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# New morphological and host data for the ectoparasitic larva of *Leptus hidakai* Kawashima (Acari, Acariformes, Erythraeidae)

Anne S. Baker[1] and Paul A. Selden[2]
[1]*Department of Entomology, The Natural History Museum, Cromwell Road, London SW7 5BD, UK*
[2]*Department of Earth Sciences, University of Manchester, Manchester M13 9PL, UK*

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**Abstract**

The larva of *Leptus hidakai* Kawashima is redescribed. This species, previously only known from its type-locality in Japan, is recorded for the first time from the uloborid spider *Miagrammopes singaporensis* Kulczynski in Singapore. Records of *Leptus* larvae infesting Arachnida are listed.

## Introduction

The cosmopolitan genus *Leptus* Latreille (family Erythraeidae) comprises some 90 nominate species, most of which are known only from the hexapod larva. *Leptus* larvae are ectoparasites of a wide range of arthropods (Welbourn, 1983), while the octopod nymphs and adults are free-living predators of other arthropods (Wendt et al., 1992). Larval *Leptus* have been reported parasitising members of five of the 11 extant orders of Arachnida (Acari, Araneae, Opiliones, Pseudoscorpiones, Scorpiones), the majority known from Opiliones (Table I).

A larval mite found on a uloborid spider collected in Singapore was identified as *L. hidakai* Kawashima, a species previously only recorded from phalangid harvestmen and a clubionid spider at its type-locality in Japan (Kawashima, 1958). This paper presents new morphological data to augment the original description of *L. hidakai*, together with details of the new host and locality records. The epigyne of the host, *Miagrammopes singaporensis* Kulczynski, is illustrated for the first time since the species was described (Kulzynski, 1908).

The terminology, abbreviations and standard data given in Table II are based on the system described by Southcott (1992). All measurements were made while the specimen was mounted in 60% lactic acid in a glass cavity slide and are given in micrometres.

## *Leptus hidakai* Kawashima, 1958

*Diagnosis*
Known only from the larva, *L. hidakai* can be distinguished from larvae of other members of the genus by the presence of a pair of short subterminal spines ventrally on the hypostome.

*Description*

Colour in life green. Length including gnathosoma 784. Idiosoma ovoid, 560 long. Other measurements given in Table II.

*Idiodorsum* (Figures 1,3). Scutum: roughly pentagonal; anterior and anterolateral margins slightly undulating, posterolaterals weakly concave; angles rounded, posterior one with median concavity; cuticle weakly punctate with light areolae flanking a more heavily sclerotised central panel; region anterior to setae AL weakly sclerotised with anterior sensillary setae ASE located on slightly differentiated area; sclerotised bands occur along approximately posterior two-thirds of posterolateral margins and horizontally between ASE and AL; bases of setae AL and PL surrounded by heavier sclerotisation; AL and PL blunt, parallel-sided, densely spinose; bases of ASE level with those of AL; posterior sensillary setae PSE (lost during remounting) borne on small mound; ASE and PSE slender, finely spinose, more strongly so in distal half. Eyes: diameter of cornea 22, approximately level with bases of PSE.

*Table 1*. Records of *Leptus* spp. parasitising Arachnida.

