

A revision of the white-headed spiny trapdoor spiders of the genus *Euoplos* (Mygalomorphae: Idiopidae: Arbanitinae): a remarkable lineage of rare mygalomorph spiders from the south-western Australian biodiversity hotspot

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Abstract. The ‘white-headed’ spiny trapdoor spiders of the *Euoplos mcmillani*-group are revised, and three new species are described from the biodiversity hotspot of south-western Western Australia: *E. cornishi* sp. nov., *E. kalbarri* sp. nov. and *E. saplan* sp. nov. Two previously described species, *E. ballidu* (Main, 2000) and *E. mcmillani* (Main, 2000), are further re-described and re-diagnosed. The *mcmillani*-group of *Euoplos* are remarkable for the unique ‘bright white’ carapace coloration of males, and we here document the known diversity and conservation status of these rare and enigmatic spiders.

Keywords: New species, subfamily Arbanitinae, taxonomy, tribe Euoplini

<http://zoobank.org/?lsid=urn:lsid:zoobank.org:pub:721740BC-BD44-4BB3-963A-8CB636D093FA>

The spiny trapdoor spiders of the genus *Euoplos* Rainbow, 1914 include some of Australia’s largest and best-known Idiopidae, with recent research highlighting the monophyly, diversity and biology of this distinctive group (Rix et al. 2017b, d, 2018c; Wilson et al. 2018a, b). Known species all build well-developed hinged doors on their burrows, and these vary from thin, wafer-like structures that incorporate leaf litter debris (see Wilson et al. 2018a, figs. 1H, I), to thick, plug-like doors that sit within characteristically beveled burrow entrances (see Wilson et al. 2018a, figs. 1D, E). These door-building behaviors are of phylogenetic significance among *Euoplos*, and correspond to the major lineages within the genus (Wilson et al. 2018a). A number of species in the *turrificus*-group also build unusual palisade-like burrow entrances (see Wilson et al. 2018b), including doors with extraordinary crenate lobes in *E. crenatus* Wilson & Rix, 2018 (see Wilson et al. 2018b, figs. 1, 2, 11, 25). However, despite this diversity of burrowing behaviors and the unusually broad distribution of the genus in Australia, the genus *Euoplos* is largely characterized by species with relatively conservative somatic and genitalic morphologies (Rix et al. 2017d).

One of the striking exceptions to the symplesiomorphic conservatism typical of *Euoplos* is the monophyletic *mcmillani*-group of ‘white-headed’ trapdoor spiders (Figs. 1–3). This remarkable lineage is characterized by males with a highly autapomorphic ‘bright white’ carapace coloration (Figs. 1, 2) – the only mygalomorph spiders known to possess such an unusual phenotype. The group was first described from two species by Main (2000), although a number of additional specimens and species have since come to light, all from the semi-arid Avon Wheatbelt and Geraldton Sandplains bioregions of south-western Western Australia (Figs.

3, 4) – a biodiversity hotspot (Rix et al. 2015). Unfortunately, the *mcmillani*-group are among the rarest and most enigmatic of Australia’s mygalomorph spiders; only 12 male specimens have ever been collected, and females are unknown. Indeed, despite multiple targeted collecting attempts at known localities, a *mcmillani*-group burrow has never been found, and the biology of these spiders remains a mystery.

In this paper, we revise the species of white-headed trapdoor spiders, and summarize their known distributions and conservation status. Three new species are described, taking the total number of species in the genus to 20.

METHODS

Morphological methods, including the format of species descriptions, follow similar recent taxonomic contributions by the authors (e.g., Rix et al. 2017a, d, 2018a–c; Wilson et al. 2018b). All 12 available male specimens were illustrated for this study, either within the primary numbered plates or, for additional non-holotype specimens, as an ‘Atlas’ series of more rapidly assembled single-shot images in four standard views (see Supplementary File 1, online at <http://dx.doi.org/10.1636/JoA-S-18-042.s1>). For readability and ease of diagnosis, ‘sp. nov.’ epithets are removed from the main text after the key to species.

Specimens are lodged at the Western Australian Museum, Perth (WAM) and the following abbreviations are used throughout the text: ALE, anterior lateral eye/s; AME, anterior median eye/s; IBRA, Interim Biogeographic Regionalisation of Australia Version 7 (see <https://www.environment.gov.au/land/nrs/science/ibra>); IUCN, International Union for the Conservation of Nature; PLE, posterior lateral eye/s; PME, posterior median eye/s; RTA, retrolateral tibial



Figures 1–2.—Live habitus images of holotype male *Euoplos cornishi* sp. nov. from Grass Valley, Western Australia. Images by V. Framenau, used with permission.

