

The genus *Gamasellodes* (Acari: Mesostigmata: Ascidae): New Australian and North American species

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Abstract

Mites of the genus *Gamasellodes* are among the smallest of Mesostigmata, but are of more general interest because of their potential as biocontrol agents of soil-root pests and because their lineage acquired a haplo-diploid genetic system (arrhenotoky) independently of other better known Mesostigmata (e.g. Macrochelidae, Laelapidae). Herein, I describe three new species of *Gamasellodes*: *G. ericae* n. sp. from the canopy of a subtropical rainforest in Australia; *G. claudiae* n. sp. from a desert woodland in the USA, and *G. adrianae* n. sp. from subtropical rainforest floor soil and litter in Australia. Arrhenotoky was experimentally demonstrated in the latter two species, and *G. adrianae* n. sp. is currently under investigation for the presence of intracellular symbionts. A key to the world species is presented.

Key words: mites, rainforest soils, arrhenotoky, biocontrol, rainforest canopy

Introduction

More than a dozen species of *Gamasellodes* Athias-Henriot (Acari: Mesostigmata: Ascidae) have been described from soil and litter and in the nests of birds and mammals in Africa, North America, Eurasia, and Australia (Athias-Henriot 1961, Hurlbutt 1970; Lindquist 1971; Walter 1987; Jordaan 1988; Halliday *et al.* 1998). These mites are among the smallest of the Mesostigmata, with body lengths typically a third of a millimetre or less in length. The described species represent a morphologically homogenous group with most species differentiated by minor variations in the ornamentation or setation of plates, relative setal lengths, or the number of marginal-submarginal setae (Lindquist 1971, Walter 1987).

Although minute, species of *Gamasellodes* are of general interest for two reasons: their feeding behaviour and their reproductive biology. These mites are voracious predators of nematodes and other small invertebrates in the soil and have the potential to be useful biocontrol agents. This is especially true because they have short generation times and reproduce by arrhenotoky or thelytoky (Walter 1987; Walter & Ikonen 1989). Thus, even a single female nymph that manages to colonize a patch of prey has the potential to rapidly establish a large population. Additionally, the evolution of arrhenotoky in *Gamasellodes* or in a lineage containing *Gamasellodes* and *Protogamasellus* Karg (see Afifi *et al.* 1986) appears to be an isolated event within the tribe Ascini. Species of other genera in the tribe require mating to reproduce or are composed of all-female species (Norton *et al.* 1993, Walter 1998). In this paper, I describe three new species of *Gamasellodes*, extend the ranged of morphological variation known in the genus, and confirm arrhenotoky in one of the new Australian species.

Materials and methods

Specimens were cleared in Nesbitt's solution, and mounted in Hoyer's medium or Heinze polyvinyl alcohol on microscope slides (Evans 1992). Measurements are given in parentheses (in micrometres), and were made from slide-mounted specimens using a stage-calibrated ocular micrometer. Shield lengths were measured along their midlines and widths at their greatest expanse. Designations for idiosomal setae follow the system of Lindquist & Evans (1965). Setae were measured from the bases of their insertions to their tips. Holotypes are deposited in the Queensland Museum, South Brisbane, Qld 4101 or in the U.S. National Mite Collection, USDA-ARS, Beltsville Agricultural Research Center, Beltsville, MD; paratypes are deposited in these institutions and in the Australian National Insect Collection, C.S.I.R.O. Division of Entomology, Canberra, ACT, and the University of Queensland Insect Collection.

Results and discussion

Gamasellodes Athias-Henriot

Gamasellodes Athias-Henriot, 1961: 480. Type species: *Gamasellodes vulgator* Athias-Henriot, 1961: 480, by original designation.

Diagnosis: Dermanyssine Mesostigmata with 2 subequal dorsal shields without transverse lines at their juncture; podonotal shield of adult with 15-17 pairs of setae, setae *j1-2*, *z1* usually in transverse row at anterior margin of shield (*z1* rarely absent); opisthonotal shield usually with complete *J*-, *Z*- and *S*-series (*S1* rarely absent) and 2 pairs of large postero-lateral glands, without horn-like processes; *R*-series in soft cuticle laterad shield. Sternal shield with 3 pairs of setae and 3 pairs of lyrifissures, *st1* usually on weakly sclerotized region; *st4* in soft cuticle; genital shield truncate posteriorly; *pilus dentilis* present and setiform; corniculi horn-like; tritosternal laciniae separate. Spermathecal system of female of laelapid type, unsclerotized. Tibia I with 13 setae: 6 dorsal, 3 ventral and 2 on each lateral aspect; leg I with pretarsus and claws; genu I with 13 setae (*av2* present); setation of tibiae II-III-IV with 10-8(7)-10(8), genua 11-8-9, respectively. Male with sternogenital and ventrianal shields; leg II without spurs; spermatodactyl linear, hooked distally or V-shaped.

