REVISION OF THE GENUS *ZYGOSEIUS* BERLESE (ACARINA: PACHYLAELAPIDAE)

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ZYGOSEIUS
ASCIDAE
PACHYLAELAPIDAE

ABSTRACT: *Zygoseius* Berlese 1916 is re-described, and *Zygoseius furciger* (Berlese) 1916 is re-described on the basis of the type specimens and additional material. *Z. furciger* has been collected in Argentina, U.S.A., Egypt, Israel, and South Africa. *Z. badrii* Hafez and Nasr, 1982 is a synonym of *Z. furciger*. Three new species are described: *Z. sarcinulus* sp. nov. from Australia, *Z. ampullus* sp. nov. from Argentina and *Z. metoecus* sp. nov. from Argentina. *Zygoseius* is provisionally considered to be a member of the family Pachylaelapidae, but its exact relationships are not fully resolved.

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ZUSAMMENFASSUNG: Die Gattung *Zygoseius* Berlese 1916 wird wiederbeschrieben. Auf der Grundlage der Typen sowie zusätzlichen Materials wird außerdem die Art *Zygoseius furciger* (Berlese) 1916 wiederbeschrieben. *Z. furciger* wurde bisher in Argentinien, U.S.A., Ägypten, Israel und Südafrika gesammelt. *Z. badrii* Hafez und Nasr, 1982 ist ein Synonym von *Z. furciger*. Drei neue Arten der Gattung *Zygoseius* werden beschrieben: *Z. sarcinulus* sp. nov. aus Australien, *Z. ampullus* sp. nov. aus Argentinien und *Z. metoecus* sp. nov. aus Argentinien. *Zygoseius* wird vorübergehend als ein Mitglied der Familie Pachylaelapidae angesehen, aber die genauen Verwandtschaftsverhältnisse sind bisher nur unvollständig geklärt.

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RÉSUMÉ : On redécrit *Zygoseius* Berlese, 1916 et *Zygoseius furciger* (Berlese) 1916 d'après les spécimens types et un matériel additionnel. *Z. furciger* a été récolté en Argentine, aux U.S.A., en Égypte, en Israël, et en Afrique du Sud. *Z. badrii* Hafez et Nasr, 1982 est un synonyme de *Z. furciger*. Trois espèces nouvelles sont décrites: *Z. sarcinulus* sp. nov. d'Australie, *Z. ampullus* sp. nov. d'Argentine, et *Z. metoecus* sp. nov. d'Argentine. *Zygoseius* est considéré provisoirement comme membre de la famille des Pachylaelapidae, mais ses parentés exactes ne sont pas pleinement élucidées.

INTRODUCTION

In 1916, BERLESE created the genus *Lasioseius* and subdivided it into six subgenera. Five of these subgenera now have full generic status in the family Ascidae (*Lasioseius*, *Cheiroseius*, *Platyseius*, *Zercoseius*, *Leioseius*). The other, *Lasioseius* (*Zygoseius*), originally contained a single species, *Lasioseius* (*Zygoseius*) *furciger* Berlese, 1916. *Zygoseius* has received little taxonomic attention, and neither the subgenus

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nor its type species have been re-described. *Zygoseius* was elevated to generic level within the Ascidae (or its synonym Aceosejidae) by EVANS (1958), SHEALS (1962) and HYATT (1964), but this action was not accompanied by an analysis of its relationships, and appears to have been taken only by analogy with the other subgenera. Apart from the type species, the only other species that have been placed in the genus are *Z. alter* Vitzthum, 1925, *Z. vitzthumi* Westerboer, 1963, *Z. tectus* Hyatt, 1964, and *Z. badrii* Hafez and Nasr, 1982.

BERLESE's (1916) diagnosis of *Zygoseius* may be translated as "Metasternal shields of the female fused with the endopodal shields". Later, in the description of *Z. furciger*, he adds "Metasternal shields absent, which is characteristic of the subgenus". VITZTHUM (1925) stated that this was also the case in *Z. alter*. However, WESTERBOER (1963) pointed out that the metasternal and endopodal shields of this species are not fused, but are separate and partially overlapping. I have examined the holotype of *Z. alter,* and found that it has been somewhat damaged since it was seen by WESTERBOER. As a result of its change in orientation, the metasternal shields are now clearly visible on both sides, and can be seen as completely separate from the endopodals. *Z. alter* is therefore not a species of *Zygoseius*, but of *Lasioseius*. The record of *Zygoseius alter* from India (BHATTACHARYYA, 1969) also clearly refers to a species of *Lasioseius*. CHANT (1963) considered that *Zygoseius* was a subgenus of *Lasioseius*, but his decision was based only on *Z. alter* Vitzthum, and not on the type species of the genus. The illustrations of WESTERBOER (1963) and HYATT (1964) show that *Z. vitzthumi* and *Z. tectus* also have separate metasternal plates. It is therefore clear that *Z. alter*, *Z. vitzthumi* and *Z. tectus* do not agree with BERLESE's original concept of *Zygoseius*, and should all be placed in the genus *Lasioseius* Berlese (Ascidae), as suggested by LINDQUIST & EVANS (1965). The only described species that are correctly placed in *Zygoseius* are *Z. furciger* (Berlese) and *Z. badrii* Hafez and Nasr. MCGREGOR (1956) illustrated an unidentified species of *Zygoseius* from California, under the name *Lasioseius* species (his Plate I, figures 1, 2, 3).

The modern concept of the family Ascidae dates from LINDQUIST & EVANS (1965), who suggested that *Zygoseius* is not an ascid genus at all, but is better placed in the Pachylaelapidae. This suggestion has been adopted by subsequent authors (HAFEZ & NASR, 1982; KRANTZ & AINSCOUGH, 1990), but has not been analysed in detail.

A considerable amount of material belonging to *Zygoseius* has been collected in recent years. The purpose of this paper is not to document and describe every known specimen belonging to the genus, but rather to re-examine some older material, to selectively describe new species as required to stabilise species concepts, and to apply this new information to a consideration of the taxonomic placement of the genus. These descriptions include the first published studies of the immature stages of any *Zygoseius* species.

METHODS

Specimens mounted by me were cleared in Nesbitt's solution and mounted in Hoyer's medium. Colour of specimens refers to those prepared in this way and examined in phase contrast illumination. Measurement of the length of the dorsal shield was taken in the midline, and its width at the level of coxae IV.

The notation used for the dorsal shield setae is that of LINDQUIST & EVANS (1965), and for the leg setae is that of EVANS (1963). The names of spermathecal structures are based on those of ATHIAS-HENRIOT (1968) and EVANS & PURVIS (1987). Abbreviations: ANIC: Australian National Insect Collection, CSIRO Division of Entomology, Canberra. CNC: Canadian National Collection of Insects, Biosystematics Research Centre, Ottawa. ISZA: Istituto Sperimentale Zoologia Agraria, Firenze, Italy. BMNH: Natural History Museum, London. MUBZ: Department of Ecology and Evolutionary Biology, Monash University, Clayton, Victoria, Australia. CSU: Department of Entomology, Colorado State University, Fort Collins.

Zygoseius Berlese

Lasioseius (*Zygoseius*) BERLESE, 1916: 41.
Zygoseius Berlese: SHEALS, 1962: 100; LINDQUIST & EVANS, 1965: 54; KRANTZ & AINSCOUGH, 1990: 642.

Lasioseius (*Zygoseius*) Berlese (in part): WESTERBOER, 1963: 279; HYATT, 1964: 468.

Type species *Z. furciger* (Berlese, 1916), by original designation.

