

***Swaustraltingis isobellae*, a new genus and new species of Australian lacebug (Insecta: Heteroptera: Tingidae), with a redescription of *Cysteochila cracentis* Drake 1954, and notes on the lacebug fauna of southwest Australia.**

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Abstract

An unusual new lacebug, *Swaustraltingis isobellae* gen. & sp. nov., is described from southwest Australia. We compare this new genus to other potentially closely related genera and give details of the species' ecology. *Swaustraltingis isobellae* gen. & sp. nov. is flightless and host-specific to the plant *Empodisma gracillimum*, which may indicate its potential to become threatened if its habitat is subject to disturbance or climate change which results in the local loss of this host. We also provide a key to the genera of tingids currently known in south-west Australia and a redescription of one resident species, *Cysteochila cracentis*.

Key words coextinction, *Cysteochila cracentis*, insect-plant interactions, Tinginae.

INTRODUCTION

Australian Tingidae are diverse and highly endemic. Cassis and Gross (1995) documented the lace bugs of Australia, recognising 147 species, of which 135 species were endemic. Recent work on four genera has expanded this fauna by 27 species (Cassis & Symonds 2008, 2011; Moir 2009; Guilbert & Moir 2010). However, the tingid fauna remains poorly known in Western Australia. The southwest of Australia stretches from north of Geraldton through to east of Esperance and encompasses an area of approximately 302,627 km² (Hopper & Gioia 2004). This area is a world diversity hotspot for flora (Myers et al. 2000) and an endemism hotspot for other invertebrate taxa (e.g., Moir et al. 2009; Rix et al. 2010; Cooper et al. 2011; Rix & Harvey 2012). To date, 22 native and two introduced species of Tingidae have been recorded from the southwest. The introduced species are *Stephanitis pyrioides* (Scott), an international pest of azalea plants, and the olive tree lacebug *Froggattia olivinia* Froggatt. Of the 22 native species,

14 (64%) are endemic to south-west Australia, and a further two species are endemic to Western Australia. In this paper, we describe a monotypic new genus from southwest Western Australia, and document aspects of the ecology and biogeography of this new species. A key to known tingid genera of south-west Australia is provided. *Cysteochila cracentis* Drake 1954 was described based on a single male specimen from Yanchep (~50km north of Perth); here we provide additional ecological and biological information on the species as well as a redescription incorporating genitalia, the first female and nymphal specimens.

METHODS AND MATERIALS

Most specimens examined here were collected by beating or vacuuming plants (as described in Moir et al. 2005a), subsequently removed from any solutions and pinned. Specimens were examined under Leitz TS microscope and Leica MZ16 stereoscope, and images were photographed using the Auto-montage Pro version 5.02(p) (Syncroscopy, Cambridge, UK) at the Western Australian Museum. Illustrations were prepared using Photoshop(R) from pencil originals.

The following abbreviations have been used in this paper: BMNH, The Natural History Museum, London, England; MLM, Melinda Moir private collection, Perth, Western Australia; MNHN, Muséum National d'Histoire Naturelle, Paris, France; WA, Western Australia; WAM, Western Australian Museum, Perth, Western Australia.

SYSTEMATICS

Key to genera of Tingidae currently known to be present in south-west Australia

(applicable only to recorded species)

