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ARRHENOSEIUS GLORIOSUS N. G., N. SP.
(ACARI: MESOSTIGMATA: ASCIDAE),
AN ARRHENOTOKOUS MITE FROM RAINFORESTS
IN QUEENSLAND, AUSTRALIA.

by David Evans WALTER * and Evert E. LINDQUIST**

ABSTRACT: We describe a new genus and species of ascid mite, Arrhenoseius gloriosus, from rainforests in Queensland, Australia. This heavily armoured predatory mite can complete a generation in less than a week when fed nematodes at 25° C. The new genus belongs to the tribe Blattisociini Lindquist and Evans and appears to be most closely related to the northern hemisphere genus Zercoseius. However, unlike other Blattisociini for which the sex determination mechanism has been determined, A. gloriosus is arrhenotokous instead of pseudo-arrhenotokous. We describe sexual dimorphism in the deutonymphal instar and ontogenetic changes in form of tarsal setae of legs II–IV. These attributes have not been previously noted among mites of the family Ascidae.

INTRODUCTION
Rainforests have an unrivalled reputation for biological diversity and unusual species. This is certainly true of the acarofauna of Australian rainforests (WALTER & PROCTOR, 1998, 1999). In this paper, we continue a series of studies dealing with the Australian fauna of mites in the family Ascidae. The family as a whole was reviewed recently for Australia by HALLIDAY et al. (1998), with the genera Asca, Lasio-
sei us (in part), Hoploseius, and the newly described Ectoantennoseius treated further in separate papers by \textit{Walter et al.} (1993), \textit{Walter \& Lindquist} (1997), and \textit{Walter} (1998a, 1998b), respectively. The present paper contains the description, ontogeny, and biological observations of an unusual new species of ascid mite for which we propose a new genus belonging to the tribe Blattiscini sensu \textit{Lindquist \& Evans} (1965). Among the known taxa in the Ascidae, this mite is highly distinctive morphologically and genetically, especially as it is one of the few species for which an arrhenotokous sex mechanism is demonstrated (\textit{Norton et al.}, 1993; \textit{Walter \& Proctor}, 1999). The ontogenetic changes in form of setae on tarsi II to IV in this species are also noteworthy, as is the sexual dimorphism in the ventral chaetotaxy of the deutonymph.

Material representing but one species of the new genus is available. Recognition of attributes that may be practically and phylogenetically diagnostic at the generic level, as distinct from the specific level, is always problematical for such monobasic taxa. In this case we have been guided primarily by the attributes used by previous authors, including ourselves, to distinguish between the currently recognized genera of Ascidae, particularly of the tribe Blattiscini.

\textbf{Materials and Methods}

Mites were cleared in Nesbitt’s solution, and mounted in Hoyer’s medium or Heinze polyvinyl alcohol on microscope slides (\textit{Krantz}, 1978; \textit{Evans}, 1992). Measurements are given in parentheses (in micrometres), and were made from flattened, slide-mounted specimens using stage-calibrated ocular micrometers. All shield measurements refer to lengths (measured along their midlines), unless width is specified (shield width is often strongly distorted in slide-mounts). The system of setal notation for the idiosoma follows \textit{Lindquist \& Evans} (1965), with modifications for the posterior region as given by \textit{Lindquist} (1994). Setae were measured from the bases of their insertions to their tips, and distance between setae as the minimum distance between their insertions. Notation for porelike structures of the idiosoma as either gland pores (solenostomes) or poroids (lyrifissures) follows \textit{Johnston \& Moraza} (1991), based on morphological and physiological distinctions reported by \textit{Athias-Henriot} (1969a, 1969b) and \textit{Krantz \& Redmond} (1987), respectively. Leg lengths were measured from the base of coxa to apex of tarsus excluding the pretarsus. Leg and palpal setal notation and chaetotaxy follow \textit{Evans} (1963, 1964, 1965), with modifications for tarsi II to IV as given by \textit{Evans} (1969).

Behavioural and other biological observations are based on a culture established from two adult females collected from subtropical rainforest litter along Dawson Creek, Mt Glorious, Queensland (17.vii.1997). Mites were reared in culture jars (7 cm diameter), or in small glass vials (5 cm high, 1 cm diameter) with charcoal-plaster floors (\textit{Walter \& Ikonen}, 1989) and fed nematodes \textit{[Panagrellus silusiae \textit{(de Man})]. Arrhenotoky was established by using isolated, virgin females and rearing any offspring they produced. Slide preparations of the larva, protonymph, deutonymph and adult female and male of \textit{Zercoseius spa-thuliger} (Leonardi, 1899) were borrowed from the collections of Dr M. L. \textit{Moraza}, University of Navarra, Spain, for comparison with these instars of \textit{A. gloriosus}.