| Host | *Leptus* species | Country | Reference |
|---|---|---|---|
| ACARI | | | |
| *Abrolophus* sp. | *L. trimaculatus* | Germany | Wendt et al., 1992 |
| *Anystis baccarum* | *L. killingtoni* | UK | Turk, 1945 |
| *An. baccarum, An. rosae* | *L. trimaculatus* | Germany | Wendt et al., 1992 |
| *Balaustium globigerum* | *L. ignotus* | Netherlands | Oudemans, 1912 |
| *Damaeus grossmani* | *Leptus* spp. | USA | Norton et al., 1988 |
| *D. verticillipes* | *Leptus* spp. | USA | Norton et al., 1988 |
| *Erythraeus* sp. | *L. echinopus* | Denmark | Southcott, 1992 |
| *Oribatella extensa* | *Leptus* spp. | USA | Norton et al., 1988 |
| *Xenillus occultus* | *Leptus* spp. | USA | Norton et al., 1988 |
| ARANEAE | | | |
| *Chiracanthium* sp. | *L. hidakai* | Japan | Kawashima, 1958 |
| *Enoplognatha ovata* | ?*Leptus* sp. | USA | Reillo, 1989 |
| *Lycosa* sp. | *L. gifuensis* | Japan | Kawashima, 1958 |
| *Miagrammopes singaporensis* | *L. hidakai* | Singapore | This paper |
| *Pachygnatha clerki* | *L. ignotus* | UK | Parker, 1962 |
| *Pardosa* sp. | *Leptus* sp. | USA | Sorkin, 1982 |
| *Philodromus imbecillus* | *Leptus* sp. | USA | Cokendolpher et al., 1979 |
| *Saitis* sp. | *L. atticolus* | South Africa | Lawrence, 1940 |
| *Systenoplacis* sp. | *L. rwandae* | Rwanda | Fain & Jocqué, 1996 |
| 'Araneae' | *L. ignotus* | France | Bruyant, 1911 |
| OPILIONES | | | |
| *Cynorta* sp. | *L. gracilipes* | Surinam | Oudemans, 1910a |
| *Discocyrtus funestus* | *L. lomani* | Chile | Oudemans, 1902 |
| *Empetrum nigrum* | *L. holmiae* | Poland | Southcott, 1992 |
| *Gagrella* sp. | *L. gagrellae* | Indonesia | Oudemans, 1910b |
| *Gragellula niveata, Gr*. sp. | *L. phuketicus* | Thailand | Southcott, 1994 |
| *Leiobunum calcar* | *L. indianensis* | USA | Fain et al., 1987 |
| *L. longipes, L. nigripes* | *L. indianensis, L. nearcticus* | USA | Fain et al., 1987 |
| *L. speciosum, L. ventricosum* | *L. indianensis* | USA | Fain et al., 1987 |
| *L. vittatum* | *L. nearcticus* | USA | Fain et al., 1987 |
| *Mitopus morio* | *L. beroni* | Belgium | Fain, 1991a |
| | *L. holmiae* | Denmark, Iceland, Ireland, Poland | Southcott, 1992 |
| | *L. ignotus* | Bulgaria | Beron, 1975 |
| | *L. kalaallus* | Greenland | Southcott, 1992 |
| | *L. phalangii* | Poland | Gabrys, 1991 |
| | *Leptus* spp. | ?Norway | Åbro, 1988 |
| *Odiellus palpinalis* | *L. ignotus* | Poland | Haitlinger, 1987 |
| | *L. phalangii* | Poland | Gabrys, 1991 |
| *Oligophorus tridens* | *L. phalangii* | Poland | Gabrys, 1991 |
| *Opilio canestrinii* | *L. holmiae* | Denmark | Southcott, 1992 |
| *Op. pentaspinulatus* | *L. hidakai* | Japan | Kawashima, 1958 |
| *Op. ruzickai* | *L. ignotus* | Bulgaria | Beron, 1975 |
| *Opilio* sp. | *L. holmiae* | Sweden | Southcott, 1992 |
| | *L. ignotus* | Sweden | Oudemans, 1912 |

*Table I.* Continued.