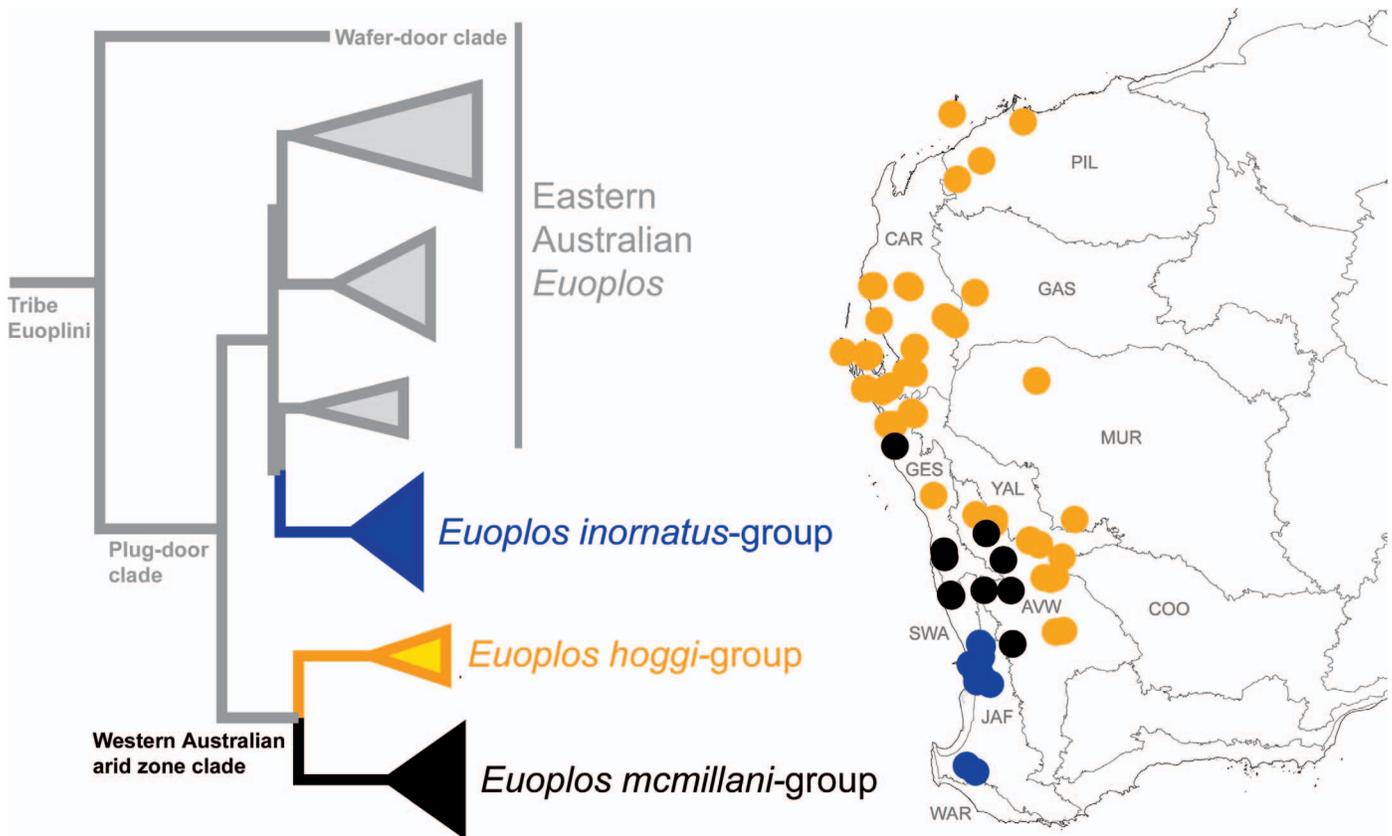


Figure 3.—Map showing collection records of male and select female specimens of *Euoplos* from Western Australia (right), color-coded according to their lineage and species-group designation. The summary Bayesian phylogeny at left, derived from the ‘FULL’ 12-gene analysis of Rix et al. (2017b; with clade posterior probabilities all ≥ 0.96), illustrates the polyphyly of the Western Australian fauna, and the eastern Australian affinities of the temperate *inornatus*-group. Note the largely mutually exclusive distributions of each Western Australian lineage, and the ‘plug-door’ and ‘wafer-door’ clade designations of Wilson et al. (2018a). Mapped IBRA bioregional acronyms at right are as follows: AVW, Avon Wheatbelt; CAR, Carnarvon; COO, Coolgardie; GAS, Gascoyne; GES, Geraldton Sandplains; JAF, Jarrah Forest; MUR, Murchison; PIL, Pilbara; SWA, Swan Coastal Plain; WAR, Warren; YAL, Yalgoo.

apophysis (of male pedipalp). Superscript DNA voucher codes are listed in the Material Examined sections for those specimens sequenced by Rix et al. (2017b).

SYSTEMATICS

Family Idiopidae Simon, 1889
 Subfamily Arbanitinae Simon, 1903
 Tribe Euoplini Rainbow, 1914
 Genus *Euoplos* Rainbow, 1914

Euoplos Rainbow, 1914: 217.

Type species.—*Euoplos spinnipes* Rainbow, 1914, by monotypy.

Diagnosis.—Species of *Euoplos* can be distinguished from other Arbanitinae by the combined presence of a small, rectangular eye group and a uniquely broad carapace profile in dorsal view (see Rix et al. 2017d, figs. 289–296). Males of most species also possess prominent, ventrally incrassate anterior leg tarsi (e.g., Figs. 24, 36), and all species can be further distinguished by the deletion of a single amino acid residue from the mitochondrial cytochrome *b* gene (see Rix et al. 2017d for nucleotide details).

Distribution.—The genus *Euoplos* has a broadly disjunct distribution to the east and west of the Australian central arid zone. In eastern Australia, they occur from Cape York Peninsula to southern Victoria and Tasmania, usually in mesic or transitional habitats (Rix et al. 2017d). In Western Australia they occur from near Manjimup in the temperate Warren bioregion, north to the Pilbara, with a range that includes the central and northern Avon Wheatbelt, western Murchison, Carnarvon, western Gascoyne and Pilbara bioregions (Fig. 3).

Composition and remarks.—The genus *Euoplos* includes 20 described species, three of which are newly described in this study. Numerous undescribed species are also known from western and eastern Australia (JDW, MGR, unpubl. data).

THE MCMILLANI-GROUP

The *mcmillani*-group comprises five known species, all of which are restricted to the heathlands and mallee woodlands in the transitional rainfall zone to the north and north-east of Perth

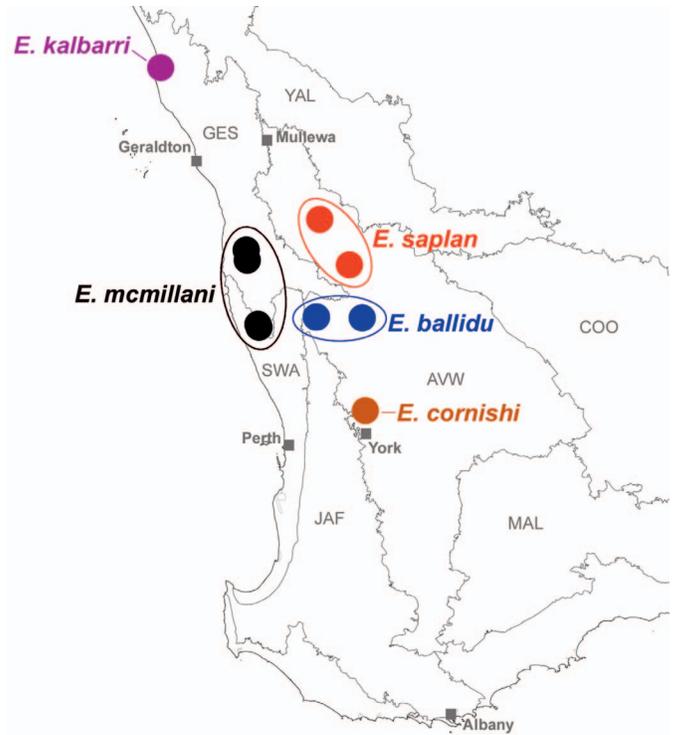


Figure 4.—Map showing collection records of white-headed *Euoplos* species of the *mcmillani*-group from south-western Australia, along with IBRA boundaries and select bioregional acronyms. AVW, Avon Wheatbelt; COO, Coolgardie; GES, Geraldton Sandplains; JAF, Jarrah Forest; MAL, Mallee; SWA, Swan Coastal Plain; YAL, Yalgoo.

(Figs. 3, 4). They have a distribution that extends from the central-western Wheatbelt, through the northern Wheatbelt and Geraldton Sandplains, north to Kalbarri (Fig. 4). The *mcmillani*-group is among the most strikingly distinctive of Australian Mygalomorphae: males are characterized by their remarkable bright white, enamel-like carapace coloration, which is in strong contrast to the much darker legs and abdomen (Figs. 1, 2). Females remain unknown, despite ongoing sequencing of Western Australian congeners and multiple targeted attempts to collect them from known localities.

