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A new species of *Cydnipolipus* (Acari: Heterostigmata: Podapolipidae), parasite of Cydnidae (Hexapoda: Hemiptera), *Cydnipolipus patpsalmondsae* on *Lobostoma giganteum* (Burmeister) in Honduras and on *Onalips bisinuatus* Froeschner in Brazil

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Abstract

A new species of parasitic mite, *Cydnipolipus patpsalmondsae* **sp. nov.** (Podapolipidae), is described from *Lobostoma giganteum* from Honduras and *Onalips bisinuatus* (Hemiptera: Cydnidae) from Brazil. The new species is compared with the single other species of the genus *Cydnipolipus*, *Cydnipolipus miyamotoi* Kurosa and Husband 1994, from Japan. A new distribution record of *C. miyamotoi* from *Aethus indicus* from Okinawa, Japan is reported.

Key words: parasites, *Cydnidae*, Acari, Podapolipidae, Japan, Western Hemisphere

Introduction

All mites in the family Podapolipidae are permanent ecto- and endoparasites of five orders of the Class Hexapoda: Coleoptera (10 families), Orthoptera (4 families), Blattaria (2 families), Hemiptera (1 family) and Hymenoptera (1 family). The single instance of podapolipid mites from Hemiptera is *Cydnipolipus miyamotoi* Kurosa and Husband 1994, the only species known in the genus *Cydnipolipus*.

This finding stimulated the search for these parasites of Cydnidae in the Western Hemisphere that might be held in local museum collections. Herein, we report the second species of this genus collected from Central and South American Cydnidae.

Materials and methods

Ninety two burrower bugs (Hemiptera: Cydnidae) in collections at the University of Michigan Museum of Zoology and the A.J. Cook Arthropod Research Collection at Michigan State University were examined for parasitic mites by the senior author. The genera and species of Cydnidae examined at Michigan State University and the University of Michigan were: *Aethus indicus* (Okinawa, Japan); Western Hemisphere; *Cyrtomenus ciliatus*, *Cyrtomenus crassus*, *Dallasiellus californicus*, *Ectinopus holomelas*, *Lobostoma giganteum Onalips bisinuatus*, *Onalips nigerrimus*, *Pangaeus fortis*, *Prolobodes giganteus*, *Sehirus dubius*, *Tominotus brevirostris* and four undetermined Cydnidae species. *Cydnipolipus* spp. were collected from the genera *Aethus*, *Lobostoma* and *Onalips*.

Cydnidae specimens were placed in water at approximately 50° Celsius for 10 minutes, allowing wings to be lifted and examined for mites without damaging the hosts. Female, male, larval mites and clusters of eggs were found on the anterior abdominal tergites under the wing bases as illustrated in Kurosa and Husband (1994). Visual observation and flushing material from burrower bugs with 70% ethanol into Petri dishes six centimeters in diameter were followed by mounting mites on slides in Hoyer's mounting medium. Labeled slides were put on a heated drying tray for five days and ringed with red insulating varnish. Small bolts were placed on cover slips to aid in accurate measurement of flattened setae and other structures.

Measurements were taken with a Zeiss compound phase contrast microscope with a stage micrometer. Measurements are given in micrometers (µm). Alveolar vestiges of setae are designated as v. Microsetae no longer than the diameter of their setal alveoli are designated as m. Other terminology is based on Lindquist (1986) and Krantz & Walter (2009).

Description of new species

Cydnipolipus patpsalmondsae Husband and Husband sp. nov.

(Fig. 1–7)

Diagnosis. Adult female. *C. patpsalmondsae* with prominent stigmata and trachea, stylets length and pharynx width more than half width of gnathosoma, a well sclerotized shield extends over the gnathosoma (Fig. 1). Opisthosomal plates C, D and EF poorly sclerotized with granular surfaces: plate C divided, plates D and EF entire, slightly crenulate posteriorly and with vestiges of setae *d* and *f*. Femur I with seta *d* present, as long as width of distal margin of femur I. Tarsus I with prominent claw-like ventral seta *s* and dorsal spine-like setae *tc''*, empodium small, not evident in all females. Femur, genu and tibia II without setae. Tarsi II with two terminal spine-like setae.