Remarks. Some authors (e.g. Karg 1993) treat *Gamasellodes* (and *Arctoseiodes* Willmann) as synonyms of *Leioseius* Berlese; however, those genera have characters such as an incised holodorsal shield and the posterior placement of seta *j2* that easily separate them from *Gamasellodes*. To date, about 13 species of *Gamasellodes* have been proposed, but several of these seem to be synonyms (Hurlbutt 1970, Lindquist 1971) or cannot be clearly differentiated from *G. bicolor* (Berlese). Below I present a key to distinguish three new species of *Gamasellodes*, two from Queensland, Australia, and one from Colorado, USA, from other members of the world fauna.

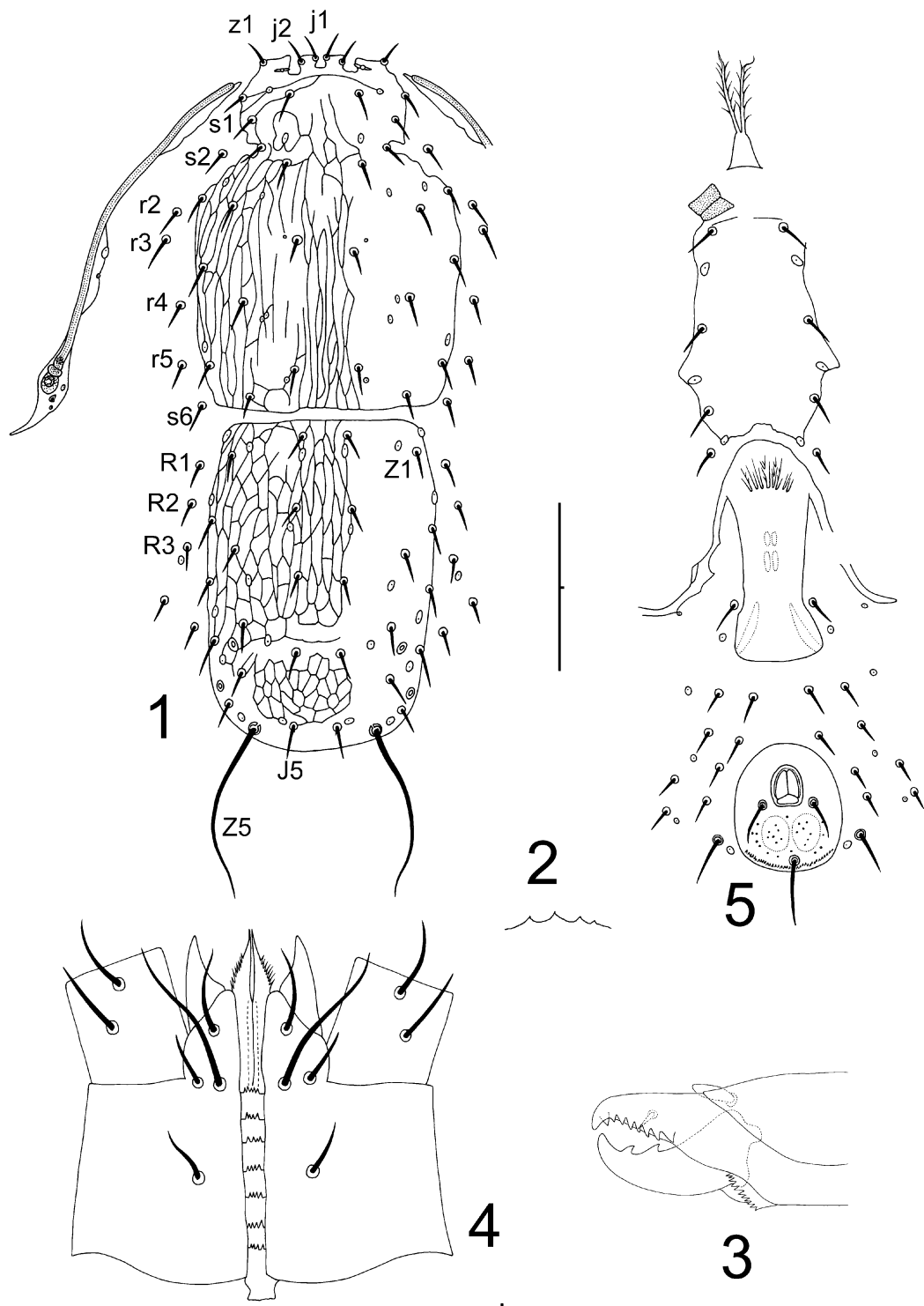
Key to adults of species of *Gamasellodes*

