

# Orsolobidae (Araneae) of the IBISCA-Queensland Project at Lamington National Park, Australia

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## ABSTRACT

Five species of the endemic Australian spider family Orsolobidae are recorded from the IBISCA-Queensland Project, a survey of invertebrates along an altitudinal gradient within continuous rainforest at Lamington National Park, Queensland, Australia. They comprise two species of *Hickmanolobus* and three species of *Tasmanoonops*, including the newly described *Hickmanolobus nimorakiotakisi* sp. nov. and *Tasmanoonops rogerkitchingi* sp. nov. Also recorded are *Tasmanoonops parvus* Forster & Platnick, of which the male is described for the first time, *Tasmanoonops complexus* Forster & Platnick and *Hickmanolobus ibisca* Baehr and Smith. Within Lamington National Park all five species have been collected only above around 750 m a.s.l. and consequently the Orsolobidae are recommended for inclusion in programs to monitor the impacts of climate change. □ Orsolobidae, Arachnida, Araneae, IBISCA, Australia, new species, systematics, taxonomy, climate change.

Orsolobids are small (body length about 4-5 mm), pallid spiders that are usually found on the forest floor or on bark in rainforests. All Australian orsolobids have a soft abdomen, whereas many species of goblin spiders, in the closely related and often sympatric family Oonopidae, have sclerotised abdominal scutes. The diagnostic feature of the Orsolobidae is the tarsal organ (found distally on the pedal tarsi) which has a specific structure for each species, but which can only be seen by placing one of the spider's legs into a scanning electron microscope.

Forster & Platnick (1985), revised the Orsolobidae and reported these spiders only in Australia, New Zealand and Chile. Since then, they have been described from South Africa (Griswold & Platnick 1987), Brazil and the Falkland Islands (Platnick & Brescovit 1994; Platnick 2011). Now with 182 described species in 28 genera, the Orsolobidae are an important component of the forest litter fauna of the southern hemisphere (Baehr & Smith 2008; Forster & Forster 1999; Hickman 1979). They are putatively a classical Gondwanan group and have hot spots of diversity in Australia and



New Zealand. To date, four genera are known from Australia but only two occur along the eastern seaboard. *Austrolobus* Forster & Platnick, 1985 is known only from Western Australia and *Cornifalx* Hickman, 1979 has been found only in Tasmania. The most common Australian genus, *Tasmanoonops* Hickman, 1930, now with 31 species, occurs mainly in the forests of Tasmania, New South Wales and Queensland, and just two species are recorded from Western Australia. *Hickmanolobus* Forster & Platnick, 1985 was originally known only from a single described species from Tasmania, *H. mollipes* Hickman, although Forster & Platnick (1985) noted an undescribed species from Queensland. Baehr & Smith (2008) subsequently described three new *Hickmanolobus* species from New South Wales and Queensland. One of these, *H. ibisca* Baehr & Smith, was collected in the IBISCA-Queensland survey (see Kitching *et al.* 2011) and initially tentatively identified by Raven as an "oonopid". To the rich complement of spiders at Lamington National Park, a further new species of *Hickmanolobus* as well as a second new species of *Tasmanoonops* are here described.

#### MATERIAL AND METHODS

Specimens were examined using a LEICA MZ16A microscope. Photomicrographic images were produced using a Leica DFC 500 and the software program AutoMontage LAS V3.7. Descriptions were generated with the aid of the PBI descriptive goblin spider database and shortened where possible. All measurements are in millimetres. Abbreviations: AM, Australian Museum, Sydney; ALE, anterior lateral eyes; IBISCA, Investigating the Biodiversity of Soil and Canopy Arthropods; NP, National Park; QM, Queensland Museum; PBI, Planetary Biodiversity Inventory; PLE, posterior lateral eyes; PME, posterior median eyes.

#### SYSTEMATICS

##### Family Orsolobidae Cooke, 1965

##### Genus *Hickmanolobus* Forster & Platnick, 1985

**Type species.** *Oonopinus mollipes* Hickman, 1932 by original designation.

**Diagnosis and description.** See Baehr & Smith (2008). The species description below mentions only differences from this generic description.

**Species.** *H. ibisca* Baehr & Smith, 2008; *H. jojo* Baehr & Smith, 2008; *H. linnaei* Baehr & Smith, 2008; *H. mollipes* (Hickman, 1932); *H. nimorakiotakisi* sp. nov.

**Distribution.** All species, except *H. mollipes* from Tasmania, are either from south-east Queensland or adjacent areas of north-eastern New South Wales.

#### KEY TO SPECIES OF *HICKMANOLOBUS* FROM QUEENSLAND AND NEW SOUTH WALES

1. Males ..... 2  
— Females (unknown for *H. jojo* and *H. nimorakiotakisi*) ..... 6
2. Palpal embolus long, spiniform (Fig. 25) ... 3  
— Palpal embolus short, triangular (Fig. 22) ... 4
3. Abdominal dorsum with 5 transverse bars (Hickman 1932: fig. 5) *H. mollipes* Hickman  
— Abdominal dorsum with 5 pale, inverted, v-shaped chevrons (Fig. 5) ..... *H. nimorakiotakisi* sp. nov.
4. Carapace yellow brown with dark purple reticulate pattern (Fig. 1); palpal bulb larger, wider than length of cymbium and tibia combined (Figs 21–23) ... *H. ibisca* Baehr & Smith  
— Carapace yellow brown without dark purple reticulate pattern; palpal bulb smaller, as wide as or less than length of cymbium and tibia combined (Baehr & Smith 2008: figs 47–52, 56–61) ..... 5



5. Palpal bulb shorter than length of cymbium and tibia combined, embolus triangular (Baehr & Smith 2008: figs 50–52, 59–61) ..... *H. jojo* Baehr & Smith
  - Palpal bulb as wide as length of cymbium and tibia combined, embolus scooped with rounded tip (Baehr & Smith 2008: figs 47–49, 56–58, 65–67) ... *H. linnaei* Baehr & Smith
6. Abdomen with five transverse bars (Hickman 1932: fig. 5) ..... *H. mollipes* Hickman
  - Abdomen with four or less inverted, v-shaped chevrons (Baehr & Smith 2008: figs 2, 4). ... 7
7. Carapace with dark purple reticulate pattern; epigastric fold with posteriorly directed, u-shaped projection, posterior margin with rectangular sclerite; internal female genitalia with large posterior receptaculum divided into three circular compartments (Baehr & Smith 2008: figs 69, 70, 73, 74) ..... *H. ibisca* Baehr & Smith
  - Carapace without dark purple reticulate pattern (Fig. 2); epigastric fold widely oval, posterior margin straight; internal female genitalia with elongated posterior receptaculum divided into three more triangular compartments (tapering posteriorly) (Baehr & Smith 2008: figs 68, 71, 72) ..... *H. linnaei* Baehr & Smith

***Hickmanolobus ibisca* Baehr & Smith, 2008**  
(Figs 1–4, 21–23, 34)

*Hickmanolobus ibisca* Baehr & Smith, 2008: 333.

