



New species of ant-mimicking jumping spiders of the genus *Myrmarachne* MacLeay, 1839 (Araneae: Salticidae) from north Queensland, Australia

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Abstract Based on taxonomic characters such as male and female genitalia and male chelicerae, four new species of *Myrmarachne* from Townsville, north Queensland are described. The proposed new species include: *Myrmarachne rubra*, *Myrmarachne aurea*, *Myrmarachne gurgulla* and *Myrmarachne smaragdina*. Information is also provided on the biology and ecology of these species and a comparison between the species is also presented, supported by data collected over 2.5 years.

Key words ant-mimics, salticids, taxonomy.

INTRODUCTION

The spider family Salticidae occurs worldwide and contains 5237 named species in 567 genera (Platnick 2009). Further subdivisions have been proposed several times to deduce phylogenetic relationships within this large taxon. Simon (1900) divided the Salticidae into the Pluridentati, the Unidentati and the Fissidentati, based on their cheliceral dentition. However, this classification has been repeatedly shown to be unnatural, and with the advancement of molecular phylogenetic techniques, divisions based on more realistic taxonomic affiliations have been put forward.

Myrmarachne MacLeay 1839, is a genus of specialised ant-mimicking salticids formerly assigned to the pluridentati group (as the chelicerae of *Myrmarachne* contain several teeth). A recent molecular study has placed *Myrmarachne* into a new group called the Astioidea, which include pluridents, unidents and fissidents (Maddison *et al.* 2008). Ant-mimicry occurs in several salticid genera, Australian ones including *Damoetas* Peckham & Peckham, 1886, *Judalana* Rix, 1999, *Ligonipes* Karsch, 1878 and *Rhombonotus* L. Koch, 1879. However, ant mimicking salticids cannot be considered an integral unit, as they are not monophyletic (Maddison & Hedin 2003).

Myrmarachne is one of the largest salticid genera, with over 200 named species most of which occur in tropical regions (Proszynski 2010). Most *Myrmarachne* species are sexually dimorphic. This difference in the sexes is especially pronounced when looking at the chelicerae, which are thought to be a sexually selected feature in males, often protruding in front of the carapace (Jackson 1982; Pollard 1994). *Myrmarachne* also display transformational mimicry (Edmunds 1978), which is when a species mimics several different models at different stages of its life (Mathew 1935). Several species also display

polymorphism in colouration (Ceccarelli & Crozier 2007; M Rix pers. comm. 2004). Taxonomic work on this salticid genus is therefore complicated by sexual dimorphism, transformational mimicry and polymorphism. The most important recent revision of the genus *Myrmarachne* has been carried out in the Ethiopian region by Wanless (1978). Bradoo (1980), Logunov and Wesolowska (1992), Berry *et al.* (1996), Wesolowska and Salm (2002) and Edmunds and Proszynski (2003) have also contributed to more recent descriptions of new *Myrmarachne* species. In addition, Edwards and Benjamin (2009) redescribed the type species of *Myrmarachne* (*Myrmarachne melanocephala* MacLeay 1839).

The genus *Myrmarachne* can be subdivided into species groups based on overall genital morphology such as the form of the tibial apophysis of the male palp, or the form of the female spermathecae. Here, three of the species groups will be described (the *tristis* group, the *formicaria* group and the *volatilis* group). Males of the *tristis* group usually have a well-developed flange, a hooked tibial apophysis and a depression in the proximal ectal margin of the cymbium; and females are characterised by the presence of lateral pouches in the epigyne. The males of the *formicaria* group generally have a more or less sinuous tibial apophysis and a poorly developed flange, and the female epigyne has looped or twisted spermathecae and a median subtriangular pouch. Males of the *volatilis* group have a large, marginate seminal reservoir, no flange and a more or less sinuous tibial apophysis; females have a median subtriangular pouch and simple spermathecae, without loops or twists. Species within one species group can show little variation in the structure of their genitalia. The *tristis* and *formicaria* groups occur in the Palearctic and Oriental regions, but could possibly be found in Australia, whereas the *volatilis* group definitely occurs in the Australasian region (Wanless 1978).

In Australia, 11 species of *Myrmarachne* have been described: *M. bicolor* (Koch 1879), *M. cognata* (Koch 1879), *M. cuprea* (Hogg 1896), *M. erythrocephala* (Koch 1879), *M. jugularis* (Simon 1900), *M. luctuosa* (Koch 1879), *M. lupata*

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(Koch 1879), *M. macleayana* (Bradley 1876), *M. maxillosa*¹ (Koch 1879), *M. simoni* (Koch 1879) and *M. striatipes* (Koch 1879). *Myrmarachne* species from South-East Asia and Papua New Guinea are unlikely to be the same species that occur in Australia (M Edmunds pers. comm. 2004), as there is a high rate of diversification and speciation within the genus (Ceccarelli & Crozier 2007).

This paper names and describes four new species of *Myrmarachne* found in north Queensland, Australia, used during the course of a study into model-mimic systems (Ceccarelli 2007, Ceccarelli 2008, Ceccarelli 2009). Species integrity was established using DNA data (Ceccarelli & Crozier 2007), and specimens were then examined for distinguishing morphological features to enable categorisation of living material. Comments on biology and ecology are provided as microhabitat use and patterns of association with the ant models provide strong clues to the identity of these *Myrmarachne* species.

MATERIALS AND METHODS

Specimens were collected in Townsville (19°13'S, 146°48'E), and preserved in 100% Ethanol until they were examined. Photographs of the specimens were taken through the eye piece of a dissecting microscope. For the females, the epigyne was removed under a dissecting microscope and mounted on a cavity slide in Grey and Weiss mounting fluid, to then be examined under a compound microscope. Further specimens from the arachnology collections at the Australian Museum (Sydney) and the Queensland Museum (Brisbane) were examined, including paratypes of already described *Myrmarachne* species. Descriptions of South-East Asian and Papuan *Myrmarachne* species were examined to exclude synonymy. Type specimens of *Myrmarachne* from this study were deposited in both the Queensland Museum and the Australian Museum.