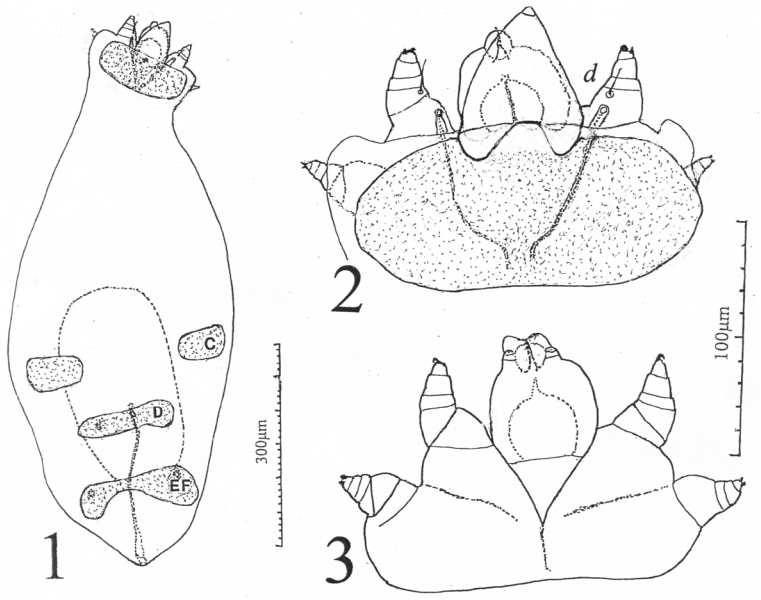

FIGURE 1–3. *Cydnipolipus patpsalmondsae* **sp. nov**. (adult female). 1. Dorsal view; 2. Dorsal view of propodosoma; 3. Ventral view of propodosoma.