\textbf{Collection Abbreviations}

\textit{QM}: Queensland Museum, South Brisbane, Queensland 4101, Australia

\textit{UQIC}: Department of Zoology \& Entomology, University of Queensland, St. Lucia, Queensland 4072, Australia

\textit{CNC}: Canadian National Collection of Insects and Arachnids, Research Branch, Agriculture \& Agri-Food Canada, Ottawa, Ontario K1A 0C6, Canada

\textbf{Arrhenoseius new genus}

\textbf{Type species}. \textit{Arrhenoseius gloriosus n. sp.} Genus based on adult, nympha1 and larval material representing one species.
Diagnosis. Protonymph with expansive opisthognal shield bearing 14 pairs of setae including 6 pairs, J1, J2, Z1, Z2, S2, S3, that are on soft cuticle in other known protonymphal Ascidae. Deutonymph with single dorsal shield bearing deep mid-lateral incisions. Adult female and male with entire dorsal shield; humeral setal pair r3 erect but simple (not tricinate); marginal R-series reduced to one pair on soft cuticle. Female with metapodal plates insensibly fused to peritrematal shields, and with expansive ventrianal shield bearing 7 pairs of ventral setae plus the 3 circumanals. Male with holoventral shield, including its union with peritrematal-exopodal shields. On deutonymph and adult: leg IV tibia with 9 setae, lacking pl-2; tarsus II with two elongate whiplike setae, ad-3, pl-2; tarsus III with one elongate whiplike seta, ad-3; tarsus IV with two elongate whiplike setae, ad-3, pd-3.

Description. With character states of tribe Blatillosociini, including: fixed chela with setiform pilus dentilis; movable chela without micro or denticles on proximal ventral surface; peritrematal shield broadly united with exopodal plate curving behind coxa IV; para-anal setae inserted at mid-level of anus, and similar in length or shorter than postanal seta; female spermathecal apparatus of phytoseiid-type, with conspicuous, well-sclerotized cervix and long, fine accessory duct. Male with sternogenital-endopodal, peritrematal-exopodal and ventrianal shields connected to form holoventral shield; endopodal projections of sternogenital shield connected with exopodal projections of peritrematal shield between bases of legs I-II, II-III, III-IV.

Gnathosoma. Base of tritosternum slender, bases of laciniae bordered by several denticles at level of their fusion. Tectum triramous. Deutosternum with seven rows of denticles, all connected by lateral margins of deutosternal groove. Corniculi well developed, stout, entire apically, well separated. Fixed chela multidentate, with small pilus dentilis and small offset subapical tooth; movable chela tridentate, with fringed hyaline envelope around base. Male spermatodactyl curving ventrally beyond tip of movable chela. Palpus normal in size and form, its trochanter and femur similar in length; palptrochanter with one seta on protonymph, v-2 added on deutonymph; deutonymphal and adult setation of palpal trochanter, femur, genu, tibia, tarsus, respectively 2-5-6-14-15.

Legs. Tarsus I with pretarsus and paired claws, with dorsal subapical sensillus s slightly clavate-tipped, strongly recurved distally. Femur I typically shaped, gradually narrowing basally. Legs II-IV with paired claws and median lobe of pulvillus broadly rounded. Leg II of female not thicker than legs III-IV, and without opposable spinelike setae on ventral surfaces of segments. Deutonymphal and adult setation of legs I-II-III-IV, trochanters: 6-5-5-5; femora: 12-11-6-6; genua: 13-11-9-9; tibiae: 13-10-8-9; setae av-2 and pv-1 present on genua II and III;
seta pl-2 absent on genu III and tibiae III and IV. None of leg setae dimorphically thickened or otherwise modified on male.

**Relationships.** *Arrhenoseius* is uniquely apomorphic among the genera of Ascidae in its protonymph having an expansive opisthosotal shield that captures setae J1, J2, Z1, Z2, S2, S3 and bears a total of 14 pairs of setae, and in its female having the metapodal plates fused to the posterior margins of the peritrematal shield. It is unusual among Ascidae in its male having a holoventral shield, an apomorphy otherwise known only in the genera *Antennoseius* (Ascini), *Zercoseius* (Blattisociini) and, rarely, *Lasioseius* (Blattisociini).

Within the tribe Blattisociini, adult *Arrhenoseius* most closely resembles *Zercoseius* which is also monobasic, and with it shares two putative apomorphies: R-marginal series reduced to just the protonymphal pair, RI (which is the only pair of marginal setae on soft cuticle) and male ventral shielding consolidated into a holoventral shield. Both genera also have females without free metapodal plates; however, the metapodal plates are incorporated into the posterior margins of the peritrematal shields in *Arrhenoseius*, whereas they are incorporated into the anterolateral areas of the ventrianal shield in *Zercoseius*. Similarly, tarsi II to IV of deutonymph and adults in both genera each have one or two long whiplike setae; however, the setae elongated as whiplike structures in *Arrhenoseius* are ad-3 and pl-2 on tarsus II, ad-3 alone on tarsus III, and ad-3 and pd-3 on tarsus IV, whereas in *Zercoseius* they are ad-3 and pd-3 on tarsi II and III, and ad-3 alone on tarsus IV. Also, females have expansive ventrianal shields bearing 7 pairs of opisthogastric setae in addition to the circumanals, but in *Arrhenoseius* these include ZV1 and exclude JV5 which remains on soft cuticle (as in *Lasioseius*), whereas in *Zercoseius* ZV1 is absent and JV5 is on the shield. *Zercoseius* also differs from *Arrhenoseius* in having a typical, dorso-ventrally flattened dorsal shield; fixed digits with 4–5 teeth; movable digits with 2 teeth; deutonymphs and adults without podonotal setae z1, s1, s2; exopodal elements that remain free from the peritrematal shields between legs I-II and II-III in adults; no recognizable calyx of the spermathecal apparatus (Athias-Henriot, 1967); the paragenital poroids captured by the posterolateral corners of the female epigynial shield; the male opisthogastric region with setae ZV2, ZV3, JV4; and genu III, tibia III and tibia IV with one more seta, pl-2, in deutonymphs and adults. Moreover, *Zercoseius* is known only from North America and Europe, *Arrhenoseius* only from Australia.