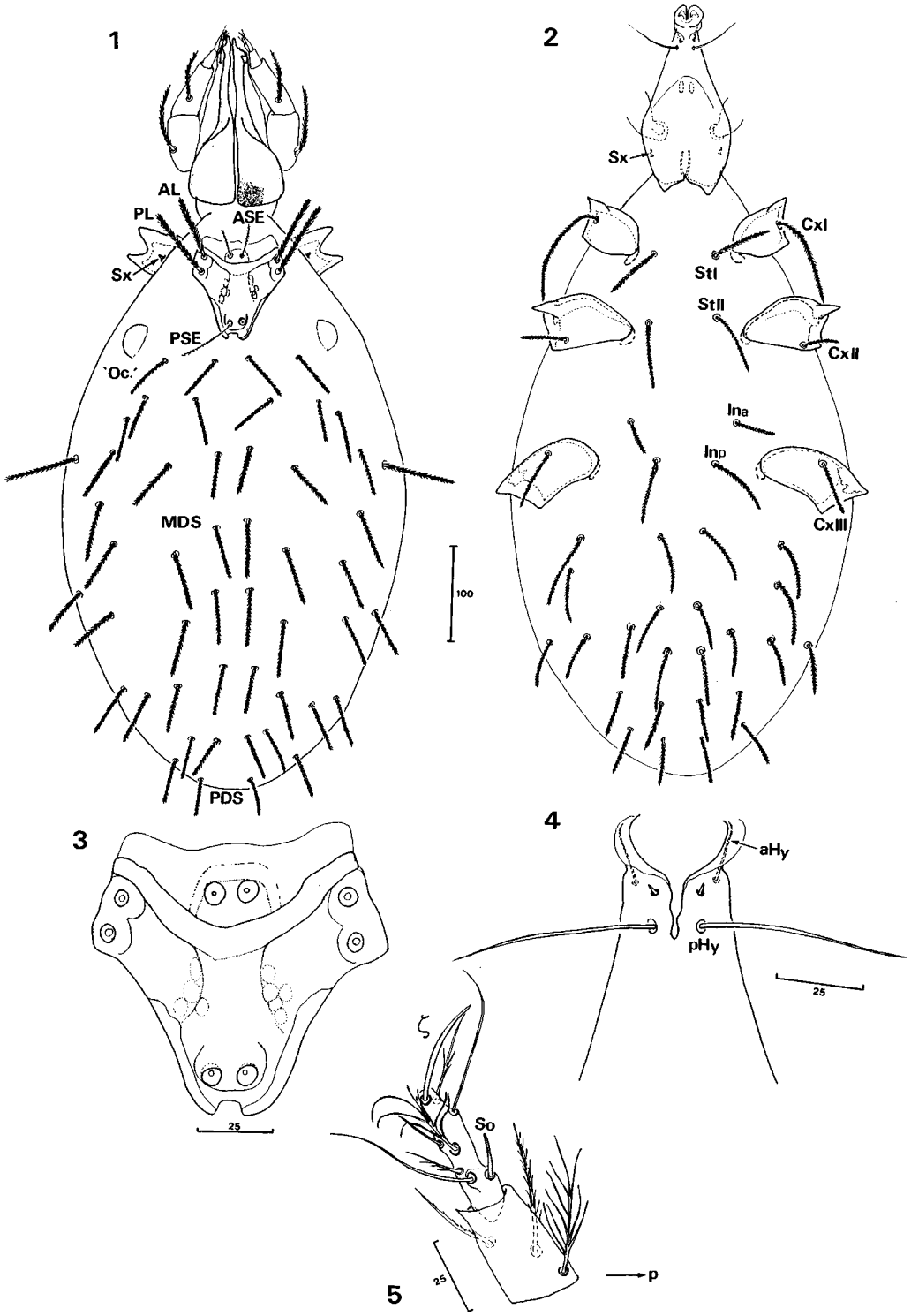
| Host | *Leptus* species | Country | Reference |
|---|---|---|---|
| OPILIONES (continued) | | | |
| *Phalangium opilio* | *L. holmiae* | UK | Southcott, 1992 |
| | *L. ignotus* | Poland | Haitlinger, 1987 |
| | *L. phalangii* | Poland | Gabrys, 1991 |
| | *L. phalangii* | UK | Evans, 1910 |
| | *Leptus* spp. | ?Norway | Åbro, 1988 |
| *P. partietinum* | *L. ignotus* | Netherlands | Oudemans, 1912 |
| *Phalangium* spp. | *L. ignotus* | France | Bruyant, 1911 |
| *Platybunus triangularis* | *L. holmiae* | UK | Southcott, 1992 |
| | *L. ignotus* | Poland | Haitlinger, 1987 |
| | *L. phalangii* | Poland | Gabrys, 1991 |
| *Trachyrhinus marmoratus* | *Leptus* sp. | USA | MacKay et al., 1992 |
| 'Opiliones' | *L. bicristatus, L. jocquei, L. puylaerti, L. polythrix* | Malawi | Fain & Elsen, 1987 |
| | *L. stieglmayri* | Brazil | Oudemans, 1905 |
| | *Leptus* sp. | USA | Welbourn, 1983 |
| PSEUDOSCORPIONES | *L. chelonethus* | Australia | Womersley, 1934 |
| SCORPIONES | | | |
| *Buthus occidanus* | *L. pyrenaeus* | France | André, 1953 |
| *Centruroides vittatus* | *Leptus* sp. | USA | Welbourn, 1983 |
| *Lychas alexandrinus* | *L. waldockae* | Australia | Fain, 1991b |
| *Urodacus abruptus* | *Leptus* sp. | Australia | Southcott, 1955 |
| *U. armatus, U. hoplurus, U. yaschenkoi* | *Leptus* sp. | Australia | Fain, 1991b |
| 'Scorpionida' | *Leptus* sp. | Mexico | Welbourn, 1983 |
| | *Leptus* sp. | Costa Rica | Welbourn, 1983 |

Setae: 25 pairs, all blunt, parallel-sided and densely spinose, spinules shorter than those of AL and PL.