1. Head extends anteriorly, surpassing 2nd antennal segment2
 -. Not as above3
2. Row of lateral spines on paranotum.....*Ceratocader* Drake, 1950 (Drake & Ruhoff, 1965, plate 5)
 -. No lateral spines on paranotum.....*Carldrakeana* Froeschner, 1968 (Guilbert & Moir, 2010, fig. 1)
3. Single longitudinal carina on pronotum.....*Radinacantha* Hacker, 1929 (Moir, 2009, fig. 1)
 -. Two or more longitudinal carinae on pronotum.....4
4. Inflated ‘cysts’ on pronotum and/or collar (not including convex pronotum).....5
 -. No inflated ‘cysts’ present (although pronotum and/or paranotum may be large and convex).....10
5. Row of lateral spines on paranotum.....6
 -. No lateral spines on paranotum.....7
6. Hook-like setae on dorsum (see Cassis & Symonds, 2011).....*Lasiacantha* Stål, 1873 (Cassis & Symonds, 2011, fig. 8b)
 -. Dorsum lacking hook-like setae*Inoma* Hacker, 1927 (Drake & Ruhoff, 1965, plate 42)
7. Inflated ‘cysts’ large, extending greater than 1.5x the height of body.....*Diplocysta* Horváth, 1925 (Drake & Ruhoff, 1965, plate 28)
 -. Inflated ‘cysts’ extend less than 1.5x the height of body.....8
8. Paranotum wide, extending the width of the head laterally either side of body.....9
 -. Paranotum narrower, not extending width of the head either side of body.....*Oncophysa* Stål, 1873
9. 4th antennal segment long, > 0.5 length of 3rd segment.....*Stephanitis* Stål, 1873 (Drake & Ruhoff, 1965, plate 47)
 -. 4th antennal segment short, < 0.25 length of 3rd segment.....*Celantia* Distant, 1903 (Drake, 1960, fig. 17)
10. Pronotum flat.....*Swaustraltingis* gen. nov.
 -. Pronotum convex11
11. Parana more than 3 cells wide.....*Cysteochila* Stål, 1873 (Drake & Ruhoff, 1965, plate 9)
 -. Parana less than 3 cells wide.....12
12. Hood present on collar.....*Ulonemia* Drake & Poor, 1937 (Drake, 1960, fig. 8)

- . Hood absent.....14
- 13. Occipital cephalic tubercles long, reaching anterior edge of eyes.....*Froggattia* Froggatt, 1901
- . Occipital cephalic tubercles short, not reaching anterior edge of eyes.....15
- 14. Head, abdomen and 4th antennal segment predominantly black.....
-*Epimixia* Kirkaldy, 1908 (Drake & Ruhoff, 1965, plate 13)
- . Head, abdomen and antennae predominantly brown.....*Ischnotingis* Horváth, 1925

Family Tingidae Laporte, 1832

Subfamily Tinginae Laporte, 1832

Tribe Tingini Laporte, 1832

Swaustraltingis gen. nov.

Type species *Swaustraltingis isobellae* sp. nov. by monotypy

Diagnosis. Body long and slender; head armed with five long and slender spines; antennae long and slender; pronotum narrow, long, flattened and tricarinate; hemelytra long, narrow, not wider than pronotum width, margins curved ventrally to cover sides of abdomen (Figs 1,2).

Other comments. *Swaustraltingis* does not resemble any other Australian genus, but is more similar to the slender African genera: *Machairotingis* Duarte Rodrigues, *Perbrinckea* Drake, and *Mafa* Hesse. In all of these genera the paranota and the hemelytra are narrow and parallel-sided, the hemelytra are often curved ventrally to cover the sides of the abdomen, the pronotum is not gibbose but somewhat flattened, and small calli are present. *Swaustraltingis* differs from all these genera by the long, slender antennae, particularly the third antennal segment, the presence of five

long cephalic tubercles, and the long lateral carinae of the pronotum which end anteriorly by forming a loop within the calli.

Etymology. This genus is named after the southwest Australian region where it was found, combining abbreviations for the southwest and Australia, “sw” and “austral”, respectively. The term “tingis” is commonly used within generic names of the family Tingidae (gender feminine).

***Swaustraltingis isobellae* sp. nov. (Figs 1, 2, 6)**

Types.

Holotype:

1M: W.A.; William Bay National Park; Mazzoletti beach, site 4; 35°01'04"S 117°13'45"E; 30 Oct. 2006; M.L. Moir, A. Sampey; Ex. Grass sp. (beat) (WAM T82764).

Paratypes:

2M: W.A.; Albany windfarm; Sandpatch rd; 35°03'57"S 117°47'43"E; 12 Mar. 2007; M.L. Moir, M.S. Harvey, M.G. Rix; Ex. *Empodisma gracillimum* (beat) (WAM T82766-7). 4F: W.A.; Albany windfarm; Sandpatch Rd; 35°03'57"S 117°47'43"E; 12 Mar. 2007; M.L. Moir, M.S. Harvey, M.G. Rix; Ex. *Empodisma gracillimum* (beat) (2F – MLM 00857; 2F - WAM T82768-9). 2F: W.A.; same as holotype (1F - MLM 00856; 1F - WAM T82770). 1M + 5F: W.A.; William Bay National Park; site 2; 35°00'06"S 117°13'45"; 30 Oct. 2006; M.L. Moir; Ex. Grass sp. (beat); on *Empodisma gracillimum* (2F - WAM T82771-2; 1M, 3F - MNHN 17697-700). 3F: W.A.; nr Quarrum Nature Reserve; site 1; 35°02'39"S 117°09'22"E; 29 Nov. 2006; M.L. Moir, K.E.C. Brennan; beat (2F - MLM 00799,852; 1F - WAM T82773). 1F: W.A.; William Bay

