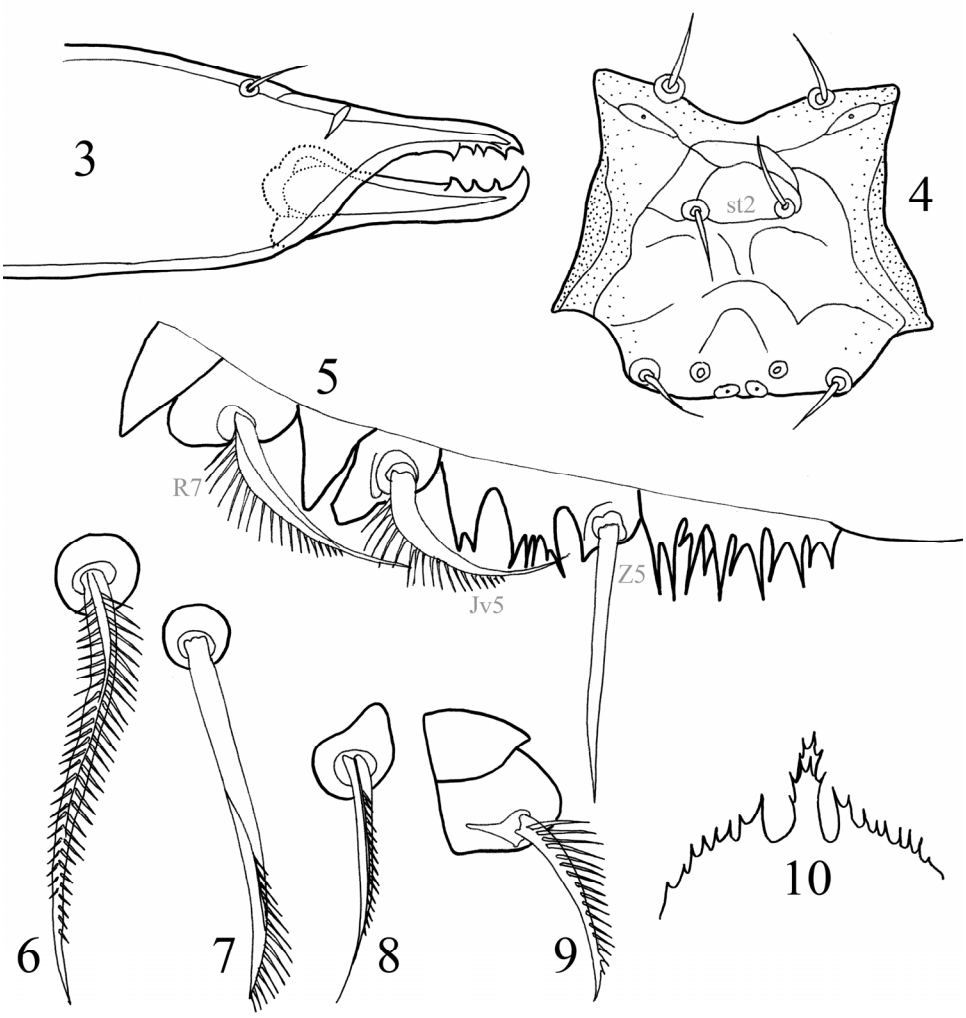


Figure 2. Ventral view of *Draconizercon punctatus* sp. nov.



Figures 3–10. Different structures of *Draconizercon punctatus* sp. nov. female: 3 = chelicera, 4 = sternal shield of paratype, 5 = posteriormost setae with marginal spines, 6 = seta J1, 7 = seta S5, 8 = seta Z3, 9 = seta R2, 10 = epistome.

sutures. Peritrematal setae r1 and r3 short, smooth and pointed. Peritremes straight, with a dilation near stigmata. Sternal shield (Fig. 4) well sclerotized, 45 μm long and 32 μm wide at the level of setae st2, with fine, reticulate ornamentation. Setae st2 situated extraordinarily near each other. Ventrianal setae short, smooth and needle-like, setae Zv1 absent. Setae Jv3–4 1.5 times longer, adanal setae 2 times longer, postanal seta 3 times longer than anterior ventrianal setae. Setae Jv5 similar in shape and length to marginal setae of opisthonotum. Anal valves with vestigial euanal setae. Glands *gv3* situated posterolateral to adanal setae. Anterior surface of ventrianal shield covered by reticulate pattern, posterior surface smooth.