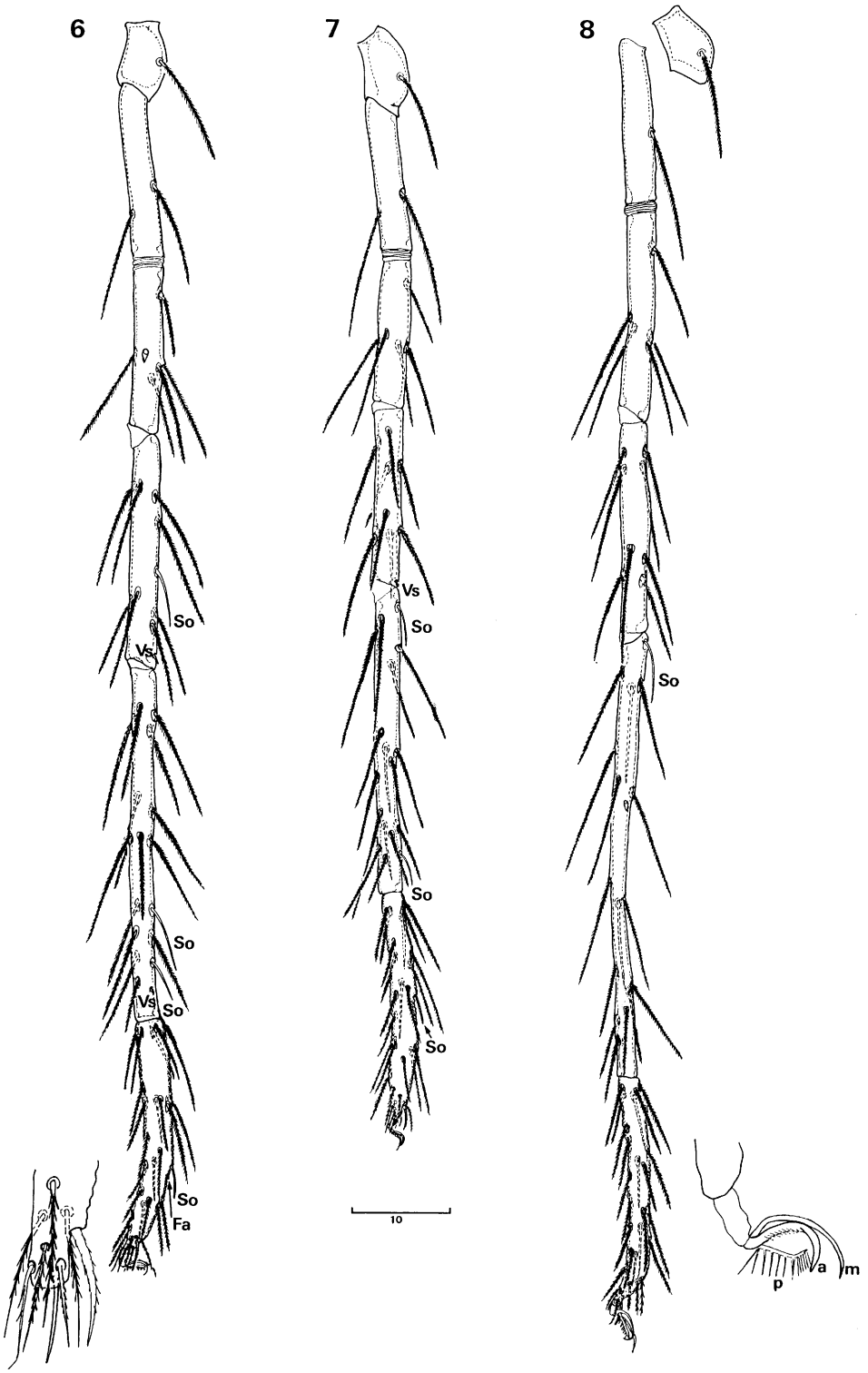
*Idioventer* (Figure 2). Setae more tapered than dorsals, otherwise same form; 4 sternal setae (StI & II); 4 intercoxal setae, anterior pair (Ina) slightly anterior to coxae III, just less than half length of posterior (Inp); 12 pairs of setae posterior to coxae III. Coxal setae: CxI markedly longer than other coxals, at 2.5 times length of CxII and 1.67 times that of CxIII.

