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Taxonomy, systematics and biology of the Australian halotolerant wolf spider genus *Tetralycosa* (Araneae: Lycosidae: Artoriinae)

Volker W. FRAMENAU [1,2,3,*] & Peter HUDSON [4]

[1] Phoenix Environmental Sciences Pty Ltd, 1/511 Wanneroo Road, Balcatta, Western Australia 6021, Australia.
[2] School of Biological Sciences, University of Western Australia, Crawley 6009, Western Australia, Australia.
[3] Department of Terrestrial Zoology, Western Australia Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia.
[4] South Australian Museum, North Terrace, Adelaide, South Australia 5000, Australia.

[*] Corresponding author: volker.framenau@phoenixenv.com.au
[4] Email: Peter.Hudson@samuseum.sa.gov.au

[1] urn:lsid:zoobank.org:author:9D67C6B0-37C2-4009-BD30-D02C4136F562
[2] urn:lsid:zoobank.org:author:AA82892F-3FF4-42F1-8FD8-49D09FDA8128

Abstract. The Australian wolf spider genus *Tetralycosa* Roewer, 1960, with *Lycosa meracula* Simon, 1909 (junior synonym of *Lycosa oraria* L. Koch, 1877) as type species, is revised to include 13 species, eight of which are described as new here: *Tetralycosa adarca* sp. nov., *T. alteripa* (McKay, 1976), *T. arabanae* Framenau, Gotch & Austin, 2006, *T. baudinettei* sp. nov., *T. caudex* sp. nov., *T. eyrei* (Hickman, 1944), *T. floundersi* sp. nov., *T. halophila* sp. nov., *T. oraria* (L. Koch, 1876), *T. orariola* sp. nov., *T. williamsi* sp. nov., *T. wundurra* (McKay, 1979) comb. nov. and *T. rebecca* sp. nov. Members of *Tetralycosa* are halotolerant, exclusively inhabiting saline environments such as coastal beaches, and mound springs, clay pans and salt lakes in the Australian interior. A phylogenetic analysis of the genus identified a monophyletic clade of eight species that live permanently on the barren surface of salt lakes suggesting a single radiation into this extremely inhospitable habitat. Some of these *Tetralycosa* species are currently known from single salt lakes only and with increasing disturbances of these systems by mining, agriculture and recreational use, research effort should be increased to study their ecology and conservation status.

Keywords. Salt lake, samphire zone, saline, systematics, phylogeny.

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Introduction

The wolf spider genus *Tetralycosa* Roewer, 1960, with the type species *Lycosa meracula* Simon, 1909, was initially listed as *nomen nudum* (Roewer 1955) and subsequently diagnosed based on somatic characters, i.e., the number of retromarginal cheliceral teeth and the arrangement of the eyes (Roewer 1960). McKay (1973) listed the species in *Lycorma* Simon, 1885, following Guy (1966) who considered *Tetralycosa* a subgenus of *Lycorma*. Subsequently, McKay (1979a) synonymised *Tetralycosa* with *Lycosa* Latreille, 1804 primarily based on the arrangement of the eyes. However, in numerous recent studies, somatic characters such as eye patterns or number of cheliceral teeth have been shown to be of limited value in wolf spider systematics (e.g., Dondale 1986; Zyuzin 1993; Vink 2002; Framenau 2006a, 2006b, 2007; Framenau & Baehr 2007; Langlands & Framenau 2010; Piacentini 2014).

In a review of the currently named species of the genus, *Tetralycosa* was re-instated as a valid genus based on a combination of characters of the male pedipalp, i.e., a curved tegular (= median) apophysis opposing a protrusion of the tegulum, reduced palea and the terminal apophysis forming a shaft for the embolus (Framenau *et al.* 2006). The genus currently includes four species, all with distinctly halotolerant habitat preferences: *Tetralycosa oraria* (L. Koch, 1876) (Fig. 1E–F), which Framenau *et al.* (2006) established as a senior synonym of *Lycosa meracula*, is only known from coastal beaches and sand dunes (Fig. 1D) in the southern half of Australia, including Tasmania; *T. eyrei* (Hickman, 1944) and *T. alteripa* (McKay, 1979) (Fig. 1C) inhabit the dry surface of Australian inland salt lakes in South Australia and Western Australia (Fig. 1A–B), and *T. arabanae* Framenau, Gotch & Austin, 2006 is almost exclusively found at arid South Australian mound springs of the Great Artesian Basin (Hudson & Adams 1996; Hudson 1997; Framenau *et al.* 2006). However, an allozyme study of Australian wolf spiders inhabiting salt lakes suggested the existence of at least one cryptic sister species for both *T. alteripa* and *T. eyrei*, and highly heterogeneous sub-structuring within both species complexes did not exclude the possibility of further speciation (Hudson & Adams 1996).

Tetralycosa oraria was included in a comprehensive molecular phylogenetic analysis of the Lycosidae (Murphy *et al.* 2006). This analysis unequivocally placed the genus in an Australasian clade that represents the sister group to the traditional Lycosinae Sundevall, 1833 and Pardosinae Simon, 1898 combined. This clade was subsequently established as the subfamily Artoriinae Framenau, 2007, characterised by the presence of a unique structure of the male pedipalp, the basoembolic apophysis (Framenau 2007). This subfamily currently includes nine described and at least one undescribed genera from the Australasian and Pacific regions (Framenau 2007, 2010) and possibly two Argentine representatives (Piacentini & Grismado 2009). The molecular analysis supported *Diahogna* (as "New Genus 2 sp.") as sister group of *Tetralycosa* (Murphy *et al.* 2006), but *Kangarosa* Framenau, 2010 may also be closely related to both, based on the eye configuration and shape of the basoembolic apophysis of the male pedipalp (Framenau 2010).

The interior of mid and south-western Australia contains a vast network of ephemeral salt lakes. These were formed by the fragmentation of palaeodrainage basins that existed prior to the aridification of the continent starting in the Miocene (Graaff *et al.* 1977). Proposed ancient basins remained well preserved because of tectonic stability and slow erosion and sedimentation (Graaff *et al.* 1977). The vast majority of Australian salt lakes are dry much of the time and only hold water after episodic rain events, often years or decades apart, although some smaller wetlands have annual fill-patterns (Timms 2005). The aquatic 'boom' episode can be of extraordinary biologic productivity. Primary production of salt lakes during the aquatic phase is generally based on microbial mats of cyanobacteria and diatoms (Bauld 1981). Feeding on these, a productive lake may host a range of halobiontic crustaceans, typically brine shrimp (*Parartemia* spp.), shield shrimp (*Triops* spp.) and a variety of ostracods and copepods (Pinder *et al.* 2002, 2005). These crustaceans provide the food for often extraordinary numbers of waterbirds (e.g., Kingsford 1995; Roshier *et al.* 2001).

The desolate dry period of salt lakes is often referred to as a 'bust' episode when the lakes represent one of the most hostile ecosystems on earth due to high incident daily temperatures and high salt concentrations in the soil that may form a thick crust on the surface. During these periods, a distinctive terrestrial invertebrate fauna is evident on the intermittent salt lakes in Australia, including tiger beetles, pogonine ground beetles, crickets, buthid scorpions, and wolf spiders (Hudson 1995, 1997, 2000; Kamoun & Hogenhout 1996; McCairns *et al.* 1997; Baehr & Hudson 2001; Pearson & Vogler 2001; Durrant & Guthrie 2004; Pons *et al.* 2006). On the saline playas, these groups are burrowing specialists that, with some exceptions, generally forage at night, often positioning themselves close to the water table enabling them to survive in an otherwise inhospitable environment. Significant wet periods may

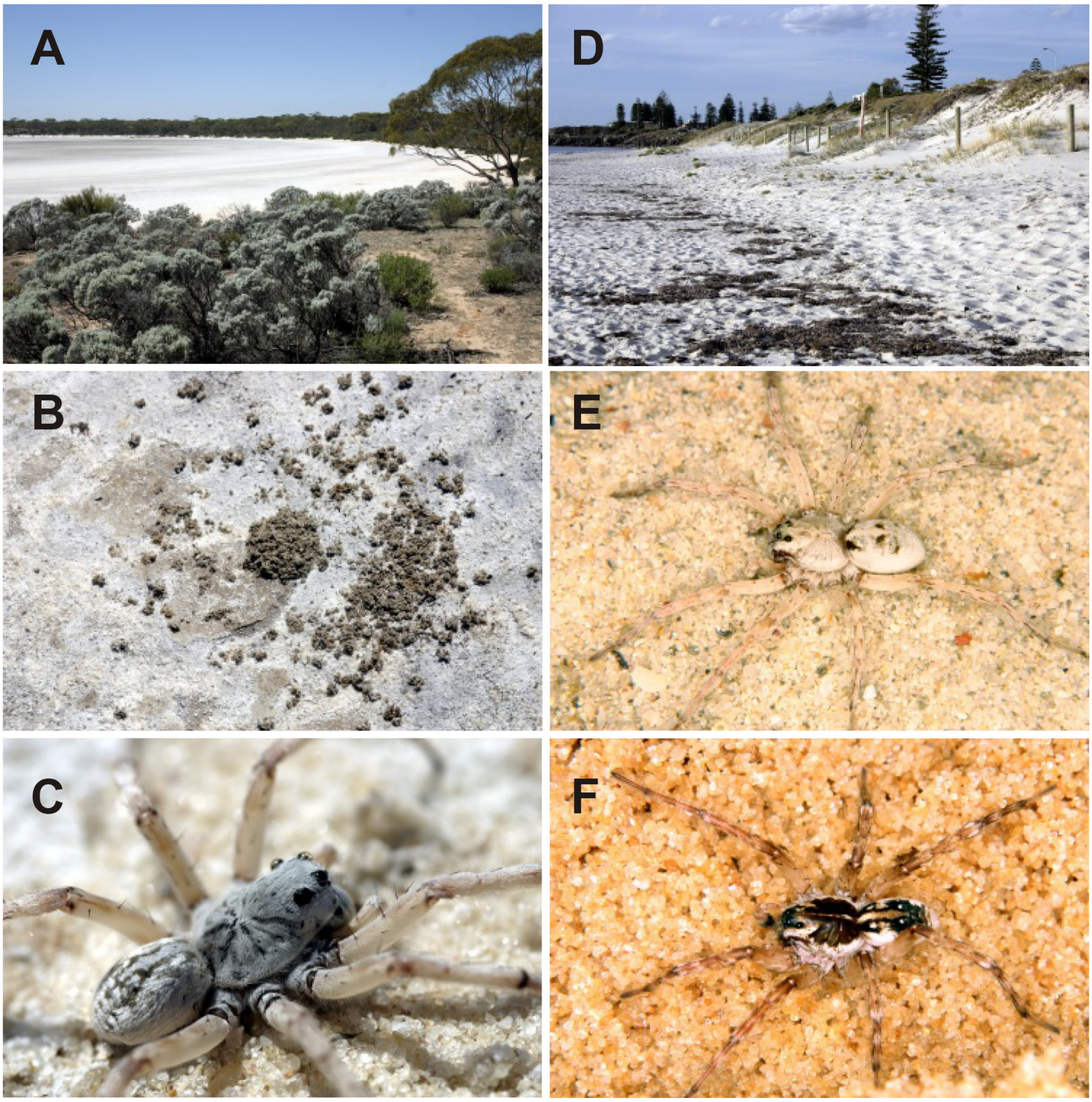

Fig. 1. Typical habitats and live images of *Tetralycosa* Roewer, 1960. **A**. Salt lake (southern Lake Lefroy, Western Australia), where *T. alteripa* (McKay, 1976) and *T. baudinettei* sp. nov. can be found. **B**. *T. alteripa* (McKay, 1976), burrow on Lake Lefroy. **C**. *T. alteripa* (McKay, 1976), ♀ from Lake Lefroy. **D**. Sea shore (Cottesloe Beach, Western Australia), where *T. oraria* (L. Koch, 1876) can be found. **E**. *T. oraria* (L. Koch, 1876), ♂ from Cottesloe Beach (WAM T65606). **F**. *T. oraria* (L. Koch, 1876), ♂ from Safety Beach (Western Australia) (WAM T65111).

pose a major problem for salt lake terrestrial fauna, which are in danger of drowning or are pushed to the narrow edge of the lake and subject to intense predatory pressure from non-lake fauna. However, the exact evolutionary and ecological costs and benefits of the changing hydrological regime of the lakes for the terrestrial fauna are poorly understood.

Wolf spiders form an integral part of the terrestrial salt lake fauna in Australia and a number of behavioural adaptations allow wolf spiders to survive these hostile places. The mobile brood care of females for both her eggs and early juvenile instars (e.g., Rovner *et al.* 1973; Townley & Tillinghast 2003) allows wolf spiders to survive in habitats that are prone to inundation (McKay 1974; Manderbach & Framenau 2001; Framenau *et al.* 2002; Morse 2002). The ability to disperse via ballooning enables many wolf spider species to quickly recolonise disturbance-prone environments after catastrophic events such as floods (Richter 1970; Crawford *et al.* 1995; Edwards & Thornton 2001). In arid conditions with high sun exposure, many wolf spider species live in permanent burrows that allow them to retreat from extreme environmental conditions during the day (e.g., Langlands & Framenau 2010; Framenau & Baehr 2016). Burrows can be deep to protect from the heat on the surface, however, salt lakes pose additional problems in that the surface is generally very hot during the day, but the water table might be just below the surface.

The aim of this study is to revise the taxonomy and systematics of the Australian fauna of the halotolerant wolf spider genus *Tetralycosa*. We present a phylogenetic hypothesis based on morphological data to test if the salt lake environment was invaded more than once in the evolutionary history of this heterogeneous genus, as our taxonomic treatment initially suggested three distinct lineages: spiders apparently related to *T. oraria* inhabit beaches, samphire flats and the periphery of mound springs and two lineages only occur on the playa of salt lakes; one associated with *T. alteripa* found in Western Australia and South Australia and one with *T. eyrei* found in South Australia, New South Wales and Victoria. Intensive collecting of wolf spiders from salt lakes has provided an intimate insight into the biology of these spiders, in particular daily activity patterns and burrow construction, which are also reported on here.

Material and methods

Morphology

This study forms part of a revision of Australian wolf spiders based on the examination of all available type material of Australian lycosids and more than 20,000 records of wolf spiders in all museum collections in Australia and historical collections overseas (London, Berlin, Hamburg and Paris museums). Descriptions are based on specimens preserved in 70% ethanol. Internal female genitalia were prepared for examination by submersion in 10% KOH at room temperature for 2–24 hrs. For clarity, the setae have been omitted from the illustrations of epigynes and male pedipalps. All measurements are in millimetres (mm).

Digital images of preserved specimens were taken with a Leica DFC500 digital camera that was attached to a Leica MZ16A stereo microscope. Photographs were taken in different focal planes and combined with the Leica Application Suite version 2.5.0R1. Images of live spiders (Fig. 1C, E–F) were taken with a Canon 5D Mark II digital SLR camera and a Sigma 105mm f/2.8 EX macro lens with a Canon Macro Twin Lite MT-24EX.

For scanning electron microscopy (SEM) (Fig. 2A–F), dissected pedipalps were passed through a graded series of ethanol up to 100% and then critical point dried using an Emscope CPD 750 critical point dryer. The dissected pedipalps were then mounted on individual stubs and coated with gold using a Polaron E5000-200 sputter coater. Examination took place using a Siemens ETEC Autoscan scanning electron microscope.

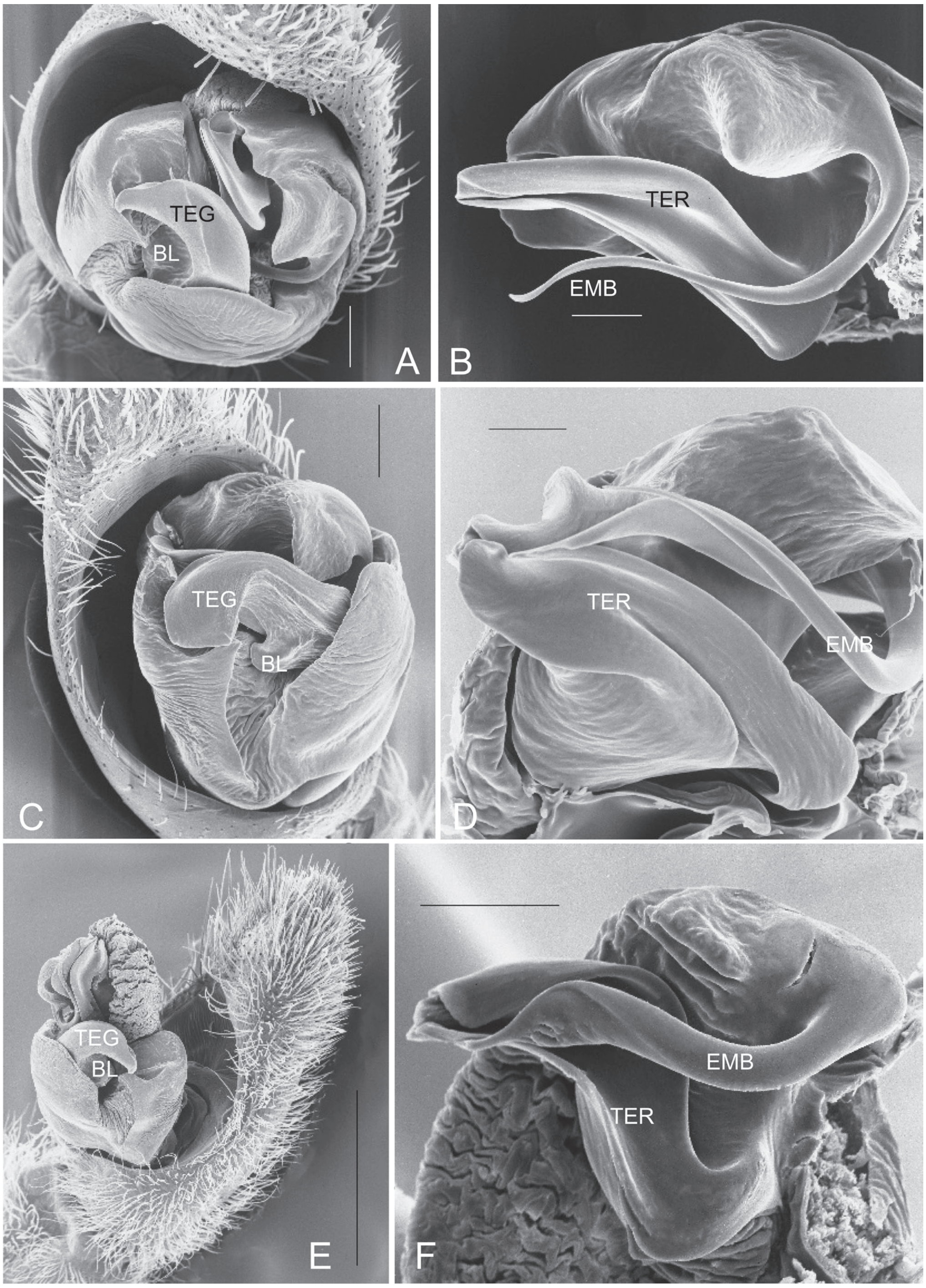

Fig. 2. Scanning electron micrographs (SEM) of *Tetralycosa* Roewer, 1960, male pedipalps. **A**. *T. alteripa* (McKay, 1976), right pedipalp, apico-ventral view (SAM NN21799). **B**. *T. alteripa* (McKay, 1976), palea region of right pedipalp, baso-ventral view (SAM NN21794). **C**. *T. eyrei* (Hickman, 1944), right pedipalp, retrolatero-ventral view (SAM NN21741). **D**. *T. eyrei* (Hickman, 1944), palea region of right pedipalp, ventral view (SAM NN21737). **E**. *T. alteripa* (McKay, 1976), left pedipalp, retrolatero-ventral view (Sinclair Gap Lake, South Australia; PH, pers. collection). **F**. *T. wundurra* (McKay, 1979), palea region of right pedipalp, ventral view (Lake Daringdella, Western Australia; P.H., pers. collection). Abbreviations: BL = basal lobe of tegular apophysis; EMB = embolus; TEG = main branch of tegular apophysis; TER = terminal apophysis. Scale bars: A = 0.5 mm; B–C, F = 0.2 mm; D = 0.1 mm; E = 1.00 mm.

Morphological terminology generally follows Framenau (2007), with the exception of female genitalia, which follows Sierwald (2000). Roewer (1959) provided a detailed discussion on the arrangement of the eyes in lycosids and used this character set extensively in his taxonomic studies. He mainly used the upper and lower tangential line of the anterior row of eyes, which is influenced both by the curvature of this row (measured by drawing a line through the centre of the eyes) and the size of the eyes. Here, to provide unequivocal character states for our phylogenetic analysis, we modify Roewer's (1959) classification: we consider the row of the anterior eyes procurved (recurved), if in frontal view the centre of the anterior lateral eyes is situated below (above) the centre of the anterior median eyes. In addition, the row of AE is 'strongly' procurved (recurved) if the anterior lateral eyes sit below (above) or just touch a horizontal line through the centre of the anterior median eyes. The ocular quadrangle refers to the position of the four posterior eyes and its dimensions are measured in dorsal view.

The tegular apophysis originates apically at the tegulum in all Artoriinae and its general direction is apicad; its base is often narrower than its tip (Framenau 2007). In contrast, the tegular apophysis originates retrolaterally at the tegulum and points retrolaterad in the Lycosinae; it is generally wider at the base than at the tip (i.e., Dondale 1986). The overall shape of the tegular apophysis is often characteristic for the Artoriinae. In *Tetralycosa* this has two branches; a large curved branch, which in some species forms a distinct hook with a tapering tip (TEG in Fig. 2A, C, E), and a smaller basal lobe, which in some species cannot be seen behind the tegulum (BL in Fig. 2A, C, E). Both branches appear to form a functional unit, as they generally form a channel for the resting embolus.

In wolf spiders, the retrolateral and basal side of the palea region of the male pedipalp is characterised by a diverse array of sclerotised structures and terminology and therefore homologisation remains contentious. This is in particular true for groups with highly derived pedipalp morphology, such as the genus *Sosippus* Simon, 1888 (Sierwald 2000). A variety of terms have been introduced for retrolateral palea structures, such as terminal apophysis, synembolus, conductor and pars pendula (Zyuzin 1993). The variability of these structures reflects their close proximity to the free end of the embolus, and their importance in guiding the embolus into the female genital tract. In *Tetralycosa*, the retrolateral and basal sides of the palea carry a strongly sclerotised structure that forms a shaft for the resting embolus and seems to support the embolus during copulation (e.g., Fig. 2B, D, F). It is beyond the scope of this study to clarify relationships of this structure to homologous structures in other lycosid genera and we therefore use the most commonly employed term, terminal apophysis, for this complex structure, although it was called conductor in Framenau *et al.* (2006).

Phylogenetic analysis

A cladistic analysis of morphological and ecological characters was employed to develop a phylogenetic hypothesis for *Tetralycosa*. To test monophyly of *Tetralycosa*, we included the representatives of two putative sister genera of *Tetralycosa*, i.e., *Diahogna martensii* (Karsch, 1878) (type species of *Diahogna* Roewer, 1960) (Framenau 2006b) and *Kangarosa properipes* (Simon, 1909) (type species of *Kangarosa* Framenau, 2010) (Framenau 2010) in our analysis. We chose *Artoriopsis expolita* (L. Koch, 1877) as outgroup. This species was included in a recent molecular phylogenetic analysis of wolf spiders (Murphy *et al.* 2006), which suggested that it represents a basal genus within the Artoriinae.

There are only a limited number of phylogenetic, cladistic or phenetic studies exploring morphological characters in wolf spiders (Vink 2002; Vink & Paterson 2003; Stratton 2005; Framenau & Yoo 2006; Yoo & Framenau 2006; Langlands & Framenau 2010) (see also Roewer (1959) for a detailed discussion on lycosid morphological characters and Casanueva (1980) for a phenetic analysis of Chilean lycosids). We tested these characters and explored many new ones as part of our phylogenetic analysis. A total of 32 characters (Table 1) remained parsimoniously informative for the 16 species included in our analysis (Table 2).

Table 1 (continued on next pages)**.** Characters and character states for the cladistic analysis of *Tetralycosa* and allied species. All character states are considered unordered for the cladistic analysis in TNT.

	Somatic characters
(1)	*Carapace width, males:* 0, small (< 4.00 mm); 1, medium-sized (4.01–6.00 mm); 2, large: > 6.00 mm. Average carapace width of males is here employed as measure of spider size. Spider size was plotted and examined for gaps. The species within *Tetralycosa* fall into three distinct size classes. The carapace width of male *T. caudex* is here estimated based on the lack of a distinct sexual size dimorphism in wolf spiders.
(2)	*Carapace profile, lateral vie*w*:* 0, horizontal; 1, cephalic region elevated. In lateral view, the dorsal line of the carapace can either be horizontal, i.e. the carapace is of similar height anteriorly and posteriorly (Fig. 6A), or the cephalic region is elevated and the dorsal line slopes towards the posterior margin of the carapace (Fig. 15A).
(3)	*Carapace profile, head flanks in frontal view, male*: 0, steep, vertical; 1, gently sloping.
(4)	*Carapace, median band:* 0, absent; 1, present. The carapace is uniformly yellow to light brown with little or no pattern as in *T. arabanae* (Fig. 5E, G) and *T. caudex* (Fig. 5I). It may also be very dark brown as in all species with affinities to *T. eyrei* (e.g., Fig. 22A, C, E, G). Alternatively, the carapace has a brown to dark brown colouration and a distinct median band or lateral bands are present (e.g., Figs 5A, C; 14A, G).
(5)	*Carapace, lateral bands:* 0, absent; 1, present.
(6)	*Eye pattern, width of anterior eye row:* 0, row of AE ≥ row of PME; 1, row of AE < row of PME. The row of the AE and PME rows are measured in frontal view. There is some divergence in the measurements for *T. oraria* males and females, as in some females the row of the AE is slightly shorter than PME.
(7)	*Eye pattern, curvature of AE row:* 0, straight or slightly procurved; 1, strongly procurved. The curvature of the AE row is determined by drawing a horizontal line through the centre of all eyes. The anterior row of eyes is procurved if the centre of the anterior lateral eyes is just below the line but still crosses the ALE. If the line does not cut the lateral eyes or just touches them, the eye row is considered strongly procurved.
(8)	*Chelicerae, number of retromarginal teeth:* 0, 2 teeth; 1, 3 teeth; 2, 4 teeth on at least on chelicera.
(9)	*Labium ratio (length/width), males:* 0, wider than long; 1, longer than wide. In most *Tetralycosa* males, the labium is wider than long, however, this pattern was reversed in most species with affinities to *T. eyrei*. Females did not show this variation.
(10)	*Abdomen, ventral colouration:* 0, uniformly yellow to light brown, no dark pattern (e.g., Fig. 5B, D, F, J); 1, overall light, but dark pattern present (e.g., Figs 14F, 18B); 2, overall dark, but light transverse line behind epigastric furrow (e.g., Fig. 26D, F).
(11)	*Abdomen, dorsal colouration:* 0, no pattern, abdomen and venter similar colour (e.g., Fig. 5G, I); 1, dorsal basic colour light, patchy colouration (e.g., Figs 5A, 10C); 2, dorsal colour uniformly dark, darker than lateral and ventral (rarely light spots) (e.g., Fig. 14E, G).
(12)	*Leg length, shortest leg, males:* 0, leg I; 1, 2, leg III. There is considerable variation in leg length within the genus *Tetralycosa*, representing an unusual intrageneric pattern within the Lycosidae. We coded the shortest leg and the second longest leg (character 13), since in all species and most wolf spiders, leg IV is the longest.
(13)	*Leg length, second longest leg, males:* 0, leg I; 1, leg II; 2, leg III.
(14)	*Femora, colour pattern, males:* 0, uniform light; 1, dark annulations (sometimes only ventral); 2, basal three quarters dark, tip light; 3, light, only apically dark.

	Genital characters, male
(15)	*Cymbium tip, macrosetae:* 0, none; 1, 1–5; 2, > 5.
(16)	*Tegular apophysis, shape:* 0, curved; 1, straight. The curved tegular apophysis is considered a synapomorphy of *Tetralycosa*. Whilst the tegular apophysis of male *A. expolita* bears a curved apical structure, its basic shape is considered straight (see Framenau 2007; Fig. 2C).
(17)	*Tegular apophysis, tip:* 0, pointy (e.g., Fig. 11A); 1, round or truncated (e.g., Fig. 24A).
(18)	*Tegular apophysis, basal lobe:* 0, absent; 1, present. The tegular apophysis of all *Tetralycosa* have a basal lobe that forms a dorsal channel together with the main branch of the apophysis that possibly guides the embolus during copulation.
(19)	*Tegular apophysis, basal lobe:* 0, not visible behind tegulum in ventral view (e.g., Fig. 19A); 1, only tip visible, connection to tegular lobe not visible (e.g., Fig. 11A); 2, fully visible, i.e., connection to tegular apophysis visible (e.g., Fig. 24A).
(20)	*Terminal apophysis, channel:* 0, absent; 1, present. In all *Tetralycosa*, the terminal apophysis forms a distinct channel which guides the embolus (e.g., Figs 6C, 24C). This channel is absent in *Artoriopsis*, *Kangarosa* and *Diahogna*.
(21)	*Terminal apophysis, base bulging ventrally:* 0, absent; 1, present. In some *Tetralycosa*, the base of the terminal apophysis is distinctly bulging (e.g., Figs 6E, 11C), but not so in others (e.g., Figs 23C, 24C).
(22)	*Terminal apophysis, complex structure connected to palea along its whole length:* 0, absent; 1, present. In species of the salt lake clade, the terminal apophysis forms a complex structure of sclerotised parts that is connected to the palea along its whole length (e.g., Figs 15D, 23C, 24C), whereas the shaft is comparatively simple in other species and generally separate from the palea (e.g., Figs 11C, 12C).
(23)	*Terminal apophysis, terminal separation between palea and shaft:* 0, undivided; 1, incised. The shaft of the terminal apophysis is incised terminally to form a U-shaped cavity near its tip (between shaft and palea) in species of the *alteripa*-group (e.g., Figs 15C, 16C), but this incision is absent in species of the *eyrei*-group.
(24)	*Basoembolic apophysis:* 0, round (e.g., Figs 12C, 24C); 1, triangular (e.g., Figs 15D, 16C); 2, square (only *Artoriopsis*).
(25)	*Embolus, shape:* 0, strong, more or less straight (e.g., Figs 7C, 24C); 1, thin, tip curved and bent apically (e.g., Fig. 22C).
	Genital characters, female
(26)	*Epigyne, shape of anterior margin:* 0, notched; 1, bridging separate hoods; 2, smooth. The anterior edge of the epigyne might have a distinct notch (as in the species of the *eyrei*-group (e.g., Fig. 24D)), or there are two separate epigyne hoods that are connected by the anterior margin (e.g., Fig. 23E), or the anterior edge is smooth without any particular structure (Fig. 8A).
(27)	*Epigyne, nibs on anterior rim:* 0, absent; 1, present. A number of *Tetralycosa* species have distinct nibs protruding posteriorly from the anterior epigyne edge (e.g., Figs 15E, 16D), which are absent in others (e.g., Fig. 8A).
(28)	*Median septum, shape:* 0, much wider than long (e.g., Fig. 16D); 1, only slightly wider than long to longer than wide (all species in the *eyrei*-group; e.g., Figs 23D, 24D); 2, longer than wide (only in *Artoriopsis*).

(29)	*Epigyne, shape:* 0, median septum present (inverted T-shaped); 1, median septum absent, atrium round to oval; 2, median septum present, distinct plate. The median septum of the epigyne can be of varying shape. Its shape is generally poorly defined in many *Tetralycosa*, sometimes inverted T-shaped (e.g., Figs 7D, 8A) and considered absent in the species of the *eyrei*-group (Figs 23D, 24D).
(30)	*Epigyne, width of spermathecal head:* 0, as wide as spermathecal stalk; 1, wider than spermathecal stalk, globous. The spermathecal heads are generally wider in diameter in most *Tetralycosa* (e.g., Figs 8B, 12F), but less so in some (e.g., Fig. 28E).
(31)	*Spermathecal stalk, orientation:* 0, anteriad; 1, antero-laterad; 2, antero-mesal.
	Ecology
(32)	*Halotolerant:* 0, no; 1, yes. Halotolerance, i.e., the ability to persist in saline environments, is a character shared by all *Tetralycosa*, although the habitat of *T. caudex* is unknown.