Protonymphs in both *Zercoseius* and *Lasioseius* have a pygidial shield with setae J1-2, Z1-2 and S2-3 inserted on the soft cuticle, rather than being captured on an expanded shield as in *Arrhenoseius*. The deutonymph of *Zercoseius spathuliger*, however, resembles that of *Arrhenoseius gloriosus* in having a well sclerotized, heavily ornamented dorsal shield with lateral incisions. In contrast with *A. gloriosus*, however, in *Z. spathuliger* setae s3 are enlarged and erect on the dorsal shield margin so as to resemble a humeral pair of setae above short, curved r2 and short, smooth r3 on soft cuticle. In transforming to the adult, setae r2 (erroneously denoted r3 in Lindquist & Evans, 1965) become enlarged and erect to resemble humeral setae in their new position on the dorsal shield, s3 become smaller and curved like other adjacent setae, and r3 become curved, slightly barbed, and undifferentiated from r4, r5. These transformations in setal forms do not occur in *A. gloriosus*; instead, setae r3 change from being curved and slightly barbed on the deutonymph to erect and smooth on the adult. The deutonymph of *Z. spathuliger* also differs in having a small ventrianal shield bearing setae JV3 and usually JV2 in addition to the circumanals, instead of an anal shield as in *A. gloriosus* (also in *Lasioseius*).

There are a number of species of *Lasioseius* whose females have heavily sclerotized and highly ornamented dorsal and ventral shielding and a spermathecal apparatus without a clearly developed cervix. At least a dozen such species have been described, including *L. imitans* (Berlese), *L. scutalis* (Banks), *L. alter* Vitzthum, *L. humberti* Athias-Henriot, *L. vitzthumi* Westerboer, *L. tectus* Hyatt, *L. convexus* Krantz, *L. americanus* Chant, *L. araucariae* Hirschmann, *L. mauchei* Loots, *L. rugosa* (Halliday), *L. zaluckii* Walter & Lindquist, representing two or more species groups. The male has been described for only one of these species, *L. vitzthumi*, and it is unusually apomorphic in *Lasioseius* in having a holoventral shield (although a line of delineation remains evident at the
junction of the sternogenital and ventrianal shields). A few of the *Lasioseius* species discussed above have been confused with the pachylaelapid genus *Zygoseius* by some authors (Vitzthum, 1925; Westerbroek, 1963; Hyatt, 1964). Adult females of *Arrhenoseius* and *Zygoseius* both have metapodal plates consolidated with peritrematal shields and their males have a holoventral shield. However, the variety of attributes that exclude *Zygoseius* from the family Ascidae, including a 3-tined apotele on the palparsus, 13 setae on femur I, a divided dorsal shield in the deutonymph but an entire dorsal shield in the adult, fusion of the metasternal and endopodal plates in the female, a non-phytoseid type spermathecal apparatus with an unpaired sperm reservoir in the female, and an S-shaped spermatodactyl with a basal posteroventral bend in the male, indicate that any similarities between these two taxa are superficial. Also, the protonym of *Zygoseius* does not have an expanded posterior dorsal shield.

In the key to world genera of Ascidae recently published by Halliday et al. (1998), *Arrhenoseius* keys readily to couplets 24 and 25, which are end points for the genera *Zercoseius*, *Accodromus* and *Lasioseius*. Couplet 24 can be modified, and an additional couplet, 24A, inserted to include *Arrhenoseius*, and to correct for the presence of setae 2 in *Zercoseius*, as follows, with no changes needed for couplet 25:

24(23). Adults with 1 pair of marginal setae (RI) on soft lateral cuticle; female metapodal plates incorporated into ventrianal or peritrematal plates, and ventrianal shield with 7 pairs of setae in addition to circumanals; male with holoventral shield... 24A

Adults with 3–9 pairs of marginal setae (r-R) on soft lateral cuticle; female metapodal plates free on soft cuticle, and ventrianal shield with 6 or fewer pairs of setae in addition to circumanals; male usually with separate sternogenital, ventrianal and peritrematal-exopodal shields... 25

24A(24) Podonotal region of adult dorsal shield lacking setae s1, s2; female with metapodal plates incorporated into ventrianal shield; female ventrianal shield lacking setae ZVI but with JV5 on its posterolateral margins; genu III with 10, tibiae III and IV with 9 and 10 setae, respectively (pl-2 absent from each of these segments)... *Zercoseius*

Podonotal region of adult dorsal shield holotrichous; female with metapodal plates incorporated into posterior margins of peritrematal shields; female ventrianal shield with setae ZVI but with JV5 inserted on soft cuticle behind its posterolateral margins; genu III with 9, tibiae III and IV with 8 and 9 setae, respectively (pl-2 absent from each of these segments)... *Arrhenoseius*

### *Arrhenoseius gloriosus* n. sp.

(Figs 1–24)


**DIAGNOSIS.** With characteristics of the genus and: dorsal shield of adults entirely covered with reticula outlined by spiculate tubercles, with nearly all setae thick, curved, barbed, longer than intervals between their bases; ventral shielding of adults entirely ornamented with embossed, smooth reticula and fovea; sternal shield of female with anteromedial patch of reticula somewhat elevated from adjacent surfaces; spermatodactyl of male with foot-like apex with anterior rounded toe and posterior pointed heel.