KEY TO EUOPLoS SPECIES OF THE MCMILLANI-GROUP FROM WESTERN AUSTRALIA (MALES REQUIRED)

1. Prolateral tibia I with distal comb of > 2 contiguous macrosetae (Figs. 25, 37)..... 2
- Prolateral tibia I with or without distal macrosetae; if macrosetae present, never more than 2 in number (Figs. 13, 49, 61)..... 3
2. Embolus broadly tapered distally, with prominent twisted flanges (Figs. 38–40)..... *E. kalbarri* sp. nov.
- Embolus more thinly tapered distally, with less prominent twisted flanges (Figs. 26–28)..... *E. cornishi* sp. nov.
3. Carapace broadly oval in dorsal view (Fig. 41); RTA prominent, distally pointed and conical in shape (Fig. 50); prolateral face of tibia I with contrasting darker brown patch on distal third of segment (Figs. 48, 49).....
- *E. mcmillani* (Main, 2000)
- Carapace more narrowly oval in dorsal view (Figs. 5, 53); RTA shorter (Figs. 14, 62); prolateral face of tibia I without contrasting darker brown patch on distal third of segment (Figs. 12, 13, 60, 61)..... 4
4. Dorsal abdomen with relatively pale, mottled grey patterning and pale posterior chevrons (Fig. 54); anterior margin of carapace relatively sharply tapered anterior to level of coxa I (Fig. 53); carapace with pair of slightly darker, tarnished-yellow triangular markings on caput, posterior to eye group (Fig. 53)..... *E. saplan* sp. nov.
- Dorsal abdomen very dark brown–black in colour, with only faint tan mottling (Fig. 6); anterior margin of carapace less sharply tapered anterior to level of coxa I (Fig. 5); carapace uniformly bright white, without pair of tarnished-yellow triangular markings on caput (Fig. 5)..... *E. ballidu* (Main, 2000)



Figures 5–13.—*Euoplos ballidu* (Main), male holotype (WAM T33152) from Ballidu (Western Australia; AVW), somatic morphology: 5–6, carapace and abdomen, dorsal view; 7, cephalothorax, lateral view; 8, eyes, dorsal view; 9, mouthparts, ventral view; 10–11, cephalothorax and abdomen, ventral view; 12, leg I, prolateral view; 13, leg I tibia, prolateral view. Scale bars = 2.0 mm.

Euoplos ballidu (Main, 2000)
(Figs. 4–16)

Arbanitis ballidu Main, 2000: 96, fig. 3A–F.

Euoplos ballidu (Main): Raven & Wishart, 2006: 552.

Type material.—*Holotype male*. AUSTRALIA: *Western Australia*: Ballidu (IBRA_AVW), 30°35'28"S, 116°45'25"E, 24

May–16 September 1996, wet pitfall trap, M.S. Harvey, J.M. Waldock (WAM T33152; examined).

Other material examined.—AUSTRALIA: *Western Australia*: 1 ♂, 8 miles N. of Walebing on Moore River (IBRA_AVW), 30°35'S, 116°10'E, 15 March 1959, B.Y. Main (WAM T136921).

Diagnosis.—Males of *Euoplos ballidu* can be distinguished from those of *E. cornishi* and *E. kalbarri* by the absence of a



Figures 14–16.—*Euoplos ballidu* (Main), male holotype (WAM T33152) from Ballidu (Western Australia; AVW), pedipalp: 14, retrolateral view; 15, retro-ventral view; 16, prolateral view. Scale bar = 2.0 mm.

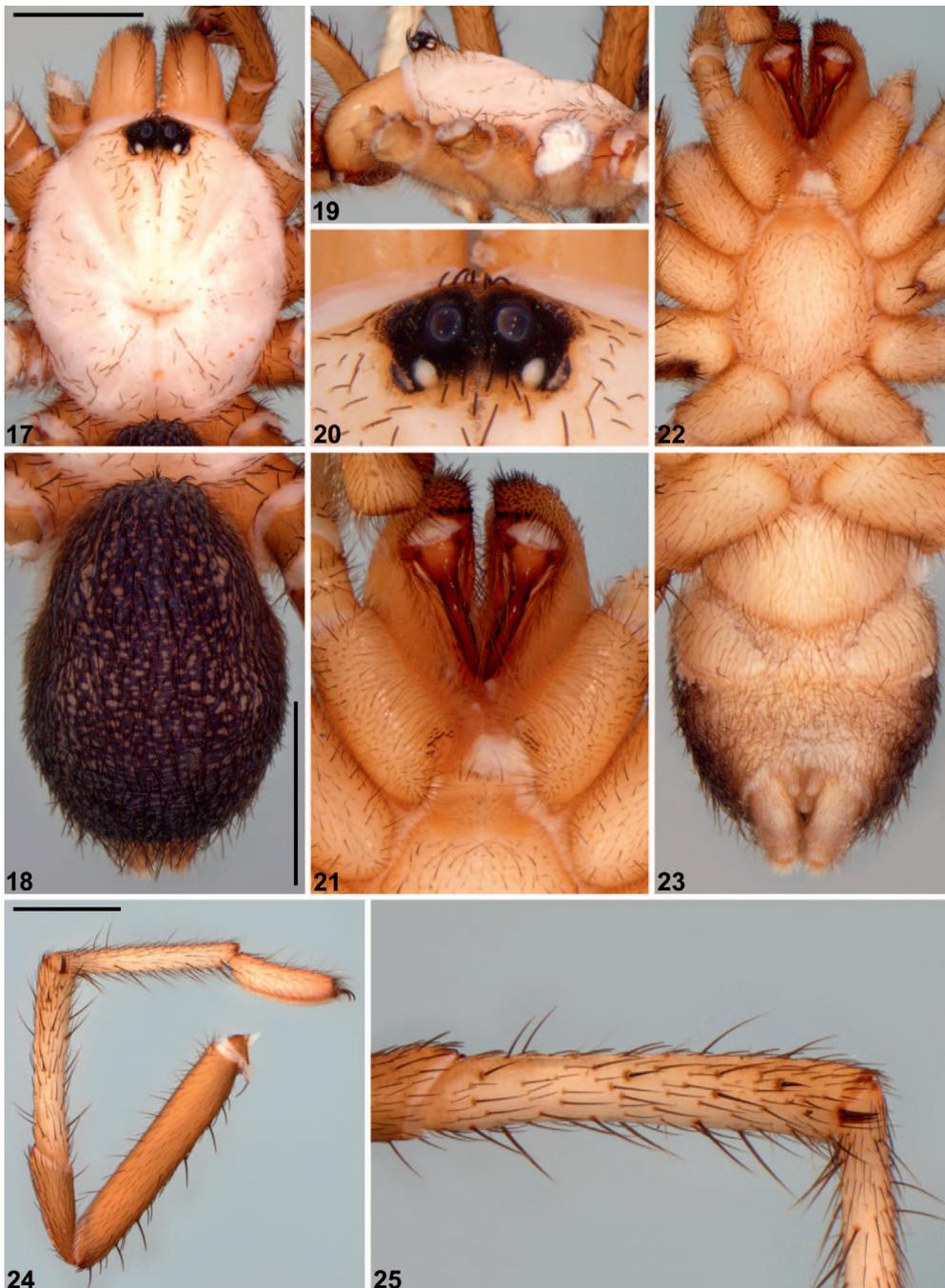
distal comb of (> 2) contiguous macrosetae on the prolateral face of tibia I (Fig. 13; cf. Figs. 25, 37); from *E. mcmillani* by the shape of the carapace, which is more narrowly oval in dorsal view (Fig. 5; cf. Fig. 41), by the shape of the RTA, which is shorter (Fig. 14; cf. Fig. 50), and by the absence of a contrasting, darker brown prolateral patch on the distal third of tibia I (Figs. 12, 13; cf. Figs. 48, 49); and from *E. saplan* by the color of the abdomen, which is very dark brown-black (Fig. 6; cf. Fig. 54), by the color of the carapace, which is uniformly bright white (Fig. 5; cf. Fig. 53), and by the shape of the anterior margin of the carapace, which is less sharply tapered anterior to the level of coxa I (Fig. 5; cf. Fig. 53). Females are unknown.

