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Santalalean-feeding plant bugs: ten new species in the genus *Hypseloecus* Reuter from Australia and South Africa (Heteroptera: Miridae: Phylinae): their hosts and placement in the Pilophorini

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Abstract Eight new species of *Hypseloecus* are described from Australia, providing the first records of Pilophorini and this formerly Indo-Pacific genus from the continent; two additional new species are described from South Africa. All species are documented as using hemiparasitic Santalales as hosts, including species of *Amyema*, *Dendrophthoe* and *Lysiana* (Loranthaceae) in Australia and *Viscum* (Viscaceae) and *Tapinanthus* (Loranthaceae) in South Africa. These new species are integrated into a prior phylogenetic analysis of the Pilophorini on the basis of morphology and DNA sequence data.

Key words biogeography, host plant, phylogenetic analysis.

INTRODUCTION

Members of the Pilophorini feeding on hemiparasitic Santalales were first described from the southern Palearctic (Puton 1888) and have subsequently been documented across the entire Indo-Pacific region (Schuh 1974, 1984, 1989, 1991). All such species are currently placed in *Hypseloecus* Reuter. Until the present paper no members of the Pilophorini had been recorded from Australia.

Extensive specialised collecting by Gerasimos Cassis and R.T. Schuh, beginning in 1995, has added greatly to our understanding of diversity of Phylinae in Australia, and since 2003 augmented our knowledge in South Africa. In the present paper we document eight new species of *Hypseloecus* from Australia and two from South Africa. All of them are shown to be exclusively associated with the Santalales.

An updated phylogenetic hypothesis for the Pilophorini, based on morphology and ribosomal DNA sequences, is conducted in an effort to place these new taxa in context.

MATERIALS AND METHODS

During the course of this research project matrix code labels were affixed to the approximately 975 specimens examined as a way to uniquely identify them; these codes are therefore referred to as 'unique specimen identifiers' (USIs). The USI codes, e.g. AMNH_PBI 00094810, comprise an institution and project code (AMNH_PBI) and a unique number (00094810). Only the numerical portion of the USI code is included in the data for specimens examined, with the exception of the holotypes.

All latitude–longitude data are presented in the 'specimens examined' section of the present paper in degrees and decimal parts thereof. Altitude data are treated as metric. Please refer to the website of the Planetary Biodiversity Inventory Project on Plant Bugs (http://research.amnh.org/pbi/heteropteraspecie spage) or http://www.discoverlife.org for additional information on specimens examined.

All measurements are in millimetres and were made using a micrometer driven stage, micrometer output being written directly to a spreadsheet.

Habitus photos are proportional to the size of the actual specimens so that relative sizes can be deduced from comparison of the specimen images. Actual sizes of specimens can be determined by referring to Table 1.

Illustrations of genitalic structures in the present paper are reproduced such that the proportional sizes of structures across taxa can be determined by comparison of illustrations. Terminology used for genitalic structures is given in Figure 6.

Information on the distributions of host plants comes from Australia's Virtual Herbarium (2010, http://avh.rbg.vic.gov.au/avh/).

Institutional depositories and the acronyms for them as used in this paper are as follows:

AM	Australian Museum, Sydney
AMNH	American Museum of Natural History, New York
MAGD	Museum and Art Gallery, Darwin, Australia
PPRI	Plant Protection Research Institute, Pretoria, South Africa
QM	Queensland Museum, Brisbane
SAMA	South Australian Museum, Adelaide
SAMC	Iziko (South African) Museum, Cape Town, South Africa
UNSW	University of New South Wales, Sydney

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Table 1 Measurements of *Hypseloecus* spp.

Hypseloecus		Length						Width			InterOc	AntSeg2
		Body	CunClyp	Head	Pron	Scut	Cun	Head	Pron	Scut		
H. amyemi												
M ($n = 5$)	Mean	2.95	2.09	0.13	0.46	0.56	0.40	1.07	1.31	0.70	0.66	0.89
	SD	0.15	0.05	0.02	0.05	0.03	0.09	0.03	0.04	0.03	0.04	0.06
	Range	0.38	0.11	0.06	0.12	0.07	0.24	0.06	0.12	0.08	0.10	0.15
	Min	2.70	2.03	0.11	0.38	0.54	0.29	1.05	1.26	0.67	0.61	0.80
	Max	3.09	2.14	0.17	0.50	0.61	0.53	1.10	1.38	0.74	0.71	0.95
F ($n = 5$)	Mean	3.24	2.34	0.17	0.49	0.59	0.40	1.13	1.39	0.80	0.72	0.92
	SD	0.10	0.06	0.03	0.03	0.01	0.05	0.04	0.06	0.02	0.03	0.03
	Range	0.24	0.15	0.08	0.09	0.04	0.12	0.11	0.14	0.06	0.07	0.07
	Min	3.10	2.27	0.14	0.44	0.58	0.34	1.08	1.31	0.77	0.68	0.89
	Max	3.35	2.43	0.22	0.54	0.61	0.46	1.18	1.45	0.83	0.76	0.96
H. amyemicola												
M ($n = 3$)	Mean	2.59	1.98	0.15	0.46	0.52	0.22	1.10	1.27	0.66	0.63	0.95
	SD	0.15	0.15	0.01	0.04	0.04	0.06	0.03	0.06	0.02	0.04	0.02
	Range	0.28	0.27	0.01	0.08	0.07	0.11	0.05	0.11	0.05	0.07	0.03
	Min	2.42	1.82	0.14	0.42	0.47	0.18	1.07	1.20	0.64	0.59	0.93
	Max	2.70	2.09	0.15	0.50	0.54	0.29	1.12	1.31	0.69	0.66	0.96
F ($n = 5$)	Mean	3.19	2.20	0.16	0.51	0.61	0.44	1.15	1.37	0.74	0.68	0.86
	SD	0.14	0.05	0.03	0.03	0.02	0.06	0.03	0.04	0.02	0.02	0.04
	Range	0.35	0.12	0.06	0.07	0.05	0.16	0.07	0.09	0.04	0.05	0.10
	Min	2.94	2.13	0.13	0.47	0.57	0.35	1.10	1.32	0.73	0.65	0.80
	Max	3.29	2.25	0.19	0.54	0.63	0.50	1.17	1.42	0.77	0.71	0.90
H. amyemopsis												
M ($n = 5$)	Mean	3.10	2.18	0.14	0.44	0.59	0.40	1.04	1.28	0.64	0.51	1.09
	SD	0.33	0.12	0.04	0.05	0.04	0.11	0.05	0.04	0.05	0.07	0.12
	Range	0.90	0.29	0.10	0.12	0.09	0.25	0.11	0.10	0.12	0.19	0.29
	Min	2.70	2.00	0.09	0.38	0.53	0.31	0.97	1.24	0.60	0.43	0.91
	Max	3.60	2.29	0.19	0.50	0.62	0.57	1.08	1.34	0.72	0.61	1.20
F ($n = 5$)	Mean	3.22	2.34	0.18	0.44	0.60	0.40	1.05	1.37	0.51	0.58	1.02
	SD	0.14	0.09	0.03	0.07	0.04	0.09	0.07	0.02	0.23	0.05	0.06
	Range	0.37	0.23	0.09	0.17	0.12	0.20	0.18	0.04	0.49	0.12	0.14
	Min	3.04	2.24	0.14	0.38	0.53	0.30	0.95	1.35	0.21	0.53	0.93
	Max	3.41	2.47	0.23	0.55	0.65	0.50	1.13	1.39	0.70	0.66	1.07
H. grossi												
M ($n = 2$)	Mean	2.61	1.92	0.13	0.41	0.53	0.26	0.96	1.16	0.65	0.54	0.00
	SD	0.04	0.09	0.00	0.07	0.00	0.03	0.02	0.03	0.01	0.03	
	Range	0.05	0.13	0.00	0.09	0.00	0.04	0.03	0.05	0.02	0.04	
	Min	2.59	1.85	0.12	0.36	0.53	0.25	0.94	1.14	0.65	0.52	
	Max	2.64	1.98	0.13	0.46	0.53	0.28	0.97	1.19	0.66	0.56	
F ($n = 5$)	Mean	3.00	2.07	0.17	0.49	0.56	0.43	1.00	1.22	0.67	0.59	0.75
	SD	0.18	0.09	0.02	0.03	0.05	0.09	0.08	0.12	0.07	0.05	0.08
	Range	0.45	0.21	0.05	0.07	0.11	0.21	0.21	0.29	0.17	0.12	0.22
	Min	2.74	2.00	0.14	0.45	0.52	0.34	0.90	1.02	0.58	0.53	0.65
	Max	3.19	2.21	0.19	0.52	0.63	0.55	1.10	1.31	0.75	0.66	0.87
H. lysiani												
M ($n = 5$)	Mean	2.64	1.85	0.16	0.41	0.52	0.35	0.94	1.12	0.58	0.50	0.79
	SD	0.18	0.04	0.03	0.02	0.06	0.10	0.05	0.04	0.04	0.04	0.10
	Range	0.43	0.11	0.06	0.04	0.14	0.24	0.13	0.11	0.10	0.11	0.26
	Min	2.41	1.78	0.12	0.39	0.49	0.25	0.87	1.09	0.53	0.45	0.67
	Max	2.84	1.89	0.19	0.43	0.63	0.49	0.99	1.19	0.63	0.56	0.93
F ($n = 5$)	Mean	2.77	1.88	0.15	0.41	0.50	0.38	0.98	1.16	0.60	0.58	0.69
	SD	0.18	0.07	0.04	0.03	0.03	0.13	0.04	0.06	0.03	0.04	0.04
	Range	0.41	0.18	0.09	0.09	0.08	0.30	0.10	0.15	0.08	0.12	0.09
	Min	2.56	1.81	0.12	0.37	0.48	0.25	0.94	1.06	0.57	0.53	0.64
	Max	2.97	1.99	0.21	0.45	0.56	0.54	1.04	1.21	0.65	0.64	0.73
H. metamyemi												
M ($n = 5$)	Mean	3.49	2.38	0.17	0.55	0.66	0.44	1.19	1.46	0.76	0.75	0.89
	SD	0.19	0.05	0.03	0.06	0.03	0.12	0.05	0.05	0.07	0.06	0.06
	Range	0.49	0.14	0.07	0.16	0.08	0.30	0.13	0.15	0.16	0.16	0.17
	Min	3.33	2.30	0.14	0.49	0.62	0.34	1.12	1.37	0.69	0.69	0.82
	Max	3.82	2.43	0.21	0.64	0.71	0.63	1.25	1.52	0.84	0.85	0.99

Table 1 Continued

Hypseloecus		Length						Width			InterOc	AntSeg2
		Body	CunClyp	Head	Pron	Scut	Cun	Head	Pron	Scut		
F ($n = 5$)	Mean	3.88	2.60	0.17	0.59	0.68	0.55	1.27	1.57	0.86	0.78	0.91
	SD	0.19	0.09	0.04	0.06	0.05	0.07	0.05	0.08	0.05	0.04	0.05
	Range	0.48	0.21	0.12	0.14	0.14	0.16	0.12	0.19	0.13	0.11	0.13
	Min	3.58	2.50	0.13	0.52	0.61	0.44	1.22	1.45	0.78	0.72	0.84
	Max	4.07	2.71	0.25	0.66	0.75	0.60	1.34	1.65	0.91	0.83	0.97
H. neoamyemi												
M ($n = 5$)	Mean	3.21	2.24	0.12	0.43	0.59	0.37	1.10	1.35	0.70	0.62	0.90
	SD	0.17	0.12	0.02	0.05	0.05	0.07	0.11	0.08	0.04	0.04	0.08
	Range	0.37	0.28	0.06	0.14	0.13	0.17	0.28	0.21	0.10	0.10	0.20
	Min	3.03	2.07	0.08	0.36	0.52	0.28	1.01	1.27	0.66	0.56	0.80
	Max	3.41	2.35	0.14	0.50	0.65	0.45	1.29	1.48	0.76	0.66	1.00
F ($n = 5$)	Mean	3.16	2.44	0.14	0.51	0.61	0.28	1.11	1.44	0.77	0.68	0.89
	SD	0.02	0.03	0.01	0.03	0.02	0.04	0.04	0.02	0.01	0.02	0.02
	Range	0.06	0.06	0.02	0.05	0.04	0.10	0.09	0.06	0.03	0.06	0.05
	Min	3.12	2.40	0.14	0.48	0.58	0.20	1.06	1.41	0.76	0.64	0.87
	Max	3.18	2.47	0.16	0.53	0.62	0.30	1.15	1.47	0.78	0.70	0.92
H. paramyemi												
M ($n = 5$)	Mean	3.13	2.29	0.15	0.48	0.63	0.33	1.30	1.43	0.79	0.79	0.80
	SD	0.18	0.09	0.02	0.03	0.07	0.08	0.05	0.06	0.02	0.05	0.06
	Range	0.41	0.20	0.05	0.08	0.17	0.18	0.14	0.17	0.06	0.14	0.17
	Min	2.91	2.20	0.12	0.43	0.55	0.23	1.24	1.34	0.76	0.72	0.71
	Max	3.32	2.39	0.18	0.51	0.72	0.41	1.38	1.51	0.82	0.86	0.88
F ($n = 5$)	Mean	3.44	2.43	0.16	0.56	0.64	0.46	1.34	1.52	0.81	0.88	0.80
	SD	0.19	0.07	0.09	0.05	0.04	0.12	0.05	0.04	0.04	0.05	0.03
	Range	0.42	0.19	0.22	0.12	0.11	0.29	0.12	0.09	0.10	0.12	0.08
	Min	3.26	2.33	0.01	0.51	0.58	0.33	1.31	1.47	0.76	0.85	0.75
	Max	3.68	2.51	0.23	0.63	0.69	0.62	1.43	1.56	0.86	0.97	0.83
H. cassisi												
M ($n = 5$)	Mean	2.86	2.03	0.11	0.30	0.60	0.35	0.93	1.22	0.76	0.48	1.00
	SD	0.12	0.09	0.02	0.03	0.03	0.06	0.03	0.09	0.06	0.02	0.08
	Range	0.28	0.21	0.06	0.08	0.08	0.14	0.08	0.22	0.15	0.06	0.19
	Min	2.71	1.92	0.09	0.25	0.57	0.30	0.90	1.07	0.68	0.46	0.95
	Max	2.99	2.13	0.15	0.34	0.64	0.44	0.98	1.28	0.84	0.51	1.13
F ($n = 5$)	Mean	2.77	2.07	0.14	0.31	0.56	0.35	0.95	1.24	0.77	0.54	0.91
	SD	0.15	0.10	0.02	0.03	0.04	0.02	0.03	0.06	0.04	0.01	0.07
	Range	0.38	0.26	0.06	0.08	0.09	0.04	0.08	0.13	0.11	0.03	0.14
	Min	2.61	1.92	0.12	0.26	0.52	0.33	0.92	1.16	0.74	0.52	0.84
	Max	2.99	2.18	0.18	0.34	0.60	0.37	1.00	1.30	0.85	0.55	0.98
H. weirauchi												
M ($n = 5$)	Mean	3.15	2.05	0.10	0.33	0.55	0.43	1.11	1.28	0.82	0.59	0.53
	SD	0.10	0.10	0.03	0.06	0.03	0.05	0.03	0.05	0.05	0.02	0.49
	Range	0.24	0.26	0.06	0.14	0.06	0.12	0.06	0.11	0.11	0.06	0.93
	Min	3.09	1.94	0.08	0.24	0.52	0.35	1.07	1.22	0.74	0.56	0.00
	Max	3.32	2.20	0.14	0.38	0.58	0.47	1.13	1.34	0.85	0.62	0.93
F ($n = 5$)	Mean	2.95	2.04	0.11	0.29	0.56	0.42	1.12	1.27	0.83	0.65	0.86
	SD	0.19	0.09	0.04	0.07	0.03	0.11	0.04	0.05	0.09	0.05	0.10
	Range	0.49	0.24	0.09	0.15	0.08	0.23	0.09	0.11	0.18	0.13	0.27
	Min	2.73	1.91	0.07	0.24	0.52	0.33	1.05	1.21	0.73	0.58	0.70
	Max	3.22	2.15	0.17	0.40	0.60	0.56	1.14	1.32	0.91	0.71	0.97

USNM United States National Museum, Smithsonian Institution, Washington, DC

ZISP Zoological Institute, Russian Academy of Sciences, St. Petersburg

Morphological character data

Morphological characters useful for understanding relationships within the Pilophorini were extracted for a subset of taxa analysed by Schuh (1991). A total of 68 characters were then coded for 60 taxa, including the 10 taxa described in this paper and two outgroups; *Tuxedo drakei* Schuh was used to root the tree, a decision informed by a more broad-based analysis of phyline relationships conducted by co-author Menard. The matrix and character descriptions are shown in Appendix I.

DNA extraction and sequencing

With the aim of acquiring data for four gene regions (Table 2) total genomic DNA was extracted for eight *Hypseloecus* spp.