1. Ventrianal shield of female large, bearing 11 setae: 4 pairs of ventral setae (*JV2-5*) and 3 circumanal setae (Fig. 15) 4
- Female ventrianal shield reduced, with 9 or fewer setae, (Fig. 8) or reduced to anal shield with only the 3 circumanal setae (Fig. 5) 2

2. Ventrianal shield with 9 setae: 3 pairs of ventral setae (*JV2*, 4, 5) and 3 circumanal setae; seta *SI* present, *Z5* simple to lightly barbed; podonotal shield smoothly micropunctate, opisthonotal shield micropunctate to weakly reticulate posteriorly; peritreme short, reaching only to coxa II (Fig. 8)..... 3
 - Only anal shield with 3 pairs of circumanal setae present (Fig. 5); posterior opisthosomal shield with 14 pairs of setae (*SI* absent), *Z5* long, whip-like; dorsal shields strongly reticulated; peritreme long, extending to coxa I (Fig. 1) ***G. ericae* sp. nov.**
3. Anterior seta *z1* present (Fig. 6); prongs of tectum denticulate (Fig. 7); male ventrianal shield broad, bearing 13 setae (*JV2-5*, *ZV2*, and 3 circumanal setae)..... ***G. claudiae* sp. nov.**
 - Anterior seta *z1* absent; tectum smoothly tripartite; male ventrianal shield subrectangular, bearing 11 setae (*ZV2* in soft cuticle)..... *G. hildae* Jordaan
4. Podonotal seta *s1* in soft cuticle of adult female (Fig. 12), podonotal shield without groove; gnathotectum smoothly tripartite; humeral seta *r3* <2x length of *r2* 5
 - Podonotal seta *s1* on shield in adult female at level of podonotal groove; lateral prongs of gnathotectum denticulate; humeral seta *r3* >3x length of *r2*.....*G. minor* Athias-Henriot
5. Peritreme long, extending to coxa I..... 6
 - Peritreme short, just reaching coxa II.....*G. insignis* (Hirschmann)
6. Opisthonotal shield flanked by 5-9 pairs of marginal and submarginal setae (Figs 1, 6) 7
 - Opisthonotal shield flanked by 3 pairs of marginal setae; submarginal setae absent (Fig. 12) ***G. adrianae* sp. nov.**
7. Anterior margin of ventrianal shield of female rounded, ventral setae *JV1*, *ZV1-2* following curve 9
 - Anterior margin of ventri-anal shield +/- straight, setae *JV1*, *ZV1-2* +/- aligned in soft cuticle anterior to shield 8
8. Opisthonotal shield lightly punctate in reticulate pattern for much of its anterior two-thirds, strongly reticulate and separately punctate posterior to setae *J4*; 7-8 marginal and submarginal setae present.....*G. plaire* Halliday, Walter & Lindquist
 - Opisthonotal shield unornamented on anterior two-thirds, and with a few transverse markings posterior to setae *J4*; 5 pairs of marginal and submarginal setae present *G. reactiventris* Lindquist
9. Setae on dorsal shields of variable lengths, seta *Z5* much longer than any other *G. bicolor* complex (10)
 - All setae on dorsal shields very short, seta *Z5* similar in size to others *G. vermivorax* Walter
10. Seta *R2* present (3 *R*-series setae anterior to pore *Rp*)..... 11
 - Seta *R2* absent (2 *R*-series setae anterior to pore *Rp*)..... *G. bicolor* (Berlese)
11. Opisthonotal shield flanked by 7 pairs of setae (*R1-6* + submarginal seta) *G. major* Athias-Henriot
 - Opisthonotal shield flanked by 6 pairs of setae (*R1-6*, submarginal seta absent) *G. vulgator* Athias-Henriot

***Gamaselodes ericae*, sp. nov. (Figs 1-5)**

Diagnosis. *Gamaselodes ericae* can be distinguished from other species of *Gamaselodes* by the presence of an anal shield bearing only the 3 circumanal setae (but see *Leioseius ulmi* Hirschmann), the strong and elongate-reticulate ornamentation of the dorsal shields, an opisthonotal shield with 14 pairs of setae (*SI* absent), and the reduced gnathotectum.