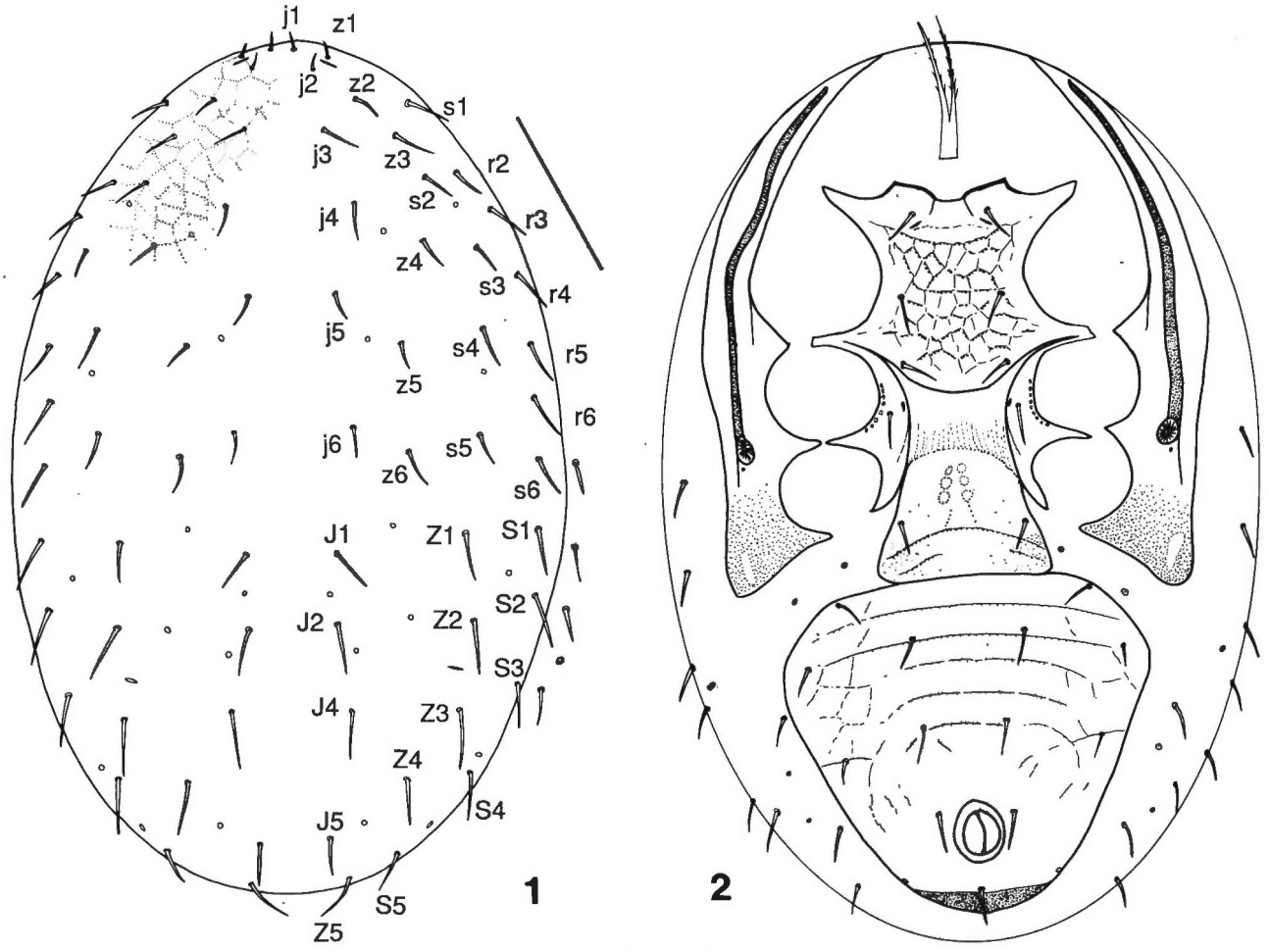
Diagnosis

Monogynaspine podospermal Mesostigmata with a divided dorsal shield in the deutonymph but a single dorsal shield in the adults. Dorsal shield of adult female bearing 37 pairs of setae, including 23 pairs in the anterior region and 14 pairs in the posterior region (J3 absent). Tritosternum with triangular base and 2 long, sparsely pilose laciniae. Presternal shields absent. Sternal shield of female with 3 pairs of setae and 2 pairs of pores, anterior margin of shield heavily sclerotised, with 2 triangular projections, posterior margin convex. Epigynial shield truncate posteriorly, weakly defined and membranous anteriorly, bearing a single pair of epigynial setae, closely abutting a large ventrianal shield. Epigynial pores located off the shield, adjacent to its posterior corners. Metasternal plates fused with endopodal plates to form a complex bearing the metasternal setae and the third pair of sternal pores. Anterior end of metasternal/endopodal shield fused with lateral extensions of sternal shield between coxae II and III. Ventrianal shield bearing 5 pairs of preanal setae and 3 circumanal setae, para-anal setae inserted slightly posterior to the anterior margin of the anal valves. Peritrematal plates wide, fused with exopodal and metapodal plates, extending from the anterior edges of coxae I to project posteriorly behind coxae IV, bearing a pair of poststigmatal pores. Posterolateral interscutal cuticle smooth, with 7 pairs of short setae laterad of the ventrianal shield, and a further 2 pairs between the peritrematal and dorsal shields at the level of coxae IV. Epistome with 2 long lateral processes, medial process absent; palp tarsal claw with 3 well-developed tines; palp trochanter with seta *av* twisted. Pilus dentilis and dorsal cheliceral seta short, fine; arthrodial brush represented by a low rounded flap. Corniculi short, not reaching anterior margin of palp trochanter. Leg chaetotaxy: Leg I: coxa 0 0/1 0/1 0, trochanter 1 0/1 1/2 1, femur 2 3/1 2/3 2, genu 2 3/2 3/1 2, tibia 2 3/2 3/1 2. Leg II: coxa 0 0/1 0/1 0, trochanter 1 0/1 0/2 1, femur 2 3/1 2/2 1, genu 2 3/1 2/1 2, tibia 2 2/1 2/1 2, tarsus 3 3/2 3/2 3 + *mv*, *md*. Leg III: coxa 0 0/1 0/1 0, trochanter 1 1/1 0/2 0, femur 1 2/1 1/0 1, genu 2 2/1 2/1 1, tibia 2 1/1 2/1 1, tarsus 3 3/2 3/2 3 + *mv*, *md*. Leg IV: coxa 0 0/1 0/0 0, trochanter 1 1/1 0/1 1, femur 1 2/1 1/0 1, genu 2 2/1 3/0 1, tibia 2 1/1 2/1 1, tarsus 3 3/2 3/2 3 + *mv*, *md*. Male with sternitigenital, peritrematal, and ventrianal shields fused to form a holoventral shield bearing 13 pairs of setae, the postanal seta, and 6 pairs of pores. Genital aperture at anterior margin of holoventral shield.

Zygoseius furciger (Berlese)

Lasioseius (Zygoseius) furciger BERLESE, 1916: 41.
Zygoseius furciger (Berlese): COSTA, 1963: 36; HYATT, 1964: 470; LINDQUIST & EVANS, 1965: 54; WALTER & IKONEN, 1989: Fig. 2A.
Zygoseius sp. cf. *furciger* (Berlese): ATHIAS-HENRIOT, 1968 (in part, Fig. 106 only).
Lasioseius (Zygoseius) furciger Berlese: WESTERBOER, 1963: 279.
Zygoseius badrii HAFEZ & NASR, 1982: 3. NEW SYNONYMY.

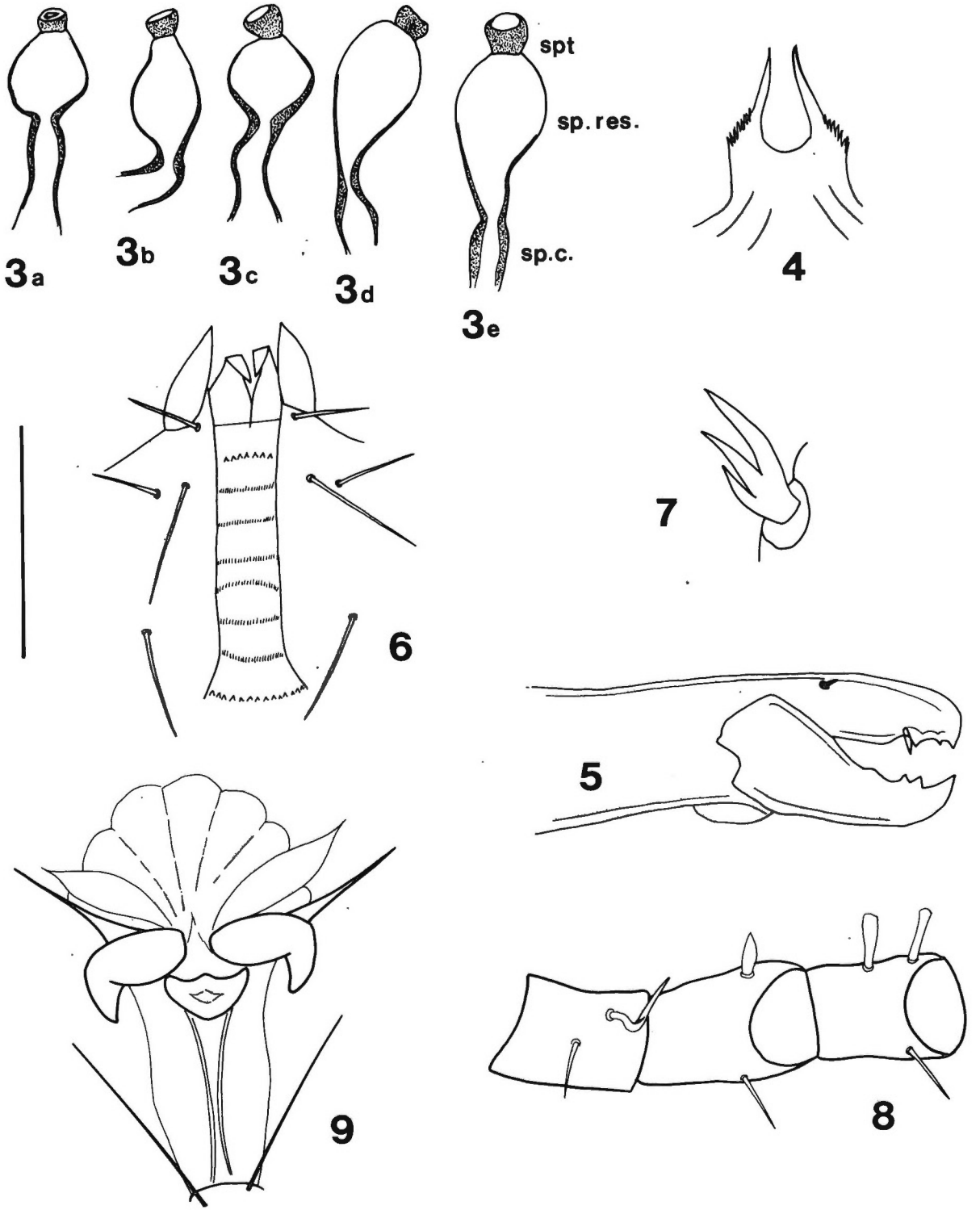
Material examined: USA: CALIFORNIA, 2 females, Bolinas, 24.iii.1960, R. O. SCHUSTER coll.; 1 female, LaGrange, 7.iii.1960, R. P. ALLEN coll., oak litter; 1 female, Pinnacles National Monument, 23.ii.1957, G. A. MARSH coll.; 1 female, 2 males, University of California, Riverside, 10.v.1958, F. RANEY coll. (CNC). COLORADO, 10 females, 15 males, 8 DN, 4 PN, 4 LV, from laboratory culture, origin Troublesome Pass, 24.ix.1987, D. E. WALTER coll. (ANIC, CSU). ISRAEL: 2 females, Oranim (Kiryat-Tivon, 20 km SE of Haifa), 4.i.1962, M. COSTA coll., manure heap, "1968.1.26:8" (BMNH). EGYPT: 5 females, 2 males, Cairo, in soil, 14.iv.1985 (Cairo University, Egypt). SOUTH AFRICA: 1 female, "Shoopkraal/Landb. Kol./ 1.7.52/Potch." [= Potchefstroom?] (BMNH). The specimens from California were compared to the syntypes of *Z. furciger* in ISZA by E. E. LINDQUIST, and were found to be indistinguishable from them (personal communication, 1991). The types were collected at Olavaria, Buenos Aires, and La Plata, Argentina, in ants' nests. I have examined photographs of these syntypes, taken by Dr. F. PEGAZZANO.



