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A New Species of Zambedania (Acari: Heterostigmatina: Pygmephoridae) from the Two Rivers Platinum Mine in South Africa and Notes on the Life-cycle of the Genus

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Anne M. Camerik, Wojciech Ł. Magowski, Peter G. Hawkes, Edward A. Ueckermann, Ronald Ochoa, and Gary R. Bauchan (2016) A new species of relatively poorly known genus *Zambedania* Mahunka, 1972 was found on the baboon spider, *Harpactirella overdijki* Gallon, 2010 (Araneae: Theraphosidae) in South Africa. Besides the abundantly available phoretic females, several males and one larva of this species in the spiders' nests were also collected. *Zambedania sekhukhunensis* n. sp. is described and illustrated based on the phoretic females, males and larva. Improved diagnosis of the genus and a new key to species are also supplied. The descriptions and illustrations of the male and larva of this species represent the first ones of these stages in the genus *Zambedania*. Due to their discovery the generic diagnosis has been significantly improved.

Key words: *Zambedania sekhukhunensis* sp. n., Larva, Male, Female, Phoresy, *Harpactirella overdijki*, Araneae, Theraphosidae, South Africa.

BACKGROUND

Currently, the genus *Zambedania* (Acari: Heterostigmata: Pygmephoridae) consists of three species from Africa and one from Argentina, all of which were described from specimens of phoretic adult females. In a recent publication, Camerik and Magowski (2014) mentioned the discovery of a species collected in South Africa, which was the third of this genus known from Africa. Adult males and immature stages of this genus have not been described or illustrated. The new *Zambedania* species, *Z. sekhukhunensis*, like the recently described *Z. africana* and *Z. madagascariana*, hails from the eastern side of southern Africa.

During a 2008 survey of the soon to be exploited North Open Pit area (Fig. 1) at the Two Rivers Platinum Mine near Lydenburg, South

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Africa, P. Hawkes and his assistants came across several specimens of baboon spiders. These were initially identified by A. Dippenaar as *Harpactirella flavipilosa* (Aranaeae: Theraphosidae); however, based on a paper published by Gallon (2010), Engelbrecht later identified the specimens as *Harpactirella overdijki* Gallon, 2010.

On some of the spiders, Dippenaar observed some mites aggregated on the cephalothorax (Fig. 2) and abdomen. The mites, all phoretic females, were sent to E.A. Ueckermann for identification. Ueckermann cleared, mounted, measured some of the specimens, identified them as belonging to the family Pygmephoridae, and forwarded them to Camerik for further study.

During his visit to South Africa in 2009, R. Ochoa suggested the mites belonged to the monotypic genus *Zambedania* Mahunka, 1972. Camerik requested Hawkes' team to collect more live spiders and in addition, their nest material and some surrounding soil. Camerik invited Magowski to collaborate in the classification project of these mites. Ochoa teamed up with G. Bauchan to take the Variable Pressure- and Low Temperature-SEM's images used in this paper.

This paper reports on discovery the new African species of *Zambedania* associated with a theraphosid spider; it also provides descriptions of previously unknown stages (male and larva) of this genus.

MATERIALS AND METHODS

Some of the host spiders with phoretic mites were fixed in 95% ethanol in the field. Others were collected alive and preserved later in the laboratory in 70% ethanol. In the nest material and soil surrounding the spider's nests, we found many more phoretic females, males and a larva of

Fig. 1. Soon to be exploited North Open Pit (NOP) area at the Two Rivers Platinum Mine at Leydenburg, South Africa (photo by P. Hawkes).

the new species. Most of the mites collected were subsequently cleared in lactophenol and mounted in Hoyer's medium. In total about 80 specimens of the new species were collected, of these, there were five males, one larva and the remaining mites were phoretic females.

The three other species (*Z. africana*, *Z. madagascariana* and *Z. argentiniana*) used for morphological analysis are described with pertaining detailed data in Camerik and Magowski (2014). The materials and methods used to produce the figures follow that of Camerik and Magowski (2014).

Measurements are in micrometers (μm) and given in the Table 1 for all instars. Idiosomal and leg measurements are taken according to Camerik and Ueckermann (1995) and Camerik (1996). General setal annotation and terminology of morphological structures used are according to Lindquist (1986). The standard leg chaeto- and solenidiotaxic homologies are presented in Tables 2, 3 and 4 for each instar. The length of the leg setae is given relative to another significant leg seta(e) or segment(s), for reasons explained in Camerik et al. (2006).

Abbreviations used in the text and figures are as follows: Ag - aggenital plate; ap - apodemes; appo - poststernal apodeme; appr -prosternal apodeme; apsej - sejugal apodeme; CX - coxisternal plates; Fe - femur; Ge - genu; Gn - gnathosomal capsule; PdS - prodorsal shield; Ps - pseudanal segment; Ta - tarsus; Ti - tibia; TiTa - tibiotarsus; Tr - trochanter.

Abbreviations used for measurements of the leg setae are: ~ subequal to; > longer than; < shorter than.

Scanning micrographs. For Low-Temperature Scanning Electron Microscopy the methods and materials of Bolton et al. (2014) was utilized to observe the mites. Images were captured using a 4pi Analysis System (Durham, NC). Images were sized and placed together to produce a single figure using Adobe® Photoshop CS 5.0. A S-3700 Variable Pressure SEM (Hitachi High Technologies America, Inc., Pleasanton, CA) with a Deben Coolstage Peltier Stage (Deben UK Ltd., Suffolk,

Fig. 2. *Zambedania sekhukhunensis* sp. n phoretic female mites aggregated in and around the fovea of the cephalothorax and around the coxae of *Harpactirella overdijki* Gallon, 2010 (Aranaeae: Theraphosidae) (photo by I. Engelbrecht).

Table 1. Measurements of *Zambedania sekhukhunensis* sp. n. (holotype and paratypes phoretic females, males and larva)

	Zambedania sekhukhunensis sp. n.														
	Female								Male						Larva
	HT	PT1	PT2	PT3	PT5	Mean	SD	Range	PT1	PT2	PT3	Mean	SD	Range	PT
Idiosoma L	274	270	309	306	303	**292**	19	270-309	172	186	176	**178**	7	172-186	**141**
Gnathosoma L	34	30	36	35	31	**33**	3	30-36	6	10	11	**9**	3	6-11	**32**
Gnathosoma W	24	25	30	27	29	**27**	2	24-30	9	8	8	**8**	1	8-9	**28**
Opisthosoma L	227	221	259	259	258	**245**	19	221-259	130	131	104	**122**	15	104-131	**112**
Opisthosoma W	104	106	97	116	89	**102**	10	89-116	71	77	96	**81**	13	91-96	**72**
Prosoma L	46	47	48	50	44	**47**	2	44-50	41	55	49	**48**	7	41-55	**29**
Prosoma W	73	63	70	74	71	**70**	4	63-74	88	77	73	**79**	8	73-88	**76**
Leg I	87	87	96	94	97	**92**	5	87-97	98	90	92	**93**	4	90-98	**67**
Leg II	91	88	89	90	93	**90**	2	88-93	90	83	85	**86**	4	83-90	**66**
Leg III	92	93	104	101	98	**98**	5	92-104	95	87	90	**91**	4	87-95	**70**
Leg IV	134	136	152	140	140	**140**	7	134-152	64	55	61	**60**	5	55-64	**-**
Dorsal setae															
v2	65	70	80	77	76	**74**	6	65-80	27	20	28	**25**	4	20-28	**11**
sc1	24	23	23	26	23	**24**	1	23-26	26	22	21	**23**	3	21-26	**35**
sc2	110	106	111	123	118	**113**	7	106-123	94	81	90	**88**	7	81-94	**103**
c1	152	139	162	158	168	**156**	11	139-168	143	115	130	**129**	14	115-143	**95**
c2	143	136	158	153	159	**150**	10	136-159	116	107	121	**115**	7	107-121	**109**
d	175	176	183	180	179	**179**	3	175-183	77	86	122	**95**	24	77-122	**126**
f	185	176	184	191	197	**187**	8	176-197	94	124	135	**118**	21	94-135	**158**
e	170	166	171	174	182	**173**	6	166-182	48	54	59	**54**	6	48-59	**122**
h1	181	177	206	201	208	**194**	15	177-208	8	8	9	**8**	1	8-9	**139**
h2	107	117	139	123	132	**123**	13	107-139	1	1	1	**1**	0	1	**125**
Ventral setae															
1a	33	34	37	38	35	**35**	2	33-38	21	28	27	**25**	4	21-28	**17**
1b	37	38	42	41	40	**39**	2	37-42	22	26	28	**25**	3	22-28	**14**
2a	39	42	46	38	44	**42**	3	38-46	35	29	32	**32**	3	29-35	**20**
2b	49	54	60	54	56	**54**	4	49-60	36	33	37	**35**	2	33-37	**22**
3a	41	43	42	44	45	**43**	2	41-45	36	29	20	**28**	8	20-36	**19**
3b	41	40	44	48	42	**43**	3	40-48	32	36	30	**33**	3	30-36	**24**
3c	39	32	43	39	42	**39**	4	32-43	26	30	19	**25**	6	19-30	**-**
4a	40	42	48	46	46	**45**	3	40-48	22	26	25	**24**	2	22-26	**-**
4b	50	50	54	55	56	**53**	3	50-56	32	28	32	**31**	2	28-32	**-**
4c	37	38	38	42	40	**39**	2	37-42	27	18	23	**23**	5	18-27	**-**
ps1	26	21	22	20	26	**23**	3	20-26	1	1	1	**1**	0	1	**16**
ps2	38	41	34	41	39	**39**	3	34-41	6	6	7	**6**	1	6-7	**19**
ps3	41	38	40	40	48	**42**	4	38-48	-	-	-				**12**

Key: HT = holotype; PT = paratype; SD = Standard deviation; measurements in μm.

Table 2. Leg chaeto- and solenidiotaxy of the genus *Zambedania sekhukhunensis* sp. n. females

SEGMENT	LEG I		LEG II		LEG III		LEG IV	
	Nr	SIGLA	Nr	SIGLA	Nr	SIGLA	Nr	SIGLA
TROCHANTER	1	*v'*	1	*v'*	1	*v'*	1	*v'*
FEMUR	3	*d,l',v"*	3	*d,l',v"*	2	*d,v'*	2	*d,v"*
GENU	4	*l',l",v', v"*	3	*l',l",v"*	2	*l',v."*	1	*v'*
TIBIOTARSUS Leg I only	13	*d,l',l",v',v",k,pl',pl",pv',pv",u',u",s*	TIBIA: 4	*d,l',v',v"*	4	*d,l',v',v"*	4	*d,l',v',v"*
Eupathidia	5	*tc',tc",p",ft',ft"*	0		0		0	
Solenidia	3	*ω1,ϕ1,ϕ2*	1	*ϕ*	1	*ϕ*	1	*ϕ*
TARSUS	1	Claws	2		2		1 or 2	
		Tactile setae	6	*pl",tc',tc",pv',pv",u*	6	pl",tc',tc",pv',pv",u	6	*pl",tc',tc",pv',pv",u*
		Solenidia	1	*ω*	0		0	

UK) set at -25°C was utilized for studying the mites on the spider.

RESULTS

Taxonomy

Family Pygmephoridae Cross, 1965
Subfamily Neopygmephorinae Cross, 1965 (Neopygmephoridae sensu Khaustov, 2004)
Genus *Zambedania* Mahunka, 1972

Zambedania sekhukhunensis sp. n. Camerik and Magowski
(Figs. 3-20)

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Diagnosis: The female of *Z. sekhukhunensis* is most similar to that of *Z. africana* in having leg IV terminating in two claws, the stigmata being undivided and aggenital plate smooth (Ag). However, the species is uniquely different from *Z. africana* by the following combination of characteristics: stigmatal peritremes about half (vs. about one third) the length of the prodorsal shield (PdS); except for setae *f*, no other idiosomal dorsal setae on protuberances (vs. setae *c*, *d*, *e*, *f* and *h1* on protuberances); setae *e* about 0.9x as long as setae *f* (vs 0.4 as long); *h1* about 1.5x as long as *h2* (vs. subequal in length); tibiotarsal solenidion ω is stemmed and about 1.3x the length of ϕ1, *2* (vs. sessile and 1.7x); Tall: *pv'*, *pv"* barbed (vs. feathered).

Description: (measurements- Table 1). Female. (Figs. 3-9, Table 2).