Live *Myrmarachne* were also observed; and data were recorded between February 2003 and September 2005 to find out more about each species' biology and ecology. Occasionally, egg sacs were brought into the lab for further studies on spiderling instar changes. From the data collected, ANOVA and chi-squared test were performed to find any interspecific differences in the four *Myrmarachne* species studied. The description of the species follows the conventions set out by Wanless (1978). Measurements of the male chelicerae and carapaces were also taken; and the data were analysed in R 2.1.1 (R_Development_Core_Team 2005) performing ANOVAs and divisive cluster analyses (diana) to see whether the chelicera-to-carapace length ratio is significantly different between the *Myrmarachne* species, and whether it contains evolutionary information. The following abbreviations are used throughout the text: AM, Australian Museum, Sydney; QM, Queensland Museum, Brisbane; ALE, anterior lateral eyes; AME, anterior median eyes; PLE, posterior lateral eyes; PME, posterior median eyes.

SYSTEMATICS

Family SALTICIDAE

Subfamily MYRMARACHNINAE

Myrmarachne rubra sp. nov.

Figures 1–9

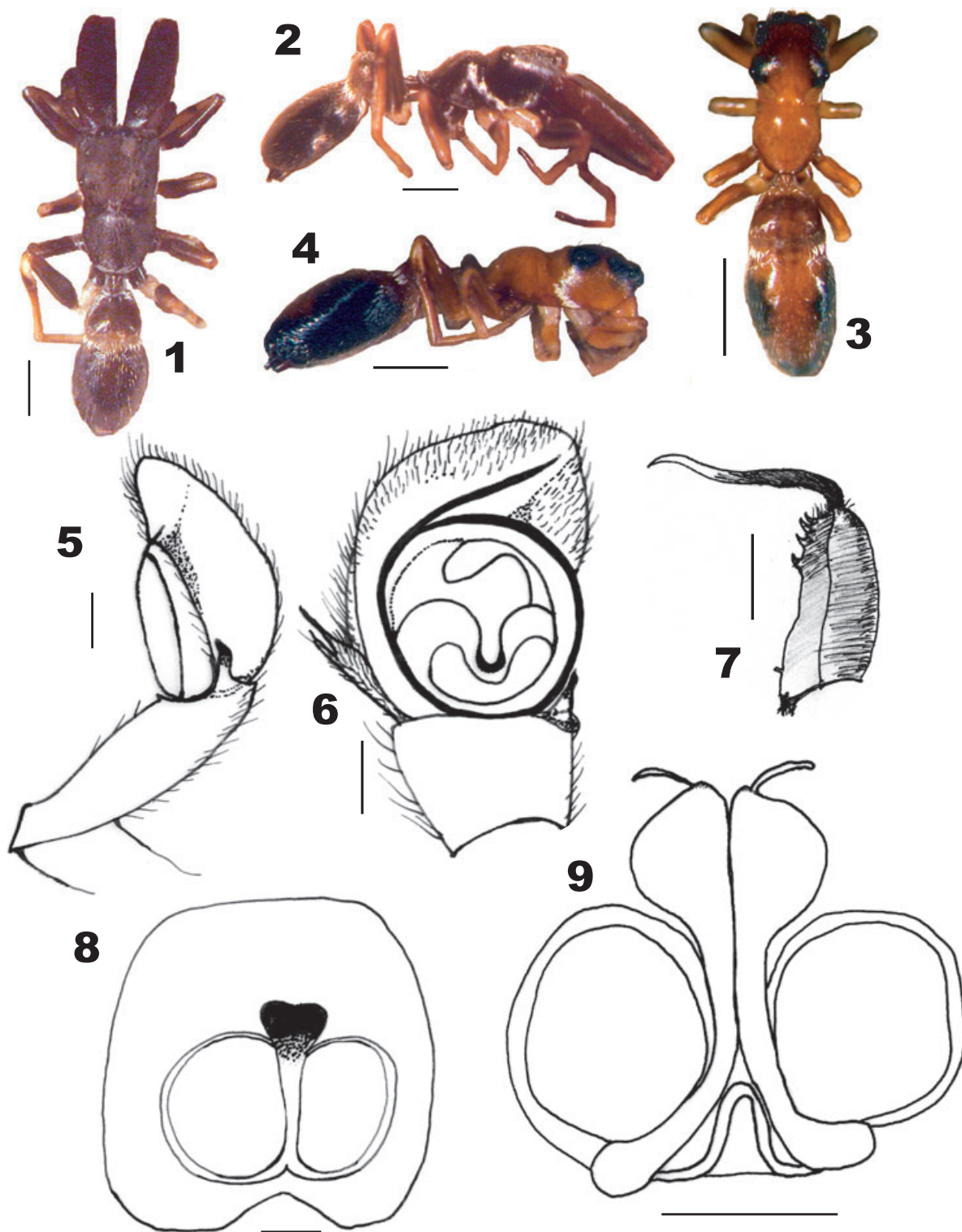
Etymology. The specific name is an adjective chosen because of the red colour that most individuals have on their carapace.

Material examined. *Holotype*: QM S66648 (male, collected by FS Ceccarelli in Townsville 19°19'39"S, 146°45'32"E, 11 March 2003). *Allotype*: QM S88158 (female, collected by FS Ceccarelli in Townsville 19°19'39"S, 146°45'27"E, 18 July 2005). *Paratypes*: QM S73296 (female, collected by BM Baehr 1 km south of Dimbulah, 5 June 1993), AM KS93121 (male, collected by FS Ceccarelli in Townsville, 5 November 2005), AM KS18335 (female, collected by M Zabka north of Kuranda, 10 June 1982), AM KS81341 (female, collected by M Zabka in the Atherton area, 18 October 2002), AM KS5770 (male, collected by NC Coleman in Wolfram, 15 June 1970).