Fourteen characters were based on somatic morphology, 17 on genitalic morphology (11 male and six female) and one on ecology (Table 1).

The character matrix was edited using Mesquite (Maddison & Maddison 2015). Phylogenetic analyses were conducted in TNT version 1.1 (Goloboff *et al.* 2008; Willi Hennig Society Edition, Version 1.1, March 2015). We used the 'traditional search' option with the following settings: number of replicates ('repls') 1,000, 'trees to save per replication' at 10, 'collapse trees after search' with default collapsing rule (min. length = 0), 'replace existing trees' and maximum trees in memory set to 100,000. A strict consensus tree was exported to WinClada vers. 1.00.08 (Nixon 2002) for character exploration. Bremer support (Bremer 1994) values were calculated using TNT. Character coding was based on well preserved specimens, in many cases type material (Table 3).

Behaviour

Details of the characteristics of the burrows of *Tetralycosa* salt lake wolf spiders are based on field work mainly carried out at Lake Gilles and Sinclair Gap Lake, South Australia, and further supplemented with observations from many other salt lakes in southern Australia. Two methods were employed in determining the profile of burrows. The usual method required excavation of a hole beside the burrow before carefully exposing it for its whole length and thus enabling measurement of the basic profile. The second method involved the preparation of plaster casts of the burrows. If burrows were sealed, the entrance was firstly revealed by careful scraping of the surface and then plaster of Paris was poured into the burrow and allowed to set. The intact cast was removed after careful excavation of the surrounding mud.

Abbreviations

Measurements

AL, AW = abdomen length, width
CL, CW = cephalothorax length, width
TL = total length

Eyes

AE = anterior
AME, ALE = anterior median, lateral

Table 2. Character states for phylogenetic analysis of *Tetralycosa* Roewer, 1960 and allied genera.

Characters	0									1										2										3		
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2
Artoriopsis expolita	0	0	1	1	1	1	0	1	0	0	1	1	0	1	0	0	–	0	–	0	0	0	–	2	1	1	0	2	0	1	2	0
Kangarosa properipes	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	–	0	–	0	0	0	–	0	0	2	0	1	–	0	1	0
Diahogna martensii	0	0	1	1	1	0	0	1	0	0	0	1	0	0	0	0	–	0	–	0	0	0	–	0	0	2	0	1	–	1	2	0
Tetralycosa oraria	0	0	1	1	1	0	0	1	0	0	1	1	1	0	1	1	0	1	1	1	1	0	–	0	1	1	0	0	0	1	2	1
T. arabanae	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	0	–	0	0	1	0	0	1	1	2	1
T. caudex	0	0	?	0	0	0	0	1	?	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	?	2	0	0	1	1	0	?
T. orariola	0	0	1	1	1	0	0	1	0	0	2	1	1	0	1	1	0	1	1	1	1	0	–	0	1	1	0	0	0	1	2	1
T. wundurra	0	0	1	0	1	0	0	1	0	0	0	1	0	0	1	1	0	1	1	1	1	0	–	0	0	1	0	0	1	1	0	1
T. alteripa	2	1	0	0	1	1	1	1	0	0	1	1	1	0	0	1	0	1	0	1	0	1	1	1	1	1	1	0	0	1	2	1
T. baudinettei	1	1	0	0	1	1	1	1	0	1	2	1	1	2	0	1	0	1	1	1	1	1	1	1	1	1	1	0	0	1	2	1
T. floundersi	0	1	0	0	1	1	1	1	0	0	1	0	2	2	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	1	2	1
T. rebecca	1	1	0	0	1	1	1	2	0	0	2	0	1	3	0	1	0	1	0	1	1	1	1	1	1	1	1	0	0	1	2	1
T. adarca	2	1	0	0	0	1	1	2	1	2	1	0	1	1	0	1	1	1	2	1	0	1	0	0	0	0	0	1	–	0	1	1
T. eyrei	1	1	0	0	0	1	1	1	0	2	1	0	1	2	0	1	1	1	2	1	0	1	0	0	0	0	0	1	–	0	1	1
T. halophila	2	1	0	0	0	1	1	2	1	2	1	0	2	1	0	1	1	1	2	1	0	1	0	0	0	0	0	1	–	0	1	1
T. williamsi	2	1	0	0	0	1	1	1	1	2	1	0	1	1	0	1	1	1	2	1	1	1	0	0	0	0	0	1	–	0	1	1

Table 3. Specimens used in phylogenetic analysis. Abbreviations: NSW = New South Wales; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia; HT = holotype; PT = paratype.

Species	Sex	Locality	Depository
A. expolita	♂/♀	Yallingup Brook catchment (WA)	WAM T55253
D. martensii	♂	Cape Naturaliste (Tas)	QVMAG 13:42218
	♀	Blackmans Lagoon (Tas)	QVMAG 13:4205
K. properipes	♂/♀	Coolinup Nature Reserve (WA)	WAM T47156
T. adarca	♂ (HT)/♀ (PT)	Lake Acraman (SA)	SAM NN21882/21732
T. alteripa	♂	Lake Johnston (WA)	SAM NN21895
	♀	Ifould Lake (SA)	SAM NN21922
T. arabanae	♂ (HT)/ ♀ (PT)	Jersey Spring (SA)	SAM NN13871/13889
T. baudinettei	♂ (HT)	Lake Goongarrie (WA)	SAM NN21891
	♀ (PT)	Lake Lefroy (WA)	SAM NN21896
T. caudex	♂ (-)/♀ (HT)	Woodstock Station (WA)	WAM T55570
T. eyrei	♂	Lake Frome (SA)	SAM NN21886
	♀	Half Moon Lake (SA)	SAM NN21892
T. floundersi	♂ (HT)/♀ (PT)	Lake Moore (WA)	SAM NN21900/21901
T. halophila	♂ (HT)/♀ (PT)	Lake Everard (SA)	SAM NN21734/21733
T. oraria	♂/♀	Guilderton (WA)	WAM T53397/T53393
T. orariola	♂ (HT)/ ♀ (PT)	Kulunilup Nature Reserve (WA)	WAM T62787/62788
T. williamsi	♂ (HT)/ ♀ (PT)	Lake Gilles (SA)	SAM NN13812/17385
T. wundurra	♂	Muir Highway South (WA)	WAM T62785
	♀	Lake Gulson (WA)	WAM T62666
T. rebecca	♂ (HT)/♀ (PT)	Rebecca Station (WA)	SAM NN21913/21914

PE = posterior
PME = posterior median
PLE = posterior lateral

Collection

AM = Australian Museum, Sydney, Australia
ANIC = Australian National Insect Collection, Canberra, Australia
BMNH = National History Museum, London, England
MHNP = Musée national d'Histoire naturelle, Paris, France
MV = Museum Victoria, Melbourne, Australia
PES = Phoenix Environmental Sciences, Balcatta, Australia
QM = Queensland Museum, Brisbane, Australia
QVMAG = Queen Victoria Museum and Art Gallery, Launceston, Australia
SAM = South Australian Museum, Adelaide, Australia
SMF = Senckenberg Museum, Frankfurt, Germany
TMAG = Tasmanian Museum and Art Gallery, Hobart, Tasmania
WAM = Western Australian Museum, Perth, Australia
ZMB = Museum für Naturkunde, Zentralinstitut der Humboldt-Universität, Berlin, Germany
ZHM = Zoologisches Institut und Zoologisches Museum der Universität Hamburg, Germany (today Centrum für Naturkunde, Universität Hamburg)

Results

We recognise 13 species in the genus *Tetralycosa* including eight new species. Most species are restricted to either South Australia or Western Australia, only two, *T. eyrei* and *T. oraria*, also occur in other states (Table 4).

The phylogenetic analysis resulted in a single most parsimonious tree (L = 71, Ci = 61, Ri = 80) (Fig. 4A–B). This topology supports the monophyly of *Tetralycosa* within our selection of taxa based on three synapomorphies, the short curved tegular apophysis (character 16), a channel in the terminal apophysis that forms a shaft to guide the embolus (20), and the presence of a median septum that is wider than long (28) (secondarily lost in a terminal clade including *T. eyrei*).

The genus *Tetralycosa* itself shows little sub-structuring and neither the preconceived *oraria*- or the *alteripa*-groups are monophyletic. However, our analysis identified a single "salt lake clade" consisting solely of obligatory salt lake dwellers with *T. alteripa* as most basal species and with *T. oraria* and *T. orariola* sp. nov. combined as sister clade (Fig. 3A). The salt lake clade is supported by six synapomorphies including a high cephalic region (character 2) that descends steeply at its flanks in males (3), a strongly procurved AE row (7), the basal lobe of the tegulum not being visible in ventral view of the pedipalp (19), the complex structure of the terminal apophysis (22) and the female epigyne with anterior nibs (27). Within the salt lake clade, a monophyletic terminal clade including *T. eyrei* (the *eyrei*-group) is well supported by five synapomorphies, including a dark ventral colouration (character 10), a pointy tip of the tegular apophysis (17), a basal lobe of the tegular apophysis that is fully visible in ventral view (19), an unincised terminal part of the terminal apophysis (23), and a notched anterior margin of the female epigyne (26). This *eyrei*-group is sister group to *T. baudinettei* sp. nov. and *T. rebecca* sp. nov. combined.

Behaviour

The burrows of spiderlings of the salt lake clade are clearly recognisable in the field by the presence of a raised turret of mud at the burrow entrance encircled by a ring of excavated mud 'pellets' (Fig. 1B). The

Table 4. Distribution of the species of *Tetralycosa*. Abbreviations: NSW = New South Wales; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia.

	Distribution	Habitat	Remarks
***oraria*-group**			
T. oraria (L. Koch, 1876)	WA, SA, Vic, NSW, Tas	coastal	senior synonym of *T. meracula*, the type species of *Tetralycosa*
T. arabanae Framenau, Gotch & Austin, 2006	SA	mound springs of Artesian Basin	
T caudex sp. nov.	WA	unknown	only known from ♀
T. orariola sp. nov.	WA	saline claypans, samphire	
T. wundurra (McKay, 1979)	WA	saline claypans, samphire	
***alteripa*-group**			
T. alteripa (McKay, 1976)	SA, WA	salt lakes	
T. baudinettei sp. nov.	WA	salt lakes	
T. floundersi sp. nov.	WA	salt lakes	known from type locality only
T. rebecca sp. nov.	WA	salt lakes	known from type locality only
***eyrei*-group**			
T. eyrei (Hickman, 1944)	SA, NSW, Vic	salt lakes	
T. adarca sp. nov.	SA	salt lakes	
T. halophila sp. nov.	SA	salt lakes	known from type locality only
T. williamsi sp. nov.	SA	salt lakes	

burrows of larger immature and adult spiders are offset in profile and usually of a depth such that there is a little free water present in the bottom (Fig. 3A). The function of the offset burrow shape is unknown. The mean burrow depth of *T. alteripa* from Sinclair Gap Lake was 104 mm (*n* = 103) and those of *T. williamsi* sp. nov. from Lake Gilles was 138 mm (n = 87). Several spiderling burrows of *T. eyrei* on Lake Frome were excavated and found to be ca 100 mm deep (J. Love, pers. comm.). However, there is great variation and a specimen of *T. alteripa* collected from North Thurlga Ramp Lake (South Australia) in February 1990 had a burrow of 600 mm depth.

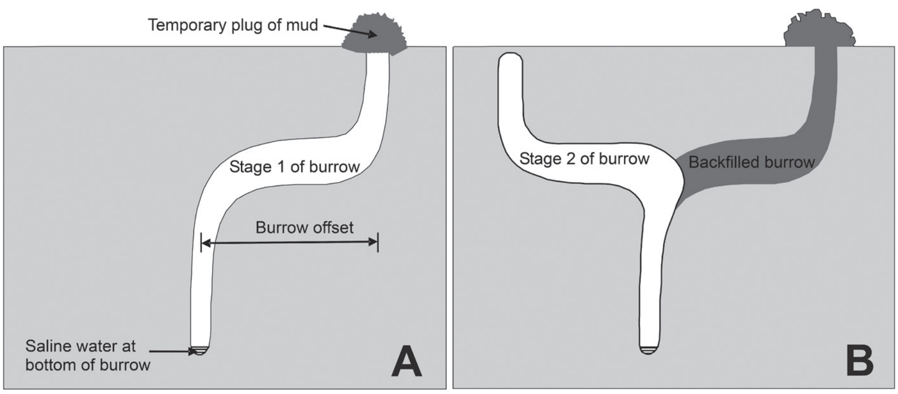

Fig. 3. Schematic burrow cross-section of salt lake dwelling *Tetralycosa* Roewer, 1960. **A**. Typical offset burrow of large immature and mature spiders. **B**. Burrow typical for the later part of summer, with original burrow backfilled.

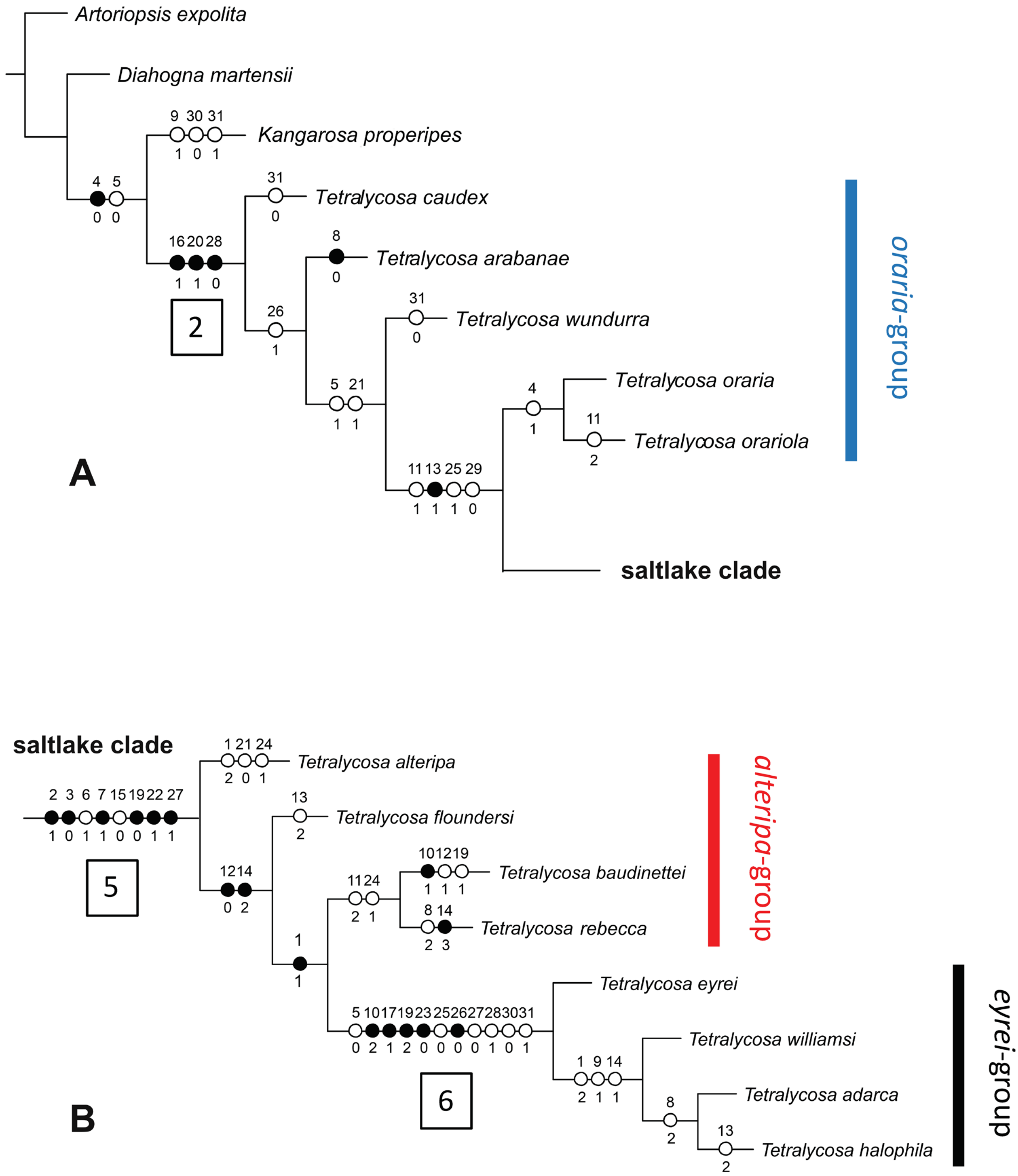

Fig. 4. Phylogenetic hypothesis of *Tetralycosa* Roewer, 1960 based on 31 morphological and one ecological characters. **A**. Basal branches including outgroups. **B**. Terminal salt lake clade (L = 71, Ci = 61, Ri = 80). Bremer support values > 1 are indicated by numbers in squares below the respective node.

Salt lake inhabiting *Tetralycosa* seal the entrance of their burrows at various times throughout the year. This can be in the form of a sheet of silk or a more substantial mud plug (Figs 1B, 4A). During the latter part of summer the upper section of the burrow is usually completely backfilled with mud acquired during the process of excavating a new upper section of burrow orientated in the opposite direction to the original (Fig. 3B). Both sexes excavate similar burrows.

Taxonomy

Key to species of *Tetralycosa*

1. Carapace profile with a straight, almost horizontal dorsal line in lateral view (Fig. 6A); anterior row of eyes as wide or wider than row of posterior median eyes (Fig. 6B) (*oraria*-group; coastal beaches, riparian zones of salt lakes and salt marshes) ……………………………………………2
– Carapace profile with an elevated cephalic area in lateral view, its dorsal line sloping downwards towards back (Fig. 15A); anterior row of eyes narrower than row of posterior median (*alteripa*- and *eyrei*-groups, only known from the playa of salt lakes) ……………………………………………6

2. Carapace and abdomen with distinct colour pattern; light lateral bands on carapace present; abdomen with dark or light spots (Figs 5A, C; 10 A, C, E, G) ……………………………………3
– Carapace and abdomen yellow to light brown, no distinct colour pattern (Fig. 5E, G, I) ……………5

3. Carapace with narrow light irregular submarginal bands and dark marginal bands (Fig. 10A, C); epigyne oval with truncated anterior edges (Fig. 11D); base of embolus exposed (Fig. 11A) (samphire zone of salt pans and lakes, southern WA) …………………………………***T. orariola*** sp. nov.
– Carapace with wide, light lateral bands (indistinct in light species) (Figs 5A, C, 10E, G); epigyne with anterior rounded edges (Fig. 6F, 12D–E); base of embolus hidden behind tegulum (Figs 6C, 12A) …4

4. Embolus of similar thickness along its length with long slightly curved and twisted tip (Fig. 6E); epigyne oval with distinct median septum (Fig. 6F) (coastal beaches and dunes only, southern Australia, incl. Tasmania) …………………………………………………***T. oraria*** (L. Koch, 1876)
– Embolus of male pedipalp broad over most of its length, apically constricted and with short tip (Fig. 12C); epigyne with very indistinct median septum (Figs 12D–E) (samphire zone of salt pans and lakes, southern WA) …………………………………***T. wundurra*** (McKay, 1979) comb. nov.

5. Anterior margin of epigyne continuous, anterior tip of median septum pointy (Fig. 8A) (male unknown) (only known from type locality in Pilbara region of Western Australia) …***T. caudex*** sp. nov.
– Anterior margin of epigyne divided into two separate hoods, anterior tip of median septum wide (Fig. 7D); lower tip of terminal apophysis with a triangle pointing upwards (Fig. 7C) (only known from mound springs of the Artesian Basin in SA) ……***T. arabanae*** Framenau, Gotch & Austin, 2006

6. Carapace with light lateral bands, sometimes indistinct and dissolved in separate spots (e.g., Figs 1C, 14A, G; 18C, E); venter of abdomen light or with grey central shimmer (e.g., Figs 14B, D, F; 18D, F, H); epigyne of variable shape with broad median septum (Figs 15E, 16D, 19C, 20C), but no round or oval atrium; tegular apophysis with pointy tip that is bent ventrally (Figs 15B–C; 16 A–B, 19A–B; 20 A–B) (*alteripa*-group) (salt lakes in SA and WA) ………7
– Carapace uniformly dark, venter of abdomen with black patch and light transverse band behind epigastric furrow (rarely absent in very dark specimen) (e.g., Figs 22B, F, H; 26D, F, H); epigyne a round or oval atrium with anterior central notch (Figs 23D, 24D, 27C, 28 D); tip of tegular apophysis truncated (23A, 24A, 27A, 28A) (*eyrei*-group) (salt lakes in SA, NSW and VIC) ………10

7. Femora yellow-brown, without dark pattern or annulations; epigyne with rectangular median septum (Fig. 15E); terminal apophysis with apical, laminar triangle (Fig. 14D) (SA, WA) ……… ……………………………………………………………………… ***T. alteripa*** (McKay, 1976)
– Femora dark brown and apically yellow-brown, or yellow-brown with apical dark annulation; epigyne without rectangular median septum; terminal apophysis without apical laminar triangle …8

8. Curved tegular apophysis forms a hook (Figs 16A, 19A); female epigyne much wider than long (Fig. 16D) or with distinct posterior edge (Fig. 19C) ……………………………………………………9
– Tegular apophysis appears as half a disk (Fig. 20A); epigyne slightly wider than long without distinct posterior edge (Fig. 20C)(WA) ……………………………………… ***T. rebecca*** sp. nov.

9. Tegular apophysis long and slim (Fig. 19A); epigyne with distinct posterior ridge (Fig. 19C) (WA) ……………………………………………………………………… ***T. floundersi*** sp. nov.
– Tegular apophysis short and strong (Fig. 16A); epigyne much wider than long (Fig. 16D) (WA) … ……………………………………………………………………………… ***T. baudinettei*** sp. nov.

10. The females of the *Tetralycosa eyrei*-group are almost impossible to separate reliably based on somatic or genitalic characters and are best identified by accompanying males. Therefore, only a key to males is provided here:
– Tegular apophyses apically with distinct broad, ventral edge (Figs 23A, 24A) …………………11
– Tegular apophysis apically without ventral edge (Figs 27A, 28A) ………………………………12

11. Upper edge of shaft of terminal apophysis bent ventrally (Fig. 23C) (SA) … ***T. adarca*** sp. nov.
– Upper edge of shaft of terminal apophysis straight (Fig. 24C) (SA) … ***T. eyrei*** (Hickman, 1944)

12. Tegular apophysis in ventral view appearing like a head of a horse (Fig. 27A) … ***T. halophila*** sp. nov.
– Tegular apophysis in ventral view a broad hook with tapered tip (Fig. 28A) … ***T. williamsi*** sp. nov.

Class Arachnida Cuvier, 1812
Order Araneae Clerck, 1758
Family Lycosidae Sundevall, 1833
Subfamily Artoriinae Framenau, 2007

Tetralycosa Roewer, 1960

Tetralycosa Roewer, 1960: 949, type species *Lycosa meracula* Simon, 1909, by original designation (considered a junior synonym of *Tetralycosa oraria* (L. Koch, 1876) by Framenau *et al.* 2006). The gender is feminine.

Diagnosis

Males of *Tetralycosa* differ from other lycosid genera within the Artoriinae by the combination of the following characters: tegular apophysis originating apically on tegulum and basally curved, opposing an apico-medially directed pointy (lobed in *T. halophila* sp. nov.) protrusion on the retrolateral section of the tegulum; basal lobe of tegular apophysis present; terminal apophysis forms a shaft for the resting embolus; female epigyne variable: with a wide median septum that displays an inverted T-shaped dark central pattern, or a round to oval opening with anterior notch.

Putative sister groups of *Tetralycosa* are *Kangarosa* Framenau, 2010 and *Diahogna* Roewer, 1960. The genital morphology within these two genera is very similar to *Tetralycosa*; however, the tegular apophysis of the male pedipalp is not curved, but is more or less straight. The female epigyne in both genera forms a small open atrium in comparison with *Tetralycosa* with its distinct median septum or large round to oval opening. Somatic characters shared by the *Kangarosa*, *Diahogna* and some species of *Tetralycosa* include the arrangement of the eyes, in particular the length of the anterior row of eyes that is as wide or wider than the posterior median row of eyes. Our phylogeny (Fig. 4A) suggest *Kangarosa* to be the sistergroup of *Tetralycosa* based on the absence of a median band on the carapace (character 4). However, only a single species of *Kangarosa* and *Diahogna* were included in our analyses, which focused on establishing intrageneric relationships within *Tetralycosa*.

Description

Small to large wolf spiders (TL 4.5–22.5 mm). Males smaller than females. Carapace longer than wide, dorsal profile straight in lateral view (*oraria*-group) (Fig. 6A), or with an elevated cephalic region and downward slope towards posterior end (*alteripa*- and *eyrei*-groups) (Fig. 15A). Head flanks in frontal view a gentle slope (*oraria*-group) or nearly vertical (*alteripa*- and *eyrei*-groups). Carapace colouration variable from uniform light yellowish-brown (*T. arabanae*, *T caudex* sp. nov.), brown with median and marginal bands (e.g., *T. wundurra* comb. nov., *alteripa*-group) to uniformly dark brown (*eyrei*-group). Anterior median eyes larger than anterior lateral eyes (except in *T. rebecca* sp. nov.), row of anterior eyes wider or as wide (*oraria*-group) or smaller (*alteripa*- and *eyrei*-groups) than row of posterior median eyes; row of anterior eyes straight, procurved or strongly procurved. Chelicerae generally with three promarginal and three retromarginal teeth, but two to four teeth on individual chelicerae possible on both margins. Labium generally as wide as or wider than long (except in *T. caudex* sp. nov., male *T. adarca* sp. nov. and male and female *T. halophila* sp. nov.). Abdomen generally with olive-grey heart mark, auxiliary colouration variable. Leg formula variable between species and sexes of the same species, leg I or leg III shortest (except in *T. caudex* sp. nov., leg II shortest). Femora I generally with three dorsal spines (rarely two or four), patella in males generally with prolateral and retrolateral spine (reduced in most females), tibiae of males generally with two dorsal spines (rarely none or only one).

Tegulum of male pedipalp deeply divided. Tegular apophysis located apically at tegulum, basally curved and opposing an apico-medially directed pointy protrusion on the retrolateral section of the tegulum. Tegular apophysis with a basal lobe. Embolus originating prolaterally on and curving ventrally around palea, long and slim. Basoembolic apophysis an unsclerotised lobe. Terminal apophysis well developed and forming a sclerotised shaft for the resting embolus. Cymbium tip without or only a few macrosetae. Female epigyne variable with a wide median septum sometimes only partially visible behind the sclerotised margins of the epigyne, which only leave a round or oval opening. Small round or oval spermathecal heads. Spermathecal stalks short and twisted.

Remarks

The type species of *Tetralycosa* is *Lycosa meracula* Simon, 1909, which was recently synonymised with *T. oraria* (Framenau *et al.* 2006). *Lycosa meracula* as illustrated by (McKay 1979a) represented material of two different but closely related species of *Costacosa* Framenau & Leung, 2013, a member of the subfamily Lycosinae (Framenau & Leung 2013).

Tetralycosa belongs to the subfamily Artoriinae Framenau, 2007 that also includes *Anoteropsis* L. Koch, 1878, *Artoria* Thorell, 1877, *Artoriopsis* Framenau, 2007, *Diahogna* Roewer, 1960, *Lycosella* Thorell, 1890, *Notocosa* Vink, 2002, and *Syroloma* Simon, 1900, an undescribed genus listed in Murphy *et al.* (2006) as 'New Genus 1' (Framenau 2007), and *Kangarosa* Framenau, 2010 (Framenau 2010). It may also include the Argentine genera *Lobizon* Piacentini & Grismado 2009 and *Navira* Piacentini & Grismado, 2009; however, the placement of these genera within the subfamily remains contentious (Piacentini & Grismado 2009).

A putative synapomorphy of this subfamily is the presence of the basoembolic apophysis on the male pedipalp. The monophyly of this subfamily is not only supported by the similar genital morphology, but also molecular data (Murphy *et al.* 2006).

The following taxonomic treatment groups the species into (in this order) the *oraria*-, *alteripa*- and *eyrei*-groups to facilitate comparison of similar species. Within each group, the species are in alphabetical order with the exception of *T. oraria*, the type species of the genus, which is treated first.

Tetralycosa oraria (L. Koch, 1876)
Figs 1E–F; 5A–D; 6A–G; 9

Lycosa oraria Koch, 1876: 883–886, pl. 76, figs 2, 2a, 3, 3a.
Lycosa candicans Koch, 1877: 888–890, pl. 76, figs 5, 5a, 6, 6a–b. Synonymy established in Framenau *et al.* (2006).
Lycosa sibyllina Simon, 1909: 188–189, fig. 7. Synonymy established in McKay (1979b).
Lycosa meracula Simon, 1909: 190–191. Synonymy established in Framenau *et al.* (2006).

Lycosa oraria – Simon 1909: 188. — Rainbow 1911: 270. — Bonnet 1957: 2656.
Lycosa candicans – Rainbow 1911: 266. — Hickman 1950: 5. — Bonnet 1957: 2637.
Lycosa sibyllina – Rainbow 1911: 272.
Lycosa meracula – Rainbow 1911: 270. — McKay 1985: 80. — Platnick 1989: 372. — Moritz 1992: 320.
Crocodilosa oraria – Roewer 1955: 238.
Tetralycosa meracula – Roewer 1955: 296; 1960: 949. — Rack 1961: 38.
Hogna sibyllina – Roewer 1955: 253.
Trochosula candicans – Roewer 1955: 304.
Trochosomma oraria – Roewer 1960: 847.
Ocyale oraria – McKay 1973: 380.
Lycorma meracula – McKay 1973: 380.
Trochosa candicans – McKay 1973: 381; 1979b: 293–294, fig. 4e; 1985: 85. — Platnick 1989: 390.
Trochosa oraria – McKay 1979b: 279–282, fig. 1a–h; 1985: 86. — Platnick 1989: 391; 1993: 510.
Tetralycosa oraria – Framenau *et al.* 2006: 26–27, fig. 58.

non Lycosa meracula – McKay 1979a: 264, fig. 9a–k: misidentification; not *L. meracula* but two species in the genus *Costacosa* Framenau & Leung, 2013 (Framenau & Leung 2013).

Diagnosis

Tetralycosa oraria is very similar to *T. orariola* sp. nov. In particular the female genitalia are indistinguishable and separating both species is easiest by the colouration of the carapace. The lateral light bands of *T. oraria* are wide, although sometimes irregular, and run straight along the carapace margin. In contrast, the light bands in *T. orariola* sp. nov. are narrow and separated from the carapace margins by narrow dark bands. *T. oraria* is overall larger than *T. orariola* sp. nov., but sizes overlap.

The wide and light marginal bands of the carapace are similar to those of *T. wundurra* comb. nov., however, both species differ in their genital morphology. The embolus of the male pedipalp in *T. wundurra* comb. nov. is very broad narrowing abruptly at more than three quarters length into a slim tip, whereas it is of similar width along its whole length and twisted apically in *T. oraria*. The median septum of the epigyne of *T. oraria* has a distinct bridge with parallel borders, which is not present in *T. wundurra* comb. nov.

Type material

AUSTRALIA: syntypes of *Lycosa oraria* L. Koch, 1876, unknown number of ♂♂ and ♀♀, King George Sound (35°02′ S, 117°56′ E, Western Australia), Bradley Collection (L. Koch, 1876). Considered lost (Framenau 2005b) (not examined).

AUSTRALIA: holotype of *Lycosa sibyllina* Simon, 1909, ♀, Albany (35°01′ S, 117°53′ E, Western Australia), 13/22 Aug. and 10 Oct. 1905, W. Michaelsen and R. Hartmeyer leg., 'Hamburger südwest-australische Forschungsreise', Station 165 (ZMB 11102) (examined).