FIGURES 1-5. *Gamasellodes ericae* n. sp., adult female. 1. Dorsal and peritrematal shields; 2. gnathotectum; 3. chelicera; 4. subcapitulum; 5. ventral shields. Scale bars = 0.080 mm.

Female. Idiosoma (320-337) with two subequal shields (Fig 1): podonotal shield (171-178 long) with 16 pairs of setae (*j1-6*, *z1-6*, *s1*, 3-5), setae *s2* and *s6* in soft cuticle; setae *j1-2* subequal (11-13), slightly longer than *z1* (8-11); opisthonotal shield (149-156) with 14 pairs of setae (*S1* absent), seta *Z5* (81-86) whip-like, 5-6x length of simple *J5* (14-16); shield flanked by 7 pairs of marginal and submarginal setae. Peritreme extending past insertion of seta *s1*. Tectum (Fig. 2) with 3-4 short denticles; second article (Fig. 3) of chelicera (68-77) with 7 teeth; movable digit (29-31) bidentate. Deutosternal groove (Fig. 4) with 7 rows of 3-4 denticles; tritosternum (55-56 total) with separate laciniae (37-38). Sternal shield (100-110 long) with anterior striate-membranous lobes (Fig. 5), *st1* on anterior margin of lightly sclerotized region, *st1-3* simple, subequal (13-17), slightly longer than *st4* (11-12). Anal shield (53-64 x 53-60 wide) oval, punctate posteriorly, with 3 setae, postanal seta (27-33) >2x paranal setae (12-13). Tibia III with 7 setae (1-1/1-2/1-1), tibia IV with 8 setae (1-1/1-3/1-1). Spermatheca not observed.

Male. Unknown.

Type material. **Holotype**, female, Lamington National Park (28°13'S, 153°07'E), Queensland, Australia, ex subtropical rainforest canopy, pyrethrum knockdown, Low canopy sample 17, 20.iii.1991, R. Kitching. **Paratypes**: 2 females, same data as holotype; 2 females, same except High canopy sample 17; 3 females, same except AA3.

Etymology. This species is named for Dr Heather Proctor, from the generic name (*Erica*) of a heather.

Remarks. This new species is known only from chemical knockdown samples in a subtropical rainforest canopy and is the most unusual of the known species of *Gamasellodes*. Unique characters include the suppression of seta *S1*, the displacement of seta *s6* into the soft cuticle, and the anal shield. The loss of setae on tibiae III and IV also probably are unique, although not enough is known about leg chaetotaxy in other species to be sure. *Gamasellodes ericae* does bear some resemblance to the intriguing *LeiOSEIUS ulmi* Hirschmann in having an anal shield, whip-like setae *Z5*, and setae *S1* suppressed. However, *L. ulmi* has short peritremes, additional setal suppressions (e.g. *J3*), and posteriorly placed setae *j2*.

***Gamasellodes claudiae*, sp. nov. (Figs 6-11)**

Gamasellodes n. sp. Walter & Ikonen (1989)

Diagnosis. *Gamasellodes claudiae* can be distinguished from other species of the genus by the combination of a ventrianal shield bearing 11 setae (otherwise known only in *G. hildae*), short peritremes (also present in *G. hildae* and *G. insignis*), and a tripartite tectum with denticulate prongs (also present in *G. minor*).