**ADULT FEMALE. Idiosomal dorsum** (Fig. 1). Holodorsal shield (length 370–410, greatest width at level of setae s6 325–330) hemispherical, extending lateroventrally, leaving only narrow band of soft striated cuticle between it and peritrematal and ventrianal...
Figs. 1–6. *Arrhenosia gloriosus* n. sp., adult female. 1. — Dorsal shield and peripheral structures on soft cuticle. 2. — Ventral shielding. 3. — Spermathecal apparatus. 4. — Gnathotectum. 5. — Hypognathum. 6. — Distal part of chelicera, paraxial view. Scale bars = 100 μm (1, 2 and 4, 5); 10 μm (3); 50 μm (6).
sion) subequal to its greatest width (117-125) along shield convexly rounded, extending over posterior length. Epigynial shield broadly subtriangular, its median truncate posterior margin; hyaline anterior margin of pair of sternal setae (23-25) and third pair of poroids plates present as free strips alongside coxae III-IV sterna!, genital and endopodal shielding. Endopodal on separate metasternal plates closely surrounded by coxae, with three simple, sharply pointed tines. Base of fringed cuticle between ventrianal and dorsal shields. Sternal shield extended anteriorly into this region. Sternal shield (median length 90-95, narrowest width between legs II 78-80) with three pairs of simple setae (30-35) and two pairs of poroids; with anteromedial patch of reticula somewhat elevated from adjacent surfaces; endopodal extensions of shield between coxae I-II with conspicuous gland pore near their lateral extremities; endopodal extensions between coxae I-II and II-III contiguous with exopodal peritrematal-exopodal shields. Fourth pair of sternal setae (23-25) and third pair of poroids on separate metasternal plates closely surrounded by sternal, genital and endopodal shielding. Endopodal plates present as free strips alongside coxae III-IV. Epigynial shield broadly subtriangular, its median length (110-115, including hyaline anterior extension) subequal to its greatest width (117-125) along truncate posterior margin; hyaline anterior margin of shield convexly rounded, extending over posterior region of sternal shield to level of setae s13; genital setae (35) inserted on lateral edges near posterior margin of shield; paragenital poroids iv5 on soft cuticle adjacent to posterolateral corners of shield. Peritrematal shield expansive, fully consolidated with exopodal shield alongside coxae II-IV, united with dorsal shield at level of setae s1; metapodal plate incorporated into truncated posterior margin of shield; shield with poroid ip1 at level of coxa II, gland pore gp1 at level of coxa III, poroid ip2 closely posterad stigma, and gland pore gp2 and poroid ip3 further posterad stigma at level of coxa IV; inguinal gland pore gp2 on exopodal extremity of shield curving behind coxa IV; peritreme extending anteriorly nearly to vertical setae j1, with crenulated margins, especially along inner (ventral) margin. Ventrianal shield expansive, its greatest width (247-250) along anterior margin over twice its median length (115-120), abutting posterior margins of epigynial and peritrematal shields, with 7 pairs of simple ventral setae (JV1-JV4, ZV1-ZV3), ZV3 shortest (15-20), others subequal (25-30), and three simple, subequal circumanal setae (15-20); one pair of poroids ivo1 near anterolateral margin of shield, para-anal gland pores gp3 indiscernible; cribrum a broad strip behind postanal seta. Narrow strip of soft cuticle between ventrianal and dorsal shields with 3 pairs of poroids ivo2-ivo4, and simple setae JV5 (12-15). Spermathecal apparatus (Fig. 3) with short (15-20) major duct leading from orifice between bases of legs III-IV to slender, cylindrical calyx whose sclerotized length (18-20 including atrium) about 5 to 6 times its width (3.5); atrium with long, fine minor duct ending without discernible enlargement.

Gnathosoma (Figs. 4-6). Gnathotectum (Fig. 4) with three simple, sharply pointed tines. Base of fringed labrum with short (6-11) spearlike supralabral process. Hypognathum (Fig. 5) with corniculi (11-12) hornlike, parallel; internal malae with fringed lateral margins and acute apices extending slightly beyond tips of corniculi; 7 moderately broad rows of deutosternal denticles, each finely multitdenticulate (14-30 denticles per row), all connected by lateral margins of deutosternal groove, 5th row constricted to about half width of 4th row, 6th row widened beyond lateral margins of groove; four pairs of sim-
subcapitular setae, anterior pair similar in length to 2nd and 4th pairs (30), 3rd pair shorter (20). Second article of chelicera (95–100) with smooth hyaline rim along its paraxial face above base of movable chela, ending in fixed digit with row of 15–17 closely spaced teeth decreasing in size apically, offset subapical tooth, and distal hook (Fig. 6); dorsal cheliceral seta (6–8) simple, somewhat flattened; pilus dentilis (3) simple. Movable digit (38–40) with 3 strong teeth; margin of hyaline envelope at base of movable chela fringed. Palp length 112–114, chae-
totaxy as described for genus, all setae smooth; palp-tarsus I (Fig. 8) with slender as on tarsus 11, but basitarsal (Fig. 9) with most setae similar in form and length as (25–27) also slender, other setae short (10–15), as on tarsus 11, but