AUSTRALIA: lectotype (designated here) of *Lycosa meracula* Simon, 1909, ♂, Albany (35°01′ S, 117°53′ E, Western Australia), 13/22 Aug. and 10 Oct. 1905, W. Michaelsen and R. Hartmeyer leg., 'Hamburger südwest-australische Forschungsreise', Station 165 (MHNP 24364) (examined).

AUSTRALIA: syntypes (paralectotypes) of *Lycosa meracula* Simon, 1909, 1 immature ♀, Denham (25°55′ S, 113°32′ E, Western Australia), 9–11 Jun.1905, W. Michaelsen and R. Hartmeyer leg., 'Hamburger südwest-australische Forschungsreise', Station 65 (ZMB 11085) (examined); 1 juvenile, same data (ZMH, Rack (1961)-catalogue 466) (examined); 1 juvenile, same data (WAM 11/4303) (examined) (None of the three immature syntypes are conspecific with the male type from Albany (Framenau *et al.* 2006)).

Other material examined

AUSTRALIA, New South Wales: 1 ♀, with spiderlings, Batemans Bay, 35°42′ S, 150°11′ E (MV K8157); 1 ♂, Eden, 37°03′ S, 149°54′ E (WAM T62653); 2 ♂♂, Nadgee Beach, 37°25′ S, 149°58′ E (AM KS2266, KS50159); 1 ♂, Richmond Beach, 35°42′ S, 150°18′ E (ANIC). – South Australia: 1 ♀, Baird Bay, 33°06′ S, 134°18′ E (WAM T65045); 1 ♀, Bald Hill Beach, Port Wakefield, 34°15′ S, 138°10′ E (SAM NN13934); 1 ♂, Charlton Gully, 34°33′ S, 135°47′ E (SAM NN13861); 1 ♀, 1 ♀ with egg sac, 3 juvs, Deep Lake, Innes National Park, 35°16′ S, 136°51′ E (SAM NN13850–1); 2 ♀♀, Edithburg, Yorke Peninsula, 35°05′ S, 137°44′ E (WAM T56654); 1 ♂, Emu Bay, Kangaroo Island, 35°38′ S, 137°32′ E (SAM NN13840); 2 ♂♂, 3 ♀♀, Flinders Island, Eyre Peninsula, 33°43′ S, 134°31′ E (SAM NN13854–7); 1 ♂, 2 ♀♀, 3 juvs, Lake Greenly, 34°20′ S, 135°25′ E (SAM NN13858–60); 3 ♂♂, Mt Rough, 12.1 km NNE of Mt Rough, Watervalley, 36°15′52″ S, 139°54′55″ E (SAM NN13440–2); 1 ♂, 2 ♀♀, Policeman Point, Coorong, 36°04′ S, 139°35′ E (SAM NN13842–4); 1 ♂, 3 juvs, Port Lincoln, 34°43′ S, 135°51′ E (AM KS85107); 1 ♂, 1 ♀, Port McDonnell, 38°03′ S, 140°42′ E (SAM NN13841); 1 ♀, Port Victoria, 34°30′ S, 137°29′ E (SAM NN13852); 1 ♀, Reevesby Island, 34°31′ S, 136°16′ E (MV K7813); 9 ♂♂, 4 ♀♀, Salt Lagoon, Kangaroo Island, 35°50′24″ S, 137°38′32″ E (SAM NN13443–5, NN13830–8); 1 ♀, Sinclairs Gap, salt lake nearby, 33°07′ S, 137°03′ E (SAM NN13928); 2 ♂♂, 2 ♀♀, 1 ♀ with spiderlings, St Kilda Boat Barbour, Adelaide, 34°44′ S, 138°32′ E (QM S61135–6); 1 ♂, 1 ♀, 1 juv., Stokes Bay, Kangaroo Island, 35°37′ S, 137°12′ E (SAM NN13839, QM S66329); 1 ♀, Thistle Island, 34°58′ S, 136°07′ E (QM S61137); 1 ♀, Thistle Island, Eyre Peninsula, 35°00′ S, 136°10′ E (SAM NN13853); 1 ♀, 1 juv., Troubridge Point, 35°09′30″ S, 137°40′00″ E (SAM NN13849); 3 ♂♂, 1 ♀, Victor Harbour, W of jetty to Granite Island, 35°33′ S, 138°38′ E (SAM NN13845–8); 1 ♀, Whyalla, sewerage ponds, 33°03′ S, 137°35′ E (SAM NN13865). – Tasmania: 4 ♂♂, 1 ♀, 5 juvs, Adventure Bay, Bruny Island, 43°17′ S, 147°17′ E (QM S66330); 3 ♀♀, 2 juvs, Brooks Creek, 41°18′ S, 144°44′ E (QVMAG 13:44304–5); 2 ♀♀, Chain of Lagoons, East Tasmania, 41°40′ S, 148°17′ E (QVMAG 13:11118); 1 ♂, 2 ♀♀, Clarke Island, 40°32′ S, 148°10′ E (QVMAG 13:25911, 13:25923); 1 ♀, 6 juvs, Darlington Beach, Maria Island, 42°37′ S, 148°05′ E (TMAG J3513); 2 ♂♂, Deal Island, 39°28′ S, 147°19′ E (MV K7810); 3 ♂♂, 1 ♀, 3 juvs, Eaglehawk Neck, 43°01′ S, 147°55′ E (QM S66331–2); 1 ♀, Flinders Island, Whitemark, 40°07′S, 148°01′ E (TMAG J650); 1 ♂, 1 ♀, 2 juvs, Hobbs Lagoon, 42°15′ S, 147°40′ E (QM S66327); 1 ♂, 1 ♀, Lauderdale, 42°54′ S, 147°29′ E (WAM T53669); 1 ♀, Pass River, King Island, 39°48′ S, 143°52′ E (QVMAG 13:44306); 2 ♂♂, Preservation

Island, Furneaux Group, 40°28′ S, 148°03′ E (TMAG J1141); 2 ♀♀, Sandspit Point, Schouten Island, 42°17′ S, 148°15′ E (TMAG J1660–1); 1 ♀, Strahan, 42°09′ S, 145°19′ E (AM KS85104); 3 ♂♂, 3 ♀♀, Wynyard, Table Cape, 40°59′ S, 145°43′ E (QM S66328). – Victoria: 1 ♂, no exact location (MV K7809); 1 ♂, Cockatoo, 37°57′ S, 145°29′ E (MV K8133); 1 ♂, Grey River, Otway Ranges, 38°41′ S, 143°50′ E (AM KS85106); 1 ♀, Mornington, 38°13′ S, 145°02′ E (MV K8154); 1 ♂, 2 ♀♀, Point Cook, 37°54′ S, 144°45′ E (MV K9088); 1 ♀, Werribee, 37°59′ S, 144°33′ E (MV K9104). – Western Australia: 1 ♀, Anvil Island, Recherche Archipelago, 33°30′ S, 123°58′ E (WAM T62359); 2 ♂♂, 1 ♀, Australind, 33°16′ S, 115°43′E (WAM 71/360–2); 1 ♀, Busselton, 33°38′ S, 115°20′ E (AM KS85105); 1 ♂, City Beach, near rifle range, 31°56′ S, 115°45′ E (WAM T53654); 1 ♂, E of Culham Inlet, 33°59′ S, 120°03′ E (WAM 98/2150); 4 ♂♂, 1 ♀, Dingo Beach, Torbay, 35°05′ S, 117°38′ E (QM W5649, W5651); 1 ♀, Dirk Hartog Island, 25°44′ S, 113°01′ E (WAM T53817); 15 ♂♂, 9 ♀♀, Dongara, 29°14′ S, 114°55′ E (WAM 71/1666–75, 71/1697–709, 71/1801); 1 ♀, 1 juv., Drummond Cove, via Geraldton, 28°39′ S, 114°36′ E (QM W5643); 1 ♀, Esperance District, 33°51′ S, 121°53′ E (MV K8145); 1 ♂, 4 ♀♀, 10 juvs, Fitzgerald River Inlet, 34°08′ S, 119°24′ E (WAM 70/3800–14, 71/642); 1 ♀, Fremantle, North Mole, 32°03′ S, 115°44′ E (WAM 70/217); 1 ♂, Fremantle, Obelisk Hill, 32°03′ S, 115°44′ E (ZMB 10583); 1 ♀, Garden Island, 32°12′ S, 115°40′ E (WAM 69/844); 3 ♂♂, 2 ♀♀, 1 juv., Geraldton, 28°46′ S, 114°37′ E (WAM 71/1690–5); 1 ♂, Goode Beach, Albany, 35°04′ S, 117°56′ E (WAM T53653); 3 ♂♂, 3 ♀♀, Guilderton, 31°21′04″ S, 115°29′52″ E (WAM T53393–7); 1 ♀ with spiderlings, Guilderton, Moore River, 31°20′ S, 115°30′ E (WAM 71/1993); 1 ♀, 1 juv., Gun Island, South Group, Houtman Abrolhos, 28°53′ S, 113°51′ E (WAM 71/1667–7); 3 ♀♀, Lancelin Island, 31°0′ S, 115°19′ E (WAM 71/771–3); 1 ♂, Leeman Swamp, 29°56′27″ S, 114°59′50″ E (WAM T93541); 1 ♀, Mettams Pool, 31°52′ S, 115°45′ E (WAM T56531); 1 ♂, 1 ♀, Middle Island, Recherche Archipelago, 34°06′ S, 123°11′ E (WAM T69946); 4 ♂♂, 7 ♀♀, 1 juv., North Island, Houtman Abrolhos, 28°43′ S, 113°47′ E (WAM 71/1680–85, 71/1802–5, 71/1991–2, 71/1994); 1 ♀, Point Malcolm, 33°47′ S, 123°45′ E (WAM T51432); 2 ♂♂, Post Office Island, South Group, Houtman Abrolhos, 28°52′ S, 113°58′ E (WAM 71/1678–9); 2 ♂♂, 1 ♀, Quarantine Bay, 37°03′ S, 149°52′ E (WAM T64979); 1 ♂, 1 ♀, Rossiter Bay, Cape Le Grand National Park, 33°58′21″ S, 122°16′13″ E (WAM T93994); 1 ♀ with egg sac, Rottnest Island, 32°00′ S, 115°36′ E (WAM T47247); 1 ♂, Safety Bay Foreshore Reserve, 32°18′ S, 115°43′ E (WAM T65111); 1 ♂, Shelly Beach, 35°02′ S, 116°44′ E (WAM T53495); 3 ♂♂, South Cottesloe Beach, 31°59′ S, 115°45′ E (WAM T65606); 2 ♀♀, Two Peoples Bay, 34°57′ S, 118°11′ E (WAM T51431, T53692); 1 ♀, Windy Harbour, back beach, 34°50′ S, 116°01′ E (WAM 72/251).

Description

Measurements. ♂ WAM T53697 (♀ WAM T53393): TL 8.25 (12.30), CL 4.50 (5.10), CW 3.45 (4.13). Eyes: AME 0.21 (0.21), ALE 0.17 (0.18), PME 0.38 (0.41), PLE 0.33 (0.37). Row of eyes: AE 0.93 (1.05), PME 0.93 (1.05), PLE 1.23 (1.54). Sternum length/width: 1.95/1.65 (2.25/1.88). Labium length/width: 0.58/0.60 (0.72/0.79). AL 2.85 (6.75), AW 4.2 (5.1). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 1.95+1.65+ – +1.25 = 4.85, I 3.60+4.50+3.30+1.80 = 13.20, II 3.75+4.65+3.75+2.25 = 14.4, III 3.38+3.83+3.60+1.65 = 12.46, IV 4.20+4.95+4.65+1.95 = 15.75 (Pedipalp 2.25+2.10+ – +1.35= 5.70, I 3.60+4.35+2.70+1.65 = 12.30, II 3.60+4.20+2.85+1.65 = 12.30, III 3.45+3.90+3.30+1.58 = 12.23, IV 4.50+5.10+4.35+1.95 = 19.90).

Variation. ♂ (♀) (range, mean ± SD): TL 6.75–9.45, 8.35 ± 0.82; CL 3.75–4.95, 4.55 ± 0.39; CW 2.85– 4.05, 3.55 ± 0.46; n = 9 (TL 9.75–14.25, 11.26 ± 1.35; CL 4.05–6.45, 5.04 ± 0.77; CW 3.15– 5.03, 3.98 ± 0.64; n = 13). *Tetralycosa oraria* is very variable in colouration. Some specimens are extremely light without a distinct colour pattern; others are dark olive-grey with light bands (Fig. 1E–F). It appears that the particular microhabitat (for example dark seaweed vs plain beach) may explain the colour patterns of individual specimens (see also McKay 1979b). There also appears to be some intraspecific morphological variation in leg length and eye position, as McKay (1979b) reported a different leg formula (IV>I>II>III) and relative length of the anterior row of eyes and posterior median eyes.

Male (based on WAM T53397)
Carapace (Fig. 5A). Dorsal line straight in lateral view (Fig. 6A); brown with indistinct and irregular light colouration medially and broad, irregular light marginal bands; indistinct darker radial pattern; covered with mainly brown setae, but white setae in marginal bands; very few brown bristles in eye region mainly between PME; four long bristles below AE; one long bristle between AME.

Eyes (Fig. 6B). Row of AE as wide as row of PME; row of AE slightly procurved (Fig. 6B).

Chelicerae. Brown, darker apically; covered with long white setae and few brown bristles medially; three promarginal teeth with the median largest; three retromarginal teeth of similar size.

Sternum (Fig. 5B). Yellow-brown, with dark pigmentation towards the margins; covered with few white setae and longer brown macrosetae that are longer towards margins.

Labium. Brown, basally dark brown; front end truncate and white.

Pedipalps (Fig. 6C–E). Tegular apophysis broad with a basally pointing tip (Fig. 6C); terminal apophysis forms sheath for the resting embolus; embolus long and thin with curved tip (Fig. 6E).

Abdomen. Dorsally dark olive-brown with light lanceolate heart mark in anterior half; few irregular light patches formed by fields of lighter setae; otherwise covered in brown setae (Fig. 5A). Ventrally yellow-brown with some mottled olive-grey discolouration and with white and fewer brown setae. Spinnerets yellow-brown (Fig. 5B).

Legs. Leg formula IV>II>I>III. Femora yellow, distal segments darker; weak scopula on tarsus I. Spination of leg I: femur: three dorsal, one apicoprolateral; patella: one prolateral; tibia: three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral.

Female (based on WAM T53393)
Carapace (Fig. 5C). Brown, indistinct narrow light median band and wide marginal bands; covered with white setae and few black setae anteriorly of fovea; brown bristles in and around eye region; four long bristles below AME, one long bristle between AME.

Eyes. Row of AE as wide as row of PME; row of AE slightly procurved.

Chelicerae. Colour, setae and dentition as male.

Sternum (Fig. 5D). Yellow-brown and somewhat darker marginally; setae as male.

Labium. As male.

Abdomen. Dorsally yellow-brown with indistinct light lanceolate heart mark; setae as male but with grey setae on dark patches (Fig. 5C). Venter and spinnerets yellow-brown with little darker pigmentation (Fig. 5D).

Epigyne. Ventral view (Fig. 6F): ovoid median septum with curved posterior border. Dorsal view (Fig. 6G): small spermathecal heads, convoluted spermathecal stalks attach posteriorly.

Legs. Leg formula IV>I=II>III. Colour pattern as male. Spination of leg I: femur: two dorsal, one apicoprolateral; tibia: three ventral pairs, two prolateral (only one on left leg); metatarsus: three ventral pairs, two prolateral; one retrolateral (only on left leg), one apicoventral.

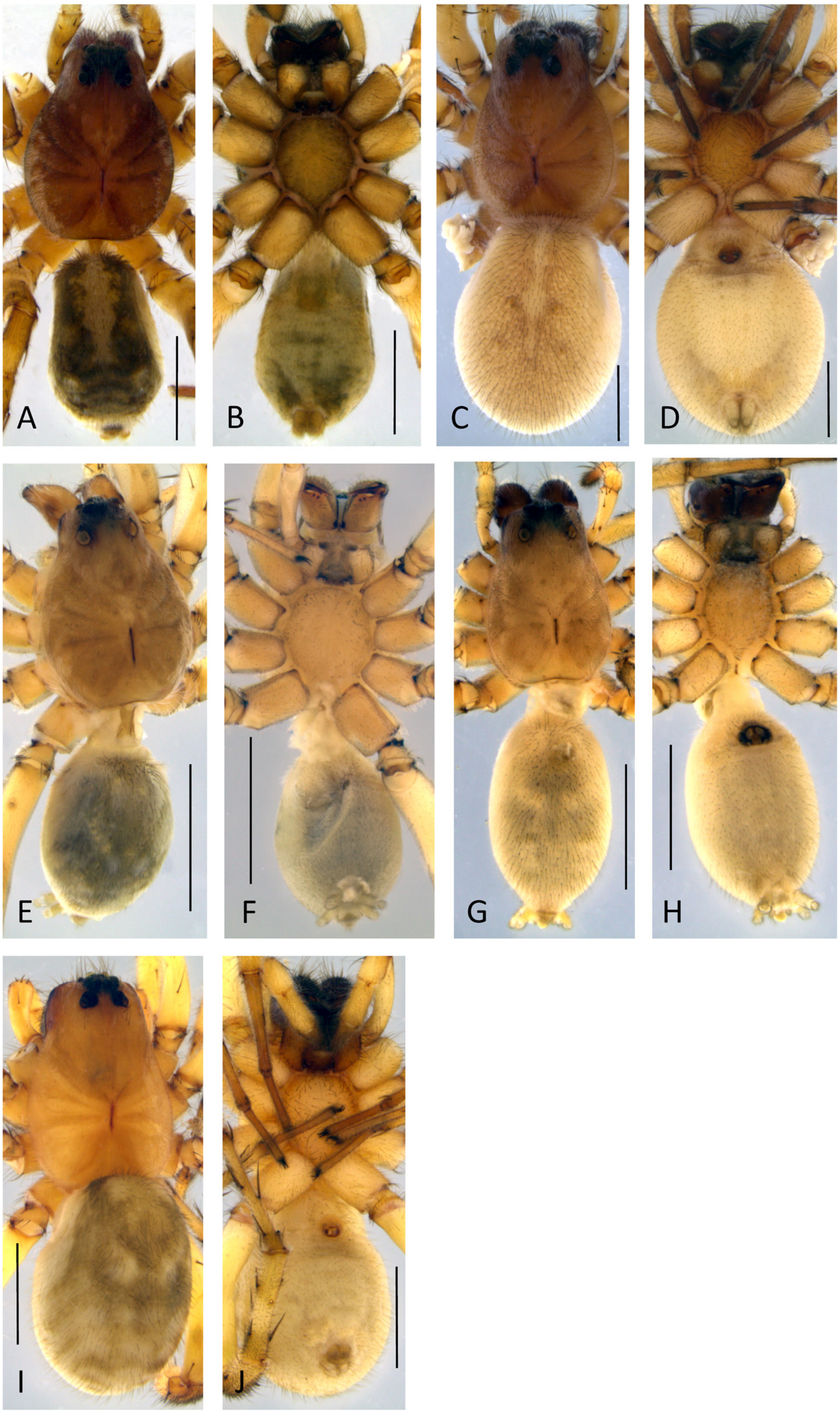

Fig. 5. *Tetralycosa* Roewer, 1960, microscopic photographs showing dorsal and ventral views. **A–B**. *T. oraria* (L. Koch, 1876), ♂ (WAM T93541). **C–D**. *T. oraria* (L. Koch, 1876), ♀ (WAM T93944). **E–F**. *T. arabanae* (Framenau, Gotch & Austin, 2006), ♂ (WAM T47298). **G–H**. *T. arabanae* (Framenau, Gotch & Austin, 2006), ♀ (WAM T47298). **I–J**. *T. caudex* sp. nov., ♀ (WAM T55576). Scale bars: A–J = 2.00 mm.

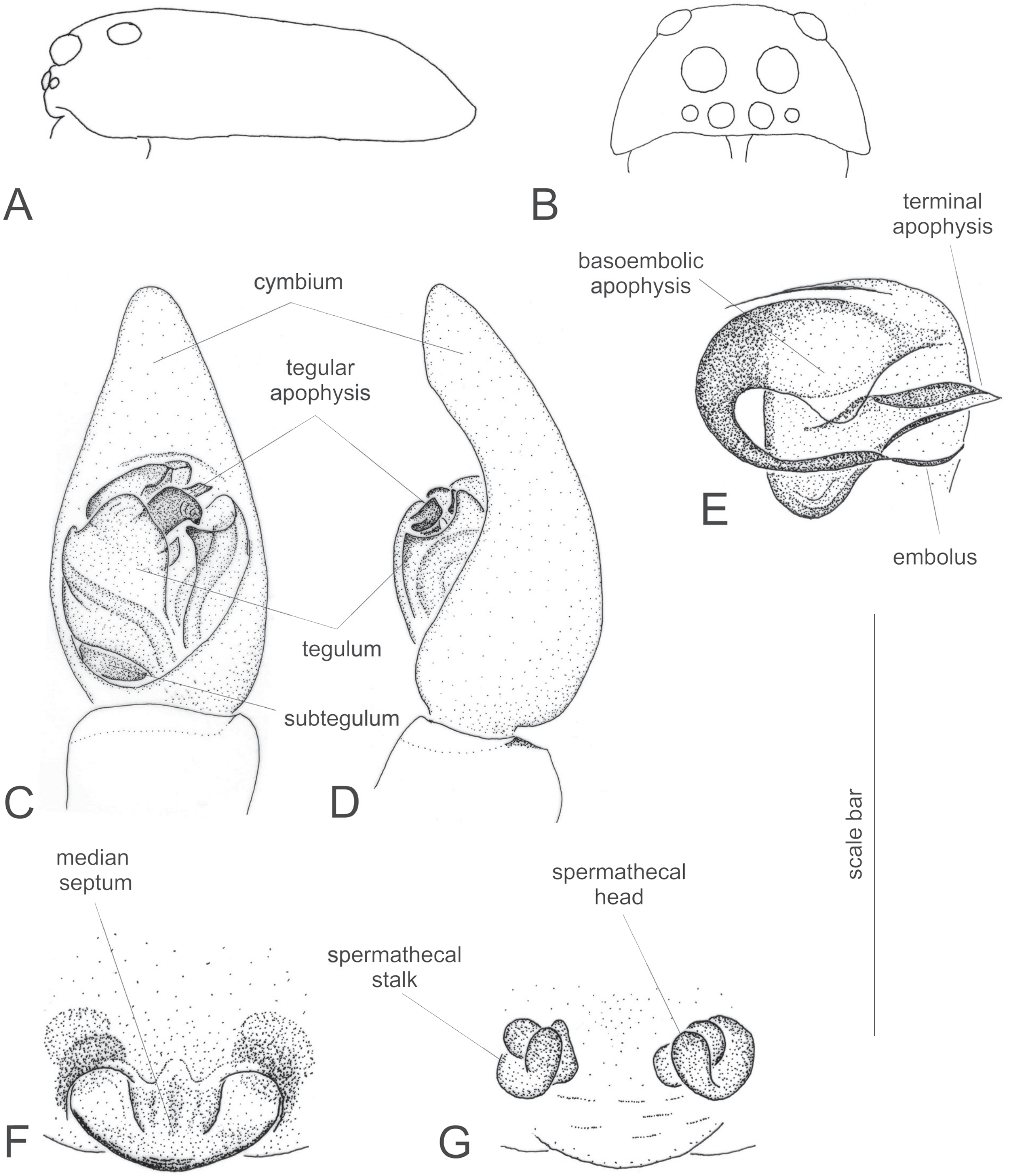

Fig. 6. *Tetralycosa oraria* (L. Koch, 1876), ♂ (WAM 71/360) and female (WAM 71/361). **A–B**. Male carapace, lateral and frontal view. **C–D**. Left male pedipalp, ventral and retrolateral view. **E**. Left male pedipalp, palea section of bulbus, ventral view. **F–G**. Female epigyne, dorsal and ventral view. Scale bar: A = 4.42 mm; B = 1.88 mm; C–D = 1.28 mm; E = 0.56 mm; F–G = 0.89 mm.

Remarks

An adult male syntype of *Lycosa meracula* was only recently discovered in the MHNP resulting in re-evaluation of the juvenile type material of this species that was examined by McKay (1979a) (Framenau *et al.* 2006). The species illustrated as *L. meracula* by McKay (McKay 1979a) is not conspecific with the male syntype of *L. meracula* from Albany. The material included two closely related coastal species in the genus *Costacosa* (Framenau & Leung 2013). To fix the taxonomic concept of *T. meracula*, the male from Albany (MHNP 24364) is here designated as lectotype.

Life history and habitat preferences

Tetralycosa oraria is an exclusively coastal species inhabiting sandy beaches and the base of sand dunes on the foreshore. Adult spiders of *T. oraria* can be found all year round and do not seem to have a clear seasonal pattern for reproduction, as females with egg sacs and spiderlings have been found from December to February, but also in July and October.

Distribution

Coastal mainland Australia south of approximately 25°S latitude, and Tasmania, although a few records are from further inland, if saline wetlands are found near the beach (Fig. 9).

Tetralycosa arabanae Framenau, Gotch & Austin, 2006
Figs 5E–H; 7A–E; 9

Tetralycosa arabanae Framenau, Gotch & Austin 2006: 24–25, figs 48–57.

Diagnosis

The somatic morphology and colouration of *T. arabanae* is very similar to that of *T. caudex* sp. nov. Both species are very light yellow-brown without any distinct colour patterns. Whereas the epigyne of *T. arabanae* has two separate anterior hoods, the anterior margin of *T. caudex* sp. nov. is continuous. The male of *T. caudex* sp. nov. is not known.

Type material

Holotype

AUSTRALIA: ♂, South Australia, Jersey Spring, 29°20′ S 136°35′ E, 18 Jul. 1996, D. Niejalke leg. (SAM NN13871) (examined).

Paratypes

AUSTRALIA: 1 ♂, 2 juvs, same data as holotype (SAM NN13872) (examined); 7 ♂♂, 2 ♀♀, 1 ♀ with 41 spiderlings, South Australia, Jersey Spring, 29°21′ S, 136°45′ E, 12 Nov. 1997, K.-J. Lamb leg. (SAM NN13887–96) (examined).

Other material examined

AUSTRALIA, South Australia: 1 ♂, Blanche Cup Mound Springs, 29°27′ S, 136°52′ E (SAM NN13884); 1 ♂, Buttercup Mound Spring, 29°29′ S, 136°54′ E (SAM NN13885); 1 ♀, Coongie Lake, 27°12′ S, 140°10′ E (SAM NN13869); 4 ♂♂, 1 ♀, Elizabeth Springs (North A), 29°21′ S, 136°46′ E (SAM NN13878–82); 1 ♀, Elizabeth Springs (North B), 29°21′ S, 136°46′ E (SAM NN13883); 1 ♀, 1 juv., Elizabeth Springs Bore, 29°21′ S, 136°46′ E (SAM NN13870); 2 ♂♂, 4 juvs, Francis Swamp mound spring, 29°06′ S, 136°18′ E (SAM NN13876–7); 1 ♀ with 67 spiderlings, Gosse East Spring, 29°28′ S, 137°21′ E (SAM NN13886); 2 ♀♀, Gosse Springs, 29°28′ S, 137°18′ E (WAM T47297); 1 ♀, 1 juv., Hermit Hill Springs, 29°34′ S, 137°25′ E (SAM NN13873); 20 ♂♂, 10 ♀♀, 1 juv., Horse East Spring, 29°29′ S, 136°55′ E (SAM NN13897–916); 2 ♀♀, Horse Springs, 29°29′ S, 136°55′ E (WAM

T47299); 1 ♀, Lake Frome, 31°00′ S, 139°46′ E (SAM NN13867); 1 ♀, Lake Hart, 31°14′ S, 136°22′ E (SAM NN13933); 1 ♀, 1 juv., Lake Hope Channel, 3.9 km S Lake Appadare, 28°15′ S, 139°12′ E (SAM NN13868); 2 ♂♂, 1 ♀, 1 juv., McLachlan Springs, 29°28′ S, 137°18′ E (WAM T47298); 1 ♀, Morris Creek Bore, 29°26′ S, 137°34′ E (WAM T47296); 1 ♂, Morris Creek Bore, 29°28′ S, 137°19′ E (WAM T47295); 1 ♂, 4 juvs, Old Finnis Spring, 29°45′ S, 137°31′ E (SAM NN13874); 1 ♂, Smith Spring, 29°30′ S, 137°22′ E (SAM NN13875); 5 ♂♂, 2 ♀♀, 5 juvs, Tregalana Salt Lake, 32°51′ S, 137°38′ E (SAM NN13862–4, NN13929–32).

Description

Tetralycosa arabanae was described recently in detail (Framenau *et al.* 2006). Microscopic photographs of males and females (Fig. 5E–H) and drawings of male and female genitalia (Fig. 7A–E) are depicted here to illustrate diagnostic features of this species.

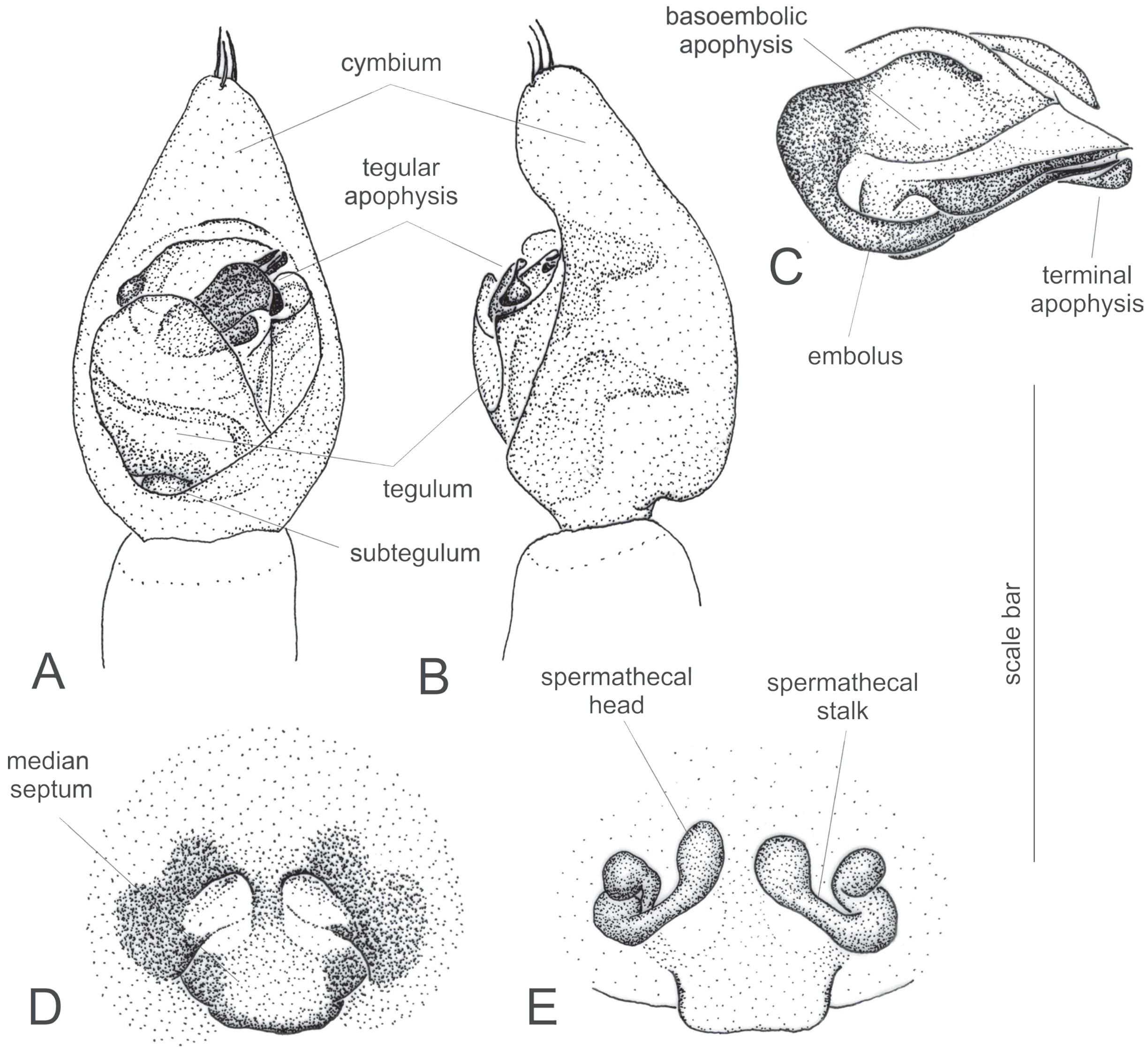

Fig. 7. *Tetralycosa arabanae* (Framenau, Gotch & Austin, 2006), ♂, paratype (SAM NN13887) and ♀ (WAM T47297, T47296). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Left male pedipalp, palea section of bulbus, ventral view. **D**. Female epigyne, ventral view (WAM T47297). **E**. Female epigyne, dorsal view (WAM T47296). Scale bar: A–B = 1.02 mm; C = 0.32 mm; D–E = 1.00.