Table 2 GenBank accession numbers for gene regions successfully sequenced

Taxon		Gene region			
Tribe	Species	COI–COII	16S	18S	28S
Pilophorini	*Hypseloecus amyemi*	JF414096	JF414067	JF414077	JF414086(p)
Pilophorini	*Hypseloecus neoamyemi*	JF414097	JF414068	JF414078	JF414087(p)
Pilophorini	*Hypseloecus paramyemi*	No data	JF414069	No data	JF414088(p)
Pilophorini	*Hypseloecus metamyemi*	JF414098	JF414070	No data	JF414089(p)
Pilophorini	*Hypseloecus amyemopsis*	JF414099	JF414071	JF414079(p)	JF414090(p)
Pilophorini	*Hypseloecus lysiani*	No data	JF414072	JF414080	JF414091(p)
Pilophorini	*Hypseloecus weirauchi*	JF414100	JF414073	JF414081	JF414092
Pilophorini	*Hypsoloecus cassisi*	HQ676991	HQ667661	HQ676876	JF414085
Pilophorini	*Neoambonea cynanchi*	JF414101	JF414074	JF414082	JF414093
Pilophorini	*Pilophorus alstoni*	HQ676962	HQ667628	HQ676836	HQ6677628
Pilophorini	*Pilophorus discretus*	AY253083.1	AY252838.1	AY252363.1	AY252581.1
Pilophorini	*Pilophorus gracilis*	AY252988.1	AY252726.1	AY252254.1	No data
Pilophorini	*Pilophorus juniperi*	JF414104	HQ667629	HQ676837	HQ6677629
Pilophorini	*Pilophorus maculata*	HQ676963	HQ667630	HQ676838	HQ6677630
Pilophorini	*Pilophorus piceicola*	AY253025.1	AY252770.1	No data	AY252543.1
Pilophorini	*Pilophorus uhleri*	AY253015.1	AY252760.1	AY252287.1	AY252533.1
Pilophorini	*Sthenaridea piceonigra*	JF414103	JF414076	JF414084	JF414095
Pilophorini	*Sthenaridea vulgaris*	JF414102	JF414075	JF414083(p)	JF414094
Phylini	*Tuxedo drakei*	HQ676966	HQ667634	HQ676843	HQ6677635
Leucophoropterini	*Sejanus albisignatus*	HQ676949	HQ667602	HQ676808	HQ6677602

Partial sequences are denoted (p).

Table 3 Primers used to amplify the large mitochondrial ribosomal subunit (16S), large and small nuclear ribosomal subunits (28S, 18S), and segment containing the cytochrome oxidase subunit II (COII)

Region	Primer name	Primer sequence	Author
COII	C1-J-279	CCW CGW CGW TAY TCW GAY TAT CC	Damgaard and Cognato (2006)
	C2-N-3554	GTT CAT GAR TGW ARD ACA TC	Damgaard and Cognato (2006)
16S	16SF_Pseudo1	GTG CAA AGG TAG CAT AAT C	P. Pedraza (unpublished 2009)
	16SR_Pseudo2	TCC GGT TTG AAC TCA GAT CAT	P. Pedraza (unpublished 2009)
18S	18s1F2†	ATG AAC CTT GAC GGC TCA GT	
	18s5R	CTT GGC AA TGC TTT CGC	Giribet *et al*. (1996)
	18s3F	GTT CGA TTC CGG AGA GGG A	Giribet *et al*. (1996)
	18sBI	GAG TCT CGT TCG TTA TCG GA	Whiting *et al*. (1997)
	18sA2	ATG GTT GCA AAG CTG AAA C	Whiting *et al*. (1997)
	18s9R	GAT CCT TCC GCA GGT TCA CCT AC	Giribet *et al*. (1996)
28S	28sRD1A	CCC SCG TAA YTT AGG CAT AT	
	28sRD4B	CCT TGG TCC GTG TTT CAA GAC	
	28sRD3.2a	AGT ACG TGA AAC GCT TCA SGG GT	
	28sB	TCG GAA GGA ACC AGC TAC TA	Whiting *et al*. (1997)
	28sA	GAC CCG TCT TGA AGC ACG	Whiting *et al*. (1997)
	28sBout	CCC ACA GCG CCA CTT CTG CTT ACC	
	28sRD4.8b†	ACC TAT TCT CAA ACT CCA AAT AG	
	28sRD7B1	GAC TTC CCT TAC CTA CAT	

†New primers.

and a subset of 12 additional taxa included in the morphological analysis. Extractions were performed using dried, whole museum specimens under modified protocols of the QIAGEN DNeasy Blood and Tissue Genomic Kit (QIAGEN 2006). Individual specimens were placed into the solution of Proteinase K and Buffer ATL for digestion, and the remaining exoskeletons were retained in glycerine for vouchering purposes. The large mitochondrial ribosomal subunit (16S rRNA), the large and small nuclear ribosomal subunits (28S rRNA and 18S rRNA, respectively), a fragment comprising approximately 570 bp of the 3′ end of COI, the intermediate leucine tRNA, and the 5′ end of cytochrome *c* oxidase subunit 2 (COII) were amplified using the illustra™ puReTaq Ready-To-Go PCR Beads (GE Healthcare 2007) and the primer pairs listed in Table 3, some of them newly designed. The annealing temperature of the PCR conditions for COII varied from 44°C to 54°C or from 50°C to 54°C, while 16S, 18S and 28S worked consistently at 48°C. The PCR purification and cycle sequencing were carried out with a Biomek NX Laboratory Automation Workstation and using the Gencourt®AMPure® and CleanSEQ® systems, with the use of BigDye® Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems 2002). The

reactions were sequenced using an automated Applied Biosystems 3730 DNA Analyzer; sequences were edited with Sequencher 4.8 (Gene Codes Corporation). The unaligned sequences of 16S are between 479 and 571 bp, the fragment containing COII was 801 bp, 18S between 1117 and 1962 bp, and 28S between 531 and 2345 bp. For the last two genes, shorter sequences are due to partial or incomplete fragments being sequenced. The fragment containing COII was aligned based on the amino acid composition of the conserved COI and COII protein domains for *Lygus lineolaris* (GenBank: ABY74767.1 and ABY74768.1). Fixed alignments for the 16S, 18S and 28S genes were created using MAFFT (Katoh & Toh 2008) on the online server (http://align.bmr.kyushu-u.ac.jp/mafft/online/server/), using the E-INS-i strategy (Katoh *et al*. 2005) for multiple conserved domains and multiple gaps. Including gaps, the fixed alignment included 874 characters for the COII data, 556 for the 16S data, 1889 for the 18S data and 2352 for the 28S data, yielding 5739 characters with the inclusion of 68 morphological characters added for the combined analysis.

Hypseloecus Reuter

Hypseloecus Reuter, 1891: 50 (n. gen.); Linnavuori, 1986: 148 (n. syn.); Schuh, 1989: 4 (n. syn.).
Ambonea Odhiambo, 1961: 393 (n. gen.); Schuh, 1974: 201 (diag); Schuh, 1984: 11 (diag.).
Wauella Carvalho, 1987: 184 (n. gen.).

Diagnosis

Recognised by the relatively broad head, the lanceolate setae scattered on the dorsum, the hind tibial spines usually with dark bases, and the endosoma with a group of glassy spicules just distad of the secondary gonopore. All species feed on members of the Santalales.

Redescription

Male: COLOURATION: Membrane unicolourous or mottled. SURFACE AND VESTITURE: **Surface**: Pronotum without punctures, moderately shining, and smooth, sometimes granulose or weakly roughened; hemelytron impunctate; corium with uniform texture. **Vestiture**: Gena with a few erect setae, sometimes rather heavy and bristle-like; hemelytron with common setae of moderate length; vertex, frons and pronotum with reclining common setae of moderate length; silvery lanceolate setae present on head, widely distributed on pronotum, scattered on scutellum, scattered on apex of scutellum, scattered or in small patches on corium, clavus, cuneus, propleuron, mesopleuron, metapleuron and abdominal venter, these setae always being appressed to the body surface. STRUCTURE: Body ovoid to nearly parallel sided. **Head**: Concave behind; gena straight in frontal view, flat or broadly rounded or weakly to moderately carinate; gula obsolete, without a ridge or roll; mandibular plate not protruding above maxillary plate; antennal segment 2 elongate, slender and nearly cylindrical; labium with segments 3 and 4 combined, much longer than segment 2; segment 1 reaching to about midpoint of prosternal xyphus, slender; buccal cavity ovoid, directed ventrally, receiving 1/2 length labial segment 1. **Pronotum**: Lateral margins weakly convex to nearly straight; calli obsolete; scutellum flat or weakly transversely rounded; mesoscutum flat and only slightly elevated anteriorly. **Hemelytron**: Weakly declining laterally, entire costa visible from above, not conforming to abdomen; costal margin convex to nearly straight, cuneus and membrane strongly declivent. **Legs**: Hind tibia cylindrical in cross-section, or nearly so. **Abdomen**: Broader basally than at any point posterior to base. GENITALIA: **Endosoma**: C- or J-shaped and more or less flat; secondary gonopore present as a lateral indentation, subtended by glassy spicules; endosomal shaft unornamented or with hook-like or spine-like developments. **Left paramere**: Body short, weakly to strongly splayed out; anterior process short, posterior process much longer. **Right paramere**: Short, broad, ovoid, with weakly acuminate apex, to moderately elongate.

Female: Colouration, surface texture and vestiture, and structure similar to male. GENITALIA: Not examined as part of this study.

Discussion: Schuh (1991), in his world phylogeny of the Pilophorini, treated *Hypseloecus* as a monophyletic group, a theory consistent with the actions of Linnavuori (1986) and Schuh (1989), who, respectively, synonymised *Ambonea* Odhiambo and *Wauella* Carvalho with *Hypseloecus*. Our effort to test that conclusion in light of the inclusion of 10 new species from Australia and Africa may benefit from the following comments.

The robust, usually rectangular body form and the very broad, flat head of the species we include in *Hypseloecus* are similar, notwithstanding some variation in colouration and details of head and body shape. The nature of the vestiture precludes placement of *Hypseloecus* species in what might be called 'higher' Pilophorini, those species Schuh (1991) placed in *Pilophorus* Hahn on the basis of the grouping of lanceolate setae into discrete patches or bands on the hemelytra and thoracic pleuron. Although the facies and host associations of species presently placed in *Hypseloecus* are remarkably consistent, the structure of the endosoma in the male shows an amount of variation equivalent to that seen in all Pilophorini. That variation ranges from a simple, tubular, endosomal shaft with no medial ornamentation to a more robust shaft without ornamentation, to an endosoma with one or two medial spines of varying structure. These medial endosomal spines are very similar in form to those seen in some species of *Pilophorus*, taxa to which *Hypseloecus* spp. would otherwise seem to be rather distantly related.

Schuh (1974, 1984, 1991) examined the female genitalia of a cross-section of representatives of the Pilophorini. Although he found the posterior wall to have a distinctively elevated posterior margin, he noted no other characters in the female genitalia that would allow for the recognition of subgroups within the Pilophorphini.

AUSTRALIAN SPECIES

Key to the Australian spp. of *Hypseloecus*

1. Body and appendages pale, often almost white (Fig. 1); endosoma as in Figure 5, with a broad medial spine and an elongate acuminate apex .....*H. amyemi*
– Body and appendages not white 2
2. Body and appendages orange; body ovoid, head closely conforming to anterior margin of pronotum (Fig. 1); endosoma as in Figure 10, without a medial spine and with a paddle-shaped apex ...*H. metamyemi*
– Body and appendages carmine red; body often strongly parallel sided, head often not so closely conforming to pronotum and eyes often protruding; endosoma variable.....3
3. Endosoma without a medial spine; dorsal margin of left paramere without a medial elevated region; meso- and metapleuron without a velvety black patch on dorsal margin.....4
– Endosoma with a medial spine, dorsal margin of endosoma with a medial elevated region; meso- and metapleuron each with a velvety black patch on dorsal margin.....6
4. Shaft of endosoma broad, heavily sclerotised, with an elongate fringe of heavy glassy spicules distad of secondary gonopore and an elongate paddle-shaped apex (Fig. 12) .....*H. paramyemi*
– Shaft of endosoma slender, weakly sclerotised, with a small grouping of small glassy spicules distad of secondary gonopore.....5
5. Apex of endosoma elongate, tapering, acuminate and very weakly sclerotised (Fig. 7); large species, mean length 3.10 .....*H. amyemopsis*
– Apex of endosoma short, barely exceeding field of glassy spicules (Fig. 9); small species, mean length 2.64 .....*H. lysiani*
6. Endosoma with a slender medial spine and a more basal apically oriented claw-like protuberance (Fig. 8) .....*H. grossi*
– Endosoma with only a slender medial spine 7
7. Dorsal margin of phallotheca with a crenulate crest (Fig. 11).....*H. neoamyemi*
– Dorsal margin of phallotheca simple, without a crest (Fig. 6).....*H. amyemicola*

Hypseloecus amyemi, sp. nov. (Figs 1,3,5, Table 1)

Diagnosis

Recognised by the entirely pale, almost white colouration of the body and appendages, with carmine red eyes. Possibly confused with *H. metamyemi*, but that species always orange, never white.

Description

Male: Elongate ovoid, lateral corial margins weakly convex; total length 2.70–3.09, width pronotum 1.26–1.38. COLOURATION (Fig. 1): General colouration of body and appendages pale, cream to white; eyes carmine red; membrane pale, transparent, with white veins; meso- and metapleuron each with a velvety brown patch; tibial spines dark with small dark bases. SURFACE AND VESTITURE: Dorsum with scattered golden lanceolate setae intermixed with short, recumbent, black, common setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, conforming to anterior margin of pronotum; eyes not protuberant. Gena equal to height of eye, nearly straight in frontal view; antenna inserted just below eye and removed from eye by diameter of antennal segment 2. GENITALIA (Fig. 5): **Endosoma**: Elongate, slender bodied, J-shaped, with a sclerotised backbone distad of secondary gonopore; secondary gonopore in the form of a distinct semicircular opening subtended distally by a small field of erect, straight, moderately long, glassy spicules; medial spine present as a well developed, flattened, scimitar-shaped process subtended proximally by a scalloped, elevated ridge. **Phallotheca**: Extreme distal portion angulate relative to body of phallotheca, tapered to a blunt apex; body with a broad quadrate extension overlapping base of apical area. **Left paramere**: Moderately strongly splayed out; process on dorsal anterior margin present, oriented in plane of anterior and posterior processes.

Female: Broader and more strongly ovoid than male; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the host genus *Amyema* (Loranthaceae).

Hosts: *Amyema maidenii maidenii* (Loranthaceae). *Amyema maidenii* is widely distributed in the dry interior of Australia, but is virtually absent from the west and south-west (Fig. 19a). *Amyema lucasii* is restricted primarily to New South Wales with scattered records from Queensland (Fig. 19a).

Distribution: Northern Territory, Western Queensland.

Holotype: **AUSTRALIA: Northern Territory:** Kings Canyon, Watarrka National Park, 24.25001°S 131.5689°E, 633 m, 2 November 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. maidenii* ssp. *maidenii* (Loranthaceae), det. NSW staff NSW666304, 1 ♂ (AMNH_PBI 00098673) (MAGD).

Paratypes: **AUSTRALIA: Northern Territory:** 74.2 km NW of Bond Springs on Tanami Rd, 23.41668°S 133.2307°E, 671 m, 22 October 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. maidenii* ssp. *maidenii* (Blakely) Barlow (Loranthaceae), det. NSW staff NSW666304, 3 ♂ (00137294–00137296), 4 ♀ (00137297–00137300) (AMNH). Finke Gorge National Park, near Palm Valley campground, 24.05°S 132.7437°E, 579 m, 4 November 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. maidenii* ssp. *maidenii* (Blakely) Barlow (Loranthaceae), det. NSW staff NSW666304, 1 ♀ (00088122) (AMNH). Jct of Arltunga Stn Rd and Ruby Gorge Rd, 23.46668°S 134.7123°E, 653 m, 26 October 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. maidenii* ssp. *maidenii* (Blakely) Barlow (Loranthaceae), det. NSW staff NSW666431, 1 ♀ (00098276) (AMNH). Kings Canyon, Watarrka National Park, 24.25001°S 131.5689°E, 633 m, 2

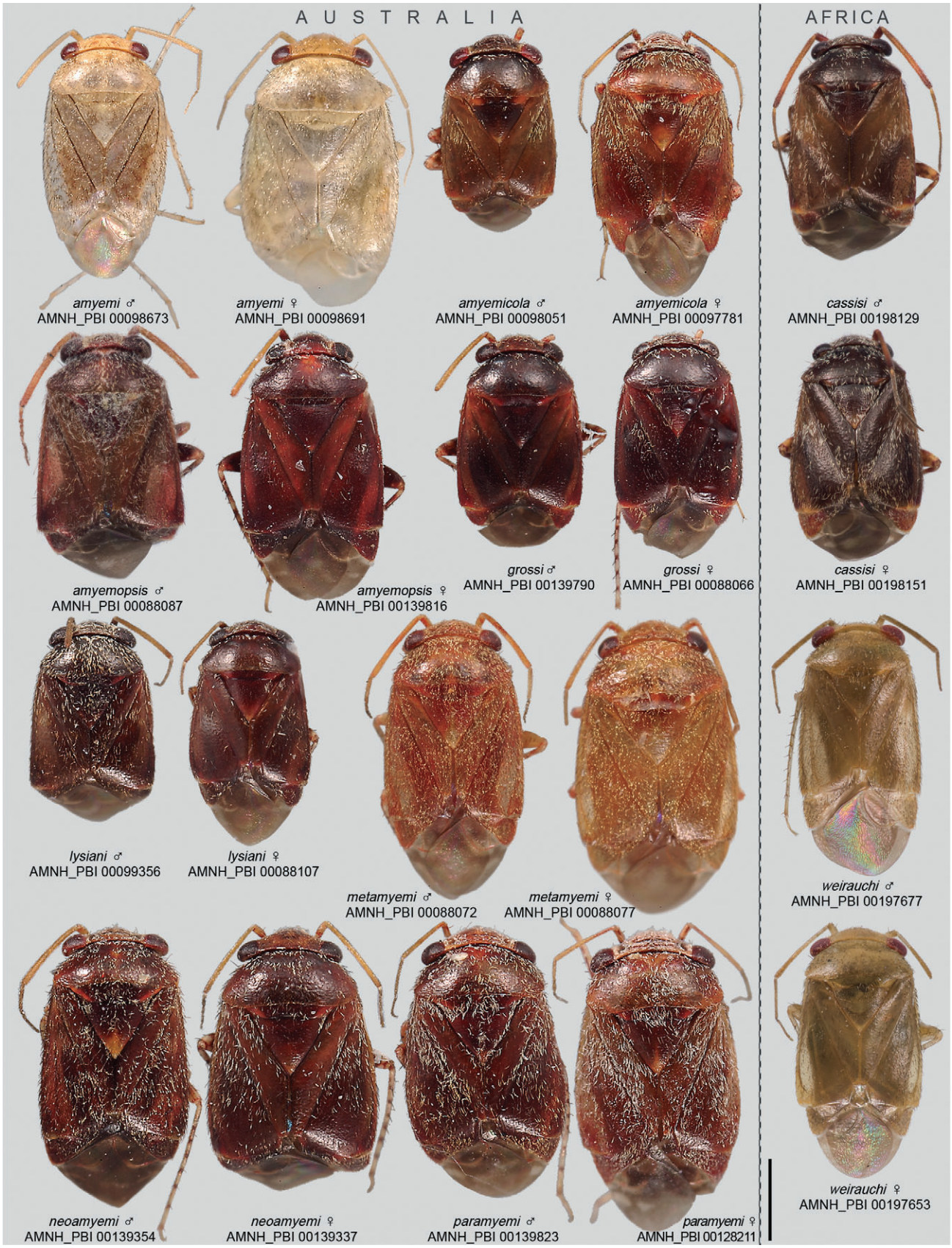

Fig. 1. Habitus images of *Hypseloecus* spp.