National Park; Mazzeletti beach, site 5; 35°01'06"S 117°13'14"E; 06 Nov. 2006; M.L. Moir, D. Jolly; Ex. Grass sp. (beat); on *Empodisma gracillimum* (F. Muell) (WAM T82765). 1F: W.A.; Torndirrup National Park; gully, site 12; 35°03'40"S 117°56'06"E; 18 Oct. 2006; M.L. Moir, J.M. Walldock; Tullgren funnel (MLM 00790).

Description

Adult

Body length; 2.78 ± 0.02 mm; width; 0.74 ± 0.04 mm (n=5). Body long and narrow (at least 4 times longer than wide), shiny, almost glabrous, uniformly brown; legs, cephalic tubercles and third antennal segment lighter brown; tarsi and fourth antennal segment dark brown to black. Legs long and slender, tarsi 3.5 times longer than wide.

Head with fine sparse setae dorsally, armed with a median tubercle, and both occipital and frontal pairs of tubercles. Tubercles spine-like, long, slender, and directed forwards; occipital tubercles longer than others, apex surpassing anterior margin of eyes; antenniferous processes short; bucculae mostly with two rows of areolae, closed anteriorly; rostrum long, reaching mid coxae; antennae long and slender, first three segments with fine, sparse setae; first two segments stouter, third the longest and slender, fourth fusiform with long setae; antennal segment measurements; I, 0.16 ± 0.03 ; II, 0.1 ± 0.02 ; III, 0.87 ± 0.05 ; IV, 0.24 ± 0 .

Pronotum 1.5 times longer than wide, with fine, sparse setae, tricarinate; carinae straight and slightly raised, with a very small row of areolae; median carina distinct all along pronotum; lateral carinae distinct from the posterior margin of pronotum and ending at calli with a small loop; progressively diverging anteriorly: collar wide, with three rows of areolae, not elevated into a hood; lateral margins straight; paranota narrow, with a single row of very small areolae,

raised upwards posteriorly and anteriorly, straight and slightly wider opposite to calli; labial sulcus straight, narrow and open behind, laminae with one row of areolae; scent gland opening narrow, almost closed, only upper part open.

Hemelytra longer than abdomen, almost as narrow as pronotum, narrowing posteriorly with apex angulate; lateral margins curved ventrally to cover sides of abdomen; main veins distinct but not raised; costal area very narrow, reduced to a ridge on anterior two-thirds of length, after which with a row of very small oval areolae on posterior third; subcostal area wider than costal area, curved ventrally with three rows of regular oval areolae on anterior two-thirds, then two rows of areolae on posterior third; Sc vein almost indistinct anteriorly; discoidal area longer than half the length of hemelytra, six areolae wide at widest part, areolae slightly larger than on subcostal and costal areas; RM vein distinct; sutural area long and narrow, narrowing posteriorly, six areolae wide at widest point, areolae as large as on discoidal area, except at apex, areolae 1.5x larger (Fig. 1). Hind wings absent.

Male genitalia. Parameres acutely curved, sensory lobe with several long setae on outer and inner margins, with less on inner margin, apophysis with minute setae on inner margin (Fig. 6). Aedaegus with distal endosomal sclerite strongly sclerotized, small and U-shaped, dorsal plate wide.

Etymology. This species is named after the first author's daughter, Isobelle.

Distribution. From sampling to date, *Swaustraltingis isobellae* appears restricted along the south coast of southwest Australia from Albany to Walpole (Figs 8,9). The tingid may occur throughout the rest of the host plant *Empodisma gracillimum*'s distribution which extends from Albany westwards around the coastline to Bunbury, although further sampling is required to confirm this.