Diagnosis. Male chelicerae usually two-thirds the length of the carapace, with four retromarginal teeth at the distal and one at the proximal end of each chelicera. The bulb of the male palp is three-quarters of the total length of the cymbium; the tibial segment has a poorly developed flange, and a small, sinuous apophysis, and the whole segment is longer than wide at its base. The female epigyne has D-shaped spermathecae, and a continuous median pouch. *M. rubra* can be distinguished from *M. erythrocephala* and *M. striatipes* (paratypes examined from QM) by the number of spines on the first pair of legs, where *M. rubra* has a pair of spines on the metatarsi, and a single spine and a pair on the tibia, whereas both *M. erythrocephala* and *M. striatipes* have two pairs of spines on the metatarsi of legs I. In addition, male *M. rubra* have protruding chelicerae with four retromarginal teeth at the distal- and one at the proximal end of each chelicera, whereas the chelicerae of *M. striatipes* males do not protrude.

Description. *Male*: *Carapace*: ranging from orange-brown to red-brown or black with sparse white hairs, wedge-shaped depressions behind the anterior lateral eyes. *Eyes*: surrounded by black pigmentation, procurved anteriors surrounded by hairs. *Clypeus*: fringed with white hairs. *Chelicerae*: rugulose and protruding, orange-brown to red-brown with black pigmentation at distal end, no fang apophysis, retromarginal dentition: one tooth on proximal end and four on distal end. *Maxillae* and *labium*: orange with black hairs and setae. *Sternum*: orange-brown with some black markings. *Opisthosoma*: distal end black, front part red-brown to orange-brown or in some cases black; sparsely covered with fine white hairs, central depression more densely fringed with white hairs. *Legs*: slender. Legs I: tarsus black; metatarsus black and orange; tibia light orange with black markings; patella light orange with black markings; femur orange brown and black; trochanter cream; coxa cream. Legs II: tarsus cream; metatarsus black and orange; tibia light orange with black markings; patella light orange with black markings; femur orange brown

¹This species' presence in Australia remains doubtful (GB Edwards and J Proszynski pers. comm. 2010).



Figs 1–9. *Myrmarachne rubra* sp. nov., male (1, 2, 5–7): 1, 2, habitus, dorsal (1) and lateral (2) views; 5, 6, palpal tibia, cymbium and bulb, retrolateral (5), and ventral (6) views; 7, chelicera medio-lateral view; female (3, 4, 8, 9): 3, 4, habitus, dorsal (3) and lateral (4) views; 8, epigyne before maceration; 9, epigyne showing internal ducts. Scale lines: 1 mm for Figures 1–4; 100 μ m for Figures 5, 6, 8, 9; 500 μ m for Figure 7.

and black; trochanter cream; coxa cream. Legs III: tarsus cream; metatarsus cream; tibia orange; patella orange; dark brown and black; femur dark brown and black; trochanter cream; coxa black. Legs IV: tarsus cream; metatarsus cream;

tibia orange; patella orange; dark brown and black; femur dark brown and black; trochanter cream; coxa yellow and black. Legs I spination: metatarsus 2, tibia 1–2, patella 0. *Palp*: tibial apophysis relatively small, sinuous and black; flange not very

developed; cymbium and proximal depression fringed with setae; embolus coiled once around bulbous tegulum of approximately 210 µm in diameter; seminal reservoir large and marginate. *Dimensions*: total length: 3.7–4.5 mm; carapace length: 1.8–2.4 mm; ratio of carapace-to-chelicera length: 1.22–1.67; Ratios AME : ALE : PME : PLE: 5.78:1.41:1:2.7.

Female: Carapace: same as ♂. *Eyes*: same as ♂. *Clypeus*: fringed with white hairs. *Chelicerae*: rugulose, non-protruding, mainly black with some dark red pigmentation. *Maxillae* and *labium*: same as ♂. *Sternum*: same as ♂. *Opisthosoma*: same as ♂, but often more bulbous. *Legs*: slender. Legs I: tarsus black; metatarsus light orange; tibia light orange and cream; patella light orange and cream; femur light orange; trochanter cream; coxa cream. Legs II: same as legs I. Legs III and IV: same as legs I and II, but slightly darker. Legs I spination: metatarsus 2, tibia 1–2, patella 0. *Epigyne*: orange and dark-red, continuous median pouch, spermathecae simple (D-shaped), ducts relatively wide. *Dimensions*: total length: 4.0–4.7 mm; carapace length: 2.0–2.5 mm; Ratios AME : ALE : PME : PLE: 5.78:1.41:1:2.7.

Distribution. Specimens recorded from north Queensland, Australia: Atherton (17°17'S, 145°30'E), Dimbulah (17°08'S, 145°04'E), Kuranda (16°48'S, 145°35'E), Townsville (19°13'S, 146°48'E) and Wolfram (17°05'S, 144°55'E); other areas unknown.

Remarks. *Myrmarachne rubra* belongs to the *volatilis* group. It is a visual mimic of the ant *Opisthopsis haddoni* Emery, 1893 (Formicidae: Formicinae). *M. rubra* can be found on tree trunks (mainly eucalyptus trees of the species *Eucalyptus platyphylla*), usually closely associated with their model ant. Males and females usually build retreats under loose pieces of bark, but male retreats tend to be sheet-like, and males are more likely to be found walking up the tree trunks. Females build more wool-like retreats with thicker strands of silk 'anchoring' the retreat to the tree, and lay between 10 and 20 eggs in their retreat, which they stay with until the spiderlings hatch. During instars 3 and 4, *M. rubra* look like small black ants from the genus *Crematogaster* Lund, 1831 (Formicidae: Myrmicinae).

***Myrmarachne aurea* sp. nov.**

Figures 10–18

Etymology. This name derives from the adjective *aurea*, chosen because of the golden appearance of the opisthosoma.