Fig. 2. Hosts of *Hypseloecus* spp. (a,b) *Amyema cambagei* (22.5 km W of Retreat). (c) *Amyema lucasii* (63 km SW of Louth towards Wilcannia). (d) *Amyema miquelii* (21 km E of Stuart Hiway on Ernest Giles Rd). (e,f) *Amyema quandang* (44.2 km E of Nyngan on Mitchell Hiway). (g,h) *Viscum continuum* (12.5 km W of Barrydale on R62).

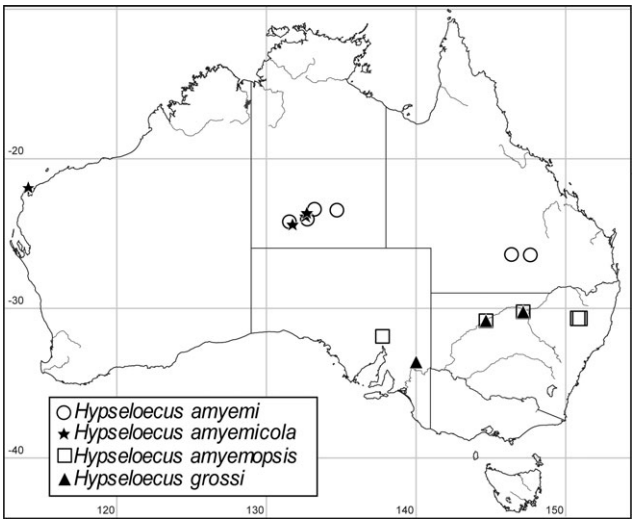

Fig. 3. Distribution of *Hypseloecus amyemi–H. gross* in Australia.

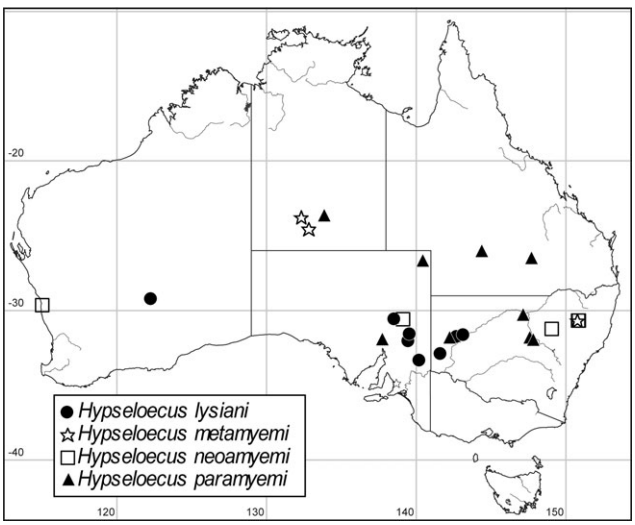

Fig. 4. Distribution of *Hypseloecus lysiani–H. paramyemi* in Australia.

November 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. maidenii* ssp. *maidenii* (Blakely) Barlow (Loranthaceae), det. NSW staff NSW666304, 12 ♂ (00098668–00098672, 00098674–00098680), 19 ♀ (00098682–00098698, 00098703–00098704) (AMNH), 2 ♀ (00098699, 00098700) (ANIC), 1 ♂ (00098667), 1 ♀ (00098702) (MAGD), 1 ♂ (00098681), 1 ♀ (00098701) (UNSW). **Queensland:** 8.2 km E of Mungallala, 26.46401°S 147.6248°E, 560 m, 31 October 1998, Schuh, Cassis, Silveira, *A. maidenii maidenii* (Blakely) Barlow (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427342, 2 ♂ (00087409, 00088128), 3 ♀ (00087410, 00088124–00088125) (AM).

Other specimens examined: **AUSTRALIA: Northern Territory:** Finke Gorge National Park, near Palm Valley campground, 24.05°S 132.7437°E, 579 m, 4 November 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. maidenii* ssp. *maidenii* (Blakely) Barlow (Loranthaceae), det. NSW staff NSW666304, 1 nymph (00088123) (AMNH). **Queensland:** 8.2 km E of Mungallala, 26.46401°S 147.6248°E, 560 m, 31 October 1998, Schuh, Cassis, Silveira, *A. maidenii maidenii* (Blakely) Barlow (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427342, 2 nymphs (00088126, 00088127) (AM). 14.2 km E of Charleville, 26.42171°S 146.3756°E, 375 m, 31 October 1998, Schuh, Cassis, Silveira, *A. lucasii* (Blakely) Danser (Loranthaceae), det. B.M. Wiecek 1996 NSW 395940, 1 ♀ (00373097) (AM).

Fig. 5. *Hyseloecus amyemi*, male genitalia (AMNH_PBI 00098680).

Hypseloecus amyemicola, sp. nov. (Figs 1,3,6, Table 1)

Diagnosis

Along with *H. grossi* and *H. neoamyemi*, recognised by blood red colouration, medial elevation on the dorsal margin of the left paramere, the elongate, slender, medial spine on the endosoma, and the velvety black patch on the dorsal margin of the meso- and metapleuron. Distinguished from *H. grossi* by the

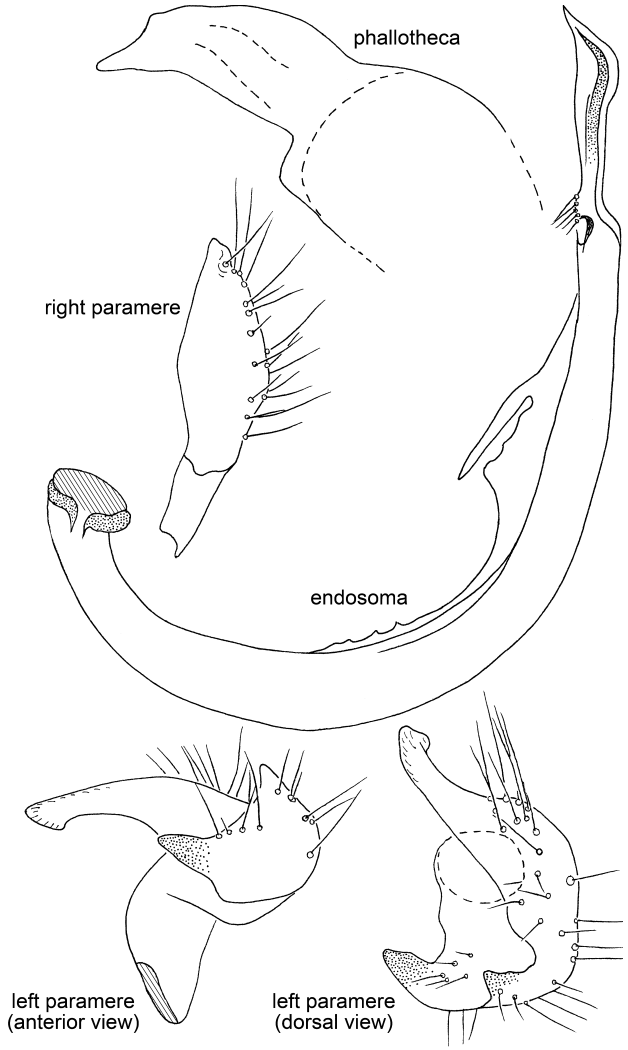

Fig. 6. *Hyseloecus amyemicola*, male genitalia (AMNH_PBI 00097774).

presence of an apically oriented claw-like process basad of the medial endosomal spine and from *H. neoamyemi* by the presence of a crenulate process on the dorsal margin of the phallotheca in that species.

Description

Male: Relatively small, more or less quadrate, lateral corial margins weakly convex; total length 2.42–2.70, width pronotum 1.20–1.31. COLOURATION (Fig. 1): Dorsum and labium brown to reddish brown, thoracic pleuron and abdominal venter castaneous; membrane moderately to heavily infuscate, veins no so dark as surrounding membrane; antennal segments 1 and 2 pale, 1 with some variable red areas, segments 3 and 4 dark; meso- and metapleuron with velvety black patch; coxae pale, nearly white; femora variably reddish with some spots; tibiae pale with conspicuous contrasting red spots at bases of heavy dark spines and a contrasting red stripe down external face. SURFACE AND VESTITURE: Dorsum with scattered silvery lanceolate setae, apparently more densely packed along claval suture, intermixed with moderately long, recumbent, black, common setae; thoracic pleuron and abdominal venter with scattered clumps of 2 or 3 silvery lanceolate setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, conforming to anterior margin of pronotum; eyes not protuberant; gena about one-third height of eye, nearly straight in frontal view; antenna inserted at ventral margin of eye and removed from eye by diameter of antennal segment 2. GENITALIA (Fig. 6): **Endosoma**: Elongate, moderately broad bodied, J-shaped, very broadly curving, with a sclerotised backbone distad of secondary gonopore; secondary gonopore in the form of a distinct semicircular opening subtended distally by a small field of erect, straight, moderately long, glassy spicules; medial spine present, short and slender, subtended proximally by an elevated, scalloped keel. **Phallotheca**: Elongate, relatively slender, extreme apical region at nearly right angle relative to body of phallotheca, in the form of a short finger. **Left paramere**: Weakly splayed out; process on dorsal anterior margin present, small, oriented in plane of anterior and posterior processes. **Right paramere**: Elongate, tapering from midpoint to apex.

Female: Broader and more strongly ovoid than male; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the host genus *Amyema* (Loranthaceae), in combination with the Latin suffix *-cola*, inhabitant.

Hosts: *Amyema preissii* (Loranthaceae). The host is widely distributed in the Eyre Basin and most of Western Australia (Fig. 19b).

Distribution: Northern Territory, central coast of Western Australia.

Holotype: **AUSTRALIA: Northern Territory:** West MacDonnell National Park, Road to Ormiston Gorge, 23.65001°S 132.7242°E, 664 m, 5 November 2001, Schuh and Schwartz, *A. preissii* (Loranthaceae), det. NSW staff NSW666335, 1 ♂ ♂ (AMNH_PBI 00098051) (MAGD).

Paratypes: **AUSTRALIA: Northern Territory:** 16.4 km W of Hermannsburg, 23.88335°S 132.6262°E, 631 m, 3 November 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. preissii* (Loranthaceae), det. NSW staff NSW666318, 2 ♀ (00097777, 00097778) (AM), 3 ♂ (00097774–00097776), 15 ♀ (00097781, 00097784–00097797) (AMNH), 2 ♀ (00097782, 00097783) (ANIC), 2 ♀ (00097779, 00097780) (UNSW). Kings Creek at Watarrka National Park, 24.40589°S 131.7745°E, 780 m, 21 December 1997, R.T. Schuh, *A. preissii* (Loranthaceae), det. PERTH staff PERTH 05272130, 1 ♂ (00103119) (AM), *A. preissii* (Loranthaceae), det. PERTH staff PERTH 05272130, 1 ♂ (00103117), 7 ♀ (00103122–00103128) (AMNH), 1 ♂ (00103121) (ANIC), 1 ♂ (00103118) (MAGD), 1 ♂ (00103120) (UNSW). West MacDonnell National Park, Road to Ormiston Gorge, 23.65001°S 132.7242°E, 664 m, 5 November 2001, Schuh and Schwartz, *A. preissii* (Loranthaceae), det. NSW staff NSW666335, 4 ♂ (00098050, 00098052–00098054), 13 ♀ (00098059–00098071) (AMNH), 2 ♀ (00098057, 00098058) (MAGD).

Western Australia: Exmouth (waste area behind sand-dune), Truscott Crescent (opposite Pony Club), 21.94606°S 114.1358°E, 10 m, 31 October 2004, Cassis, Wall, Weirauch, Tatarnic, Symonds, *A. preissii* (Loranthaceae), det. PERTH staff PERTH6989500, 6 ♂ (00373076–00373081), 15 ♀ (00373082–00373096) (AM), 9 ♂ (00103098–00103106), 10 ♀ (00103107–00103116) (AMNH).

Other specimens examined: **AUSTRALIA: Northern Territory:** West MacDonnell National Park, Road to Ormiston Gorge, 23.65001°S 132.7242°E, 664 m, 5 November 2001, Schuh and Schwartz, *A. preissii* (Loranthaceae), det. NSW staff NSW666335, 2 nymphs (00098055, 00098056) (AMNH).

Hypseloecus amyemopsis, sp. nov. (Figs 1,3,7, Table 1)

Diagnosis

Along with *H. lysiani*, recognised among those species with a blood red dorsum by the relatively short, slender, weakly sclerotised endosoma. Distinguished from the similar appearing *H. lysiani* by the elongate acuminate apex of the endosoma, the endosomal apex in *H. lysiani* barely exceeding the field of glassy spicules.

Description

Male: Elongate, parallel sided, lateral corial margins nearly straight; moderately large, total length 2.99–3.60, width pronotum 1.27–1.34. COLOURATION (Fig. 1): Body, antennal segment 1, labium, and legs dark, blood red; membrane heavily and entirely infuscate, veins somewhat lighter; antennal segment 2 pale, tinged with red, segments 3 and 4 dark; meso- and metapleuron without velvety black patch; forecoxae and distalmost portion of femora pale; tibiae pale with conspicuous contrasting red spots at bases of dark spines. SURFACE AND VESTITURE: Dorsum with scattered, silvery, lanceolate setae intermixed with moderately long, reclining, black, common setae; metathoracic pleuron and abdominal venter with scattered, silvery, lanceolate setae. STRUCTURE: **Head**: Posterior margin of head including eyes nearly straight, not closely conforming to anterior margin of pronotum; eyes protuberant. Gena about one-fourth height of eye, nearly straight in frontal view; antenna inserted close to eye and somewhat above ventral margin. GENITALIA (Fig. 7): **Endosoma**: Elongate, slender, tubular, C-shaped, with a weakly sclerotised backbone distad of secondary gonopore; secondary gonopore in the form of a distinct semicircular opening subtended distally by a small field of erect, straight, moderately long, glassy spicules; medial spine absent. **Phallotheca**: Elongate, relatively slender, apical portion nearly at right angle relative to body of phallotheca, elongate, finger-like, parallel sided. **Left paramere**: Weakly splayed out; no process on dorsal anterior margin. **Right paramere**: Short and broad.

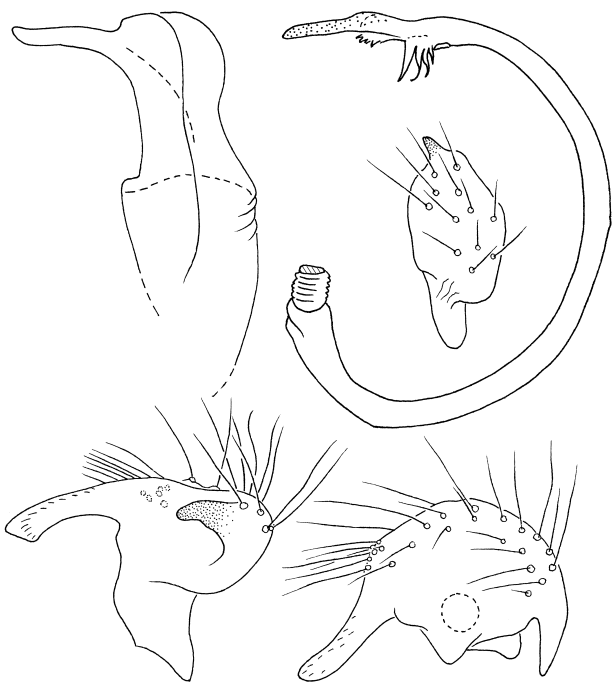

Fig. 7. *Hyseloecus amyemopsis*, male genitalia (AMNH_PBI 00088089).

Female: Similar to male but eyes not so strongly protuberant and lateral corial margins more strongly rounded; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the host genus *Amyema* (Loranthaceae), in combination with the Greek suffix *-opsis*, like.

Hosts: *Amyema lucasii* and *Dendrophthoe vitellina* (Loranthaceae). The record from *Brachychiton populneus* (Sterculiaceae) is certainly not that of a breeding host. *Amyema lucasii* is restricted primarily to New South Wales (Fig. 19a), with scattered records from Queensland, whereas *D. vitellina* occurs only on the east side of the Great Dividing Range (Fig. 19c).