FIGS. 1-2: *Zygoseius furciger* (Berlese). Female.
1. — Dorsal shield. 2. — Ventral idiosoma. Scale bar = 100 μm.

Female: Colour yellow/brown. Dorsal shield (Fig. 1): Oval shaped, length 418-518 μm, maximum width 260-329 μm (n=15). Margins of shield smooth, surface with very faint punctate ornamentation forming a weak polygonal network, indistinct medially. Shield carrying 37 pairs of smooth, pointed setae (23 podonotal, 14 opisthonotal), and approximately 14 pairs of pores. Opisthonotal setae slightly longer and thicker than podonotal setae.

Ventral idiosoma (Fig. 2): Sternal shield ornamented with polygonal network of fine lines, lines defining polygons with puncta along their posterior edges only, interior of polygons smooth. Ornamentation very weak around bases of setae; a pair of more distinct lines runs obliquely from lateral corners of shield anterior to second pair of pores. Epigynial shield with very slight punctation in the posterolateral corners and a curved transverse punctate line behind epigynial setae. Metasternal/endopodal plates carrying smooth, pointed metasternal setae, a pair of lyriform pores, and a curved row of approximately 10 indistinct puncta adjacent to coxa III. Ventrianal shield trapezoidal, slightly wider than long, length 150-192 μm, width 168-210 μm (n=5), ornamented throughout with very fine even punctation. Superimposed on this punctation is a series of faint transverse lines, punctate on their posterior edges. Laterally these transverse lines connected by shorter diagonal or longitudinal lines, to form irregular polygons. Shield carrying 5 pairs of preanal setae, 2 central pairs much longer than those near shield margins, all smooth and pointed. Integument laterad of ventri-



FIGS. 3-9: *Zygoseius furciger* (Berlese). Female.

3. — Spermathecal apparatus: sp.c = spermatic canal; sp.res = sperm reservoir; spt = spermatheca. 3a-3c, specimens from Troublesome Pass, Colorado; 3d, specimen from Bolinas, California; 3e, syntype from La Plata, Argentina. 4. — Epistome. 5. — Chelicera. 6. — Hypostome. 7. — Palp tarsal claw. 8. — Palp trochanter, femur and genu. 9. — Pretarsus II. Scale bar = 50 μm for 3, 4, 6, 8; 25 μm for 5, 7, 9.

anal shield with 2 pairs of smooth setae close to shield and a row of 7 setae extending from level of stigma to level of postanal seta.

Sacculus foemineus unsclerotised, not visible in cleared specimens, fed by 2 adductor canals leading from posterior margins of coxae III. Spermatic canal long and narrow with thick walls, constricted distally, opening into an elongate oval-shaped sperm reservoir and a sessile cup-shaped spermatheca, shape of sperm reservoir somewhat variable depending on orientation (Fig. 3).

Gnathosoma: Epistome with 2 long anteriorly directed lateral points, which vary from smooth to slightly serrated, and serrated lateral margins, medial process absent (Fig. 4). Fixed digit of chelicera with 2 large teeth, a minute distal tooth, and a terminal hook. Movable digit with a low, blunt proximal tooth, a bidentate distal tooth, and a terminal hook (Fig. 5). Hypostome with 8 transverse rows of denticles, 12-15 denticles each, the posterior row widest and having the coarsest denticles (Fig. 6). Internal malae triangular, smooth, folded ventrally. Palp chaetotaxy: trochanter 0 0/1 0/1 0, femur 1 2/0 1/0 1, genu 2 2/0 1/0 1, tibia 3 3/1 3/1 3. Seta *av* on palp trochanter twisted to form one turn of a corkscrew. Seta *al*1 on palp femur and *al*1 and *al*2 on palp genu expanded and spatulate distally, all other palp setae fine, smooth, pointed (Fig. 8). Palp tarsal claw with 3 fully developed tines (Fig. 7).

Legs: On tarsi II, III, IV, setae *al*1, *pl*1, *av*1, *pv*1 are short, thick, and spine like. All other leg setae fine, smooth, pointed; legs without spurs or protuberances. Pretarsi I-IV each with a pair of strongly sclerotised claws, a membranous pulvillus with a rounded median lobe and a pair of longer, pointed lateral lobes, and a pair of narrow, pointed operculi which project slightly beyond the claws (Fig. 9).

Male: Colour yellow/brown. Dorsal shield: Oval shaped, length 342-389 µm, maximum width 206-229 µm (n=12); structure and chaetotaxy as for female.

Ventral idiosoma (Fig. 10): Holoventral shield ornamented with a faint polygonal pattern anteriorly, punctate areas posterior to stigmata and surrounding anus, and weak transverse lines posterior to coxae IV.

Gnathosoma: Cheliceral digits each with one tooth and a terminal hook (Fig. 11). Movable digit greatly expanded basally, with a longitudinal rib contiguous with the proximal margin of the tooth. Spermatodactyl slightly longer than cheliceral digits, basally broad, with a complex fusion to the base of the movable digit, sinuous, attenuating at the tip. Other features of gnathosoma as for female.

Leg chaetotaxy and pretarsi as for female. Femur II with a small rounded ventral protuberance between setae *av* and *pv*1, other leg segments unarmed.

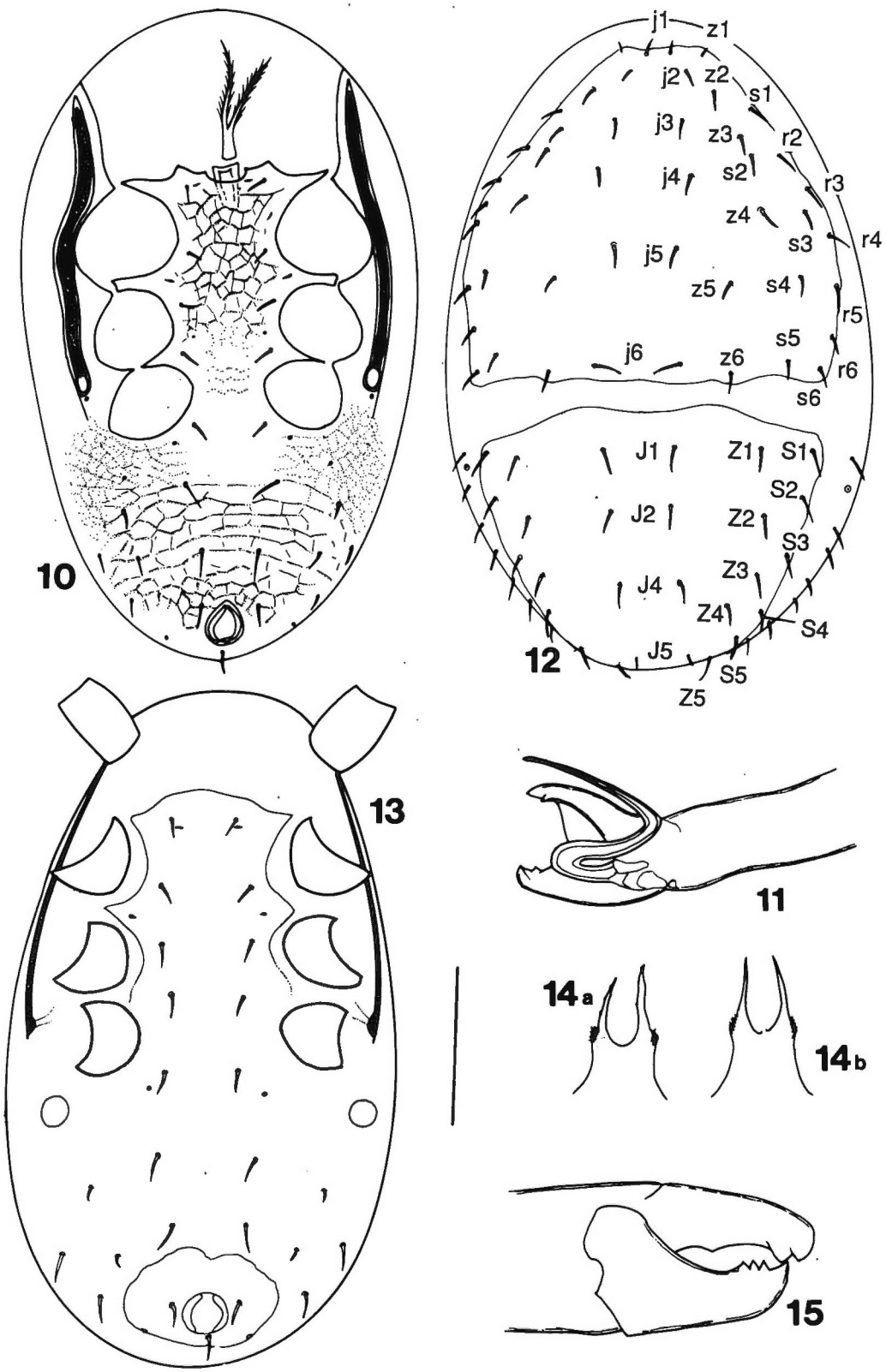
Deutonymph: Colour white, semitransparent. Length of idiosoma 352-387 µm, maximum width 197-245 µm (n=7). Dorsal surface weakly sclerotised and unornamented, with 2 distinct shields (Fig. 12); podonotal shield with 23 pairs of setae, opisthonotal shield with 14 pairs, all smooth and pointed.