Biology. The tingid has been found in both spring and autumn, and may occur as adults throughout the year. Although many individuals can be seen when beating the host plant during these times, no nymphs were discovered. This is more likely due to their small size and light colouration against the beating tray than absence from samples. Samples collected by a different method, such as vacuuming and sorting under a microscope, may reveal the nymphs.

Genus *Cysteochila* Stål, 1873

***Cysteochila cracentis* Drake 1954. (Figs 3, 4, 5, 7)**

Diagnosis. Body long and slender, approximately 4.5x longer than wide; head armed with four short stout tubercles (Fig. 3); pronotum gibbose; tricarinate; paranota developed and reflexed dorsally to rest on the pronotum, covering most of lateral carinae; hemelytra surpassing abdomen, as wide as pronotum, constricted at mid-length, and expanded at apex, margins curved ventrally. *Cysteochila cracentis* is similar to *C. brunnea* Hacker 1928 and *C. hackeri* Drake 1939. It differs in the costal area, which is reduced to a ridge in *C. cracentis*, but is present as a uniserate row of areolae in the other two species.

Types.

Holotype:

1M: W.A.; Yanchep, 32 miles N Perth, 20-31 Dec. 1935; R.E. Turner (BMNH).

Other material examined:

1M + 2F: W.A.; Site 1, Stirling Range Dr, Stirling Range National Park; 308m; beat 6; 34°21.505S 118°02.367E; 05 Sept. 2007; M.L. Moir; Ex. *Grevillea depauperata*. 1M: W.A.;

Stirling Range Dr., Stirling Range National Park; 244m; 34.39719°S 117.84607°E; 06 Oct. 2008; M.L. Moir; Ex. *Hakea tuberculata*. 1M + 1F: W.A.; site 20, North Ongerup; 325m; beat 2; 33.85308°S 118.67692°E; 06 Oct. 2008; M.L. Moir; Ex. *Grevillea anethifolia*. 1M + 2F: W.A.; Site 2, Stirling Range National Park; 285m; vacuum 4,6,14; 34°19.477S 118°12.502E; 07 Sept. 2007; M.L. Moir; on *Grevillea* sp. 'Stirling Range'. 1M + 1F: W.A.; Site 1, Stirling Range Dr, Stirling Range National Park; 308m; vacuum 7; 34°21.505S 118°02.367E; 06 Sept. 2007; M.L. Moir; Ex. *Grevillea depauperata*. 1M: W.A.; Site 1, Stirling Range Dr, Stirling Range National Park; 308m; vacuum 3; 34°21.505S 118°02.367E; 06 Sept. 2007; M.L. Moir; Ex. *Hakea trifurcata*. 1F: W.A.; Site 10, Bluff Knoll, Stirling Range National Park; 1039m; beat 6; 34°22.843S 118°18.035E; 17 Nov. 2007; M.L. Moir; Ex. *Dryandra baxteri* [now *Banksia biterax*]. 1M + 1F: W.A.; Site 15, Southern Stirling Range NP; 151m; 34.50315°S 118.25518°E; beat; 05 Oct. 2008; M.L. Moir; Ex. *Grevillea nudiflora*. 2F: On *Grevillea wilsonii*; Jarrahdale, W.A.; Nov. 2001; M. Moir. 2M: M96R3P5 [= *Hakea lissocarpha*]; Jarrahdale W.A.; May 2001 (TB [= beating]); M. Moir. 2M: M94R2P10 [= *Hakea undulata*]; Jarrahdale W.A.; May 2001 (TB [= beating]); M. Moir. 1 fifth instar: W.A.; Site 5; The Lookout, Stirling Range NP; 354m; beat; 34°25.330S 117°56.000E; 03 Dec. 2007; M.L. Moir; Ex. *Grevillea depauperata*.

Redescription

Adult

Body length: 3.94±0.34 mm; width: 0.81±0.14 mm (n=13). Body approximately 4.5x longer than wide; shiny, covered with short setae on dorsum; body golden brown, legs and antennae lighter brown, head, top of pronotum, wide transversal band across hemelytra and apex of hemelytra brown; hind wings transparent with dark brown veins for most of length, entire wings dark

brown in posterior quarter; fourth antennal segment and apex of tarsi dark brown to black (Figs 3, 4). Legs slender, tarsi 4x longer than wide. Head short, almost as wide as long; with two longitudinal rows of short setae on dorsal surface; armed with a small, stout median tubercle, and both occipital and frontal pairs of tubercles, the occipital tubercles short and stout, the frontal tubercles short, spiny and directed forwards; antenniferous processes absent; antennal segments I and II short and stout, antennal segment III long and slender, antennal segment IV short, fusiform and pilose (Figs 3, 4), antennal segment measurements: I, 0.21 ± 0.02 ; II, 0.14 ± 0.02 ; III, 1.22 ± 0.10 ; IV, 0.30 ± 0.02 . Bucculae closed anteriorly, wide, with two rows of areolae; rostrum surpassing mid coxae but not reaching hind coxae.