Gnathosoma (Figs. 4A, B). Orientation: hypognathous; shape ovoid. Cheliceral setae (*ch1* smooth, *ch2* barbed) setiform, subequal in size; ch_1 located antero- mediad of ch_2. Palpal supracoxal setae (*pp*) present. Dorso-median apodeme prominent. The antero-laterad pedipalpal segments are fused, bearing smooth setae *dFe* and *dGe*. Subcapitulum (= infracapitulum) with a pair of slender, simple, smooth setae (*su*) and a mushroom-shaped accessory setigenous structure (*ass*) located anteromedially and laterally flanked by a clavate, non-striated solenidion.

Pharyngeal system (Figs. 4C) subdivided into three striate, muscular pumps; in ventral view extending from the gnathosomal foramen to beyond apodeme 2. The first (anterior) pump is suboval, rather short and is immediately attached to the second pump. The second is narrow, rectangular and the longest of the three pumps. A short stretch of pharyngeal tube connects the second to the third pump, which is the widest and sclerotized at its anterior and posterior edges.

Idiosomal dorsum (Figs. 3A, 9A). Cuticle strongly sclerotized with uniform sparse punctate sculpturing. Prodorsal shield (PdS) with long, slit-like, obliquely placed stigmata reaching its anterior edge; capitate sensillae (*sc1*) with tiny barbs (Figs. 3A, 9B) are placed in circular bothridia; two pairs of well-developed tapered, setiform, barbed setae located posteriad of the stigmata; of these, vertical (*v2*) anterolaterad and shorter than the long and more robust scapular setae (*sc2*). Opisthosoma elliptical, five segmented with four dorsal segments: C, D, EF (coalesced) and H; the fifth segment, pseudanal shield (Ps) located caudo-ventrally. All segments bear two pairs of setae, except D which has one pair only. All dorsal setae very long, tapered, setiform and barbed, except setae *v2* which is similar in form to the other dorsal setae but less than one third as long. Only seta *f* on a short protuberance. No cupules observed.

Table 3. Leg chaeto- and solenidiotaxy of the genus *Zambedania sekhukhunensis* sp. n. males.

SEGMENT	LEG I		LEG II		LEG III		LEG IV	
SEGMENT	Nr	SIGLA	Nr	SIGLA	Nr	SIGLA	Nr	SIGLA
TROCHANTER	1	*v'*	1	*v'*	1	*v'*	1	*v'*
FEMUR	3	*d,l',v"*	3	*d,l',v"*	2	*d,v'*	2	*d,v"*
GENU	4	*l',l",v', v"*	3	*l',l",v"*	2	*l',v"*	1	*v'*
TIBIA	6	*l',l",v',v",k,d*	4	*d,l',v',v"*	4	*d,l',v',v"*	4	*d,l',v',v"*
Solenidia	2	*ϕ1, ϕ2*	1	*ϕ*	1	*ϕ*	1	*ϕ*
TARSUS	7	*pl',pl",pv',pv",u',u",s*	7	*pl",tc',tc",pv',pv",u',u"*	7	*pl",tc',tc",pv',pv",u',u"*	6	*pl",tc',tc",pv',pv",u',u"*
Eupathidia	6	*tc', tc", p', p", ft', ft"*	0		0		0	
Solenidia	2	*ω1 , ω2*	1	*ω*	1	*ω*	0	
Claws	1		2		2		1	

Idiosomal venter (Fig. 3B). All ventral setae short (at least half the size of dorsal opisthosomal setae) and slightly barbed. Ap. 1, 2 complete, well-sclerotized, originating at the anterior margin of coxisternal plates I and II respectively. Ap. 1 forming an Y-shaped juncture with prosternal apodeme (appr). Ap. 2 slightly oblique, originating from the anterior base of legs II, extending across plates I, II and uniting postero-medially with the appr. The appr is incomplete, not fused with the well developed and strongly sclerotized sejugal apodeme (apsej). Ap. 3, 4 complete, anteriorly arched, medially joined to the poststernal apodeme (appo). Distribution of coxisternal setae typical for the genus. Setae *2b* and *4b* are the longest coxisternal setae. Ps with three pairs of setae, $ps_{1, 2, 3}$, of which ps_2 is the longest pseudanal seta.

Legs (Figs. 5 - 8). The first two pairs of legs are subequal in length; legs III, IV are distinctly longer. All tectal leg setae are setiform, tapering, distally acute and more or less barbed, pilose or one-sided barbed with long barbs (feathered, see Fig. 9 C, D).

Leg I. (Figs. 5A, B; 9C, D). Tr: *v'* < Fe *v"*; Fe: long *l'* > *v"*, *d* strongly barbed longest seta on segment; Ge: *l'* strongly barbed, ~ Fe *d*; *v'* > *l"* > *v"*. TiTa with a long and strongly sclerotized, single, longitudinally ribbed apical claw closing into a butterfly-shaped counterpiece made up of the setae *u'* and *u"* (Fig. 9D). Claw with small auxiliary blade located inwards near its base, and similarly small blunt protrusion even more proximally at its

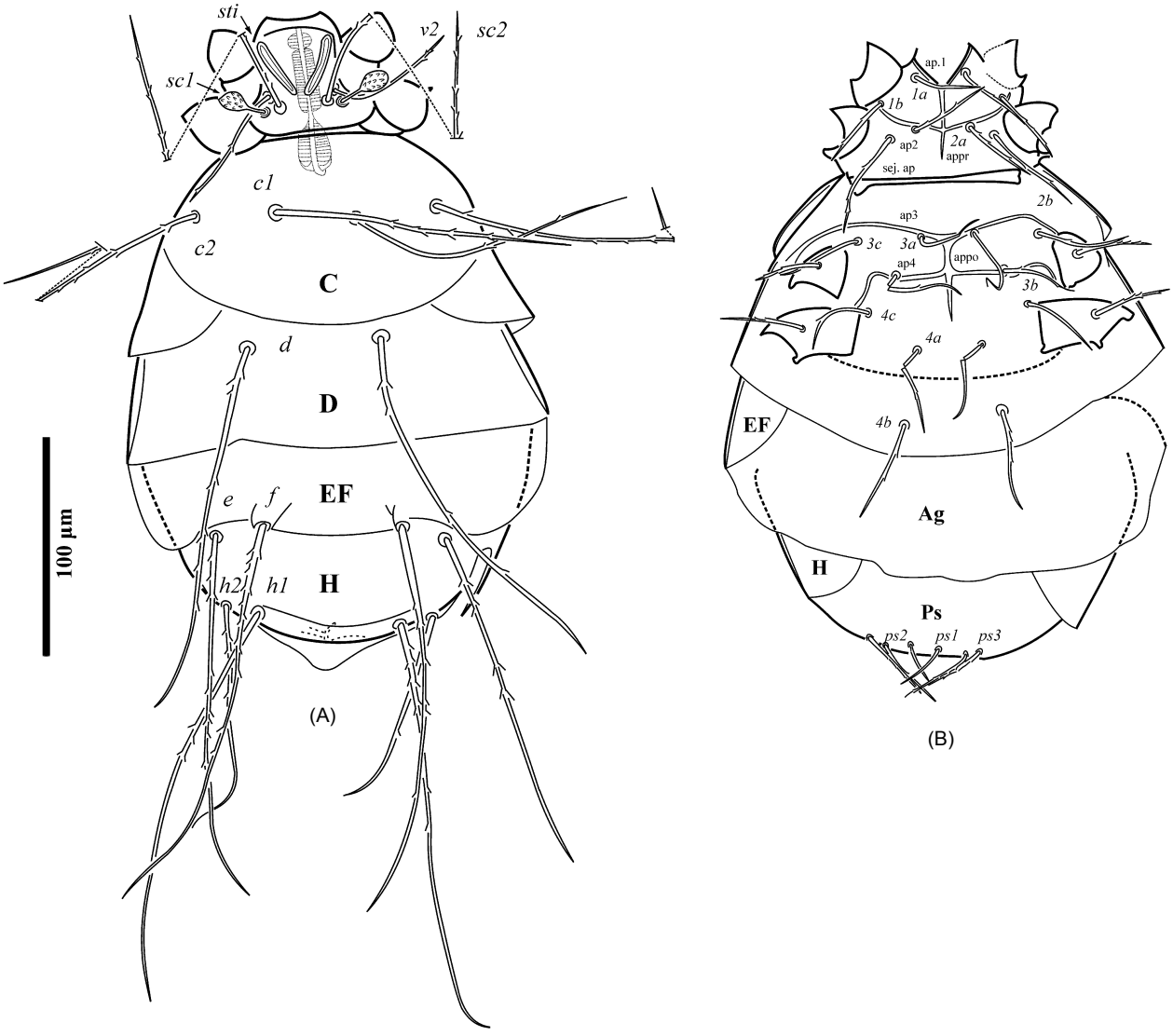

Fig. 3. *Zambedania sekhukhunensis* sp. n. Female holotype. Idiosoma: A- dorsum, B- venter; sculpture omitted.

base. The "lock" on the dorsal side of tarsal part of the segment at the base of the flexed claw is well exposed in figure 9C. Barbed seta *k* < *d*. Setae *v'* ~ *v"*, both feathered; *l'* ~ *l"*, both barbed; feathered *pv'* < *pv"* typically brush-like barbed at distal end (Fig. 5B); *pl'* < *pl"* either barbed. Seta *s* is situated antero-laterad of the claw, but difficult to observe with a light microscope because of the accumulation of setae there. However *s* is clearly visible in figure 9D and easily observed on the larva and male. Three striated solenidia: stemmed solenidion ω > $\phi_{1,2}$. Striation of ϕ_2 wider apart than both of ϕ_1 and ω. Eupathidia on pinnaculi (*p'* missing): *p"*, *ft'* < *ft"*. Distalmost seta on the verticil *tc'* < *tc"*.

Leg II (Fig. 6). Tr: barbed *v'* < barbed Fe *v";* Fe: *l'* > *v"*; *d* longest seta of leg; Ge: *l'* ~ *l"* ~ *v'* with strongly sclerotized annulus at its base; Ti: *d* shortest seta on segment, close to slim striated ϕ, feathered *l'* < *v'* < barbed *v"*; Ta: barbed *pl"* > barbed *tc'*; *tc'* > smooth *tc"*; *pv'* < barbed *pv"*~ slim, smooth *u*. Solenidion ω stout, club-shaped. Terminal two simple claws with a fan-shaped empodium.

Leg III (Fig. 7). Tr: one-sidedly barbed *v'* ~ Fe *v'*, Fe *d* longest seta on the leg; Ge: *l'* > *v'*; Ti: ϕ stout, club-shaped; slightly barbed *l'* ~ barbed *d*; smooth *v'*< barbed *v"*; Ta: barbed *pl"* longest seta on verticil, barbed *tc'* ~ smooth *tc"*; smooth *pv'* < barbed *pv",* distal-most barbed *u* ~ *pv'*. Terminal pair of simple claws with a fan-shaped empodium.

Leg IV (Fig. 8). Tr: *v'* ~ Fe *v'*, each barbed; Fe: robust, barbed *d* with strongly sclerotized annulus, longest seta on leg; Ge: barbed *v'* < Ti *v'*; Ti: smooth *l'* ~ *v'* ~ *v"*, both barbed; *d* long, barbed with strongly sclerotized annulus and tiny solenidion ϕ in sacculus at its base. Ta: *pl"* pilose; whipped *tc'* > smooth *tc"*, *pv"* ~ *pv'* both barbed; and *pv'* > barbed *u'*.

Etymology: The specific name *sekhukhunensis* refers to the collecting locality of the spider hosts, Sekhukhuneland, near Lydenburg, Mpumalanga, South Africa.