Ventral idiosoma (Fig. 13): Tritosternum as in adult. Sternal shield very weakly sclerotised and unornamented, anterior margin barely discernible, lateral margins more distinct, posterior margin not discernible; metasternal and epigynial area not visibly sclerotised; metapodal plates and anal plate weakly sclerotised, peritrematal plate not sclerotised. Ventral idiosoma with 12 pairs of setae and the 3 circumanal setae; 3 pairs posterior to coxae IV conspicuously shorter than remaining setae.

Gnathosoma: Epistome with 2 long, smooth anterior points and serrated lateral margins (Fig. 14a). Three of the 6 specimens in which the epistome is clearly visible have in addition a short, smooth median point (Fig. 14b). Fixed digit of chelicera with one large triangular tooth and a terminal hook, movable digit with 3 smaller triangular teeth and a terminal hook (Fig. 15). Palp as for adult female, except seta *av* on palp trochanter short and straight, not twisted. Other features of gnathosoma as for adult female.

Legs: Structure and chaetotaxy as for adult female.

Protonymph: Colour white, semitransparent. Length of idiosoma 247-276 µm (n=4). Dorsal idiosoma (Fig. 16) with a weakly sclerotised podonotal shield carrying 11 pairs of setae (j1-j6, z2, z4, z5, s2, s4), and a small, more strongly sclerotised pygidial shield, with an irregular anterior margin, carrying 6 pairs of setae (J4, J5, Z3, Z4, Z5, S4), S5 displaced slightly to a ventroterminal position. Interscutal membrane with 9 pairs of setae and 2 pairs of weakly sclerotised platelets.

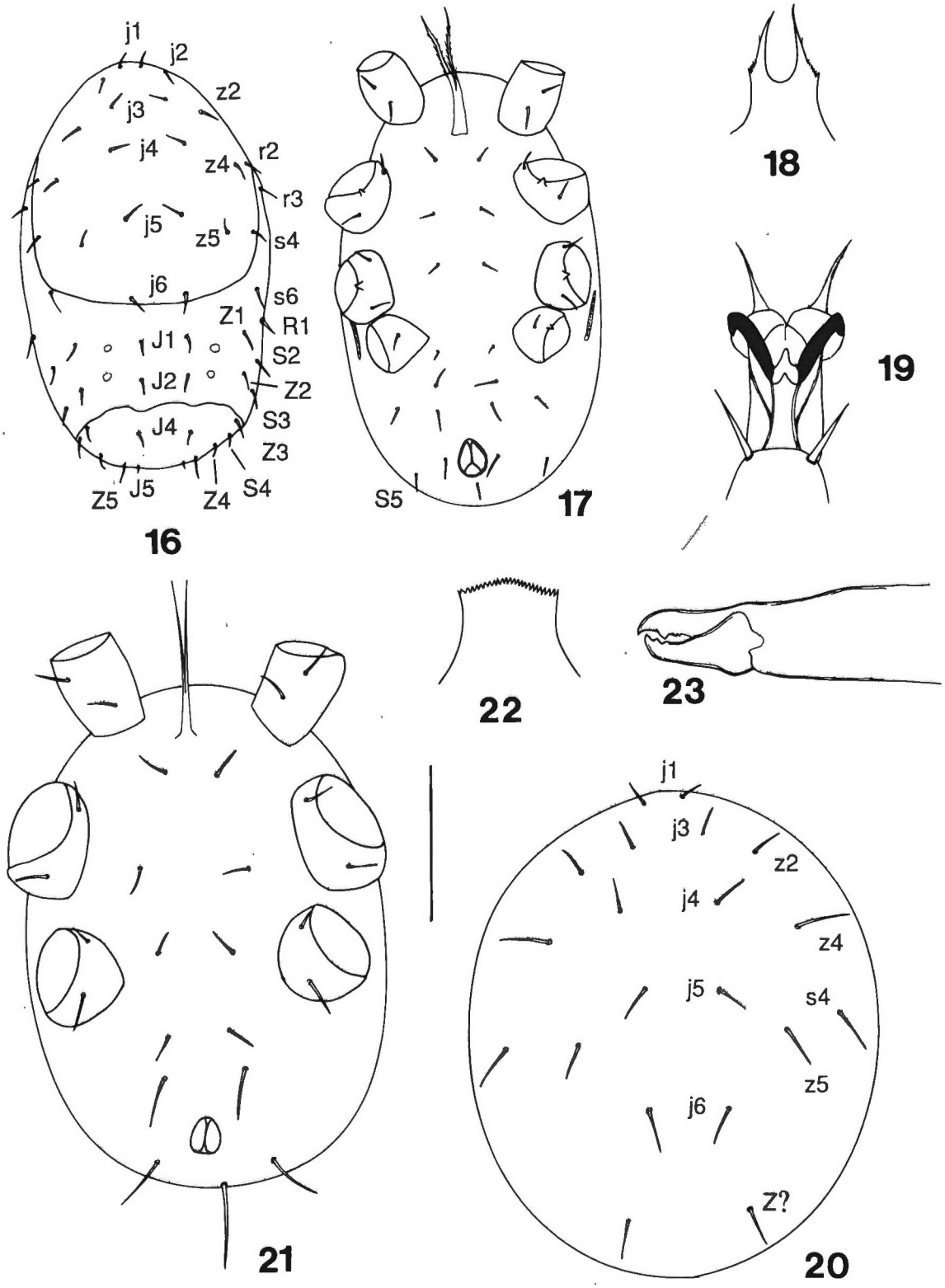


FIGS. 10-11. *Zygoseius furciger* (Berlese). Male.

10. — Ventral idiosoma. 11. — Chelicera.

FIGS. 12-15. *Zygoseius furciger* (Berlese). Deutonymph.

12. — Dorsal idiosoma. 13. — Ventral idiosoma. 14a-14b. — Epistomes from two different specimens. 15. — Chelicera. Scale bar = 100 µm for 10, 12, 13; 75 µm for 11; 40 µm for 14; 20 µm for 15.



FIGS. 16-23. *Zygoseius furciger* (Berlese).

16-19. Protonymph. 16. — Dorsal idiosoma. 17. — Ventral idiosoma. 18. — Epistome. 19. — Pre-tarsus. 20-23. Larva. 20. — Dorsal idiosoma. 21. — Ventral idiosoma. 22. — Epistome. 23. — Chelicera. Scale bar = 100 µm for 16, 17; 30 µm for 18, 23; 15 µm for 19; 65 µm for 20, 21.

Ventral idiosoma (Fig. 17) without discernible sclerites, with 9 pairs of setae and the postanal seta, all setae short, smooth, pointed; fourth pair of setae substantially shorter than other pairs. Peritreme short, extending from the level of the middle of coxa IV to the level of the middle of coxa III.

Gnathosoma: Epistome like that of deutonymph, but finer and with lateral serrations less distinct (Fig 18). Other features of gnathosoma not discernible in available specimens.

Legs: Chaetotaxy: Leg I: coxa 0 0/1 0/1 0, trochanter 1 0/1 0/1 1, femur 2 2/1 2/2 1, genu 1 2/1 2/1 1, tibia 1 3/1 2/1 1. Leg II: coxa 0 0/1 0/1 0, trochanter 1 0/1 0/1 1, femur 1 2/1 2/1 1, genu 1 2/0 2/0 1, tibia 1 1/1 2/1 1, tarsus 3 3/2 3/2 3 + *md*. Leg III: coxa 0 0/1 0/1 0, trochanter 1 0/1 0/1 1, femur 1 2/1 1/0 0, genu 1 2/0 2/0 1, tibia 1 1/1 2/1 1, tarsus 3 3/2 3/2 3 + *md*. Leg IV: coxa 0 0/1 0/0 0, trochanter 1 0/1 0/2 0, femur 1 2/0 1/0 0, genu 1 2/0 2/0 0, tibia 1 1/1 2/1 1, tarsus 3 3/2 3/2 3 + *md*. Pretarsi I-IV each with a pair of sclerotised claws, a membranous pulvillus with a small rounded median lobe and a pair of larger rounded lateral lobes, and a pair of long pointed opercula (Fig 19); pretarsus I conspicuously smaller than II-IV.