Gnathosoma. Situation of hypostomal and subcapitular setae typical for the family. Setae h1–2 similar in appearance, elongate, needle-like. Setae h3 shorter than h1–2, needle-like, h4 somewhat longer than previous setae, serrate. Corniculi horn-like, internal malae with a pair of bifurcate anterocentral branches and with serrate margins. Fixed digit of chelicerae (Fig. 3) with 5 teeth, movable digit with 4 teeth. Epistome (Fig. 10) of *Prozercon*-type.

Male and immature stages unknown.

Etymology. The name of the new species refers to the punctuate opisthonotal ornamentation.

DISCUSSION

The generic classification of Zerconidae suffers from several problems. With the appearance of more and more exotic and special species it has become obvious that some of the previously used characters are not suitable for generic delimitation or some of them have to be handled with care. The newest results show that most of the characters previously kept discrete (e.g. shape of peritrematal setae and shields) have several intermediate stages, others show intraspecific variation, which makes them difficult to apply. The case of genus *Prozercon* Sellnick 1943 serves as a perfect example: due to the intensive research of the last decades (e.g. Mašán & Fenďa, 2004; Urhan, 2008; Ujvári, 2011e) the genus became the second largest among Zerconidae, with more than 50 species. With the discovery of several interesting species the diagnosis of the genus was changed from time to time, some restrictions have been erased, new observations have been added, but it is almost sure that neither the latest diagnosis given is perfect (Ujvári, 2011e).

Another problem is, however the new diagnosis of *Prozercon* is in accordance with the latest observations, most of the genera of the family have not been dealt with. It is obvious that the whole family badly needs an overall revision.

Because of these problems I had much trouble with the insertion of the new species described above into the existing Zerconidae system therefore, it was necessary to establish a new genus *Draconizercon* gen. nov. to accommodate it.

I tried to choose the most reliable characters during the classification of the new species. There is a well-recognizable character regarding the shape of the body which is not easy to define. There are at least two different types of Zerconidae on the basis of the body shape. One of these possesses a carapace-like podonotal shield, which is extended anteroventrally and lateroventrally (Lindquist & Moraza, 1998) and have relatively short legs in proportion to the body length (e.g. *Aspar* Halašková, 1977, *Echinozercon* Błaszak, 1976, *Mesozercon* Błaszak, 1976 and *Prozercon* Sellnick, 1943). The species belonging to this type are generally small. The other type has not been defined yet, but the podonotal shield of these zerconids is not extended ventrally and they usually have longer legs in proportion to the body length. Latter type has large (*Zercon* C. L. Koch, 1836) and small (*Zeronella* Willmann, 1953) representatives as well. *Draconizercon* gen. nov. belongs to the first group possessing carapace-like podonotal shield.

The second character chosen was the number and general appearance of setae shifted to peritrematal shields. Those genera which possess three pairs of setae on peritrematal shields are most probably closely related to each other, constituteing a separate evolutionary lineage within the family. The unique, hipertrichous *Syskenozercon* Athias-Henriot, 1977 represents also a separate, probably the most ancient linage of Zerconidae. However the majority of zerconid mites possess two pairs of peritrematal setae (r1 and r3). The shape of peritrematal setae shows a large degree of variation and has to be handled with care (Ujvári, 2010, 2011e). Setae r1 are always relatively short, and apart from some exceptions (e.g. *Echinozercon* Błaszak, 1976) are always shorter than or as long as setae r3. To reduce the mutual character stages of r1 and r3 I considered only the relative size of them: both r1 and r3 short or r3 significantly longer than r1. *Draconizercon* gen. nov. belongs to the group possessing two short peritrematal setae.