Distribution: Interior of New South Wales with a single record from coastal South Australia.

Holotype: **AUSTRALIA: New South Wales:** 37 km W of Retreat (20 km E Manilla), 30.66668°S 150.8°E, 450 m, 24 October 1995, Schuh and Cassis, *D. vitellina* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395929, 1 ♂ (AMNH_PBI 00088087) (AM).

Paratypes: **AUSTRALIA: New South Wales:** 22 km W of Retreat (35 km E Manilla), 30.66668°S 150.8833°E, 600 m, 23 October 1995, Schuh and Cassis, *B. populneus* (Sterculiaceae), det. Det: B.J. Conn 1996 NSW 395923, 2 ♂ (00088096, 00088097) *D. vitellina* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395922, 3 ♂ (00373060–00373062), 1 ♀ (00373063) (AM). 37 km W of Retreat (20 km E Manilla), 30.66668°S 150.8°E, 450 m, 24 October 1995, Schuh and Cassis, *D. vitellina* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395929, 1 ♂ (00087196), 1 ♀ (00087197), 4 ♂ (00088086, 00088088, 00088093–00088094) (AM), 1 ♂ (00088089), 3 ♀ (00088090–00088092) (AMNH). 38 km WNW of Carinda towards Brewarrina, 30.25001°S

147.1667°E, 150 m, 26 October 1995, Schuh and Cassis, *A. lucasii* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395940, 3 ♀ (00373049, 00373051, 00373053) (AM), 2 ♂ (00139791, 00139792), 9 ♀ (00139809–00139813, 00139815–00139816, 00139818–00139819) (AMNH). 63 km SW of Louth towards Wilcannia, 30.83335°S 144.6833°E, 100 m, 28 October 1995, Schuh and Cassis, *A. lucasii* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395950, 2 ♂ (00373037, 00373038), 1 ♀ (00373039) (AM). **South Australia:** 67 km N of Port Augusta, 31.8989°S 137.763°E, G. Cassis (Loranthaceae), 1 ♂ (00087194), 1 ♀ (00087195) (AM).

Hypseloecus grossi, sp. nov. (Figs 1,3,8, Table 1)

Diagnosis

Along with *H. amyemicola* and *H. neoamyemi*, recognised by blood red colouration, the medial elevation on the dorsal margin of the left paramere, the slender, medial spine on the endosoma, and the velvety black patch on the dorsal margin of the meso- and metapleuron. Distinguished from *H. amyemicola* and *H. neoamyemi* by the absence of an apically oriented claw-like process basad of the medial endosomal spine and from *H. neoamyemi* by the presence of a crenulate process on the dorsal margin of the phallotheca in that species.

Fig. 8. *Hyseloecus grossi*, male genitalia (AMNH_PBI 00088065).

Description

Male: Relatively small, more or less quadrate, lateral corial margins weakly convex; total length 2.59–2.64, width pronotum 1.14–1.19. COLOURATION (Fig. 1): Body, labium and legs mostly deep blood red; membrane moderately to heavily infuscate, veins not so dark as surrounding membrane; antennal segments 1 and 2 pale, 1 with some variable red areas, segments 3 and 4 darker; meso- and metapleuron with velvety black patch; forecoxa pale, middle and hind coxae deep red; femora with some pale markings near distal end; tibiae pale with conspicuous contrasting red spots at bases of dark spines and a contrasting red stripe down external face. SURFACE AND VESTITURE: Dorsum with scattered silvery lanceolate setae intermixed with recumbent, dark, common setae of moderate length; thoracic pleuron and abdominal venter with scattered clumps of 2 or 3 silvery lanceolate setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, conforming to anterior margin of pronotum; eyes not protuberant. Gena about one-third height of eye, nearly straight in frontal view; antenna inserted at ventral margin of eye and very weakly removed from eye. GENITALIA (Fig. 8): **Endosoma**: Elongate, moderately broad bodied, J-shaped, rather sharply curving at base, with a sclerotised backbone distad of secondary gonopore; secondary gonopore in the form of a distinct semicircular opening subtended distally by a few short, straight, glassy spicules; medial spine present, short and slender, arising close to secondary gonopore, subtended proximally by an elevated, keel; endosoma with a second, short, strongly curved spine, appearing in the form of a rose thorn, arising just before midpoint. **Phallotheca**: Elongate, nearly erect, with a broadly but strongly curving dorsodistal margin and a short acuminate apex. **Left paramere**: Weakly splayed out; process on dorsal margin present, small, oriented dorsally. **Right paramere**: Short, broad, of uniform width over most of length.

Female: Similar to male but eyes not so strongly protuberant and lateral corial margins more strongly rounded; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the late Gordon F. Gross, in recognition of his contributions to the study of Heteroptera in Australia.

Hosts: *Amyema lucasii* (Loranthaceae). The host is restricted primarily to New South Wales with scattered records from Queensland (Fig. 19a).

Distribution: South-eastern South Australia and interior New South Wales.

Holotype: **AUSTRALIA: New South Wales:** 38 km WNW of Carinda towards Brewarrina, 30.25001°S 147.1667°E, 150 m, 26 October 1995, Schuh and Cassis, *A. lucasii* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395940, 1 ♂ (AMNH_PBI 00139790) (AM).

Paratypes: **AUSTRALIA: New South Wales:** 38 km WNW of Carinda towards Brewarrina, 30.25001°S 147.1667°E, 150 m, 26 October 1995, Schuh and Cassis, *A. lucasii* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395940, 1 ♂ (00373044), 4 ♀ (00373045–00373048) (AM), *A. lucasii* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395940, 2 ♀ (00373050, 00373052) *A. lucasii* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395940, 2 ♀ (00139814, 00139817) (AMNH). 63 km SW of Louth towards Wilcannia, 30.83335°S 144.6833°E, 100 m, 28 October 1995, Schuh and Cassis, *A. lucasii* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395950, 1 ♂ (00373036), 4 ♀ (00373040–00373043) (AM). **South Australia:** 51 km NW of Morgan, 33.58334°S 140°E, 150 m, 1 November 1995, Schuh, Cassis and Gross, 2 ♀ (00373058, 00373059), 2 ♂ (00088064, 00088065), 5 ♀ (00088066–00088070) (AM), 2 ♂ (00373056, 00373057) (AMNH).

Hypseloecus lysiani, sp. nov. (Figs 1,4,9, Table 1)

Diagnosis

Along with *H. amyemopsis*, recognised among those species with a blood red dorsum by the relatively short, slender, weakly sclerotised endosoma. Distinguished from *H. amyemopsis* by the elongate acuminate apex of the endosoma in that species, the endosoma in *H. lysiani* barely surpassing the field of glassy spicules.

Description

Male: Ovoid, lateral corial margins distinctly convex; relatively small, total length 2.41–2.84, width pronotum 1.09–1.19. COLOURATION (Fig. 1): Body, antennal segment 1, labium, and legs castaneous; membrane heavily and entirely infuscate, veins somewhat lighter; antennal segment 2 pale, segments 3 and 4 dark; meso- and metapleuron without velvety black patch; distalmost portion of femora pale; tibiae pale with conspicuous contrasting red spots at bases of dark spines and a contrasting red strip running down external face. SURFACE AND VESTITURE: Dorsum with scattered silvery lanceolate setae intermixed with moderately long, recumbent, black, common setae; thoracic pleuron and venter with scattered patches of 2 or 3 lanceolate setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, closely conforming to anterior margin of pronotum; eyes not protuberant, gena about one-fourth height of eye, nearly straight in frontal view; antenna inserted at ventral margin of eye and very weakly removed from eye. GENITALIA (Fig. 9): **Endosoma**: Slender, tubular, C-shaped; secondary gonopore subapical, in the form of a distinct semicircular opening subtended distally by a few erect, straight, glassy spicules; medial spine absent. **Phallotheca**: Elongate, relatively slender, extreme apical portion nearly at right angle relative to body of phallotheca, finger-like, elongate, parallel sided; posterior surface with a quadrate extension overlapping base of apical area. **Left paramere**: Weakly splayed out; no process on dorsal anterior margin. **Right paramere**: Not examined.

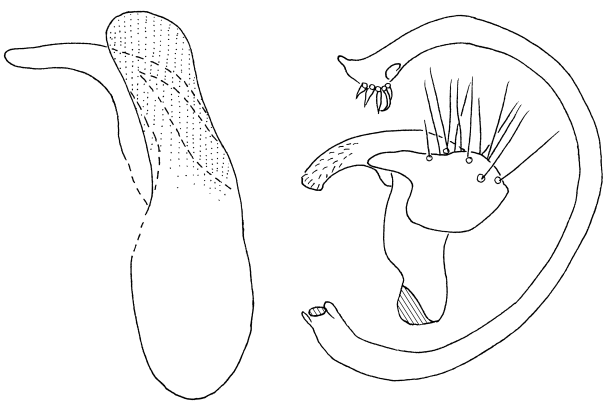

Fig. 9. *Hyseloecus lysiani*, male genitalia (AMNH_PBI 00099569).

Female: Similar to male but eyes not so strongly protuberant and lateral corial margins more strongly rounded; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the host genus *Lysiana* (Loranthaceae).

Hosts: *Lysiana exocarpi* ssp. *exocarpi* and *Amyema melaleucae* (Loranthaceae). *Lysiana exocarpi* is widely distributed in the dry interior of Australia, but is absent from the far west and south-west (Fig. 19a). *Amyema melaleucae* is almost exclusively restricted to near coastal areas along the Great Australian Bight (Fig. 19c).

Distribution: Most records from the interior of New South Wales and eastern South Australia with a single record from south-central Western Australia.

Holotype: **AUSTRALIA: South Australia:** 72 km N of Yunta, Nillinghoo Creek, 32.00924°S 139.4523°E, 194 m, 9 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Loranthaceae), det. NSW staff NSW666380, 1 ♂ (AMNH_PBI 00099356) (SAMA).

Paratypes: **AUSTRALIA: New South Wales:** 23 km W of Wilcannia on Barrier Hiway, 31.58335°S 143.1459°E, 107 m, 10 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666390, 11 ♂ (00128145–00128155), 14 ♀ (00128176–00128189) (AMNH), 1 ♂ (00128158) (ANIC), 1 ♂ (00128156), 2 ♀ (00128190, 00128191) (UNSW), 1 ♂ (00128157) (USNM), 1 ♂ (00128159) (ZISP). 116 km S of Broken Hill, 32.85°S 141.61666°E, 1 April 1975, Z. Liepa, 1 ♂ (00373098) (AM). 119.9 km E of Broken Hill on Barrier Hiway, 31.71668°S 142.6912°E, 231 m, 10 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666388, 11 ♂ (00099559–00099569), 17 ♀ (00099574–00099590) (AMNH), 2 ♀ (00099593, 00099594) (ANIC), 2 ♀ (00099595, 00099596)

(USNM), 2 ♀ (00099591, 00099592) (ZISP). **South Australia:** 12 km E of Copely, Flinders Range, 30.53334°S 138.5312°E, 322 m, 7 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666348, 5 ♂ (00098212–00098216), 6 ♀ (00098217–00098222) (AMNH). 14.3 km S of Erudina Woolshed, 31.53334°S 139.5506°E, 86 m, 9 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666373, 1 ♂ (00099239), 6 ♀ (00099240–00099245) (AMNH). 72 km N of Yunta, Nillinghoo Creek, 32.00924°S 139.4523°E, 194 m, 9 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666380, 7 ♂ (00099353–00099355, 00099357–00099360), 15 ♀ (00099362–00099376) (AMNH). 96 km NW of Morgan, Pine Valley Stn, 33.31667°S 140.2°E, 150 m, 2 November 1995, Schuh, Cassis and Gross, *A. melaleucae* (Miq.) Tieghem (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395975, 4 ♂ (00088098–00088101), 19 ♀ (00088102–00088120) (AM). **Western Australia:** 7.5 km NNW of Mt. Linden, 29.195°S 122.25°E, 17 March 1979–23 March 1979, T. F. Houston, 1 ♂ (00388372) (WAMP).

Other specimens examined: **AUSTRALIA: New South Wales:** 23 km W of Wilcannia on Barrier Hiway, 31.58335°S 143.1459°E, 107 m, 10 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666390, 16 nymphs (00128160–00128175) (AMNH). 119.9 km E of Broken Hill on Barrier Hiway, 31.71668°S 142.6912°E, 231 m, 10 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666388, 3 nymphs (00099570–00099572) (AMNH). **South Australia:** 72 km N of Yunta, Nillinghoo Creek, 32.00924°S 139.4523°E, 194 m, 9 November 2001, Cassis, Schuh, Schwartz, *L. exocarpi* ssp. *exocarpi* (Behr) Tiegh. (Loranthaceae), det. NSW staff NSW666380, 1 nymph (00099361) (AMNH). 96 km NW of Morgan, Pine Valley Stn, 33.31667°S 140.2°E, 150 m, 2 November 1995, Schuh, Cassis and Gross, *A. melaleucae* (Miq.) Tieghem (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395975, 1 nymph (00088121) (AM).

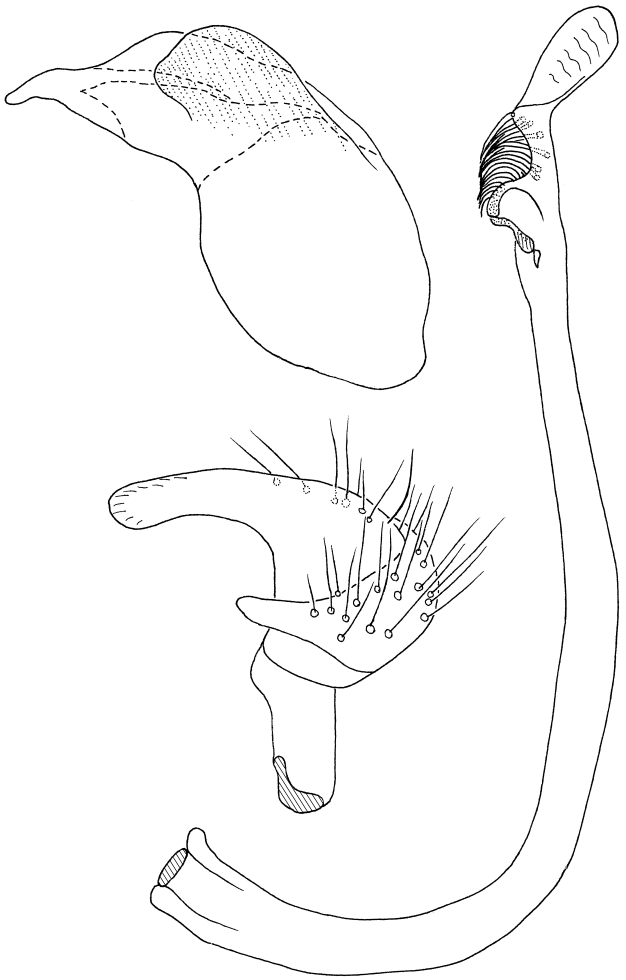

Fig. 10. *Hyseloecus metamyemi*, male genitalia (AMNH_PBI 00098707).

Hypseloecus metamyemi, sp. nov. (Figs 1,4,10, Table 1)

Diagnosis

Along with *H. paramyemi*, recognised by the large fringe of heavy, glassy spicules distad of the secondary gonopore. Distinguished by *H. paramyemi* by its more slender, untwisted endosoma, the endosoma of *H. paramyemi* being broad, stout, heavily sclerotised and twisted at the base.

Description

Male: Elongate ovoid, lateral corial margins weakly convex; total length 3.33–3.82, width pronotum 1.37–1.52. COLOURATION (Fig. 1): Body, labium and legs variable, from weakly orange to rather deep reddish brown; membrane moderately infuscate in darker specimens, veins orange to red; antennal segments 1 and 2 pale with some variably red areas, segments 3 and 4 dark; metapleuron without velvety black patch; tibiae pale with conspicuous contrasting spots at bases of pale spines and a contrasting dark stripe down external face. SURFACE AND VESTITURE: Dorsum with scattered golden lanceolate setae intermixed with moderately long, reclining, black, common setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, conforming to anterior margin of pronotum; eyes very weakly protuberant. Gena equal to half height of eye, nearly straight in frontal view; antenna inserted at ventral margin of eye and removed from eye by diameter of antennal segment 1. GENITALIA (Fig. 10): **Endosoma**: Elongate, moderately broad bodied, J-shaped, with a single asymmetrical apical paddle-shaped structure; secondary gonopore in the form of a tiny semicircular opening subtended distally by a large field of long, curving, glassy spicules. **Phallotheca**: Extreme apical portion angulate relative to body of phallotheca, short, narrow, finger-like; body with a broad quadrate extension overlapping subapical area.

Left paramere: Not splayed out, without process on dorsal anterior margin. **Right paramere**: Not examined.

Female: Broader and more strongly ovoid than male; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the host genus *Amyema* (Loranthaceae), in combination with the Greek prefix *meta-*, among, near.

Hosts: *Amyema miquelii* (Loranthaceae). The host is widely distributed in Australia, except possibly is the most severe desert areas (Fig. 19b).

Distribution: Interior New South Wales and Northern Territory.

Holotype: **AUSTRALIA: New South Wales:** 37 km W of Retreat (20 km E Manilla), 30.66668°S 150.8°E, 450 m, 24 October 1995, Schuh and Cassis, *A. miquelii* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395928, 1 ♂ (AMNH_PBI 00088072) (AM).