Larva: Colour white, semitransparent, unsclerotised. Length of idiosoma 192-250 µm, maximum width 145-171 µm. Dorsal idiosoma with 10 pairs of short setae (Fig. 20), apparently with only 1 pair of opisthonotal setae, probably a member of the Z series. Ventral idiosoma unsclerotised, with 6 pairs of setae and the postanal seta, postanal seta conspicuously longer than others; tritosternum very fine, laciniae smooth (Fig. 21). Epistome with a serrated convex anterior edge and smooth lateral margins (Fig. 22). Fixed digit of chelicera with 3 small teeth, a large distal tooth, and a terminal hook. Movable digit with 2 low blunt teeth and a terminal hook (Fig. 23). Palp tarsal claw 3 tined.

Legs: Chaetotaxy: Leg I: Coxa 0 0/1 0/1 0, trochanter 1 0/1 0/1 1, femur 2 2/1 2/2 1, genu 1 2/1 2/1 1, tibia 1 2/1 2/1 1, tarsus 3 3/2 3/2 3. Leg II: coxa 0 0/1 0/1 1, trochanter 1 0/1 0/1 1, femur 1 2/0 2/1 1, genu 1 2/0 2/0 1, tibia 1 1/1 2/1 1, tarsus 3 3/2 3/2 3. Leg III: Coxa 0 0/1 0/1 0, trochanter 1 0/1 0/1 1, femur 1 2/1 1/0 0, genu 1 2/0 2/0 1, tibia 1 1/0 2/1 1, tarsus 3 3/2 3/2 3.

Remarks: My attempts to obtain the type specimens of *Z. badrii* were unsuccessful, so my observations on this species are based on topotypic material. The description of *Z. badrii* given by HAFEZ & NASR (1982) states that tibia IV bears 3 posterodorsal setae. In all the specimens I have examined, including those from the type locality of this species, this segment bears 1 anterodorsal seta and 2 posterodorsals, although the anterior-posterior separation of these setae is admittedly very slight. The chaetotaxy of the remaining leg segments of *Z. badrii* is the same as for *Z. furciger*. HAFEZ & NASR illustrate, but do not describe, a protuberance or spur on femur II of the female of *Z. badrii*. This structure is not visible on any of the specimens examined here. The distinguishing features of this species as given by HAFEZ & NASR are those of the genus and not the species, and I have been unable to distinguish the Cairo specimens from *Z. furciger* from Argentina or USA.

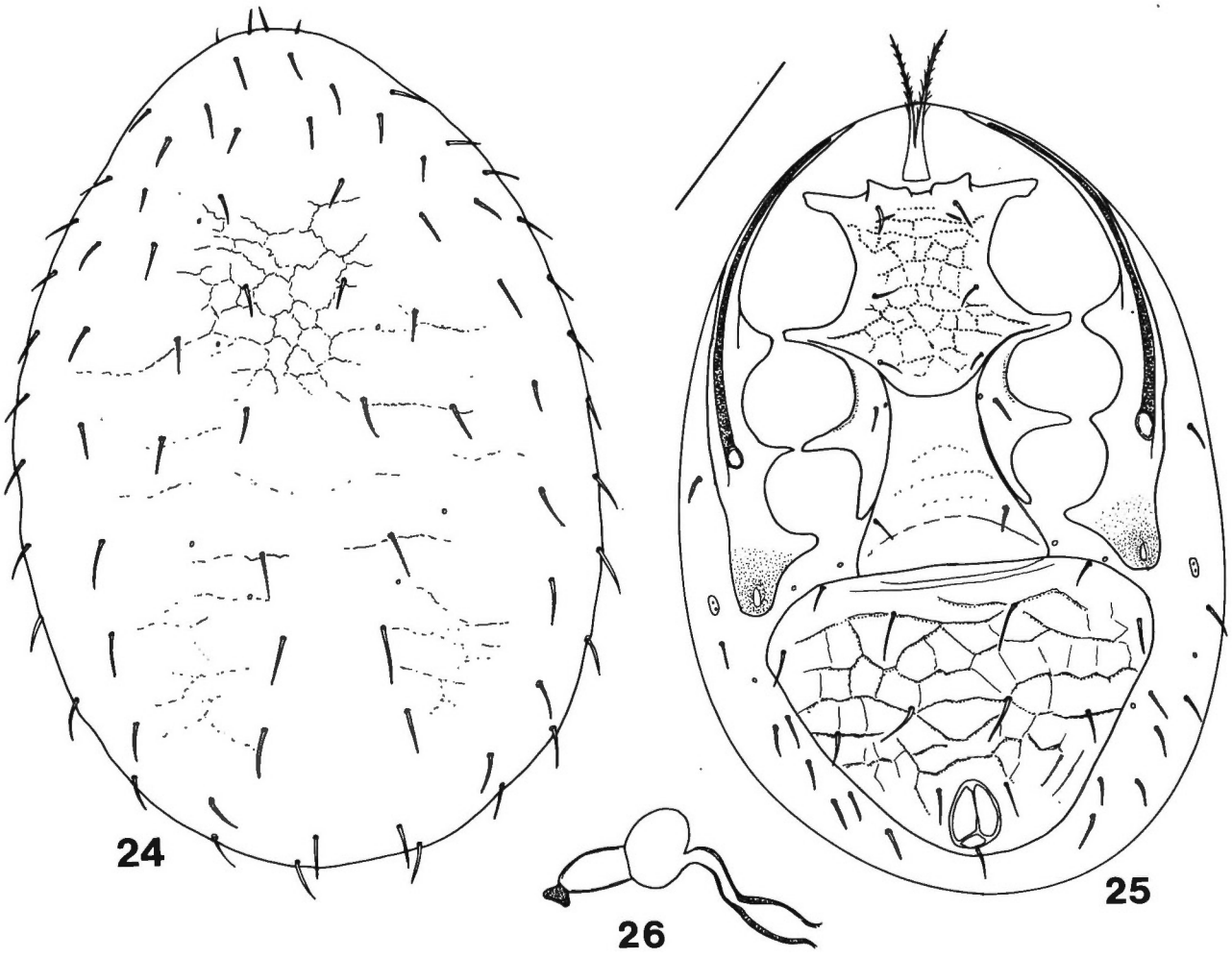
The record of *Z. furciger* from Angostura River, Argentina (SHEALS, 1962) is here considered to refer to a mixture of *Z. ampullus* sp. nov. and *Z. metoecus* sp. nov. ATHIAS-HENRIOT (1968) illustrated 2 different sets of spermathecal structures of "*Zygoseius* spp.", from Argentina. Her figure 106 is that of *Z. furciger*, and her figure 105 is that of *Z. ampullus* sp. nov.

Zygoseius ampullus sp. nov.

Zygoseius sp. cf. *furciger*: ATHIAS-HENRIOT, 1968 (in part, Fig. 105 only).
Zygoseius furciger (Berlese): SHEALS, 1962: 100 (in part).

Material examined: *Holotype* female and 5 paratype females, ARGENTINA, Quebrada de la Angostura, nr River Angostura, 28.i.1956, P. WYGODZYNSKY coll., in rotting vegetation (*Alnus* leaves) (BMNH).

Female: Colour brown. Dorsal shield (Fig. 24) oval shaped, length 405-444 µm, maximum width 271-308 µm (n=6). Anterior margins of shield smooth, lateral margins slightly dentate, posterolateral margins more distinctly dentate; surface of shield with indistinct polygonal ornamentation medially and a few weak transverse ridges, otherwise very weakly punctate. Shield with 37 pairs of smooth pointed



FIGS. 24-26. *Zygoseius ampullus* sp. nov. Female.
24. — Dorsal shield. 25. — Ventral idiosoma. 26. — Spermathecal apparatus. Scale bar = 100 µm for 24, 25; 40 µm for 26.

setae and approximately 12 pairs of pores. Opisthonotal setae longer and thicker than podonotal setae.

Ventral idiosoma (Fig. 25): Structure and arrangement of sclerites as described for genus. Sternal shield ornamented with a pattern of irregular polygons, very weakly defined except for their punctate anterior borders; a pair of slightly stronger punctate lines lead inward from the lateral corners of the shield through the second pair of sternal pores. Ventrianal shield wider than long, length 142-160 µm, width 184-213 µm (n=4), ornamented with distinct curved transverse lines and weaker longitudinal and oblique lines; a pair of very distinct lines projects inward from the margins of the shield through bases of posterior pair of preanal setae.

Sacculus foemineus not visible, spermatic canal long, narrow and thick walled, opening into a bottle-shaped sperm reservoir with a small sessile kidney-shaped spermatheca (Fig. 26).

Gnathosoma and legs as for *Z. furciger*.

Male and juveniles unknown.

Remarks: *Z. ampullus* may be recognised by the distinctive shape of its spermathecal structures, in which the sperm reservoir is distinctly subdivided

into a globular basal part and a cylindrical neck leading to the spermatheca. The specimens examined for this species and the next were borrowed from BMNH, and were referred to by SHEALS (1962) as *Zygoseius furciger* Berlese. The BMNH material comprised 2 vials of specimens in alcohol. The first was labelled "1956.1 28.22-25 (part)/*Zygoseius furciger* Berl., 2 females/Loc. Quebrada de la Angostura,/Argentina. Rotting vegetation/Coll. P. WYGODZYNSKY. Det. G. O. E[VANS]." This vial proved to contain 2 females of *Z. ampullus* sp. nov. The second vial was labelled "1956.1.28.22-25/*Zygoseius furciger* Berl., 1 male, 3 females/Loc. Rotting vegetation (*Alnus*/leaves). Quebrada de la Angostura/1800 m nr River Angostura, Argentina/Coll. Dr. P. WYGODZYNSKY. Det. G. O. E[VANS]." This vial contained 4 females of *Z. ampullus* sp. nov. and 4 females of *Z. metoecus* sp. nov. Note that the material from this locality does not contain any specimens of *Z. furciger*, nor any males. I have not had the opportunity to examine the specimens referred to by SHEALS from "Nahuel Huapi B". It is not clear which specimens were used by SHEALS as the basis for his illustrations, but they could be genuine *Z. furciger*.