Legs (Figs 7–9). All legs with well developed pretarsi (12–15) and paired claws. Excluding ambulacra, lengths of leg I 285–290, leg II 260–265, leg III 235–242, leg IV 285–290. Ventral surfaces of coxae I–IV embossed with reticula or fovea; coxa I with denticulate ridge near dorsal anterior margin, and cluster of 2 poroids and gland pore ventrally and ending in fixed digit with row of 10–11 teeth and offset subapical tooth, and distal hook; movable digit (28–29) with one tooth and spermato-dactyl (length from basal union with chela to apex 27–29) which in lateral view curves gradually antero-

Gnathosoma. Gnathotectum, hypognathum and palpi as in adult female, except corniculi slightly more incurved and internal malae extended slightly farther beyond tips of corniculi. Cheliceral structures (Fig. 16) as in adult female except fixed chela (79–82) with row of 10–11 teeth and offset subapical tooth, separated by edentate interval (5) before distal hook; movable chela (28–29) with one tooth and spermato-
dactyl (length from basal union with chela to apex 27–29) which in lateral view curves gradually antero-


Larva. Idiosomal dorsum (Fig. 17). Dorsum (length 175–215) with lightly sclerotised, unornamented podonotal shield (length 107–140, width at level of setae s6 135–140) bearing 9 pairs of well developed, simple setae, 3 pairs of poroids, and 1 pair of

ADULT MALE. Idiosomal dorsum. Dorsum entirely covered by strongly sclerotised, hemispherical holodorsal shield as in female but about 0.7 smaller (length 275–310, greatest width at level of setae s6 210–220); dorsal shield ornamentation, setation and porelike structures as in female; setae RI on narrow strip of soft cuticle as in female.

Idiosomal venter (Fig. 15) entirely covered by strongly sclerotised holoventral shield consisting of consolidated sternogential, ventrianal and peritrematal-exopodal elements; transverse rim — or line-like vestige of division between sternogential and ventrianal shields sometimes evident between setae s6 and JV1; shield length mediadly 232–240, width at posterior margin of coxae IV 182–190, ornamented with embossed reticula or fovea much as in female; setal and porelike elements as in female, except: paragenital poroids iv5 on shield behind setae s6, poroids ivow2-ivow4 on shield lateral setae ZV2, setae JV3 on posterolateral margins of shield, and setae JV4, ZV1, ZV3 absent.

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Arrhenoseus gloriosus n. sp., adult male. 15.—Ventral shielding. 16.—Distal part of chelicera with spermatodactyl, paraxial view. Scale bars = 100 μm.


Idiosomal venter. Tritosternum well developed (Fig. 18), with elongate trapezoidal base (10–11); laciniae (49–52) free along 80 percent of length, sparsely plumose. Sternal setae st1 on faintly sclerotized rectangular plate; st2-st3 on separate faintly sclerotized, quadrate plate. Setae JV1, JV2, JV5, ZV2, S5, Z5, 1 pair of poroids in soft cuticle. Anal shield (Fig. 19) broadly oval (length 28–30, width at level of para-anal gland pores 34–40), with simple para-anal (30–35) and postanal (16–20) setae; euanal setae (2) rudimentary; cribrum absent.

Gnathosoma. Gnathotectum (Fig. 20) with anterior margin triramous, each tine serrated, dorsal surface covered with minute denticles except smooth medially. Hypostome with 7 finely multidenticulate rows of deutosternal denticles of similar width (posterior rows slightly wider), bordered and connected on either side by a longitudinal line; hypognathum with a transverse, serrated rim on either side of deutosternal gutter just behind attachment of palpi; 2 pairs (h1-h2) of simple subcapitular setae (22–24); corniculi well developed, simple, well separated; internal malae with lateral margins fringed, and with
acute apices extending slightly beyond tips of corni­
culi. Fixed cheliceral digit (62-68) with dorsal chelici-
ral seta (5) and row of 9–10 closely set teeth of
which apicalmost 2 or 3 smaller than others, a tiny
offset subapical tooth, distal hook, and minute pilus
dentilis; movable digit (25–28) with 2 teeth. Palpal
length 77–98; palp trochanter, femur, genu, tibia,
tarsi setation, respectively: 0-4-5-12-11; anterolateral
seta on genu and femur spatulate; dorsal setae d-1, d-2
barbed on palpfemur.