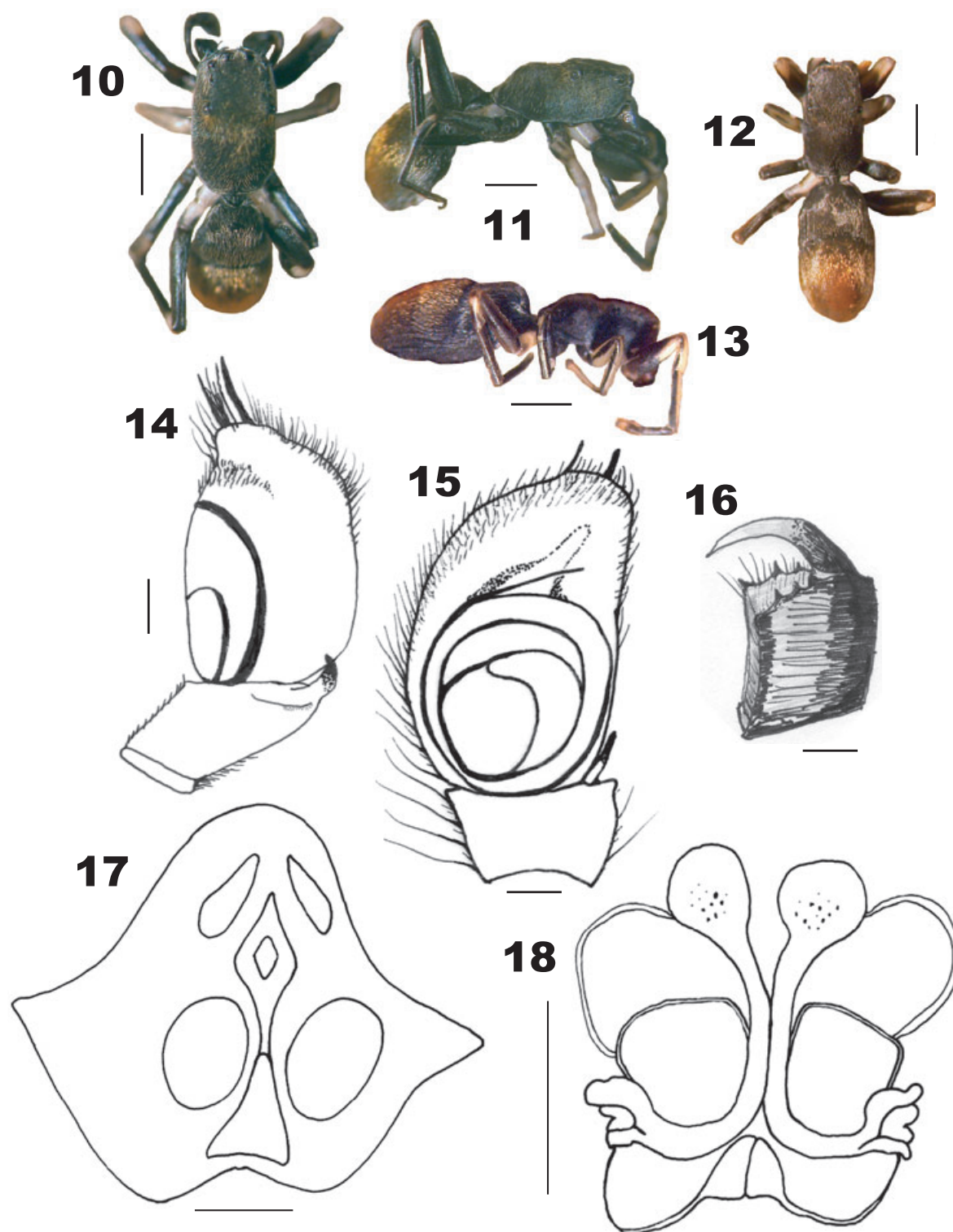
Material examined. *Holotype*: AM KS93119 (male collected by FS Ceccarelli in Townsville, 19°19'40"S, 146°45'33"E, 16 November 2005). *Allotype*: QM S66649 (female collected by FS Ceccarelli in Townsville, 19°19'39"S, 146°45'32"E, 4 June 2003). *Paratypes*: QM S41386 (female collected by MF Downs in Townsville, 1 June 1981); QM S20339 (female collected by M Shaw near Canowindra, 14 March 1992); QM S73293 (male collected by BM Baehr at Mary Creek 25 km south of Musgrave, Northern Territory, 29 May 1993); AM KS56467 (two females collected by G Milledge in Kenilworth state forest, 7

May 1998); AM KS93120 (female collected by FS Ceccarelli in Townsville, 16 November 2005).

Diagnosis. Males *chelicerae* are not protruding when viewed from above, and contain three promarginal and three retromarginal teeth. The tibia of the male palps has a poorly developed flange, and a sinuous apophysis; the diameter of the tegulum is approximately two-thirds the length of the cymbium. The cymbium contains two larger setae at the distal tip. Females have small, round spermathecae that are separated from each other; there are also two lateral pouches that are found in contact with each other. *M. aurea* can be distinguished from *M. luctuosa* by the fact that *M. aurea* male *chelicerae* do not protrude.

Description. *Male*: Carapace: black with few white hairs, wedge-shaped depression with more dense white hairs. *Eyes*: procurved, surrounded by white hairs. *Clypeus*: fringed with white hairs. *Chelicerae*: not protruding, black with a dark red fang, retromarginal dentition: three teeth, promarginal dentition: three teeth. *Maxillae* and *labium*: black maxillae with a yellow inner edge, labium black. *Sternum*: black. *Opisthosoma*: black and yellow with fairly densely packed golden yellow hairs, giving the opisthosoma a golden sheen, slightly constricted in the middle. *Legs*: slender. Legs I: tarsus black; metatarsus black; tibia yellow with black marks, typically a line running down the length of the leg segment; patella same as tibia; femur same as tibia and patella; trochanter black and yellow; coxa yellow/cream coloured. Legs II: tarsus yellow with black markings; metatarsus yellow with black markings; tibia yellow with black markings; patella yellow with black markings; femur yellow with black markings; trochanter yellow with black markings; coxa black. Legs III: tarsus yellow; metatarsus black; tibia black; patella yellow; femur black; trochanter black; coxa black. Legs IV: tarsus black; metatarsus black; tibia black; patella black and yellow; femur black; trochanter yellow and black; coxa yellow. Legs I spination: metatarsus 2-1, tibia 2-2-2, patella 0. *Palp*: tibial apophysis with a black sinuous hook, embolus coiled around bulbous tegulum, about 200 µm in diameter (about two-thirds the length of the cymbium), large, marginate seminal reservoir, cymbium and proximal depression fringed with setae with two larger ones at the distal end. *Dimensions*: total length: 4.5–5.5 mm; carapace length: 1.8–2.5 mm; ratio of carapace-to-chelicera length: 2–4; Ratios AME : ALE : PME : PLE: 4.12:1.61:1:2. *Female*: Carapace: same as ♂. *Eyes*: same as ♂. *Clypeus*: same as ♂. *Chelicerae*: same as ♂. *Maxillae* and *labium*: same as ♂. *Sternum*: same as ♂. *Opisthosoma*: same as ♂, but occasionally more bulbous. *Legs*: same as ♂. Legs I spination: metatarsus 2-2, tibia 2-2-2, patella 0. *Epigyne*: black and yellow pigmentation, lateral pouches separate, spermathecae simple and round, ducts relatively wide. *Dimensions*: total length: 3.8–4.5 mm; carapace length: 1.8–2.1 mm; Ratios AME : ALE : PME : PLE: same as ♂.