Ventral idiosoma (Fig. 28): Structure and arrangement of sclerites as described for genus. Sternal shield ornamented with a series of irregular circular to oval shaped depressions, anterior margins of these depressions more distinct than posterior margins; a distinct row of 5-6 such markings occurs just inside the posterior margin of the shield. Endopodal/metasternal plates with 4 large puncta. Ventrianal shield wider than long, length 113-126 µm, width 139-166 µm (n=4), ornamented with distinct curved transverse lines and weaker longitudinal and oblique lines; a pair of very distinct lines projects inward from margins of shield through bases of most posterior pair of ventrianal setae.

Sacculus foeminus not visible, spermatic canal wide basally, long, thick walled, opening into a globular sperm reservoir with a small kidney-shaped spermatheca on a short stalk (Fig. 29).

Gnathosoma and legs as for *Z. furciger*.

Male and juveniles unknown.

Remarks: *Z. metoecus* may be distinguished from all the other species considered here by its small size, distinctive sternal shield ornamentation, and the structure of the spermathecal apparatus.

Zygoseius metoecus sp. nov.

Zygoseius furciger Berlese: SHEALS, 1962: 100 (in part).

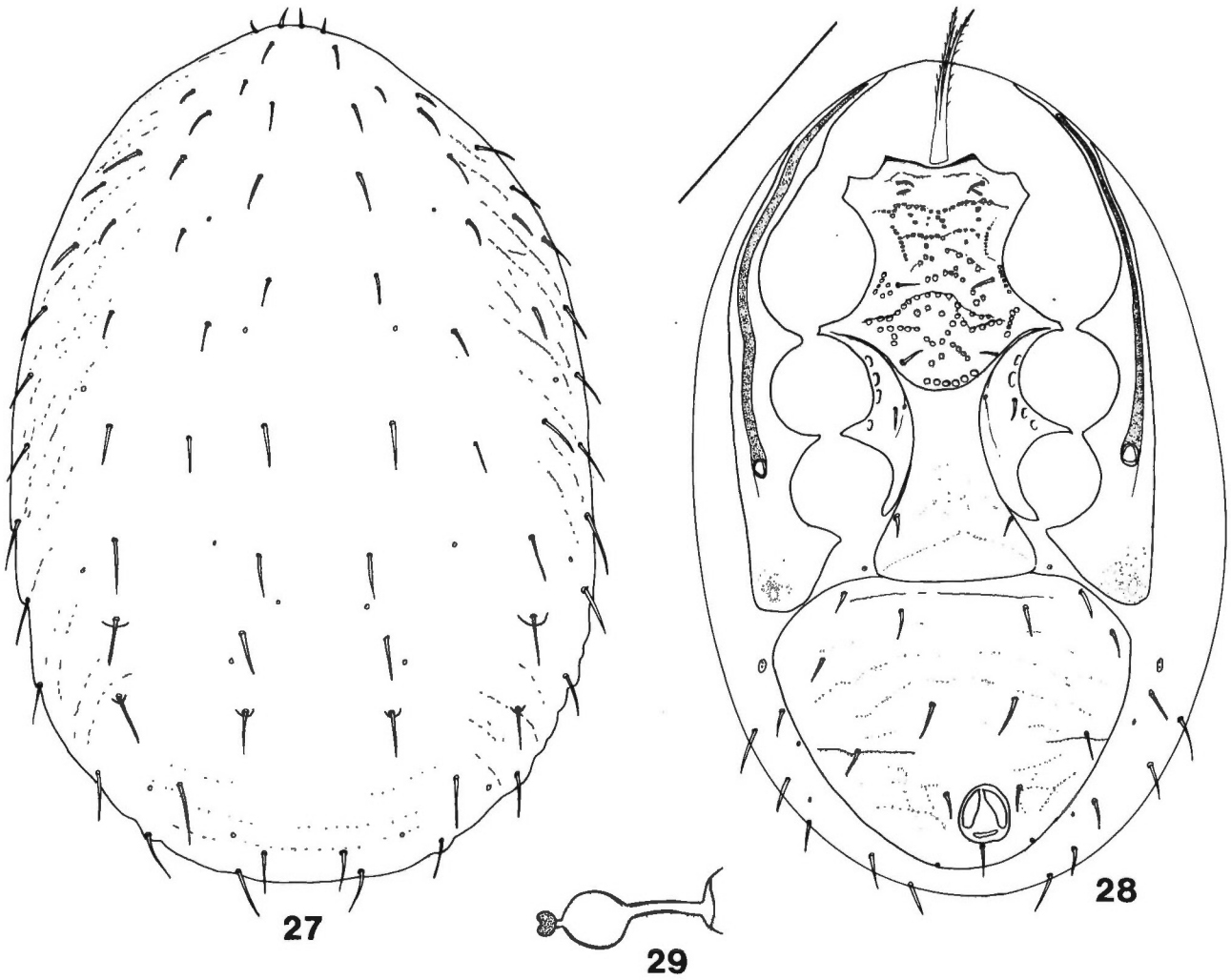
Material examined: *Holotype* female and 3 paratype females, ARGENTINA, Quebrada de la Angostura, nr River Angostura, alt. 1800 m, rotting vegetation, (*Alnus* leaves), coll. P. WYGODZYNSKY, 1956.1.28.22-25 (BMNH). The specimens were identified by G. O. E[VANS] as *Zygoseius furciger* Berl.

Female: Colour yellow. Dorsal shield (Fig. 27): Oval shaped, length 329-355 µm, maximum width 200-234 µm (n=4). Anterior margin of shield smooth, lateral and posterolateral margins dentate; surface of shield smooth except for weak punctate ornamentation; ornamentation weakest medially and strongest posterolaterally. Shield with 37 pairs of smooth pointed setae and approximately 12 pairs of pores. Opisthonotal setae longer and thicker than podonotal setae.

Zygoseius sarcinulus sp. nov.

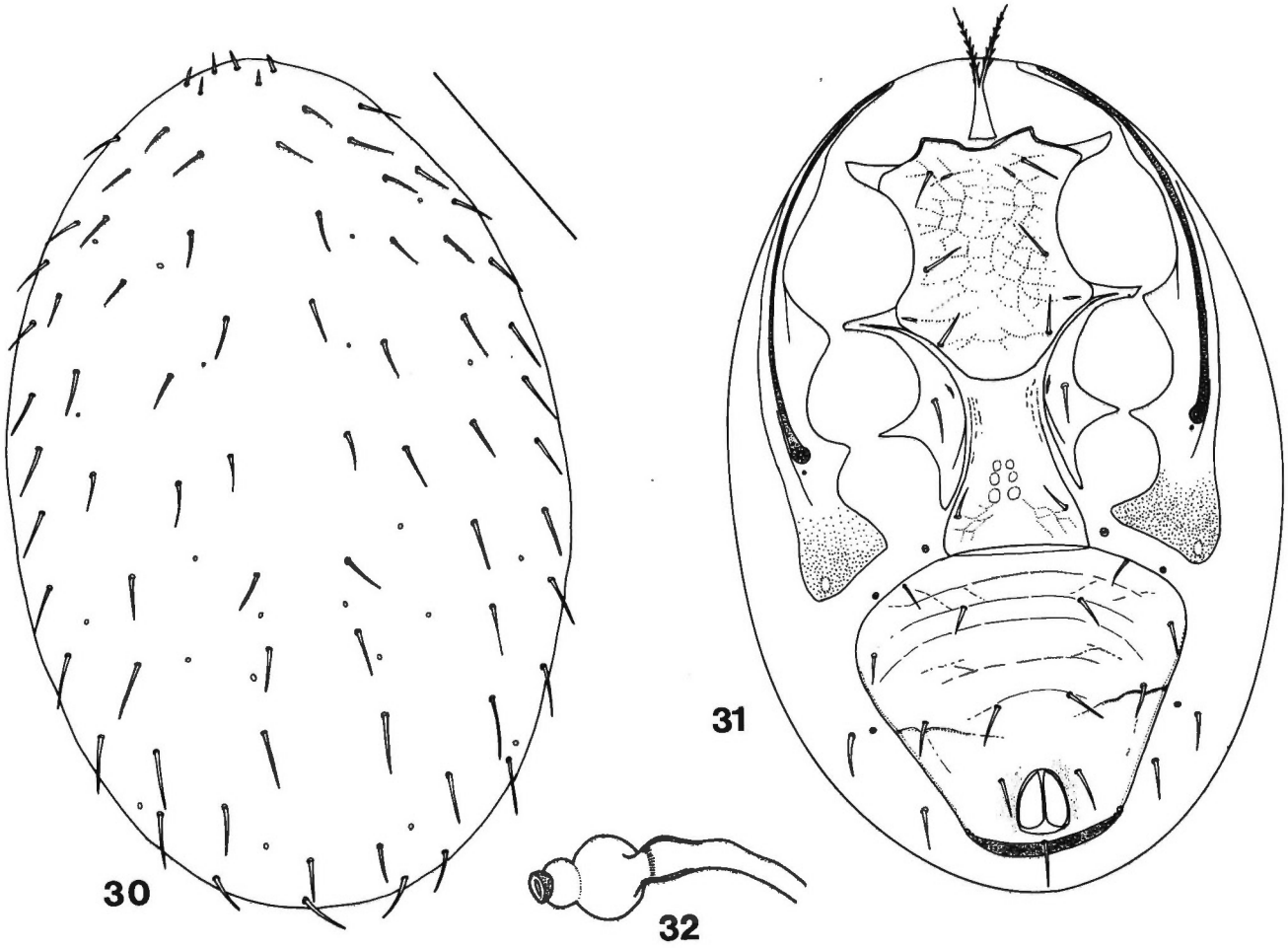
Zygoseius sp.: RIDSDILL-SMITH & HALL, 1984: Tables 1-4.