**Material.** ♂ holotype, ♀ allotype, Queensland, Lamington NP, IBISCA site 700B, 775 m, 28.192°S, 153.124°E, 2–6 October 2006, rainforest, B. Baehr, K. Staunton, pitfall trap (♂: QM S81126, PBI\_OON\_6345; ♀: PBI\_OON\_22897, QM S55526). **Other Material:** QUEENSLAND, 1♂, IBISCA site 700C, 748 m, 28.193°S, 153.128°E, 11–20 October 2006, K. Staunton, pitfall (QM S81069, PBI\_OON\_6344); 1♂, IBISCA site 700D, 748 m, 28.204°S, 153.129°E, (QM S81119, PBI\_OON\_22718). NEW SOUTH WALES, 1♂, Cherry Tree North State Forest, 400 m, 28°54'S, 152°45'E, rainforest, April–May 1976, M. Gray, C. Horseman, pitfall trap (AM KS10314, PBI\_OON\_20230).

**Description.** See Baehr & Smith (2008).

**Distribution and habitat.** Rainforests in south-eastern Queensland and north-eastern New South Wales (Baehr & Smith 2008: fig. 75, Fig. 34).

***Hickmanolobus nimorakiotakisi* sp. nov.**  
(Figs 5–8, 24–26, 34)

**Etymology.** A patronym in honour of Dr. Bill Nimorakiotakis, the Deputy Director of the Australian Venom Research Unit at the University of Melbourne, who supports spider taxonomy with great passion.

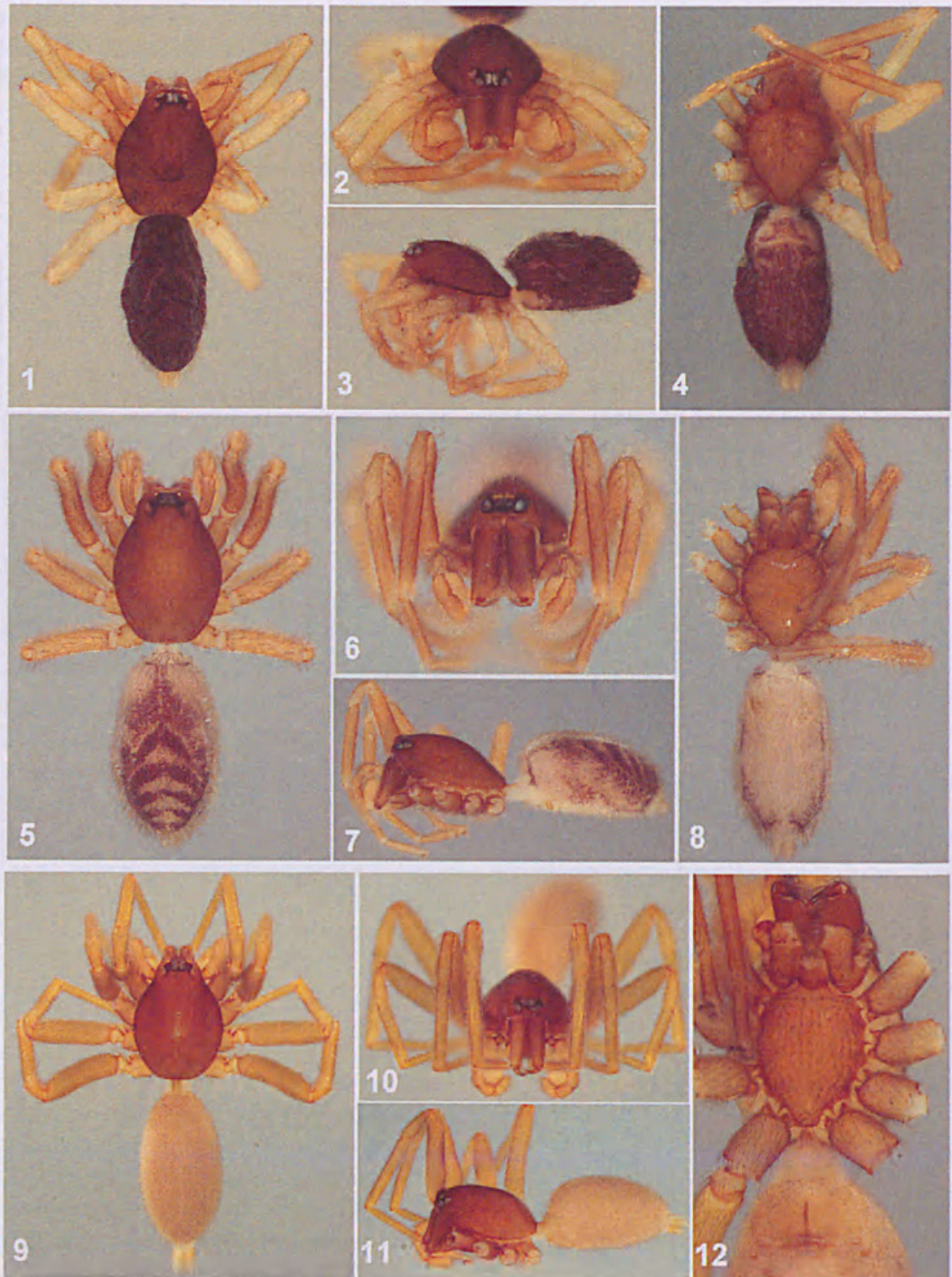
**Material.** Holotype ♂: Queensland, Lamington NP, IBISCA site 1100C, 28.260°S, 153.167°E, 1106m, 26 Oct 2006, C. Burwell, pyrethrum knockdown (PBI\_OON\_23258, QM S86313). **Other Material:** Queensland, 1♂, Mount Asplenium, 28°09'S, 152°26'E, 1290 m, 20 Jan 1993, G. Monteith, pyrethrum knockdown (PBI\_OON\_23261, QM S49514).