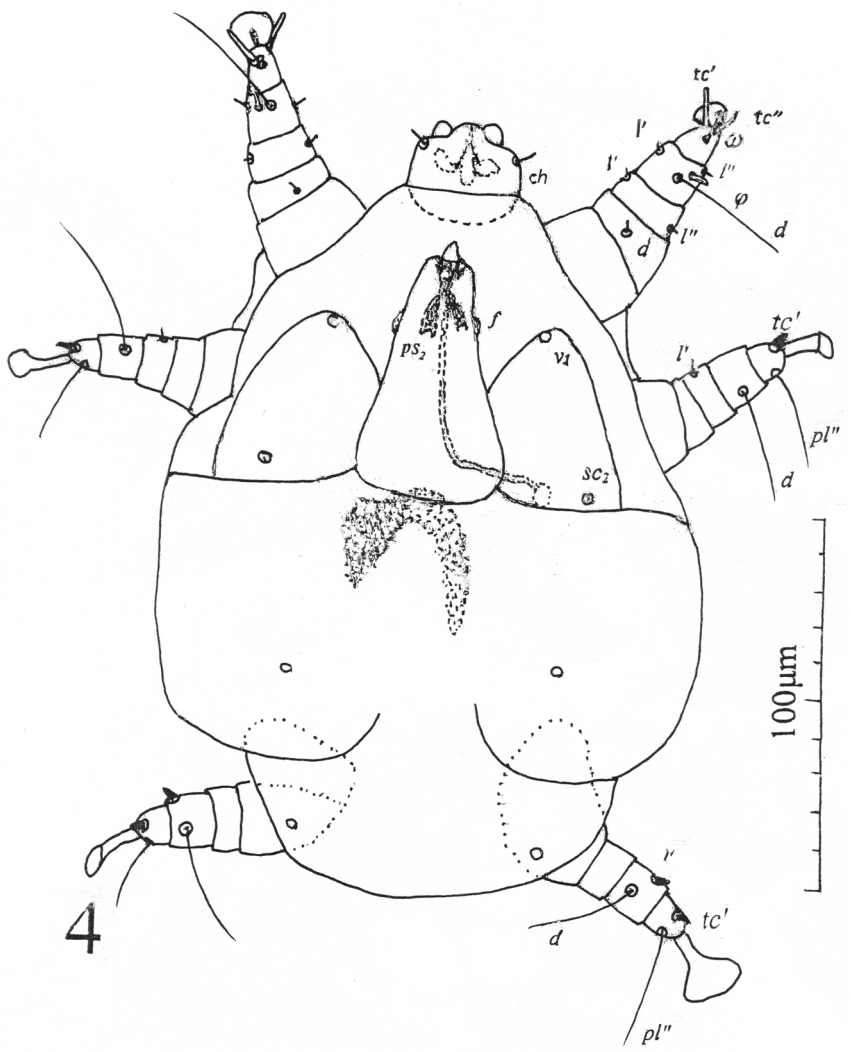

FIGURE 4. *Cydnipolipus patpsalmondsae* **sp. nov**., male, dorsal

*Male***.** Gnathosoma as wide as long, with short setae *ch*. Cheliceral stylets shorter than width of gnathosoma. Genital capsule pointed, extending over the prodorsal plate to or beyond the base of the gnathosoma, setae *f* (at level of bases of internal setae ps_2) microsetae, rarely evident, on lateral aspect of genital capsule. Uric acid crystals obscure the base of the genital capsule in many males. All idiosomal setae short. Coxal setae vestigial or lacking. Femur I with short seta *l'*, seta *d* short and long seta *v"*. Genu I with short *l', l", v",* tarsus I setae *tc', tc"* blunt, solenidion ω 2. Tarsus I seta *s* spine-like with adjacent short setae *pv', pv"* and setae *pl', pl"* anteriorly and posteriorly. Tibiae I, II setae *d* nearly equal to width of gnathosoma. Abulacrum I shorter than basal width of tarsus I, with a small claw. Femur II setae *l'* difficult to find in males.

Larval female. Gnathosoma as wide as long, setae *ch* more than two times length of setae *su*. Tibiae I, II setae *d* nearly equal to width of gnathosoma. Cheliceral stylet length usually longer than width of gnathosoma. Prodorsal plate setae v_1 as long and sc_2 longer than width of gnathosoma. Coxisternal plate III separate, setae h_2 short, equal to the distance h_2–h_2. Three pairs of legs, ambulacral length as in males. Tarsus I solenidion ω near base of seta *tc"*, not visible in all larval

females. Tibia I solenidion φ clear, witout adjacent seta *k*. Femur II seta *l'* conspicuous, seta *d* vestigial.

Description

Female (Figs. 1–3, n = 3): Gnathosoma; length 55–65 width 49–50 (Table 1), prodorsal plate over gnathosoma, cheliceral stylets 15–20, pharynx length 30–33, width 29–30. Palps short, about as long as wide, 3 segments evident (Fig, 3).

Idiosoma. Length 650–700, width 325–450 (Fig. 1). Stigmata near posterolateral margins of gnathosoma, tracheoles conspicuous under prodorsal plate (Fig. 2). Plates PD, C, D and EF surface granular. Plate C divided, left plate C length 50, width 100, right plate C length 40, width 60; plate D entire, mid length 29–35, width 160–162; plate EF entire, mid length 17–30, width 205. Idiosomal setae not on granular plates D and EF but vestiges apparent in normal position under plates D and EF. Venter with apodemes 1 and 2 evident, no coxal setae (Fig. 3).

Legs. Femur I with prominent seta *d* 16–20, tibia and genu I without setae, empodium I small, claw and sucker absent. Tarsus I with claw-like seta *s* 5–7, dorsal spine-like setae *tc"* 3. Femur II, genu II, tibia II without setae. Tarsus II with spine-like setae *tc'* 5, tc" 4.