Legs. Lengths of legs, excluding ambulacra, I
(14–15) and II–III (10–11) with well developed,
evenly curved claws; median lobe of pulvillus with
rounded apical margin. Setation of legs I–II–III res-
pectively, coxae: 2-2-2; trochanters: 4-4-4; femora:
10-7-5; genua: 8-6-6; tibiae: 8-7-7. Chaetotactic for-
mulae, femora: 2/2-1, 2/1-2; 1/2-1, 2/0-0; 1/1-1, 2/0-0;
genua: 1-2/1, 2/1-1; 1-2/0, 2/0-1; 1-2/0, 2/0-1; tibiae:
1-2/1, 2/1-1; 1-1/1, 2/1-1; 1-1/1, 2/1-1. Most of ad, pd
and some pl setae barbed on femur, genu, tibia of legs
I–III; other setae smooth. Tarsus I without notably
elongated setae; sensillus s (21–23) slightly clavate-
tipped, strongly recurved apically. Tarsi II–III (Figs.
13–14) with apical setal processes ad-1, pd-1 well
developed (10–12), and with setae ad-3, pl-2 elongate
(35–45), reaching nearly to base of pretarsus, untape-
ered along most of length, curved whiplike apically;
between these setae, pd-3 of moderate length (25–26),
slender, similar to those on basitarsus; other setae on
telotarsi II–III short (9–12), stout, somewhat spine-
like. Pretarsi II–III with prominent, simple paradact-
tyli (11–12).

Protonym. Idiosomal dorsum (Fig. 21). Idioso-
ma (length 250–300) covered by two dorsal shields
covered in dense spiculate-tuberculate ornamenta-
tion that obliterates ready discernment of poreli-
que structures. Anterior shield (length 145–160, greatest
width 190–215), bearing 11 pairs of elongate, barbed
setae, j1–j6, z2, s4–z5, s4–s5; s6 in soft cuticle at shield
corner; r2, r3, r5 simple, in soft cuticle; poroids idz3 in
soft cuticle alongside notch of lateral margin of shield;
setal lengths: j1 (18–21), j2 (25–28), j3–j5
(35–40), j6 (40–41), z2, z4, z5 (38–43), s4 (42–45), s5
(45–49), s6 (45–52), r2 (35–36), r3, r5 (20–24). Poste-
rior shield (length 103–125, greatest width 160–195)
with 14 pairs of mostly elongate, barbed setae: J1–J5,
Z1–Z5, S2–S5; setal lengths: J1–J3 (25–35), J4
(40–44), J5 (15–16), Z1, Z2 (50–54), Z3 (60–73), Z4
(75–88), Z5 (40–42), S2 (35–36), S3 (20–22), S4
(20–29), S5 (20–24); shield notched behind S2; R1
(8–14) in soft cuticle.

Idiosomal ventral. Ectal shield faintly sclerotized,
with 3 pairs of setae, st1–st3 (17–20), and 2 pairs of
poroids, iv1–iv2; setae st5 (8–9) in soft cuticle. Opis-
thogaster with 4 pairs of setae, JV1-JV2, JV5, JVZ in
soft cuticle, JV1 (17) longer than JV2, JV5, JVZ
(10–11). Anal shield (Fig. 22) oval (length 50, width
60), with para-anal setae (16–18) subequai to posta-
nal seta, euanal setae suppressed; with dense cribrum
field behind and beside postanal seta; posterior mar-
gin of anal shield closely flanked by posterior margin
of posterior dorsal shield. Peritreme short (30–35),
reaching to insertion of r5.

Gnathosoma. Gnathotectum (Fig. 23) as in larva
but tines less serrated, and dorsal surface smooth.
Hypognathum with 4 pairs of simple setae, h1, h2, pc
(22–25) longer than h3 (15–17); other hypognathal
structures as in larva. Fixed cheliceral digit (67–75)
with row of 13–14 teeth, a tiny offset subapical tooth,
and pilus dentilis (3); movable digit (27–33) with 3
teeth. Palpal length 90–100; palp trochanter, femur,
genu, tibia, tarsus setation, respectively: 1-4-5-12-15;
anterolateral seta on genu and femur spatulate; dor-
sal setae d-1, d-2 smooth on palpfemur.

Legs. Lengths of legs, excluding ambulacra, I
Pretarsal structures as in larva. Setation of legs I–II–
III–IV respectively, coxae: 2-2-2-2; trochanters: 4-4-
4-4; femora: 10-8-6-5; genua: 8-6-6-5; tibiae: 8-7-7-7.
Chaetotactic formulae, femora: 2/2-1, 2/1-2; 1-2/1, 2-
1-1; 1-1/1, 2/0-0; 1-1/0, 2/0-0; genua: 1-2/1, 2/1-1;
1-2/0, 2/0-1; 1-2/0, 2/0-1; tibiae: 1-2/1, 2-
1-1; 1-1/1, 2/1-1; 1-1/0, 2/1-1; 1-1/1, 2/1-1. Most dorsal
and lateral setae slightly barbed on femur, genu, tibia
of legs I–IV; other setae smooth. Form of setae,
pseudopletaram, claws on tarsi I as in larva. Tarsi II–IV
(Figs. 10–12) with apical setal processes ad-1, pd-1
(11–14), pretarsi (12–14), paradactyli (12–13) and
claws as in larva. Tarsus II with only seta pl-2 elon-
gate (32–35), whiplike, reaching nearly to base of
pretarsus; ad-3 similar to pd-3 in moderate length
(21–25), slender, similar to basitarsal setae (20–24);
other telotarsal setae, including mediodorsal ad-2
added on protonymph, short (7–12), stout, as in larva. Tarsus III with setae formed as on tarsus II except pl-2 on telotarsus (7–10) and pl-4 on basitarsus (9–12), short, stout. Tarsus IV with setae formed as on tarsus III except al-2 longer (17) and slenderer, and ventrals av-2, pv-2 moderately long (22–25), slender, like ad-3, pd-3, and pd-4 longer (32).