**Diagnosis.** This species resembles *H. mollipes* but differs in that the abdominal pattern consists of five inverted, v-shaped chevrons (Fig. 5) and the male bulb is more slender.

**Description.** *Male* (holotype QM S86313) (Figs 5–8). Total length 1.63. Carapace 0.76 long, 0.58 wide; abdomen 0.87 long, 0.51 wide. Carapace yellow-brown, ovoid in dorsal view, pars cephalica flat in lateral view, anteriorly narrowed to 0.5–0.75 times its maximum width, with rounded posterolateral corners, surface granulate, fovea absent, rebordered. Clypeus straight in front view, vertical in lateral view, high; ALE separated from edge of carapace by their radius. Chilum absent. Eyes six, well developed, all subequal, ALE oval, PME oval, PLE circular; posterior eye row recurved from both above and front; ALE separated by more than their diameter, ALE–PLE touching, PME touching throughout most of their length, PLE–PME separated by more than PME diameter. Endites more than three times as long as wide. Abdomen purple, with five inverted, v-shaped pale median chevrons. Legs yellow-brown. Palp (Figs 24–26), bulb pyriform with long thin embolus.

*Female.* Unknown.





FIGS 1–12. Orsolobidae of Lamington National Park. Habitus, 1, 5, 9, dorsal; 3, 7, 11, lateral; 2, 6, 10, frontal; 4, 8, 12, ventral. 1–4, *Hickmanolobus ibisca* Baehr & Smith; 5–8, *Hickmanolobus nimorakiotakisi* sp. nov.; 9–12, *Tasmanoonops parvus* Forster & Platnick, (9–11, male; 12, female).



**Distribution.** Known only from Lamington NP, south-east Queensland (Fig. 34).

Genus *Tasmanoonops* Hickman, 1930

*Tasmanoonops* Hickman, 1930: 97.

**Type species.** *Tasmanoonops alipes* Hickman, 1930 by original designation.

**Diagnosis and description.** See Forster & Platnick, 1985.

*Tasmanoonops complexus*

Forster & Platnick, 1985

*Tasmanoonops complexus* Forster & Platnick, 1985: 71, figs 236–243, 245–248, 833, 834.

**Diagnosis.** From Forster & Platnick, 1985. Unlike all other species, males lack a lateral flange on the claws; females have a sclerotic plate anterior and posterior to the epigastric plate.

**New material.** QUEENSLAND, 1♀, Lamington NP, IBISCA site 1100D, 1140 m, 28.262°S, 153.170°E, 16–26 Jan 2007, G. Monteith, flight intercept (QM S76294).

**Distribution.** Known only from Lamington NP, south-east Queensland (Fig. 34).

*Tasmanoonops parvus* Forster & Platnick, 1985

(Figs 9–12, 27–30, 34)

*Tasmanoonops parvus* Forster & Platnick 1985: 60, figs 188–190, 213.

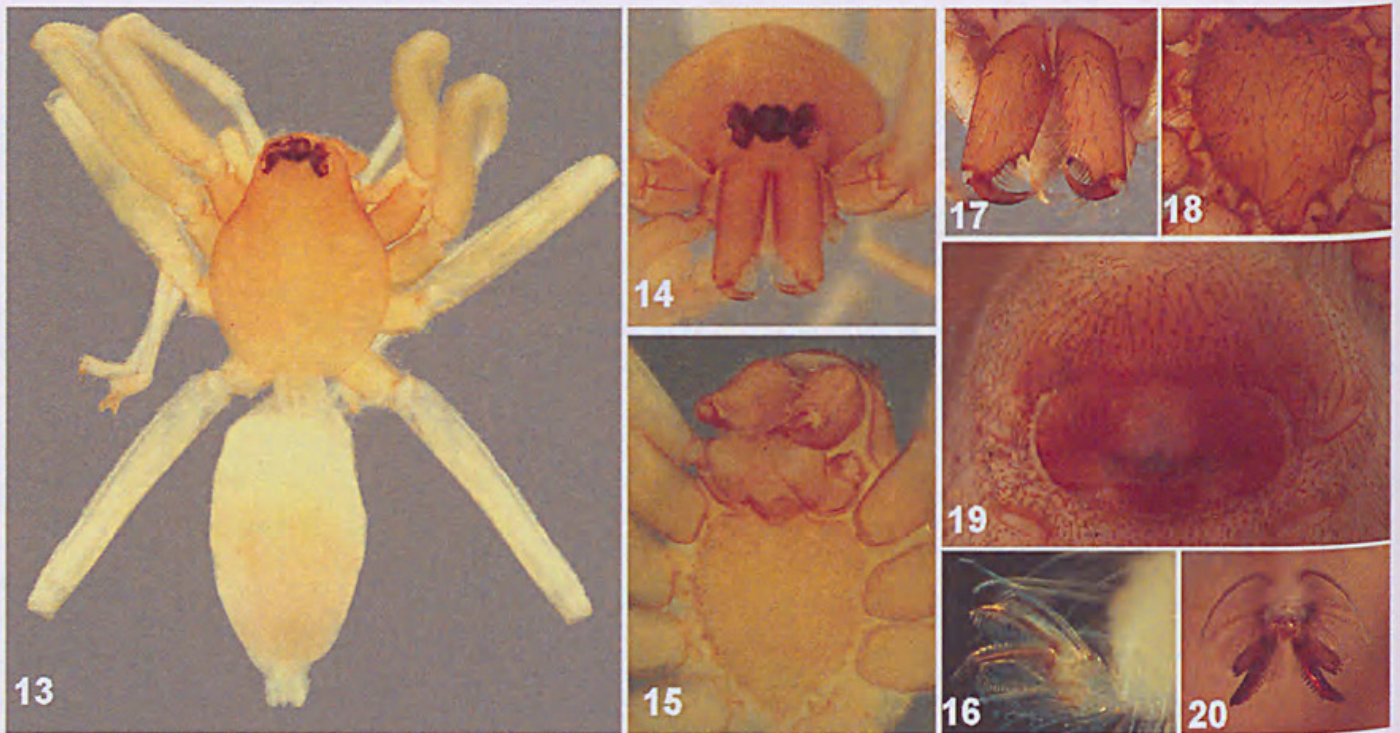
**New material.** QUEENSLAND, Lamington NP, 1♂, 0.6 km N Joalah Lookout, 28.367°S 153.333°E, 955 m, 21 Mar 2008, S. Wright, A. Nakamura, berlese (PBI\_OON 23311, QM S86367). IBISCA site 900A, 904 m, 28.234°S 153.141°E: 1♀, 12–21 Feb 2007, K. Staunton, pitfall (PBI\_OON 23318 QM S76188); 1♂, 11–20 Mar 2007, D. Putland, K. Staunton, pitfall (PBI\_OON 23305 QM S86373). IBISCA site 900C, 28.240°S 153.149°E, 910 m: 1♀, 12–21 Feb 2007, K. Staunton, pitfall (PBI\_OON 23314, QM S76195); 1♂, 11–20 Mar 2007, D. Putland, K. Staunton, pitfall (PBI\_OON 23306, QM S86372); 1♀, 24 Jan 2008, S. Wright, berlese (PBI\_OON 23309, QM S86371). IBISCA site 900D, 28.227°S 153.131°E, 920 m: 1♂, 11–20 Mar 2007, D. Putland, K. Staunton, pitfall (PBI\_OON 23257; QM S86383 drawing and images); 1♂, 5–8 Oct 2006, K. Staunton, B. Baehr, pitfall (PBI\_OON 22549, QM S81144); 4♂♂, 11–20 Mar 2007, D. Putland, K. Staunton, pitfall (PBI\_OON 23307, QM S86370; PBI\_OON 23312, QM S86384). IBISCA site 1100A, 1141 m, 28.258°S 153.159°E: 1♀, 12–21 Feb 2007,