Description (male holotype).—Total length 11.5. Carapace 4.3 long, 3.6 wide. Abdomen 4.8 long, 2.9 wide. Carapace (Fig. 5) oval, glabrous and bright white in color, with rows of scattered black setae on pars cephalica and pars thoracica; lateral margins with sparse, evenly-spaced fringe of porrect black setae, longest posteriorly; fovea slightly procurved, with posterior medial indentation. Eye group (Fig. 8) rectangular, $0.5 \times$ as long as wide, PLE–PLE/ALE–ALE ratio 1.1; AME separated by less than their own diameter; PME separated by $3.7 \times$ their own diameter; PME and PLE almost contiguous. Maxillae with field of cuspules confined to inner corner (Fig. 9); labium without cuspules. Abdomen (Fig. 6) oval, dark charcoal-brown in dorsal view with paler beige-brown mottling and faint posterior chevrons; sclerotized sigilla absent. Legs (Figs. 12, 13) dark tan-brown on femora and patellae, paler beige-tan on tibiae–tarsi, with light scopulae on tarsi I–II; prolateral tibia I without macrosetae or distal modifications. Leg I: femur 4.7; patella 2.4; tibia 3.5; metatarsus 3.6; tarsus 2.1; total 16.3. Leg I

femur–tarsus/carapace length ratio 3.8. Pedipalpal tibia (Figs. 14–16) $2.5 \times$ longer than wide, with short, conical RTA and field of 24 retrolateral spinules. Cymbium (Figs. 14–16) setose, without spinules. Embolus (Figs. 14–16) curved, slightly twisted and longitudinally-flanged, with thinly tapering tip.

Distribution and remarks.—*Euoplos ballidu* is known only from Ballidu and Walebing, in the central-western Wheatbelt south and south-west of Dalwallinu (Fig. 4). The habitat at the type locality is “mixed open wodjil/heath on yellow sand” (Main 2000: 97). Nothing else is known of the biology of this species, although based on the two male specimens that have been collected, males may wander in search of females in autumn and winter.

Conservation status.—This species is known from just two sites in the heavily cleared central-western Wheatbelt. The Ballidu site was visited in 1999 by MSH, along with Barbara Main and Julianne Waldock, and the ground was extensively searched for trapdoor spider burrows. No *Euoplos* burrows were detected, suggesting that they are locally rare or that the burrows are extremely cryptic. Long-term pitfall trapping surveys have also occurred in surrounding areas (e.g., Lake Ninan, Manmanning Dam Nature Reserve, Martinjinni Nature Reserve, Wongan-Hills–Ballidu Road; see Keighery 2004), although these have failed to locate any further populations. Even if the extent of occurrence of *E. ballidu* was several orders of magnitude larger than current evidence suggests, and the species therefore had a distributional range that abutted those of other species, the scale of land clearing in the Wheatbelt is such that this species would easily fall well under the 500 km^2 area of occupancy threshold for an IUCN threatened listing. Furthermore, with less than five popula-



Figures 17–25.—*Euoplos cornishi* sp. nov., male holotype (WAM T80645) from Grass Valley (Western Australia; AVW), somatic morphology: 17–18, carapace and abdomen, dorsal view; 19, cephalothorax, lateral view; 20, eyes, dorsal view; 21, mouthparts, ventral view; 22–23, cephalothorax and abdomen, ventral view; 24, leg I, prolateral view; 25, leg I tibia, prolateral view. Scale bars = 2.0 mm.

tions known, and continuing severe decline in the quality of remnant habitats in the central Wheatbelt (e.g., Laurance et al. 2011), this species is conservatively considered to be Endangered (IUCN B1ab[jiii], B2ab[jiii]). However, a Critically Endangered listing may be warranted in the future if the actual extent of occurrence is less 100 km², and if this species is suffering contemporary population declines (see Rix et al. 2017c, 2018a).

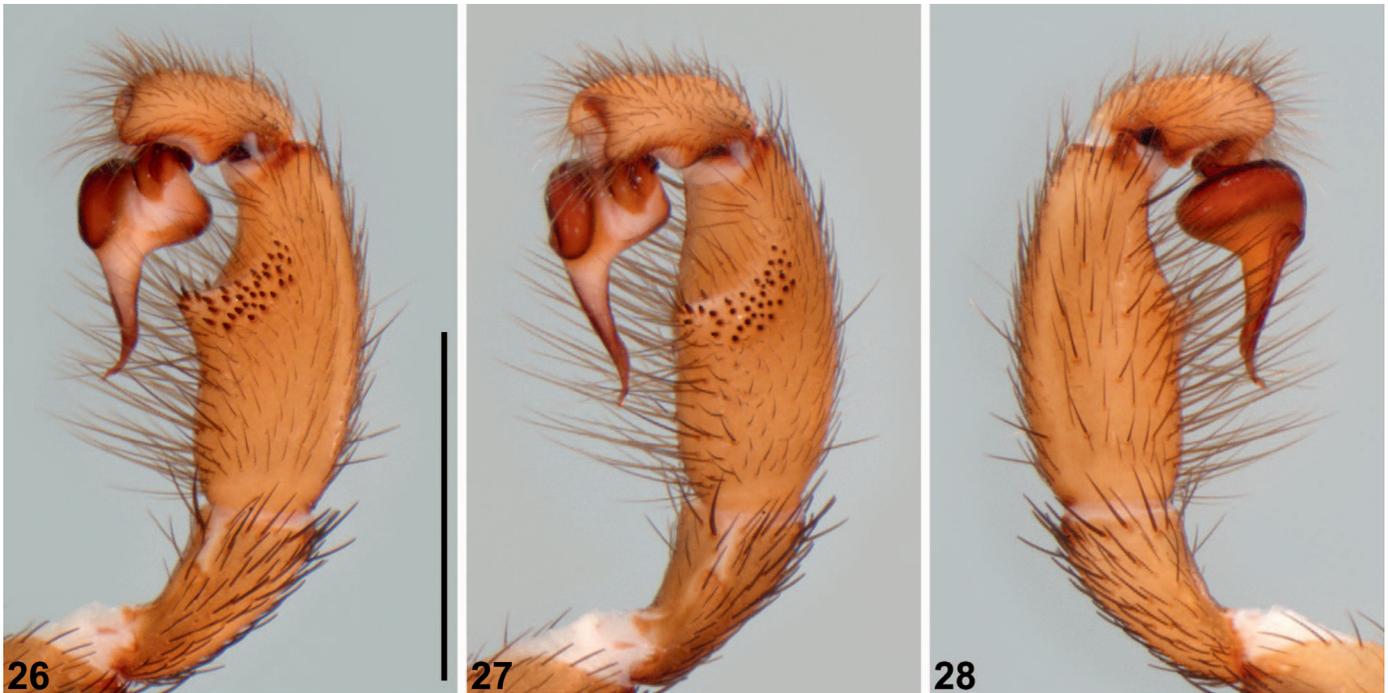
Euoplos cornishi sp. nov.