**Deutonymph. Idiosomal dorsum** (Fig. 24). Dorsum covered by shield (length 300–375, greatest width 250–270) with deep midlateral incisions extending to level of setae z6; shield covered in dense spiculate-tuberculate ornamentation except in posterior marginal scalloped areas, discernment of porelike structures occluded; spicules reduced in areas posterior to setae Z4. Anterior portion of shield bearing 16 pairs of setae, j1–j6, z1–z6, s3–s6, these barbed and mostly elongate, except z1 short, smooth; 6 pairs of setae, s1–1, r2–5, in soft cuticle laterad shield, these slightly barbed except short s2 smooth, none erect; setal lengths: j1 (24), j2 (38), j3–j6 (45–50), z1 (14), z2 (50), z3 (43), z4 (52), z5–z6 (41–46), s1 (27), s2 (15), s3–s4 (51), s5 (55), s6 (60), r2 (22), r3 (30), r4 (25), r5 (35). Posterior portion of shield with 15 pairs of setae, J1–J5, Z1–Z5, S1–S5, these mostly elongate, barbed, except S1 smooth, J5 sparsely barbed basally; R1 smooth, in soft cuticle laterad shield; setal lengths: J1–J3 (43–46), J4 (50), J5 (22), Z1 (62), Z2 (53), Z3 (62), Z4 (100), Z5 (59–61), S1 (32), S2 (51), S3–S5 (39–41), RI (19).

**Idiosomal venter.** Sternoventral shield lightly sclerotized, smooth, except genital region lightly ornamented with oblique wavy lines; with 4 pairs of setae, st1–st4 and 3 pairs of poroids, iv1–iv3; st1–st3 (25–31) longer than st4 (17); setae st5 (21) and poroids iv3 in soft cuticle. Opisthogastrid soft cuticle with 8 pairs of setae on females (JV1–JV5, ZV1–ZV3), but with 5 pairs on males (lacking JV4, ZV1, ZV3); these setae of moderate length (13–21). Anal shield smooth, subquadrate (length ca 60–80, width ca 80–85), with para-anal setae (16) nearly as long as postanal seta (16–21), euanal setae suppressed; with pair of widely spaced gland pores gp3 on lateral edges of shield at level of para-anal setae, and with broad (width 50) cruribium field behind postanal seta. Peritrematal shield lightly sclerotized, free from dorsal shield anteriorly, with poroid ip1 at level of setae r3, gland pore gp1 at level of r4, and poroid ip2 on posterior extremity closely behind stigma; peritreme extending to level of insertion of j2.

**Gnathosoma.** Gnathotectum triramous, tines smooth, sharply pointed. Hypognathum as in protonymph, except 5th row of deutosternal denticles conspicuously narrower than 4th and 6th rows. Fixed cheliceral digit (75–85) with row of 14–15 teeth, otherwise as in protonymph; movable digit (30–35) with 3 teeth. Palpal length 115; palp trochanter, femur, genu, tibia, tarsus setation, respectively: 2-5-6-14-15; form of palpal setae as on protonymph, palp genu with al-2 spatulate like al-1.

**Legs.** Lengths of legs, excluding ambulacra, I (295), II (250), III (230), IV (268). Setation of legs I–II–III–IV respectively, coxae: 2–2–2–2; trochanters: 6–5–5–5; femora: 12–11–6–6; genua: 13–11–9–9; tibiae: 13–10–8–9. Chaetotactic formulae, femora: 2/3, 2/2,1/2–1; 2-3/1,2/2–1; 1-2/1,2/0–0; 1-2/1,1/4–1; genua: 2-3/2,3/1–1; 2-3/1,2/1–1; 2-2/1,1/4–1; 1-2/1,1/4–1; tibiae: 2-3/2,3/1–1; 2-2/1,2/1–1; 2-1/4,1/4–1; 2-1/4,1/4–1. All setae on legs I–IV smooth. Form of setae, pretarsus, claws on tarsus I as in protonymph. Tarsi II–IV with apical setal processes ad-1, pd-1, pretarsi (11–13) and claws as in protonymph; paradoctyli (10–11) relatively smaller than in protonymph. Tarsus II with setae formed much as in protonymph: only seta pl-2 elongate (40), whiplike, reaching nearly to base of pretarsus; ad-3 similar to pd-3 in moderate length (28), and similar in slender form and length to medioventral seta av-3 added on deutonymph and to basitarsal setae (25–26); other telotarsal setae short (8–15), stout. Tarsus III with setae formed as in protonymph; medioventral seta av-3 added on deutonymph slender (26). Tarsus IV with setae formed much as in protonymph: pd-3 (34) longer than ad-3 (24); medioventral seta av-3 (30) added on deutonymph and ventrals av-2, pv-2 (28) moderately long, slender; basitarsus with pl-4 short (10), stout, pd-4 (40) conspicuously longer than ad-4 and al-4 (25).

**Biology.** Populations of *Arrhenoseius gloriosus* are present in subtropical rainforest litter in south east Queensland from the moist montane forests in the Border Ranges along the New South Wales border, at least as far north as the similar forests in the Conondale...
Ranges in the Sunshine Coast hinterlands, and west to the dry rainforests of the Bunya Mountains. Most collections are from forest floor litter, but the mites also inhabit crows nest fern litter in the rainforest canopy at Lamington National Park. The larva and all subsequent instars are voracious predators of nematodes. Cultures were established from a collection from about the middle of its known range, on Mt Glorious north of Brisbane.