K. Staunton, pitfall (PBI\_OON 23317, QM S76216). IBISCA site 1100B, 1142 m, 28.259°S 153.162°E: 1♂, 2♀♀, 12–21 Feb 2007, K. Staunton, pitfall (PBI\_OON 23335, QM S83626). IBISCA site 1100C, 1106 m, 28.260°S 153.167°E: 1♀, 7–11 Oct 2006, K. Staunton, pitfall (PBI\_OON 23332, QM S81131); 1♀, 16–21 Jan 2007, G. Monteith, pitfall (PBI\_OON 23316, QM S86118). IBISCA site 1100D, 1140 m, 28.262°S 153.170°E: 1♀, 12–21 Feb 2007, K. Staunton, pitfall (PBI\_OON 23319, QM S76207); 2♀♀, 4♂♂, 11–20 Mar 2007, D. Putland, K. Staunton, pitfall (PBI\_OON 23260, QM S86369, PBI\_OON 23310, QM S86368); 1♀, 23 Mar–2 Apr 2007, R. Menendez, G. Monteith, malaise trap (PBI\_OON 23315, QM S86119); 1♀, 27 Jan 2008, S. Wright, A. Nakamura, berlese (PBI\_OON 23259, QM S86374). 1♂, 1.0 km S Binna Burra Lodge, 850 m, 28.333°S 153.3167°E, 18 Mar 2008, C. Burwell, S. Wright, K. Staunton, pitfall berlese (PBI\_OON 23308, QM S86376).

**Diagnosis.** This species was originally described only from four females from Lamington NP (Forster & Platnick 1985). The males of this species are newly described below and can be distinguished from all other *Tasmanoonops* species by the combination of the pyriform bulb which has a long straight spiniform embolus, three dark spine-like projections and a semicircular membranous conductor, as well as by the distinctive tarsal organ.

**Description.** *Male* (QM S86367) (Figs 9–11). Total length 2.95. Carapace 1.35 long, 1.00 wide, abdomen 1.60 long, 0.92 wide. Carapace yellow-brown, without pattern, ovoid in dorsal view, pars cephalica flat in lateral view, anteriorly narrowed to 0.49 times its maximum width or less, with rounded posterolateral corners, surface finely reticulate, rebordered. Clypeus curved downwards in front view, vertical in lateral view, low, ALE separated from edge of carapace by less than their radius. Chilum absent. Eyes six, well developed, all subequal, oval; posterior eye row recurved from both above and front; ALE separated by more than their diameter, ALE–PLE separated by less than ALE radius, PME touching throughout most of their length, PLE–PME separated by PME radius to PME diameter. Sternum longer than wide, yellow-brown, uniform, not fused to carapace, surface finely reticulate, extensions of pre-coxal triangles





FIGS 13–20. Orsolobidae of Lamington National Park. 13, habitus dorsal; 14, 17, chelicerae; 15, 18, sternae; 16, 20, tarsal claw. 13–16, *Tasmanoonops rogerkitchingi* sp. nov. male; 17–20, *Tasmanoonops complexus* Forster & Platnick, female.

present, lateral margins with narrow extensions between coxae; setae abundant, dark, needle-like, evenly scattered, originating from surface. Mouthparts: Chelicerae, endites and labium yellow-brown. Chelicerae straight, anterior face unmodified; with one tooth on both promargin and retromargin; setae dark, needle-like, evenly scattered; paturon inner margin with pairs of enlarged setae, distal region abruptly narrowed. Labium rectangular, not fused to sternum, anterior margin indented at middle. Endites twice as long as wide, distally not excavated, serrula a single row. Abdomen: ovoid, pale orange. Booklung covers large, ovoid. Pedicel tube short, unmodified, setae uniform, dark, needle-like. Legs pale orange. Palpal bulb pyriform, with long straight spiniform embolus, three dark spine-like projections and a semi-circular membranous conductor (Figs 27–30).