Female. Idiosoma (342-371) with two subequal shields (Fig. 6): podonotal shield (176-192 long) with 16 pairs of setae (*j1-6*, *z1-6*, *s3-6*), setae *j1-2* subequal (13-18), almost 2x *z1* (8-9); opisthonotal shield (161-183 x 115-132 wide) with 15 pairs of setae, seta *Z5* (28-37) sparsely barbed and 2x length of simple *J5* (12-15); shield flanked by 6-7 pairs of marginal and submarginal setae. Peritreme short (83-93) just reaching coxa II. Tectum (Fig. 7) tripartite, each prong with 2-4 denticles; second article of chelicera (81-86) with 4 teeth; movable digit (33-35) bidentate. Deutosternal groove with 7 rows of 2-4 denticles; tritosternum (62-74 total) with separate laciniae (45-50). Sternal shield (110-120 long) with anterior striate-membranous lobes (Fig. 8), *st1* on anterior margin of lightly sclerotized region, *st1-3* simple, subequal (16-21), similar to *st4* (17-20). Ventrianal shield (88-100 x 89-105 wide) punctate, with 9 setae, *JV5* (25-31) somewhat longer than

JV4 (18-22), postanal seta (25-33) ca. 50% longer than paranal setae (17-20). Leg chaetotaxy normal for genus. Spermatheca simple.

Male. Similar to female (Fig. 9) except smaller (idiosoma 273-290 long) with larger ventrianal shield (Fig. 10) bearing 13-14 setae (*ZV3* sometimes captured). Fixed digit of chelicera with 4 teeth, movable digit (21-22) with one tooth and linear spermatodactyl (20-26) with hooked tip (Fig. 11).

Type material. **Holotype**, female, Upper Ute Canyon (2000 m), Colorado National Monument, Mesa County, Colorado, USA, ex soil under gramma and bunchgrasses in pinyon-juniper-sage woodland, 28.ii.1988. DE Walter. **Paratypes**: 2 females, same data as holotype; female, same data except ex pinyon-juniper litter near Visitor's Center, 13.ix.1989; 27 females, 20 males, ex culture derived from type locality; female, Jornada Longterm Ecological Research Site west of Las Cruces, New Mexico, USA, ex creosote litter, 31.viii.1987. All DE Walter.

Etymology. This mite is named for a park ranger at Colorado National Monument.

Remarks. The feeding and reproductive behaviour of this species are discussed in Walter & Ikonen (1989). Like most other members of the genus that have been tested, these mites are arrhenotokous. The female from the Jornada LTER has only 6 marginal and submarginal setae, but otherwise is similar to the collections from Colorado.

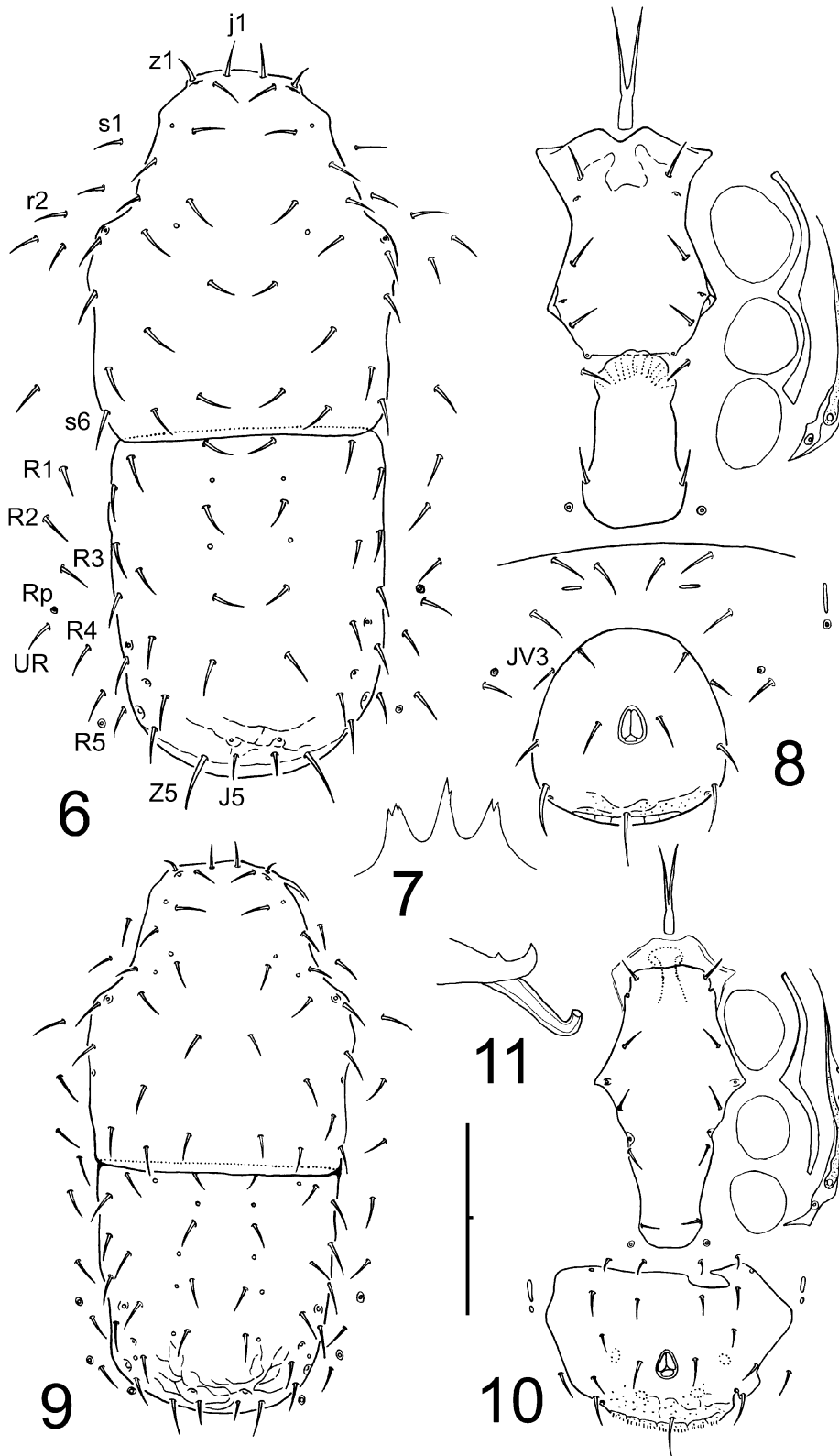
***Gamasellodes adrianae*, sp. nov. (Figs 12-17)**