Life history and habitat preference

Tetralycosa arabanae was mainly collected at South Australian artesian springs (Framenau *et al.* 2006). Here, it inhabits the lower parts of the spring tail and the ephemeral wet regions beyond the permanent vegetated wetland. It has also been found near semi-permanent saline waterholes near Hermit Hill Springs. Most females and males have been found between July and December; however, there is also some adult activity in April and May.

Distribution

Tetralycosa arabanae can mainly be found at springs fed by the Great Artesian Basin in South Australia (Fig. 9).

Tetralycosa caudex sp. nov.

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Figs 5I–J; 8A–B; 9

Diagnosis

Tetralycosa caudex sp. nov. is very similar to *T. arabanae* (see 'Diagnosis' there).

Etymology

The specific epithet is a noun in apposition, from the Latin '*caudex*', wooden stem, in reference to the type locality, Woodstock Station.

Type material

Holotype

AUSTRALIA: ♀, Western Australia, Woodstock Station, 21°37′00″ S, 119°01′24″ E, pitfall trap, site WS9, trap #3, 27 Mar. 1988, W.F. Humphreys leg. (WAM T55570).

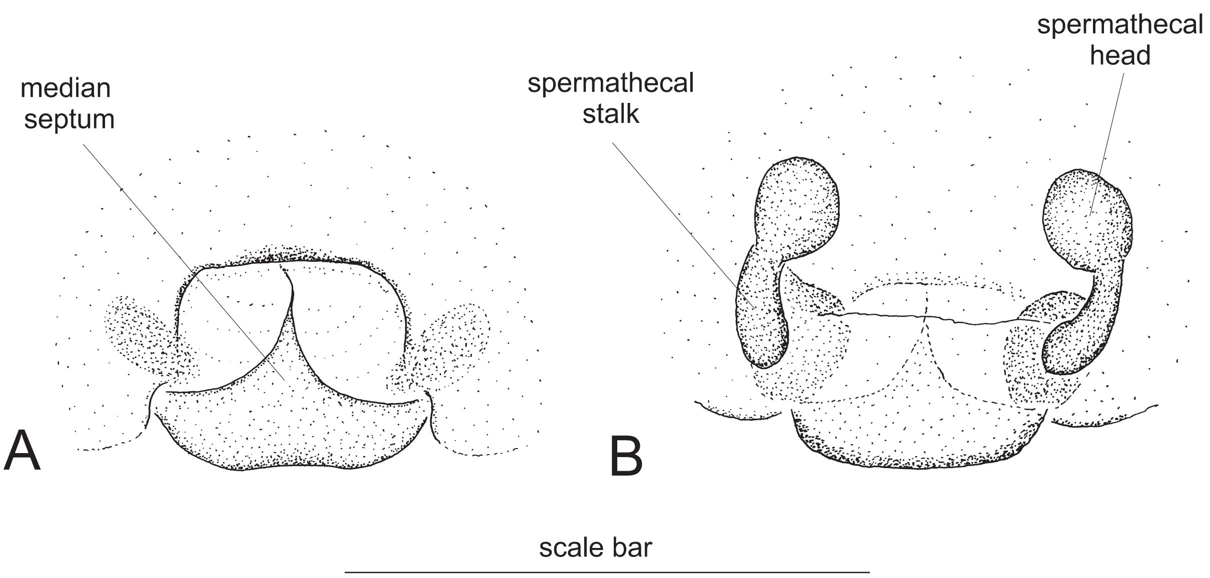

Fig. 8. *Tetralycosa caudex* sp. nov. **A**. Epigyne, dorsal view (holotype, ♀, WAM T55570). **B**. Epigyne, ventral view (♀, WAM T62497). Scale bar: A–B = 0.47 mm.

Other material examined

AUSTRALIA, Western Australia: 10 ♀♀, 1 ♀ with spiderlings, 23 juvs, Woodstock Station, 21°37′00″ S, 119°01′24″ E (WAM T55576, T62493, T62497, T62611).

Description

Male
Unknown.

Female (based on holotype, WAM T55570)
MEASUREMENTS. ♀ holotype, WAM T53393: TL 7.80, CL 3.83, CW 2.28. Eyes: AME 0.20, ALE 0.16, PME 0.33, PLE 0.23. Row of eyes: AE 0.80, PME 0.74, PLE 0.97. Sternum length/width: 1.73/1.43.

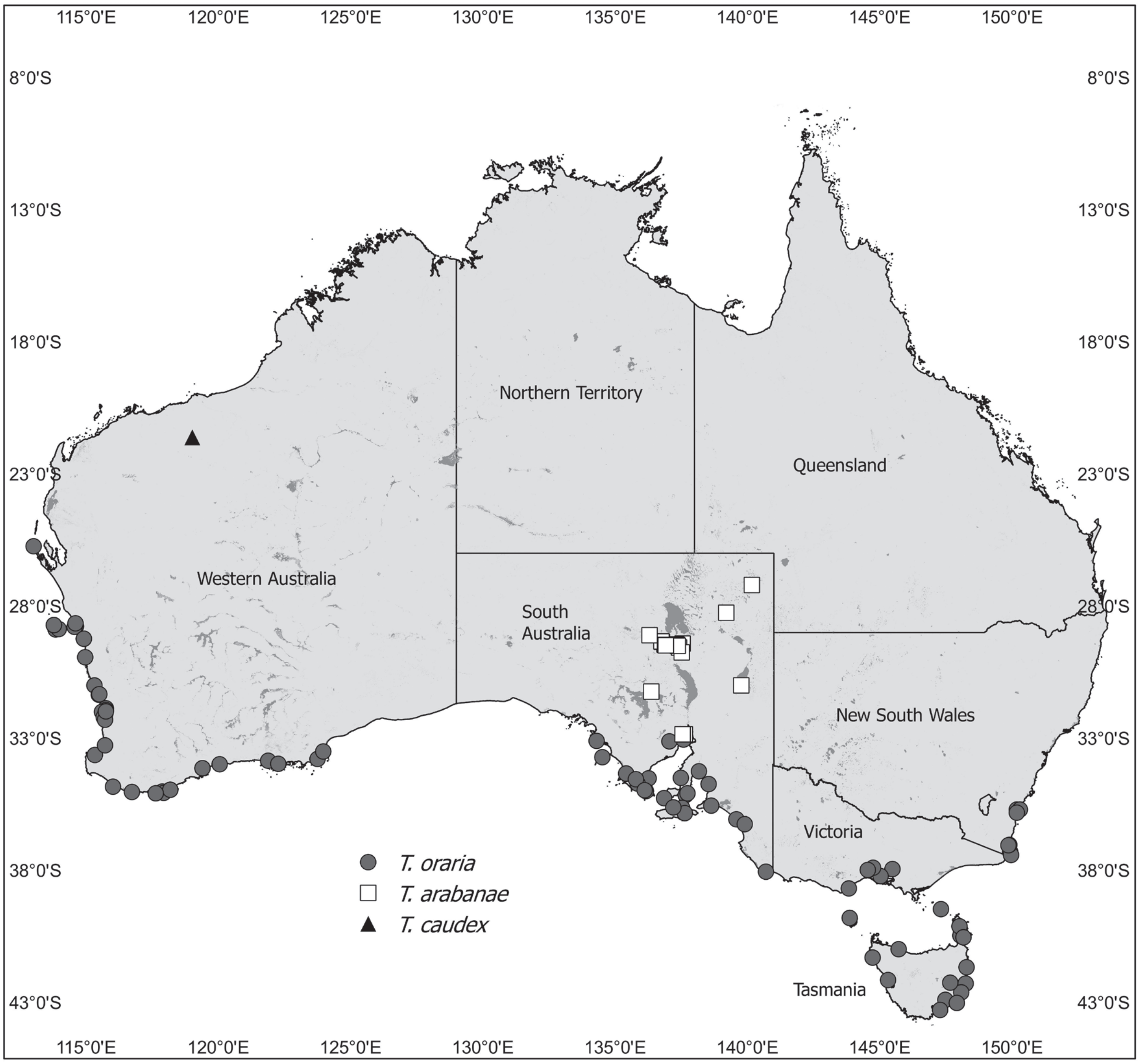

Fig. 9. *Tetralycosa oraria* (L. Koch, 1876), *T. arabanae* (Framenau, Gotch & Austin, 1976) and *T. caudex* sp. nov., distribution records in Australia.

Labium length/width: 0.57/0.53. AL 3.98, AW 3.00. Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 1.49+1.52+ – + 0.92 = 3.93, I 2.80+3.38+2.17+1.06 = 9.41, II 2.57+3.09+2.15+1.06 = 8.87, III 2.55+2.89+2.37+1.26 = 9.07, IV 3.20+4.35+3.03+1.54 = 12.12.

VARIATION. ♀ (range, mean ± SD): TL 5.85–9.00, 7.18 ± 1.07; CL 3.00–4.20, 3.56 ± 0.47; CW 2.25–3.15, 2.70 ± 0.36; n = 8.

CARAPACE (Fig. 5I). Dorsal line straight in lateral view; yellow-brown with lighter radial pattern; cephalic area slightly darker; indistinct grey pigmentation anteriorly of fovea, few white setae along carapace margins and laterally of PE; brown macrosetae in eye region and between eye region and fovea; six long bristles below AME, one long bristle between AME.

EYES. Row of AE slightly wider than row of PME; row of AE straight.

CHELICERAE. Brown; covered with brown setae and macrosetae. Two promarginal teeth, with the apical largest, three retromarginal teeth, with the basal smallest.

STERNUM (Fig. 5J). Yellow-brown; covered with long brown setae.

LABIUM. Dark brown, basally darker; front end truncate and white.

ABDOMEN. Dorsally olive-brown with pairs of irregular lighter patches; indistinct brown lanceolate heart mark; mainly brown and fewer white setae, few brown macrosetae (Fig. 5I). Venter yellow-brown with brown setae. Spinnerets yellow-brown (Fig. 5J).

EPIGYNE. Ventral view (Fig. 8A): median septum inverted T-shaped with rounded anterior curves; anterior margin continuous and nearly straight. Dorsal view (Fig. 8B): large bulbous spermathecal heads; spermathecal stalks slim and attach posteriorly to spermathecae.

LEGS. Leg formula IV>I>III>II. Light brown, some grey pigmentation; basal two thirds of femora yellow-brown. Pedipalp with very long claw. Spination of leg I: femur: three dorsal, one apicoprolateral, two retrolateral; tibia: two ventral pairs, two prolateral; metatarsus: two ventral pairs, one prolateral, one apicoventral.

Remarks

Although the male of *T. caudex* sp. nov. is unknown, female somatic and genital morphology match the diagnosis of the genus and our phylogenetic analysis places it here. Some characters are unusual within the *Tetralycosa*; for example, *T. caudex* sp. nov. is the only species within the genus in which leg II is the shortest. In addition, the type and only locality of this species in northern Western Australia falls outside the general distribution of the genus (Fig. 9).

Life history and habitat preferences

Only a limited number of female *T. caudex* sp. nov. have been found, some of them in granite with sand near a creek. Most records are from May, one female was found in March.

Distribution

Only known from the type locality, Woodstock Station in the Pilbara region of Western Australia (Fig. 9).

Tetralycosa orariola sp. nov.
urn:lsid:zoobank.org:act:6F8133B4-6684-49CD-95D7-2A2269FAAB90
Figs 10A–D; 11A–E; 13

Diagnosis

Tetralycosa orariola sp. nov. is very similar to *T. oraria* (see Diagnosis there).

Etymology

The specific epithet is an adjective in apposition and the Latin diminutive of '*oraria*' ('*orarius*', coastal), referring to the very similar but larger species *T. oraria*.

Type material

Holotype

AUSTRALIA: ♂, Western Australia, Kulunilup Nature Reserve, Wittenoom Road, 34°20′00″ S, 116°48′03″ E, wet pitfall trap, CALM Salinity Action Plan, site UN8, 15 Oct. 1999–1 Nov. 2000, N.A. Guthrie leg. (WAM T62787).

Paratypes

AUSTRALIA: 1 ♀, data as holotype (WAM T62788); 4 ♂♂, 3 ♀♀, data as holotype (WAM T47203); 1 ♂, data as holotype (WAM T62321).

Other material examined

AUSTRALIA, Western Australia: 6 ♂♂, 8 ♀♀, Camel Lake Nature Reserve, 34°15′50″ S, 117°57′49″ E (WAM T47214–5); 4 ♂♂, 3 ♀♀, Coolinup Nature Reserve, 33°34′02″ S, 122°17′55″ E (WAM T47216); 1 ♂, 1 ♀, Coyrecup Lake Nature Reserve, 33°43′12″ S, 117°05′54″ E (WAM T47160); 2 ♀♀, Dragon Rocks Nature Reserve, 32°38′40″ S, 118°59′11″ E (WAM T47151–2); 1 ♀, Duke of Orleans Bay Caravan Park, 33°56′ S, 122°35′ E (WAM T47246); 1 ♂, Fitzgerald River (no exact location) (WAM T51416); 19 ♂♂, 4 ♀♀, 6 juvs, Gulson Lake Nature Reserve, 32°45′57″ S, 119°24′40″ E (WAM T47158, T47202); 1 ♀, Kulunilup Nature Reserve, 34°20′00″ S, 116°48′03″ E (WAM T47150); 18 ♂♂, 6 ♀♀, 1 juv., Lake Bryde West Nature Reserve, Lake Bryde Road, 33°21′40″ S, 118°48′14″ E (WAM T47209); 19 ♂♂, 3 ♀♀, Lake Goorly, 29°56′08″ S, 116°53′09″ E (WAM T47211); 2 ♂♂, 1 ♀, Lake Ninan Shire Reserve, 30°56′31″ S, 116°38′28″ E (WAM T47207); 1 ♂, Mortlock Creek, Wongan Hills, 30°45′ S, 116°38′ E (WAM 99/1102); 1 ♀, near Lort River, North Rollands Road, W of Grass Patch, 33°12′20″ S, 121°18′08″ E (WAM T47212); 2 ♂♂, 1 juv., Ongerup, 2 miles E of Ongerup, 33°57′ S, 118°30′ E (WAM T53858); 7 ♂♂, 8 ♀♀, Wittenoom Hill Nature Reserve, Wittenoom Road, 33°28′11″ S, 122°00′50″ E (WAM T47149, T47201); 2 ♂♂, 2 ♀♀, 2 juvs, Wittenoom Road, near junction with Dempster Road, 33°38′15″ S, 122°00′50″ E (WAM T47206).

Description

MEASUREMENTS. ♂ holotype, WAM T62787 (♀ paratype, WAM T62788): TL 7.58 (8.55), CL 4.35 (4.50), CW 3.15 (3.45). Eyes: AME 0.20 (0.20), ALE 0.18 (0.14), PME 0.34 (0.40), PLE 0.32 (0.30). Row of eyes: AE 0.89 (1.00), PME 0.89 (0.96), PLE 1.23 (1.20). Sternum length/width: 1.95/1.65 (1.80/1.65). Labium length/width: 0.54/0.63 (0.57/0.74). AL 3.15 (4.05), AW 2.55 (3.45). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 1.65+1.50+ – +1.35 = 4.50, I 3.30+4.20+3.15+1.73 = 12.38, II 3.30+4.20+3.45+1.73 = 12.68, III 3.00+3.53+3.08+1.50 = 11.11, IV 3.75+4.50+4.05+1.80 = 13.95 (Pedipalp 1.58+1.50+ – +1.13= 4.21, I 3.00+3.60+2.40+1.50 = 10.50, II 3.00+3.30+2.55+1.35 = 10.20, III 2.85+3.00+2.40+1.35= 9.60, IV 3.75+4.20+3.75+1.73 = 13.43).

Variation. ♂ (♀) (range, mean ± SD): TL 5.10–11.25, 6.92 ± 1.66; CL 3.00–4.50, 3.64 ± 0.44; CW 2.10– 3.45, 2.70 ± 0.37; n = 16 (TL 6.15–10.20, 8.14 ± 1.51; CL 3.15–4.80, 3.84 ± 0.52; CW 2.25–3.30, 2.94 ± 0.34; n = 14).

Male (based on holotype, WAM T62787)

Carapace (Fig. 10A). Dorsal line straight in lateral view; dark brown with a dark radial pattern; irregular light brown median band and thin but continuous and undulating light brown lateral bands; covered with

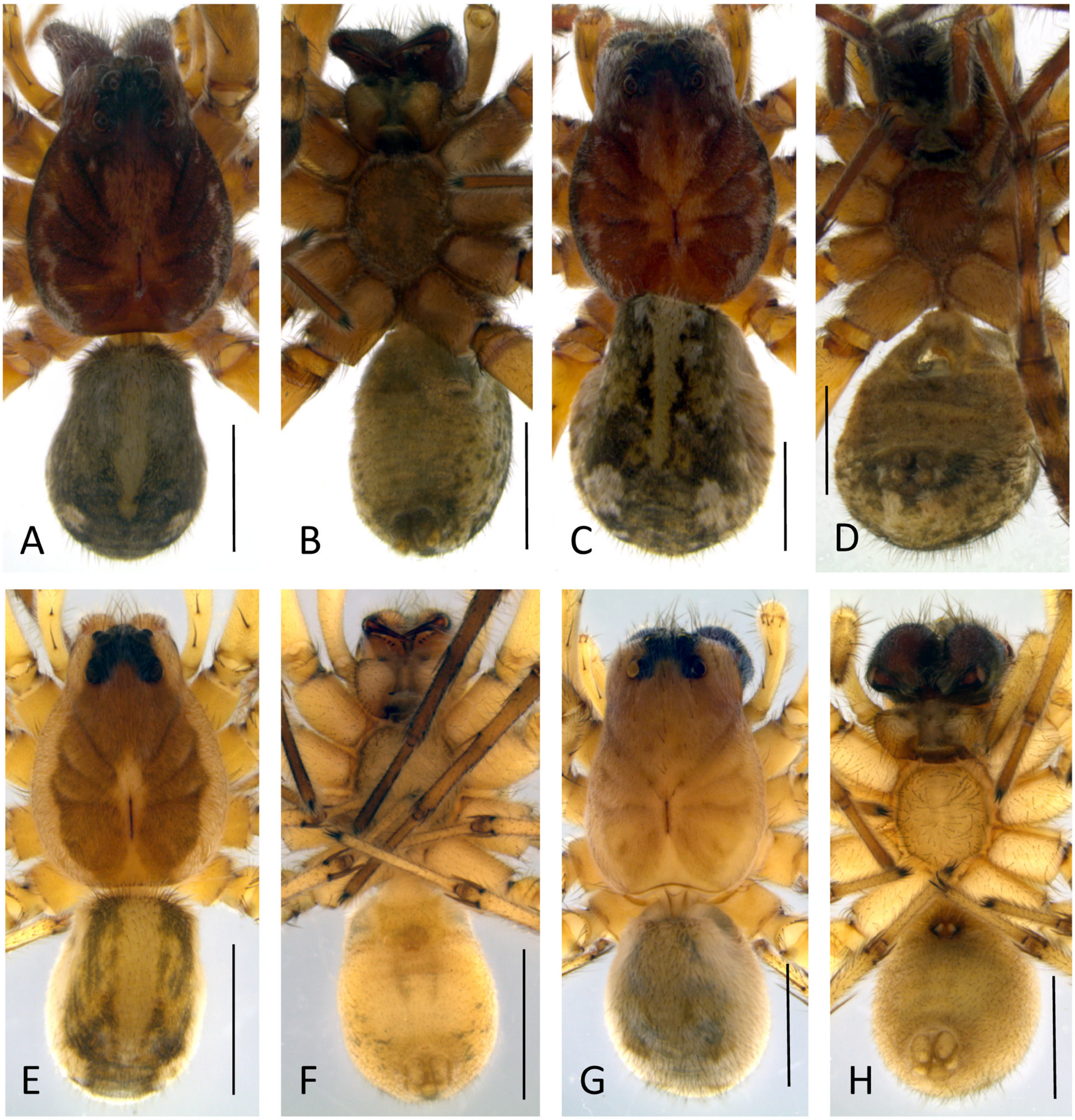

Fig. 10. *Tetralycosa* Roewer, 1960, microscopic photographs showing dorsal and ventral views. **A–B**. *T. orariola* sp. nov., ♂, holotype (WAM T62787). **C–D**. *T. orariola* sp. nov., ♀, paratype (WAM T62788). **E–F**. *T. wundurra* (McKay, 1979), ♂ (WAM T70503). **G–H**. *T. wundurra* (McKay, 1979), ♀ (WAM T70296). Scale bars: A–H = 2.00 mm.

mainly black setae, but white setae in median and lateral bands; black macrosetae in eye region, mainly around PE; four long bristles below AE; one long bristle between AME.

Eyes. Row of AE of same width as row of PME; row of AE slightly procurved.

Chelicerae. Dark reddish-brown; covered with white setae and few brown macrosetae centrally; three promarginal teeth with the median largest; three retromarginal teeth of similar size.

Sternum (Fig. 10B). Brown with grey pigmentation; covered with brown setae that are longer towards margins.

Labium. Dark brown; front end truncate and white.

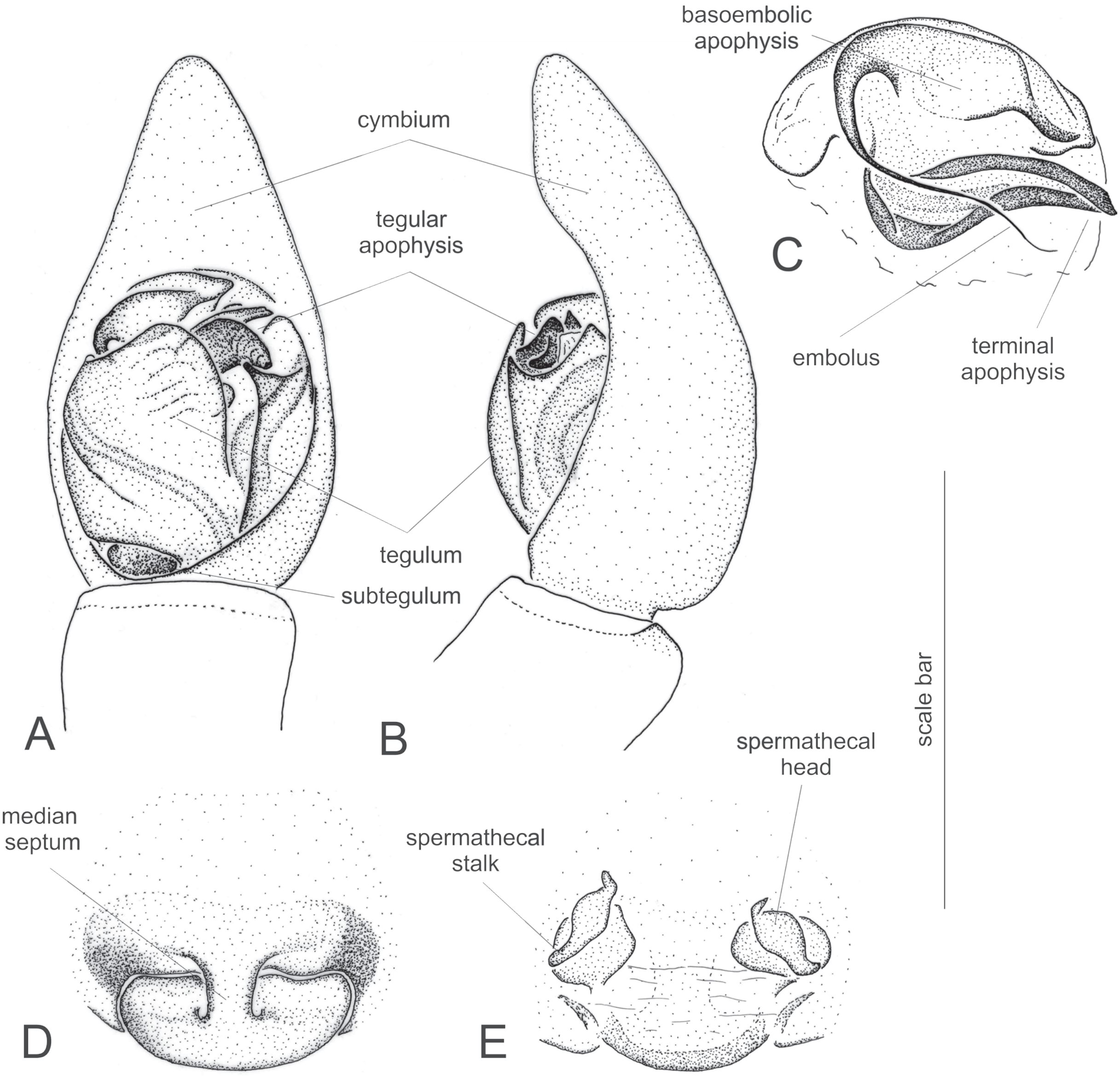

Fig. 11. *Tetralycosa orariola* sp. nov., ♂, holotype (WAM T62787) and ♀, paratype (WAM T62788). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Left male pedipalp, palea section of bulbus, ventral view. **D–E**. Female epigyne, ventral and dorsal views. Scale bar: A–B = 1.09 mm; C = 0.57 mm; D–E = 0.78.

Pedipalps (Fig. 11A–C). Tegular apophysis broad with a basally pointing tip (Fig. 11A); terminal apophysis forms shaft with broad edges; embolus long and thin, tip curved apically (Fig. 11C).

Abdomen. Very dark olive-grey; yellow-grey lanceolate heart mark in anterior half; one pair of yellow-grey patches in posterior half; covered with black setae and fewer macrosetae, white setae in heart mark and posterior patches (Fig. 10A). Ventrally olive-grey with white and fewer brown setae. Spinnerets olive-brown (Fig. 10B).

Legs. Leg formula IV>II>I>III; brown with dark annulations; base of femora yellow-brown. Spination of leg I: femur: three dorsal, one apicoprolateral, two retrolateral; patella: one prolateral, 1 retrolateral; tibia: one dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, WAM T62788)

Carapace (Fig. 10C). Shape, colouration and setae as male; however, the left lateral band is dissolved into single light patches.

Eyes. Row of AE wider than row of PME; row of AE slightly procurved.

Chelicerae. Colouration and setae as male; three promarginal teeth with the median largest; three retromarginal teeth of similar size on left chelicera, one additional small apical tooth on right chelicera.

Sternum and labium (Fig. 10D). As male.

Abdomen. As male, however, indistinctly mottled dark and light grey (Fig. 10C). Venter and spinnerets as male (Fig. 10D).

Epigyne. Ventral view (Fig. 11D): ovoid median septum with curved posterior border. Dorsal view (Fig. 11E): narrow, elongated spermathecal heads.

Legs. Leg formula IV>I>II>III. Colour pattern as male, however basal third of femora not lighter. Spination of leg I: femur: three dorsal, one apicoprolateral (two on right leg); tibia: three ventral pairs, two prolateral, one apicoventral.

Life history and habitat preferences

Tetralycosa orariola sp. nov. has mainly been collected at a variety of sites of the Avon Wheatbelt Survey ('Salinity Action Plan') of the Department of Conservation and Land Management (CALM) (today called Department of Parks and Wildlife, Western Australia) near ephemeral, often saline lakes (Harvey *et al.* 2004; Keighery *et al.* 2004). The long-term exposure of the pitfall traps during the survey does not allow an interpretation of the phenology of this species.

Distribution

South-west Western Australia (Fig. 13).

Tetralycosa wundurra (McKay, 1979) comb. nov.
Figs 2F; 10E–H; 12A–F; 13

Trochosa wundurra McKay, 1979b: 296–297, figs 4i–j.

Trochosa wundurra – McKay 1985: 87. — Platnick 1989: 391.

Diagnosis

Within the *oraria*-group, *T. wundurra* comb. nov. is most similar to *T. oraria* (see Diagnosis there).

Type material

AUSTRALIA: holotype of *Trochosa wundurra* McKay, 1979, ♀, Western Australia, Hyden Lake, Hyden, 32°27′ S, 118°54′ E, on sandy shoreline, 28 Mar. 1970, R.J. McKay leg. (QM S96).

Other material examined

AUSTRALIA, Western Australia: 1 ♂, Damboring East Road, 30°31′ S, 116°44′ E (WAM T70296); 1 ♂, Dumbleyung Lake North, 32°21′29″ S, 117°38′40″ E (WAM T47200); 1 ♀, Jerramungup, 33°56′34″ S, 118°54′54″ E (WAM T70503); 1 ♀, Kellerberrin SE, Shackleton Road, 31°54′39″ S, 117°50′15″ E (WAM T47208); 1 ♀, Lake Bryde East Nature Reserve, Lake Bryde Road, 33°21′20″ S, 118°54′26″ E (WAM T47205); 2 ♀♀, Lake Gulson, 65 km SE of Hyden, 32°45′59″ S, 117°24′12″ E (WAM T51472, T62666); 2 ♂♂, 1 ♀, Muir Highway South, Thomson Road, 34°26′43″ S, 116°38′44″ E (WAM T47326, T62785); 2 ♀♀, Salt River, 45 km ENE of Quairading, 31°53′31″ S, 117°49′46″ E (WAM T51467, T51469); 41 ♀♀, 11 juvs, Taarblin Lake, SW shore, 10 km SW of Toolibin Lake, 32°59′20″ S, 117°32′37″ E (WAM T48062–3, T51453, T62667); 1 ♂, 1 ♀, Toolibin Lake, 32°55′05″ S, 117°36′57″ E (WAM T47159).

Description

Measurements. ♂ WAM T62785 (♀ holotype, QM S96): TL 6.60 (7.65), CL 4.05 (4.50), CW 2.93 (3.45). Eyes: AME 0.19 (0.18), ALE 0.14 (0.15), PME 0.29 (0.28), PLE 0.26 (0.26). Row of eyes: AE 0.83 (0.90), PME 0.77 (0.79), PLE 1.17 (1.23). Sternum length/width: 1.65/1.35 (1.80/1.50). Labium length/width: 0.43/0.57 (0.59/0.61). AL 3.00 (3.50), AW 2.4 (3.50). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 1.35+1.20+ – +1.13 = 3.68, I 2.85+3.75+2.85+1.35 = 10.80, II 2.85+3.60+2.85+1.35 = 10.65, III 2.70+3.00+2.85+1.28 = 9.83, IV 3.30+4.05+3.75+1.65 = 12.75 (Pedipalp 1.50+1.73+ – +1.13= 4.36, I 2.85+3.60+2.25+1.20 = 9.90, II 2.85+3.45+2.40+1.20 = 9.90, III 2.78+3.15+2.55+1.20 = 9.68, IV 3.30+4.20+3.45+1.65 = 12.60).

Variation. ♂ (♀) (range, mean ± SD): TL 5.25–6.30, 5.90 ± 0.57; CL 3.30–3.75, 3.60 ± 0.26; CW 2.70–2.85, 2.80 ± 0.09; n = 3 (TL 5.40–10.50, 7.71 ± 1.19; CL 2.85–5.25, 4.02 ± 0.68; CW 1.95–3.75, 3.03 ± 0.46; n = 14).

Male (based on WAM T62785)

Carapace (Fig. 10E). Dorsal line straight in lateral view; brown with indistinct darker radial pattern; indistinct narrow light median band limited to posterior two thirds and very distinct light lateral bands of one tenth of carapace width extending to margin; covered with brown setae, white setae in marginal band; few dark setae between eyes; brown bristles lateral of PE and between PME and PLE; four long bristles below AE; one long bristle between AME.