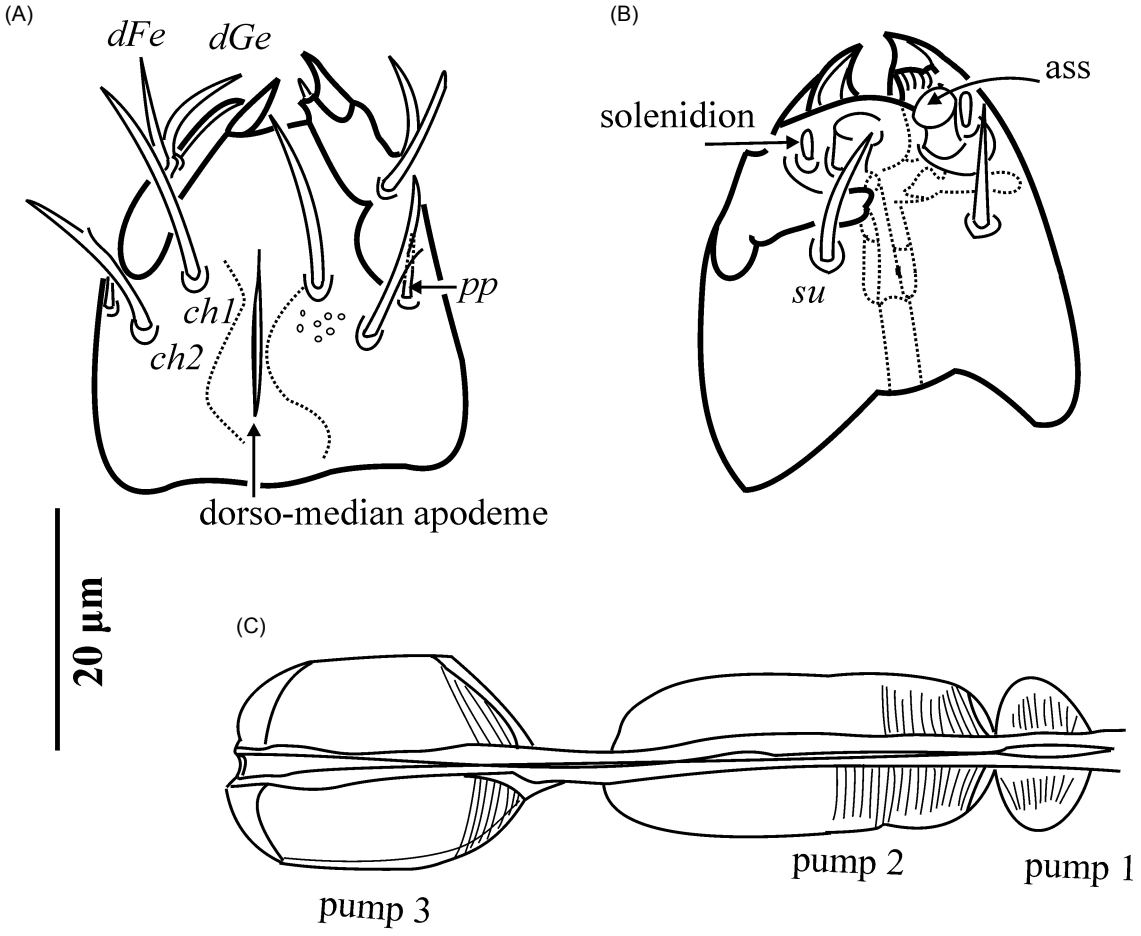

Fig. 4. *Zambedania sekhukhunensis* sp. n. Female holotype. Gnathosoma A- dorsum, B- venter, C- pharyngeal pumps.

Male (Figs. 10-15, Table 3).

Gnathosoma (Fig. 10C, D). Gnathosomal capsule of the male much smaller than that of female. However, most of the external structures of the female capsule present on the male gnathosoma except that the mouthparts are absent. The stylophore extends anteriorly into a truncated-triangular distal edge bearing two pairs of tiny, sub-equal in size, smooth cheliceral setae: *ch1* and *ch2*. Unlike the female, the male lacks palpi, palpal supracoxal setae (*pp*) and chelicerae. Subcapitulum with a pair of relatively long slender, simple setae (*su*); anteriad setigenous accessory structures (*ass*) laterally flanked by relatively long clavate, non-striated solenidia (sol).

Pharyngeal system: absent.

Idiosomal dorsum (Figs 10A, 11A). Males on average much smaller than females (range of lengths 172-186 vs 270-309) and with well sclerotized, sparsely punctate exoskeleton. Prodorsal shield (PdS) triangular, dome-shaped, without stigmata, tracheal system or bothridia; verticals (*v2*) antero-mediad of setiform short scapulars *sc1* and long *sc2*. Opisthosoma with tergites CD fused, EF fused, and dorsodistally partly covers greatly reduced tergite H which coalesced with caudoventral pseudanal shield (Ps) to form HPs, the genital capsule. All dorsal setae barbed, except for smooth setae *e*, *h1* and *h2*. Fused shield CD bearing two pairs of very long tapered, setiform barbed setae (*c1*, *c2*) anteriorly and a pair (*d*) of similar setae postero-laterally. Shield EF with setae *e* less than half as long as barbed *f*, covering HPs. Shield H (Fig. 11A) with two pairs of setae: anteriormost setae (*h1*) smooth, short, thorny and pointed, *h2* setae strongly modified into button-like structures in sucker-shaped rings. Membranous copulatory flanges border the H shield posteriorly.

Idiosomal venter (Figs 10B, 11B). Compared with the long clearly barbed dorsal setae the ventral setae short, smooth or more or less barbed. Coxisternal plates: anterior and posterior edges of ventral shields smooth, not subdivided, and widely curved. The setae are distributed as in the females. Ap1 very short, seemingly a mere widening of the

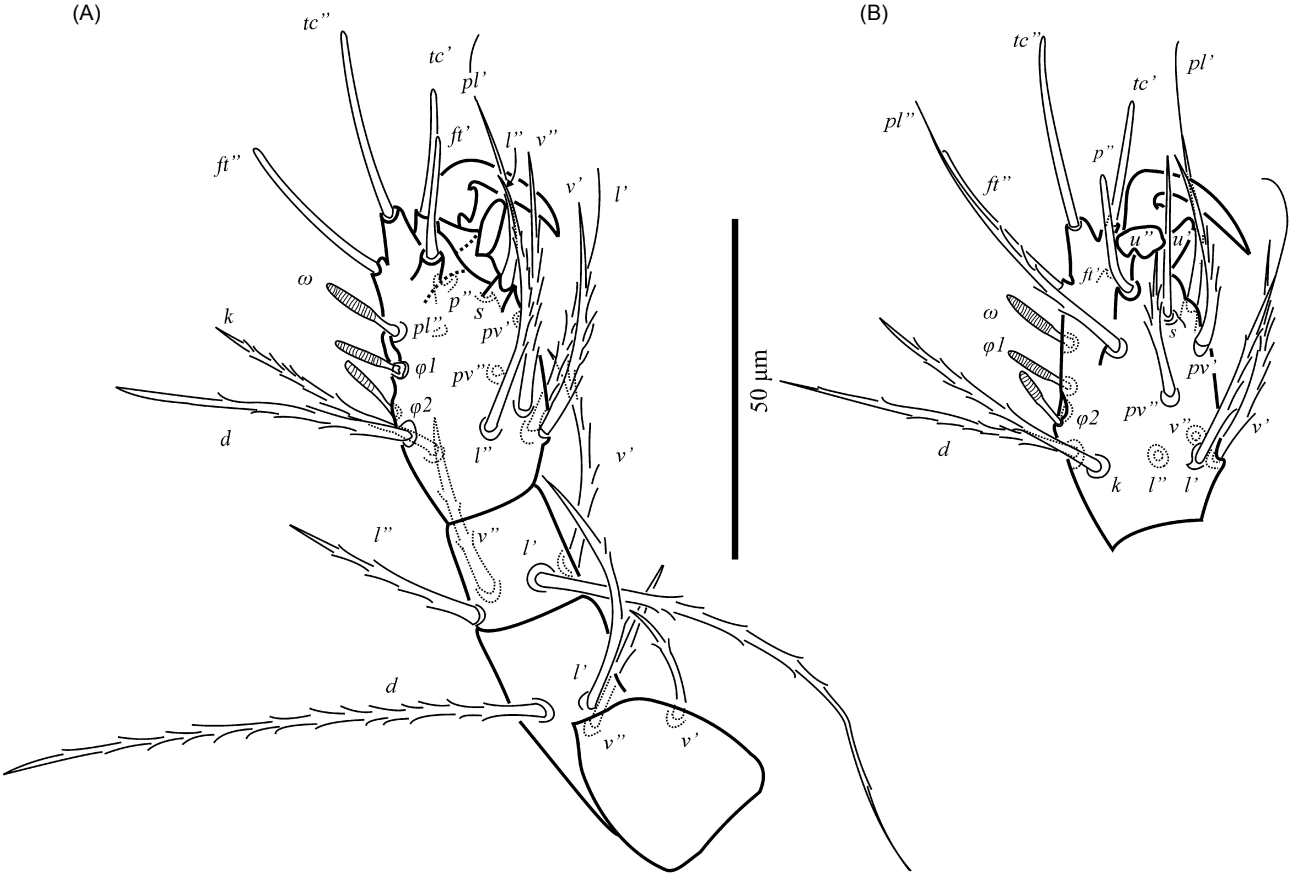

Fig. 5. *Zambedania sekhukhunensis* sp. n. Female holotype. Leg I A- (left): antaxial view, B- tibiotarsus (left): paraxial view.

anterior part of the prosternal apodeme (appr). The appr extends uninterruptedly caudad to form a Y-shaped juncture with complete ap2, to continue posteriorly towards the apsej. Ap3, 4 complete, anteriorly arched; ap3 medially concavely and ap4 convexly joined to completely formed poststernal apodeme (appo). Appo meeting posteriorly of setae *4a* with ap5 from the posterior condyle of Tr IV. Setae *4b* proximal-most on coalesced plate HPs. On the genital capsule modified pseudanal setae *ps2* on a slight elevation, medio-laterad of and very close to *ps3*. Setae *ps1* (Fig. 11A) probably implanted medio-anteriorly of *ps2*, *3* and covered by copulatory flanges, on either side of the folded aedeagus. No cupules seen.

Legs. Leg I (Fig. 12). All tactile leg setae setiform, tapering, distally acute and barbed. Trochanter length *v'* ~ Fe *v"*; Fe *d* setiform and longest seta of leg I; *l'* > ½ *d*, *v"* ~ ⅔ *l'*. Genu *v'* ~ *l"* > *v"*, *l'* longest seta of verticil. All tibial setae barbed on one-side, except smooth *l'*. Setae *v'* ~ *l"* < *k*; *v"* longest, *d* shortest seta on verticil. Solenidion slim ϕ1 > ϕ2. Tarsal solenidion ω2 proximal-most on the verticil, close to and much shorter and thinner than robust ω1. One-sidedly barbed *pv"* ~ *pv'*, *pl"* ~1½ *pl'*. Seta *s* ~ ω1. Setae *u'* < *u"*. Eupathidia (ξ) *ft'* ~ *ft"*; *tc'* < *tc"*; *p'* < *p"*. Tectals and prorals on pinnaculum, dorso-laterad of single claw.

Leg II (Fig. 13). Trochanter: *"v'* < Fe *v","* the latter barbed on one side. Fe *l'* barbed on one side, lacking on right leg, but present on the left, shortest seta on segment, *d* the longest. Genual smooth *l"* ~ slightly barbed *l'* < one-sidedly barbed *v'*. Tibial one-sidedly barbed *l'* longest seta on verticil, *v'* > *v"*,

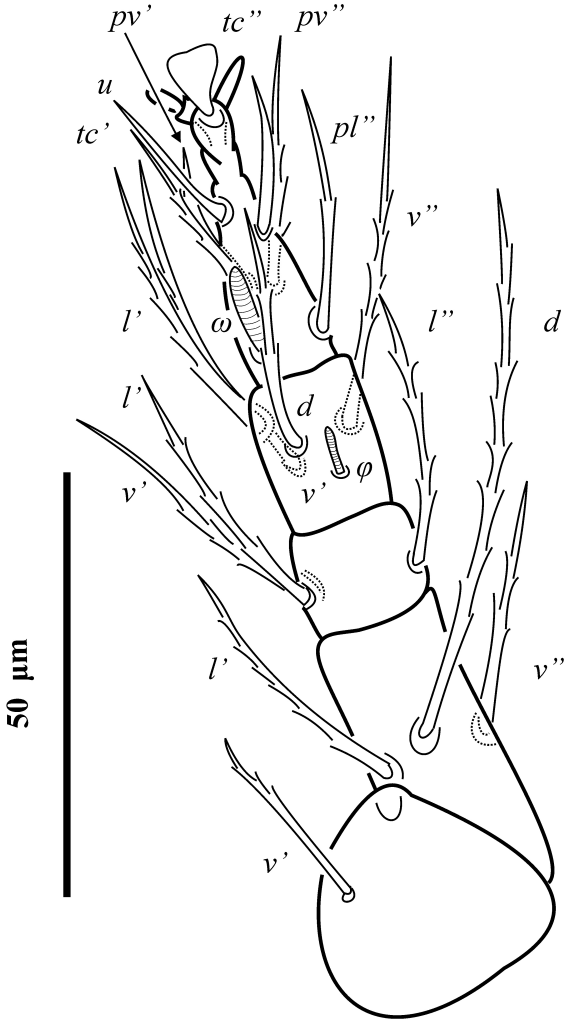

Fig. 6. *Zambedania sekhukhunensis* sp. n. Female holotype. Leg II (right): dorsal view.