Male (Figs. 4, 5, n =13): Gnathosoma; length 30–40, width 36–38; setae *ch* 4, *su* m, distance *ch – ch* 29–30, *su–su* 20–26, cheliceral stylets 16–20: pharynx length 10, width 7.

Idiosoma. Length 177–180, width 148–155. Setae represented by setal acetabulae, difficult to observe. Genital capsule length 55, mid width 20, lateral setae *f* m, rarely evident, capsule pointed apically, with 2 dorsal lobes and sclerotized elongated internal setae ps_2 (Fig. 4). In one male, genital capsule extending nearly to the apex of the gnathosoma. Coxae I setae vestigial, unable to detect acetabulae of setae of coxae II or III. Coxisternal plates III fused (Fig. 5).

Legs. Three pairs of legs. Setae on femur, genu, tibia, tarsus I, II, III respectively are 3-3-6-8, 1-1-4-4, 0-1-4-4. Pretarsus I with one claw and sucker, length 5-8. Pretarsi II, III without claws, lengths 16-20. Tarsus I solenidion ω length 2-3, tibia I solenidion φ 5-6, without adjacent seta *k.* Tarsi II, III setae *tc'* spine-like, seta *u* spine-like. Tibia I spine-like, seta *v'* spine-like and tibiae II, III with setae ***l***'spine-like. Genu I setae *l'* 5, *v"* 2, *l"* 2, *su* spine-like. Femur I setae *l'* 4, *d* v, *v"* 4 (setae *d* not clear in most specimens). Tibiae I, II, III setae *d* length 30–37, near width of gnathosoma 26–37.

Larval female (Figs. 6, 7, n =12): *Gnathosoma*; length 45–57, width 50–63, cheliceral stylets 58–70, setae *ch* 38–44, *su* 11–15. Palp length 7–12, basal and distal setae 2. Distance *ch–ch* 47–60, *su –su* 23–27.

Idiosoma. Length 200–304, width 155–230. Prodorsal plate length 60–67, width 103–128, setae v_1 60–77, v_2 v, sc_1 v, sc_2 123–130 (Fig. 6). Plates C, D fused, Plate CD length 80–90, width 150–165, setae c_1 m. Setae c_2, *d* and *f* poorly tapered and with microspines. Setae c_2 22–36, setae *d* 25–37, setae *f* 27–37. Plate EF length 45–50, width 62–73. Plate H length 32–34, width 52–58, setae h_1 130–170, h_2 4–5. Distance between idiosomal setae v_1–v_1 50–60, sc_2–sc_2 70–78, c_1–c_1 48–80, *d–d* 36–60, *f–f* 47–57. Idiosoma venter (Figure 7): apodemes I reaching sternal apodeme, apodemes II not reaching sternal apodeme. Setae *1a* 7–13, *2a 2–7, 3a* 3–4. Coxae III separated from each other and coxae II.

Legs. Ambulacrum I with small bifid claw in a sucker-like pad; tarsus I setae *tc'* 12–15, *tc"* 10–12, solenidion ω 2–3, *pv'* 2–5, *pl'* 4–6, *s* 3–4, *pv"* 2–4, *pl"* 7–10; tibia I setae *v'* 12–14, *l'* 10–16, *d* 40–53, φ 8–11, v"12–17; genu I *l'* 6–10, *l"* 9–15, *v"* 15–20: femur I *l'* 6–8, *d* 40–45, v" 16–22; femur II *l'* 5, genu II l' 5–7, tibia II l' 7–10, *d* 65–75, *v'* 26–33, *v"* 27–36; tarsus II tc'spine-like 3–4, *pl"* 25–40, seta *u* spine-like 5, *pv"* 4–7; genu III *l'* 5–7, tibia III *l'* 7–12, *d* 75–91, *v'* 30–40, *v"* 28–43; tarsus II *tc'* spine-like 4–5, seta *u* spine-like 4–6, *pv"* 5–7, *pl"* 37–60.