Distribution. Specimens recorded from Queensland, Australia: Canowindra (33°35'S, 148°38'E), Townsville (19°13'S, 146°48'E) and Kenilworth state forest (27°41'S, 147°46'E); and Northern Territory, Australia: Musgrave (26°05'S, 132°00'E); other areas unknown.



Figs 10–18. *Myrmarachne aurea* sp. nov., male (10, 11, 14–16): 10, 11, habitus, dorsal (10) and lateral (11) views; 14, 15, palpal tibia, cymbium and bulb, retrolateral (14), and ventral (15) views; 16, chelicera medio-lateral view; female (12, 13, 17, 18): 12, 13, habitus, dorsal (12) and lateral (13) views; 17, epigyne before maceration; 18, epigyne showing internal ducts. Scale lines: 1 mm for Figures 10–13; 100 μ m for Figures 14, 15, 17, 18; 200 μ m for Figure 16.

Remarks. *Myrmarachne aurea* belongs to the *volatilis* group, and is widely distributed in Townsville and surrounding areas, and can be found either walking on trees, in particular eucalypts (*E. platyphylla* and *Corymbia tessellaris*), or inside

retreats under loose bits of bark. It is not uncommon to find more than one retreat under a piece of bark, with several *M. aurea* (typically between two and six, often at different instar stages), each living in a separate retreat. The model ant species

for *M. aurea* is *Polyrhachis* nr. *obtusa* Smith, 1857 (Formicidae: Formicinae). *M. aurea* and its model ant species *P.* nr. *obtusa* are found living in sympatry, but not always on the same tree. *M. aurea* do not develop the golden-haired opisthosoma until they reach adulthood. Before that, the spiderlings are of a dark brown colour with white markings on both the pro- and opisthosoma.

***Myrmarachne gurgulla* sp. nov.**

Figures 19–27

Etymology. This name comes from the adjective ‘gurgul’ meaning black in Wulguru (indigenous language of the Townsville area), chosen because of the black colouration of the spider’s cuticle.

Material examined. *Holotype*: QM S66650 (male collected by FS Ceccarelli in Townsville, 19°19′34″S, 146°45′31″E 29 April 2003). Unregistered male (collected by FS Ceccarelli in Townsville, 7 October 2003); unregistered male (collected by FS Ceccarelli in Townsville, 7 July 2005); unregistered female (collected by FS Ceccarelli in Townsville, 5 June 2003).

Diagnosis. Male chelicerae protrude, but are only about half the length of the carapace, containing one retromarginal tooth at the proximal end, and three at the distal end. The tibial segment of the palp is shorter than the width at its proximal end; the flange is well-developed and the tibial apophysis is black, sinuous and relatively large. The diameter of the tegulum is approximately four-fifths the length of the cymbium. The female epigyne has oval-shaped spermathecae and a continuous median pouch. *M. gurgulla* can be distinguished from *M. erythrocephala* and *M. striatipes* by the spination of the tibiae of the first pair of legs, where *M. gurgulla* has one spine (and the females have an additional pair), whereas *M. erythrocephala* has none, and *M. striatipes* has three pairs of spines on their tibiae.

Description. *Male*: *Carapace*: all black, wedge-shaped depression in centre fringed with white hairs. *Eyes*: anterior medians procurved. *Clypeus*: fringed with white hairs. *Chelicerae*: all black and protruding, but when seen from the side at a slight downward angle, retromarginal dentition: one tooth at proximal end and two large and one small tooth on distal end; no fang apophysis. *Maxillae* and *labium*: black, maxillae with dark red margins. *Sternum*: black. *Opisthosoma*: black, sparsely covered with white hairs, central depression fringed with dense white hairs. *Legs*: slender. Legs I: tarsus black; metatarsus black; tibia red-brown and dark brown; patella yellow and red-brown; femur yellow and black; trochanter yellow and black; coxa white/cream. Legs II: tarsus dark yellow; metatarsus dark yellow; tibia dark yellow; patella dark yellow; femur dark yellow with black marks; trochanter yellow with black marks; coxa white/cream. Legs III: tarsus yellow; metatarsus yellow; tibia yellow and red-brown; patella dark brown; femur red-brown and black; trochanter red-brown and black; coxa black. Legs IV: tarsus yellow; metatarsus yellow; tibia red-brown and black; patella dark brown; femur brown and black; trochanter white; coxa white and black. Legs I spination: metatarsus 2-2, tibia 1, patella 0. *Palp*: tibial apo-

physis with a sinuous black hook, flange well-developed, embolus coiled once around bulbous tegulum, about 170 µm in diameter (making up four-fifths of the length of the cymbium), seminal reservoir marginate, cymbium and proximal depression fringed with setae. *Dimensions*: total length: 4.0–4.8 mm; carapace length: 1.7–2.1 mm; ratio of carapace-to-chelicera length: 1.48–2.11; Ratios AME : ALE : PME : PLE: 4:1.8:1:2.5. *Female*: *Carapace*: same as ♂. *Eyes*: same as ♂. *Clypeus*: same as ♂. *Chelicerae*: not protruding, black. *Maxillae* and *labium*: same as ♂. *Sternum*: same as ♂. *Opisthosoma*: same as ♂. *Legs*: slender. Legs I: tarsus white with black markings; metatarsus white with black markings; tibia red-brown; patella white with black markings; femur brown with black markings; trochanter white with black markings; coxa white with black markings. Legs II: tarsus cream; metatarsus cream, tibia cream with brown markings; patella cream with brown markings; femur cream with brown markings; trochanter cream; coxa cream. Legs III: tarsus white; metatarsus white; tibia red-brown and white; patella red-brown and white; femur red-brown and black; trochanter black and red-brown; coxa black. Legs IV: tarsus white; metatarsus white; tibia red-brown; patella white with brown markings; femur brown and black; trochanter light brown; coxa white. Legs I spination: metatarsus 2-2, tibia 1-2, patella 0. *Epigyne*: white, surrounded by red-brown pigmentation; continuous median pouches, spermathecae simple and oval-shaped, ducts relatively wide, not touching along the whole length. *Dimensions*: total length: 4.5–5.0 mm; carapace length: 2.0–2.3 mm; ratios AME : ALE : PME : PLE: 3.5:1.8:1:2.2.