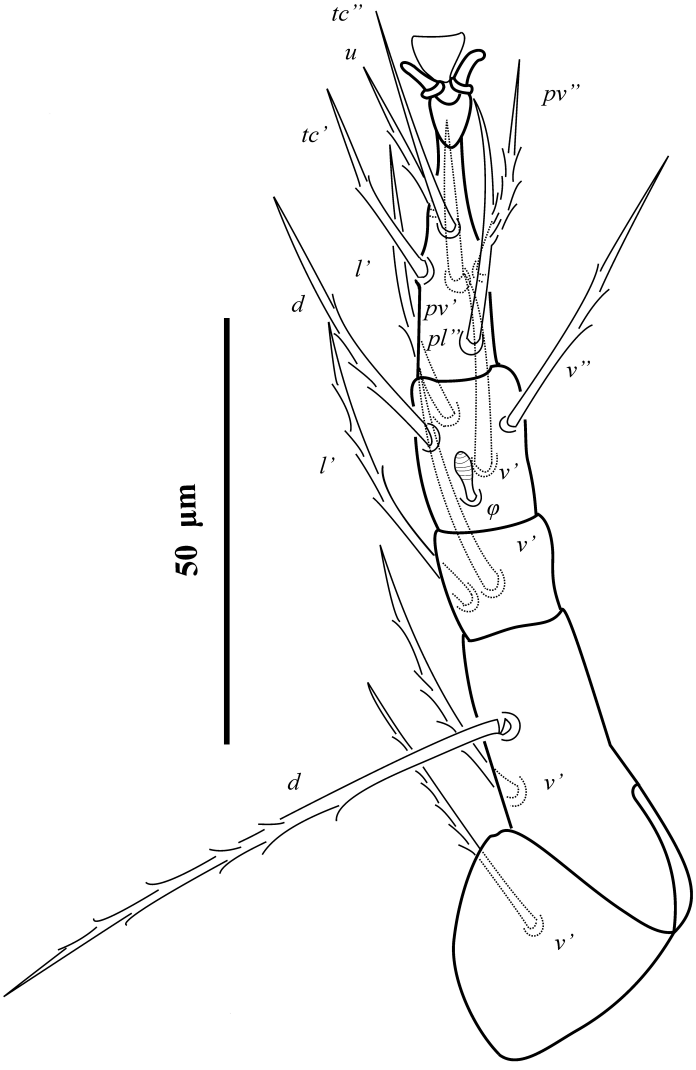

Fig. 7. *Zambedania sekhukhunensis* sp. n. Female holotype. Leg III (right): dorsal view.

d shortest seta, closest to solenidion. Tarsus with robust solenidion ω proximal-most on segment; *pl"* longest seta, on protuberance; barbed *tc'* < smooth *tc"*, *pv'* < one-sidedly barbed *pv"*, *u'* < to *u"*, both one-sidedly barbed. Cordate empodium with medial fold between a pair of simple claws,

Leg III (Fig. 14). Third leg very much like the second leg; trochanteral setae barbed *v'* > barbed Fe *v'*. Femur with longest, robust, barbed seta *d* extending to tarsus. Genu with barbed setae *v'* ~ *l'*. Tibial *d* closest to solenidion ϕ and < one-sidedly barbed *l'*. Seta *v'* ~ *v"*, both slightly barbed; similar to leg II, leg III bears a robust tarsal solenidion ω; one-sidedly barbed *pl"* longest seta on segment, slightly barbed *tc'* > smooth *tc"*, slightly barbed *pv'* ~ one-sidedly barbed *pv"*; barbed *u'* < smooth *u"*; as in leg II terminating in a pair of simple claws with a cordate empodium in-between.

Leg IV (Fig. 15). Leg IV modified; trochanteral seta barbed *v'* >Fe *v'*; Fe *d* slightly barbed ~ barbed *v'*. Genu: barbed *v'* > Fe *v'*; *l'* absent. Tibia: short ϕ close to smooth *d*; smooth *l'* < *d*; one-sidedly barbed *v'* longest on segment, smooth *v"* the shortest. Tarsus very short with modified claw that seems to fit in a hooked claw-like structure *u'*. Setae *pl", pv"* and *pv'* short and smooth; very long

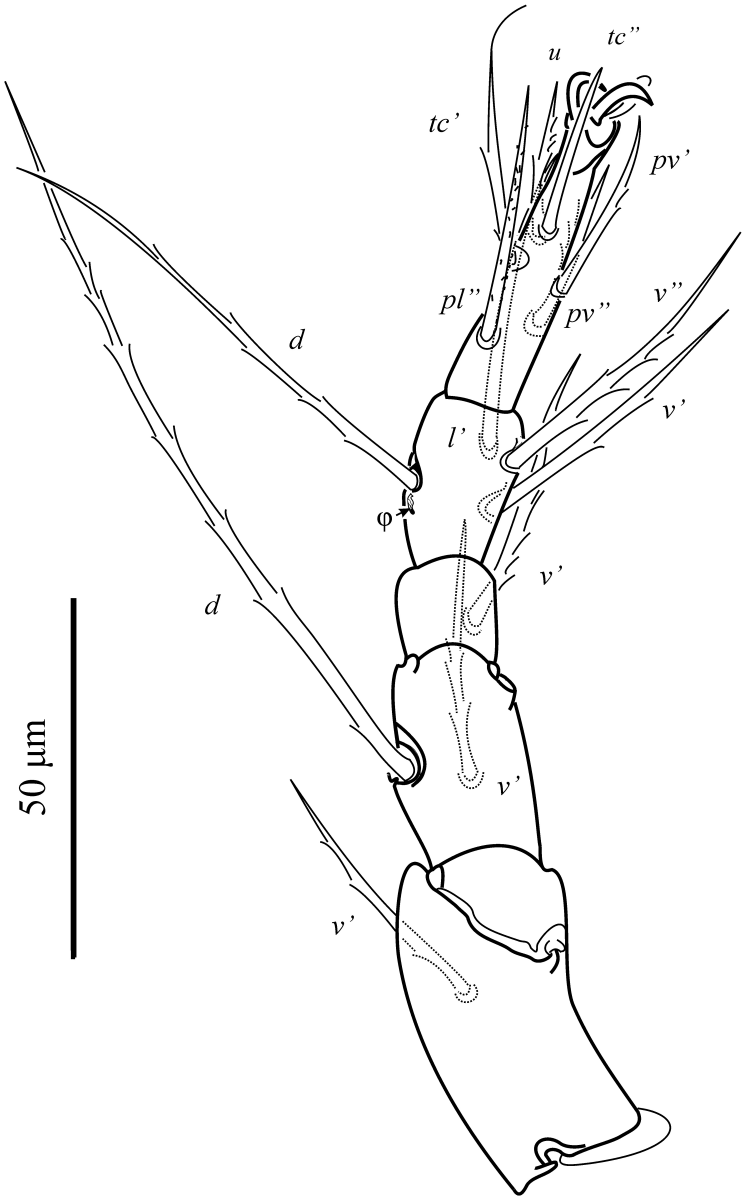

Fig. 8. *Zambedania sekhukhunensis* sp. n. Female holotype. Leg IV (right): paraxial view.

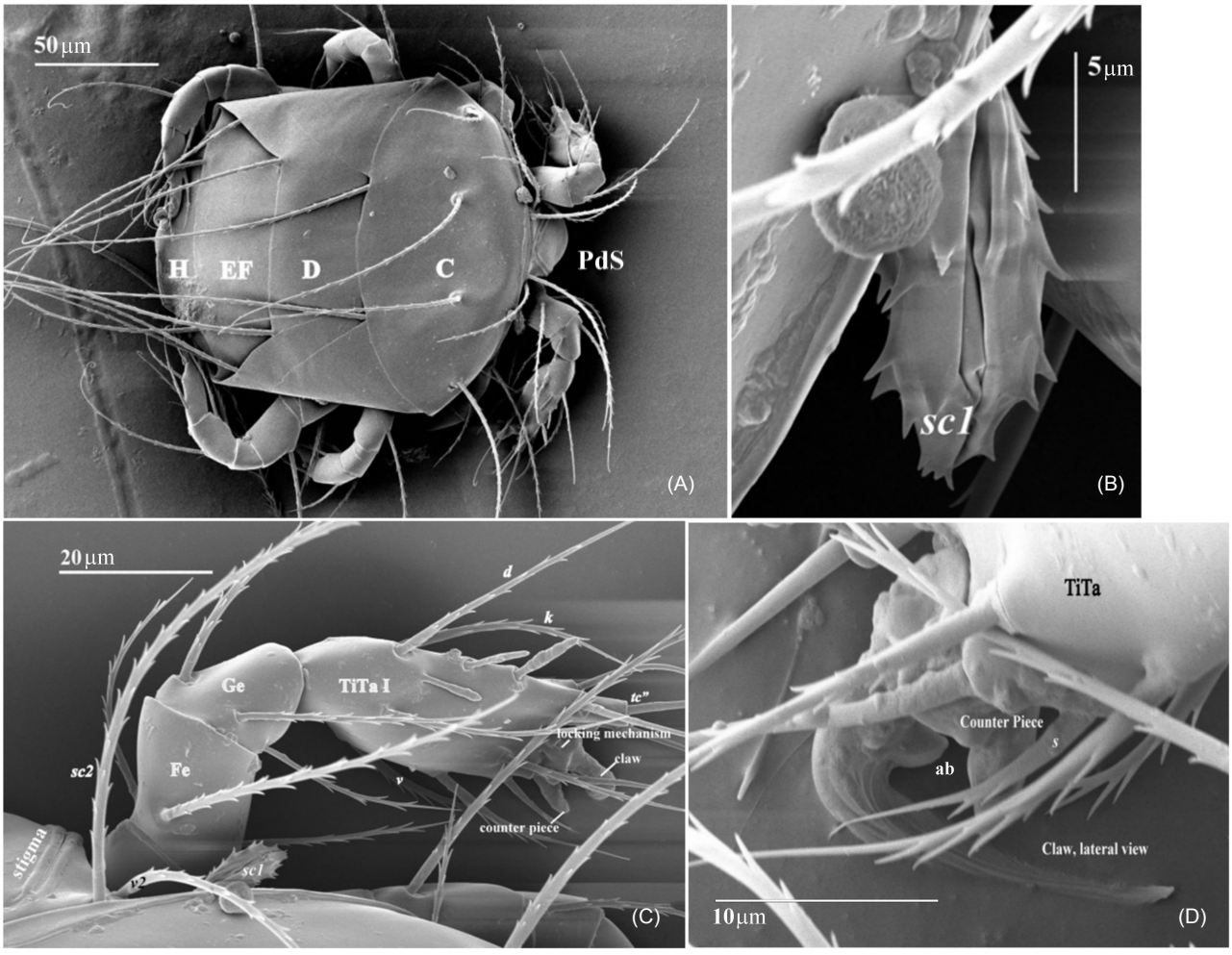

Fig. 9. *Zambedania sekhukhunensis* sp. n. Female. A- dorsal view; B- caput of bothridial seta, dorsal view; in front "pilose" setae; C- Leg I (right). Note TiTa in dorsal view. At distal end "turret" carrying claw with at its base dorsal pinnaculum of the "locking system", flanked by part of counterpiece. Eupathidia dorsad on pinnaculi. The cluster *d* and *k* associated with the three solenidia. Ventro-laterad near to counter piece seta *s* followed by feathered *pv* and *v.* D- detail distal end of left TiTa I in lateral view, claw and butterfly-shaped counter piece made up of setae *u'* - *u"*, below seta *s,* followed by "feathered" primiventrals *pv'* and *pv"* (photos by G. Bauchan and R. Ochoa).