TABLE 1. Comparison of selected longest measurements of *Cydnipolipus miyamotoi* from Japan (cmj), *Cydnipolipus patpsalmondsae* from Honduras (cph), from Brazil (cpb) and of genera with species with females with two pairs of legs coupled with males with genital capsules ending at or beyond bases of gnathosomas. These are: *Locustacarus* (loc) (vestigial legs II), *Rhynchopolipus rhynchophori* (rhy), *Simalurapolipus hiraii* (sim) and *Tenebrapolipus ceropriae* (ten). All measurements are in micrometers (μm). The symbol ms indicates that microspines are attached to setae, m denotes microsetae.

	cmj	cph	cpb	loc	rhy	sim	ten
FEMALE							
Idiosoma length	490	700	650	582	515	520	579
Idiosoma width	380	450	325	542	466	520	460
Gnathosoma length	52	55	65	58	68	65	51
Cheliceral stylets	30	20	33	31	43	22	27
Femur I *d*	0	16	20	0	0	0	0
MALE							
Idiosoma length	170	180	no	156	155	230	182
Idiosoma width	170	155	male	129	142	206	165
Gnathosoma length	29	40	_	31	32	30	33
Gnathoma width	28	38	_	31	35	35	37
Cheliceral stylets	13	16	_	12	18	15	17
Pharynx width	5	7	_	17	7	10	9
Genital capsule length	52	55	_	92	117	57	45
Genital cap, mid width	19	26	_	10	43	54	
Genital capsule, setae *f*	5	m	_	0	0	0	0
LARVAL FEMALE							
Idiosomal length	177	304	225	171	235	188	225
Idiosomal width	157	230	167	138	170	159	152
Gnathosoma length	52	52	57	37	65	60	54
Gnathosoma width	53	73	63	40	80	62	58
Gnathosoma setae *ch*	36	44	48	28	32	40	39
Gnathosoma setae su	23	15	17	34	24	20	17
Cheliceral stylets	47	70	78	18	123	53	56
Plate PD, setae v_1	50	60	77	34	34	40	50
Plate CD, setae c_2	43ms	37ms	22ms	68	68	5	0
Plate CD, setae *d*	35ms	37ms	35ms	24	6	10	8
Plate EF, setae *f*(*e*)	34ms	38ms	35ms	13	7	36	17
Femur I setae *d*	35	45	42	51	6	12	28

Egg (n = 2): length 270–343, width 158–180.

Etymology. *Cydnipolipus patpsalmondsae* is named for the late Patricia Psalmonds Husband, research assistant with the senior author and co-author of three acarological publications, in recognition of her efforts in adding to knowledge of Podapolipidae and bumblebee hosts for podapolipid mites.