Eyes. Row of AE slightly wider than row of PME; row of AE very slightly procurved.

Chelicerae. Light orange-brown; white setae and brown macrosetae; three promarginal teeth with the median largest; three retromarginal teeth of similar size.

Sternum (Fig. 10F). Yellow-brown with some grey pigmentation; covered with brown setae that are longer and denser towards margins.

Labium. Brown; front end truncate and white.

Pedipalps (Fig. 12A–C). Tegular apophysis broad with a baso-laterally pointing tip (Fig. 12A); embolus broad with short, slim tip (Figs 2F, 12C).

Abdomen. Dorsally olive-grey with lighter brown spots and lines; yellow-brown lanceolate heart mark in anterior half; a pair of two large yellow-brown patches in posterior half; covered with olive-brown setae, light brown or white setae in heart mark and posterior patches (Fig. 10E). Ventrally light yellow-brown with some rudimentary, indistinct olive-grey median discolouration; covered with white setae. Spinnerets yellow-brown (Fig. 10F).

Legs. Leg formula IV>I>II>III; light yellow-brown; distal half of metatarsi and tarsi of leg I darker; hair-like erect setae in particular on metatarsi of leg I. Spination of leg I: femur: three dorsal, two prolateral, two retrolateral; patella: one prolateral, one retrolateral; tibia: one dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

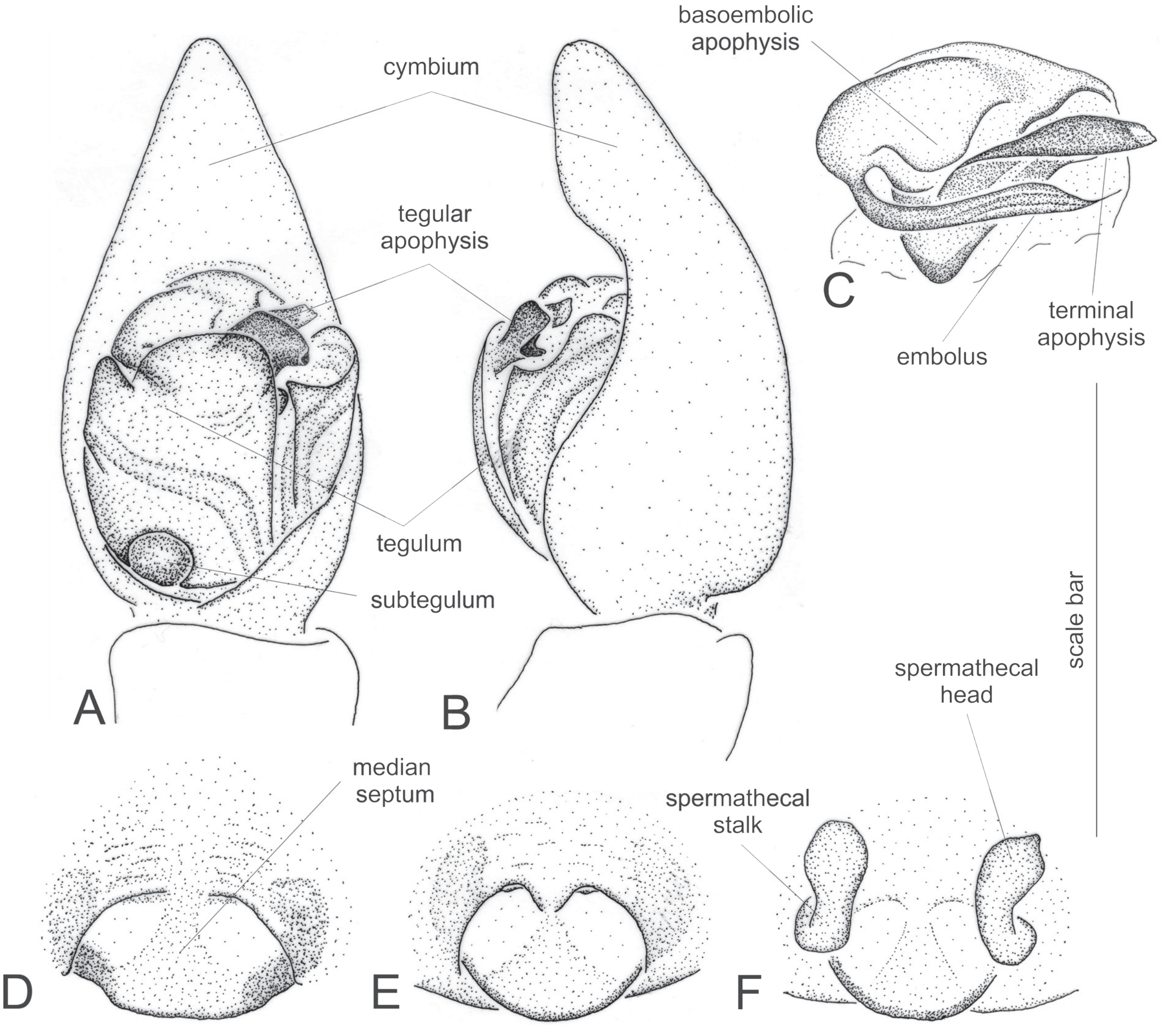

Fig. 12. *Tetralycosa wundurra* (McKay, 1979) comb. nov. **A–B**. Left male pedipalp, ventral and retrolateral view (WAM T62785). **C**. Left male pedipalp, palea section of bulbus, ventral view (WAM T62785). **D**. Female epigyne, ventral view (holotype QM S96). **E–F**. Female epigyne, ventral and dorsal views (WAM T47205). Scale bar: A–B = 0.86 mm; C = 0.51 mm; D–F = 0.80 mm.

Female (based on WAM T70296)

Carapace (Fig. 10G). Light brown with indistinct darker radial pattern; indistinctly lighter medially; distinct lighter lateral bands and indistinct grey marginal bands; covered with brown setae, but white setae in lateral bands; brown bristles around eyes; four long bristles below AME, one long bristle between AME.

Eyes. Row of AE wider than row of PME; median line through AE slightly procurved.

Chelicerae. Very dark reddish-brown, long silverish setae and long brown bristles medially; three promarginal teeth with the median one largest, three retromarginal teeth of similar size.

Fig. 13. *Tetralycosa orariola* sp. nov. and *T. wundurra* (McKay, 1979) comb. nov., distribution records in Australia.

Sternum (Fig. 10H). Yellow-brown with some grey pigmentation; brown bristles, denser and longer towards margin.

Labium. Dark brown, darker centrally; front end truncate and wide.

Abdomen. Irregularly dark olive-grey, indistinct yellow-brown lanceolate heart mark in anterior half; mainly white setae and fewer brown macrosetae (Fig. 10G). Venter yellow-brown; setae as dorsal but less macrosetae. Spinnerets yellow-brown (Fig. 10H).

Epigyne. Ventral view (Fig. 12D–E): wider than long, median septum with indistinct inverted T-shaped dark pattern. Dorsal view (WAM T47205; Fig. 12F): spermathecal heads distinctly wider than spermathecal stalks that attach posteriorly.

Legs. Leg formula IV>I=II>III. Light brown, basal third of femora lighter. Spination of leg I: femur: two dorsal, one retrolateral; tibia: one apicoventral pair; metatarsus: three (small) ventral pairs, one apicoventral.

Remarks

Tetralycosa wundurra comb. nov. was initially described in the lycosine genus *Trochosa* solely based on the eye pattern, with the row of the anterior eyes being wider than that of the posterior median eyes (McKay 1979b). However, genital characters clearly identify this species as a member of the genus *Tetralycosa* with no affinities to the Lycosinae and it is consequently transferred from *Trochosa*. The male of *T. wundurra* comb. nov. is here described for the first time.

Life history and habitat preferences

Most specimens where collected in pitfall traps exposed from October to March in samphire vegetation near salt lakes or on the lake floor.

Distribution

South-western Western Australia (Fig. 13).

Tetralycosa alteripa (McKay, 1976)

Figs 1C; 2A–B, E; 14A–D; 15A–F; 17

Lycosa alteripa McKay, 1976: 418–420, Fig. 2a–e.

Lycosa alteripa – Brignoli 1983: 450. — McKay 1985: 74.
Tetralycosa alteripa – Framenau *et al.* 2006: 25.

Diagnosis

Tetralycosa alteripa is most similar to *T. baudinettei* sp. nov. Males can be distinguished by the shape of the embolus that is fairly strong and straight in *T. alteripa* and much slimmer with a curved tip in *T. baudinettei* sp. nov. The shape of the epigyne distinguishes females; it is rectangular in *T. alteripa*, whereas in *T. baudinettei* sp. nov. only the posterior rim is visible in ventral view.

Type material examined

AUSTRALIA: holotype of *Lycosa alteripa* McKay, 1976, ♂, Western Australia, Fitzgerald River, claypan near mouth, 34°05′ S, 119°35′ E, 11 Jul. 1970, R.J. McKay and R. Prince leg. (WAM 71/40) (examined).

AUSTRALIA: paratypes of *Lycosa alteripa* McKay, 1976, 2 ♂♂, 4 juvs, same data as holotype (WAM 71/41–6) (examined); 1 ♀, Western Australia, salt lake near Israelite Bay, 33°33′ S, 123°53′ E, 19 Apr. 1974, A.V. Thomas leg. (WAM 74/501; erroneously listed as WAM 71/501 by McKay (1976)) (examined).

Other material examined

AUSTRALIA, South Australia: 1 ♀, Agars Lake, 32°53′30″ S, 135°23′45″ E (SAM NN21821); 1 ♂, Lake Fowler, 35°04′45″ S, 137°34′55″ E (SAM NN21852); 1 ♀, Ifould Lake near road crossing, 30°54′15″ S, 132°05′31″ E (SAM NN21922); 1 ♀, Lochiel Lake D, 33°54′40″ S, 138°13′00″ E (SAM NN21825); 1 ♂, Poodina Lake, 32°37′15″ S, 135°53′57″ E (SAM NN21902); 1 ♂, 1 ♀ with spiderlings, Serpentine Lakes, 28°29′20″ S, 129°00′30″ E (SAM NN21908–9); 5 ♂♂, 6 ♀♀, Sinclair Gap Lake, 33°07′30″ S, 137°03′08″ E (SAM NN21791–4, NN21797, NN21799–801, NN21815–7); 3 ♀♀, Yorke Peninsula Lake I, 35°01′00″ S, 137°37′28″ E (SAM NN21846–7, NN21850). – Western Australia: 1 ♀, Boorabin, 31°13′ S, 120°19′ E (WAM T55430); 1 ♂, 1 ♀, 1 ♀ with spiderlings, Buningonia Springs Reserve, Lake Harris Dunes, 31°19′30″ S, 123°36′30″ E (WAM T47354–6); 1 ♂, Camel Lake Nature Reserve, 34°15′50″ S, 117°57′49″ E (WAM T45402); 1 ♂, Lake Ballard, 29°32′ S, 121°12′ E (SAM NN21883); 1 ♂, Lake Gilmore, 32°37′ S, 121°36′ E (WAM T42145); 1 ♂, Lake Johnston, 32°25′40″ S, 120°38′40″ E (SAM NN21895); 1 ♂, Lake Lefroy, 31°25′18″ S, 121°46′37″ E (PES 10062); 3 ♂♂, Lake Lefroy, 31°26′24″ S, 121°42′41″ E (PES 9872); 1 ♂, same location (PES 9865).

Remark

Due to the poor condition of the male holotype, *T. alteripa* is here redescribed based on a well preserved representative male and female from Buningonia Spring Reserve in Western Australia.

Description

MEASUREMENTS. ♂ WAM T47354 (♀ WAM T47356): TL 18.30 (22.05), CL 9.60 (9.90), CW 7.05 (7.20). Eyes: AME 0.52 (0.54), ALE 0.32 (0.37), PME 0.86 (1.03), PLE 0.80 (0.86). Row of eyes: AE 2.29 (2.60), PME 2.93 (3.03), PLE 4.05 (4.50). Sternum length/width: 4.25/3.60 (4.43/3.75). Labium length/width: 1.35/1.43 (1.49/1.54). AL 9.00 (12.00), AW 5.70 (8.70). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 4.20+3.45+ – +2.95 = 10.60, I 7.95+9.30+9.60+3.75 = 30.60, II 8.10+9.30+10.65+3.90 = 31.95 III 7.80+8.40+10.50+3.75 = 30.45, IV 8.70+10.35+12.60+4.50 = 34.65 (Pedipalp 4.13+3.90+ – +2.70 = 10.73, I 7.95+9.15+8.10+3.15 = 28.35, II 7.95+9.00+8.10+3.15 = 28.20, III 7.50+8.25+8.40+3.30 = 27.45, IV 8.70+10.20+10.20+3.90 = 33.00).

VARIATION. ♂ (♀) (range, mean ± SD): TL 12.75–17.85, 15.99 ± 1.68; CL 6.90–10.05, 8.90 ± 1.00; CW 5.25–7.35, 6.51 ± 0.68; n = 10 (TL 17.25–21.75, 19.35 ± 1.86; CL 9.30–10.80, 9.93 ± 0.54; CW 6.45–7.80, 7.14 ± 0.58; n = 5.

Male (based on WAM T47354)

CARAPACE (Fig. 14A). Cephalic area highest in lateral view (Fig. 15A) and steep vertical slopes in frontal view; brown with dark radial pattern; somewhat lighter around fovea and in two small patches behind PLE; distinct but discontinuous light brown lateral bands; covered with dark brown setae, white setae in lateral bands and around eyes; brown macrosetae around PE.

EYES. Row of AE strongly procurved; row of PME wider than row of AE.

CHELICERAE. Dark reddish-brown; covered frontally with white setae; three promarginal teeth with the median largest; three retromarginal teeth of similar size.

Sternum (Fig. 14B). Yellow-brown with dense grey pigmentation; covered with white setae and brown macrosetae.

Labium. Brown; front end truncate and white.

Pedipalps (Figs 2A–B, E; 15B–D). Tegular apophysis curved with tapering tip that points ventrally (Fig. 2A–B, E; 15B); embolus strong and straight in ventral view (Fig. 15D), but twisted in more basal view (Fig. 2B).

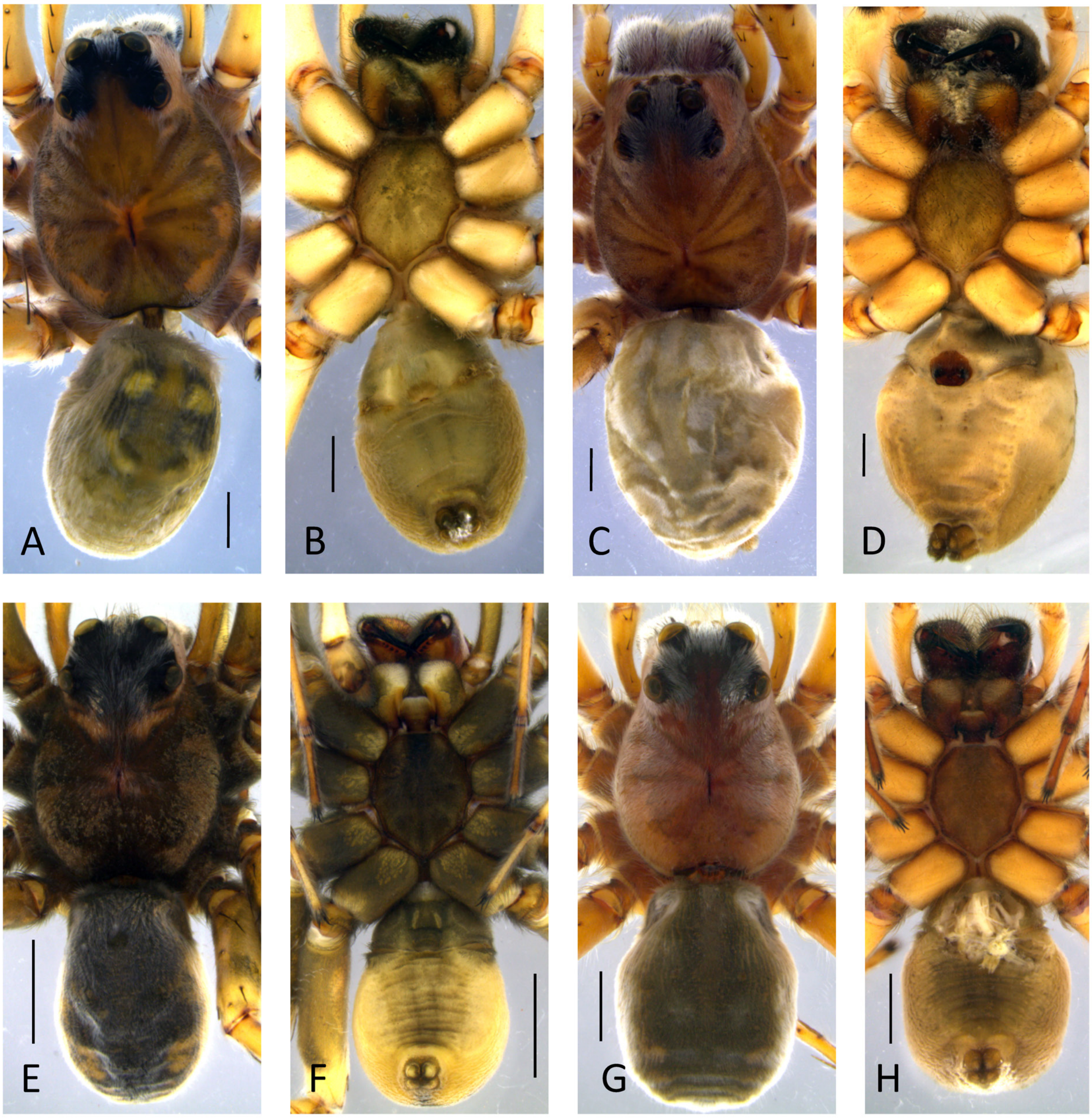

Fig. 14. *Tetralycosa* Roewer, 1960, microscopic photographs showing dorsal and ventral views. **A–B**. *T. alteripa* (McKay, 1976), ♂ (WAM T47354). **C–D**. *T. alteripa* (McKay, 1976), ♀ (WAM T47356). **E–F**. *T. baudinettei* sp. nov., ♂, holotype (WAM 141307). **G–H**. *T. baudinettei* sp. nov., ♀, paratype (SAM NN21896). Scale bars: A–H = 2.00 mm.

Abdomen. Dorsally dark olive-grey; light olive-grey lanceolate heart mark in anterior half; irregular yellow-brown patches; setae colouration corresponds to basic colours (Fig. 14A). Ventrally yellow-brown with white setae. Spinnerets light brown (Fig. 14B).

Legs. Leg formula IV>II>I>III; Brown, femora generally lighter, in particular in ventral view; tibiae, metatarsi and tarsi of leg I and II dark brown; metatarsi and tarsi of leg I and II with ventral scopulae. Spination of leg I: femur: three dorsal, two apicoprolateral (left leg with one additional prolateral), four

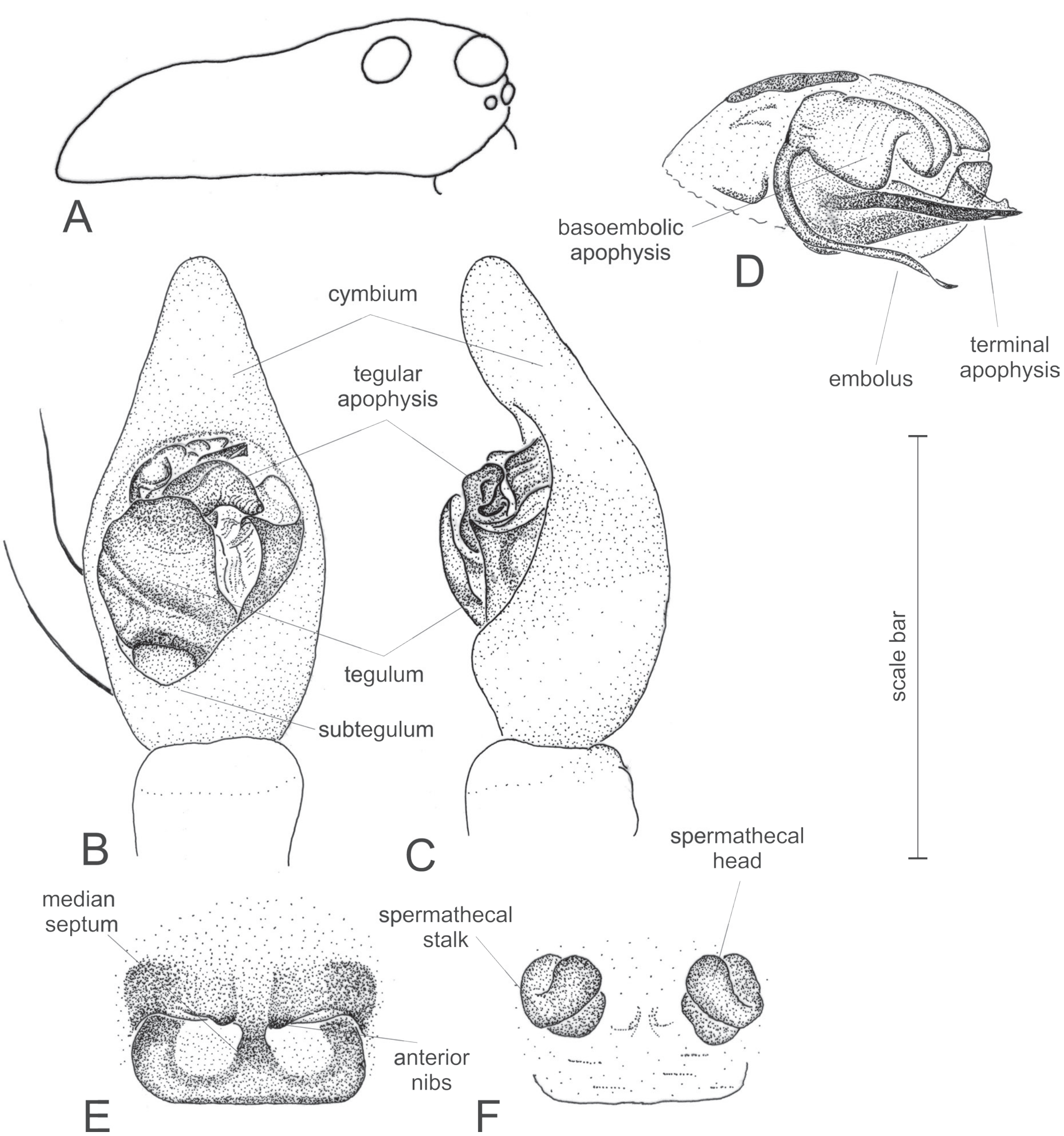

Fig. 15. *Tetralycosa alteripa* (McKay, 1976), ♂ (WAM T47354) and ♀, paratype (WAM T47356). **A**. Male carapace, lateral view. **B–C**. Left male pedipalp, ventral and retrolateral view. **D**. Left male pedipalp, palea section of bulbus, ventral view. **E–F**. Female epigyne, ventral and dorsal view. Scale bar: A = 8.83 mm; B–C = 2.56 mm; D = 1.47 mm; E–F = 1.91 mm.

retrolateral; patella: one prolateral (left leg with one additional prolateral), one retrolateral; tibia: two dorsal; three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on WAM T47356)

CARAPACE (Fig. 14C). As male, but lateral bands and light patches less distinct.

EYES, CHELICERAE, STERNUM AND LABIUM (Fig. 14D). As male.

ABDOMEN. As male, but spinnerets slightly lighter (Fig. 14C–D).

EPIGYNE. Ventral view (Fig. 15E): distinctly wider than long, median septum rectangular. Dorsal view (Fig. 15F): spermathecal heads slightly thicker than short spermathecal stalks that attach posterolaterally.

LEGS. Leg formula IV>I>II>III. Light brown, metatarsi and tarsi of legs I and II darker; scopulae ventrally on metatarsi and tarsi of leg I and II. Spination of leg I: femur: three dorsal, two apicoprolateral, two retrolateral (three on left leg); patella: one prolateral; tibia: three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, one retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Life history and habitat preferences

This species is typically found on the surface of salt lakes in South Australia and Western Australia (Hudson 1997; Hudson & Adams 1996; McKay 1976). Adult spiders were found between February and July with a peak in March and April, two females carrying young were collected in April.

Distribution

Southern South and Western Australia (Fig. 17).

Tetralycosa baudinettei sp. nov.

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Figs 14E–H; 16A–E; 17

Diagnosis

Tetralycosa baudinettei sp. nov. is very similar to *T. alteripa* (see 'Diagnosis' there).

Etymology

The specific epithet is a patronym in honour of the late Professor Russell Baudinette for his support and mentoring of P.H. during his salt lake studies.

Type material

Holotype

AUSTRALIA: ♂, Western Australia, Lake Lefroy, 31°30′09.36″ S, 121°42′36.89″ E, playa of lake, burrow excavation, PES 152581, Dec. 2013, E.S. Volschenk leg. (WAM T141307).

Paratype

AUSTRALIA: ♀, Western Australia, Lake Lefroy, 31°26′36″ S, 121°34′02″ E., Feb. 1994, P. Hudson leg. (SAM NN21896).

Other material examined

AUSTRALIA, Western Australia: 2 ♂♂, Lake Goongarrie, 29°59′50″ S, 121°09′20″ E (SAM NN21890–1); 1 ♂, Lake Goongarrie, 30°00′ S, 121°12′ E (WAM 98/2160); 2 ♀♀, Lake Lefroy area, ca 31°15′ S, 121°44′ E (WAM T45401); 1 ♀, Lake Lefroy, 31°26′36″ S, 121°34′02″ E (SAM NN21855); 2 ♂♂, Lake Lefroy, 31°12′03″ S, 121°41′23″ E (SAM NN21897–8); 1 ♀, Lake Roe, 30°40′00″ S, 122°30′20″ E (SAM NN21903); 1 ♂, Lake Yindarlgooda, 30°36′50″ S, 122°13′20″ E (SAM NN21912).

Description

Measurements. ♂ holotype, WAM T141307 (♀ paratype, SAM NN21896): TL 8.46 (12.78), CL 4.79 (6.58), CW 3.29 (4.70). Eyes: AME 0.27 (0.35), ALE 0.23 (0.29), PME 0.66 (0.89), PLE 0.58 (0.85). Row of eyes: AE 1.34 (1.93), PME 1.79 (2.54), PLE 2.35 (3.29). Sternum length/width: 2.07/1.79 (3.01/2.54). Labium length/width: 0.66/0.71 (1.01/1.01). AL 3.57 (6.11), AW 2.82 (4.70). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 2.07+2.15+ – +1.69 = 5.91, I 3.67+4.04+3.29+1.50 = 12.50, II 3.76+4.04+3.76+1.50 = 13.06, III 3.38+3.67+3.95+1.50 = 12.50, IV 4.14+4.42+4.79+1.69 = 15.04 (Pedipalp 2.54+2.44+ – +1.60 = 6.58, I 4.98+5.17+4.23+1.79 = 16.17, II 4.98+5.17+4.89+1.88 = 16.92, III 4.61+4.79+5.36+1.88 = 16.64, IV 5.64+5.83+6.58+2.07 = 20.12).

Variation. ♂ (♀) (range, mean ± SD): TL 9.00–10.80, 9.78 ± 0.65; CL 5.25–7.05, 5.97 ± 0.86; CW 3.75–5.10, 4.38 ± 0.67; n = 5 (TL 13.05–14.25, 13.55 ± 0.62; CL 6.75–8.10, 7.45 ± 0.68; CW 5.10–6.00, 5.60 ± 0.46; n = 3).

Male (based on holotype, WAM T141307)

Carapace (Fig. 14E). Cephalic area highest in lateral view and steep vertical slopes in frontal view; brown with an indistinct darker radial pattern; slightly lighter around fovea and posteriorly of eye region; wide, yellow-brown lateral bands; eye region black; covered with brown setae, but white setae in lighter carapace areas and in eye region; brown bristles in eye region mainly around PME; eight long bristles below AE; one long bristle between AME.

Eyes. Row of AE shorter than row of PME; row of AE strongly procurved.

Chelicerae. Light orange-brown, apically darker; covered frontally with mainly white setae but brown setae apically; three promarginal teeth with the median one largest; three retromarginal teeth of similar size.

Sternum (Fig. 14F). Dense grey pigmentation; covered with light brown setae that are longer towards margins.

Labium. Light brown, basally darker; front end truncate and white.

Pedipalps (Fig. 16A–C). Tegular apophysis curved with tapering tip that points ventrally (Fig. 16A–B); terminal apophysis with strongly bulging base; embolus very thin and curved at tip (Fig. 16C).

Abdomen. Uniformly dark olive-grey, laterally with thin yellow, longitudinal lines, some light patches posteriorly; covered with white setae (Fig. 14E). Venter yellow-brown with indistinct triangular olive-grey patch; covered with white setae. Spinnerets light brown (Fig. 14F).

Legs. Leg formula IV>II>I=III. Femora olive-grey, dorsally with an orange-brown longitudinal line; tibiae light orange-brown, apically darker; metatarsi and tarsi ventrally orange-brown; long, hair-like setae around metatarsus II. Spination of leg I: femur: three dorsal, two apicoprolateral, one apicoretrolateral; patella: one prolateral, one retrolateral; tibia: two dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, SAM NN21896)
Carapace (Fig. 14G). As male, but overall lighter and lateral bands more distinct.

Eyes. As male.

Chelicerae. Dark reddish-brown, apically darker; covered with white setae which are denser in basal half; dentition as male.

Sternum (Fig. 14H). Brown with grey pigmentation, slightly lighter marginally; setae as male.

Labium. Brown, front end truncate and white.

Abdomen. As male, but lateral lines less distinct and with two pairs of small light spots in posterior half; setae as male (Fig. 14G). Venter and spinnerets as male (Fig. 14H).

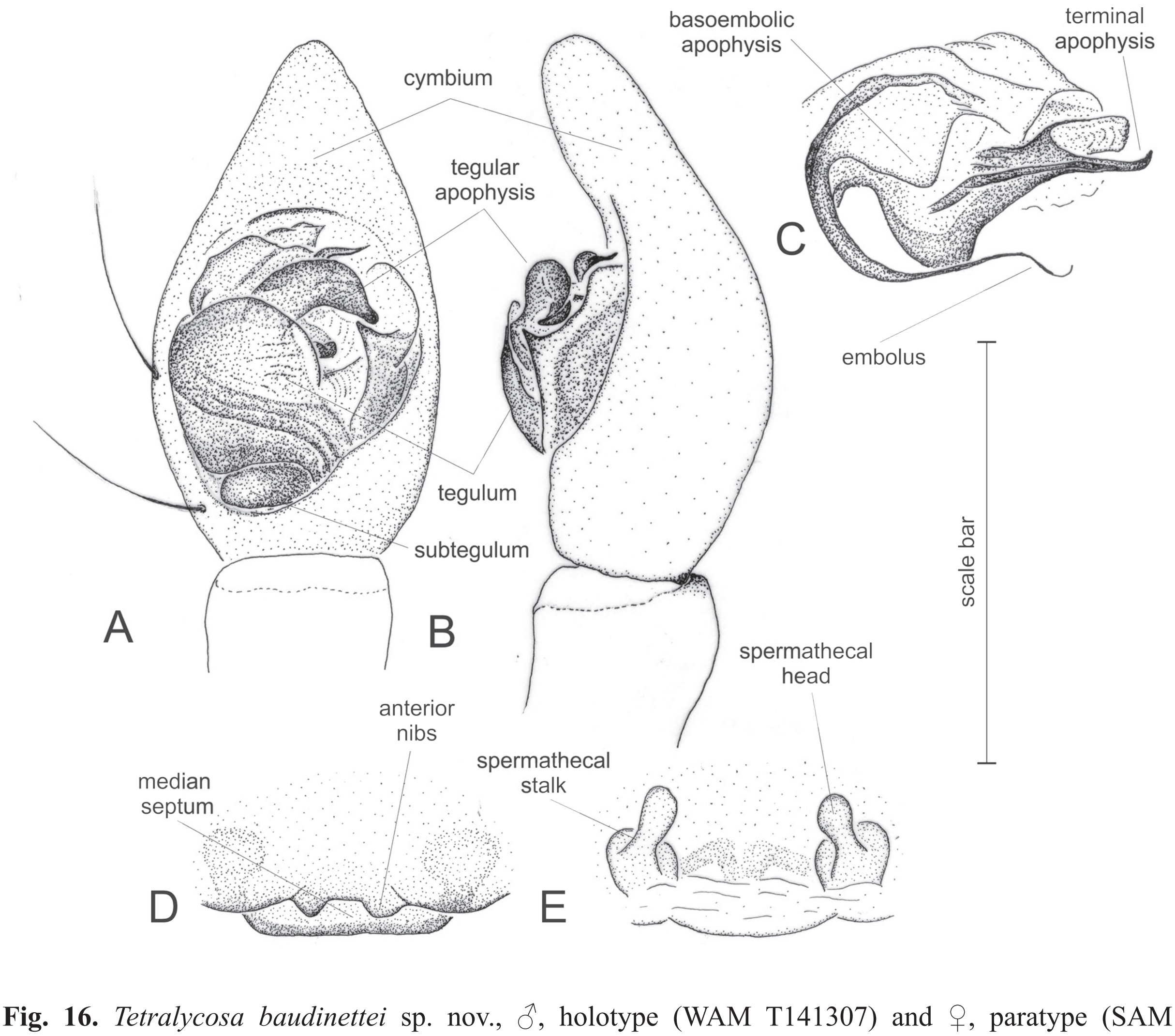

Fig. 16. *Tetralycosa baudinettei* sp. nov., ♂, holotype (WAM T141307) and ♀, paratype (SAM NN21896). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Left male pedipalp, palea section of bulbus, ventral view. **D–E**. Female epigyne, ventral and dorsal view. Scale bar: A–B =1.38 mm; C = 0.76 mm; D–E = 1.26.