Table 4. Leg chaeto- and solenidiotaxy of the genus *Zambedania sekhukhunensis* sp. n. larva

	LEG I		LEG II		LEG III	
SEGMENT	Nr	SIGLA	Nr	SIGLA	Nr	SIGLA
TROCHANTER	0		0		0	
FEMUR	3	*d,l',v"*	3	*d,l',v"*	2	*d,v'*
GENU	4	*l',l",v', v"*	3	*l',v",v'*	2	*l',v'*
TIBIA	6	*l',l",v',v",k,d*	4	*d,l',v',v"*	4	*d,l',v',v"*
Solenidia	1	*ϕ1*	1	*ϕ*	1	*ϕ*
TARSUS	11	*pl',pl",pv',pv",u',u",s,tc',tc",ft"*	7	*pl",tc',tc",pv',pv",u',u"*	7	*pl",tc',tc",pv',pv",u*
Eupathidia		*ft'*	0		0	
Solenidia	1	*ω1*	1	*ω*	0	
Claws	2		2		2	

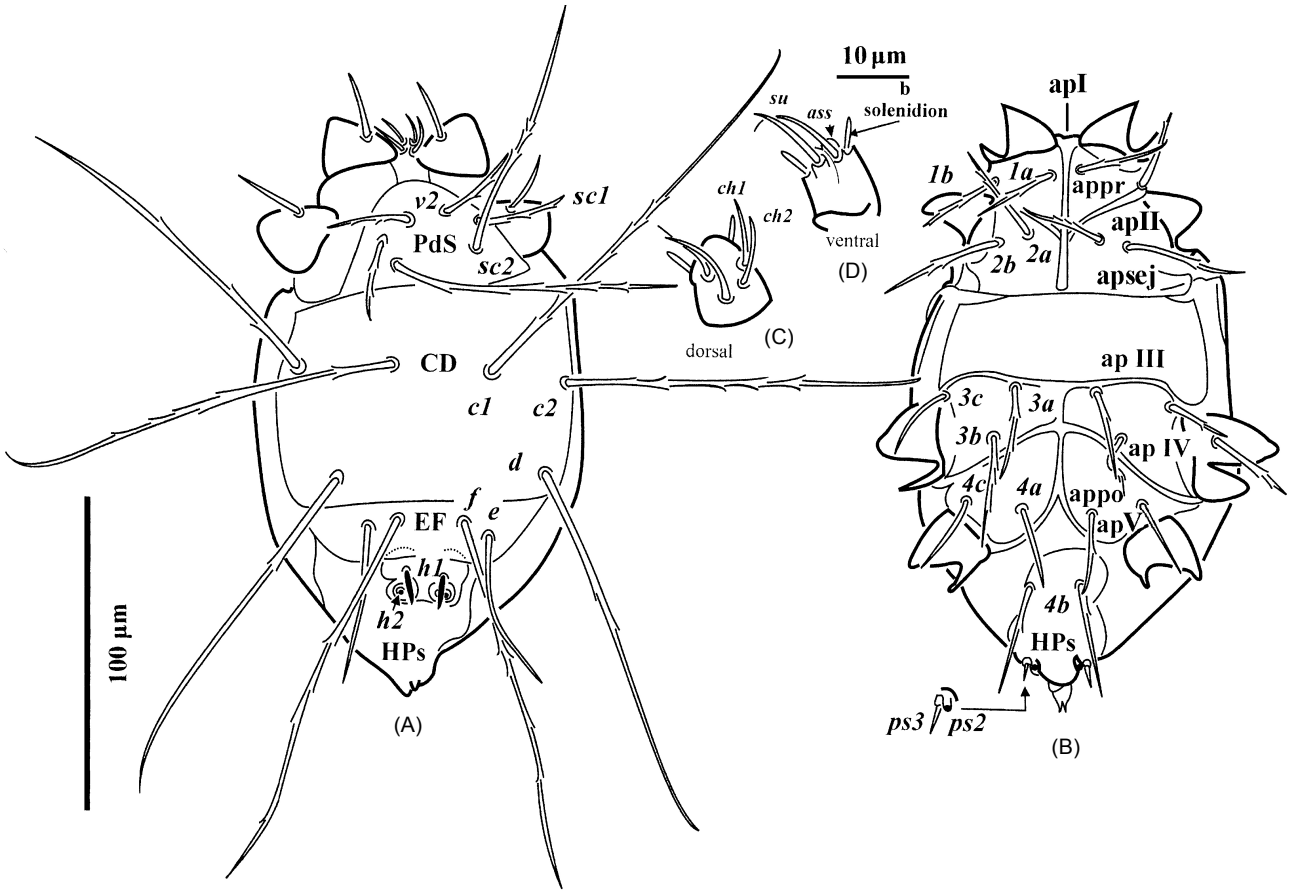

Fig. 10. *Zambedania sekhukhunensis* sp. n. Male paratype. Idiosoma: A- dorsum, B- venter; gnathosoma: C- dorsum, D- venter; a- scalebar for idiosoma, b- scalebar for gnathosoma; sculpture omitted.

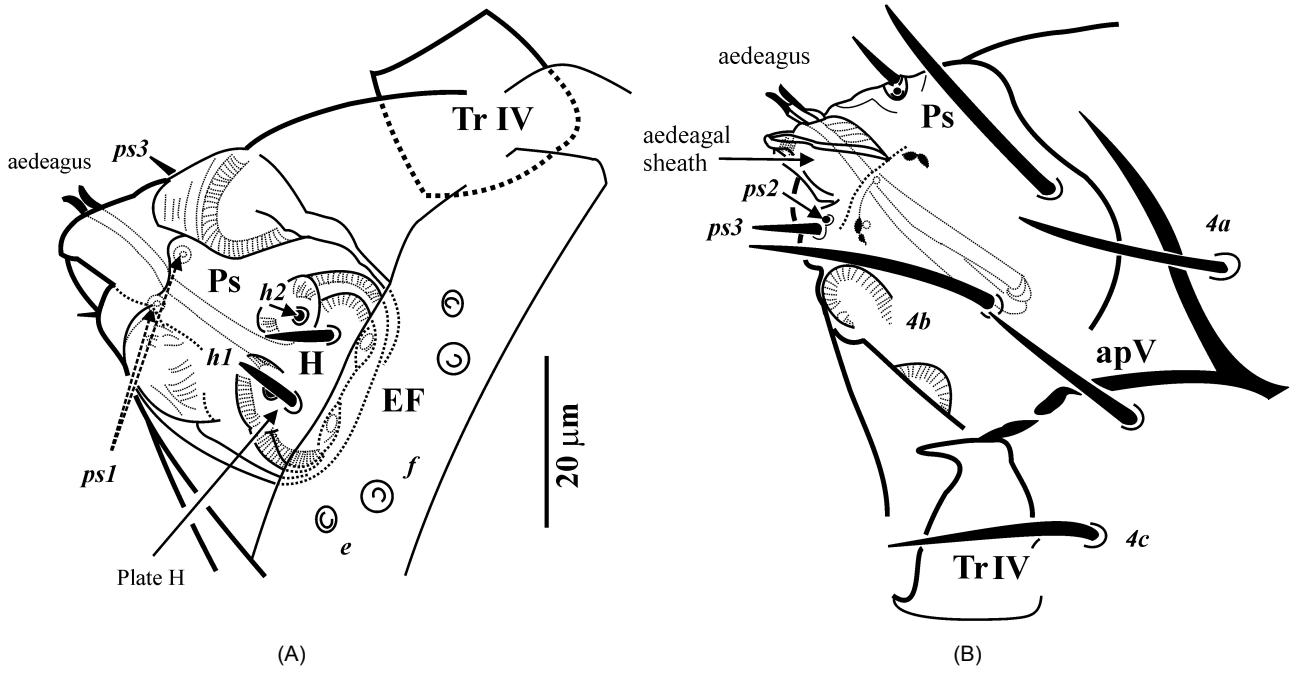

Fig. 11. *Zambedania sekhukhunensis* sp. n. Male paratype. Genital capsule: A- dorsal view, B. ventral view.

tc' ~ 1½ *tc"*, both setae barbed. Seta *u"* inserted laterad of claw.

Larva (Figs 16-20, Table 4).

Gnathosoma (Figs. 17A, B). The gnathosoma about the same size and shape as that of the adult female. Dorsally the stylophore terminates in a trapezoid antero-distal edge. The pedipalps situated antero-laterad and subdivided into four segments, palptrochanter, fused palpfemoro-genu with smooth setae *dFe* and *dGe*, and palptibiotarsus. The palptrochanter fused with the stylophore. The palptrochanter and palpfemoro-genu connected by membranes as are the palpfemoro-genu and the palptibiotarsus. The palptibiotarsus, laterad of the stylophore clearly subdivided into three parts. The distal claw medially with thorn-like structures. Stylophore with very short, blunt peglike ch_1 setae and slightly postero-laterad thereof smooth setiform ch_2, which is about three and a half times the length of ch_1. Palpal supracoxal setae *pp* absent. Subcapitulum with a pair of slender, simple, smooth subcapitular setae (*su*); antero-mediad a mushroom-shaped setigenous accessory structure (*ass*) and laterad at its base a clavate, non-striated solenidion (*sol*).

Pharyngeal system (Fig. 17C) similar to that of the adult female situated in the propodosomal area. The pharyngeal pumps shaped similarly to those of the adult female, but more compact and very thin.

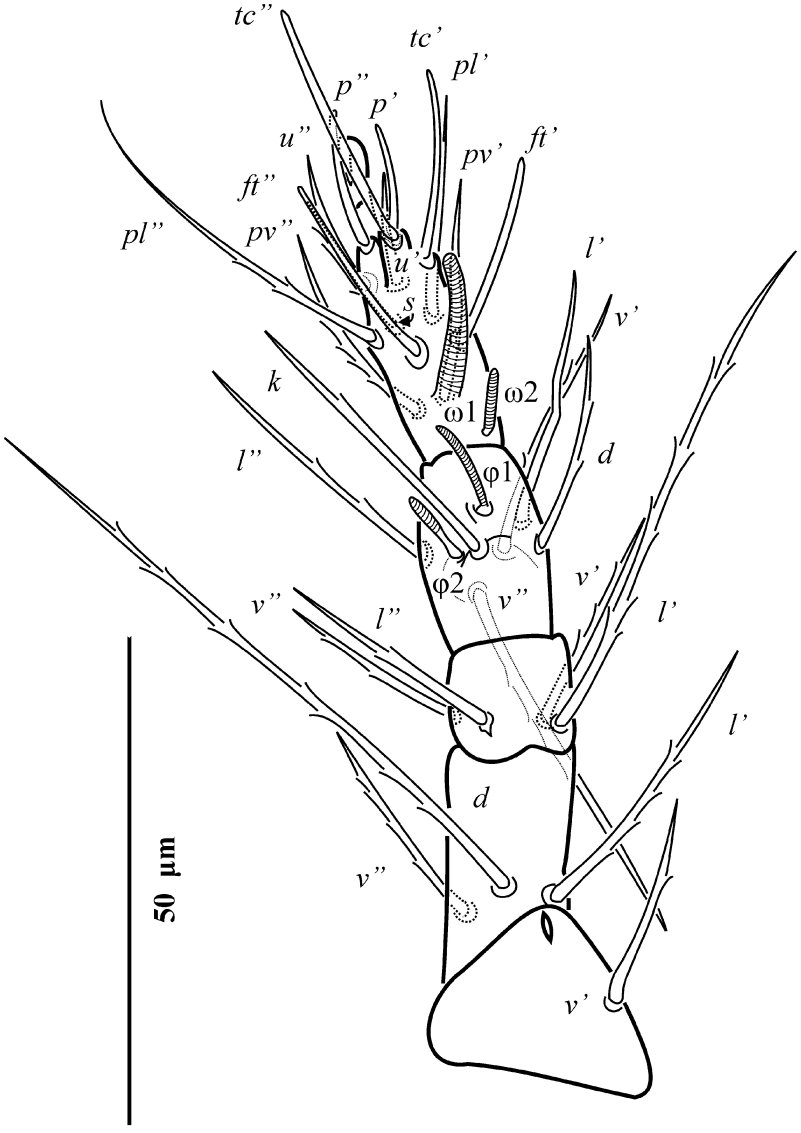

Fig. 12. *Zambedania sekhukhunensis* sp. n. Male paratype. Leg I (right): dorsal view.

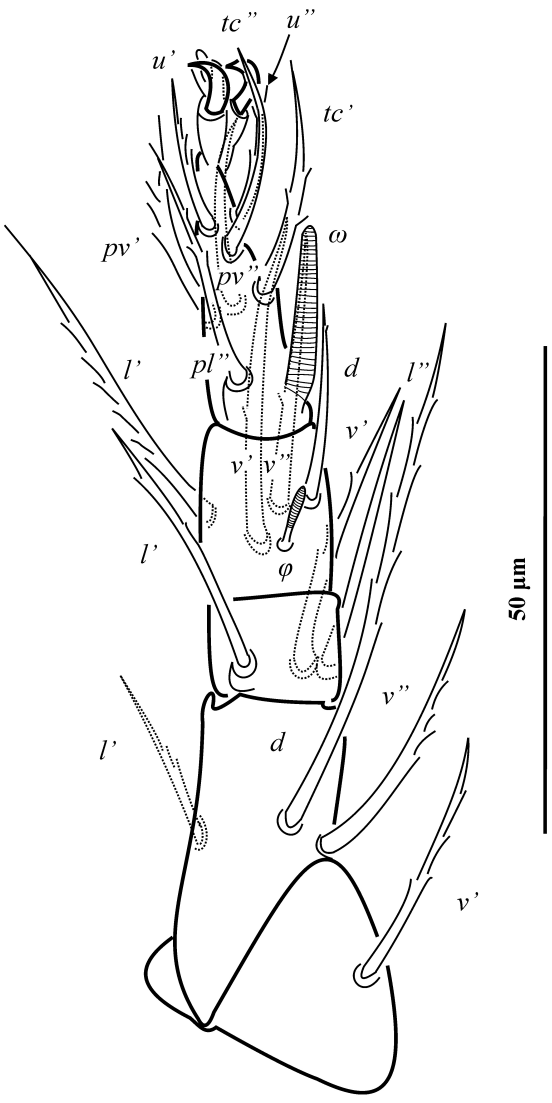

Fig. 13. *Zambedania sekhukhunensis* sp. n. Male paratype. Leg II (right): dorsal view.