At a constant temperature of 25° C, *A. gloriosus* develops from egg to adult in 6–7 days, with males reaching maturity about a half day earlier than females. Female deutonymphs are guarded by males, which rest their front legs on the torpid nymphs or sit on their backs, and are mated immediately after eclosion. Females can live for 3–4 weeks after reaching maturity and lay an average of 1 egg per day during this period. Males will also court older, fully sclerotised females, riding their backs and eventually descending onto the female’s venter and applying their mouthparts to the leg bases; however, these mating attempts apparently are futile. For females mated when recently emerged, progeny sex ratios are strongly female-biased (65 ± 2% female); however, females that are not allowed access to males until they are fully sclerotised have only sons. Virgin females kept isolated from any contact with males lay fertile eggs, but these also develop only into males, indicating that males are probably haploid and that the genetic system in *A. gloriosus* is arrhenotoky.

**REMARKS**

What little is known of the biology of *Zercoseius spathuliger* is difficult to compare with the observations above for *A. gloriosus*. Based on observations of ATHIAS-HENRIOT (1967), some populations of *Z. spathuliger* seem to be thelytokous, while others may possibly be arrhenotokous rather than pseudoarrhenotokous, in view of the highly female-biased sex ratios that she noted.

Spiculate dorsal shield ornamentation has rarely been noted among mesostigmatic mites, and ascid mites in particular. We have observed a less dense spiculation on adults of an undescribed species of *Proctolaelaps* that inhabits *Cryptoporus* shelf fungi in coniferous forests of northeastern California, a completely different habitat than that of *Arrhenoseius gloriosus*.

The absence of deutonymphal setae JV4, ZV1, ZV3 on the adult male of *A. gloriosus* is noteworthy, as this may reflect either of two phenomena. If these setae are present on the deutonymphal male, then they must be suppressed subsequently in the adult. If they are absent on the deutonymphal male, then deutonymphs are sexually dimorphic in opisthogastric setation and they may be recognized as male or female. The arrhenotokous genetic mechanism in *A. gloriosus* makes it a useful animal to readily address this question. Our study of all-male progeny reared from an unmated female indicate that the male deutonymph lacks setae JV4, ZV1, ZV3, as in the male adult, indicating deutonymphal sexual dimorphism. In contrast with *A. gloriosus*, both male and female adults of *Z. spathuliger* retain the same full complement of opisthogastric setae that are present in the deutonymph.

**DISCUSSION**

Though unusual and evidently apomorphic, the protonymphal attribute of an expansive posterior dorsal shield in *Arrhenoseius* can not be compared effectively for phylogenetic analysis, as the protonymph of relatively few other taxa of Ascidae and related families are known or described. Similarly, the patterns of ontogenetic changes in setal form on tarsi II to IV in *Arrhenoseius* can not be assessed cladistically in the absence of comparable observations and data for other taxa. The latter points to a more general problem concerning the inadequacy and incompleteness of descriptions of taxa of Mesostigmata, especially as they concern changes in structures through ontogeny. For example, MORAZA & LINQUIST (1999) noted the unusual absence of one of the pseudosymmetric pairs of ventral setae on tarsi II to IV in their newly-described zeronoid genus *Coprozeracon*; but even more unexpected was their observation that this is a regressive deficiency, i.e., a suppression of setae that are present on the deutonymph. The uniqueness of that condition is uncertain in view of the lack of comparable data for many other taxa of
Gamasida. The following observations of ontogenetically abrupt changes in form of tarsal setae in Arrhenoseius may be another case in point.

Tarsi II and III of the larva of Arrhenoseius gloriosus are nearly identical in form of their setation: setae ad-3 and pl-2 are similarly elongated and whiplike; between them, pd-3 is shorter and slender like the four basitaltarsal setae; and the other telotarsal setae are short and stout (Figs. 13, 14). On the protonymph, ad-3 of tarsi II–III and pl-2 of tarsus III are shortened and no longer whiplike, and tarsus III further differs from tarsus II in pl-4 being short and stout; setation of tarsus IV resembles that of tarsus III except for ad-2 and especially av-2 and pv-2 being longer and slender on the telotarsus, and pd-4 being longer on the basitarsus (Figs. 11–12). Apart from the normal addition of medioventral seta av-3, setation of tarsi II–IV on the deutonymph resembles that on the protonymph. By contrast, on the adult of both sexes, tarsus II reverts to the larval condition in having the medioventral seta ad-3 (instead of av-2) elongated, whiplike, as in the larva but pl-2 short, spinelike, as in the protonymph; and tarsus IV expresses a new pattern in having ad-3 and adjacent pd-3 (instead of pl-2) elongated, whiplike, and having av-2 and pd-4 shorter but pv-2 and av-3 longer than in the deutonymph (Figs. 7–9). Such patterns of change in setal form, both among tarsi II to IV of the same instar and between tarsi II to IV of different instars, do not occur in Zerconeius spatuliger and have not been documented among other taxa in Ascidae or related families. There may be a wealth of new attributes of potential phylogenetic importance among such patterns.

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