Epigyne. Ventral view (Fig. 16D): median septum much wider than long. Dorsal view (Fig. 16E): small spermathecae, copulatory ducts slightly narrower and attached posteriorly.

Legs. Leg formula IV>II>III>I. Femora orange-brown, one grey annulation at two thirds their length, patella dark brown, tibiae as male; metatarsi and tarsi orange-brown,. Spination of leg I: femur: three dorsal, two apicoprolateral, one apicoretrolateral; patella: one prolateral, one retrolateral; tibia: two ventral pairs (basal pair reduced), two prolateral, one retrolateral; metatarsus: three ventral pairs, two prolateral, one retrolateral, one apicoventral.

Life history and habitat preferences

Adult males and females were exclusively found between February and March on the surface of salt lakes.

Distribution

The species has a limited distribution in southern Western Australia (Fig. 17).

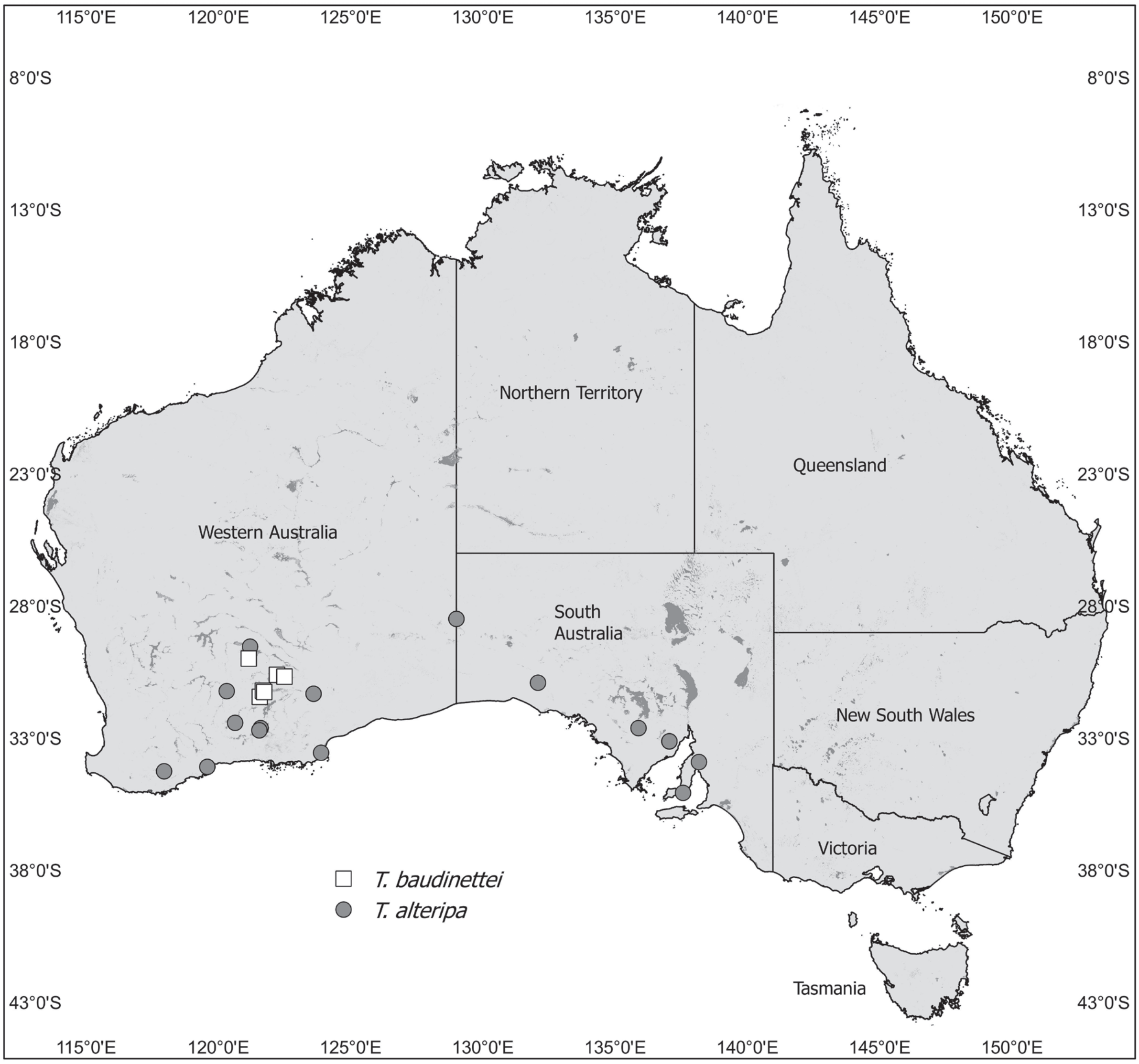

Fig. 17. *Tetralycosa alteripa* (McKay, 1976) and *T. baudinettei* sp. nov., distribution records in Australia.

Tetralycosa floundersi sp. nov.
urn:lsid:zoobank.org:act:8E26D710-05D2-4A60-A0A4-E1753048B0CB
Figs 18A–D; 19A–C; 21

Diagnosis

This species is most closely related to *T. alteripa*, *T. baudinettei* sp. nov. and *T. rebecca* sp. nov., but the tegular apophysis in males of *T. floundersi* sp. nov. is much slimmer than in any of these species and the epigyne of females has a distinct and unique posterior rim that widens laterally.

Etymology

The specific epithet is a patronym in honour of the late Ben Flounders, prominent natural historian in Whyalla (South Australia), and who first introduced the junior author (P.H.) to salt lakes.

Type material

Holotype

AUSTRALIA: ♂, Western Australia, Lake Moore, 29°25′44″ S, 117°47′49″ E, 10 Mar. 2002, P. Hudson leg. (SAM NN21900).

Paratype

AUSTRALIA: ♀, data as holotype (SAM NN21901).

Description

Measurements. ♂ holotype, SAM NN21900 (♀ paratype, SAM NN21901): TL 9.31 (9.68), CL 5.36 (4.89), CW 3.95 (3.48). Eyes: AME 0.29 (0.28), ALE 0.24 (0.24), PME 0.67 (0.63), PLE 0.57 (0.57). Row of eyes: AE 1.36 (1.46), PME 1.74 (1.69), PLE 2.40 (2.40). Sternum length/width: 2.26/1.97 (2.16/1.79). Labium (length/width) 0.70/0.74 (0.68/0.76). AL 4.23 (4.61), AW 3.01 (3.67). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 2.44+2.72+ – +1.83 = 6.99, I 4.61+4.98+4.61+1.88 = 16.08, II 4.79+4.89+5.26+1.97 = 16.91, III 4.61+4.79+5.73+2.07 = 17.20, IV 5.36+5.55+6.96+2.35 = 20.22 (Pedipalp 1.88+1.97+ – +1.32 = 5.17, I missing, II femur 3.76 (all other segments missing), III 3.57+3.85+4.14+1.79 = 13.35, IV 4.32+4.70+4.98+2.07 = 16.07).

Variation. Only known from holotype male and paratype female.

Male (based on holotype, SAM NN21900)

Carapace (Fig. 18A). Cephalic area highest in lateral view and steep vertical slopes in frontal view; brown with indistinct broad and light lateral bands; indistinct darker radial pattern; black in eye region; covered with brown setae but with white setae in lateral bands in eye region and few anteriorly of fovea; brown bristles mainly around PME and some posteromedially of PLE; eight long bristles below AE; one long bristle between AME.

Eyes. Row of AE shorter than row of PME; row of AE strongly procurved; ocular trapeze wider than long.

Chelicerae. Light brown; covered with white setae; three promarginal teeth with the median one largest; three widespread retromarginal teeth of similar size.

Sternum (Fig. 18B). Light yellow-brown with dense grey pigmentation; covered with brown setae, which are longer towards margins.

Labium. Brown, basally and laterally darker; front end truncate and white.

Pedipalps (Fig. 19A–B). Tegular apophysis curved, forming a long and thin hook (Fig. 19A); terminal apophysis not dissected as only known from single male.

Abdomen. Light yellow-brown, anterior half with dark grey mottled pattern that dissolves laterally; yellow-grey lanceolate heart mark in anterior half; covered with white setae, brown setae in darker areas (Fig. 18A). Venter yellow-brown, medially with grey pigmentation. Spinnerets light yellow-brown (Fig. 18B).

Legs. Leg formula IV>III>II>I; coxae and femora dark grey, in particular ventrally; other segments brown and metatarsi and tarsi somewhat darker; hair-like setae on metatarsi II (and few on I). Spination

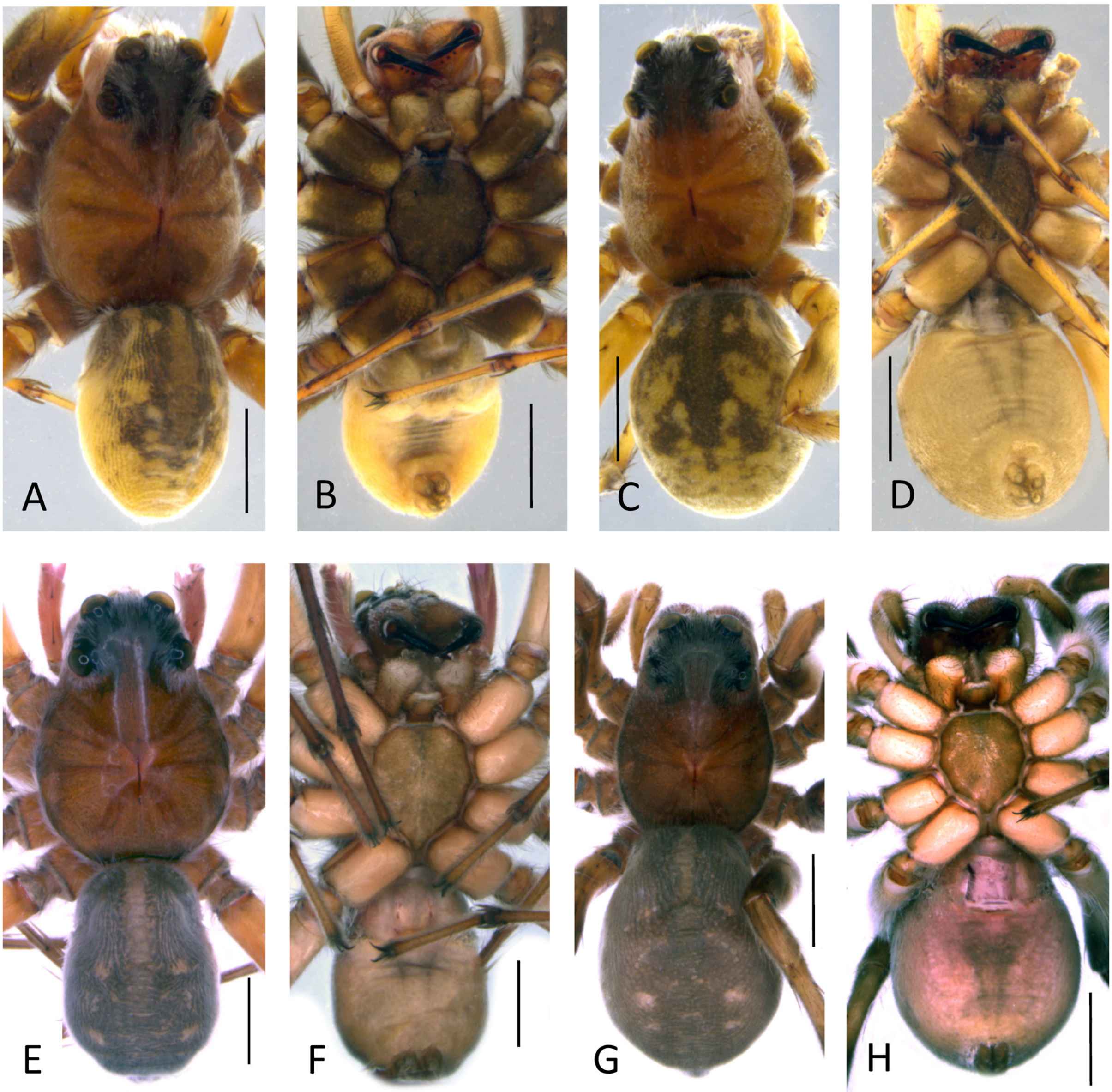

Fig. 18. *Tetralycosa* Roewer, 1960, microscopic photographs showing dorsal and ventral views. **A–B**. *T. floundersi* sp. nov., ♂, holotype (SAM NN21900). **C–D**. *T. floundersi* sp. nov., ♀, paratype (SAM NN21901). **E–F**. *T. rebecca* sp. nov., ♂, holotype (SAM NN21913). **G–H.** *T. rebecca* sp. nov., ♀, paratype (SAM NN21914). Scale bars: A–H = 2.00 mm.

of leg I: femur: three dorsal, two apicoprolateral, four retrolateral; patella: one prolateral, one retrolateral; tibia: three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, SAM NN21901)
CARAPACE (Fig. 18C). As male, slightly lighter.

EYES. As male.

CHELICERAE. Brown, white setae; dentition as male.

STERNUM AND LABIUM (Fig. 18D). As male.

ABDOMEN. As male, but the ventral grey pattern consists only of two longitudinal stripes. Spinnerets yellow-brown (Fig. 18C–D).

EPIGYNE. Ventral view (Fig. 19C): wider than long, distinct posterior ridge that widens laterally. Dorsal view: not examined, only known from single female.

LEGS. Leg formula unknown (only legs III and IV complete). Femora and tibiae light brown, dorsally with indistinct grey annulation. Spination of leg I: unknown (legs I missing).

Life history and habitat preferences

The male and female types of *T. floundersi* sp. nov. were found on the surface of a salt lake in March.

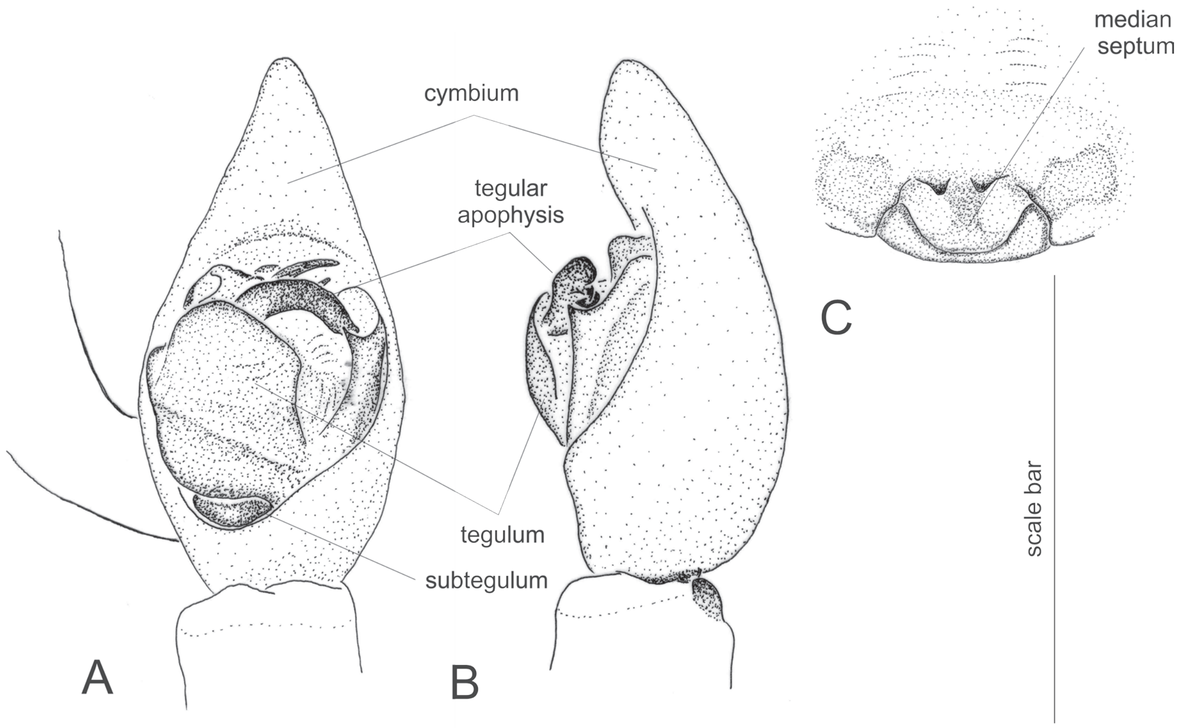

Fig. 19A–C. *Tetralycosa floundersi* sp. nov., ♂, holotype (SAM NN21900) and ♀, paratype (SAM NN21901). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Female epigyne, ventral view. Scale bar: A–B = 1.55 mm; C = 0.87 mm.

Distribution

Only known from Lake Moore in southern Western Australia (Fig. 21).

Tetralycosa rebecca sp. nov.

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Figs 18E–H; 20A–C; 21

Diagnosis

Tetralycosa rebecca sp. nov. is the only species within the genus in which the anterior median eyes are smaller than the anterior lateral eyes. In addition, males of *T. rebecca* sp. nov. differ from all other males of *Tetralycosa* by a straight basal margin of the tegular apophysis, which forms an arch in the other species. The female epigyne is most similar to that of *T. floundersi* sp. nov., however, the posterior transverse part is much wider than in the latter species.

Etymology

The specific epithet is a noun in apposition and refers to the type locality, Lake Rebecca, in Western Australia.

Type material

Holotype

AUSTRALIA: ♂, Western Australia, Lake Rebecca, 15 km N of Yindi Station, 30°15′40″ S, 122°29′00″ E, 11 Mar. 1996, P. Hudson leg. (SAM NN21913).

Paratype

AUSTRALIA: ♀, data as holotype (SAM NN21914).

Description

Measurements. ♂ holotype, SAM NN21913 (♀ paratype, SAM NN219414): TL 10.25 (10.53), CL 5.73 (5.36), CW 4.04 (3.57). Eyes: AME 0.17 (0.19), ALE 0.25 (0.24), PME 0.71 (0.73), PLE 0.64 (0.70). Row of eyes: AE 1.60 (1.50), PME 1.93 (2.07), PLE 2.68 (2.77). Sternum length/width: 2.73/2.26 (2.26/1.97). Labium (length/width) 0.83/0.92 (0.88/0.89). AL 4.42 (5.73), AW 3.38 (4.32). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 2.26+2.43+ – +1.82 = 6.51, I 5.08+5.17+4.79+1.88 = 16.92, II 4.89+5.26+5.455+1.97 = 17.57, III 4.61+4.89+5.55+2.07 = 17.12, IV 5.45+5.83+6.67+2.35 = 20.25 (Pedipalp 1.88+1.97+ – +1.60 = 5.45, I 3.85+4.23+3.29+1.69 = 13.06, II 3.76+4.23+3.67+1.69 = 13.35, III 3.76+4.14+3.95+1.88 = 13.73, IV 4.42+5.17+5.08+2.16 = 16.83).

Variation. Only known from holotype male and paratype female.

Male (based on holotype, SAM NN21913)

Carapace (Fig. 18E). Cephalic area highest in lateral view and steep vertical slopes in frontal view; brown, with indistinct darker radial pattern; some indistinct lighter patches above margins and indistinctly lighter around fovea; covered with mainly brown setae, but white setae towards margins and between and around PE; few brown bristles around PME; eight long bristles below AE; one long bristle between AME.

Eyes. Row of AE shorter than row of PME; row of AE strongly procurved.

Chelicerae. Orange-brown, covered with mainly white setae, but some brown setae apically; three promarginal teeth with the median largest; left chelicera with three retromarginal teeth of equal length, right chelicera with four retromarginal teeth, the second basal one very small.

Sternum (Fig. 18F). Yellow-brown with grey pigmentation; covered with light brown setae that increase in length towards margins.

Labium. Brown, basally darker; front end truncate and white.

Pedipalps (Fig. 20A–B). Tegular apophysis curved with straight basal margin (Fig. 20A); terminal apophysis not dissected, only known from single male.

Abdomen. Dark olive-grey with indistinct light lanceolate heart mark in anterior half; one pair of light spots in anterior half, two pairs of spots in posterior half; covered with mainly grey setae (Fig. 18E). Venter uniformly yellow with white setae. Spinnerets brown (Fig. 18F).

Legs. Leg formula IV>II>III>I; yellow-brown, lighter ventrally. Femora with grey pigmentation apically, tibiae darker apically and basally, metatarsi and tarsi of leg I and II darkest; hair-like setae ventrally on metatarsi I and II and tibiae II. Spination of leg I: femur: three dorsal, four retrolateral (only three on right leg), two apicoprolateral; patella: one prolateral, one retrolateral; tibia: two dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, SAM NN219414)

Carapace (Fig. 18G). Uniformly dark brown with indistinct darker radial pattern; lateral band reduced to two small light spots above leg II and III; covered with brown setae, longer white setae in eye field; few light brown bristles around PME; eight long bristles below AE; one long bristle between AME.

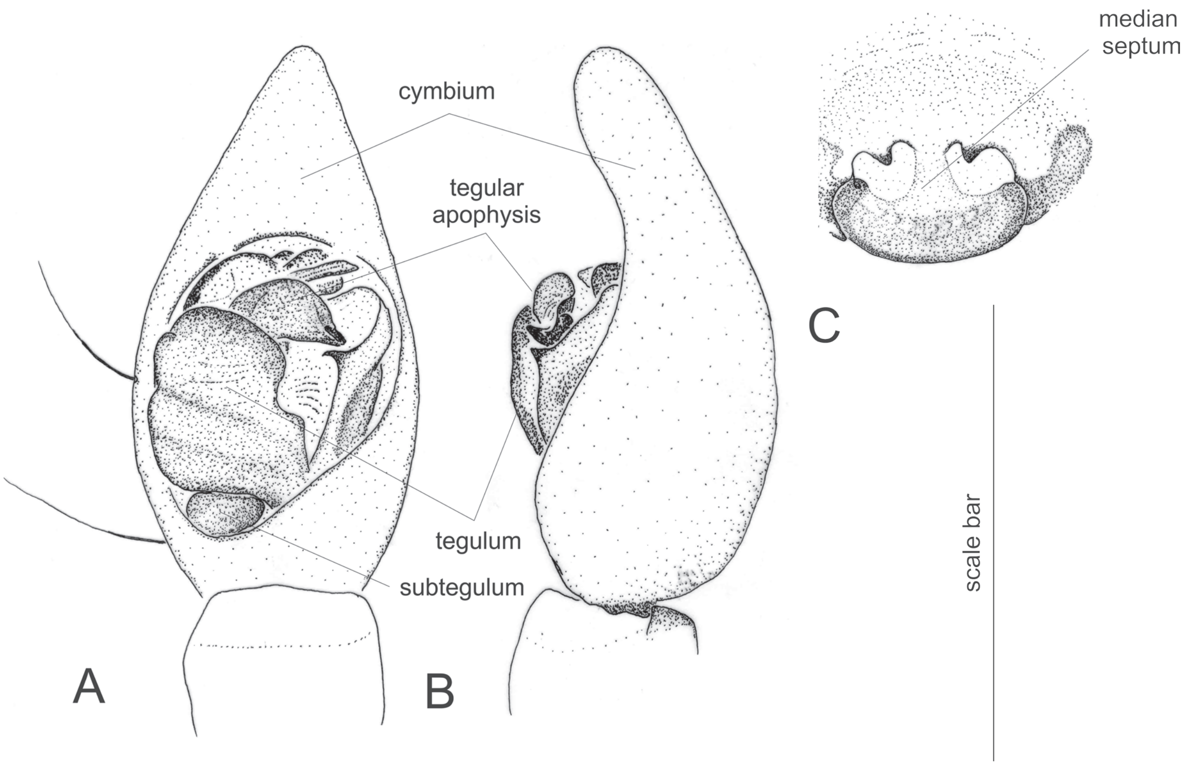

Fig. 20. *Tetralycosa rebecca* sp. nov., ♂, holotype (SAM NN21913) and ♀, paratype (SAM NN21914). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Female epigyne, ventral view. Scale bar: A–B = 1.68 mm; C = 1.28.

Eyes. Row of AE shorter than row of PME; row of AE slightly procurved; ocular trapeze wider than long.

Chelicerae. Colour, setae and dentition as male.

Sternum (Fig. 18H). Light brown with grey, irregular pigmentation; covered with brown setae that increase in length towards margin.

Labium. As male.

Abdomen. Uniformly dark olive-grey with an indistinct lanceolate heart mark in anterior half; two pairs of light spots in posterior half; covered with grey setae (Fig. 18G). Venter yellow-grey, slightly darker centrally; covered with light grey setae. Spinnerets light brown (Fig. 18H).

Epigyne. Ventral view (Fig. 20C): anterior margin with two sclerotised protrusions, posterior transverse part forms an arch with lateral ends pointing anterolateral. Dorsal view: not dissected, only known from single female.

Fig. 21. *Tetralycosa floundersi* sp. nov. and *T. rebecca* sp. nov., distribution records in Australia.

Legs. Leg formula IV>III>II>I. Femora light brown, apically and dorsally darker, light double bands dorsally; tibiae light brown, basally and apically darker; metatarsi light brown with three darker annulations; tarsi light brown. Femora ventrally covered with white setae, metatarsi I and II ventrally with scopulae. Spination of leg I: femur: three dorsal, one retrolateral (right leg two), two apicoprolateral; tibia: one apicoventral pair, two prolateral; metatarsus: three ventral pairs, one apicoventral.

Life history and habitat preferences

The male and female types of *T. rebecca* sp. nov. were found on the surface of a salt lake in March.

Distribution

Only known from the type locality Lake Rebecca, south-western Western Australia (Fig. 21).

Tetralycosa adarca sp. nov.

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Figs 22A–D; 23A–E; 25

Diagnosis

Males of *T. adarca* sp. nov. differ from all other males of *Tetralycosa* by the shape of the tegular apophysis, which has a rounded meso-basal flap. Females are not distinguishable from *T. halophila* sp. nov., *T. williamsi* sp. nov. and *T. eyrei* due to a very similar genital morphology although the epigyne of *T. halophila* sp. nov. and *T. williamsi* sp. nov. appears to be relatively wider than in *T. adarca* sp. nov. and *T. eyrei*. However, there is only limited information on intraspecific variation, as most species are only known from one to a few individuals.

Etymology

The specific epithet is a noun in apposition from the Latin '*adarca*', salt coating on a marsh plant, and refers to the salt lake environment that these spiders occupy.

Type material

Holotype

AUSTRALIA: ♂, South Australia, Lake Acraman, 32°05′24″ S, 135°31′20″ E, 10 Jul. 1995, P. Hudson leg. (SAM NN21882).

Paratype

AUSTRALIA: ♀ with egg sac, South Australia, Lake Acraman, 32°01′10″ S, 135°21′00″ E, 3 Mar. 1993, P. Hudson leg. (SAM NN21732).

Other material examined

AUSTRALIA, South Australia: 1 ♂, 1 ♀, Lake Gairdner, 32°07′41″ S, 135°53′19″ E (SAM NN21721, NN21888); 1 ♀ with egg sac, Lake Gairdner North, 31°13′10″ S, 135°56′00″ E (SAM NN21777).

Description

Measurements. ♂ holotype, SAM NN21882 (♀ paratype, SAM NN21732): TL 15.32 (16.17), CL 7.99 (8.08), CW 6.02 (5.73). Eyes: AME 0.44 (0.43), ALE 0.30 (0.33), PME 1.09 (1.05), PLE 0.96 (0.99). Row of eyes: AE 2.16 (2.16), PME 2.91 (2.91), PLE 4.14 (4.14). Sternum length/width: 3.57/2.91 (3.48/2.73). Labium length/width: 1.18/1.17 (1.17/1.18). AL 7.33 (7.52), AW 4.70 (5.64). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 3.57+4.58+ – +3.15 = 11.30, I 7.24+7.90+7.14+2.44 = 24.72, II 7.33+7.90+7.33+2.44 = 25.00, III 7.05+7.71+7.90+2.54 = 25.20, IV 8.18+9.21+9.78+2.82 = 29.99 (Pedipalp 3.20+2.82+ – +2.16 = 8.18, I 6.67+7.05+5.73+2.16 =

21.61, II 6.58+6.96+5.92+2.16 = 21.62, III 6.11+6.58+6.58+2.26 = 21.53, IV 7.80+8.27+8.55+2.63 = 27.25).

Variation. In addition to the type material, only one further male (SAM NN21888, TL 18.75, CL 10.35, CW 7.65) and female (SAM NN21777, TL 19.50, CL 9.75, CW 7.65) were found.