*Legs* (Figures 6–8). Slender, total lengths (including coxae, excluding claws) I 973, II 881, III 1076. Setae: densely spinose, tapering; all tarsi terminate in cluster of eight setae (detail, Figure 6). Specialised setae: supracoxal I a small blunt spine, visible in dorsal view (Figure 1); solenidial formulae (genu-tibia-tarsus) I 1-2-1, II 0-2-1, III 0-1-0; vestigiala on genua I and II and tibia I; famulus on tarsus I very small. Apotele: anterior claw rayed, more robust and acutely curved than median; posterior claw with apex flexed dorsally and bearing *c.* 13 fine spines.

*Gnathosoma* (Figures 1,2,4,5). Chelicerae: cuticle punctate; flask-shaped in outline; both pairs of hypostomal setae smooth, posterior (pHy) approximately 3 times length of anterior pair (aHy); one pair of short subterminal spines located ventrally just anterior to pHy. Palp: setal formula 0-1-1-3-8; supracoxal seta same form as that of leg I; femoral and genual seta both densely spinose and tapering; posteroventral tibial seta filamentous, posterodorsal spinose and anterodorsal weakly serrated; tarsus with short basal solenidion and long apical eupathidium ($\zeta$), one long smooth seta basally and subterminally, one median filamentous seta, one terminal seta and one basal seta (latter two ornamented with several spicules).




*Figures 1–5*. *Leptus hidakai* Kawashima, larva: 1. Idiosoma and gnathosoma, dorsal view; 2. Idiosoma and gnathosoma, ventral view; 3. Scutum; 4. Hypostome, venter of apex. 5. Palp tibia and tarsus, ventral view. *Abbreviations*: AL, anterolateral scutal seta; ASE, anterior sensillary seta; aHy, anterior hypostomal seta; Cx, coxal seta; In, intercoxal seta; MDS, mid-idiodorsal setae; 'Oc.', 'ocular' seta; p, posterior; PDS, posterior idiodorsal setae; pHy, posterior hypostomal seta; PL, posterolateral scutal seta; So, solenidion; St, sternal seta; Sx, supracoxal seta; ζ, eupathidium. Scale-bars in micrometres.




*Figures 6–8. Leptus hidakai* Kawashima, larva: 6. Leg I, anterolateral view, with detail of terminal cluster of setae (apotele omitted); 7. Leg II, anterolateral view; 8. Leg III, anterolateral view. *Abbreviations*: a, anterior; Fa, famulus; m, middle; p, posterior; So, solenidion; Vs, vestigiala. Scale-bar in micrometres.

*Table II.* Standard data for *Leptus hidakai* Kawashima (in micrometres).