Distribution. Specimens recorded from north Queensland, Australia: Townsville (19°13′S, 146°48′E); other areas unknown.

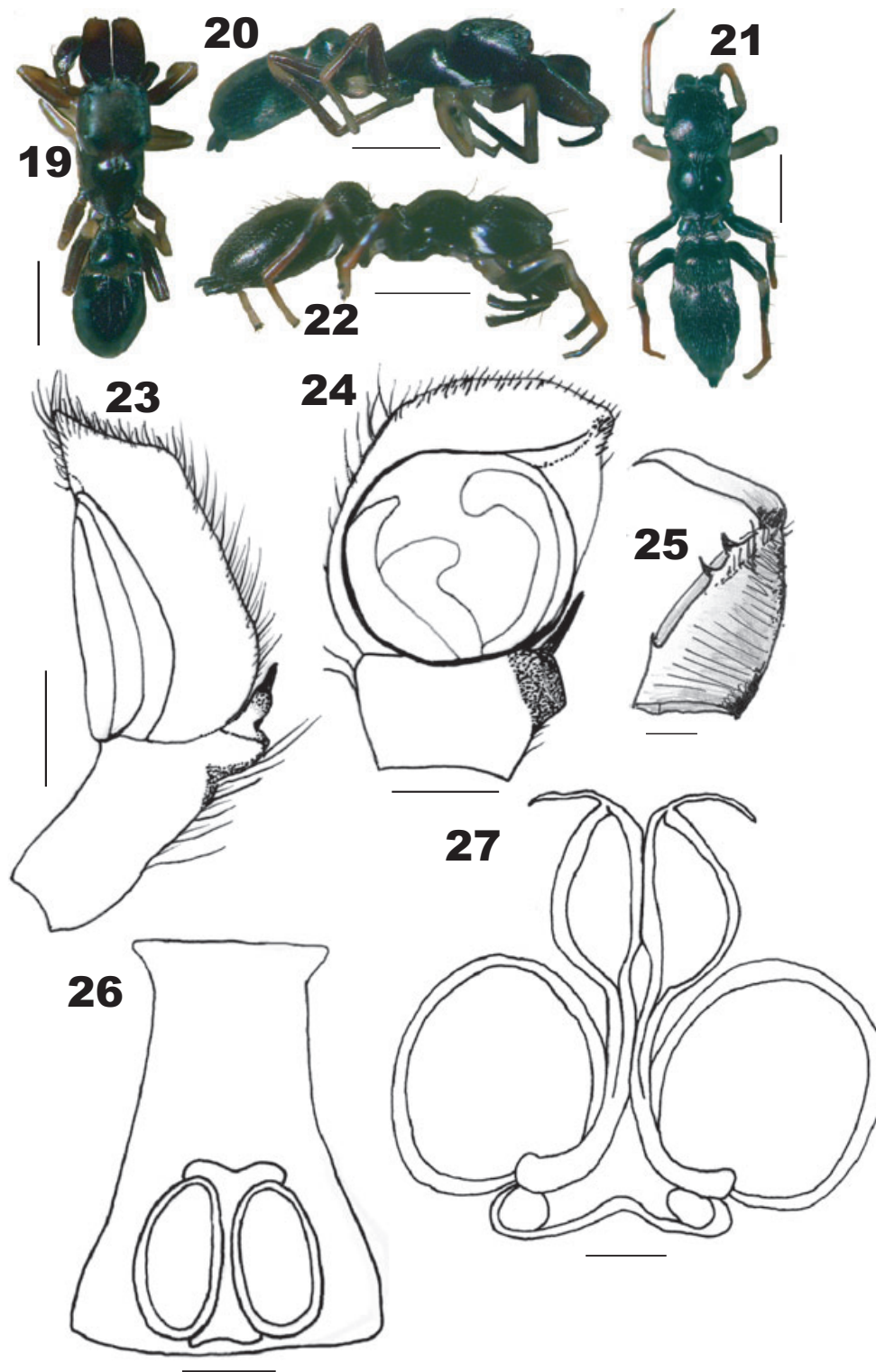
Remarks. *Myrmarachne gurgulla* belongs to the *volatilis* group, and is the mimic of the ant *Tetraponera punctulata* Smith 1877 (Formicidae: Pseudomyrmecinae), positively associated with its ant model. This species is the least abundant in Townsville of the four species described here, and can easily be mistaken for *M. rubra*. The spiders can be found walking on trees (mainly eucalyptus trees of the species *E. platyphylla*), or inside retreats they build under pieces of bark, or in small indentations of the tree trunk. Males build sheet-like retreats, whereas the female retreats are more wool-like in appearance. Females lay between 10 and 15 eggs. The spiderlings are black during every stage of their life cycle.

***Myrmarachne smaragdina* sp. nov.**

Figures 28–36

Etymology. Named after its model ant, *Oecophylla smaragdina* (Fabricius, 1775) (Formicidae: Formicinae), the name *smaragdina* deriving from the adjective denoting the green colour of the gaster.