Male (based on holotype, SAM NN21882)

Carapace (Fig. 22A). Cephalic area highest in lateral view and steep vertical slopes in frontal view; uniformly dark reddish-brown with indistinct darker radial pattern; covered with dark brown setae,

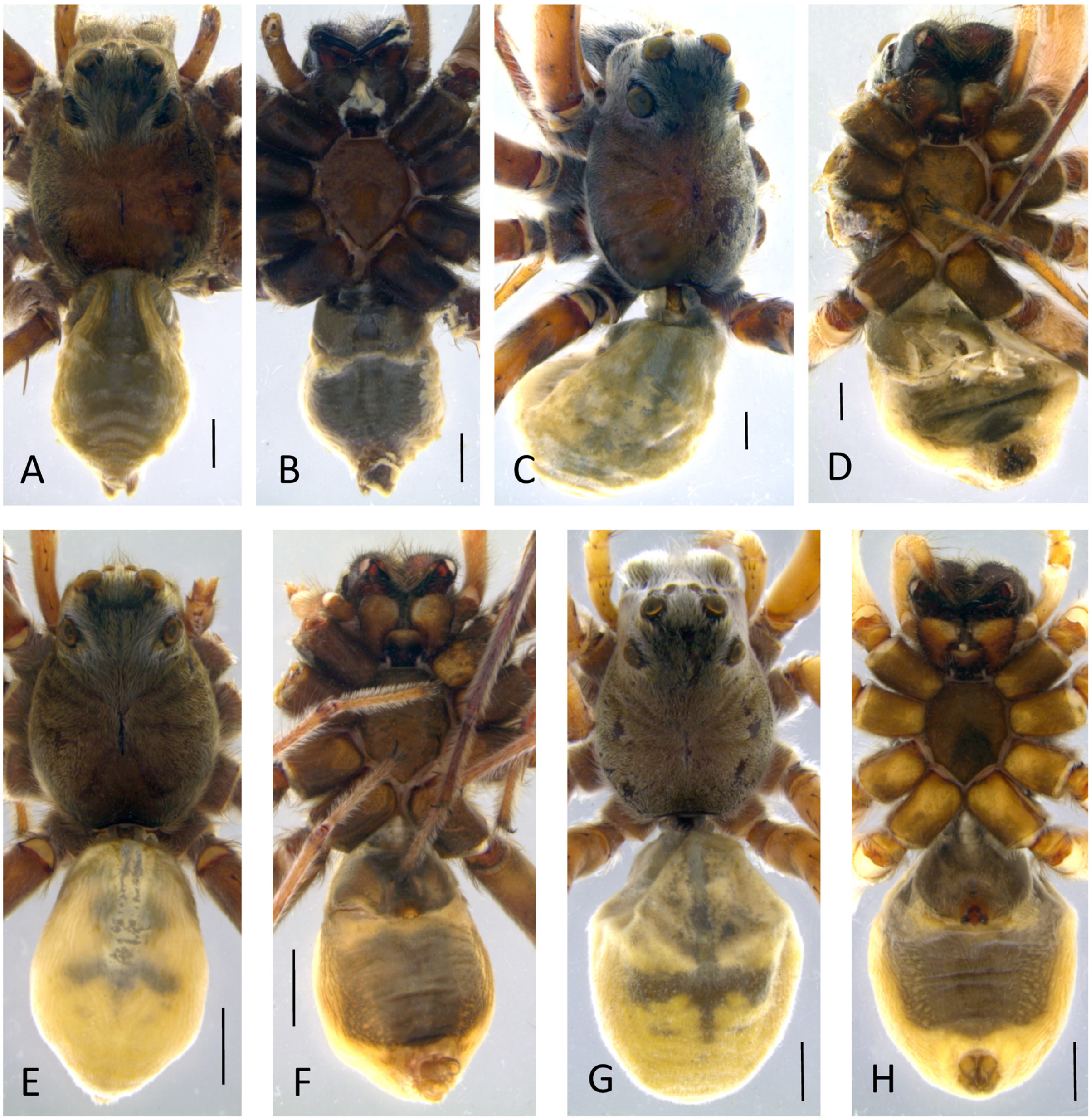

Fig. 22. *Tetralycosa* Roewer, 1960, microscopic photographs showing dorsal and ventral views. **A–B**. *T. adarca* sp. nov., holotype, ♂ (SAM NN21882). **C–D**. *T. adarca* sp. nov., paratype, ♀ (SAM NN21732). **E–F**. *T. eyrei* (Hickman, 1944), ♂ (SAM NN2737). **G–H**. *T. eyrei* (Hickman, 1944), ♀ (SAM NN13813). Scale bars: A–H = 2.00 mm.

white towards margins and anteriorly of fovea and in eye region; brown macrosetae around PE; ca 12 long bristles below AE; one long bristle between AME.

Eyes. Row of AE of shorter than row of PME; row of AE strongly procurved.

Chelicerae. Reddish-brown, dark brown apically; covered with white setae basally; three promarginal teeth with the median largest; three retromarginal teeth of similar size (right chelicerae with additional small apical tooth).

Sternum (Fig. 22B). Dark reddish-brown with grey pigmentation; covered with brown setae that are longer towards margins.

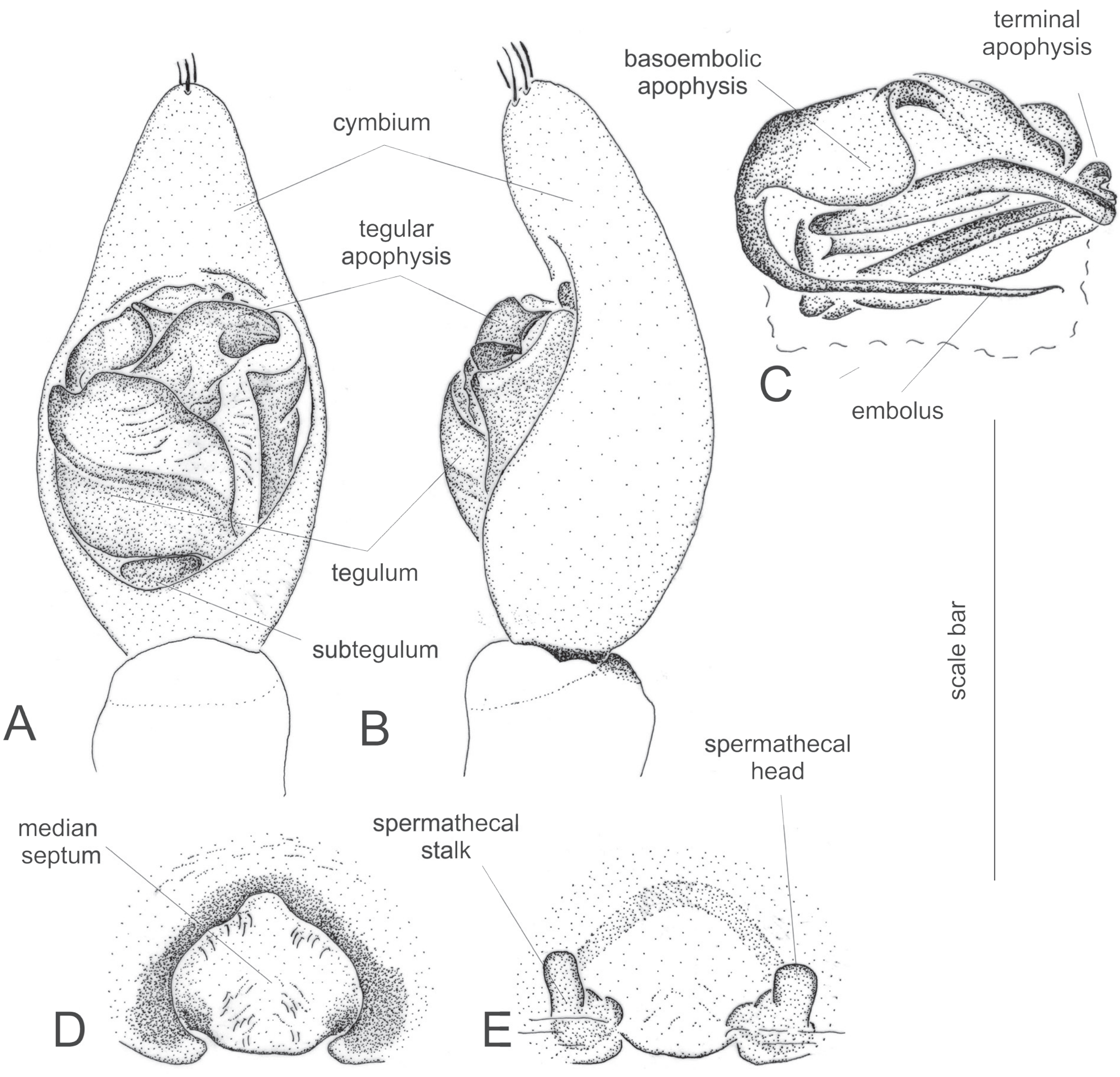

Fig. 23. *Tetralycosa adarca* sp. nov. **A–B**. Left male pedipalp, ventral and retrolateral view (holotype SAM NN21882). **C**. Left male pedipalp, palea section of bulbus, ventral view (SAM NN21888). **D–E**. Female epigyne, ventral and dorsal view (paratype SAM NN21732). Scale bar: A–B = 2.34 mm; C = 1.37 mm; D–E = 1.82.

Labium. Brown, laterally darker; front end truncate and white.

Pedipalps (Fig. 23A–C). Tegular apophysis with a meso-basal rounded flap (Fig. 23A); upper edge of terminal apophysis shaft bend about half-way; embolus relatively thick and straight (Fig. 23C).

Abdomen. Dorsally yellow-brown with indistinct lanceolate heart mark in anterior half; olive-grey mottled pattern in anterior half that forms transverse bars in posterior half; covered with grey setae (Fig. 22A). Ventrally yellow-brown with olive-grey central patch that dissolves with yellow-brown spots laterally; three longitudinal bands of dense white setae. Spinnerets light brown (Fig. 22B).

Legs. Leg formula IV>II>III>I; brown. Femora of legs III and IV with two dark ventral annulations; tibiae, metatarsi and tarsi of leg I and II dark brown. Spination of leg I: femur: three dorsal, two apicoprolateral, four retrolateral; patella: one prolateral, one retrolateral; tibia: two dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, SAM NN21732)
Carapace and eyes (Fig 22C). As male.

Chelicerae. Dark reddish-brown, setae and dentition as male (including the fourth apical tooth on right retromargin).

Sternum (Fig. 22D). As male, but with less grey pigmentation.

Labium. As male.

Abdomen. Poorly preserved; dorsal pattern as male but lighter (Fig. 22C). Venter light yellow-brown with a large grey central patch through darker setae. Spinnerets as male (Fig. 22D).

Epigyne. Ventral view (Fig. 23D): circular atrium with anterior notch. Dorsal view (Fig. 23E): spermathecal heads cylindrical with indistinct spermathecal stalks.

Legs. Leg formula IV>II>I>III. Colour pattern as male; scopulae on metatarsi and tarsi of legs I and II. Spination of leg I: femur: three dorsal, four retrolateral, two apicoprolateral; patella: one prolateral, one retrolateral; tibia: one dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Life history and habitat preferences

Adult spiders were found on the surface of a salt lake in March and July. Both females were carrying an egg sac.

Distribution

Known from Lake Acraman and Lake Gairdner, South Australia (Fig. 25).

Tetralycosa eyrei (Hickman, 1944)

Figs 2C–D; 22E–H; 24A–E; 25

Pardosa eyrei Hickman, 1944: 24–25, pl. 1, figs 11–13.

Pardosa eyrei – Roewer 1955: 185. — McKay 1973: 378.
Lycosa eyrei – McKay 1985: 76. — Platnick 1989: 370.
Tetralycosa eyrei – Framenau *et al.* 2006: 26.

Diagnosis

Males of *T. eyrei* can be distinguished from other species in *Tetralycosa,* especially the similar *T. adarca* sp. nov., *T. halophila* sp. nov. and *T. williamsi* sp. nov., by the shape of the tegular apophysis, in particular its broadly truncated tip. Females in this group cannot be separated with certainty (see 'Diagnosis' of *T. adarca* sp. nov.).

Type material

Holotype

AUSTRALIA: ♂, South Australia, surface of North Lake Eyre, 2.5 miles from shore, 28°29′00″ S, 137°37′30″ E, Simpson Desert Expedition 1939 (AM KS5738) (examined).

Other material examined

AUSTRALIA, New South Wales: 1 ♂, 1 juv., Scotia Lakes, 33°07′27″ S, 141°22′47″ E (SAM NN21904). – South Australia: 1 ♀, Francis Swamp, near southern end, 29°09′ S, 136°17′ E (SAM NN13813); 1 ♂, 1 ♀, Half Moon Lake, 29°57′58″ S, 133°23′09″ E (SAM NN21892–3); 2 ♂♂, 1 ♀, Lake Eyre North, 28°58′40″ S, 137°45′00″ E (SAM NN21737–8, NN21741); 1 ♂, 2 ♀♀, 1 ♀ with spiderlings, 1 juv., Lake Frome, 30°38′00″ S, 139°38′10″ E (SAM NN13811, NN13814–5, NN21915); 1 ♂, 1 juv., north corridor of Lake Frome, 30°38′00″ S, 139°38′10″ E (SAM NN21886–7); 3 ♀♀, Lake Torrens, 30°36′ S, 138°03′ E (MV K8126); 2 ♂♂, 2 ♀♀, Scrubby Peak Lake, NE part of lake, 32°35′00″ S, 135°13′12″ E (SAM NN13810, NN21905–7). – Victoria: 1 ♂, Lake Tyrell, 35°27′10″ S, 142°51′45″ E (SAM NN21911).

Description

Measurements. ♂ holotype, SAM NN21737 (♀ SAM NN13813): TL 13.91 (16.80), CL 6.77 (7.35), CW 4.98 (5.40). Eyes: AME 0.45 (0.40), ALE 0.28 (0.26), PME 0.84 (0.89), PLE 0.71 (0.80). Row of eyes: AE 1.79 (1.89), PME 2.35 (2.55), PLE 3.30 (3.75). Sternum length/width: 3.01/2.54 (3.00/2.70). Labium length/width: 1.09/1.26 (1.12/1.17). AL 6.86 (8.40), AW 4.98 (8.25). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 3.38+3.29 + – +2.02 = 8.69, I 6.58+7.14+6.49+2.54 = 22.75, II 6.67+7.43+7.05+2.63 = 23.78, III 6.11+7.05+7.24+2.44 = 22.84, IV 7.52+8.18+8.65+2.91 = 27.26 (Pedipalp 2.85+3.15+ – +1.95 = 7.95, I 5.70+(missing)+(missing)+(missing) = unknown, II 5.55+6.30+4.95+2.40 = 19.20, III 5.25+6.00+5.55+2.25 = 19.05, IV 6.45+7.50+7.35+2.70 = 24.00).

Variation. ♂ (♀) (range, mean ± SD): TL 11.55–15.75, 14.08 ± 1.61; CL 6.00–8.10, 7.38 ± 0.83; CW 4.20– 6.45, 5.48 ± 0.81; n = 6 (TL 7.50–18.00, 13.79 ± 3.92; CL 4.05–9.30, 6.63 ± 1.66; CW 2.70–6.75, 4.80 ± 1.41; n = 11). The size variation of females is quite remarkable, since the measurements of the largest animals are more than double the measurements of the smallest spiders.

Male (based on SAM NN21737)

Carapace (Fig. 22E). Cephalic area highest in lateral view and steep vertical slopes in frontal view; brown with an indistinct darker radial pattern; mainly covered with white setae, densest towards margins and around eyes; brown macrosetae around eyes; eight long bristles below AE; one long bristle between AME.

Eyes. Row of AE of shorter than row of PME; row of AE strongly procurved.

Chelicerae. Orange-brown; covered with white setae mainly in basal half; three promarginal teeth with the median largest; three retromarginal teeth of similar size.

Sternum (Fig. 22F). Dark orange-brown, margins brown; covered with brown setae that are longer towards margins.

Labium. Brown, basally darker; front end truncate and white.

Pedipalps (Figs 2C–D, 24A–C). Tegular apophysis curved with broadly truncated tip (Figs 2C, 24A); embolus straight over most of its length with slightly curved tip (Fig. 2D, 24C).

Abdomen. Dorsally yellow-brown with indistinct darker lanceolate heart mark in anterior half; heart mark laterally widened through triangular pattern of olive-grey patches; covered mainly with white setae (Fig. 22E). Venter dark olive-grey. Spinnerets light brown (Fig. 22F).

Legs. Leg formula IV>II>III>I; light brown. Femora brown, apically lighter; tarsi, metatarsi and tibiae of leg I and II dark brown. Spination of leg I: femur: three dorsal, two apicoprolateral, four retrolateral; patella: one prolateral, one retrolateral; tibia: two dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

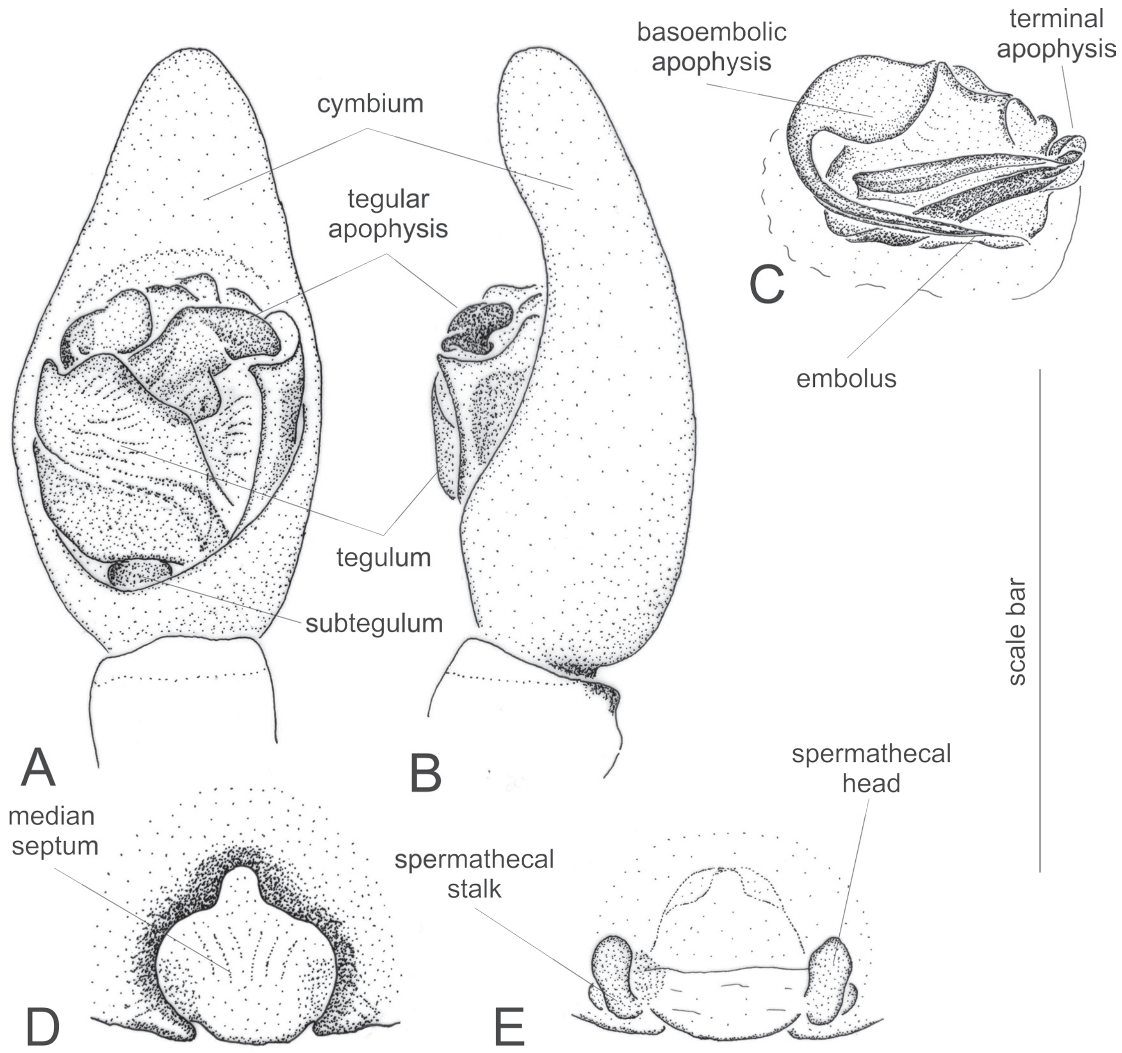

Fig. 24. *Tetralycosa eyrei* (Hickman, 1944), ♂ (SAM NN21737) and ♀ (SAM NN13814). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Left male pedipalp, palea section of bulbus, ventral view. **D–E**. Female epigyne, ventral and dorsal views. Scale bar: A–B = 1.89 mm; C = 1.23 mm; D–E = 1.26 mm.

Female (based on SAM NN13813)
CARAPACE (Fig. 22G). As male, but without dark radial pattern.

EYES. As male.

CHELICERAE. Very dark brown; covered with brown setae; dentition as male.

STERNUM (Fig. 22H). Shiny dark brown; covered with brown setae.

LABIUM. Brown, centrally darkest; front end truncate and white.

ABDOMEN. Yellow; darker lanceolate heart mark accompanied by two lateral triangular patches and crossed by grey line; covered with white setae, but light brown setae in heart mark (Fig. 22G). Venter olive-brown with an indistinct central patch of brown setae. Spinnerets as male (Fig. 22H).

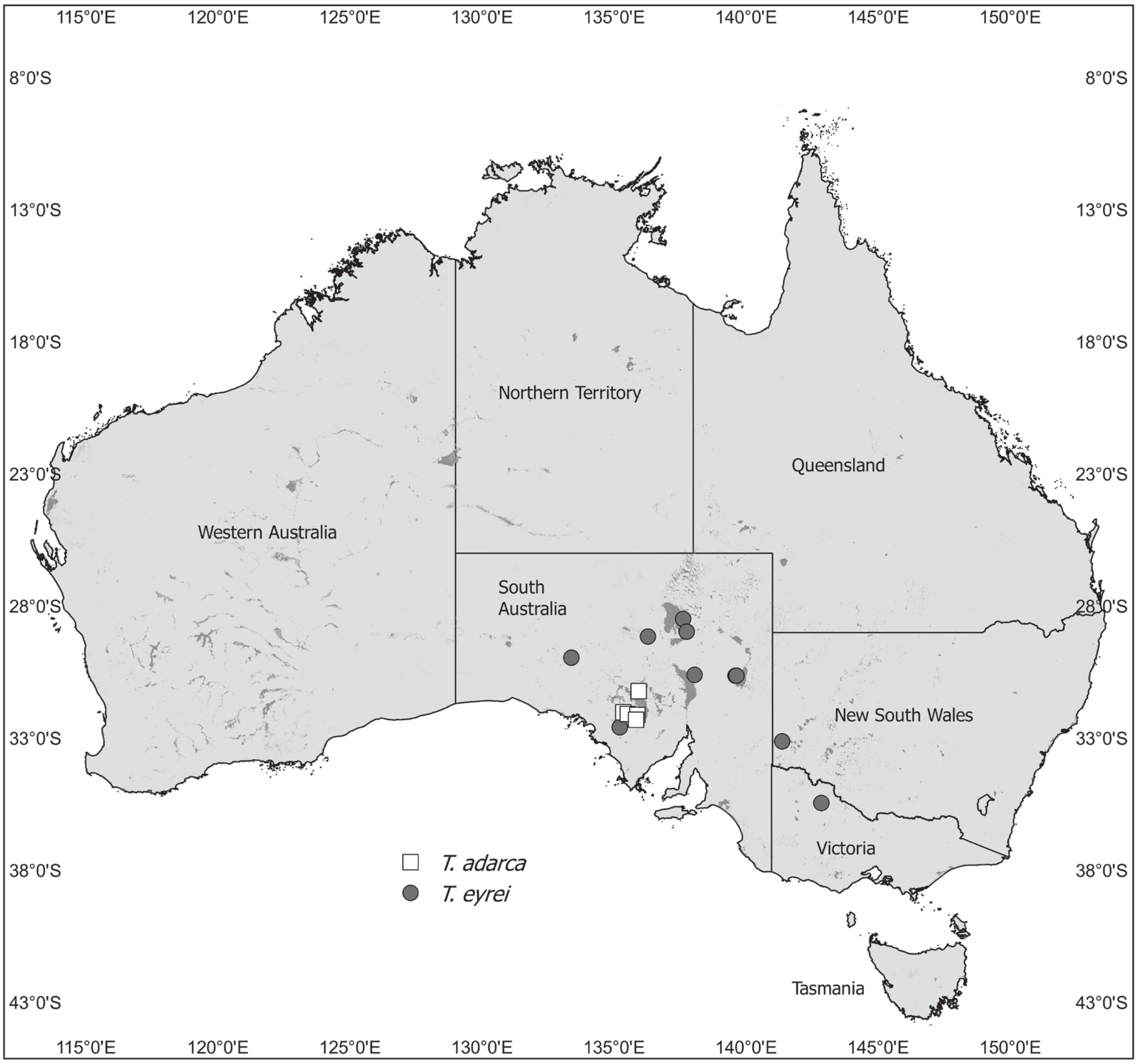

Fig. 25. *Tetralycosa adarca* sp. nov. and *T. eyrei* (Hickman, 1944), distribution records in Australia.

EPIGYNE. Ventral view (Fig. 24D): circular atrium with anterior notch. Dorsal view (Fig. 24E): spermathecal heads slightly wider than the short spermathecal stalks.

LEGS. Leg formula IV>II>III (legs I missing). Light brown, femora with two dark annulations, which are much more distinct on ventral side. Spination of leg I: femur: three dorsal, two apicoprolateral, four retrolateral (tibia, patella, metatarsus, and tarsus missing on both legs).

Life history and habitat preferences

Most adult spiders were found on salt lakes between March and July, the only female with spiderlings was recorded in July.

Distribution

New South Wales, South Australia, Victoria (Fig. 25).

Tetralycosa halophila sp. nov.

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Figs 26A–D; 27A–D; 29

Diagnosis

The male of *T. halophila* sp. nov. differs from all other species of *Tetralycosa* by protrusion on the retrolateral part of the tegulum that opposes the tip of the tegular apophysis. This protrusion is rounded in *T. halophila* sp. nov., whereas it is pointy in all other species of *Tetralycosa*. Females cannot be separated with certainty from other species in the *eyrei*-group (see 'Diagnosis' of *T. adarca* sp. nov.).

Etymology

The specific epithet is an adjective in apposition derived from the Greek '*halos*', salt, and '*phileo*', preferring, regarding as friend.

Type material

Holotype

AUSTRALIA: ♂, South Australia, Lake Everard, 31°36′00″ S, 135°25′30″ E, 3 Mar. 1993, P. Hudson leg. (SAM NN21734).

Paratypes

AUSTRALIA: 1 ♀, same data as for holotype (NN21735); 1 ♀, location as holotype, 4 March 1993, P. Hudson leg. (SAM NN21733).

Description

MEASUREMENTS. ♂ holotype, SAM NN21734 (♀ paratype, SAM NN21733): TL 19.08 (21.15), CL 9.49 (10.34), CW 7.05 (7.61). Eyes: AME 0.75 (0.56), ALE 0.42 (0.38), PME 1.50 (1.22), PLE 1.32 (1.03). Row of eyes: AE 3.10 (2.68), PME 4.14 (3.48), PLE 5.73 (4.94). Sternum length/width: 4.32/3.38 (4.23/3.48). Labium length/width: 1.88/1.68 (1.60/1.50). AL 8.84 (11.19), AW 6.77 (9.12). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 4.32+4.65+ – +3.38 = 12.35, I 8.37+9.31+8.18+2.82 = 28.68, II 8.46+9.21+8.46+2.82 = 28.95, III 8.46+9.12+8.84+3.01 = 29.43, IV 9.59+10.62+10.81+3.29 = 34.31 (Pedipalp 3.85+4.04+ – +1695 = 9.58, I 8.18+8.93+7.14+2.56 = 26.79, II 8.18+8.93+7.52+2.54 = 27.17, III 8.18+8.84+8.18+2.54 = 27.74, IV 9.02+10.06+10.34+3.01 = 32.43).

VARIATION. This species is only known from the holotype male and two paratype females (second female, SAM NN21735: TL 22.50, CL 11.25, CW 9.00).

Male (based on holotype, SAM NN21734)

CARAPACE (Fig. 26A). Cephalic area highest in lateral view and steep vertical slopes in frontal view; uniformly dark reddish-brown with very indistinct radial pattern; covered with grey and black setae, white setae towards margins and in eye region; light brown macrosetae around PE; ten long bristles below AE; one long bristle between AME.

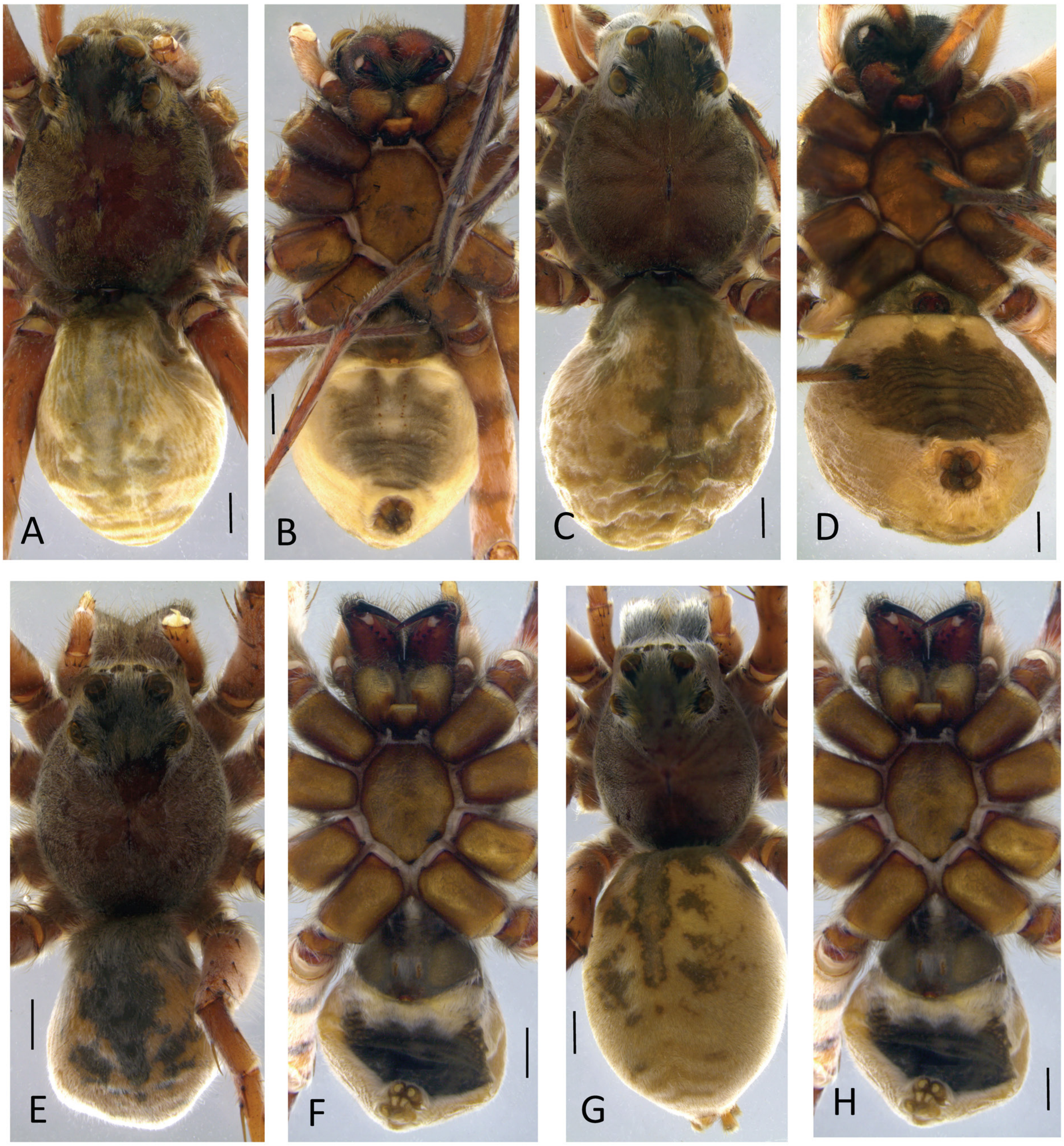

Fig. 26. *Tetralycosa* Roewer, 1960, microscopic photographs showing dorsal and ventral views. **A–B**. *T. halophila* sp. nov., ♂, holotype (SAM NN21734). **C–D**. *T. halophila* sp. nov., ♀, paratype (SAM NN21733). **E–F**. *T. williamsi* sp. nov., ♂, holotype (SAM NN13812). **G–H**. *T. williamsi* sp. nov., ♀, paratype (SAM NN17385). Scale bars: A–H = 2.00 mm.

EYES. Row of AE shorter than row of PME; row of AE strongly procurved.

CHELICERAE. Reddish-brown; covered with grey setae in basal half; brown macrosetae medially and mainly in apical half; three promarginal teeth with the median largest; four retromarginal teeth of similar size.

STERNUM (Fig. 26B). Orange-brown, margins brown; covered with few white setae and longer brown macrosetae that increase in length towards margins.

LABIUM. Dark brown, apically light brown; front end truncate and white.

PEDIPALPS (Fig. 27A–B). Tegular apophysis bent to point retrolaterally; retrolateral tegular protrusion a rounded lobe (Fig. 27A); terminal apophysis not dissected, as only known from single male.