<http://zoobank.org/?lsid=urn:lsid:zoobank.org:act:606A995F-E420-4D73-AC97-4C6D0B1FD6C6>

(Figs. 4, 17–28)

Euoplos 'sp. 195_T80645_M_EU': Rix et al., 2017b: 313, fig. 6, suppl. files 5, 11.

Type material.—*Holotype male.* AUSTRALIA: *Western*



Figures 26–28.—*Euoplos cornishi* sp. nov., male holotype (WAM T80645) from Grass Valley (Western Australia; AVW), pedipalp: 26, retrolateral view; 27, retro-ventral view; 28, prolateral view. Scale bar = 2.0 mm.

Australia: Grass Valley, Vivian Street (IBRA_AVW), 31°38'20"S, 116°47'49"E, 13 July 2011, hand collected near back of house, J. Cornish (WAM T80645^{DNA_Voucher_195}).

Etymology.—The specific epithet is named in honor of Grass Valley resident John Cornish who, through careful observation and attention to detail, collected the type (and only known) specimen of this species in 2011.

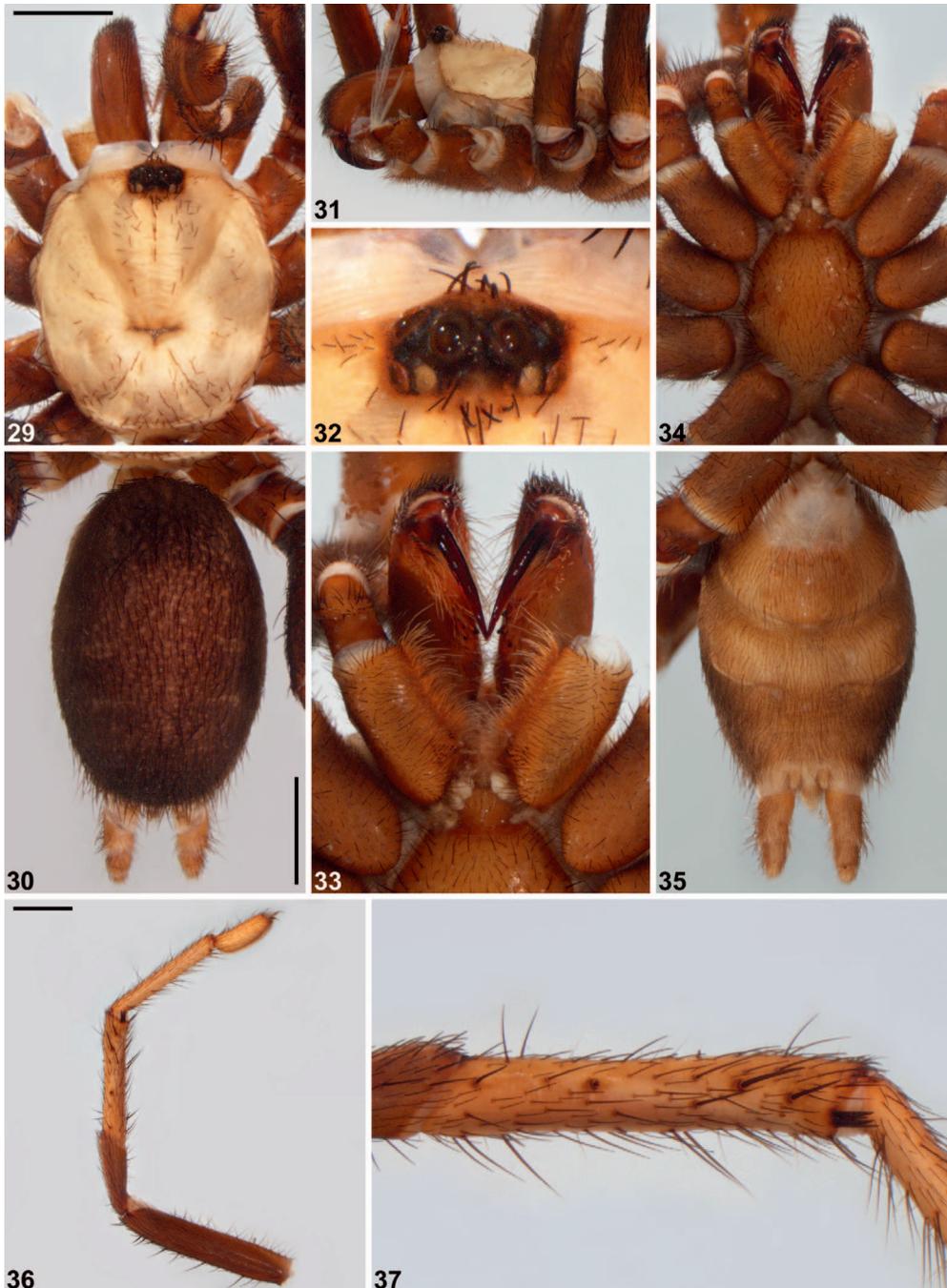
Diagnosis.—Males of *Euoplos cornishi* can be distinguished from those of *E. ballidu*, *E. mcmillani* and *E. saplan* by the presence of a distal comb of > 2 contiguous macrosetae on the prolateral face of tibia I (Fig. 25; cf. Figs. 13, 49, 61); and from *E. kalbarri* by the shape of the embolus, which is more thinly tapered distally, with less prominent twisted flanges (Figs. 26–28; cf. Figs. 38–40). Females are unknown.

Description (male holotype).—Total length 10.2. Carapace 4.8 long, 4.0 wide. Abdomen 4.0 long, 2.8 wide. Carapace (Fig. 17) broadly oval, glabrous and bright white in color, with rows of scattered black setae on pars cephalica and pars thoracica; lateral margins with evenly-spaced fringe of porrect black setae, longest posteriorly; fovea slightly procurved, with posterior medial indentation. Eye group (Fig. 20) rectangular, 0.5 × as long as wide, PLE–PLE/ALE–ALE ratio 1.0; AME separated by less than their own diameter; PME separated by 3.6 × their own diameter; PME and PLE almost contiguous. Maxillae with field of cuspules confined to inner corner (Fig. 21); labium without cuspules. Abdomen (Fig. 18) oval, dark charcoal-brown in dorsal view (black in life; Figs. 1, 2), with paler beige-brown mottling; sclerotized sigilla absent. Legs (Figs. 24, 25) tan-brown on femora and patellae (femora dark brown-black in life; Figs. 1, 2), paler beige-tan on tibiae–tarsi, with light scopulae on tarsi I–II; prolateral tibia I with distal comb of four macrosetae. Leg I: femur 4.8; patella 2.4; tibia 3.6; metatarsus 3.6; tarsus 2.0; total 16.4. Leg I femur–tarsus/

carapace length ratio 3.4. Pedipalpal tibia (Figs. 26–28) 2.4 × longer than wide, with short, conical RTA and field of 35 retrolateral spinules. Cymbium (Figs. 26–28) setose, without spinules. Embolus (Figs. 26–28) curved, slightly twisted and longitudinally-flanged, with thinly tapering tip.

Distribution and remarks.—*Euoplos cornishi* is known only from Grass Valley, in the western Wheatbelt east of Northam (Fig. 4). Nothing is known of the biology of this species, although based on the single specimen that has been collected, males may wander in search of females in winter.