Material examined: *Holotype*: Female, AUSTRALIA, AUSTRALIAN CAPITAL TERRITORY, Uriarra, 25 km west of Canberra, 30.x.1979, in dung, M. TYNDALE-BISCOE coll. The specimen formed part of an ecological experiment, from which it bears the reference number DBF42(03)11. *Paratypes*: AUSTRALIAN CAPITAL TERRITORY: 6 females, same data as holotype; 10 females, Uriarra, 9.xi.1976, on *Onthophagus granulatus* flying to cow dung, M. M. H. WALLACE and E. HOLM coll.; 1 female, Uriarra, 11.xi.1976; 2 females, Uriarra, 21.vi.1978, in dung, E. HOLM coll.; NEW SOUTH WALES: 2 females, Kemp Creek, 24.vi.1977, K. BAILEY coll.; 1 female, Narrabri, 26.x.1976, in cow dung, M. TYNDALE-BISCOE coll.; 1 female, Durras Lake, 24.xii.1964, on *Onthophagus tabellifer*, G. F. BORNEMISSZA coll.; 9



FIGS. 27-29. *Zygoseius metoecus* sp. nov. Female.
27. — Dorsal shield. 28. — Ventral idiosoma. 29. — Spermathecal apparatus. Scale bar = 100 μm for 27, 28; 40 μm for 29.

females, Corowa, 12.xi.1950, on *Onthophagus pentacanthus*, J. CALABY coll.; 3 females, Putty, 14.iv.1965, on *Onthophagus tenebrosus*, G. F. BORNEMISSZA and G. A. YAPP coll.; 1 female, Kincumber, 31.v.1983, in soil with dung beetles, R. SMITH coll.; 1 female, Picton, no date, on *Onthophagus leai*, H. DAVIDSON coll.; 2 females, 35 km south of Dubbo, 30.x.1976, R. D. HUGHES and M. TYNDALE-BISCOE coll.; 11 females, 1 male, 4 km south of Dubbo, 30.x.1976, R. D. HUGHES and M. TYNDALE-BISCOE coll.; 2 females, 20 km south of Wellington, 30.x.1976, R. D. HUGHES and M. TYNDALE-BISCOE coll. QUEENSLAND: 1 female, Somerset Dam, 29.i.1971, on *Onthophagus leanus*, R. KOHOUT coll.; 2 females, Craighoyle (30 km north of Rockhampton), 11.xii.1984, dung-baited trap, A. MACQUEEN coll.; 2 females, Craighoyle (ditto), 7.iii.1984, dung-baited trap, A. MACQUEEN coll. SOUTH AUSTRALIA: 2 females, 10 km east of Padthaway, 1.x.1976, on *Onthophagus mniszechi* in cow dung, J. FEEHAN and S. RUNKO coll.TASMANIA: 2 females, Mt. Nelson, Hobart, 12.ii.1980., on *Aphodius* sp., G. F. BORNEMISSZA coll.VICTORIA: 2 females, 5 km north of Sale, 28.ix.1976, on *Onthophagus australis* flying to sheep dung, J. FEEHAN and S.



FIGS. 30-32. *Zygoseius sarcinulus* sp. nov. Female.
30. — Dorsal shield. 31. — Ventral idiosoma. 32. — Spermathecal apparatus. Scale bar = 100 μm for 30, 31; 40 μm for 32.

RUNKO coll.; 2 females, 2 males, Monash University, Clayton, 10.iv.1991, in chicken dung and sawdust, D. E. WALTER and M. MANNING coll.; 2 females, 1 male, same locality, 7.x.1991, aged cow dung, D. E. WALTER; 1 female, Frankston, 15.iv.1991, in bagged compost, D. E. WALTER coll.; 7 females, 14 males, Frankston, 11. vi. 1991, compost, D. E. WALTER; 3 females, 5 males, Melbourne, from lab culture based on specimens from compost, D. E. WALTER coll. WESTERN AUSTRALIA: 5 females, Dardanup, 18.x.1977, dung-baited trap, J. RIDSDILL-SMITH coll.; 1 female, Dardanup, 19.vii.1979, dung-baited trap, J. RIDSDILL-SMITH coll.; 1 female, Dardanup, 4.x.1979, dung-baited trap, J. RIDSDILL-SMITH coll.; 1 female, Dardanup, 17.ix.1979, dung-baited trap, J. RIDSDILL-SMITH coll.; 1 female, De Grey, near Goldsworthy, vi.1977; 5 females, 15 km east of Geraldton, 21.viii.1979 to 19.ix.1979, dung-baited trap, J. MATTHIESSEN coll.; 3 females, 15 km south of Busselton, 12.vii.1979 to 6.xii.1979, dung-baited trap, G. P. HALL coll.; 1 female, 15 km south of Busselton, 16.viii.1979, on *Onthophagus ferox*, G. P. HALL coll.; 4 females, Yathroo, 16.ix.1980; 1 female, Cunderdin, 24.viii.1978, G. P. HALL coll.; 1 female, 4 km west of Armadale, 10.viii.1978, G. P. HALL coll. All localities are in Australia. (Holotype and paratypes in ANIC, paratypes in CNC, ISZA, BMNH, MUBZ.)

Female: Colour yellow/brown. Dorsal shield (Fig. 30): Oval shaped, length 355-429 µm, maximum width 200-247 µm (n=14). Structure and chaetotaxy as described for genus.

Ventral idiosoma (Fig. 31): Structure and chaetotaxy of ventral sclerites as described for genus. Metasternal/endopodal plates unornamented except for a faint line extending posteriorly from near metasternal pore. Ventrianal shield trapezoidal, slightly wider than long, length 113-150 µm, width 139-168 µm (n=14).

Sacculus foemineus not visible, spermatic canal long, thick walled, opening into a double-chambered globular sperm reservoir, with a small sessile cup-shaped spermatheca (Fig. 32). Tubuli annulati and their points of insertion not visible in any of the available specimens. Many females contain a single large egg, smoothly oval in shape, slightly larger than the ventrianal shield.

Gnathosoma and legs as for *Z. furciger*.

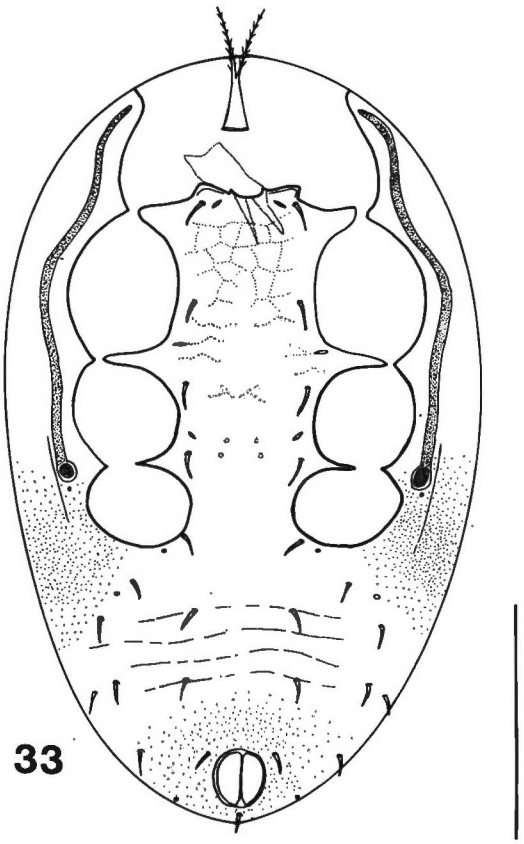
Male: Colour yellow/brown. Dorsal shield: Oval shaped, length 295 µm, maximum width 150 µm (n=1); structure and chaetotaxy as for female.

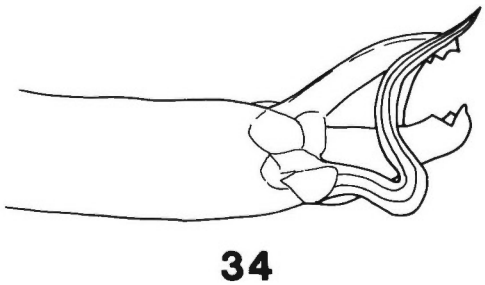
Ventral idiosoma (Fig. 33): Holoventral shield ornamented with a faint polygonal pattern anteriorly, punctate areas posterior to the stigmata and surrounding the anus, and weak transverse lines posterior to coxae IV.

Gnathosoma: Cheliceral digits each with one tooth and a terminal hook (Fig. 34). Movable digit greatly expanded basally, with a longitudinal rib contiguous with the proximal margin of the tooth. Spermatodactyl slightly longer than cheliceral digits, basally broad, with a complex fusion to the base of the movable digit, sinuous, attenuating at the tip. Other features of gnathosoma as for female.