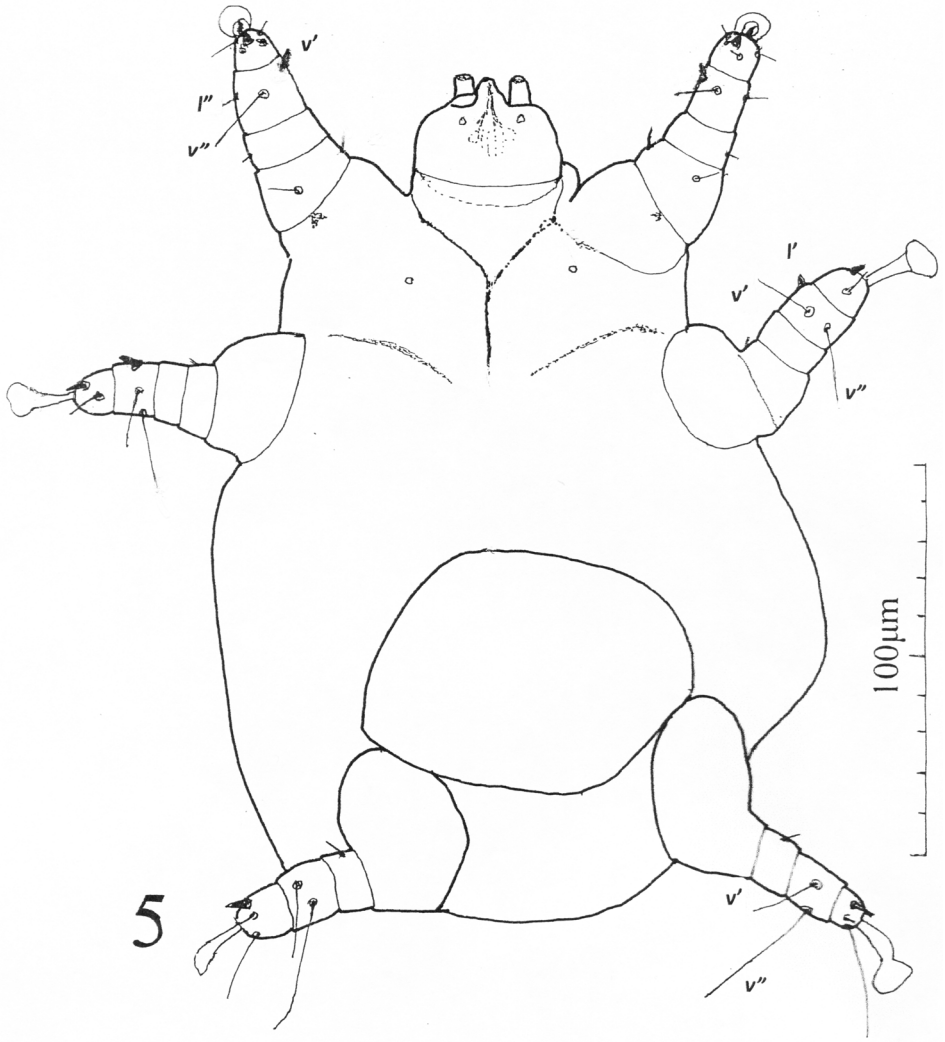

FIGURE 5. *Cydnipolipus patpsalmondsae* **sp. nov**., male, ventral.

Type material: holotype, adult female (RWH16XI2016-2), from *Lobostoma giganteum* Burmeister (Hemiptera: Cydnidae), Esq. Agr. Pan Zomerano, 2600' (hortaliza), Dept. Morazan, Honduras, 1 July 1948, coll. T. H. Hubbell, deposited in the University of Michigan Museum of Zoology, Ann Arbor, Michigan, U.S.A. Paratypes, same data as holotpe, one adult female, 13 males, 13 larval females (one slide with four larval females and two eggs). Paratypes, from *Onalips bisinuatus* Froeschner (Hemiptera: Cydnidae), 65 km. S. Ariquemes, vicinity of Vazenda, Rancho Grande near Cacaulandia, Rondonia State, Brazil, 7–19 November 1994, coll. Frank West, one adult female, two larval females.

One male and one larval female paratype are deposited in each of the following collections: National Museum of Nature and Science, Tsukuba, 306-0005, Japan (NMNSTJ; University of Michigan Museum of Zoology, Ann Arbor, Michigan (UMMZ); A.J. Cook Arthropod Research Collection, Michigan State University, East Lansing, Michigan, Michigan (CARC); The Acarology Laboratory, Museum of Biological Diversity, The Ohio State University, Columbus, Ohio (OSAL); United States National Museum of Natural History, Washington, D.C.(NMNH); Queensland

Museum, South Brisbane, Australia (QMBA); Tarbiat Modares University, Tehran, Iran (TMUI); Tyumen University, Tyumen, Russia (TUTR). Remaining paratypes are deposited at UMMZ with the holotype and the type host.