Pronotum almost 2x as long as wide, gibbose, tricarinate, carinae raised with one row of areolae; collar not raised, two or three areolae wide; paranota wide, eight areolae deep at widest part, reflexed to rest on the pronotum, concealing most of lateral carinae and in contact with median carina, in some specimens paranota overlap median carina to meet; posterior pronotal process sharply angulate; rostral sulcus narrow, meso- and metasternal laminae wide, with two rows of areolae, metasternal laminae almost in contact posteriorly.

Hemelytra slightly longer than abdomen, not wider than pronotum, apex widely rounded; costal area narrow, with a single row of narrow and long ovoid areolae (Fig. 3), depressed in subcostal region, except at apex; subcostal area deflexed ventrally, covering sides of abdomen, two areolae wide, areolae larger than those of costal area; discoidal area longer than half the length of hemelytra, five areolae wide at widest part, areolae similar size to those of subcostal area; sutural area long and wide, eight areolae wide at apex, areolae predominantly larger than on subcostal and discoidal area. Hind wings longer than abdomen but not surpassing forewings.

Abdomen flat, subgenital plate small and rounded; ninth paratergite twice the length of other abdominal segments, covered with numerous small setae, setae at apex longer.

Male genitalia. Parameres acutely curved, sensory lobe wide with several long setae on outer margin and short setae on inner margin, apophysis short, curved, without setae. Adaegus with distal endosomal sclerite weakly sclerotized, wide and V-shaped, dorsal plate wide and V-shaped (Fig. 7).

Fifth instar (Fig. 5)

Body yellowish, shiny, glabrous. Dorsum sparsely covered by both very small, spine-like tubercles and larger multi-branched tubercles. Body length: 1.12 mm; width: 2.8 mm.

Head short, as wide as is long; armed with five cephalic tubercles, a median one, an occipital pair and a frontal pair. Tubercles long (as long as head), slender and multi-branched, with several shorter branches along length of each tubercle (Fig. 5). Tubercle length; 0.25 mm.

Pronotum wider than long, somewhat flat, the lateral margin dilated and slightly raised; lateral margins armed with several small multi-branched tubercles directed downwards, and five tubercles directed upwards, the latter longer than the former. Tubercles increasing in length from front to posterior; the last tubercle the longest and multi-branched, similar to the cephalic tubercles; two pairs of tubercles across median dorsal surface of pronotum, a simple anterior pair of tubercles and a posterior pair of multi-branched tubercles as on head (Fig. 5).

Hemelytral pads with lateral margins armed with several small multi-branched tubercles, mostly directed downwards; three longer tubercles directed upwards; a simple tubercle anteriorly, a second longer tubercle in middle, and a third multi-branched tubercle posteriorly. Median pair of multi-branched tubercles present on dorsal surface of hemelytra pads.

Distribution. Despite having a number of host plant species, the distribution of this tingid is restricted to southwest Australia, along with all species of host plant recorded to date (Fig. 8).

Biology. *Cysteochila cracentis* has been collected from early September through to May, but not during June-August (Southern Hemisphere winter). It most likely occurs as adults throughout most of the year, perhaps overwintering as eggs and nymphs.

This tingid has been collected from multiple species of Proteaceae within the genera *Hakea*, *Grevillea* and *Banksia* (Fig 12). Although found on a number of different species, *C. cracentis* clearly prefers certain plants, such as *Grevillea depauperata* R.Br. and *Hakea tuberculata* R.Br..

DISCUSSION

The majority of specimens identified in this paper were collected with the objective of assessing the potential coextinction of insects on plants in southwest Australia (e.g., Moir et al. 2010, 2012). Although the two species cited here appear restricted to wetter regions of the southwest with rainfall exceeding 400 mm/per annum, their host range, and their coextinction potential varies greatly.