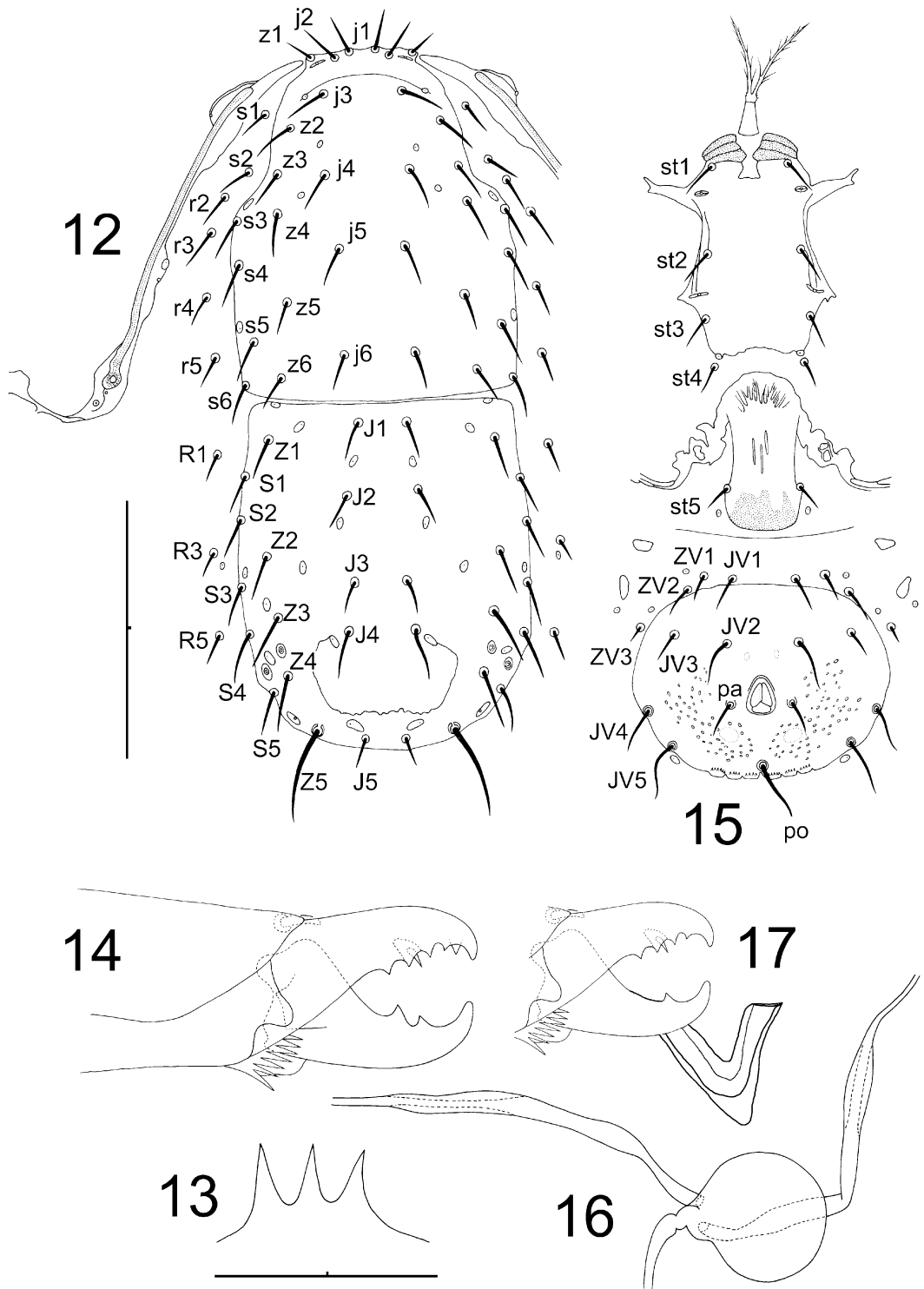
Diagnosis. *Gamasellodes adrianae* can be distinguished from other species of the genus by the extreme reduction in *R*-series setae (only *RI*, 3, 5 present), the loss of all submarginal setae, and by the deeply V-shaped male spermatodactyl.