Conservation status.—This species is known from just one site, in the township of Grass Valley. Natural habitat at this site is limited to a just two small town reserves and several road reserves, although active burrows have never been located despite targeted searches. Long-term pitfall trapping surveys have also occurred in surrounding areas (e.g., Drummond Nature Reserve, Durokoppin Nature Reserve, Wroth Road Nature Reserve; see Keighery 2004), and these too have failed to locate any additional populations. Even if the extent of occurrence of *E. cornishi* was several orders of magnitude larger than current evidence suggests, the scale of land clearing in the Wheatbelt is such that this species would easily fall well under the 500 km² area of occupancy threshold for an IUCN threatened listing. Furthermore, with less than five populations known, and continuing severe decline in the quality of remnant habitats in the Wheatbelt (e.g., Laurance et al. 2011), this species is conservatively considered to be Endangered (IUCN B1ab[iii], B2ab[iii]). However, a Critically Endangered listing may be warranted in future if the actual extent of occurrence is less 100 km², and if this species is suffering contemporary population declines (see Rix et al. 2017c, 2018a).



Figures 29–37.—*Euoplos kalbarri* sp. nov., male holotype (WAM T40463) from Kalbarri (Western Australia; GES), somatic morphology: 29–30, carapace and abdomen, dorsal view; 31, cephalothorax, lateral view; 32, eyes, dorsal view; 33, mouthparts, ventral view; 34–35, cephalothorax and abdomen, ventral view; 36, leg I, prolateral view; 37, leg I tibia, prolateral view. Scale bars = 2.0 mm.

GenBank records.—The following 10 nucleotide sequences for this species are available on GenBank: cytochrome *c* oxidase subunit 1 (KY295258); cytochrome *b* (KY295380); 18S rRNA (KY294746); 28S rRNA (KY294867); internal transcribed spacer 1–5.8S rRNA–internal transcribed spacer 2 (KY295003); histone H3 (KY295130); 39S ribosomal protein L45, mitochondrial (KY295502); ribosome production factor 2 homolog (KY295624); probable Xaa-Pro aminopeptidase 3 (KY295751); and histone acetyltransferase type B catalytic subunit (KY304524).

***Euoplos kalbarri* sp. nov.**

<http://zoobank.org/?lsid=urn:lsid:zoobank.org:act:A9FB48E2-3A84-4CFD-8F12-F67F9C749185>
(Figs. 4, 29–40)

Type material.—*Holotype male.* AUSTRALIA: *Western Australia:* Kalbarri (IBRA_GES), ca. 27°43'S, 114°10'E, 1 May 1982, pitfall trap, G.T. Smith (WAM T40463).

Etymology.—The specific epithet is a noun in apposition, taken from the type locality.



Figures 38–40.—*Euoplos kalbarri* sp. nov., male holotype (WAM T40463) from Kalbarri (Western Australia; GES), pedipalp: 38, retrolateral view; 39, retro-ventral view; 40, prolateral view. Scale bar = 2.0 mm.

Diagnosis.—Males of *Euoplos kalbarri* can be distinguished from those of *E. ballidu*, *E. mcmillani* and *E. saplan* by the presence of a distal comb of > 2 contiguous macrosetae on the prolateral face of tibia I (Fig. 37; cf. Figs. 13, 49, 61); and from *E. cornishi* by the shape of the embolus, which is broadly tapered distally, with prominent twisted flanges (Figs. 38–40; cf. Figs. 26–28). Females are unknown.

Description (male holotype).—Total length 14.6. Carapace 5.5 long, 4.8 wide. Abdomen 6.2 long, 4.0 wide. Carapace (Fig. 29) broadly oval, glabrous and tarnished white in color, with rows of scattered black setae on pars cephalica and pars thoracica; lateral margins with evenly-spaced fringe of porrect black setae, longest posteriorly; fovea slightly procurved, with posterior medial indentation. Eye group (Fig. 32) rectangular, $0.5 \times$ as long as wide, PLE–PLE/ALE–ALE ratio 1.0; AME separated by less than their own diameter; PME separated by $4.0 \times$ their own diameter; PME and PLE almost contiguous. Maxillae with field of cuspules confined to inner corner (Fig. 33); labium without cuspules. Abdomen (Fig. 30) oval, dark chocolate-brown in dorsal view with paler beige-brown mottling and faint posterior chevrons; sclerotized sigilla absent. Legs (Figs. 36, 37) dark brown on femora and patellae, paler tan on tibiae–tarsi, with light scopulae on tarsi I–II; prolateral tibia I with distal comb of four macrosetae. Leg I: femur 5.9; patella 3.0; tibia 4.1; metatarsus 4.4; tarsus 2.0; total 19.4. Leg I femur–tarsus/carapace length ratio 3.5. Pedipalpal tibia (Figs. 39–40) $2.2 \times$ longer than wide, with pointed, conical RTA and field of 39 retrolateral spinules. Cymbium (Figs. 39–40) setose, without spinules. Embolus (Figs. 39–40) curved, twisted and longitudinally-flanged, with broadly tapering tip.

Distribution and remarks.—*Euoplos kalbarri* is known from only a single indeterminate location in the Kalbarri region, on the north-western Geraldton Sandplains south of Zuytdorp (Fig. 4). Nothing is known of the biology of this species, although based on the single specimen that has been collected, males may wander in search of females in winter.

Conservation status.—This species is considered data deficient for the purposes of conservation assessment; additional surveys in the Kalbarri National Park and surrounding areas are required to ascertain the abundance and distribution of remaining populations.

Euoplos mcmillani (Main, 2000)
(Figs. 4, 41–52)