Paratypes: **AUSTRALIA: New South Wales:** 37 km W of Retreat (20 km E Manilla), 30.66668°S 150.8°E, 450 m, 24 October 1995, Schuh and Cassis, *A. miquelii* (Loranthaceae), det. B.M. Wiecek 1996 NSW 395928, 1 ♂ (00087411), 2 ♀ (00087412, 00373075), 3 ♂ (00088071, 00088073–00088074), 7 ♀ (00088075–00088081) (AM). **Northern Territory:** 21 km E of Stuart Hiway on Ernest Giles Rd, 24.56668°S 132.8539°E, 471 m, 29 October 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. miquelii* (Loranthaceae), det. NSW staff NSW658416, 8 ♂ (00098327–00098334), 18 ♀ (00098351–00098368) (AMNH). jct of Namitjara Rd and Gosse Bluff track, 23.78335°S 132.359°E, 711 m, 4 November 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. miquelii* (Loranthaceae), det. NSW staff NSW666331, 4 ♂ (00098705–00098708), 1 ♀ (00098709) (AMNH).

Other specimens examined: **AUSTRALIA: New South Wales:** 37 km W of Retreat (20 km E Manilla), 30.66668°S 150.8°E, 450 m, 24 October 1995, Schuh and Cassis, *A. miquelii* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395928, 4 nymphs (00088082–00088085) (AM). **Northern Territory:** 21 km E of Stuart Hiway on Ernest Giles Rd, 24.56668°S 132.8539°E, 471 m, 29 October 2001, Cassis, Schuh, Schwartz, Silveira, Wall, *A. miquelii* (Loranthaceae), det. NSW staff NSW658416, 14 nymphs (00098337–00098350) (AMNH). **South Australia:** Athelstone, 34.87116°S 138.70668°E, 8 January 1974, J. J. H. Szent-Ivany, 1 ♂ (00169261) (SAMA).

Hypseloecus neoamyemi, sp. nov. (Figs 1,4,11, Table 1)

Diagnosis

Along with *H. amyemicola* and *H. grossi*, recognised by blood red colouration, medial elevation on the dorsal margin of the left paramere, the elongate, slender, medial spine on the endosoma, and the velvety black patch on the dorsal margin of the meso- and metapleuron. Distinguished from *H. grossi* by the presence of an apically oriented claw-like process basad of the medial endosomal spine in that species and from *H. amyemicola* and *H. grossi* by the absence of a crenulate process on the dorsal margin of the phallotheca in those species.

Fig. 11. *Hyseloecus neoamyemi*, male genitalia (AMNH_PBI 00088143).

Description

Male: Elongate, parallel sided, lateral corial margins nearly straight; total length 3.03–3.41, width pronotum 1.27–1.48. COLOURATION (Fig. 1): Body, labium and legs dark, blood red; membrane heavily and entirely infuscate, veins dirty red; antennal segments 1 and 2 pale, with some variable red areas, segments 3 and 4 dark; meso- and metapleuron with velvety black patch; tibiae pale with conspicuous contrasting red spots at bases of dark spines and a contrasting red stripe down external face. SURFACE AND VESTITURE: Dorsum with scattered golden lanceolate setae intermixed with moderately long, reclining, black, common setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, conforming to anterior margin of pronotum; eyes not protuberant; gena about two-thirds height of eye, nearly straight in frontal view; antenna inserted at ventral margin of eye and weakly removed from eye. GENITALIA (Fig. 11): **Endosoma**: Elongate, slender bodied, J-shaped, with a sclerotised backbone distad of secondary gonopore; secondary gonopore in the form of a distinct semicircular opening subtended distally by a small field of erect, straight, moderately long, glassy spicules; medial spine present as a relatively slender, irregular spine of

moderate length. **Phallotheca**: Elongate, relatively slender, extreme apical portion nearly at right angle relative to body of phallotheca, finger-like; sinuous, body with a broad quadrate extension with a crenulate apical margin arising from posterior surface. **Left paramere**: Strongly splayed out; process on dorsal margin present, oriented in plane of anterior and posterior processes. **Right paramere**: Elongate, strongly tapering from base to apex.

Female: Similar to male, but eyes not so strongly protuberant and lateral corial margins more strongly rounded; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male.

Etymology: Named for the host genus *Amyema* (Loranthaceae), in combination with the Greek prefix *neo-*, new.

Hosts: *Amyema cambagei* and *Amyema linophyllum orientale* (Loranthaceae). *Amyema cambagei* occurs in New South Wales and southern Queensland in areas adjacent to the Great Dividing Range (Fig. 19c), whereas *A. linophyllum* is restricted almost exclusively to the interior of New South Wales (Fig. 19a).

Distribution: Interior New South Wales and north-eastern South Australia with a single record from near Eneabba, Western Australia.

Holotype: **AUSTRALIA: New South Wales:** 22 km W of Retreat (35 km E Manilla), 30.66668°S 150.8833°E, 600 m, 23 October 1995, Schuh and Cassis, *A. cambagei* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395919, 1 ♂ (AMNH_PBI 00139354) (AM).

Paratypes: **AUSTRALIA: New South Wales:** 22 km W of Retreat (35 km E Manilla), 30.66668°S 150.8833°E, 600 m, 23 October 1995, Schuh and Cassis, *A. cambagei* (Blakely) Danser (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395919, 18 ♂ (00139358–00139365, 00139406–00139415), 23 ♀ (00139367–00139378, 00139380–00139390) (AMNH), 1 ♂ (00139356) (ANIC), 1 ♂ (00139355) (UNSW), 1 ♂ (00139357) (USNM). 27 km W of Retreat (30 km E Manilla), 30.66668°S 150.8333°E, 350 m, 24 October 1995, Schuh and Cassis, *A. cambagei* (Blakely) Danser (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395919, 1 ♂ (00373033), 2 ♀ (00373034, 00373035) (AM). Warrumbungle National Park, Wambelong Campground, 31.21666°S 149.08333°E, 550 m, 25 October 1995, Schuh and Cassis, *A. cambagei* (Blakely) Danser (Loranthaceae), det. B.M. Wiecek 1996 NSW 395934, 1 ♀ (00373074) 1 ♂ (00088129), 13 ♀ (00088130–00088142) (AM), 19 ♂ (00139738–00139750, 00139796–00139801), 35 ♀ (00139328–00139339, 00139757–00139768, 00139770–00139773, 00139783–00139789) (AMNH), 2 ♀ (00139776, 00139777) (ANIC), 2 ♀ (00139778, 00139779) (UNSW), 2 ♀ (00139774, 00139775) (USNM). **South Australia:** 17 km E of Nepebunna, Gammon Ranges National Park, 30.57312°S 139.1273°E, 480 m, 7 November 1998, Schuh, Cassis, Silveira, *A. linophyllum orientale* (Fenzl) Tieghem (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427344, 3 ♂ (00373064–00373066), 7 ♀ (00373067–00373073) (AM), 2 ♂ (00139751, 00139752), 1 ♀ (00139753) (AMNH). **Western Australia:** 31 km NW of Eneabba, 29.62°S 115.04°E, 11 September 1990, G. Cassis, 1 ♂ (00088143), 5 ♀ (00088144–00088148) (AM).

Hypseloecus paramyemi, sp. nov. (Figs 1,4,12, Table 1)

Diagnosis

Along with *H. metamyemi*, recognised by the large fringe of heavy, glassy spicules distad of the secondary gonopore. Distinguished from *H. metamyemi* by its endosoma being very broad, stout, heavily sclerotised and twisted at the base, the endsoma in *H. metamyemi* being more slender and untwisted.

Description

Male: Elongate ovoid, lateral corial margins conspicuously convex; total length 2.91–3.32, width pronotum 1.34–1.51. COLOURATION (Fig. 1): Body, labium and legs dark, blood red; membrane weakly to moderately infuscate, veins mostly red; antennal segments 1 and 2 pale, with some variable red areas, segments 3 and 4 dark; metapleuron without velvety black patch; tibiae pale with conspicuous contrasting red spots at bases of pale spines and a contrasting red stripe down external face. SURFACE AND VESTITURE: Dorsum densely covered with silver lanceolate setae intermixed with

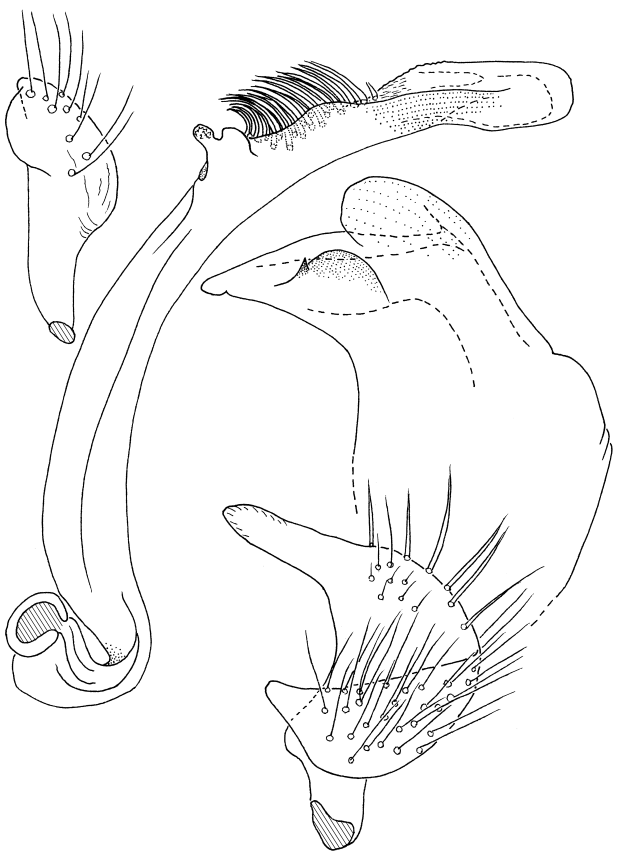

Fig. 12. *Hyseloecus paramyemi*, male genitalia (AMNH_PBI 00128203).

moderately long, reclining, dark, common setae; thoracic pleuron and abdominal venter densely covered with patches of silver lanceolate setae. STRUCTURE: **Head**: Posterior margin of head and eyes smoothly concave, conforming to anterior margin of pronotum; eyes not protuberant. Gena slightly less than height of eye, nearly straight in frontal view; antenna inserted at ventral margin of eye and removed from eye by nearly two times diameter of antennal segment 1. GENITALIA (Fig. 12): **Endosoma**: Very broad bodied, with a sharp curve at extreme base, and apex in the form of a single, asymmetrical, paddle-shaped structure; secondary gonopore not visible in lateral view, subtended distally by a large field of long, curving, glassy spicules. **Phallotheca**: Distal half at nearly right angle to proximal half, narrowing conically towards apex; body with a broad, rounded extension overlapping base of apical area and with a short rounded ridge on the posterior surface. **Left paramere**: Not splayed out; process on dorsal anterior margin absent. **Right paramere**: Short, broad basally, tapering towards apex.

Female: Similar to male; total length 2.88–3.01, length apex clypeus-cuneal fracture 1.99–2.07, width pronotum 0.90–0.96. COLOURATION (Fig. 1): As in male

Etymology: Named for the host genus *Amyema* (Loranthaceae), in combination with the Greek prefix *para-*, near.

Hosts: *Amyema quandang* var. *quandang* (Loranthaceae). *Amyema quandang* is widely distributed west of the Great Dividing Range but is absent from Western Australia except for a small area in the south-east portion of the state near Rawlinna (Fig. 19a).

Distribution: Interior New South Wales, adjacent South Australia, Northern Territory and southern Queensland.

Holotype: **AUSTRALIA: Queensland:** 24.7 km W of Mitchell, 26.4881°S 147.7384°E, 490 m, 31 October 1998, Schuh, Cassis, Silveira, *A. quandang* var. *quandang* (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427346, 1 ♂ (AMNH_PBI 00139823) (QM).

Paratypes: **AUSTRALIA: New South Wales:** 38 km WNW of Carinda towards Brewarrina, 30.25001°S 147.1667°E, 150 m, 26 October 1995, Schuh and Cassis, *A. quandang* (Loranthaceae), det. Det: B.M. Wiecek 1996 NSW 395942, 1 ♂ (00088151) (AM). 44.2 km E of Nyngan on Mitchell Hiway, 31.78335°S 147.612°E, 205 m, 11 November 2001, Cassis, Schuh, Schwartz, *A. quandang* var. *quandang* (Loranthaceae), det. NSW staff NSW666396, 1 ♂ (00128192), 7 ♀ (00128194–00128200) (AMNH), 1 ♂ (00128193), 1 ♀ (00128201) (ANIC). 73 km E of Nyngan on Mitchell Hiway, 31.93335°S 147.8553°E, 216 m, 11 November 2001, Cassis, Schuh, Schwartz, *A. quandang* var. *quandang* (Loranthaceae), det. NSW staff NSW666401, 3 ♂ (00128202–00128204), 6 ♀ (00128208–00128213) (AMNH). 77.2 km E of Broken Hill on Barrier Hiway, 31.76668°S 142.2592°E, 150 m, 10 November 2001, Cassis, Schuh, Schwartz, *A. quandang* var. *quandang* (Loranthaceae), det. NSW staff NSW666386, 7 ♂ (00099326–00099327, 00099329–00099333), 4 ♀ (00099347, 00099350–00099352) (AMNH). **Queensland:** 24.7 km W of Mitchell, 26.4881°S 147.7384°E, 490 m, 31 October 1998, Schuh, Cassis, Silveira, *A. quandang* var. *quandang* (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427346, 1 ♂ (00373054), 1 ♀ (00373055) (AM), 5 ♂ (00139824–00139828), 8 ♀ (00139341–00139348) (AMNH), 1 ♂ (00139822), 1 ♀ (00139349) (QM). 91 km N of Quilpie, 25.99847°S 144.4098°E, 300 m, 2 November 1998, Schuh, Cassis, Silveira, *A. quandang* var. *quandang* (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427341, 2 ♂ (00087407, 00088149), 2 ♀ (00087408, 00088150) (AM). **South Australia:** 18.8 km NW of Cordillo Downs Homestead, 26.64315°S 140.4723°E, 140 m, 5 November 1998, Schuh, Cassis, Silveira, *A. quandang* var. *quandang* (Loranthaceae), det. Det: Royal Bot Gard. NSW NSW427343, 1 ♂ (00139803), 3 ♀ (00139804–00139806) (AMNH). 67 km N of Port Augusta, 31.8989°S 137.763°E, G. Cassis, Loranthaceae, 9 ♂ (00088152–00088160), 14 ♀ (00088169–00088182) (AM).

Other specimens examined: **AUSTRALIA: New South Wales:** 73 km E of Nyngan on Mitchell Hiway, 31.93335°S 147.8553°E, 216 m, 11 November 2001, Cassis, Schuh, Schwartz, *A. quandang* var. *quandang* (Loranthaceae), det. NSW staff NSW666401, 3 nymphs (00128205–00128207) (AMNH). 77.2 km E of Broken Hill on Barrier Hiway, 31.76668°S 142.2592°E, 150 m, 10 November 2001, Cassis, Schuh, Schwartz, *A. quandang* var. *quandang* (Loranthaceae), det. NSW staff NSW666386, 12 nymphs (00099334–00099345) (AMNH). **Northern Territory:** Todd River, 9 km N by E of Alice Springs, 23.63333°S 133.88333°E, 10 October 1978, M. S. Upton, 1 ♂ (00168814) (ANIC). **South Australia:** 67 km N of Port Augusta, 31.8989°S 137.763°E, G. Cassis, Loranthaceae, 8 nymphs (00088161–00088168) (AM).

SOUTH AFRICAN SPECIES

Key to South African *Hypseloecus* species

1. Colouration of dorsum pale green (Fig. 1) .....*H. weirauchi*
– Colouration of dorsum rust brown to carmine 2
2. Colouration of dorsum rust brown; large species, total length 3.80.....*H. rustenbergensis*
– Body and appendages carmine to brown; not so large, total length less than 3.32 3
3. Colouration carmine; dorsal margin of phallotheca with an elongate, acuminate projection; Highveld .....*H. munroi*
– Colouration mostly dark brown (Fig. 1); dorsal margin of phallotheca simple, without an elongate, acuminate projection (Fig. 14); Little Karoo, Namaqualand .....*H. cassisi*

Hyseloecus cassisi, sp. nov. (Figs 1,13,14, Table 1)

Diagnosis

Most similar to *H. munroi* in size, but colouration mostly brown as opposed to carmine in *H. munroi*; dorsal margin of phallotheca simple, as opposed to *H. munroi* with its elongate projection.

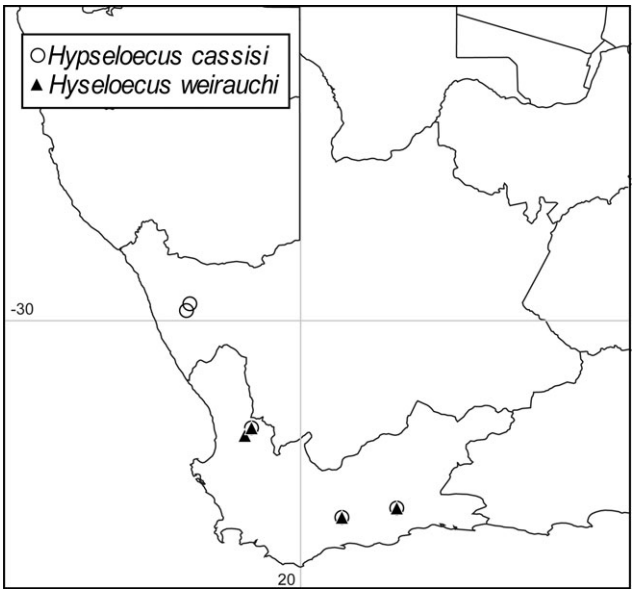

Fig. 13. Distribution of new South African *Hypseloecus* spp.