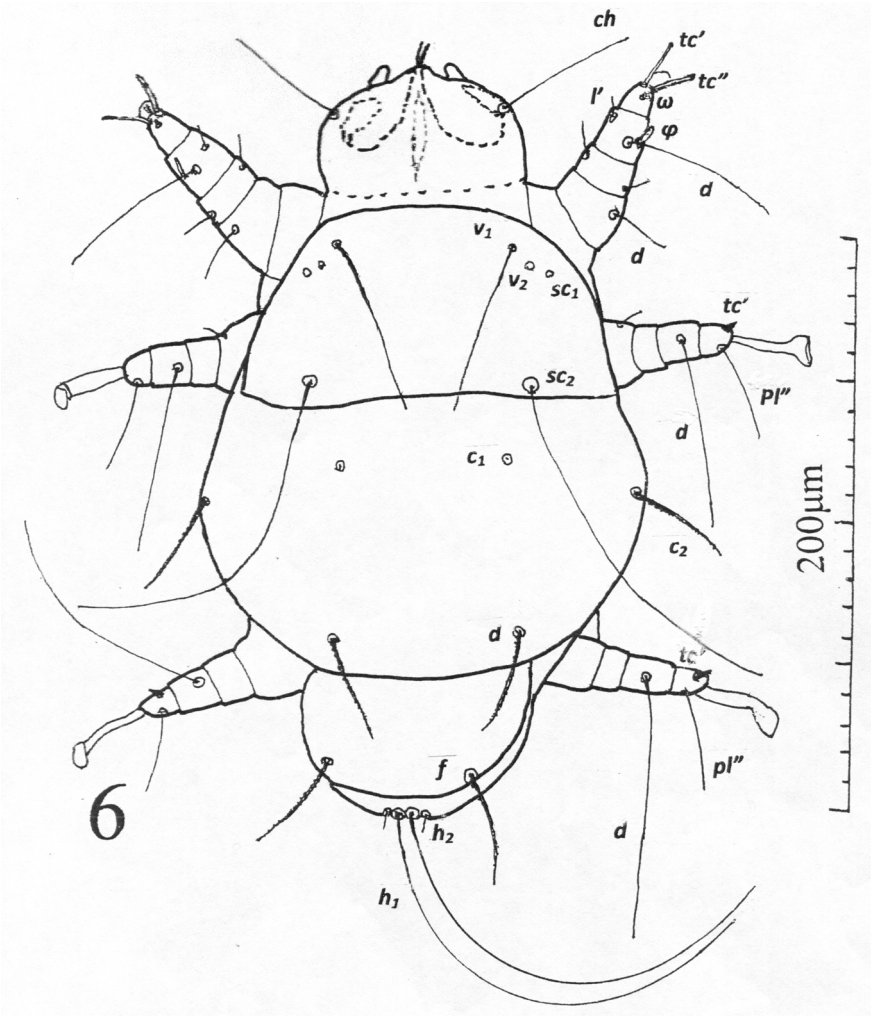

FIGURE 6. *Cydnipolipus patpsalmondsae* **sp. nov.**, larval female, dorsal.

New Distribution Record

Cydnipolipus miyamotoi Kurosa and Husband 1994

A single larval female *Cydnipolipus miyamotoi* was collected from *Aethus indicus* (Westwood) from Itoman, Okinawa on 8 August 1946, collector unknown, deposited at Michigan State University (CARC).