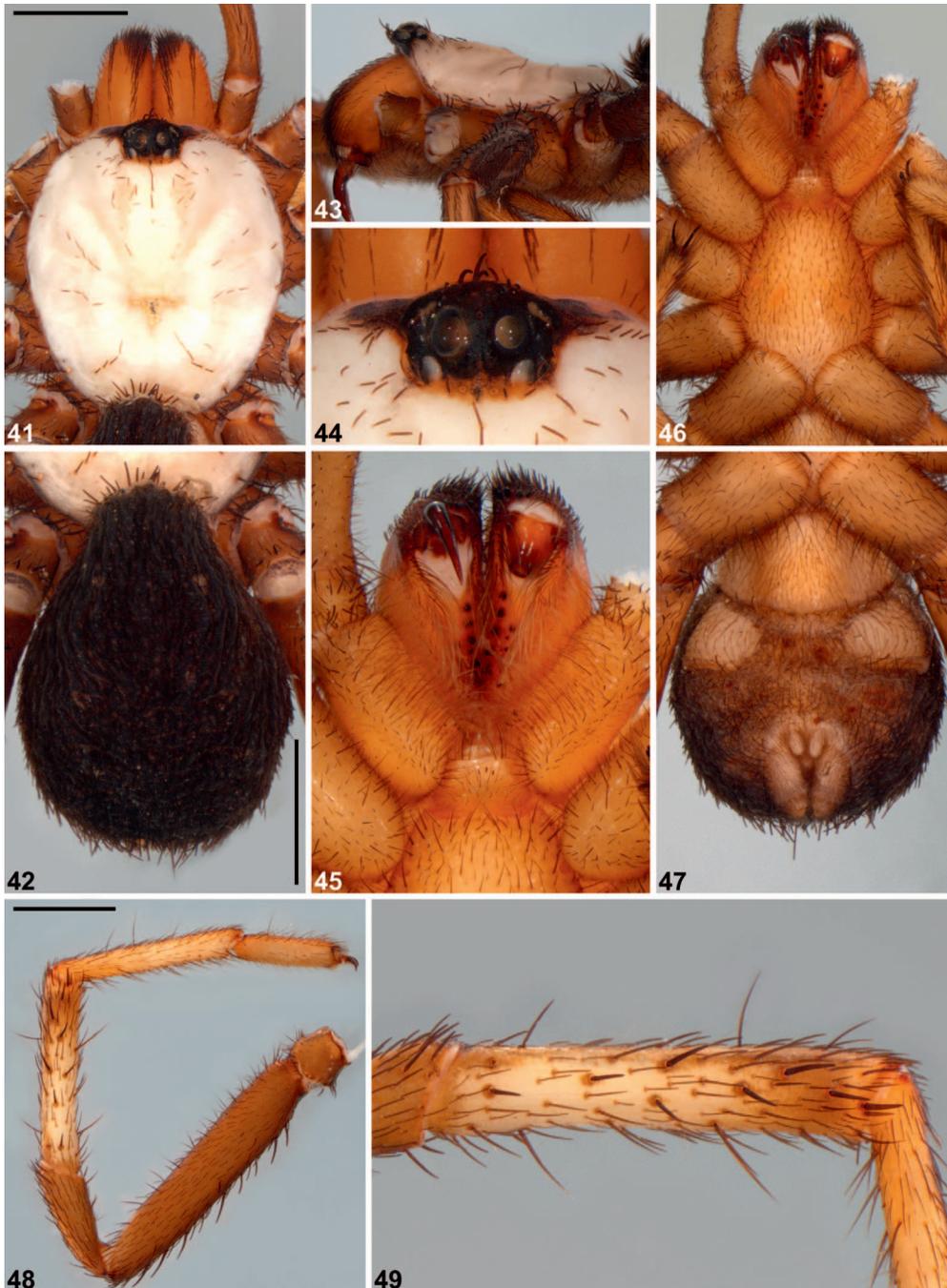
Arbanitis mcmillani Main, 2000: 93, figs. 1, 2A–N.

Euoplos mcmillani (Main): Raven & Wishart, 2006: 552. Rix et al., 2017b: 313, fig. 6, suppl. files 5, 11. Rix et al., 2017d: 631, figs. 291, 292, 296, 298, 302.

Type material.—*Holotype male*. AUSTRALIA: *Western Australia*: Eneabba, sand mine rehabilitation site 7 of R.G.C. (Western) Mineral Sands (IBRA_GES), 29°49'S, 115°16'E, 1 April 1992, pitfall trap, R.P. McMillan (WAM T24582; examined).

Paratype. AUSTRALIA: *Western Australia*: 1 ♂, Eneabba, sand mine rehabilitation site 8 of R.G.C. (Western) Mineral Sands (IBRA_GES), 29°56'S, 115°17'E, 8 August 1998, pitfall trap, P.L.J. West & R.P. McMillan (WAM T37765).

Other material examined.—AUSTRALIA: *Western Australia*: 1 ♂, Cooljarloo, 15 km NW. of Cataby (IBRA_GES), 30°40'S, 115°25'E, 15 August 2010, mammal pitfall, M. Bamford (WAM T110280^{DNA_Voucher_112}); 1 ♂, same data



Figures 41–49.—*Euoplos mcmillani* (Main), male holotype (WAM T24582) from Eneabba (Western Australia; GES), somatic morphology: 41–42, carapace and abdomen, dorsal view; 43, cephalothorax, lateral view; 44, eyes, dorsal view; 45, mouthparts, ventral view; 46–47, cephalothorax and abdomen, ventral view; 48, leg I, prolateral view; 49, leg I tibia, prolateral view. Scale bars = 2.0 mm.

(WAM T110281); 1 ♂, 6.4 km SE. of Cooljarloo (IB-RA_GES), 30°42'S, 115°26'E, 3 August 2014, Bamford Consulting Ecologists (WAM T135188^{DNA_Voucher_256}).

Diagnosis.—Males of *Euoplos mcmillani* can be distinguished from those of *E. cornishi* and *E. kalbarri* by the absence of a distal comb of (> 2) contiguous macrosetae on the prolateral face of tibia I (Fig. 49; cf. Figs. 25, 37); and from *E. ballidu* and *E. saplan* by the shape of the carapace, which is broadly oval in dorsal view (Fig. 41; cf. Figs. 5, 53), by the

shape of the RTA, which is longer and more conical in shape (Fig. 50; cf. Figs. 14, 62), and by the presence of a contrasting darker brown patch on the distal third of the prolateral face of tibia I (Figs. 48, 49; cf. Figs. 12, 13, 60, 61). Females are unknown.

Description (male holotype).—Total length 11.8. Carapace 5.1 long, 4.6 wide. Abdomen 5.1 long, 3.8 wide. Carapace (Fig. 41) broadly oval, glabrous and bright white in color, with rows of scattered black setae on pars cephalica and pars thoracica;



Figures 50–52.—*Euoplos mcmillani* (Main), male holotype (WAM T24582) from Eneabba (Western Australia; GES), pedipalp: 50, retrolateral view; 51, retro-ventral view; 52, prolateral view. Scale bar = 2.0 mm.

lateral margins with evenly-spaced fringe of porrect black setae, longest posteriorly; fovea straight, with posterior medial indentation. Eye group (Fig. 44) rectangular, $0.5 \times$ as long as wide, PLE–PLE/ALE–ALE ratio 1.0; AME separated by less than their own diameter; PME separated by $3.3 \times$ their own diameter; PME and PLE almost contiguous. Maxillae with field of cuspules confined to inner corner (Fig. 45); labium with three small spinules (Fig. 45). Abdomen (Fig. 42) oval, charcoal-black in dorsal view with paler beige-brown mottling; sclerotized sigilla absent. Legs (Figs. 48, 49) brown on femora, patellae and distal third of tibia I, paler beige-tan on tibiae–tarsi, with light scopulae on tarsi I–II; prolateral tibia I with two contiguous macrosetae distally. Leg I: femur 5.4; patella 2.7; tibia 3.8; metatarsus 3.8; tarsus 2.0; total 17.7. Leg I femur–tarsus/carapace length ratio 3.5. Pedipalpal tibia (Figs. 50–52) $2.2 \times$ longer than wide, with pointed, conical RTA and field of 39 retrolateral spinules. Cymbium (Figs. 50–52) setose, without spinules. Embolus (Figs. 50–52) curved, slightly twisted and longitudinally-flanged, with thinly tapering tip.

Distribution and remarks.—*Euoplos mcmillani* is known from the ‘kwongan’ heathlands north of Perth, from Cooljarloo north to Eneabba (Fig. 4). It is seemingly the most common species in the *mcmillani*-group, although must still be considered extremely rare given the few specimens that have ever been found. This species appears to favor heathland habitats on white sand, and based on the specimens that have been collected in pitfall traps, males wander in search of females in autumn to late winter.