**Distribution.** Known only from Lamington NP, south-east Queensland.

*Tasmanoonops rogerkitchingi* sp. nov.  
(Figs 13–16, 31–33, 34)

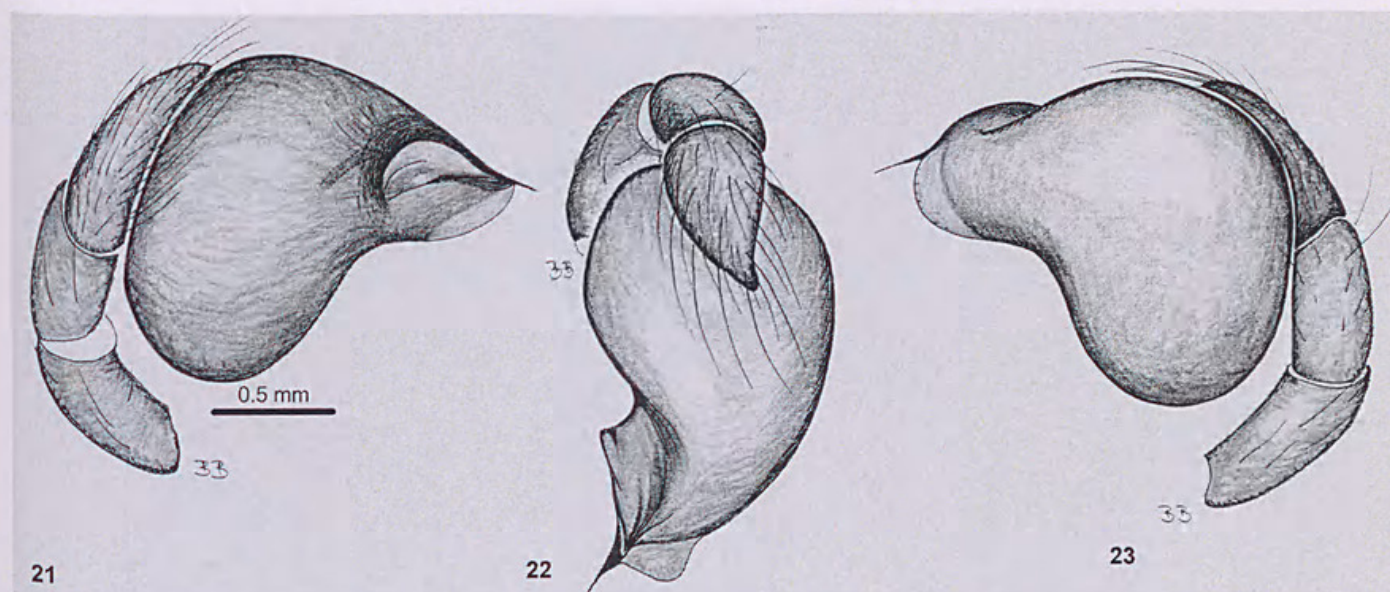
**Etymology.** A patronym in honour of Professor Roger Kitching, Griffith University, who founded the IBISCA-Queensland Project.

**Diagnosis.** The male resembles that of *T. complexus* in the general shape of the palpal bulb, but differs in the bulb having a thin semicircular embolus, a big beak-shaped process and a semicircular, membranous, cup-shaped projection.

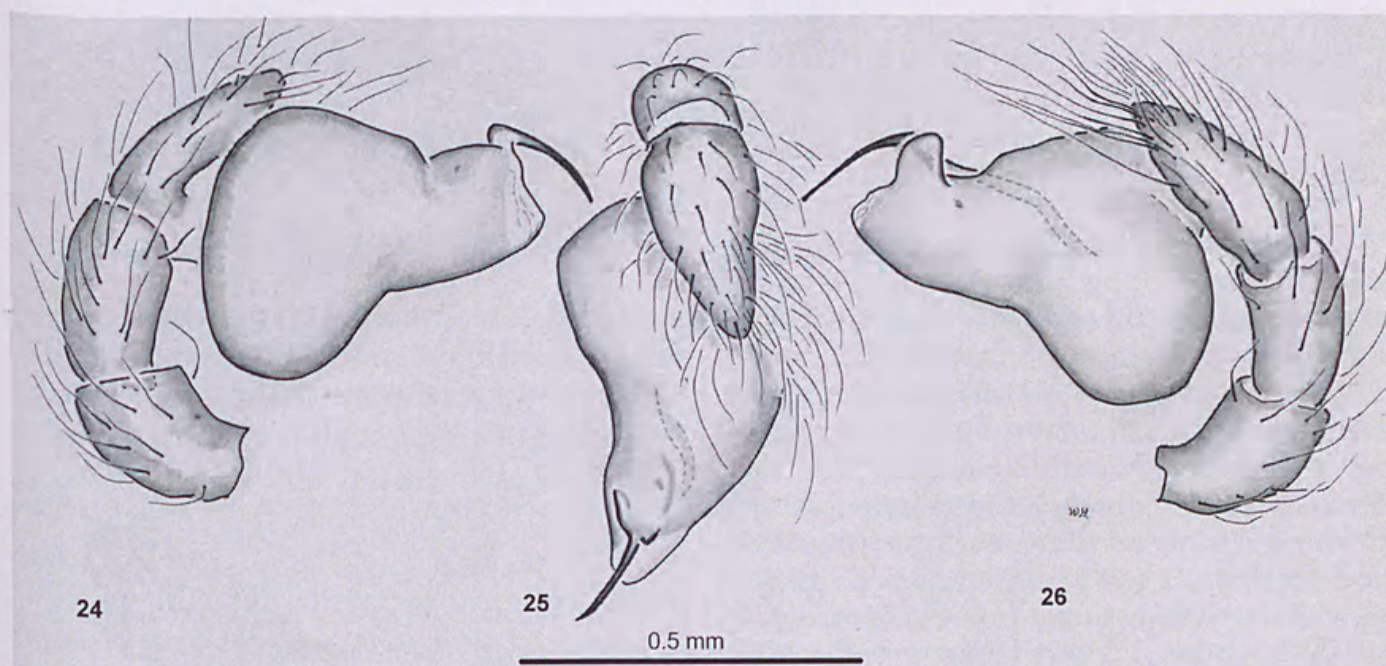
**Material.** Holotype ♂: Queensland, Lamington NP, O'Reilly's, 28.233°S 153.133°E, 960 m, 16 Nov 1977, V. Davies, E. Dahms, pitfall (PBI\_OON 23333, QM S86418). **Other Material:** Queensland, 1 ♂, same data as holotype (PBI\_OON 23334, QM S86419).