For *C. cracentis*, a large host range, good dispersal ability and relatively broad distribution should buffer it against extinction. It has been found in a number of different habitat types including Jarrahdale (GPS 32°16'S, 116°04'E), which is dominated by Jarrah/Marri forest (*Eucalyptus marginata* and *Corymbia calophylla* see Moir et al. 2005b). At Jarrahdale it has demonstrated the ability to disperse by recolonising restored mine sites within four years, although in low numbers presumably as its favoured host plant in this region, *Grevillea wilsonii*, has been absent from restoration as mature plants (M. Moir unpublished data; Moir et al. 2011a). Approximately 300 km to the south of Jarrahdale *C. cracentis* was discovered predominantly in

sandplain heath communities of the Stirling Ranges (Figs 11,12). This heath comprises many different plant species, but is generally dominated by Proteaceae, Myrtaceae and Fabaceae species (M. Moir pers. obs.) corresponding to the plant community of “*Dryandra concinna* R.Br. - *Xanthorrhoea platyphylla* Bedford” as listed by Pignatti *et al.* (1993). It will be interesting to find whether all Australian species of *Cysteochila* are restricted to Proteaceae, particularly *Grevillea* and *Hakea* species (neither Drake & Ruhoff 1965, nor Cassis & Gross 1995, list any hosts for Australian species of *Cysteochila*). In this aspect, as well as with morphological characters, *Cysteochila* shows similarity to the genus *Oncophysa*. This is because some undescribed species of *Oncophysa* from Western Australia appear associated with certain species of *Hakea* (M. Moir unpublished data).

In contrast, *Swaustaltingis isobellae* is restricted to one host plant species (*Empodisma gracillimum*, Fig. 10). Together with its propensity to occur in cooler, wetter coastal environments with this host (see Fig. 9), *S. isobellae* may be at greater risk of coextinction following the protocol set by Moir *et al.* (2011b). All the areas in which *S. isobellae* was found (Torndirrup National Park, Albany windfarm, Quarrum Nature Reserve and William Bay National Park) were dominated by coastal heathland comprising peppermint trees (*Agonis flexuosa*) with a grass-like groundcover (usually *Empodisma gracillimum*, Fig. 9), or tall *Banksia* species with grass-like (including *Empodisma gracillimum*) and reed understoreys (M. Moir pers. obs.). We recognise that *S. isobellae* populations may also comprise macropterous individuals, as some other tingid genera contain both brachypterous and macropterous forms (e.g., *Inoma* Hacker: Cassis & Symonds 2008). However, the host plant, *E. gracillimum*, was sampled at multiple locations and at different times of year without uncovering any macropterous individuals amongst many specimens (only a small subset of individuals were

collected for description; M Moir pers. obs.). If *S. isobellae* is represented by only brachypterous individuals, its poor dispersal ability would further increase the likelihood of local extinction with the removal or reduction in population sizes of its host plant.

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Legend to Figures

- Figures 1–2** *Swaustraltingis isobellae* gen. nov. sp. nov.; 1, dorsal view paratype (WAM T82767); 2, lateral view paratype (MLM 00857).
- Figures 3–5** *Cysteochila cracentis* 3, dorsal view; 4, lateral view; 5, nymph, dorsal view on left with dorsal tubercle shown enlarged on right, scale line = 1.0 mm left and 0.5 mm right.
- Figures 6–7** Male genitalia, with parameres top and aedaegus bottom, from; 6. *Swaustraltingis isobellae* (holotype); 7. *Cysteochila cracentis*. Scale line = 0.1 mm.
- Figure 8** Map of Australia with collection localities for the two species of Tingidae discussed here. Symbols represent the following: diamonds – *Cysteochila cracentis*; and stars – *Swaustraltingis isobellae*.
- Figures 9–10** Habitat of *Swaustraltingis isobellae* showing; 9. coastal woodland at William Bay National Park, Western Australia; 10. host plant *Empodisma gracillimum*.
- Figures 11–12** Habitat of *Cysteochila cracentis* showing; 11. heathland at the central lookout in the Stirling Range National Park, Western Australia; 12. host plant species *Grevillea* sp. ‘Stirling Range’.