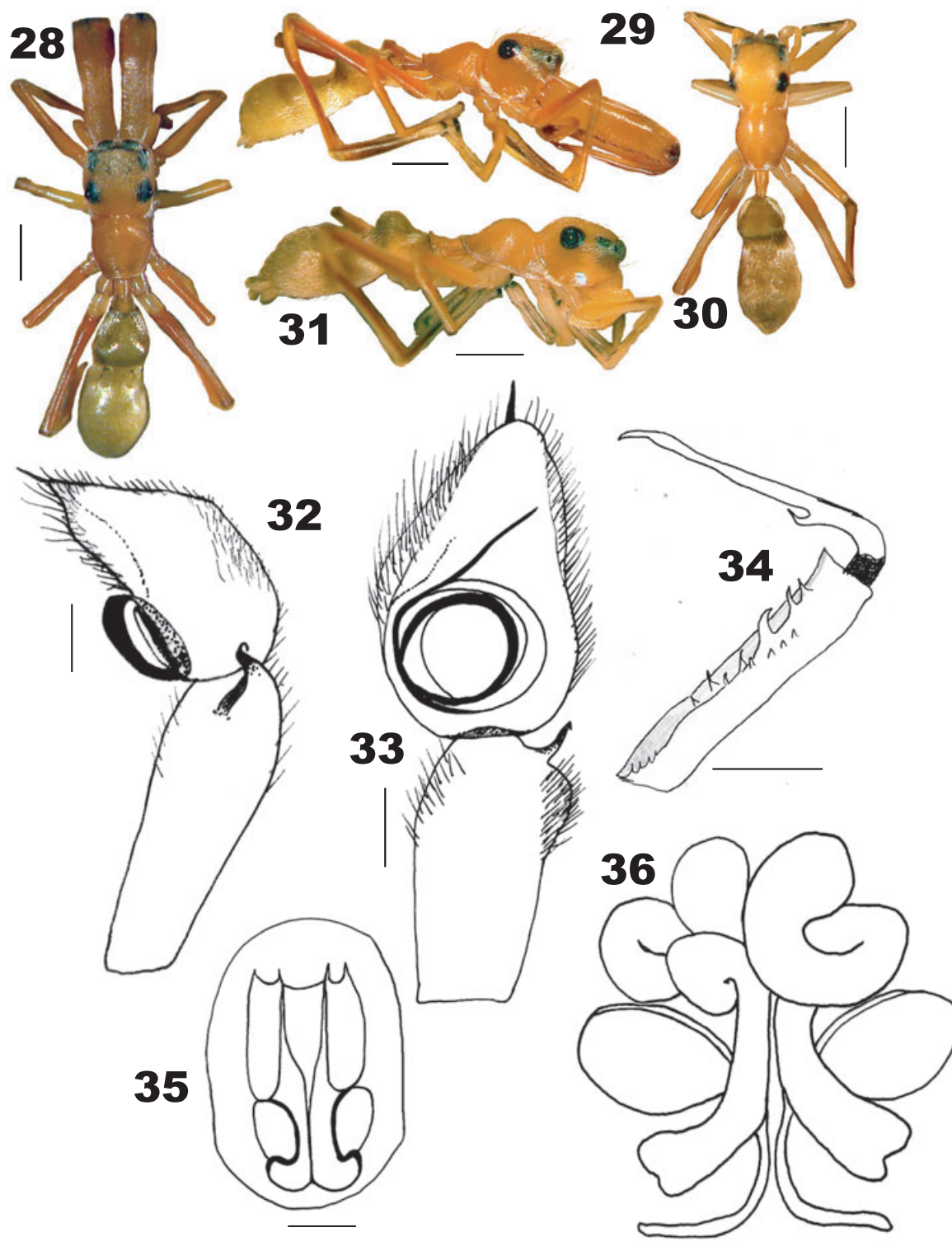
Material examined. *Holotype*: QM S66653 (male, collected by FS Ceccarelli on Magnetic Island, 19°09′11″S, 146°50′52″E, 28 August 2003). *Allotype*: QM S66652 (female, collected by FS Ceccarelli on Magnetic Island, 19°09′11″S, 146°50′52″E, 28 August 2003). *Paratypes*: QM S403 (male,



Figs 19–27. *Myrmarachne gurgulla* sp. nov., male (19, 20, 23–25): 19, 20, habitus, dorsal (19) and lateral (20) views; 23, 24, palpal tibia, cymbium and bulb, retrolateral (23), and ventral (24) views; 25, chelicera medio-lateral view; female (21, 22, 26, 27): 21, 22, habitus, dorsal (21) and lateral (22) views; 26, epigyne before maceration; 27, epigyne showing internal ducts. Scale lines: 1 mm for Figures 19–22; 100 µm for Figures 23, 24, 26; 500 µm for Figure 25; 50 µm for Figure 27.

collected by GB Monteith by the McIver river, 40 miles north of Cooktown, 7 May 1970); QM S73295 (female, collected by BM Baehr 3 km north of Mudjinberri, 4 November 1984); AM KS18304 (female collected by R Mascord in Edmonton, 2

September 1976); AM KS19169 (two females collected by D Levitt in Angurugu via Darwin, Northern Territory, 28 May 1969); AM KS44998 (male, collected by D Citin at Berrimah research station, 24 March 1988); AM KS44999 (male,



Figs 28–36. *Myrmarachne smaragdina* sp. nov., male (28, 29, 32–34): 28, 29, habitus, dorsal (28) and lateral (29) views; 32, 33, palpal tibia, cymbium and bulb, retrolateral (32), and ventral (33) views; 34, chelicera medio-lateral view; female (30, 31, 35, 36): 30, 31, habitus, dorsal (30) and lateral (31) views; 35, epigyne before maceration; 36, epigyne showing internal ducts. Scale lines: 1 mm for Figures 28–31, 34; 100 μ m for Figures 32, 33, 35 and 36.

collected by D Citin at Berrimah research station, 24 March 1988); AM KS5771 (female, collected by R Mascord in Edmonton, 27 August 1970); AM KS93122 (male, collected by FS Ceccarelli in Townsville, 4 January 2006).