Conservation status.—This species is of uncertain conservation status, as while it has a total (minimum) extent of occurrence of $< 5,000 \text{ km}^2$, and occurs in a region with a

modest proportion of protected and/or un-cleared habitat, it has currently only been collected on active or proposed mining tenements. Additional survey work is required to ascertain the full extent of the range of this species.

GenBank records.—The following 19 nucleotide sequences for this species are available on GenBank: cytochrome *c* oxidase subunit 1 (KY295273, KY295245); cytochrome *b* (KY295395, KY295370); 18S rRNA (KY294761, KY294735); 28S rRNA (KY294882, KY294857); internal transcribed spacer 1–5.8S rRNA–internal transcribed spacer 2 (KY295018, KY294991); histone H3 (KY295145, KY295118); 39S ribosomal protein L45, mitochondrial (KY295517, KY295493); ribosome production factor 2 homolog (KY295639, KY295612); probable Xaa-Pro aminopeptidase 3 (KY295766, KY295739); and histone acetyltransferase type B catalytic subunit (KY304539).

Euoplos saplan sp. nov.

<http://zoobank.org/?lsid=urn:lsid:zoobank.org:act:7CF84909-D559-4FE6-B31B-A1A0ECA79340>
(Figs. 4, 53–64)

Type material.—*Holotype male*. AUSTRALIA: *Western Australia*: Buntine Rocks Nature Reserve (IBRA_AVW), $29^{\circ}59'06''\text{S}$, $116^{\circ}35'35''\text{E}$, 22 May–17 September 1996, wet pitfall trap, M.S. Harvey, J.M. Waldock (WAM T33153).

Paratype. AUSTRALIA: *Western Australia*: 1 ♂, same data as holotype (WAM T33154).

Other material examined.—AUSTRALIA: *Western Australia*: 1 ♂, West Perenjori Nature Reserve, west, site MO1 (IBRA_AVW), $29^{\circ}27'52''\text{S}$, $116^{\circ}12'36''\text{E}$, 15 September–18



Figures 53–61.—*Euoplos saplan* sp. nov., male holotype (WAM T33153) from Buntine Rocks Nature Reserve (Western Australia; AVW), somatic morphology: 53–54, carapace and abdomen, dorsal view; 55, cephalothorax, lateral view; 56, eyes, dorsal view; 57, mouthparts, ventral view; 58–59, cephalothorax and abdomen, ventral view; 60, leg I, prolateral view; 61, leg I tibia, prolateral view. Scale bars = 2.0 mm.

October 1999, wet pitfalls 1–5, L. King, CALM S.A.P. Survey (WAM T139602).

Etymology.—The specific epithet is an acronym in reference to the WAM/CALM Salinity Action Plan (“saplan”) survey of 1997–2000 (Keighery 2004; Harvey et al. 2004), which resulted in the collection of this species and numerous other fascinating Idiopidae from the Wheatbelt region of south-western Australia.

Diagnosis.—Males of *Euoplos saplan* can be distinguished from those of *E. cornishi* and *E. kalbarri* by the absence of a distal comb of (> 2) contiguous macrosetae on the prolateral face of tibia I (Fig. 61; cf. Figs. 25, 37); from *E. mcmillani* by the shape of the carapace, which is more narrowly oval in dorsal view (Fig. 53; cf. Fig. 41), by the shape of the RTA, which is shorter (Fig. 62; cf. Fig 50), and by the absence of a contrasting, darker brown prolateral patch on the distal third



Figures 62–64.—*Euoplos saplan* sp. nov., male holotype (WAM T33153) from Buntine Rocks Nature Reserve (Western Australia; AVW), pedipalp: 62, retrolateral view; 63, retro-ventral view; 64, prolateral view. Scale bar = 2.0 mm.

of tibia I (Figs. 60, 61; cf. Figs. 48, 49); and from *E. ballidu* by the color of the abdomen, which is mottled grey with pale posterior chevrons (Fig. 54; cf. Fig. 6), by the color of the carapace, which is white with a pair of slightly darker, tarnished-yellow triangular markings on the caput, posterior to the eye group (Fig. 53; cf. Fig. 5), and by the shape of the anterior margin of the carapace, which is relatively sharply tapered anterior to the level of coxa I (Fig. 53; cf. Fig. 5). Females are unknown.

Description (male holotype).—Total length 10.1. Carapace 3.9 long, 3.1 wide. Abdomen 4.6 long, 2.9 wide. Carapace (Fig. 53) oval, glabrous and tarnished white in color, with tarnished yellow triangular markings on caput and rows of scattered black setae on pars cephalica and pars thoracica; lateral margins with sparse, evenly-spaced fringe of porrect black setae, longest posteriorly; fovea straight, with posterior medial indentation. Eye group (Fig. 56) rectangular, $0.5 \times$ as long as wide, PLE–PLE/ALE–ALE ratio 0.9; AME separated by less than their own diameter; PME separated by $3.1 \times$ their own diameter; PME and PLE almost contiguous. Maxillae with field of cuspules confined to inner corner (Fig. 57); labium without cuspules. Abdomen (Fig. 54) oval, mottled beige-grey in dorsal view with faint posterior chevrons; sclerotized sigilla absent. Legs (Figs. 60, 61) tan-brown on femora and patellae, paler beige-tan on tibiae–tarsi, with light scopulae on tarsi I–II; prolateral tibia I without macrosetae or distal modifications. Leg I: femur 3.9; patella 2.0; tibia 2.9; metatarsus 3.2; tarsus 1.9; total 13.9. Leg I femur–tarsus/carapace length ratio 3.5. Pedipalpal tibia (Figs. 62–64) $2.7 \times$ longer than wide, with short, conical RTA and field of 28 retrolateral spinules. Cymbium (Figs. 62–64) setose, without spinules. Embolus (Figs. 62–64) curved, slightly twisted and longitudinally-flanged, with thinly tapering tip.

Distribution and remarks.—*Euoplos saplan* is known only from Buntine Rocks Nature Reserve and West Perenjori Nature Reserve, in the northern Wheatbelt bioregion (Fig. 4). The substrate at the type locality is “yellow sand” (Main 2000: 97). Nothing else is known of the biology of this species, although based on the few male specimens that have been collected, males may wander in search of females in winter and spring.

Conservation status.—This species is known from just two sites in the heavily cleared northern Wheatbelt, and while long-term pitfall trapping surveys have occurred in surrounding areas, these have failed to locate any further populations. Even if the extent of occurrence of *E. saplan* was several orders of magnitude larger than current evidence suggests, and the species therefore had a distributional range that abutted those of other species, the scale of land clearing in the Wheatbelt is such that this species would easily fall well under the 500 km² area of occupancy threshold for an IUCN threatened listing. Furthermore, with less than five populations known, and continuing severe decline in the quality of remnant habitats in the northern Wheatbelt (e.g., Laurance et al. 2011), this species is conservatively considered to be Endangered (IUCN B1ab[iii], B2ab[iii]). However, a Critically Endangered listing may be warranted in the future if the actual extent of occurrence is less 100 km², and if this species is suffering contemporary population declines (see Rix et al. 2017c, 2018a).

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