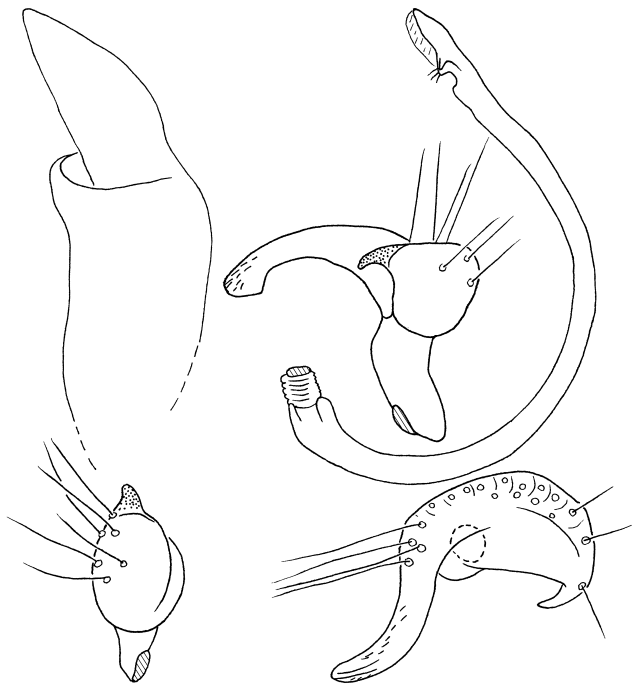

Fig. 14. *Hyseloecus cassisi*, male genitalia (AMNH_PBI 00198138).

Description

Male: Elongate, parallel sided, lateral corial margins nearly straight; moderately large, total length 2.71–2.99, width pronotum 1.07–1.28. COLOURATION (Fig. 1): Body, antennal segments 1, 3 and 4, labium, and femora mostly brown, clavus and endocorium faded; exocorium with a narrow cream marking, cuneus and endocorium appearing faded in comparison with remainder of dorsum; cuneus more distinctly red than remainder of hemelytron; membrane heavily and entirely infuscate, veins adjacent to cuneus nearly white; antennal segment 2 dark basally and apically, intervening area somewhat lighter; head below eyes, prosternum, and coxae white; femora brown, pale at apex and at bases of trichobothria; meso- and metapleuron dorsally with velvety black patch; tibiae pale with conspicuous contrasting brown spots at bases of dark spines. SURFACE AND VESTITURE: Dorsum with scattered silvery lanceolate setae intermixed with moderately long, reclining, black, common setae; metathoracic pleuron and abdominal venter with uniformly distributed clumps of silvery, lanceolate setae. STRUCTURE: **Head**: Posterior margin of head and eyes closely conforming to anterior margin of pronotum; posterior margin of vertex narrowly carinate, erect; eyes weakly protuberant. Gena about two-thirds height of eye, nearly straight in frontal view; antenna inserted close to eye at ventral margin. GENITALIA (Fig. 14): **Endosoma**: Elongate, slender, uniformly tubular, J-shaped, with a very weakly sclerotised backbone distad of secondary gonopore; secondary gonopore in the form of a distinct semicircular opening subtended distally by a field of a few erect, glassy spicules; medial spine absent. **Phallotheca**: Elongate, relatively slender, apical half tapered, conical, not angled relative to body of phallotheca. **Left paramere**: Weakly splayed out; no process on dorsal anterior margin; anterior process claw-like; posterior process greatly elongate, decurved in lateral view, sinuously curving in dorsal view. **Right paramere**: Moderately broad, lateral margins rounded, apex in the form of a short, broad point.

Female: Similar to male except hemelytra broader at level of cuneal fracture; total length 2.61–2.99, width pronotum 1.16–1.30. COLOURATION (Fig. 1): As in male.

Etymology: Named for Gerasimos Cassis, University of New South Wales, Sydney, who participated in the collection of the known specimens.

Hosts: *Viscum continuum*, *Viscum capense* (Viscaceae) and *Tapinanthus oleifolius* (Loranthaceae).

Distribution: Known from the arid Little Karoo Region adjacent to the south coast of South Africa with additional records from the Springbok area in northern Namaqualand in the far north-west of South Africa.

Discussion: At 12.5 km W of Barrydale and Gamka Mountain Nature Reserve this species was collected in association with *H. weirauchi*.

Holotype: **SOUTH AFRICA: Western Cape:** 12.5 km W of Barrydale on R62, 33.85142°S 20.82127°E, 452 m, 2 November 2003, Schuh, Cassis, Weirauch, *V. continuum* (Viscaceae), det. C Cupido VOUCHER-NYBG, 1 ♂ (AMNH_PBI 00198129) (PPRI).

Paratypes: **SOUTH AFRICA: Northern Cape:** 4.7 km W of Springbok on R355, 29.68108°S 17.84683°E, 866 m, 5 September 2004, Schuh, Schwartz, Henry, Wyniger, Forero, *T. oleifolius* (J.C.Wendl.) Danser (Loranthaceae), det. C Cupido VOUCHER-NYBG, 1 ♂ (00198198) (AMNH), 2 ♀ (00198199, 00198200) (SAMC). **Western Cape:** 12.5 km W of Barrydale on R62, 33.85142°S 20.82127°E, 452 m, 2 November 2003, Schuh, Cassis, Weirauch, *V. continuum*

E.Mey. ex Sprague (Viscaceae), det. C Cupido VOUCHER-NYBG, 19 ♂ (00388328–00388346), 17 ♀ (00388347–00388363) (AM), 25 ♂ (00198113–00198128, 00198130–00198138), 46 ♀ (00198140–00198185) (AMNH), 2 ♂ (00198109, 00198110), 6 ♀ (00198139, 00198190–00198194) (PPRI), 6 ♂ (00387273–00387278), 6 ♀ (00387279–00387284) (UNSW), 2 ♂ (00198111, 00198112), 4 ♀ (00198186–00198189) (USNM). Gamka Mountain Nature Reserve, SE of Calitzdorp, 33.67148°S 21.889°E, 346 m, 3 November 2003, Schuh, Cassis, Weirauch, *V. continuum* E.Mey. ex Sprague (Viscaceae), det. Field ID, 2 ♂ (00198215, 00198221), 2 ♀ (00058642, 00198207) (AMNH), 5 ♂ (00198210–00198214) (PPRI), 3 ♀ (00198206, 00198208–00198209) (SAMC). *c.* 25 km E of Clanwilliam, on plains below Pakhuispas, 32.10577°S 19.0575°E, 534 m, 29 October 2003, Schuh, Cassis, Weirauch, *V. capense* L.f. (Viscaceae), det. NBG staff VOUCHER-NYBG, 3 ♂ (00198203–00198205) (AMNH).

Other specimens examined: **SOUTH AFRICA: Northern Cape:** 4.7 km W of Springbok on R355, 29.68108°S 17.84683°E, 866 m, 5 September 2004, Schuh, Schwartz, Henry, Wyniger, Forero, *T. oleifolius* (J.C.Wendl.) Danser (Loranthaceae), det. C Cupido VOUCHER-NYBG, 2 nymphs (00198201, 00198202) (AMNH). 8.1 km SW of N7 towards Messelpad, 29.80868°S 17.7802°E, 745 m, 8 September 2004, Schuh, Schwartz, Henry, Wyniger, Forero (Loranthaceae), 3 nymphs (00198195–00198197) (AMNH). **Western Cape:** 12.5 km W of Barrydale on R62, 33.85142°S 20.82127°E, 452 m, 2 November 2003, Schuh, Cassis, Weirauch, *V. continuum* E.Mey. ex Sprague (Viscaceae), det. C Cupido VOUCHER-NYBG, 1 nymph (00388364) (AM), 4 nymphs (00198105–00198108) (AMNH).

Hyseloecus weirauchi, sp. nov. (Figs 1,13,15, Table 1)

Diagnosis

Recognised by the very broad head, nearly parallel-sided hemelytra, and the unique pale green colouration of the body and appendages.

Description

Male: Elongate, parallel sided, lateral corial margins nearly straight; moderately large, total length 3.09–3.32, width pronotum 1.22–1.34. COLOURATION (Fig. 1): Body and appendages pale, green to yellow green; eyes bright red; membrane weakly and entirely infuscate, veins somewhat lighter; middle and hind femora with weakly contrasting pale spots at bases of trichobothria; tibial spines dark, without contrasting dark bases. SURFACE AND VESTITURE: Dorsum with scattered silvery lanceolate setae intermixed with moderately long, reclining, black, common setae; metathoracic pleuron and abdominal venter with scattered, silvery, lanceolate setae. STRUCTURE: **Head**: Posterior margin of head nearly straight between eyes, narrowly carinate, erect; vertex and eyes closely conforming to anterior margin of pronotum; eyes weakly protuberant. Gena about two-thirds height of eye, nearly straight in frontal view; antenna inserted just below eye and removed from eye by diameter of antennal segment 2. GENITALIA (Fig. 15): **Endosoma**: Elongate, J-shaped, tubular but of varying diameter over length, with a weakly sclerotised backbone distad of secondary gonopore, apex with a quadrangular membranous flap; secondary gonopore in the form of a distinct semicircular opening subtended distally by a small field of erect, straight, glassy spicules; medial spine absent. **Phallotheca**: Apical region relatively short, erect, with an erect protruding finger on ventral margin, dorsal margin heavily sclerotised. **Left paramere**: Splayed out; no process on dorsal anterior margin; posterior process strongly decurved

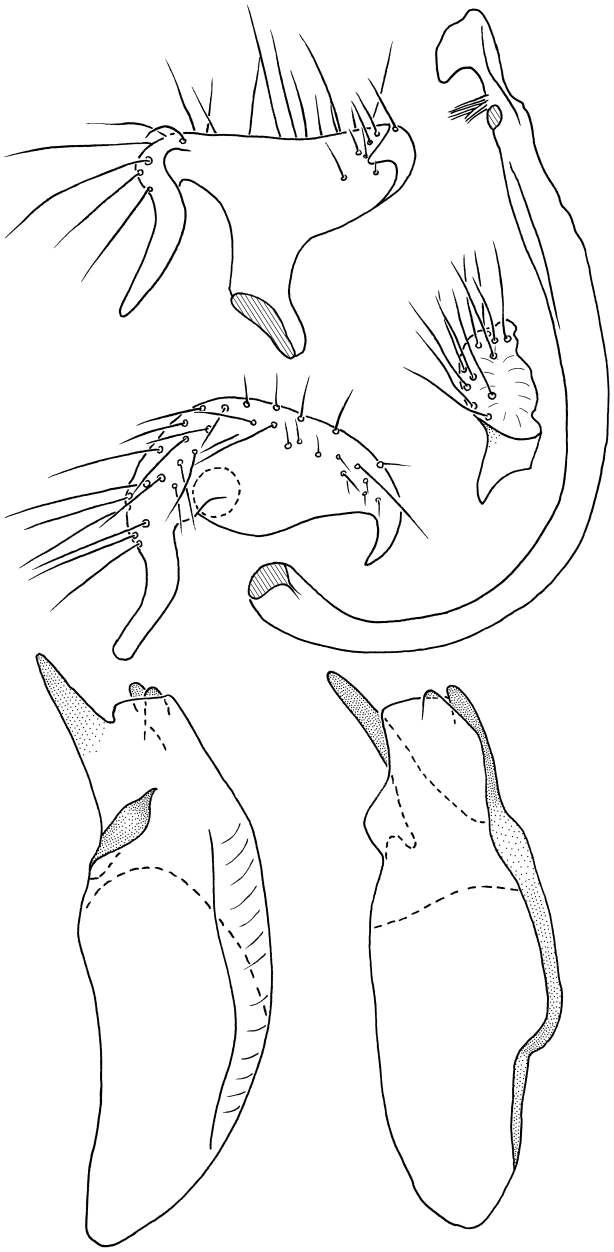

Fig. 15. *Hyseloecus weirauchi*, male genitalia (AMNH_PBI 00197717).

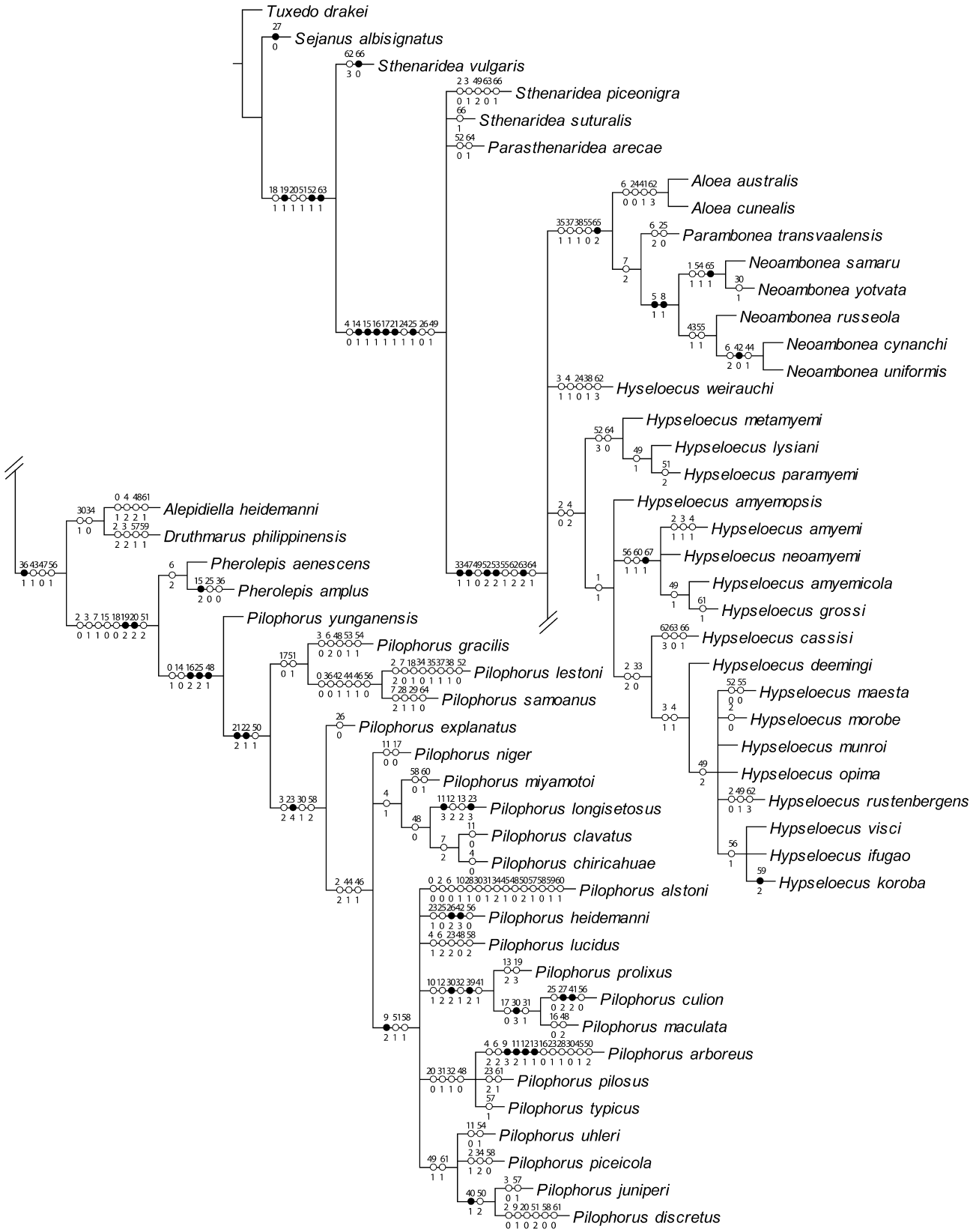

Fig. 16. Phylogenetic relationships of *Hypseloecus* spp. based on morphological data. Strict consensus of 192 trees.

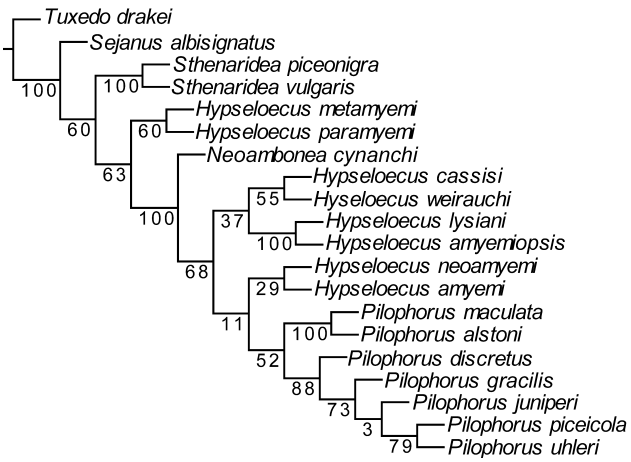

Fig. 17. Phylogenetic relationships of restricted set of *Hypseloecus* spp. based on DNA sequence data. Genes sampled and GenBank accessions listed in Table 2. Symmetric resampling values computed using TNT listed at nodes.

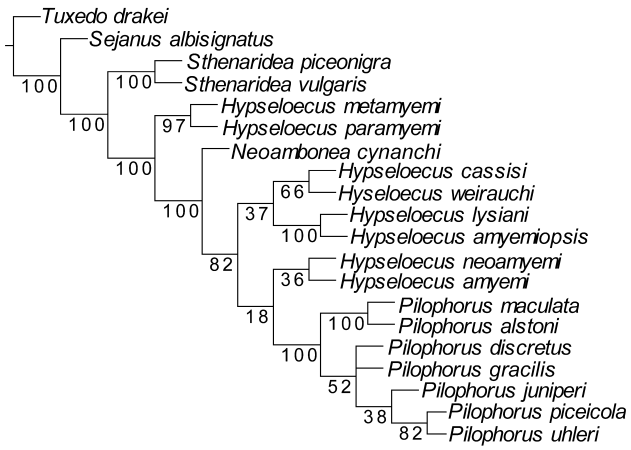

Fig. 18. Phylogenetic relationships of restricted set of *Hypseloecus* spp. based on combined analysis of morphological data and DNA sequence data.