As the third character I have chosen the shape of peritrematal shields. Nowadays we recognize several different stages: in some groups these shields end truncate, in most of the cases posteriorly separated from podonotal shields (e.g. *Zercon* C. L. Koch, 1836); in other cases the posterolateral tips of these shields are expanded posteriorly, in a different degree (e.g. *Prozercon* Sellnick, 1943). Rarely can we see special sclerotized areas next to the ventrianal shield which are usually called ventrilateral shields. The originof these sclerotized areas is not clear, but presumably is different in different groups. In *Ma-*

crozercon Błaszak, 1975 it seems to be an expansion of the ventrianal shield, in *Rotundozercon* Ujvári, 2011 it seems if the dorsal sclerotization would shifted ventrally, but the ventrilateral shields in *Krantzas* Błaszak, 1981 may have been detached from the peritrematal shields. To reduce the number of stages of peritrematal shields' shape I considered only the relative ending of it: posteriorly truncate or expanded (including *Krantzas* as well, with its special ventrilateral shields). *Draconizercon* gen. nov. belongs to the group possessing posteriorly expanded peritrematal shields.

The fourth major character chosen was the size of peritremes. Three stages can be recognized. The majority of species possess peritremes reaching the anterior margin of coxae III. Some groups have reduced peritremes reaching only the posterior margin of coxae III (*Skeironozercon* Halašková, 1977, *Syskenozercon* Athias-Henriot, 1977 and *Zerconella* Willmann, 1953), other groups possess elongate peritremes reaching level of coxae II (*Carpathozercon* Balan, 1991 and *Echinozercon* Błaszak, 1976). No matter which of these three stages is the ancient one, it seems to be sure that each derived stages are formed independently in different groups, as a result of convergent evolution. *Draconizercon* gen. nov. belongs to the largest group possessing peritremes reaching anterior margin of coxae III.

With the discovery of more and more new species in the Nearctic and Eastern Palearctic regions the significance of dorsal adenotaxy is becoming increasingly conspicuous in systematics of Zerconidae. The special position of proper dorsal pores most probably reflects phylogenetic relationship reliably, which is also supported by the distribution pattern of the morphologically similar genera. I chose the position of the third pair of podonotal and the third pair of opisthonotal glands. There is a group of genera in East Asia the members of which (*Aquilonozercon* Halašková, 1979, *Eurozercon* Halašková, 1979, *Kaikiozercon* Halašková, 1979, *Koreozercon* Halašková, 1979 and *Mesozercon* Błaszak, 1975) are very similar to the newly established genus *Draconizercon* gen. nov., but the position of the third podonotal glands (situated lateral to s-series, near r4 in former genera) suggests that *Draconizercon* gen. nov. does not belong to this group (besides *Draconizercon* gen. nov. possesses epistome of *Prozercon*-type, while the other East Asian genera have epistome of *Parazercon*-type).

Close phylogenetic relationship between *Draconizercon* gen. nov. and some Nearctic genera can also be excluded by considering the situation of the third pair of opisthonotal pores. There is an endemic Nearctic group of genera possessing the third pair of opisthonotal glands in association with the J-series (e. g. *Bakeras* Błaszak, 1984, *Blaszakiella* Sikora & Skoracki, 2008 and *Microzercon* Błaszak, 1975). This unique phenomenon can not be observed on any Palearctic species, the third pair of opisthonotal glands of latter are always associated to the Z-series.

Applying these restrictions only five genera remained as a possibility to classify the new Taiwanese species with. Two of these (*Prozercon* Sellnick, 1943 and *Aleksozercon* Petrova, 1978) are distributed in the Western Palearctic region, the other three (*Blaszakzercon* Kemal et Koçak, 2009, *Cosmozercon* Błaszak, 1981 and *Krantzas* Błaszak, 1981) are Nearctic genera. If we consider the special shape of opisthomarginal setae as a mark of phylogenetic relationship, the new species can only be related to *Cosmozercon* Błaszak, 1981 and *Krantzas* Błaszak, 1981. This is also supported by the distribution pattern of these genera: the eastern distribution border of *Prozercon* Sellnick, 1943 lies in Mongolia (Błaszak, 1979), the single species of *Aleksozercon* Petrova, 1978 is known only from the northeastern shores of the Black Sea (Petrova, 1978), while *Blaszakzercon* Kemal & Koçak, 2009 seems to be endemic in the Appalachian Mountains (Ujvári, 2012). Therefore, apparently there is no sign of possible biogeographical connection between the former genera and the new Taiwanese species as well. On the contrary, *Cosmozercon* Błaszak, 1981 and *Krantzas* Błaszak, 1981 are distributed on the Pacific Coast of North America. Asia and Western North America were connected by Trans-Beringian land bridges several times from the Mid Creataceous, which served as an important dispersal route for different ani-