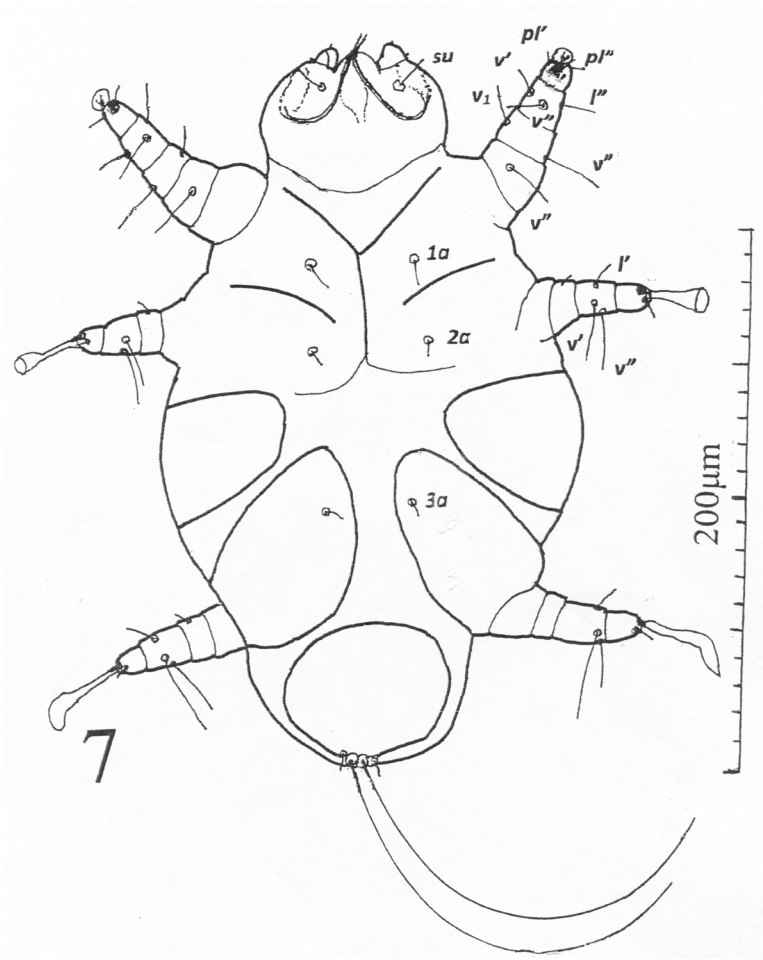

FIGURE 7. *Cydnipolipus patpsalmondsae* **sp. nov.**, larval female, ventral.

Discussion

Kurosa and Husband (1994) described the new genus and species *Cydnipolipus miyamotoi* from *Aethus indicus* (Heteroptera, Cydnidae) from the Ryukyu Islands, Southwest Japan. It was the only species of Podapolipidae from the insect order Hemiptera prior to the current study. Females of the new species have some notably different character states: the absence of a conspicuous acetabulum (sucker) on tarsus I of females, the presence of strong *d* on femora I and the divided plate C.

Cydnipolipus belongs to the group of Podapolipidae with adult females with two pairs of legs, which were discussed in Kurosa and Husband (1994). Today, this group comprises 16 genera, including genera with vestigial second pair of legs such as *Tenebrapolipus* and *Locustacarus.* This group is further reduced to a smaller number of genera that also share males with genital capsules that extend over the prodorsal plate to near or beyond the gnathosoma. Legs II in *Tenebrapolipus* are much reduced but have a spine-like seta on tarsus II while legs II in *Locustacarus* are represented by reduced coxae II. The presence of femur I seta *d* is variable in the genus *Cydnipolipus* but not present in the remaining four genera (Table 1).

Mite genera with adult females with two pairs of legs and males with genital capsules extending near the gnathosoma in the family Podapolipidae are less common than several genera with males with genital capsules restricted to plate CD or extending over the posterior surface of the prodorsal plate. Genera with genital capsules extending to the gnathosoma are: *Cydnipolipus*, *Tenebrapolipus* and *Simalurapolipus*. *Locustacarus* and *Rhynchopolipus* have genital capsules often extending beyond the anterior margin of the gnathosoma. These genera are discussed in Husband and Flechtmann (1972), Husband and OConnor (1999), Husband & Kurosa (2000), Kurosa & Husband (2001) and Kurosa and Husband (2013).

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