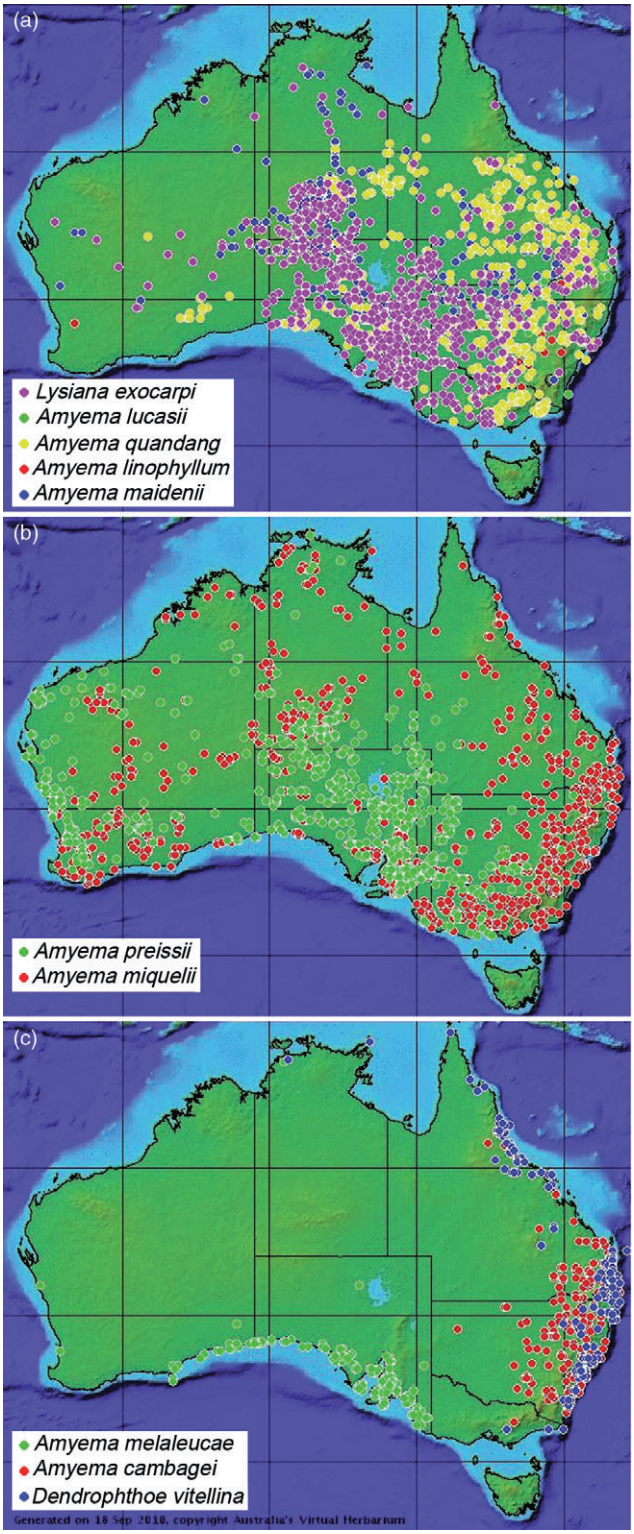

Fig. 19. Distribution of hosts of Australian *Hypseloecus* spp.

ventrally. **Right paramere**: Small, rounded on posterior margin, anterior margin and apex ill defined.

Female: Similar to male; total length 2.73–3.22, width pronotum 1.21–1.32. COLOURATION (Fig. 1): As in male.

Etymology: Named for Christiane Weirauch, Department of Entomology, University of California, Riverside, who participated in the collection of the known specimens.

Hosts: *Viscum continuum* and *V. capense* (Viscaceae).

Distribution: Little Karoo Region and southernmost regions of Namaqualand, South Africa.

Discussion: At 12.5 km W of Barrydale and Gamka Mountain Nature Reserve this species was collected in association with *H. cassisi*.

Holotype: **SOUTH AFRICA: Western Cape:** Gamka Mountain Nature Reserve, SE of Calitzdorp, 33.67148°S 21.889°E, 346 m, 3 November 2003, Schuh, Cassis, Weirauch, *V. continuum* (Viscaceae), det. Field ID, 1 ♂ (AMNH_PBI 00197677) (PPRI).

Paratypes: **SOUTH AFRICA: Western Cape:** 12.5 km W of Barrydale on R62, 33.85142°S 20.82127°E, 452 m, 2 November 2003, Schuh, Cassis, Weirauch, *V. continuum*

(Viscaceae), det. C Cupido VOUCHER-NYBG, 1 ♂ (00388326) (AM), 2 ♂ (00198092, 00198096), 4 ♀ (00198101–00198104) (AMNH), 2 ♀ (00198099, 00198100) (PPRI), 5 ♂ (00198093–00198095, 00198097–00198098) (SAMC). Gamka Mountain Nature Reserve, SE of Calitzdorp, 33.67148°S 21.889°E, 346 m, 3 November 2003, Schuh, Cassis, Weirauch, *V. continuum* E.Mey. ex Sprague (Viscaceae), det. Field ID, 3 ♂ (00197718–00197720) (AM), 32 ♂ (00197678–00197708, 00197717), 20 ♀ (00197653–00197654, 00197656–00197673) (AMNH), 5 ♂ (00197712–00197716) (PPRI), 5 ♀ (00197649–00197652, 00197655) (SAMC), 3 ♂ (00197709–00197711), 3 ♀ (00197674–00197676) (UNSW). *c.* 25 km E of Clanwilliam, on plains below Pakhuispas, 32.10577°S 19.0575°E, 534 m, 29 October 2003, Schuh, Cassis, Weirauch, *V. capense* (Viscaceae), det. NBG staff VOUCHER-NYBG, 2 ♂ (00198088, 00198089) (AM), 1 ♀ (00198087) (AMNH). ~11 km S of Clanwilliam, E side of reservoir, 32.25784°S 18.928°E, 167 m, 29 October 2003, Schuh, Cassis, Weirauch, *V. capense* (Viscaceae), det. C Cupido VOUCHER-NYBG, 10 ♀ (00198069–00198073, 00198075–00198079) (AM), 16 ♂ (00197779–00197782, 00198056–00198058, 00198060–00198068), 2 ♀ (00198059, 00198074) (AMNH).

Other specimens examined: **SOUTH AFRICA: Western Cape:** 12.5 km W of Barrydale on R62, 33.85142°S 20.82127°E, 452 m, 2 November 2003, Schuh, Cassis, Weirauch, *V. continuum* E.Mey. ex Sprague (Viscaceae), det. C Cupido VOUCHER-NYBG, 1 nymphs (00388327) (AM), 2 nymphs (00198090, 00198091) (AMNH). Gamka Mountain Nature Reserve, SE of Calitzdorp, 33.67148°S 21.889°E, 346 m, 3 November 2003, Schuh, Cassis, Weirauch, *V. continuum* (Viscaceae), det. Field ID, 20 nymphs (00197721–00197740) (AMNH). *c.* 25 km E of Clanwilliam, on plains below Pakhuispas, 32.10577°S 19.0575°E, 534 m, 29 October 2003, Schuh, Cassis, Weirauch, *V. capense* (Viscaceae), det. NBG staff VOUCHER-NYBG, 4 nymphs (00198080–00198083) (AM), 3 nymphs (00198084–00198086) (AMNH). ~11 km S of Clanwilliam, E side of reservoir, 32.25784°S 18.928°E, 167 m, 29 October 2003, Schuh, Cassis, Weirauch, *V. capense* (Viscaceae), det. C Cupido VOUCHER-NYBG, 38 nymphs (00197741–00197778) (AMNH).

PHYLOGENETIC ANALYSES

Morphological analysis

Analysis of morphological data (Appendix I) was performed with TNT (Goloboff *et al*. 2003a), using the sectorial search, ratchet, drift and tree fusing algorithms in combination with traditional search algorithms. This analysis yielded 192 most parsimonious trees of 308 steps with a consistency index of 37 and a retention index of 79. The strict consensus of those trees is shown in Figure 16.

The position of *H. weirauchi* in this analysis is ambiguous relative to the remaining species we place in the genus. All remaining species here placed in *Hypseloecus* form a monophyletic group supported by the homoplasious characters 2-0 (antennal segment 2 dark) and 4-2 (hind tibia spotted at bases of tibial spines). The Australian species do not form a monophyletic group, although all remaining species – except *H. weirauchi* – do. The ambiguous position of *H. weirauchi* is doubtless influenced by the fact that the antennae and tibiae are entirely pale.

Analyses including DNA sequence data

Fixed alignments for available molecular data (Table 2) were analysed with TNT (Goloboff *et al*. 2003b), using the sectorial search, ratchet, drift and tree fusing algorithms with 5000 random addition sequences. This analysis yielded one most parsimonious tree (Fig. 17) of 2883 steps. Support values for each node were calculated using symmetric resampling with a change probability of 33 (Goloboff *et al*. 2003b).

A combined analysis of morphological and molecular data for the same set of taxa seen in Figure 17 is shown in Figure 18; the tree length is 3046 steps. The results of these two analyses are substantially similar, indicating that the sequence data overwhelm the morphology, most notably the placement of *Neoambonea cynanchi* Schuh within a paraphyletic *Hypseloecus* (Fig. 16), and also firmly place *H. weirauchi* within *Hypseloecus*, whereas the morphological data do not.

Phylogenetic conclusions

Our molecular data include for the first time members of the genus *Sthenaridea* Reuter. Schuh (1991) treated all Pilophorini other than *Sthenaridea* as a monophyletic group, a result corroborated by our current findings, both molecular and morphological. The issue the paraphyly of *Sthenaridea* (Schuh 1991) will, however, only be resolved by assembling molecular data for a much larger sample of taxa within the genus.

Hypseloecus is treated as monophyletic (with the exception of *H. weirauchi*) in the morphological analysis, but as paraphyletic in all analyses involving molecular data. Because *Hypseloecus* demonstrates a certain homogeneity of appearance and, more particularly, host association, we have chosen to recognise the *Hypseloecus* as conceived by Linnavuori (1986) and Schuh (1989), even though the amount of morphological character evidence supporting that conclusion is limited and all of the characters show homoplasy. To reorganise the classification of *Hypseloecus* on the basis of limited molecular evidence for a strongly biased taxon sample would be a disservice, in our view.

The placement of *N. cynanchi* within a broadly conceived *Hypseloecus* in the molecular results may be the result of limited molecular sampling in this part of the pilophorine tree. Schuh (1974) documented feeding by *Neoambonea* Schuh species on vines in the genus *Cynanchum* (Asclepiadaceae); this host association was corroborated for *N. cynanchi* by Schuh, Cassis and Weirauch in 2003. Inclusion of species from the genera *Neoambonea, Parambonea* Schuh and *Aloea* Linnavuori from Africa and the Arabian Peninsula might help to clarify the nature of relationships of taxa we place in

Hypseloecus. Credibility of results will also likely be facilitated by sequencing a broader range of genes to address the relationships in a larger range of possible divergence times.

ASSOCIATIONS WITH PARASITIC PLANTS

All species we place in the genus *Hypseloecus* feed on stem-parasitic members of the Santalales. The current classification (Nickrent *et al*. 2010) indicates that the hosts of *Hypseloecus* belong to two separate clades within the Santalales, Loranthaceae and Viscaceae. Within Australia, all *Hypseloecus* spp. feed on members of the Loranthaceae, most are known from the genus *Amyema* (tribe Lorantheae, subtribe Amyeminae), with lesser numbers having been collection on *Dendrophthoe* (tribe Lorantheae, subtribe Dedrophthoinae) and *Lysiana* (tribe Elytrantheae) (see Fig. 2). There are, nonetheless, Australian species of Heteroptera (Pentatomidae and Miridae: Phylini) that feed on members of the Santalaceae, namely the root-parasitic genus *Exocarpos*. This association was recently documented by Weirauch (2007) for three species of the phyline genus *Exocarpocoris* Weirauch, a taxon whose relationships are with other members of a large clade of Phylinae endemic to Australia (see also Schuh & Weirauch 2010; Weirauch & Schuh 2011), and not to members of the Pilophorini, to which *Hypseloecus* belongs. The South African species of *Hypseloecus* described in this paper have most frequently been collected on the genus *Viscum* (Viscaceae), although *H. cassisi* has also been collected on the genus *Tapinanthus* (Loranthaceae, tribe Lorantheae, subtribe Tapinanthinae).

Several phytophagous insect groups – in addition to the Miridae – are known to feed on the hemiparasitic Santalales. Whittaker (1984) described the insect fauna of *Phoradendron* (Viscaceae) from south Texas, including Lepidoptera in five families, two species of Curculionidae, *Leptoglossus brevirostris* Barber (Coreidae), one species of Aphididae and three Coccoidea spp. Within the Miridae, the genus *Viscacoris* was recently described by Weirauch (2009) with four species, presumably all feeding on species of *Phoradendron* from Mexico and the south-western USA. Although Whittaker (1984) undertook a phenological study, he apparently failed to encounter species of *Viscacoris*, even though his study would appear to have taken place within its distributional range. Polhemus and Polhemus (1985) described the genus *Phoradendrepulus* (Miridae: Phylinae: Hallodapini) as occurring on *Phoradendron*, although the precise relationship of these rarely collected and strongly myrmecomorphic insects with the hemiparasite has not been studied. R.T. Schuh (pers. comm. 2004) collected *Tuxedo bicinctus* (Van Duzee) (Miridae: Phylinae) on *Phoradenron densum* parasitising *Juniperus* sp. near Palmdale, California. Braby (2005, 2006) and Braby and Nishida (2007) have documented the use of mistletoes by members of the butterfly family Pieridae in Africa and the neotropics, respectively. Also, members of the families Lycaenidae and Pieridae are known to feed on species of Loranthaceae in Australia. Kashima *et al*. (2006) recorded the feeding of *Parastrachia japonensis* (Hemiptera: Pentatomoidea: Parastrachiidae) on the drupes of *Schoepfia jamsinidora* (Santalales: Schoepfiaceae).

Australian *Hypseloecus* spp., although not entirely host specific, nonetheless show a substantial amount of host fidelity. Table 4 presents a listing of documented hosts, the number the localities at which they were encountered, the number of specimens collected, and the *Hypseloecus* spp. collected on them. Evidence from the 36 available documented host associations indicates that the majority Australian *Hypseloecus* spp. are known from a single host species. To the maximum degree possible the evidence is unbiased, because all plant identifications were performed by botanical specialists with no knowledge of the insects associated with them.

Our morphology-based phylogenetic results suggest that the Australian fauna forms a paraphyletic group, all of whose members feed on the genera *Amyema, Dendrophthoe* and *Lisiana*, all three plant genera belonging to the Loranthaceae. Although the hosts of many of the remaining species now placed in *Hypseloecus* are not known, those that are all pertain to the Viscaceae, with most records in Africa and all from the Palearctic being from the genus *Viscum*. We might predict that all non-Australian members of *Hypseloecus* will be found to feed on members of the Viscaeae. *Viscacoris* belongs to the Phylini, rather than the Pilophorini, indicating that the parasistic plant associations in the Old and New Worlds represent associations that have evolved independently.

BIOGEOGRAPHICAL CONSIDERATIONS

As documented by Schuh (1974, 1984, 1991) *Hypseloecus* showed an Indo-Pacific distribution, exclusive of Australia. Information adduced in the present paper adds substantial diversity in Australia to that distribution. As mentioned above, our phylogenetic analyses suggest that members of the Australian fauna form a paraphyletic group and that most – if not all – remaining species placed in the genus from a monophyletic group (Fig. 16). Although our analysis could benefit from additional character information, the available results suggest that the role of Australia in the biogeographical history of *Hypseloecus* is an ancient one, as opposed to that of a more recent invasion and radiation of a single lineage, with its closest relatives in New Guinea, for example.

Within Australia *Hypseloecus* is not uniformly distributed, at least to the degree that we have an accurate picture of actual distributions. Most of the known diversity is in eastern and central Australia (Figs 3,4). Only three species are known from Western Australia, and all of those are distributional extensions for taxa with more widespread distributions.

When we compare the distributions of the *Hypseloecus* spp. herein described from Australia with those of their hosts (Fig. 19) we see a substantial amount of correspondence. Of those loranthaceous species known to serve as hosts, most are restricted to the eastern half of the continent, and it is in that

Table 4 Hosts of Australia *Hypseloecus* spp.