Idiosomal dorsum (Fig. 16A). The larval exoskeleton very lightly sclerotized and without clearly defined tergites and sculpture. The PdS with three pairs of tapered setiform setae: one pair of short, smooth verticals (*v*) anterolaterad of barbed scapulars *sc1*, followed posterolateral by a very long pair *sc2*. Bothridia, stigmata or podocephalic canals absent. Opisthosomal tergites fused in pairs: CD (partly), EF, and dorso-ventrocaudal HPs. All dorsal opisthosomal setae very long and barbed. Segment C is subdivided into three shields, the median one coalesced with plate D bearing setae *c1* and two separate laterals with *c2*. Setae *c1* are situated mediad of *c2* and

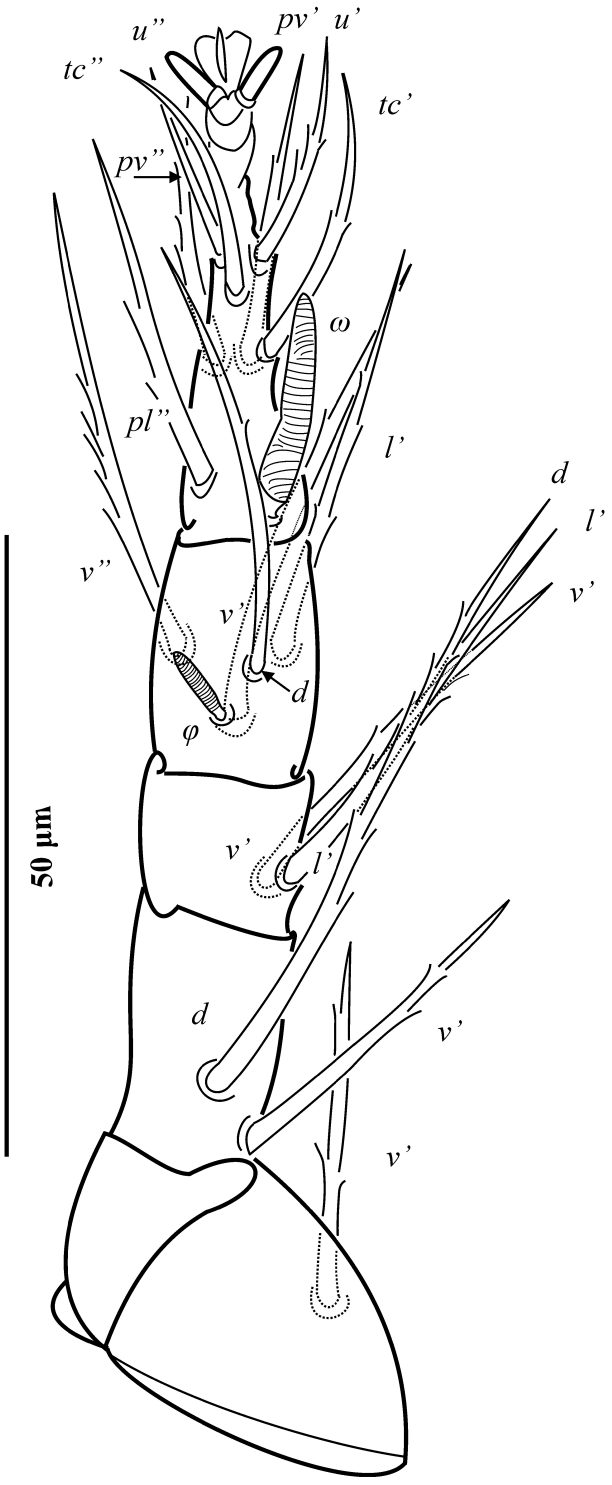

Fig. 14. *Zambedania sekhukhunensis* sp. n. Male paratype. Leg III (right): dorsal view.

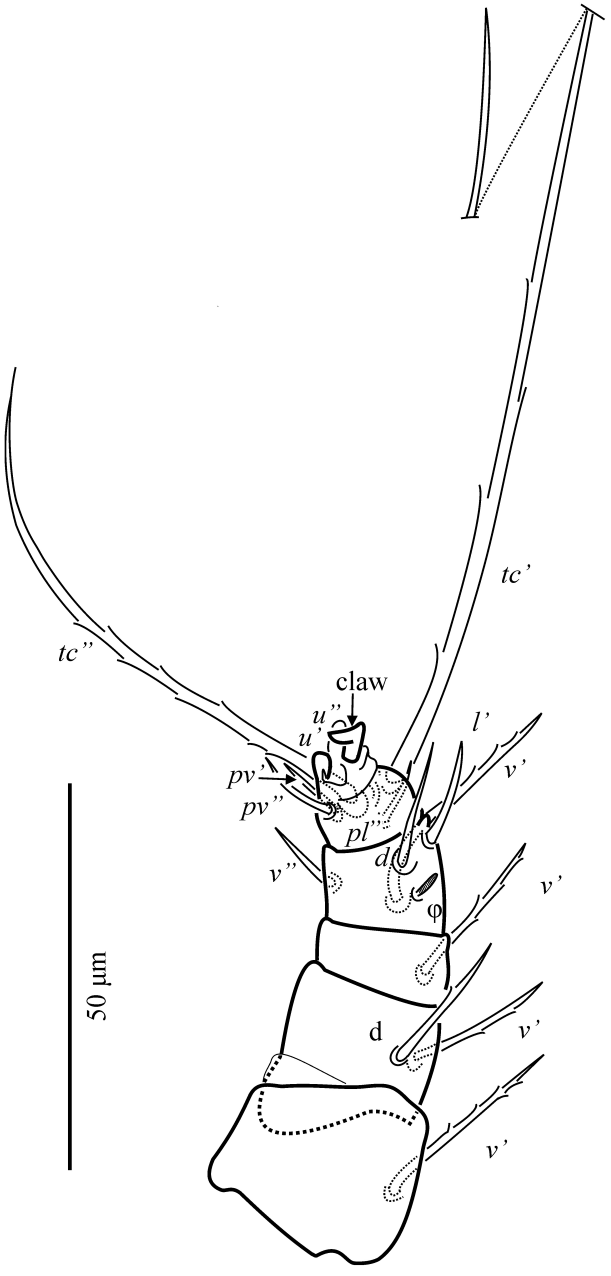

Fig. 15. *Zambedania sekhukhunensis* sp. n. Male paratype. Leg IV (left): dorsal view.

anteriad of *d*. Setae *d* on CD and *f* on plate EF implanted on protrusions. Setae *e* laterad of seta *f* on segment EF. On segment HPs setal pair *h1* positioned slightly antero-mediad of *h2* on the dorsal side, and the pseudanal *ps1*, *2*, *3* ventro-caudad.

Idiosomal venter (Fig. 16B). Coxisternal plates I and II lightly sclerotized bearing two pairs of setae on each plate (*1a*, *1b* and *2a*, *2b* respectively). Anterior edges of the plates form apodemes (ap) 1 and 2, medially separated from each other and do not form the prosternal (appr) apodeme. Sejugal apodeme (apsej) absent. CX III with two pairs of setae (*3a*, *3b*). Ap3 and poststernal apodeme (appo) absent. In place of appo, some creases between CX III plates present. All ventral setae short, tapered and smooth.

Legs. Leg I (Fig. 18). Femur: barbed *d* longest seta on segment, slightly barbed *l'* > smooth *v"*, both on pinnaculum. Genu: all setae barbed, except smooth *v"* < *v'*; *l'* (on pinnaculum) longest seta and *l"* the shortest; all tibial setae on pinnaculi and smooth except feathered *v'*: *v"* > *l'* > *l"* > *d* ~ *k*. Striation of solenidion ϕ wider than of ω (both

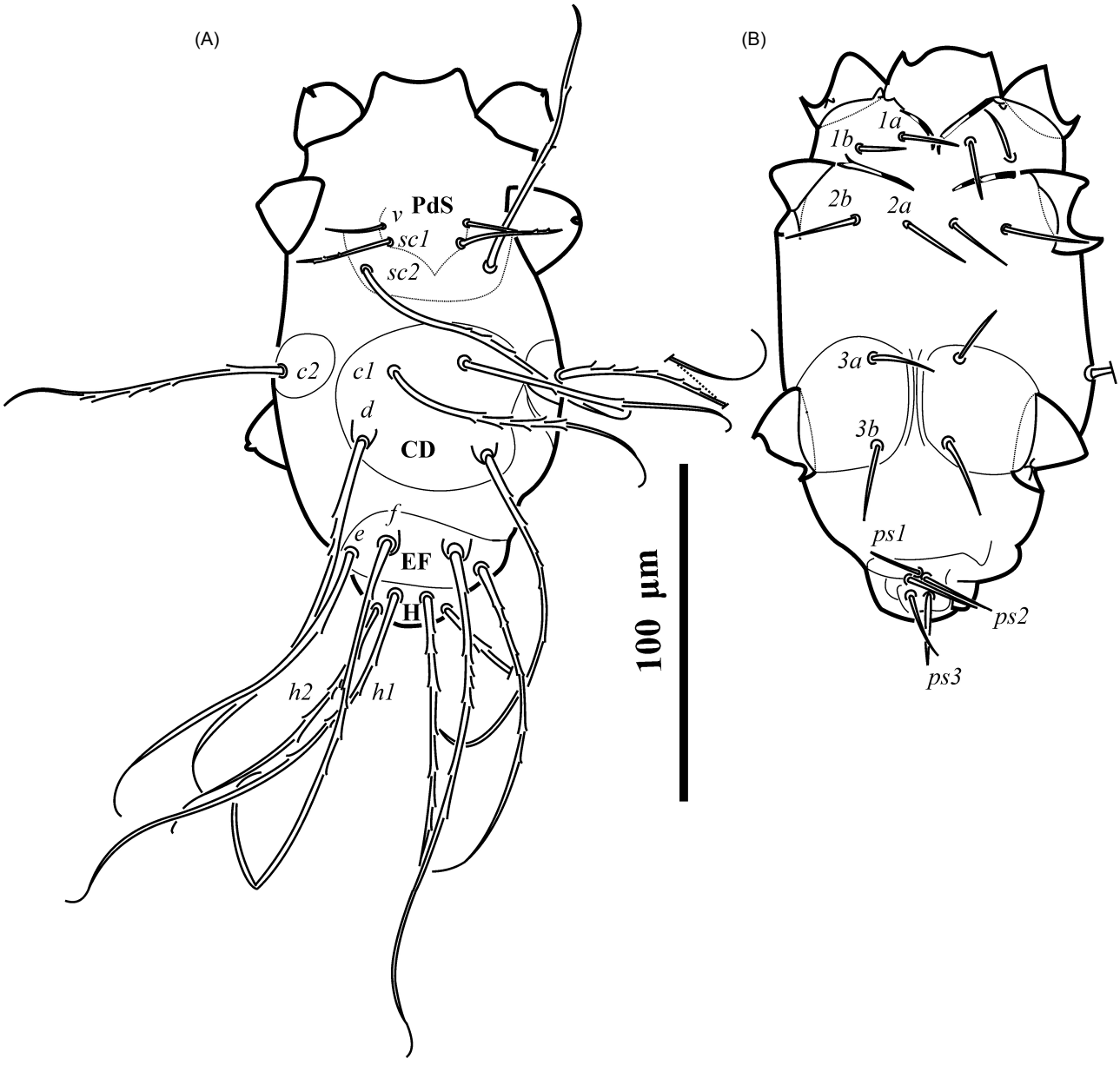

Fig. 16. *Zambedania sekhukhunensis* sp. n. Larva paratype. Idiosoma: A- dorsum, B- venter.

on pinnaculi). Tarsal setae all smooth except little barbed *pl'*; *pl' ~ pl"*; *pv" > pv'*; *ft'~ ft" > s > u' > u"*; *ft' < tc' < tc"*. Setae *pv'*, *pl"*, *ft'*, *tc'* and *tc"* on pinnaculi. On tarsus two distal claws present (only one on the right leg- artefact); no empodium between the claws.