**Description.** *Male* (PBI\_OON 23333) (Fig. 13). Total length 4.16. Carapace 1.95 long, 1.50 wide, abdomen 2.21 long, 1.32 wide. Carapace yellow, without pattern, ovoid in dorsal view, pars cephalica flat in lateral view, anteriorly narrowed to 0.49 times its maximum width or less, with





FIGS 21–23. *Hickmanolobus ibisca* Baehr & Smith. Left palp, 21, prolateral; 22, dorsal; 23, retrolateral.

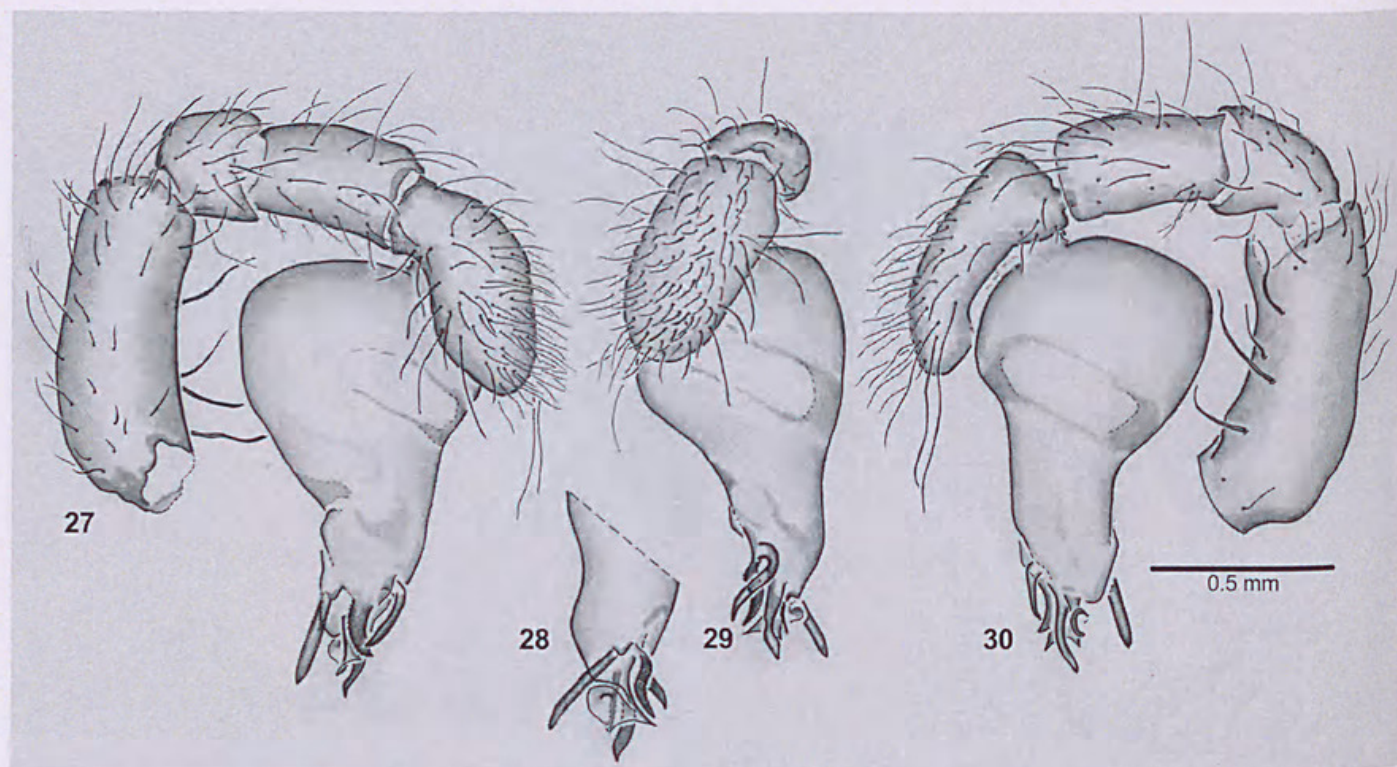


FIGS 24–26. *Hickmanolobus nimorakiotakisi* sp. nov. Left palp, 24, prolateral; 25, dorsal; 26, retrolateral.

rounded posterolateral corners, surface smooth, fovea absent, lateral margin rebordered. Clypeus straight in front view, vertical in lateral view, low; ALE separated from edge of carapace by less than their radius. Chilum absent. Eyes six, well developed, all sub-equal, all eyes oval; posterior eye row recurved from both above and in

front; ALE separated by more than their diameter, ALE–PLE touching, PME touching throughout most of their length, PLE–PME separated by PME radius to PME diameter. Sternum as long as wide, yellow, not fused to carapace, surface smooth, extensions of pre-coxal triangles present, lateral margins with narrow extensions between coxae





FIGS 27–30. *Tasmanoonops parvus* Forster & Platnick. Left palp, 27, prolateral; 28, ventral; 29, dorsal; 30, retrolateral.

(Fig. 15); setae sparse, light, needle-like, evenly scattered, originating from surface. Chelicerae, endites and labium yellow-brown. Chelicerae straight; promargin without teeth, retromargin with two teeth (Fig. 14); setae light, needle-like, evenly scattered; paturon inner margin with pairs of enlarged setae. Labium rectangular, not fused to sternum, anterior margin indented at middle, same as sternum in sclerotisation. Endites distally not excavated, twice as long as wide, serrula a single row. Abdomen pale, ovoid; book lung covers large, ovoid; pedicel tube short, unmodified, setae uniform, light, needle-like. Colulus represented only by setae. Legs long, pale yellow, tarsal claws as in Fig. 16. Palp (Figs 31–33): Distal part of bulb with thin semicircular embolus, with big beak-shaped process and semicircular membranous cup-shaped projection.