Female. Idiosoma (263-279) with two subequal shields (Fig. 12): podonotal shield (130-139 long) with 16 pairs of setae (*j1-6*, *z1-6*, *s3-6*), setae *j1-2* subequal (14-17), about two-thirds longer than *z1*; opisthonotal shield (133-142 x 96-111 wide) with 15 pairs of setae and median posterior depression, seta *Z5* (31-39) simple to sparsely barbed and 3-4x length of simple *J5* (9-10). Peritreme extending past insertion of seta *s1*. Tectum (Fig. 13) smoothly tripartite; second article of chelicera (65-67) with 5-teeth (Fig. 14); movable digit (24-26) bidentate. Deutosternal groove with 7 rows of 2-4 denticles; tritosternum (48-54 total) with separate laciniae (33-40). Sternal shield (91-97 long) with anterior striate-membranous lobes (Fig. 15), *st1* on anterior margin of lightly sclerotized region, *st1-3* simple, subequal (15-17), slightly longer than *st4* (11-12). Ventrianal shield (99-110 x 70-86 wide) punctate, with 11 setae, *JV5* (20-30) ca. twice length of *JV4* (11-18), postanal seta (25-30) ca. twice length of paranal setae (11-16). Leg chaetotaxy normal for genus. Spermatheca simple (Fig. 16).

Male. Similar to female except much smaller (idiosoma 208-229 long) and with somewhat larger shields: *s1* captured by podonotal shield; *JVI*, *ZV2* captured by ventrianal shield (*ZV3* absent). Fixed digit of chelicera with 4 teeth, movable digit with one tooth and large, V-shaped spermatodactyl (Fig. 17).

FIGURES 6-11. *Gamasellodes claudiae* n. sp., adult female. 6. Dorsal shields; 7. gnathotectum; 8. ventral and peritrematal shields. Adult male. 9. Dorsal shields; 10. ventral and peritrematal shields; 11. spermatodactyl. Scale bar = 0.100 mm, 7 & 11 not to scale.





FIGURES 12-17. *Gamasellodes adrianae* n. sp., adult female. 12. Dorsal and peritrematal shields; 13. gnathotectum; 14. chelicera; 15. ventral shields; 16. Spermatheca. Adult male. 17. chelicera with spermatodactyl. Scale bar (12, 15) = 0.100 mm; (13, 14, 16, 17) = 0.025 mm.