Leg II (Fig. 19). Femur: slightly barbed *l'* >smooth *v"* (both on pinnaculi), *d* longest on segment and barbed. Genu: *v' ~ l'*, both one-sidedly barbed; slightly barbed *l"* shortest seta. Tibia: one-sidedly barbed *l'* > slightly barbed *d*; pilose *v'* < one-sidedly barbed *v"*; solenidion *j* < Ta ω. Tarsus: smooth *pl"* > smooth *tc'* > smooth *tc"*; slightly barbed *pv'* > smooth *pv"*; slightly barbed *u'* > *u"*. Solenidion ω large. Two claws with a spatulate empodium in between. Tibial setae *d*, *v'*, *v"*, ϕ and tarsal *pl"*, *tc'* and ω on pinnaculi.

Leg III (Fig. 20). Femur: barbed *v'* < long one-sidedly feathered *d* (on pinnaculum). Genu: smooth *v'* < one-sidedly barbed *l'*. Tibia: all setae one-sidedly barbed: *l'* < *v'* < *v"* < *d* which is closest to solenidion *j*. Tarsus: smooth *pl"* < smooth, robust *tc'* > smooth *tc"*; slightly barbed *pv'* > smooth *pv"* > smooth *u' ~ u".* Two claws with a fan-shaped empodium in between.

Material examined: Holotype adult female, 28 paratype adult females, 5 paratype adult males and 1 paratype larva. Females primarily aggregated in and around the fovea (Fig. 2) of the cephalothorax and around the coxae, near the spinnerets and anus of spiders; in addition, females found with associated males and larva in and around spider's nests.

Host: *Harpactirella overdijki* Gallon, 2010 (Araneae: Theraphosidae). Specimens were found on 4 females and 2 immature spiders. Site: most spiders were collected under a large tree (Fig. 1); 200m transect; midpoint of transect: 24.9086 S, 30.09971 E; altitude 945 m (range 938-950 along transect). Locality: Two Rivers Platinum Mine, 38 km SE of Burgersfort, 40 km WNW of Lydenburg, Sekhukhuneland, Limpopo Province, South Africa. Dates: 25 March - 25 April 2008, 3-7 November 2008, 19 April 2010, 12-13 January 2011 and

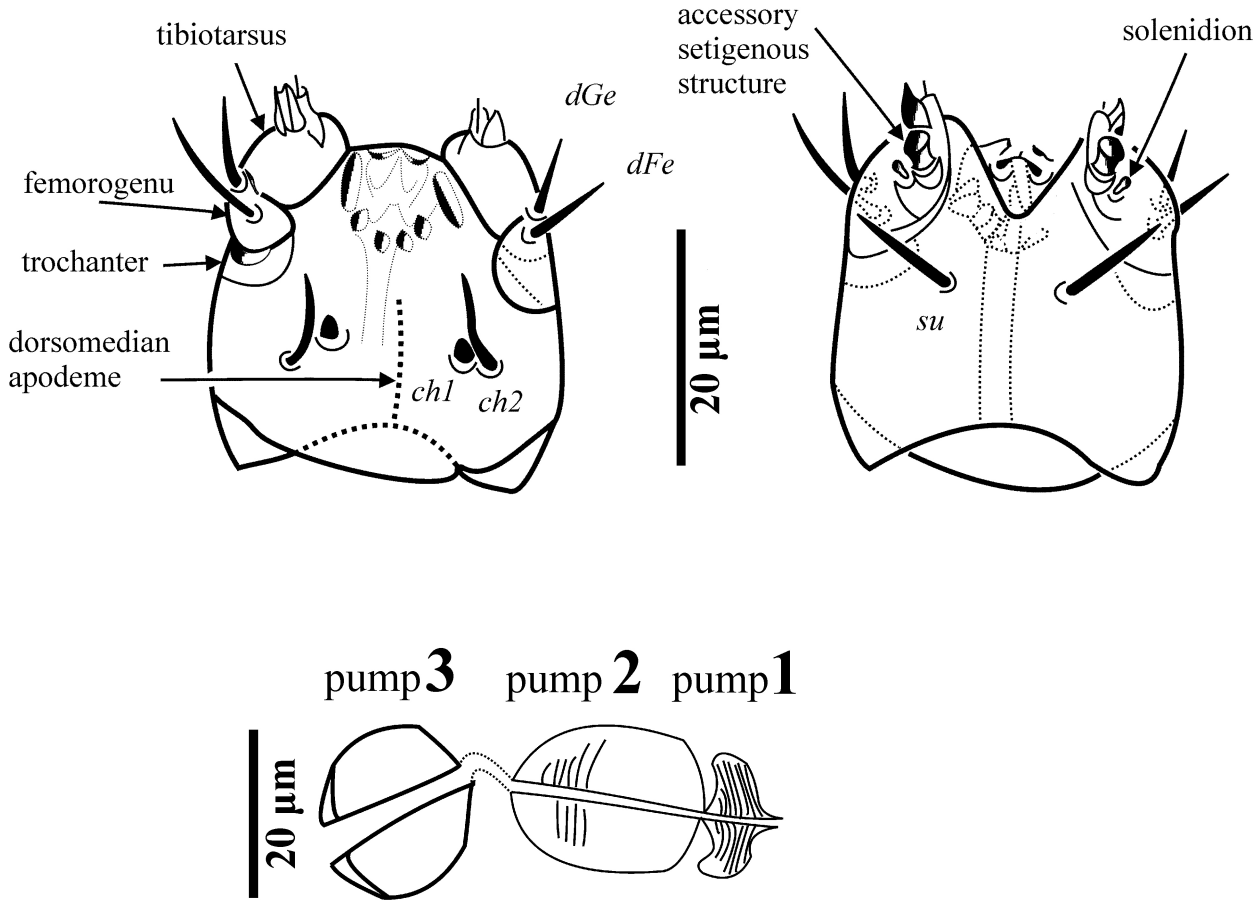

Fig. 17. *Zambedania sekhukhunensis* sp. n. Larva paratype. Gnathosoma: A- dorsal view, B. ventral view, C- pharyngeal pump system.

7-11 February 2011. Collectors: Peter Hawkes, Jonathan Fisher and assistants: Faith Kgafane, Katarina Jovanovic, Maphilisi Zulu, Matimba Baloyi, Michael Pierce, Nkosinathi Babu and Philippa Wing.

Deposition of types: Holotype female, 4 paratype females, 1 paratype male and 1 paratype larva, deposited in the USNM mite collection, Beltsville, Maryland, USA; 6 paratype females and 1 paratype male in the collection of the University Adam Mickiewicz University in Poznań, Poland; 4 paratype females and 1 paratype male in the collection of the Zoologisches Institut und Museum of Universität Hamburg, Germany; 4 paratype females and 1 paratype male in the Muséum d' Histoire naturelle, Département des Arthropodes et d' Entomologie, Genève, Switzerland; 10 paratype females and several non-type female specimens and 1 paratype male in the Arachnida Collection of the ARC Plant Protection Research Institute, Pretoria, South Africa.

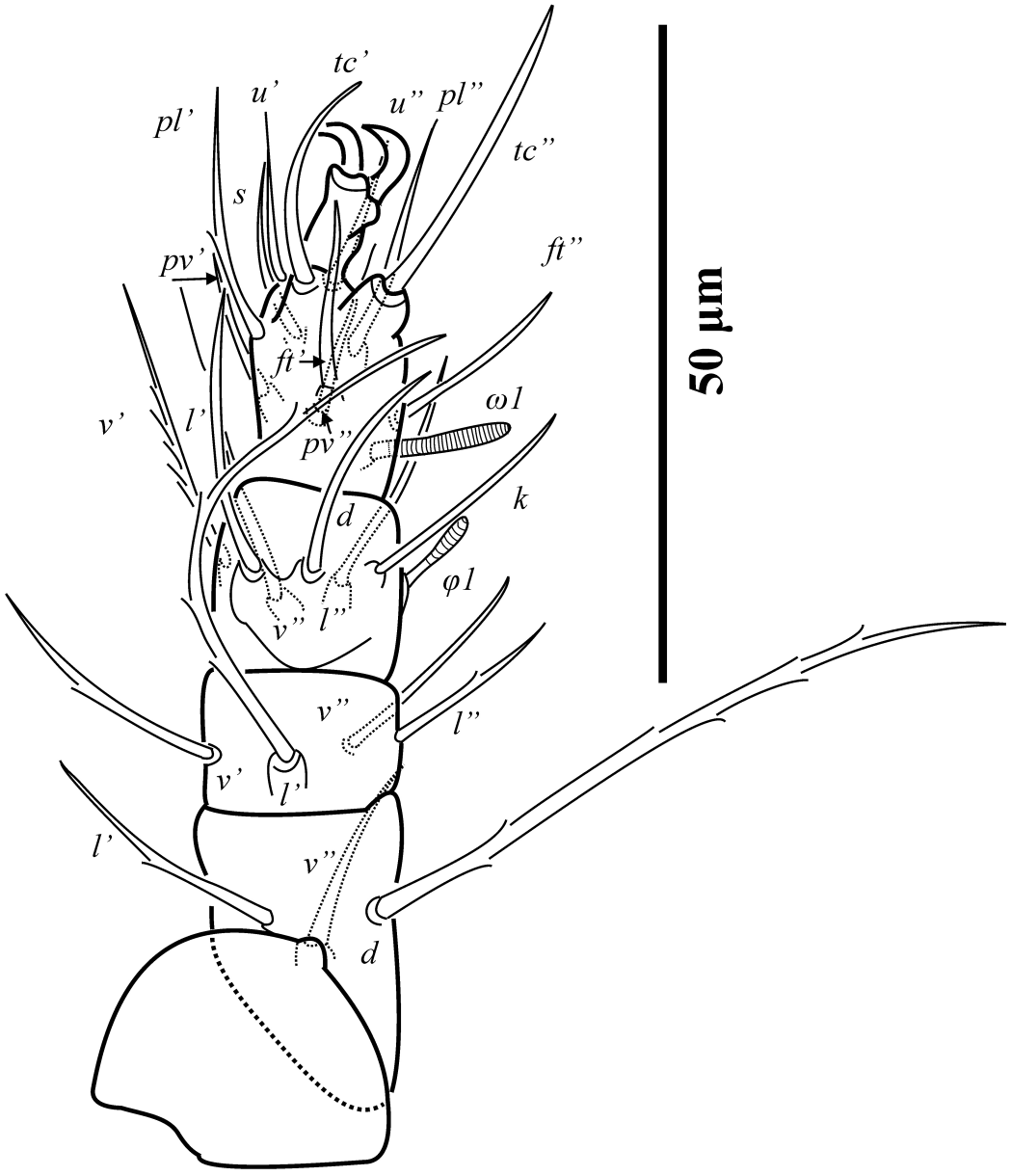

Fig. 18. *Zambedania sekhukhunensis* sp. n. Larva paratype. Leg I (right): dorsal view.

DISCUSSION

Biology

The collected females are all phoretic forms having four-segmented first legs. Non-phoretic females having five-segmented first legs, like those described by Camerik et al. (2006) of dimorphic pygmephorid *Pediculaster mesembrinae*, were not found among specimens collected on spiders nor in spider's nests where both males and a larva were present. This indicates, that *Z. sekhukhunensis* can successfully complete its life cycle without entering a non- phoretic morph generation. Several evolutionary advantages may be acquired by species in which the females have relinquished their function of intensive environmental resource exploitation (whose primary goal is feeding and reproducing) towards the phoretomorph (whose primary goal is facilitating dispersal). When the available resources of the habitat are not abundant or stable enough, and this becomes a fixed environment characteristic, the elimination of the non-phoretic morph females can be a positive trade-off, offering substantial energy/time saving over costs of an uncertain food source acquisition.