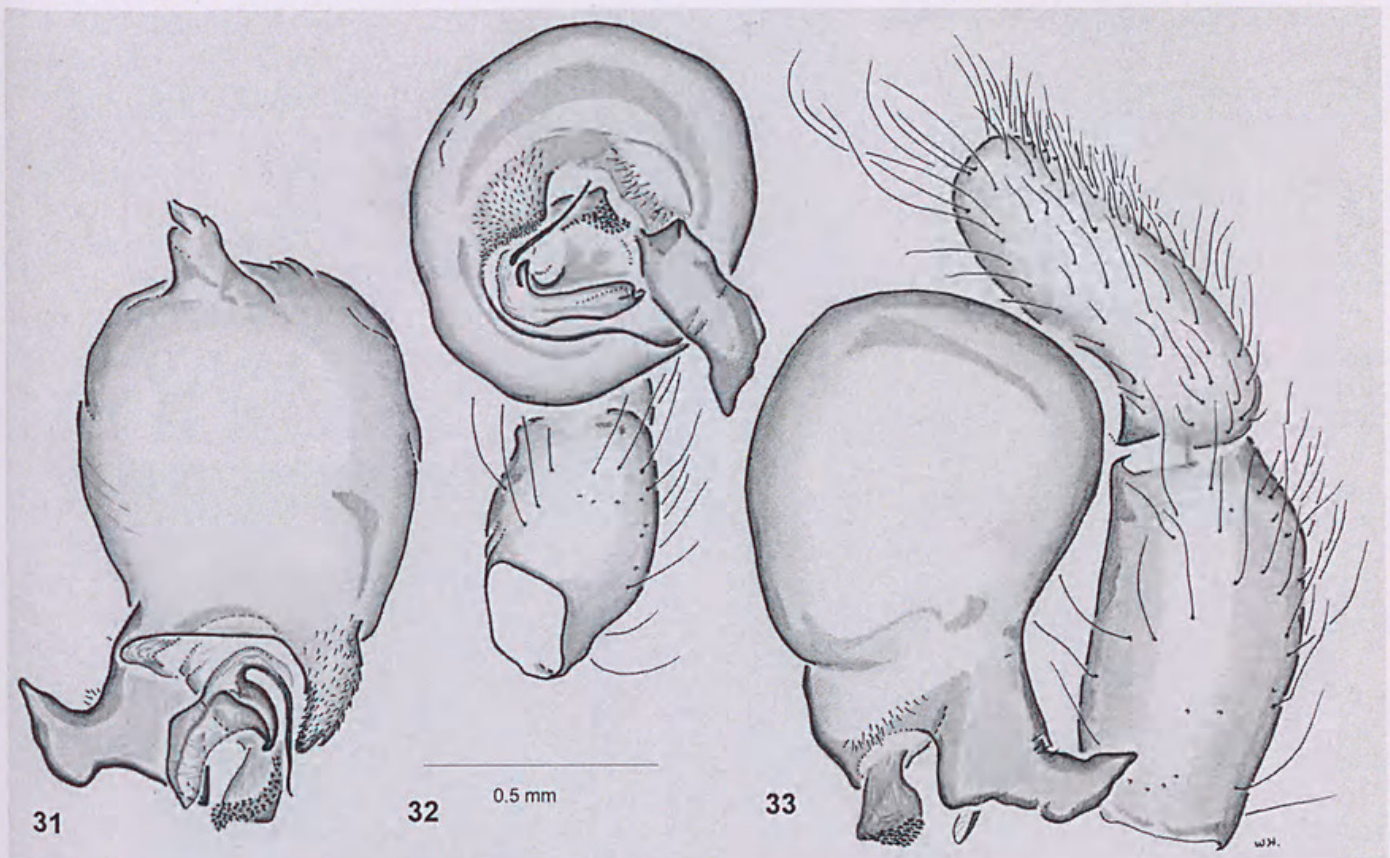
**Distribution.** Known only from Lamington NP, south-east Queensland (Fig. 34).

## DISCUSSION

The specimens examined in this study were mainly collected on the visionary IBISCA-Queensland Project, initiated by Prof. Roger Kitching. This project aimed to document the distributions of insects and spiders along an altitudinal gradient from approximately 300 to 1100 m above sea level, within continuous rainforest at Lamington National Park, Queensland, using rigorous ecological protocols (Kitching *et al.* 2011). During the project, intensive surveys were undertaken at four plots (A, B, C and D) within each of five altitudinal zones at approximately 300, 500, 700, 900 and 1100 m a.s.l. (see Kitching *et al.* 2011 for details).

All orsolobid specimens at Lamington were collected at higher altitudes, from between around 750 and 1150 metres above sea level: *H. ibisca* was taken in pitfall traps at three of





FIGS 31–33. *Tasmanoonops rogerkitchingi* sp. nov. Left palp, 31, prolateral; 32, ventral; 33, retrolateral.

the four plots at the 700 m a.s.l. zone; *T. parvus* at all plots at the 900 and 1100 m a.s.l. zones, except 900 B; and *T. rogerkitchingi* sp. nov. was taken only at 960 m in pitfall traps (prior to the IBISCA-Qld Project Fig. 34). The highest orsolobid diversity was found within the 1100 m a.s.l. zone with 3 species: *H. nimorakiotakisi* collected on bark using pyrethrum knockdowns; *T. complexus* collected with a flight intercept trap; and *T. parvus* Forster & Platnick, collected in leaf litter extracts or pitfall traps. Despite similar intensive surveys at lower altitude rainforests in Queensland's south-east corner, orsolobids remain known only from rainforest-clad mountains that reach higher than 700 m a.s.l. However, *H. ibisca* has been collected from as low as 400 m a.s.l. from a site in rainforest in northern New South Wales about 80 km south and 60 km west of the IBISCA-Qld sites. Apart from being more southerly, the aspect

of this site may well have been southerly and hence cooler, explaining the occurrence of *H. ibisca* at this relatively low elevation. Earlier studies at Lamington National Park (e.g., Davies 1977), although thorough and intensive, were not so rigorously conducted as IBISCA-Qld and were conducted only at higher elevations (900 m a.s.l. and higher) and hence data from them are useful only as qualitative measures of diversity. Davies (1977) reported only one species of *Tasmanoonops* (here described as *T. rogerkitchingi* sp. nov.) from 960 metres elevation.