mal groups (Sanmartín et al. 2001). Besides, with the drop of sea level several other land bridges may have emerged in the Northern Pacific region, especially through the recent island arcs of the Pacific Plate (Aleutian Islands, Kuril Islands, Japanese Islands etc.), resulting in other possible dispersal routes. These paleogeographic connections might explain the relationship between the fauna of the Western Nearctic and the Eastern Palearctic and support the hypothesis of the common origin of *Draconizercon* gen. nov., *Cosmozercon* and *Krantzas*.

The presence or absence of adgenital glands *gv2* is applied with a great emphasis, and (so far) seems to be a very useful and stable character in classification of Zerconidae. Both *Cosmozercon* Błaszak, 1981 and *Krantzas* Błaszak, 1981 lack these glands, this is the main reason why I decided to establish a new genus for the new Taiwanese species.

The presence or absence of ventrianal setae Zv1 is a character I did not take into account with great relevance. It seems that the presence of Zv1 is a plesiomorphic stage within Zerconidae. During the evolutionary history, many groups might lost these setae independently from each other, as a result of convergent evolution. This can be proven by examples selected from genus *Zercon* C. L. Koch, 1836. There are different, closely related groups (from external morphological point of view) within *Zercon*, the members of which differ by the presence of Zv1. These hypothetical groups represent different branches within the evolutionary tree of *Zercon*. Presumably these groups diverged much earlier than the separation inside a group has taken place by losing Zv1. Therefore losing setae Zv1 can be considered as a frequent phenomenon, which usually occurs independently during speciation processes in different groups of Zerconidae. Hence it does not seem to be a good character for generic delimitation. Excluding species with lacking Zv1 from a genus usually possessing Zv1 may results a morphological classification which does not correspond to the evolutionary history, puts proper, closely related species into separate genera, while other, more distant relatives would remain in the same genus.

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Table 1. Distinctive characters of *Draconizercon* gen. nov, *Aleksozercon*, *Blaszakzercon*, *Cosmozercon*, *Krantzas* and *Prozercon*.

character	*Draconizercon*	*Aleksozercon*	*Blaszakzercon*	*Cosmozercon*	*Krantzas*	*Prozercon*
gv2	present (single)	present (single)	present (double)	absent	absent	absent
posterolateral tips of peritrematal shield	expanded to posterior R-setae, fitting to opisthonotal shield	expanded to posterior R- setae, fitting to opisthonotal shield	expanded to anterior R-setae, separate from opisthonotal shield	expanded to posterior R-setae, fitting to opisthonotal shield	as separate ventri-lateral shields, fitting to opisthonotal shield	with different measure of expansion, fitting to or slightly separate from opisthonotal shield
podonotal and opisthonotal shields	separate	central and lateral regions fused	separate	separate	separate	separate or laterally fused
general number of R-setae	7 or 8	7	7	6	8	6 or 7
shape of R-setae	long, bent, apically tapering and serrate	short, smooth, thorn-like	short, thorn-like, smooth / pilose or longer, brush-like and plumose	long, bent, apically tapering and serrate	long, bent, apically tapering and serrate	short, thorn-like, smooth / pilose or longer, brush-like and plumose
epistome	with 1 central branch	with 1 central branch	with 2 central branches	with 1 central branch	with 1 central branch	with 1 central branch

Table 2. Length of opisthonotal setae and distance between their bases in *Draconizercon punctatus* sp. nov.

	F		F		F
J1	45	**Z1**	33	**S1**	24
J1-J2	31	**Z1-Z2**	23	**S1-S2**	23
J2	55	**Z2**	38	**S2**	26
J2-J3	31	**Z2-Z3**	22	**S2-S3**	19
J3	53	**Z3**	30	**S3**	40
J3-J4	26	**Z3-Z4**	30	**S3-S4**	37
J4	55	**Z4**	37	**S4**	40
J4-J5	13	**Z4-Z5**	80	**S4-5**	43
J5	37	**Z5**	32	**S5**	44

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