Host genus and species	No. specimens	Locality	Miridae species
Amyema cambagei	45	NSW: 22 km W of Retreat (35 km E Manilla)	*H. neoamyemi*
Amyema cambagei	3	NSW: 27 km W of Retreat (30 km E Manilla)	*H. neoamyemi*
Amyema cambagei	75	NSW: Warrumbungle Nat Park, Wambelong Cmpgrd	*H. neoamyemi*
Amyema linophyllum orientale	13	SA: 17 km E of Nepebunna, Gammon Ranges Nat Park	*H. neoamyemi*
Amyema lucasii	14	NSW: 38 km WNW of Carinda towards Brewarrina	*H. amyemopsis*
Amyema lucasii	10	NSW: 38 km WNW of Carinda towards Brewarrina	*H. grossi*
Amyema lucasii	3	NSW: 63 km SW of Louth towards Wilcannia	*H. amyemopsis*
Amyema lucasii	5	NSW: 63 km SW of Louth towards Wilcannia	*H. grossi*
Amyema lucasii	1	QLD: 14.2 km E of Charleville	*H. amyemi*
Amyema maidenii maidenii	7	NT: 74.2 km NW of Bond Springs on Tanami Rd	*H. amyemi*
Amyema maidenii maidenii	2	NT: Finke Gorge National Park, near Palm Valley cmpgrd	*H. amyemi*
Amyema maidenii maidenii	1	NT: Jct of Arltunga Stn Rd and Ruby Gorge Rd	*H. amyemi*
Amyema maidenii maidenii	38	NT: Kings Canyon, Watarrka National Park	*H. amyemi*
Amyema maidenii maidenii	7	QLD: 8.2 km E of Mungallala	*H. amyemi*
Amyema melaleucae	24	SA: 96 km NW of Morgan, Pine Valley Stn	*H. lysiani*
Amyema miquelii	18	NSW: 37 km W of Retreat (20 km E Manilla)	*H. metamyemi*
Amyema miquelii	40	NT: 21 km E of Stuart Hiway on Ernest Giles Rd	*H. metamyemi*
Amyema miquelii	5	NT: jct of Namitjara Rd and Gosse Bluff track	*H metamyemi*
Amyema preissii	24	NT: 16.4 km W of Hermannsburg	*H. amyemicola*
Amyema preissii	12	NT: Kings Creek at Watarrka National Park	*H. amyemicola*
Amyema preissii	22	NT: West MacDonnell Nat. Pk, Rd to Ormiston Gorge	*H. amyemicola*
Amyema preissii	40	WA: Exmouth, Truscott Crescent (opposite Pony Club)	*H. amyemicola*
Amyema quandang	1	NSW: 38 km WNW of Carinda towards Brewarrina	*H. paramyemi*
Amyema quandang var. *quandang*	10	NSW: 44.2 km E of Nyngan on Mitchell Hiway	*H. paramyemi*
Amyema quandang var. *quandang*	12	NSW: 73 km E of Nyngan on Mitchell Hiway	*H. paramyemi*
Amyema quandang var. *quandang*	23	NSW: 77.2 km E of Broken Hill on Barrier Hiway	*H. paramyemi*
Amyema quandang var. *quandang*	18	QLD: 24.7 km W of Mitchell	*H. paramyemi*
Amyema quandang var. *quandang*	4	QLD: 91 km N of Quilpie	*H. paramyemi*
Amyema quandang var. *quandang*	4	SA: 18.8 km NW of Cordillo Downs Homestead	*H. paramyemi*
Dendrophthoe vitellina	6	NSW: 22 km W of Retreat (35 km E Manilla)	*H. amyemopsis*
Dendrophthoe vitellina	11	NSW: 37 km W of Retreat (20 km E Manilla)	*H. amyemopsis*
Lysiana exocarpi	38	NSW: 119.9 km E of Broken Hill on Barrier Hiway	*H. lysiani*
Lysiana exocarpi ssp. *exocarpi*	47	NSW: 23 km W of Wilcannia on Barrier Hiway	*H. lysiani*
Lysiana exocarpi ssp. *exocarpi*	11	SA: 12 km E of Copely, Flinders Range	*H. lysiani*
Lysiana exocarpi ssp. *exocarpi*	7	SA: 14.3 km S of Erudina Woolshed	*H. lysiani*
Lysiana exocarpi ssp. *exocarpi*	24	SA: 72 km N of Yunta, Nillinghoo Creek	*H. lysiani*

part of Australia that areas of endemism within *Hypseloecus* might be recognised. We might also expect some of the species of *Hypseloecus* to be more widespread than current knowledge suggests. Of the three species of *Hypseloecus* known from far western Australia, only *A. amyemicola* has a documented host, the widespread *Amyema preissii* (Fig. 19b).

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APPENDIX 1

Characters 0–67

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                                0    5    10   15   20   25   30   35   40   45   50   55   60   65
                                |    |    |    |    |    |    |    |    |    |    |    |    |    |
Tuxedo drakei                   00111010000100000000000001100000010000001100000001000000-----200020
Sejanus albisignatus            00001010000100000000000001000000010000001000000000003000-----100020
Sthenaridea vulgaris            00001010000100000011100000110000001000000010000000111000-----310000
Sthenaridea piceoniger          00010010000100111111110011010000001000000010000020111000-----100010
Sthenaridea suturalis           00100010000100111111110011010000001000000010000010111000-----110010
Parasthenaridea arecae          00100010000100111111110011010000001000000010000010101000-----111020
Aloea australis                 00100000000100111111110001010000011101100110000101012200 0-----321220
Aloea cunealis                  00100000000100111111110001010000011101100110000101012200 0-----321220
Parambonea transvaalensis       00??00220001001111111100100100000111011000100001000 10?000-----??1220
Neoambonea cynanchi             00101122100100111111110011010000011101100001100101014301 0-----221220
Neoambonea uniformis            00101122100100111111110011010000011101100001100101014301 0-----221220
Neoambonea russeola             00101112100100111111110011010000011101100011000101014301 0-----221220
Neoambonea samaru               01100112100100111111110011010000011101100010000101013310 0-----221120
Neoambonea yotvata              01101112100100111111110011010010011101100010000101013310 0-----221120
Hypseloecus visci               01211010000100111111110011010000001000000010000102012201101000221020
Hypseloecus deemingi            01211010000100111111110011010000001000000010000100012201 0----0221020
Hypseloecus ifugao              01211010000100111111110011010000001000000010000102012201101000221020
Hypseloecus koroba              01211010000100111111110011010000001000000010000102012201 1-12-0221020
Hypseloecus maesta              01211010000100111111110011010000001000000010000102010200 0----0221020
Hypseloecus morobe              01011010000100111111110011010000001000000010000102012201 0----0221020
Hypseloecus munroi              01211010000100111111110011010000001000000010000102012201 0----0221020
Hypseloecus opima               01211010000100111111110011010000001000000010000102012201 0----0321020
Hypseloecus rustenbergens       01011010000100111111110011010000001000000010000101012201 0----0321020
Hypseloecus cassisi             01202010000100111111110011010000001000000010000100012201 0----0301010
Hyseloecus weirauchi            00111010000100111111110001010000011000100010000100012201 0----0321020
Hypseloecus amyemi              01111010000100111111110011010000011000000010000100012201101010221021
Hypseloecus amyemicola          01--20100001001111111100110100000110000000100001010122011010102210 21
Hypseloecus amyemopsis          01002010000100111111110011010000011000000010000100 01-2010----0221020
Hypseloecus grossi              01--20100001001111111100110100000110000000100001010122011010112210 21
Hypseloecus lysiani             00002010000100111111110011010000011000000010000101 01-2010----0220020
Hypseloecus metamyemi           00002010000100111111110011010000011000000010000100 0132010----0220020
Hypseloecus neoamyemi           01002010000100111111110011010000011000000010000100 0122011010102210 21
Hypseloecus paramyemi           00002010000100111111110011010000011000000010000101 023-010----0220020
Alepidiella heidemanni          10102010000100111111110011110010010010000021000020012201101001221020
Druthmarus philippinensis       00220010000100111111110011110010010010000011000000012201111100221020
Pherolepis aenescens            00010021000100101102210021010000011010000021000000022201102000221020
Pherolepis amplus               00010021000100121102210020010000011000000021000000022201100000221020
Pilophorus lestoni              002?00100001000?01??210??1100000101011000111010101102010----0221020
Pilophorus samoanus             00011012000100 00??0??210??1111000110000000111010101122010----0220020
Pilophorus arboreus             10212020030211000203021122111101111010000021111000212201101000221020
Pilophorus pilosus              10220010020100002203021202110011111010000021101000112201101001221020
Pilophorus typicus              10210010020100002202021402110111111010000021101000112201111000221020
Pilophorus alstoni              00020000021100002202221402111001012010000021111000212201110110221020
Pilophorus culion               102?00100211200020022214001200311110100202211010101122010010002210 20
Pilophorus maculata             102?00100211200000022214021100311110100201211010201122011010002210 20
Pilophorus prolixus             10210010021122002203221422110020111010020121101010 1??????????0?????0
Pilophorus heidemanni           10220010020100002202221120210010011010000031101010112201001000221020
Pilophorus uhleri               00220011020000002202221422110010011010000021101011112211101001--1020
Pilophorus lucidus              10221020020100002202221202110010011010000021101000112201102000221020
Pilophorus yunganensis          10010011010100002202210012110000011010000021000010022201101?00221020
Pilophorus clavatus             10221012010000002202221422110010011010000021101000122201102000221020
Pilophorus miyamotoi            10221011010100002202221422110010011010000021101010122201100010221020
Pilophorus niger                10220010010000002002221422110010011010000021101010122201102000221020
Pilophorus chiricahuae          10220012010100002202221422110010011010000021101000122201102000221020
Pilophorus explanatus           10020011010100002202221422010010011010000021000010122201102000221020
Pilophorus longisetosus         10221011010322002202221322110010011010000021101000122201102000221020
Pilophorus juniperi             00200010020100002202221422110010011010001021101011212201111001221020
Pilophorus discretus            00020010010100002202021422110010011010001021101011222201100000--1020
Pilophorus piceicola            10120011020100002202221422110010012010000021101011112201100001--1020
Pilophorus gracilis             10001021000100000002021022110000011010000021000000112111111010--1020
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Character descriptions

COLORATION

0. Membrane: unicolourous or mottled = 0; with a large dark patch at least partially covering cells = 1.
1. Metapleuron: without velvety black patch = 0; with velvety black patch = 1.
2. Antennal segment 3: dark = 0; light = 1; light proximally and dark distally = 2. [non-additive].
3. Segment 4: dark = 0; light = 1; light proximally and dark distally = 2. [non-additive].
4. Hind tibia: unicolourous dark = 0; unicolourous light = 1; spotted at bases of tibial spines = 2. [non-additive].

SURFACE

5. Pronotum: without punctures = 0; with punctures = 1.
6. Pronotum: dull = 0; moderately shining = 1; highly polished and shining = 2. [additive].
7. Pronotum: smooth and sometimes granulose or weakly roughened = 0; weakly to moderately rugulose = 1; strongly rugose = 2. [additive].
8. Hemelytron: impunctate = 0; punctate = 1.
9. Corium: with uniform texture = 0; weakly polished posterolaterally, dull, matte-like posteromesially = 1; weakly polished posteriorly, dull and matte-like anteriorly = 2; polished, shining anteriorly and posteriorly, remainder tomentose = 3. [non-additive].

VESTITURE

10. Gena: with a few erect setae, sometimes heavy and bristle-like = 0; numerous long erect setae = 1.
11. Hemelytron: with erect bristle-like setae = 0; with common setae of moderate length and reclining = 1; with common setae of moderate length and nearly erect = 2; with long to very long and nearly erect common setae = 3. [non-additive].
12. Vertex and frons: with reclining common setae of moderate length = 0; with moderately long and erect common setae = 1; with very long and erect common setae = 2. [non-additive].
13. Pronotum: with moderately long, reclining common setae = 0; with moderately long and erect common setae = 1; with very long and erect common setae = 2. [non-additive].
14. Scale-like setae: absent on head = 0; present on head = 1.
15. Scale-like setae: absent on pronotum = 0; widely distributed on pronotum = 1; present only on anterior margin of pronotum = 2. [non-additive].
16. Scale-like setae: absent laterally on scutellum = 0; scattered on scutellum = 1; weakly to strongly aggregated on scutellum = 2. [additive].
17. Scale-like setae: absent on apex of scutellum = 0; scattered on apex of scutellum = 1; weakly to strongly aggregated on apex of scutellum = 2. [additive].
18. Scale-like setae: absent on propleuron = 0; scattered individual or in small patches on propleuron = 1.
19. Scale-like setae: absent on mesopleuron = 0; scattered or in small patches on mesopleuron = 1; on posterior margin of mesepimeron directed posteroventrally = 2; aggregated and directed anteroventrally on mesopleuron = 3. [non-additive].
20. Scale-like setae: absent on metapleuron = 0; scattered or in small patches on metapleuron = 1; usually aggregated on posterior margin of metepisternum = 2. [additive].
21. Scale-like setae: absent on hemelytron = 0; scattered on hemelytron = 1; aggregated in patches or bands on hemelytron = 2. [additive].
22. Scale-like setae: absent as band anteriorly on corium = 0; present as band anteriorly only on corium = 1.
23. Scale-like setae: absent as a posterior band = 0; with a posterior band in the form of patches = 1; with a posterior band only on exocorium and clavus = 2; with posterior band offset at radial or cubital vein = 3; with complete posterior band = 4. [non-additive].
24. Scale-like setae: absent on cuneus = 0; scattered on cuneus = 1; aggregated anteriorly or anteromesially on cuneus = 2. [additive].
25. Scale-like setae: absent on abdomen = 0; scattered or in small patches on abdomen = 1; aggregated in a patch anterolaterally on venter of abdomen = 2. [additive].

STRUCTURE

26. Body: ovoid = 0; elongate = 1; short and stout = 2. [non-additive].
27. Head: convex behind = 0; concave behind = 1; concave behind but exserted = 2. [non-additive].
28. Gena: straight in frontal view = 0; distinctly convexly rounded in frontal view = 1.
29. Gena: flat or broadly rounded or weakly to moderately carinate = 0; conspicuously elevated and strongly carinate = 1.
30. Gula: obsolete = 0; short to moderately long = 1; long without carina = 2; long and with a carina = 3. [additive].
31. Gula: without a ridge or roll = 0; with a ridge or roll = 1.
32. Mandibular plate: not protruding above maxillary plate = 0; protruding above maxillary plate = 1.

33. Gena: obsolete = 0; often approaching half height of eye = 1.
34. Antennal segment 2: terete or box-like = 0; elongate, slender and nearly cylindrical = 1.
35. Labium with: segments 3 and 4 combined, much longer than segment 2 = 0; segments 3 and 4 enlarged, combined length ~ segment 2 = 1.
36. Labial segment 1: reaching to about midpoint of prosternal xyphus = 0; about same length as buccal cavity = 1.
37. Labial segment 1: slender = 0; very heavy = 1.
38. Buccal cavity: ovoid, facing ventrally, receiving 1/2 length labial segment 1 = 0; round, posteroventral, receiving only base of labial segment 1 = 1.
39. Pronotum: not constricted between anterior and posterior lobes = 0; weakly constricted between anterior and posterior lobes = 1; strongly constricted, more or less hourglass shaped = 2. [additive].
40. Pronotum: not campanulate = 0; campanulate = 1.
41. Calli: obsolete = 0; distinct but not conical = 1; in the form of long conical projections = 2. [additive].
42. Scutellum: bulbous = 0; flat or weakly transversely rounded = 1; elevated anteromesially and flattened laterally and apically = 2; strongly elevated mesially and nearly conical = 3. [non-additive].
43. Mesoscutum: flat and only slightly elevated anteriorly = 0; moderately to highly elevated anteriorly = 1.
44. Hemelytron: weakly declining laterally entire costa visible from above = 0; strongly declining laterally costal margin partially obscured = 1.
45. Hemelytron: not conforming to abdomen = 0; conforming to abdomen = 1.
46. Costal margin: convex = 0; weakly to strongly sinuous = 1.
47. Cuneus and membrane: not strongly declivent relative to corium = 0; strongly declivent relative to corium = 1.
48. Hind tibia: nearly cylindrical in cross-section = 0; weakly to moderately flattened = 1; strongly flattened = 2. [additive].
49. Hind tibia: nearly straight in lateral view = 0; weakly to moderately curved in lateral view = 1; strongly curved in lateral view = 2. [additive].
50. Abdomen: broader basally than at any point posterior to base = 0; parallel sided or weakly constricted basally = 1; strongly constricted basally and bulbous apically = 2. [additive].

GENITALIA

51. Endosoma: sigmoid or otherwise not as below = 0; C-shaped and more or less flat at least basally = 1; C-shaped and distinctly twisted = 2. [non-additive].
52. Endosoma: variously modified but never as follows = 0; apex simple, attenuated, tubular = 1; with a sclerotised backbone distad of secondary gonopore = 2; apex with a single asymmetrical wing-like structure = 3; apex with large paired wing-like structures = 4. [non-additive].
53. Secondary gonopore: strongly sclerotised and horse-collar shaped = 0; absent = 1; present as a lateral indentation on endosoma = 2; present as circular opening, without horse-collar ornamentation = 3. [non-additive].
54. Endosoma: without hook-like formation proximal to secondary gonopore = 0; with hook-like formation proximal to secondary gonopore = 1.
55. Endosoma: without glassy spicules subtending secondary gonopore = 0; with glassy spicules subtending secondary gonopore = 1.
56. Mesial endosomal spine: absent = 0; present as a well developed lanceolate or cylindrical process = 1.
57. Mesial endosomal spine: arising from inner surface of endosoma = 0; arising from lateral surface of endosoma = 1.
58. Mesial endosomal spine: with a barb or denticle = 0; without ornamentation = 1; with a thumb-like process = 2. [non-additive].
59. Mesial endosomal spine apically: simple = 0; bifid = 1; unnamed state = 2. [non-additive].
60. Mesial endosomal spine: more or less cylindrical = 0; flattened and broadest at about midpoint = 1.
61. Barb on endosoma: absent = 0; subtending mesial spine = 1.
62. Phallotheca: curved = 1; curved but with short and narrow apical portion = 2; erect and more or less straight = 3. [non-additive].
63. Phallotheca apex: acutely pointed = 0; elongate but not acutely pointed = 1; beak-like or without distinctive ornamentation = 2. [non-additive].
64. Left paramere: not splayed out = 0; weakly to strongly splayed out = 1.
65. Left paramere: not cleft = 0; weakly cleft = 1; strongly cleft = 2. [non-additive].
66. Left paramere, posterior process: flattened, elevated, dorsal margin angulate = 0; flattened and greatly elongated and usually acuminate at apex = 1; not strongly flattened or elevated, dorsal margin not angulate = 2. [non-additive].
67. Left paramere, process on dorsal anterior margin: absent = 0; present = 1.