Consequently, it would appear that orsolobid spiders of Lamington National Park are effectively mid to high elevation specialists and may be useful candidates for incorporation in programs designed to help monitor the effects of climate change, especially those of global warming. We suggest that the distribution of



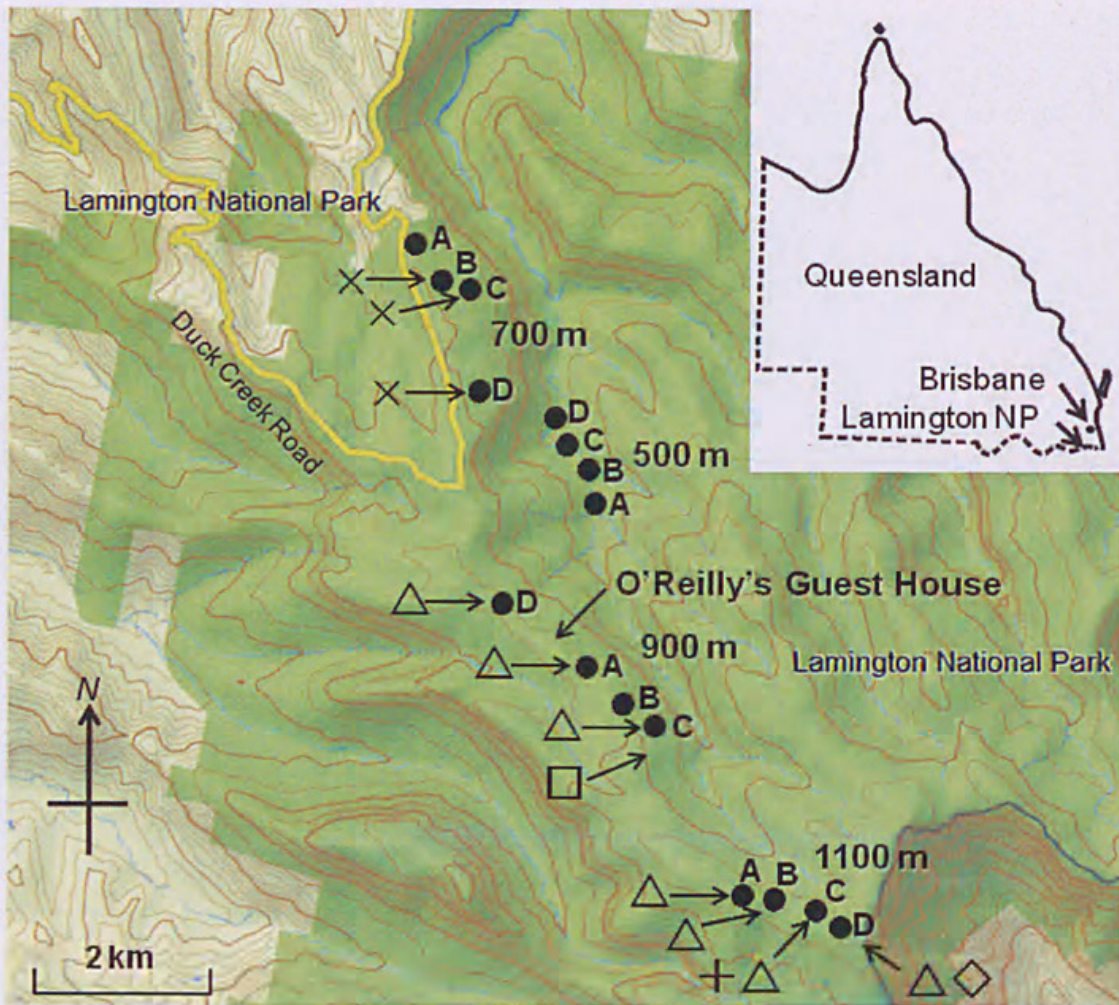


FIG. 34. Known distribution of five species of Orsolobidae within Lamington National Park. ×, *Hickmanolobus ibisca*; +, *H. nimorakiotakisi*; ◇, *Tasmanoonops complexus*; △, *T. parvus*; □, *T. rogerkitchingi*. Solid circles indicate the locations of IBISCA-Queensland Project study plots which are labelled A-D within their altitudinal zones; 500, 700, 900 and 1100 m a.s.l. (see also Fig. 1 in Kitching *et al.* 2011 for IBISCA-Qld plot locations). Note *T. rogerkitchingi* was not collected from an IBISCA-Qld plot.

orsolobid species along the IBISCA-Qld gradient is restricted by the higher temperatures and lower humidities at lower altitudes. As the climate warms, orsolobid species are predicted to shift to higher elevations in order to track their preferred temperatures and humidities. These predicted changes can be monitored through consistent standardised sampling. The Orsolobiidae are an ideal target group for monitoring the impacts of climate change at Lamington NP. In addition, the species apparently restricted to the highest elevations along the gradient may

be under threat of at least local extinction in the relatively near future.

#### ACKNOWLEDGEMENTS

Most of the specimens examined in this study were collected during the IBISCA-Queensland Project and as such we are grateful to the Department of State Development of the State of Queensland for the Smart State funding which made this project possible. Their generous funding was matched by funding from Griffith University,



the Queensland Museum, the Queensland Herbarium, the Global Canopy Programme (Oxford), NRM Queensland (SEQ Catchments) and the Queensland National Parks Association. The project also received cash support from the federal Department of Environment, Heritage and the Arts and O'Reillys' Rainforest Resort. We would like to thank the IBISCA-Queensland team, especially, Queensland Museum staff, C. Burwell, A. Nakamura, G. Monteith, S. Wright, as well as D. Putland and K. Staunton, for their excellent collecting work, and A. Nakamura and C. Burwell for producing the distribution map. This paper is dedicated to people and institutions that support taxonomic science with their encouragement. This paper would not have been completed, without the support of IBISCA-Queensland and the National Science Foundation's PBI (Planetary Biodiversity Inventory) program provided through grant DEB-0613754.

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