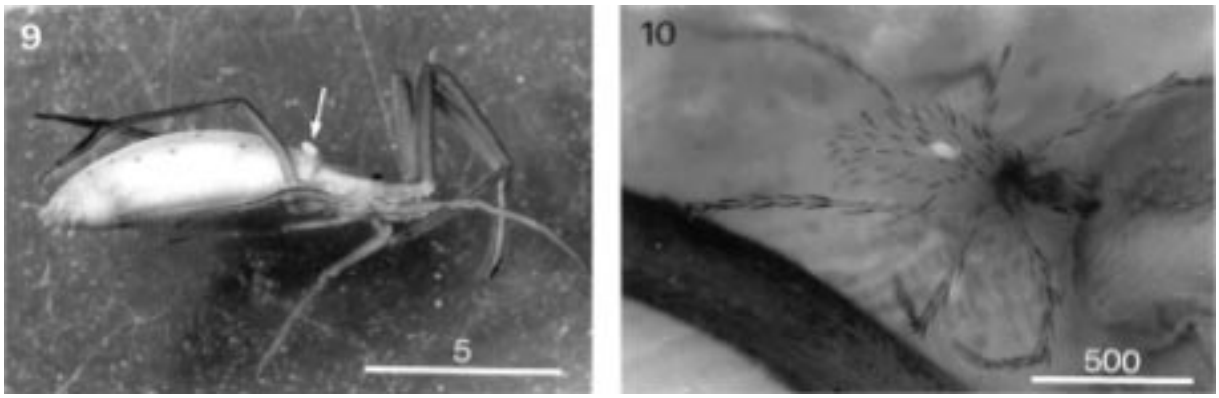
| Character | Measurement | Character | Measurement |
|---|---|---|---|
| Scutum: | | Chelicerae: | |
| AW(AL-AL) | 77 | Length | 190 |
| PW(PL-PL) | 85 | Max. combined width | 103 |
| SBa (ASE-ASE) | 10 | Leg segments – lengths: | |
| SBp (PSE-PSE) | 12 | Genu I | 177 |
| LX (anterior margin-AL) | 30 | Tibia I | 256 |
| ASBa (anterior margin-ASE) | 30 | Tarsus I | 191 |
| ASBM (anterior-posterior margin) | 16 | Genu II | 137 |
| ISD (ASE-PSE) | 64 | Tibia II | 222 |
| L (maximum length) | 108 | Tarsus II | 154 |
| W (maximum width) | 99 | Genu III | 162 |
| AAS (ASE-AL) | 33 | Tibia III | 333 |
| A-P (AL-PL) | 16 | Tarsus III | 170 |
| Setal lengths: | | Leg segments – heights: | |
| AL (anterolateral scutal seta) | 81 | TaI | 20 |
| PL (posterolateral scutal seta) | 89 | TaII | 18 |
| ASE (anterior sensillary seta) | 47 | TaIII | 16 |
| PSE (posterior sensillary seta) | 80 | Ratios: | |
| 'Oc.' (nearest to eye) | 49 | TiI/GeI | 1.45 |
| MDS (mid-idiodorsal) | 50–54 | TiII/GeII | 1.62 |
| PDS (posterior idiodorsal) | 44–48 | TiIII/GeIII | 2.06 |
| Sternal setae: | | AW/ISD | 1.20 |
| StI | 51 | ISD/A-P | 4.00 |
| StII | 63 | AW/A-P | 4.80 |
| Coxal setae: | | TiI/AW | 3.32 |
| CxI | 101 | TiIII/AW | 4.32 |
| CxII | 40 | AW/AL | 0.95 |
| CxIII | 59 | AL/AAS | 2.45 |
| Intercoxal setae: | | TiIII/TiI | 1.30 |
| Ina | 32 | TiII/PW | 2.61 |
| Inp | 77 | L/W | 1.09 |
| Hypostomal setae: | | PW/AW | 1.10 |
| aHy | 19 | AL/PL | 0.91 |
| pHy | 59 | | |

*Material examined*

Singapore, Bukit Timah Nature Reserve, original rain forest, *ex* female *Miagrammopes singaporensis* Kulczynski, near posterior margin of cephalothorax, coll. P.A. Selden, 24.vi.1992 [larva and host deposited in The Natural History Museum, London; reg. nos BMNH(E)1996-102 & 103, respectively].

## Remarks

Type-material of *L. hidakai* was unobtainable, but the larva from Singapore possesses the majority of the definitive characters described by Kawashima (1958); namely, the pair of ventral subterminal spines on the hypostome, the number, length and form of idiosomal and gnathosomal setae, the scutal shape and the complement of leg solenidia and vestigiala. Some differences, however, do occur. Kawashima (1958) described the posterodorsal seta of the palp tibia and four setae in addition to the eupathidium on the palp tarsus as smooth. The spicules ornamenting these setae in the Singaporean larva were difficult to discern and so may have been overlooked by Kawashima. The lengths of the chelicerae and palps of the holotype of *L. hidakai* are given as 92 and 90, respectively, i.e. approximately




*Figures 9–10. Leptus hidakai* Kawashima, larva: 10. Position on *Miagrammopes singaporensis* Kulczynski arrowed; 11. Detail of attached larva. Scale-bars in millimetres (9) and micrometres (10).