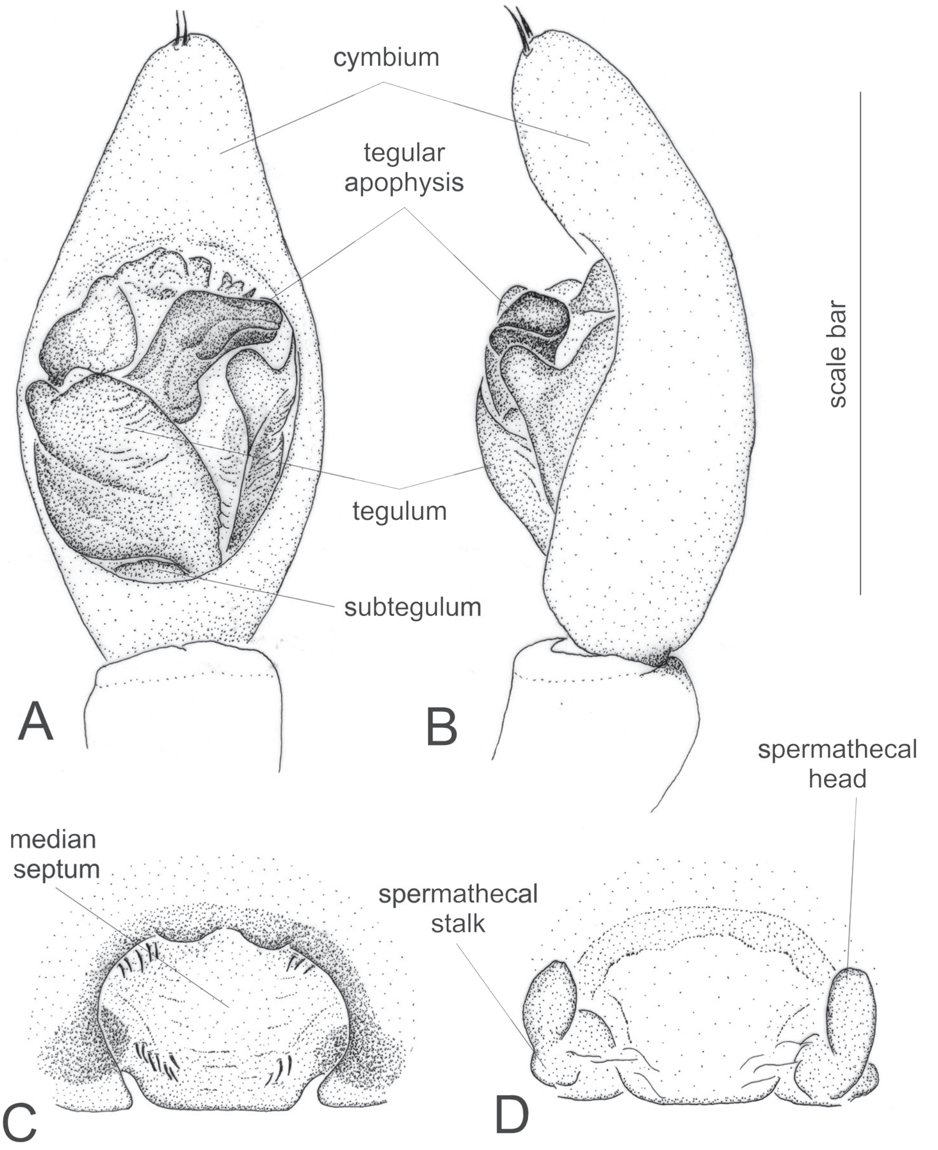

Fig. 27. *Tetralycosa halophila* sp. nov., ♂, holotype (SAM NN21734) and ♀, paratype (SAM NN21733). **A–B**. Left male pedipalp, ventral and retrolateral view. **C–D**. Female epigyne, ventral and dorsal view. Scale bar: A–B = 2.78 mm; C–D = 1.43 mm.

ABDOMEN. Dorsally yellow-brown, anteriorly with indistinct grey mottled pattern in which there is an indistinct lighter lanceolate heart mark; covered with light brown setae. Ventrally yellow-brown with greyish central patch formed by grey setae; this patch light yellow in centre; otherwise white setae. Spinnerets light brown.

LEGS. Leg formula IV>III>II>I; brown. Femora with two dark ventral annulations; metatarsi and tarsi of legs I and II dark reddish-brown. Spination of leg I: femur: three dorsal, two apicoprolateral, four retrolateral; patella: one prolateral, one retrolateral; tibia: two dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, SAM NN21733)
CARAPACE (Fig. 26C). As male, but with indistinct light brown margins.

EYES. As male.

CHELICERAE. Very dark reddish-brown; setae and dentition as male.

STERNUM (Fig. 26D). Orange-brown with dark grey pigmentation; setae as male.

LABIUM. As male.

ABDOMEN. Dorsally as male, but dark mottled pattern and heart mark more distinct (Fig. 26C). Venter as male, but grey patch larger and more distinct and not lighter centrally. Spinnerets as male (Fig. 26D).

EPIGYNE. Ventral view (Fig. 27C): wider than long with two anterior lobes. Dorsal view (Fig. 27D): spermathecal heads oval, spermathecal heads indistinct and short.

LEGS. Leg formula IV>III>II>I. As male, dorsal and ventral annulations on femora of leg III and IV only; metatarsi and tarsi of leg I dark reddish-brown; metatarsi and tarsi of legs I and II with white scopulous setae. Spination of leg I: femur: three dorsal, two apicoprolateral, one apicoretrolateral; patella: one prolateral, one retrolateral; tibia: one dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral; one apicoprolateral; one apicoretrolateral.

Life history pattern and habitat preferences

All spiders were found in March on a salt lake.

Distribution

Currently only known from type locality, Lake Everard in South Australia (Fig. 29).

Tetralycosa williamsi sp. nov.
urn:lsid:zoobank.org:act:11336396-ED5B-4EBC-938B-DDDD097D5816
Figs 26E–H; 28A–E; 29

Diagnosis

The tegular apophysis of the male pedipalp in *T. williamsi* sp. nov. is most similar to that of *T. eyrei*; however, it is not as broadly truncated. Females cannot be separated with certainty from *T. adarca* sp. nov., *T. halophila* sp. nov. and T. *eyrei* (see 'Diagnosis' of *T. adarca* sp. nov.).

Etymology

The specific epithet is a patronym in honour of the late W.D. (Bill) Williams, eminent limnologist, champion of salt lake ecology and conservation, and mentor of the junior author (P.H.).

Type material

Holotype

AUSTRALIA: ♂, South Australia, Lake Gilles, 2 km from shore, 32°47′ S, 136°48′ E, on salt lake, 3 Oct. 1995, E.P. Shore leg. (SAM NN13812).

Paratypes

AUSTRALIA: 1 ♂, 1 ♀, 2 juvs, South Australia, Lake Gilles, 32°42′00″ S, 136°54′30″ E, 12 Apr. 1980, P. Hudson leg. (SAM NN17384–5).

Other material examined

AUSTRALIA, South Australia: 1 ♀, Lake Dutton, 31°48′30″ S, 137°10′30″ E (SAM NN21884); 1 ♂, Lake Finniss, 31°43′ S, 136°50′ E (SAM NN21885); 1 ♂, Lake Gilles, 33°03′52″ S, 136°40′08″ E (SAM NN21889); 2 ♂♂, 5 ♀♀, 1 ♀ with spiderlings, 2 juvs, Lake Gilles, 32°47′ S, 136°48′ E (SAM NN13809, NN21694, NN21916–8); 3 ♀♀, 1 ♀ with spiderlings, Lake Gilles, NE part of lake, 32°41′30″ S, 136°54′50″ E (SAM NN 21700, NN21706, NN21710); 1 ♂, 1 ♀ with egg sac, Lake Hart, 31°13′40″ S, 136°22′45″ E (SAM NN21749, NN21894); 1 ♂, Lake McFarlane, 31°44′ S, 136°36′ E (SAM NN21899); 1 ♀, 3 juvs, Lake Torrens, 30°36′ S, 138°03′ E (MV K8183); 1 ♂, 3 ♀♀, 1 juv. Tregalana Lake, 32°51′00″ S, 137°37′30″ E (SAM NN21910; NN21919–21); 2 ♂♂, 2 ♀♀, Wirraminna 2 Lake, 31°29′40″ S, 136°18′25″ E (SAM NN21780, NN21782, NN21784).

Description

Measurements. ♂ holotype, SAM NN 13812 (♀ paratype, SAM NN 17385): TL 16.20 (19.50), CL 8.55 (9.90), CW 6.15 (7.20). Eyes: AME 0.52 (0.52), ALE 0.29 (0.34), PME 1.13 (1.20), PLE 0.98 (1.03). Row of eyes: AE 2.26 (2.52), PME 3.20 (3.32), PLE 4.50 (4.80). Sternum length/width: 4.28/3.15 (4.20/3.60). Labium length/width: 1.40/1.23 (1.49/1.57). AL 7.50 (9.00), AW 6.45 (7.05). Legs: Lengths of segments (femur + patella/tibia + metatarsus + tarsus = total length): Pedipalp 4.20+4.20+ – +2.85 = 11.25, I 8.25+8.85+8.40+2.70 = 28.20, II 8.55+9.00+9.30+2.85 = 29.70, III 8.10+8.70+9.45+2.70 = 28.95, IV 9.60+10.35+11.63+3.30 = 34.88 (Pedipalp 3.90+4.35+ – +2.70 = 10.95, I 8.40+9.60+7.50+2.55 = 28.05, II 8.70+10.05+8.10+2.70 = 29.55, III 8.10+9.30+7.95+2.55 = 27.90, IV 10.05+11.25+10.80+3.15 = 35.25).

Variation. ♂ (♀) (range, mean ± SD): TL 13.20–21.75, 17.93 ± 2.44; CL 7.95–10.20, 9.43 ± 0.73; CW 6.00–7.80, 7.05 ± 0.52; n = 9 (TL 15.45–24.90, 19.95 ± 3.05; CL 8.40–11.25, 9.79 ± 0.92; CW 6.15–8.25, 7.31 ± 0.75; n = 7).

Male (based on holotype, SAM NN13812)

Carapace (Fig. 26E). Cephalic area highest in lateral view and steep vertical slopes in frontal view; uniformly dark reddish-brown; covered with black setae, white setae towards margins and in cephalic area; brown macrosetae around PE; eight long brown bristles below AE; one long bristle between AME.

Eyes. Row of AE shorter than row of PME; row of AE strongly procurved.

Chelicerae. Dark reddish-brown; covered with white setae and few brown macrosetae; three promarginal teeth with the median largest; three retromarginal teeth of similar size.

Sternum (Fig. 26F). Light brown with darker pigmentation; covered with brown setae and laterally with longer brown macrosetae.

Labium. Brown; front end truncate and white.

Pedipalps (Fig. 28A–C). Tegular apophysis curved with a truncated tip (Fig. 28A); embolus straight and thin (Fig. 28C).

Abdomen. Dorsally yellow-brown, black arrow-shaped heart mark; laterally of heart mark irregular black spots; covered with white setae and fewer macrosetae (Fig. 26E). Ventrally very dark olive-grey; yellow transverse band with three posterior tips behind epigastric furrow. Spinnerets brown (Fig. 26F).

Legs. Leg formula IV>II>III>I; brown, distal segments darker (in particular tibiae, metatarsi and tarsi of leg I and II). Femora III and IV with two black annulations ventrally; scopulae on metatarsi and tarsi of leg I and II. Spination of leg I: femur: three (four on right leg) dorsal, four retrolateral,

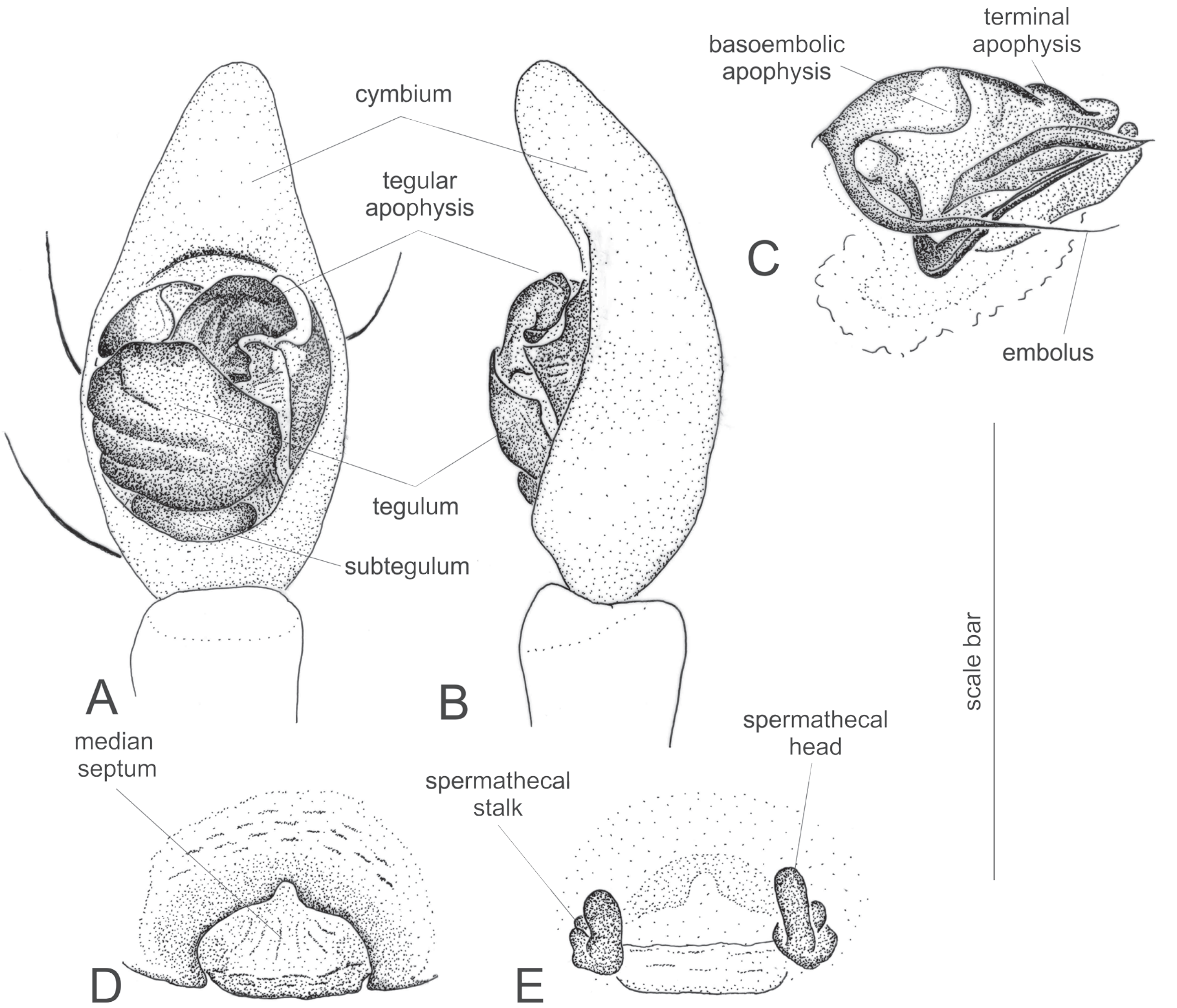

Fig. 28. *Tetralycosa williamsi* sp. nov., ♂, holotype (SAM NN13812) and ♀, paratype (SAM NN17384). **A–B**. Left male pedipalp, ventral and retrolateral view. **C**. Left male pedipalp, palea section of bulbus, ventral view. **D–E**. Female epigyne, ventral and dorsal view. Scale bar: A–B = 1.92 mm; C = 1.23 mm; D–E = 1.32.

two apicoprolateral; patella: one prolateral, one retrolateral; tibia: one dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral, one apicoprolateral, one apicoretrolateral.

Female (based on paratype, SAM NN17385)
CARAPACE, EYES, CHELICERAE, STERNUM, LABIUM, ABDOMEN (Fig. 26G–H). As male.

EPIGYNE. Ventral view (Fig. 28D): ovoid median septum with anterior notch. Dorsal view (Fig. 28E): small spermathecal heads, convoluted spermathecal stalks attach posteriorly.

LEGS. Leg formula IV>II>I>III. Colour pattern as male but distal segments not darker. Femoral annulations and scopulae as male. Spination of leg I: femur: three dorsal, two apicoprolateral, four retrolateral; patella: one prolateral; tibia: one dorsal, three ventral pairs, two prolateral, two retrolateral; metatarsus: three ventral pairs, two prolateral, two retrolateral, one apicoventral; one apicoprolateral; one apicoretrolateral.

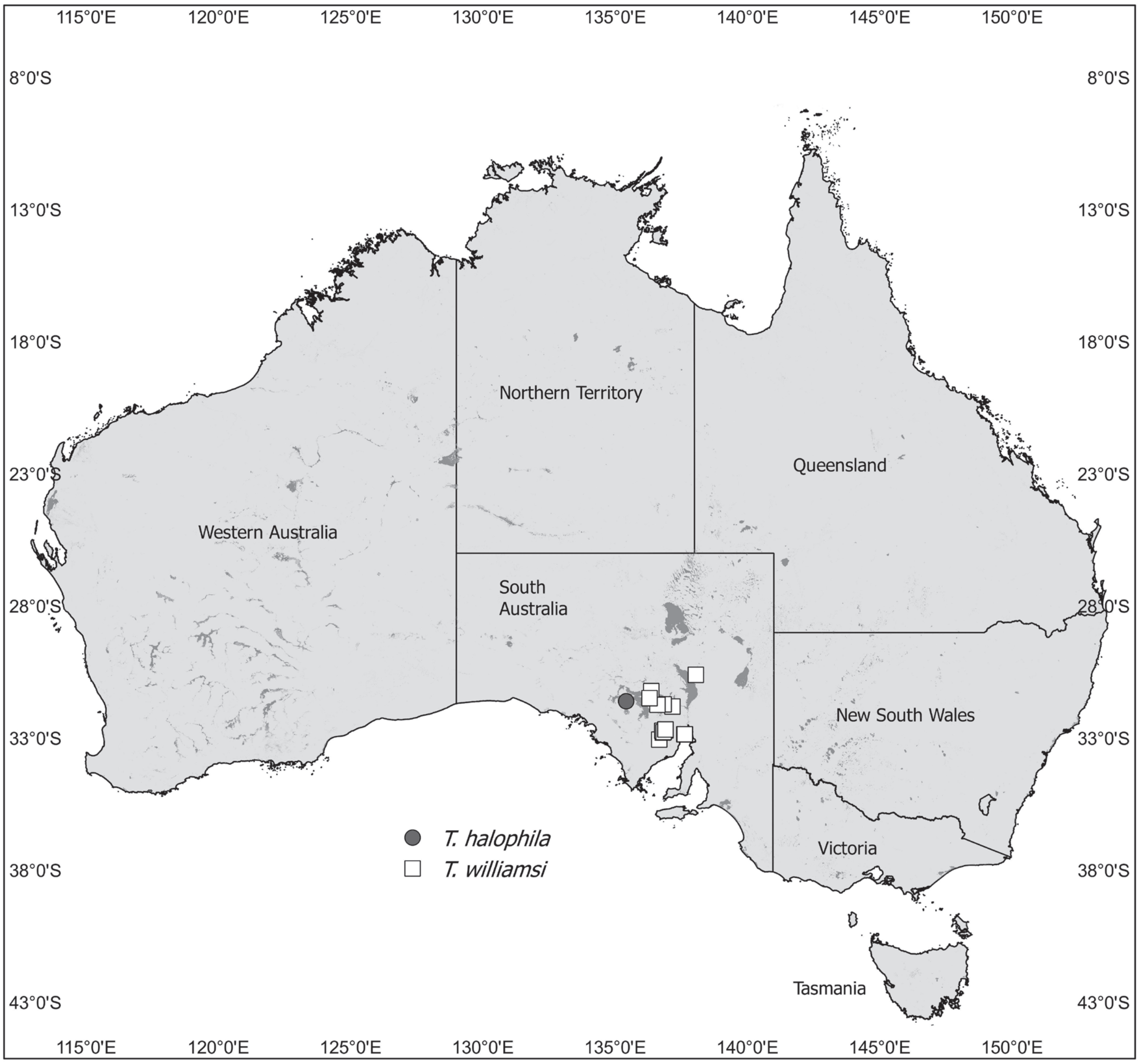

Fig. 29. *Tetralycosa halophila* sp. nov. and *T. williamsi* sp. nov., distribution records in Australia.

Life history and habitat preferences

Adult spiders have been found on the surface of salt lakes between September and May (with a peak in December), but not in November and January. Females carrying an egg sac or spiderlings were found between January and March (PH personal observation).

Distribution

Salt lakes in South Australia (Fig. 29).

Discussion

Morphology and phylogeny

The phylogenetic analysis of our limited taxon sample, which focused on testing hypotheses in relation to the monophyly of three a-priori defined species groups within *Tetralycosa*, confirmed the importance of male genitalic characters in establishing genera within the Artoriinae. Artoriine genera have generally been identified based on the shape of the tegular apophysis or the basoembolic apophysis of the male pedipalp (Framenau 2007). Similarly, *Tetralycosa* is defined by the curved tegular apophysis (character 16), that has a different morphology in all other artoriine genera, including those incorporated in our analysis (Fig. 4A). In addition, the shape of the terminal apophysis, that forms a channel for the embolus (character 20), is characteristic for the genus. The terminal structures of the male lycosid pedipalp are highly variable and otherwise of little systematic value within the Artoriinae (Framenau 2002, 2005b, 2007, 2010).

As male genital characters are unknown for *T. caudex* sp. nov., its inclusion in *Tetralycosa* must be considered tentative. Within our taxon sample, the phylogenetic hypothesis placed it in *Tetralycosa* mainly based on the shape of the female epigyne (character 28) (Fig. 4A). If the pedipalp morphology of *T. caudex* sp. nov. does not feature the synapomorphies here identified for *Tetralycosa*, i.e., the curved tegular apophysis and the terminal apophysis forming a channel for the embolus, it may belong to a different genus within the Artoriinae, possibly one of the genera here included as outgroups in our analysis.

At the onset of our study we recognised three morphological groups. Species similar to *T. oraria*, the *oraria*-group, are comparatively small, have horizontal carapace profiles in lateral view and, if not uniformly yellow-brown, have a generally mottled colouration. Whilst clearly halotolerant and only found on sand beaches or on clay pans and samphire flats at the margins of salt lakes, none of these species have been reported exclusively from the dried surface of salt lakes. In contrast, the two other morphological groups, the *alteripa*- and *eyrei*-groups, were exclusively found on the playa of dried salt lakes and this salt lake clade is well supported. These spiders were of comparatively large size, with a sloping carapace profile in lateral view. The two salt lake groups differed in overall colour pattern, but also distinctly in the overall shape of the female epigyne, which presents an almost circular atrium without median septum in species associated with *T. eyrei* but is much more variable in species apparently related to *T. alteripa*. Somatic differences between the salt lake dwellers on the one hand and those of beaches and clay pans were so striking, in particular in relation to size, carapace profile and colouration that we initially considered them to belong to different genera. However, our phylogenetic analysis did not support this assumption (Fig. 4A–B). With the exception of the terminal, well supported clade of species associated with *T. eyrei*, neither the *T. oraria*-group nor the *T. alteripa*-group were monophyletic in our topology and with the lack of reciprocal monophyly between any of the groups, they are here considered congeneric.

Our phylogenetic analysis proposes a single salt lake clade supported by six synapomorphies, three based on somatic characters such as carapace shape and eye pattern (characters 2, 3, 7) and three genitalic characters, both male and female (19, 22, 27). A raised carapace in wolf spiders has previously been associated with burrowing behaviour (e.g., Zyuzin 1990, 1993) and could be considered adaptive due to the obligatory burrowing behaviour required on salt lakes and therefore of limited use to support monophyly of the salt lake clade. However, the three genitalic characters are non-adaptive and strongly support monophyly of the clade.

Our topology supports a biogeographic origin of *Tetralycosa* in Western Australia, where all species of the 'basal' *oraria*- and *alteripa*-groups, except *T. arabanae*, are found (Table 4). Similarly, the initial conquest of salt lakes by the salt lake clade appears to have occurred in Western Australia. From here, the exploitation of salt lakes has expanded to the east, as all species of the terminal *eyrei*-group have exclusively been found in South Australia or further east in New South Wales and Victoria (Table 4).

Our morphological assessment of the species within the *alteripa*-group is in good agreement with the allozyme study of Hudson & Adams (1996), with *T. baudinettei* sp. nov. representing their "*L.* sp. nov. group" from Lake Lefroy. Populations of *T. floundersi* sp. nov. and *T. rebecca* sp. nov. were not included in the allozyme study of Hudson & Adams (1996). Within the *eyrei*-group, *T. williamsi* sp. nov. is in good agreement with Hudson & Adams (1996); however, there are some discrepancies between the allozyme analysis and morphological species hypotheses within the other three species, *T. adarca* sp. nov., *T. eyrei* and *T. halophila* sp. nov. This does not surprise, as in particular females are difficult even impossible to identify in this group. However, our species hypotheses are derived on unambiguous male genitalic morphology, which should be considered reliable in wolf spider taxonomy. Only future systematic studies, possibly including modern molecular tools targeting mitochondrial and nuclear genes, may clarify the identity of females.

Ecology and behaviour

Little is known about the ecology of species within the *oraria*-group; however, it is unlikely that these are obligatory burrowing spiders such as those within the salt lake clade. Not only do they lack the raised cephalic region of burrowing wolf spiders, it also appears that both males and females are frequently collected in similar numbers in pitfall traps, such as *T. wundurra* comb. nov. and *T. orariola* sp. nov. within surveys of the Western Australian Salinity Action Plan (e.g., Harvey *et al.* 2004). In burrowing spiders, females generally remain sedentary in their burrow and only the wandering males searching for a mate are collected in pitfall traps (Framenau 2005a).

In contrast, all species in the salt lake clade, i.e., the *alteripa*- and *eyrei*-groups, are obligatory burrowers and have generally been retrieved from their burrow. All species of salt lake inhabiting *Tetralycosa* plug their burrow with mud. There are three potential benefits of this behaviour: the exclusion of predators, the maintenance of high burrow humidity (especially at the time of ecdysis), and minimising the effects of environmental extremes such as high temperatures or flooding.

Tetralycosa species in the *alteripa*- and *eyrei*-groups are not the only wolf spiders specialised to life on salt lakes. *Lycosa salifodina* McKay, 1976, a wolf spider species in the subfamily Lycosinae Sundevall, 1833 is widespread in arid Australia (Hudson 2000; McKay 1976). *Tetralycosa* species and *L. salifodina* often occur together on the same lake, where burrow plugging may also facilitate effective temporal separation of their activities. For example, during a visit by the junior author (PH) to Wyola Lakes (South Australia) in April 1994, all of the observed *L. salifodina* were in open or silk-sealed burrows and were sitting astride their burrows during the evening. In contrast, *T. alteripa* were only found in plugged burrows that showed no sign of recent activity. However, *T. alteripa* and *T. baudinettei* sp. nov. have both been recorded from Lake Lefroy (Western Australia) and it is not clear if and how they separate ecologically or spatially.

The burrows of larger immature and adult *L. salifodina* tend to be more variable in profile than those of the *alteripa* and *eyrei*-groups. They range from what appear to be simple vertical burrows through to an offset profile similar to that of *Tetralycosa*. The entrance to the burrow of *L. salifodina* has been found sealed with a sheet of silk and with mud plugs. In the literature there is some confusion regarding the burrow of this species. The type specimens were reported in McKay (1976) as having 15 cm-deep vertical burrows whilst Koch (1977) noted that his records of these specimens showed offset burrows that were 45 cm deep. The junior author (P.H.) has had the opportunity to collect this species from a number of localities (including that of the type) and observed that their burrows are usually clearly offset in profile and 15 to 20 cm deep. As the position of the water table is probably a major determinant of burrow depth, severe climatic conditions could result in considerable variation in maximum burrow depth. Other spiders are known to plug their burrows. Among lycosids, Gwynne & Watkiss (1975) reported that *Geolycosa wrightii* (Emerton, 1912) blocks its burrow to prevent infilling by windblown sand. Burrow plugging has previously been reported in *L. salifodina* (C.R. Elkington, pers. comm.; in Main 1981). In Australia, plugging of burrows in wolf spiders is mainly known in the subfamily Lycosinae, in particular from *Hoggicosa* species (Langlands & Framenau 2010), some *Tasmanicosa* species (Humphreys 1976a, 1976b; Framenau & Baehr 2016) and an unnamed species colloquially referred to as Grey Wolf Spider (wrongly illustrated as *Dingosa simsoni* (Simon, 1898) in Hickman 1967) (for taxonomy see Framenau & Baehr 2007). However, burrow construction with an offset secondary burrow, such as described for salt lake inhabiting *Tetralycosa*, does not appear to have been reported for wolf spiders before. The new burrow entrance is clearly excavated from within the burrow as the actual opening is made last of all. Field observations suggest that there can be a delay of some weeks before the actual opening is made.

Conservation

A number of imminent threats to saline wetlands have been identified in Australia, including changes to the catchment of the lakes (in particular land clearing due to agriculture that may change the hydrological regime and balance of salt), direct physical disturbance due to mining and transport infrastructure (which may also lead to changes in groundwater movement and may therefore destroy the sensitive hydrological balance of a wetland), and water discharge onto lakes (with concomitant influx of pollutants from mining and agriculture) (Coleman 2003; Timms 2005). Some species of *Tetralycosa* appear to have a very limited distribution and some are known only from a single salt lake. For example, *T. floundersi* sp. nov. (Lake Moore) and *T. rebecca* sp. nov. (Lake Rebecca) are currently known from single lakes in Western Australia, as is *T. halophila* sp. nov. (Lake Everard) in South Australia. *Tetralycosa baudinettei* sp. nov. has only been found on four neighbouring salt lakes in the Goldfields region of Western Australia. All can be considered short- or narrow-range endemics and their naturally small distributions should make them a focus of conservation efforts (Harvey 2002; New & Sands 2002; Ponder & Colgan 2002). For example, the Environmental Protection Authority (EPA) of Western Australia has recognised short-range endemic invertebrates as an environmental factor that has to be considered in environmental impact assessments (EPA 2016). However, current resource developments in Western Australia mainly consider the aquatic fauna and flora of salt lakes in their environmental impact assessment (Chaplin *et al.* 1999; Gregory *et al.* 2009; SIGM 2010), presumably due to a limited awareness of the existence and potential sensitivity of the terrestrial fauna of the lake. Even well-educated biologists are often surprised when confronted with the existence of a distinct terrestrial invertebrate fauna on salt lakes that are generally presumed biologically dead until they become inundated.

In addition to direct habitat destruction, two main factors may more subtly impact on the terrestrial salt lake fauna. Firstly, extraction and evaporation of the groundwater of a lake, for example to extract lake brine for the production of sulphate of potash as base for fertiliser (e.g., Rewards Minerals 2016), may lower the groundwater of the lake, which may result in drying out and hardening of the surface that cannot be penetrated to construct burrows, or the spiders may not be able to reach the potentially life-saving groundwater. Secondly, mines near salt lakes often discharge hypersaline process water onto lakes causing local increases in depth of the surface salt crust, which in turn becomes uninhabitable as it is impenetrable by burrowing invertebrates (e.g., Curtin University of Technology 1999).

Overall, our current knowledge of salt lake wolf spider biology and that of other salt lake dwellers such as tiger beetles (Cicindelinae) and crickets (Orthoptera) (e.g., Baehr & Hudson 2001; Hudson 1995) is poor and the effects of human disturbances on salt lakes on the terrestrial invertebrate fauna are little understood. For example, two closely related species of *Tetralycosa*, *T. alteripa* and *T. baudinettei* sp. nov. in addition to *L. salifodina*, occur in sympatry on Lake Lefroy in Western Australia, which is subject to gold and nickel mining, tourism (in particular disturbance by 4WD enthusiasts) and road infrastructure (Curtin University of Technology 1999; SIGM 2010). It remains unknown, if and how the three species separate ecologically, if they occur in different densities on different parts of the lake and if any of these, in particular the short-range endemic *T. baudinettei* sp. nov., is differentially more impacted by human disturbance. Only in-depth research into the ecology and behaviour of these species will be able to shed light on how much risk human disturbance poses to their persistence on the lake. We hope that this study will increase the awareness of terrestrial invertebrates on dry salt lakes, which in turn may lead to an increase in research on these fascinating animals and ultimately to more rigorous conservation efforts.

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