Morphology

The larval dorsal shield of *Z. sekhukhunensis* is somewhat peculiar by an apparent fusion of medial C sclerite (bearing setae *c1*) with that of the D sclerite. In the majority of known larvae of Pygmephoroidea and Scutacaroidea (e.g. *Pediculaster mesembrinae*), these two shields remain clearly separate, with the exception of

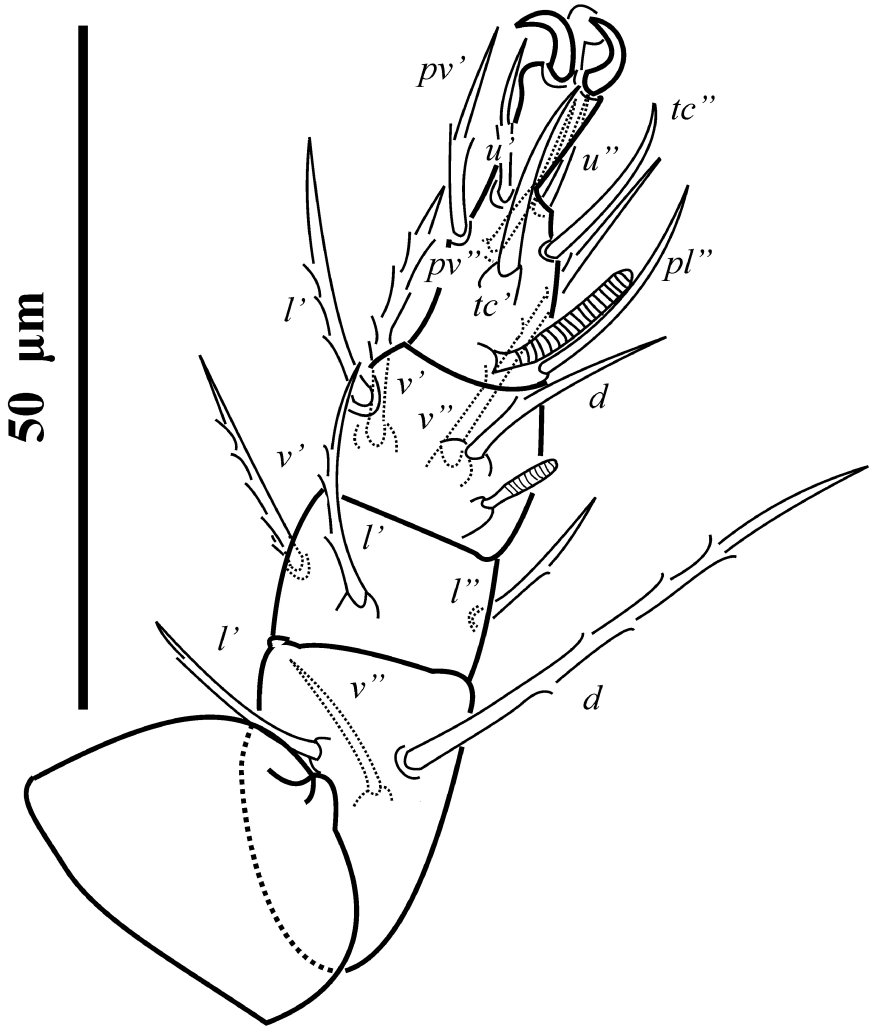

Fig. 19. *Zambedania sekhukhunensis* sp. n. Larva paratype. Leg II (right): dorsal view.

Pediculaster fusarii and *P. trichoderma* (originally described as "*Siteroptes*") whose larvae are depicted with no division between C and D in Smiley and Moser (1976). This might however been caused by an indistinctive expression of sclerites, as can be seen in many heterostigmatic mites, generally those which have larvae with thin cuticles. The state of fusion of mediad C and D shields is more characteristic of pygmephorid males; but this similarity may be only a sign of superficially convergent evolution of larval and male instars in *Zambedania*.

The femoral and genual chaetotaxy of *Zambedania* larvae and males is more similar to that of known same instars of Microdispidae, Scutacaridae and some Pygmephoridae (*Petalomium*) than *Pediculaster* because of the common lack of Fe I seta *l"*. Additionally, femur IV of male bears two setae (*d* and *v'*) as can be found in males of Scutacaridae and certain Pygmephoridae (*Pygmephorus*, *Siteroptes*); however this state contrasts with males of *Brennandania*, *Bakerdania*, *Diroptes* and *Pediculaster* which lack the Fe IV *v'* seta. Except for the large tarsal solenidion of leg III of the male in *Zambedania*, the tibial and tarsal chaetotaxy of the male and larva appear to be identical with those of *Pediculaster* species.

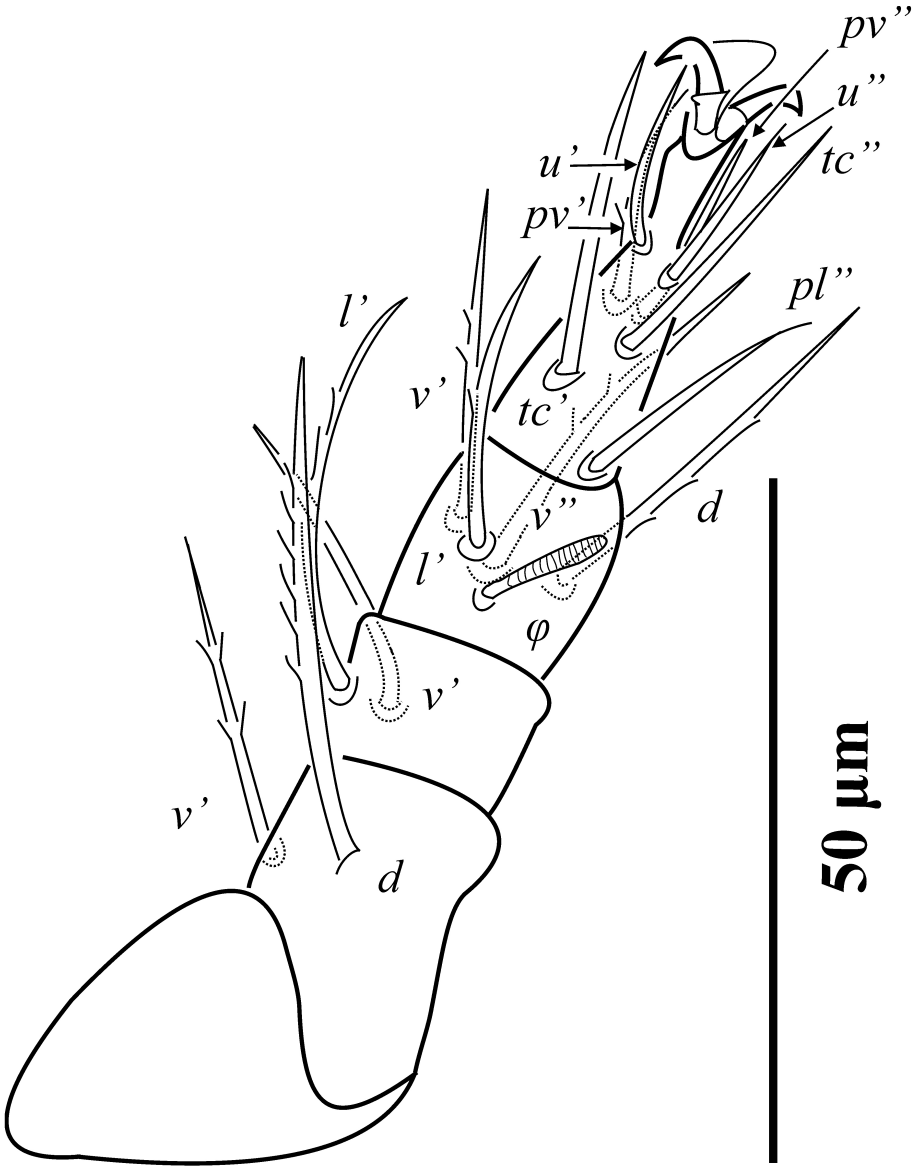

Fig. 20. *Zambedania sekhukhunensis* sp. n. Larva paratype. Leg III (right): dorsal view.

While tectal setae (*tc'* and *tc"*) of *Zambedania* larva are typically eupathidial (as stated by Lindquist (1986) p.154), the condition of fastigials remains not entirely resolved. The *ft"* does not depart in shape and appearance from other simple setae on tarsus I, however, *ft'* seems to be more similar to the tectal setae, thus being supposedly eupathidial, in accordance with Lindquist's (1986) p. 155: 133(A) interpretation. Unfortunately, only one larva has been studied, therefore the observation needs to be confirmed based on a more representative sample.

CONCLUSIONS

Amendment to the diagnosis of the genus *Zambedania* Mahunka, 1972 sensu Camerik and Magowski (2014): Male - The adult male of *Zambedania* differs from that of *Diroptes* Kaliszewski, 1988 by lacking the prodorsal setae *v1* and ventral setae *1c*, but having ventral *4c* present. Such an arrangement is similar to that observed in males of the genera *Bakerdania*, *Petalomium* (Pygmephoridae), *Archidispus*, *Heterodispus* and *Imparipes* (Scutacaridae). However, *Zambedania* males differ from them by having setae *c1* over 4x longer that the distance between their bases, genital capsule without dimpled sculpture dorsally, Ta III with stout solenidion and seta *v"* on tibia IV not spur-like or apparently thickened. Larva - The larval instar of *Zambedania* is unique among those of other known species of Pygmephoroidea and Scutacaroidea in having all opisthosomal dorsal setae collectively very long, attenuate; notably *c1* being approximately 4x longer than the distance between their bases, and dorsal shields C and D apparently integrated. Comment: Males and larvae of species belonging to the Pygmephoroidea-Scutacaroidea branch of the Heterostigmatina cohort are scarce, and sometimes inadequately described and illustrated. Therefore, the generic diagnoses for these instars of *Zambedania* should be considered as tentative and may need considerable refinement in the future.

Key to species (phoretomorph females) of the genus *Zambedania*:

1. Stigmata long, more than half the length of PdS, reaching to the anterior edge of the PdS; tibiotarsus (TiTa) over twice as long as its maximum width 2
- Stigmata short, less than half the length of PdS, not reaching to anterior edge of the PdS; TiTa less than twice as long as its maximum width 3
2. Surface of Ag plate on venter with scale-like ornamentation; tarsus IV with one large claw laterad of the empodium .... *Z. argentiniana* Camerik and Magowski, 2014
- Surface of Ag plate on venter smooth; Ta IV with one or two claws and an empodium ..... *Z. sekhukhunensis* sp. n.
3. Stigmata undivided, dorsal setae *h1* ca. twice as long as *h2*; tarsus IV with two claws ..... *Z. africana* Mahunka, 1972
- Stigmata divided into two sections, dorsal setae *h1* as long as *h2*; tarsus IV with one claw .... *Z. madagascariana* Camerik and Magowski, 2014

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REFERENCES

Bolton SJ, Klompen H, Bauchan GR, Ochoa R. 2014. A new genus and species of Nematalycidae (Acari: Endeostigmata). J Nat Hist **48(23-24):**1359-1373. doi: 10.1080/00222933.2013.859318.

Camerik AM. 1996. Phoretic females of *Pediculaster gautengensis* n. sp. (Acari: Pygmephoridae). Mitt hamb zool Mus Inst **93:**161-170.

Camerik AM, Ueckermann EA. 1995. *Pediculaster norrbomialis* sp. n. and *P. gracilis* sp. n. (Acari: Heterostigmata: Pygmephoridae) from South Africa, with notes on host and dung preference of their phoretic females. Mitt hamb zool Mus Inst **92:**73-86.

Camerik AM, de Lillo E, Lalkhan C. 2006. The neotype of *Pediculaster mesembrinae* (Canestrini, 1881) (Acari: Siteroptidae) and the description of all life stages. Int J Acarol **32:**45-67.

Camerik AM, Magowski WŁ. 2014. The genus *Zambedania* Mahunka 1972 (Acari: Heterostigmatina: Pygmephoridae)-redescription of the type species *Z. africana* and descriptions of two new species from Africa and South America. Zootaxa **3793:**71-98. doi: http://dx.doi.org/10.11646/zootaxa.3793.1.3.

Gallon RC. 2010. On some Southern African Harpactirinae, with notes on the eumenophorines *Pelinobius muticus* Karsch, 1885 and *Monoen tropella* sp. Strand, 1907 (Araneae, Theraphosidae). Arachnology **15:**29-48.

Kaliszewski M. 1988. *Diroptes* gen. n. (Acari, Pygmephoroidea) with a key to the species. Mitt hamb zool Mus Inst **9:**115-122.

Khaustov AA. 2004. Mites of the family Neopygmephoridae Cross, 1965 stat. n. and its position in Heterostigmata. Materials of VIII all-russian acarological meeting, St. Petersburg, 2004, p. 137. (in Russian)

Lindquist EE. 1986. The world genera of Tarsonemidae (Acari: Heterostigmata): a morphological, phylogenetic and systematic revision, with a reclassification of family-group taxa in the Heterostigmata. Mem Ent Soc Can **136:**1- 517.

Mahunka S. 1972. Neue und interessante Milben aus dem genfer Museum III. Mitt Schweiz Ent Ges **45:**151-153.

Smiley RL, Moser JC. 1976. Two new phoretomorphic *Siteroptes* from galleries of the Southern Pine Beetle. Beitr Ent Berlin **26:**307-322.