Leg chaetotaxy and pretarsi as for female. Femur II with a small rounded ventral protuberance between setae *av* and *pv*1, other leg segments unarmed.

Remarks: All the Australian specimens of *Z. sarcinulus* for which biological information is available have been collected in dung, in dung-baited pitfall traps, compost heaps, or were phoretic on dung beetles — *Onthophagus granulatus* Boheman, *O. tabellifer* Gillet, *O. pentacanthus* Harold, *O. leai* Blackburn, *O. tenebrosus* Harold, *O. leanus* Goidanich, *O. mniszechi* Harold, *O. australis* Guerin, *O. ferox* Harold, and a





33. — Ventral idiosoma. 34. — Chelicera. Scale bar = 100 µm for 33; 40 µm for 34.

species of *Aphodius* (Coleoptera: Scarabaeidae). The phoretic specimens were all adult females, and were found around the anterior coxae of the beetles, attached by grasping the beetles' hairs in their chelicerae. This is the only species in the genus that is known to practise phoresy. RIDSDILL-SMITH & HALL (1984) reported large numbers of *Zygoseius* sp., here identified as *Z. sarcinulus*, in dung-baited traps in southern Western Australia. Largest numbers of specimens were obtained in August and September, coincident

with large catches of *Aphodius pseudolividus* and *Onthophagus* spp. (Scarabaeidae).

Z. sarcinulus may be recognised by its phoresy, by the fact that it appears to be endemic to Australia, and by the formation of the spermatheca into a globular, double-chambered sac. Also, *Z. sarcinulus* is considerably more slender than *Z. furciger* — the width of the dorsal shield of *Z. sarcinulus* never exceeded 250 µm in the available specimens, while that of *Z. furciger* was never less than 260 µm. The pattern of ornamentation of the sternal shield of *Z. sarcinulus* exhibits intra-species variation. Some specimens have smooth crescentic areas at the lateral edges of the sternal shield, while others have very weak ornamentation throughout the shield, or weak ornamentation medially. The lines that delimit the polygonal fields on the shield vary in their degree of distinctness and punctation. This type of variation also occurs in *Z. furciger*, making the sternal ornamentation an unreliable character for species discrimination.

Discussion

The genus *Zygoseius* now comprises 4 described species — *Z. furciger* from Argentina, USA, Egypt, Israel, and South Africa, *Z. sarcinulus* from Australia, and *Z. ampullus* and *Z. metoecus* from Argentina. Other undescribed species are known to occur in USA and several parts of Central and South America, but these are not described here because the available material is inadequate (specimens in CNC, CSU).

The fusion of the metasternal and endopodal plates in this genus is remarkable but not unique. Van Aswegen & Loots (1970) described 5 species of *Hypoaspis* Canestrini sens. lat. (Laelapidae) in which the metasternal setae are located on the endopodal plates. In most of these, the third pair of sternal pores is unchanged in position, in the soft integument mediad of the endopodal plate. In at least one species, however, *Hypoaspis (Laelaspis) lawrencei* Van Aswegen and Loots, both the seta and the pore are on the endopodal plate, forming a structure very similar to that in *Zygoseius*. An important difference is that related species of *Hypoaspis* never have a metasternal plate, and the metasternal seta and pore are separate structures, lying free in the soft integument. The metasternal/endopodal complex in some species of *Hypoaspis* is clearly not homologous with that in *Zygoseius*. The same fusion has also apparently occurred independently in the parholaspidid genus *Holaspulus* Berlese (Ishikawa, 1991; Halliday, 1995).

The taxonomic placement of *Zygoseius* presents some very interesting problems. It clearly belongs in the monogynaspid and podospermal Mesostigmata. Johnston (1982) referred to these groups collectively as the cohort Dermanyssina, which he divided into 5 superfamilies. This system has some important differences from other recent attempts to develop a classification for these groups (e.g. Krantz, 1978; Karg, 1993), indicating that the Dermanyssina, like many other mite taxa, cannot yet be organised into a stable higher classification. *Zygoseius* illustrates some of the difficulties involved — it has features in common with both the Eviphidoidea and the Ascoidea, but will not fit into any superfamily as currently defined.

An objective taxonomic placement of *Zygoseius* would appear to depend on a comprehensive generic level phylogenetic analysis of the Eviphidoidea and Ascoidea and related groups. Such an analysis cannot be attempted with the data that are presently available, but some tentative conclusions can nevertheless be reached. *Zygoseius* has often been placed in the Ascidae (or its synonym Aceosejidae), on the basis of its resemblance to *Lasioseius* (e.g. by Evans, 1958; Chant, 1963). However, this view stems from a concept of *Zygoseius* that is based on *Lasioseius alter* Vitzthum, and not on the type species *Z. furciger*. I have already shown that *L. alter* is not a species of *Zygoseius*, so this argument cannot be sustained, at least on the basis of this comparison. *Zygoseius* has some very distinctive features which can not be accommodated in the Ascidae as presently conceived (e.g. by Lindquist & Evans, 1965), especially the fully developed 3-tined claw on the palp tarsus, the presence of 13 setae on femur I, the incorporation of the metapodal plates into the peritrematal plates, the existence of a holoventral shield in adult males, and a dorsal shield that is divided in the deutonymph but entire in the adults. It also differs from the Ascidae in

the loss of dorsal shield seta J3 in all instars, and the loss of 5 further pairs of opisthonotal setae in the larva.

LINDQUIST & EVANS (1965), HAFEZ & NASR (1982), and KRANTZ & AINSCOUGH (1990) suggested that *Zygoseius* should be placed in the Pachylaelapidae, and that suggestion is followed here. However, the presence of 6 dorsal setae on tibia I and 8 setae on tibia III, mean that it will not run to the Pachylaelapidae in identification keys, such as those of KRANTZ (1978) and KRANTZ & AINSCOUGH (1990). (It should be noted that all the specimens I have examined have 8 setae on tibiae III and IV (2 1/1 2/1 1), and not 10, as stated by KRANTZ & AINSCOUGH, 1990.) In these keys, *Zygoseius* runs to the superfamily Ascoidea, but does not agree with any of the included families.

The fusion of the metasternal and endopodal plates in *Zygoseius* could be considered as an expansion of the endopodal plate to capture the metasternal pore and the associated seta. Similarly, the peritrematal plate appears to have expanded posteriorly to capture the metapodal platelets. These expansions and fusions of plates may be the precursors of those shown by various genera of the family Parholaspididae (see, for example, PETROVA, 1977), and as carried to an extreme in *Pachylaelaps*. These trends therefore suggest affinities with the Eviphidoidea. *Zygoseius* also appears to be similar to the pachylaelapid genus *Pachyseiulus* Moraza and Johnston, 1990, especially in the chaetotaxy of the legs.

MORAZA & JOHNSTON (1990) suggested 6 apomorphies that *Pachyseiulus* shares with other Pachylaelapidae, namely (1) enlargement of the palp tibia and tarsus; (2) sternal shield extended posteriorly and fused with endopodals; (3) epigynial shield widened to abut the parapodal sclerites and enlarged posteriorly to include at least setae Jv1; (4) spermatheca of *Pachylaelaps* type; (5) enlargement of leg II in female; (6) sternitigenital sclerite of male separated from ventral shield. *Zygoseius* has none of these character states. However, these character states are not universal diagnostic features of the family — in *Pachyseius* the sternal shield is not fused with the endopodal plates of coxae III/IV and the epigynial shield is not widened (HYATT, 1956; KOROLEVA, 1977); in *Olopachys* the ducts of the spermathecae often arise on coxae IV, not coxae III (KOROLEVA, 1977); and in *Pachylaelaps* the sternitigenital shield of the male is completely fused to the genital shield (HIRSCHMANN & KRAUSS, 1965).

If *Zygoseius* is considered to be a pachylaelapid, it would run to *Sphaerolaelaps* in the key of MORAZA JOHNSTON (1990), due to the lack of spur like setae on tarsus II. However, these 2 genera can easily be distinguished by the different pattern of fusion of the ventral sclerites. Its identification to the family level will require the addition of yet another exception to couplet 7 of the keys of KRANTZ (1978) and KRANTZ & AINSCOUGH (1990), to accommodate the plesiomorphic occurrence of 6 dorsal setae on tibia I. This change would also allow *Pachyseiulus* Moraza and Johnston to be identified as a pachylaelapid.

KARG (1973) attempted a phylogenetic analysis of the Eviphidoidea. His concept of the superfamily includes a greatly expanded concept of the Macrochelidae, including the genera that are normally placed in the Pachylaelapidae and Parholaspididae. One of the major synapomorphies he suggested for the superfamily was the expansion of the pygidial shield of the protonymph to the extent that it carries a minimum of 8 pairs of setae. The pygidial shield of *Zygoseius* protonymphs is small, and carries only 6 pairs of setae (Fig. 16). *Zygoseius* also differs from KARG's diagnosis of the superfamily in the chaetotaxy of tibia III, tibia IV and genu IV. In this classification, *Zygoseius* would have to be regarded as the sister group of all the Eviphidoidea, in a superfamily of its own. However, the characters and character states used in KARG's analysis are not always explicitly defined and, as KARG admits, his analysis was not carried out by computer. A satisfactory resolution of the systematic placement of enigmatic genera such as *Zygoseius* must wait until this analysis has been repeated with a comprehensive data set, incorporating some 50 genera of monogynaspid podospermal Mesostigmata, and using the best modern analytical methods.

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