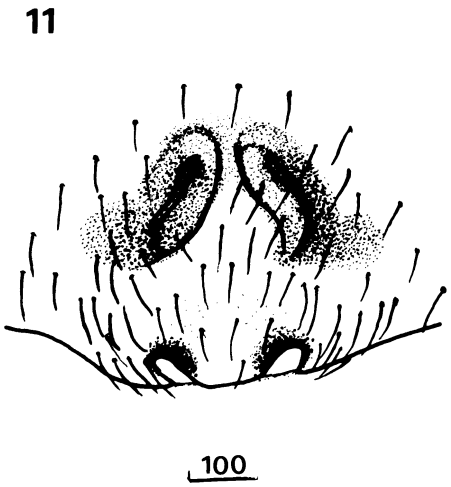



*Figure 11. Miagrammopes singaporensis* Kulczynski, epigyne. Scale-bar in micrometres.

half the size of those of the larva described here. It is suspected that Kawashima's measurements were miscalculated because, if this were not the case, the length of the gnathosoma would be approximately equal to that of the scutum, an unprecedented character for *Leptus* larvae which would surely have been highlighted in the description. Kawashima (1958) gives measurements of the leg segments of the holotype only, but the differences seen in those of the Singaporean larva fall within ranges given for other species (e.g. *L. bakeri* Southcott, 1992).

The colour of living *Leptus* larvae, including the holotype of *L. hidakai*, is typically described as red or orange. It is very unusual, therefore, to find a green specimen. *Leptus* larvae feed on the haemolymph and tissue fluids of their host (Åbro, 1988) and the colour of the Singaporean specimen presumably originated in the same way, since both host and larva were the same shade of green in life. The preserved type-specimen of *Miagrammopes singaporensis* was described as pale yellow-brown by Kulczynski (1908), and both mite and host faded to this colour after some months of storage in 70% ethanol. *Miagrammopes* females characteristically employ crypsis as their main defence mechanism, using both morphological and behavioural features (Opell, 1984). Colour is also an important component of the cryptic defence mechanism in this genus (Opell, 1989). Since these spiders lack strong cuticular pigments and guanine granules, their colouration must rely, to a large extent, on haemolymph colour. Gillespie (1989) has demonstrated diet-induced colour changes in Hawaiian happy-face spiders (*Theridion grallator* Simon). This species has a base colour of translucent yellow (as in *M. singaporensis*) which changed

when fed certain natural prey items and dyes. Green colouration was observed following feeding on lepidopteran larvae and Homoptera, both of which are green in life. It seems likely, therefore, that the *M. singaporensis* host fed on green prey, which coloured the haemolymph of host and mite larva and enhanced the cryptic defence mechanism on the green-leafed plants on which it was found.

*L. hidakai* has previously only been recorded from a clubionid spider (*Cheiracanthium* sp.) and phalangid harvestmen (*Opilio pentaspinulatus* Suzuki), all collected in Japan (Kawashima, 1958). Our record, therefore, adds *M. singaporensis* Kulczynski (family Uloboridae) to the hosts it parasitises and extends its geographical range to Singapore. The epigyne of *M. singaporensis*, an important character for identification, is illustrated (Figure 11) because the only other published figure appears in the original description and lacks much detail (Kulczynski, 1908).

There are too few host records on which to base firm conclusions about the host specificity of *Leptus* spp., but the majority are restricted to at least a single class of arthropod (Table I). It is likely, therefore, that future records of *L. hidakai* larvae will be confined to arachnids. *L. ignotus* (Oudemans), *L. phalangii* (De Geer) and *L. trimaculatus* (Rossi) have been reported from both arachnid and insect hosts, but there is uncertainty about the true identity of larvae placed in these species (Fain, 1991a; Gabrys, 1991; Southcott, 1992; Wendt et al., 1992).

The illustration of *L. hidakai* larvae distributed over the leg segments and body of its opilione host (Kawashima, 1958) and the location of the larva described here (Figures 9,10) are consistent with observations that *Leptus* larvae prefer areas of heavily sclerotised integument for attachment sites (Southcott, 1992; Norton et al., 1988). However, the instances of parasitism of prostigmatid mites (Wendt et al., 1992) and the observation of Åbro (1988) of an apparent preference for soft opilionid cuticle, demonstrate that *Leptus* larvae will also attach to weakly sclerotised areas.

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