Type material. **Holotype**, female, Mt Glorious, Cedar Creek (27°19'S, 152°46'E), Queensland, Australia, ex riparian rainforest litter, 5.vii.1995, DE Walter. **Paratypes**: Mt Glorious: male, same data as holotype; 2 females, Manorina National Park (27°19'S, 152°46'E), ex riparian rainforest litter, 17.vii.1997. Lamington National Park: female, Brush Box Circuit (28°13'S, 153°08'E), litter in trunk cavity on brush box (1-1.5 m), 25.xi.1999; 2 females, 2 males, culture from Deep Creek rainforest litter, 7.xi.2000; 5 females, 5 males, 11.ii.2003. Conondale Ranges: 3 females, Lobster Creek (26°39'S, 152°37'E), ex riparian rainforest litter, 13.vii, 20.ix.1995; female, Bundaroo Creek (26°42'S, 152°36'E), ex riparian rainforest litter, 13.vii.1995; female, Peters Creek (26°41'S, 152°36'E), ex riparian rainforest litter, 13.vii.1995. Cooloola: female, Rainbow Beach (25°57'S, 153°00'E), ex wet sandy heath litter, 13.xi.1997. All DE Walter.

Etymology. This mite is named for Adriana Najjar, a student in my laboratory investigating the distribution of *Wolbachia*-like bacterial endosymbionts in mesostigmatans.

Remarks. Except for the extreme reduction in marginal and submarginal setae and the unusual male spermatodactyl, *G. adrianae* is a rather typical member of the genus. It inhabits humid forest types: subtropical and riparian rainforests and heath on sandy soils. Drier forest types in southeast Queensland have other, undescribed species belonging to the *G. bicolor* complex. As with other species that have been tested, *G. adrianae* has an arrhenotokous genetic system: virgin females lay eggs that develop only into males. This mite is easily reared on nematodes and has a generation time of about 10 days at 25°C.

References

- Afifi, A.M., Hassan, M.F. & Nawar, M.S. (1986) Notes on the biology and feeding habits of *Protogamasellus minutus* (Hafez, El-Badry & Nasr (Acari: Gamasida: Ascidae). *Bulletin of the Entomological Society of Egypt*, 66, 251-259.
- Athias-Henriot, C. (1961) Mésostigmates (Urop. excl.) édaphiques Méditerranéens (Acaromorpha, Anactinotrichida) (collect. Prof. H. Franz et C. Athias-Henriot). Première Série. *Acarologia*, 3, 381-509.
- Evans, G.O. (1992). *Principles of Acarology*. CAB International, Wallingford, 563 pp.
- Halliday, R.B., Walter, D.E. & Lindquist, E.E. (1998) Revision of the Australian Ascidae (Acarina: Mesostigmata). *Invertebrate Taxonomy*, 12, 1-54.
- Hurlbutt, H. W. (1970) *Gamasellodes bicolor* (Berlese, 1918) (Acarina : Ascidae) and its relatives. *Acarologia*, 12, 474-8.
- Jordaan, L. C. (1988) *Gamasellodes hildae* (Acari: Ascidae), a new species from South Africa. *Phytophylactica*, 20, 39-41.
- Karg, W. (1993) *Raubmilben, Acari (Acarina), milben Parasitiformes (Anactinochaeta) Cohors Gamasina Leach. Die Tierwelt Deutschlands 59 Teil.* Gustav Fischer Verlag: Jena. 523 pp.
- Lindquist, E. E. (1971) New species of Ascidae (Acarina : Mesostigmata) associated with forest insect pests. *Canadian Entomologist*, 103, 919-42.
- Lindquist, E.E. & Evans, G. O. (1965) Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina : Mesostigmata). *Memoirs of the Entomological Society of Canada*, 47, 1-64.
- Norton, R.A., J.B. Kethley, D.E. Johnston & OConnor, B.M. (1993) Phylogenetic perspectives on genetic systems and reproductive modes of mites. In: Wrensch, D.L. & Ebbert, M.A. (eds.) *Evolution and Diversity of Sex Ratio in Insects and Mites*. Chapman & Hall, New York, pp. 8-99.
- Walter, D. E. (1987) Life history, trophic behavior, and description of *Gamasellodes vermivorax* n. sp. (Mesostigmata : Ascidae), a predator of nematodes and arthropods in semiarid grassland soils. *Canadian Journal of Zoology*, 65, 1689-95.

- Walter, D.E. (1998) *Ectoantennoseius kitchingi*, n. gen., n. sp. (Acari: Mesostigmata: Ascidae) from the rain-forest canopy in Australia and a cladistic hypothesis about its relationships. *International Journal of Acarology*, 24, 45-51.
- Walter, D. E. & Ikonen, E. K. (1989) Species, guilds, and functional groups : Taxonomy and behavior in nematophagous arthropods. *Journal of Nematology*, 21, 315-27.

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