Diagnosis. Male chelicerae about the same length as the carapace, containing 18 retromarginal teeth, and a fang apophysis. The tibial apophysis of the male palp is black and hooked, and the flange is not developed. The diameter of the tegulum is

approximately one-third of the length of the cymbium; the distal end of the cymbium contains one major seta. The female epigyne contains looped spermathecae (into a figure-of-eight) and lateral pouches. *M. smaragdina* can be differentiated from *M. lupata* by the relative length of the male chelicerae, by the orientation of the embolus and by the spination of the first pair of legs. The chelicerae of male *M. lupata* are described as being longer than the carapace by a quarter of its length, whereas the chelicerae of *M. smaragdina* are about the same length as the carapace. In the male palps of *M. lupata*, the embolus points straight towards the tip of the cymbium, whereas the depression in the cymbium of *M. smaragdina* forces the embolus to lie at a 45° angle relative to the longitudinal line of the cymbium. Finally, *M. lupata* has no spines on its first pair of legs, whereas *M. smaragdina* has two pairs of spines on the metatarsus, and four pairs on the tibia of legs I.

Description. *Male:* Carapace: orange/light brown with black pigmentation around the eyes; sparsely covered with white hairs; wedge-shaped constriction in the middle of the carapace. *Eyes:* procurved AMs, fringed with hairs and black pigment. *Clypeus:* fringed with white hairs. *Chelicerae:* protruding, orange/light brown with black pigmentation at the distal end; fang apophysis present, retromarginal dentition: 18 teeth (3 large and 15 small ones). *Maxillae* and *labium:* maxillae cream with brown margins. *Sternum:* yellow and orange. *Opisthosoma:* green with sparse white hairs, constriction in the middle fringed with more white hairs. *Legs:* slender. Legs I: tarsus white; metatarsus white; tibia light orange; patella light orange; femur light orange; trochanter white; coxa orange/light brown. Legs II: tarsus white; metatarsus white; tibia light orange; patella light orange; femur cream; trochanter white; coxa orange/light brown. Legs III: tarsus white; metatarsus white; tibia light orange; patella light orange; femur light orange; trochanter white; coxa orange/light brown. Legs IV: tarsus white; metatarsus white; tibia light orange; patella light orange; femur light brown; trochanter white; coxa orange/light brown. Legs I spination: metatarsus 2-2, tibia 2-2-2-2, patella 0. *Palp:* tibial apophysis black, with a backward-curved distal hook; flange not very developed; cymbium and proximal depression fringed with setae, with one large seta at the distal end of the cymbium; embolus coiled 1 1/2 times around bulbous tegulum of approximately 100 µm in diameter (about one-third of the length of the cymbium); seminal reservoir not very large. *Dimensions:* total length: 4.0–6.2 mm; carapace length: 2.7–3.1 mm; ratio of carapace-to-chelicera length: 0.75–1.2; Ratios AME : ALE : PME : PLE: 3.29:1.13:1:1.62. *Female:* Carapace: same as ♂. *Eyes:* same as ♂. *Clypeus:* same as ♂. *Chelicerae:* non-protruding, light brown. *Maxillae* and *labium:* same as ♂. *Sternum:* same as ♂. *Opisthosoma:* same as ♂. *Legs:* slender, same as ♂. Legs I spination: same as ♂. *Epigyne:* white and orange/brown; lateral pouches separate, spermathecae simple, in a figure-of-eight configuration. *Dimensions:* total length: 5.5–6.0 mm; carapace length: 2.6–2.9 mm; Ratios AME : ALE : PME : PLE: 3.31:1.10:1:1.59.

Distribution. Specimens recorded from Queensland, Australia: Cooktown (15°30'S, 145°16'E), Townsville (19°13'S,

146°48'E) and Edmonton (17°02'S, 145°46'E); Northern Territory, Australia: Angurugu (14°00'S, 136°25'E), Berrimah research station (12°45'S, 130°95'E) and Mudjinberri (12°05'S, 132°88'E); other areas of distribution unknown.

Remarks. *Myrmarachne smaragdina* belongs to the *tristis* group, mimics the green tree ant *Oecophylla smaragdina* (Formicinae), and can be found in close association to model ant colonies. A previous study (where *M. smaragdina* is referred to as *Myrmarachne* sp. F) has shown that this species can distinguish between ants and other ant-mimics (Ceccarelli 2009). As with their model ants *M. smaragdina* typically occurs on trees in the proximity of creeks, with no apparent preference for the type of tree they live on. The retreats are usually built on the upper surface of leaves, the males building sheet-like retreats, and the females building woolly-looking ones, often with 'anchoring' threads of silk, joining the retreat and the leaf. Retreats have been found on the outside of *O. smaragdina* nests themselves, although this is a rare occurrence. *M. smaragdina* have also been found in leaf-litter, but this is presumably because the leaves on which the retreats were built fell from the tree. The females lay between 15 and 20 eggs, and the spiderlings have a brown carapace and a black opisthosoma during the first two instar stages after leaving the egg sac, bearing a close resemblance to ants of the genus *Crematogaster*. The last instar before adulthood looks like the smaller workers from *O. smaragdina* colonies, with the same colour patterns, except for more white pigmentation on the opisthosoma.

Comparison of species

Morphological differences

As mentioned previously in several papers (Wanless 1978; Berry *et al.* 1996), the genitalia of *Myrmarachne* species are not always differentiated well enough to use them as a discriminating feature. However, in this case the female genitalia do show considerable differentiation. *M. rubra* and *M. gurgulla* can be similar-looking because of the degree of colour polymorphism in *M. rubra*, which ranges from bright red to very dark red (almost mistakable for black – the colour of *M. gurgulla*). A feature that seems to be consistently similar between individuals of the same species is the patterns of the leg coloration (even though the colour hues may vary between individuals). The leg patterns vary slightly between sexes in *M. rubra* and *M. gurgulla*, which means that both the pattern of males and females need to be known. The male cheliceral dentition also varies between the species, as well as the proportion of the chelicera-to-carapace length in males (see Figs 37,38). *Myrmarachne* males with enlarged chelicerae are thought to resemble ants with a parcel in their mandibles, making the *Myrmarachne* compound mimics (Nelson & Jackson 2006). The enlarged chelicerae have also been said to be a sexually selected character, as they complicate feeding (Pollard 1994). Comparing the molecular phylogeny of the *Myrmarachne* species (Ceccarelli & Crozier 2007) with the cluster analysis tree (Fig. 38) shows that the evolution of

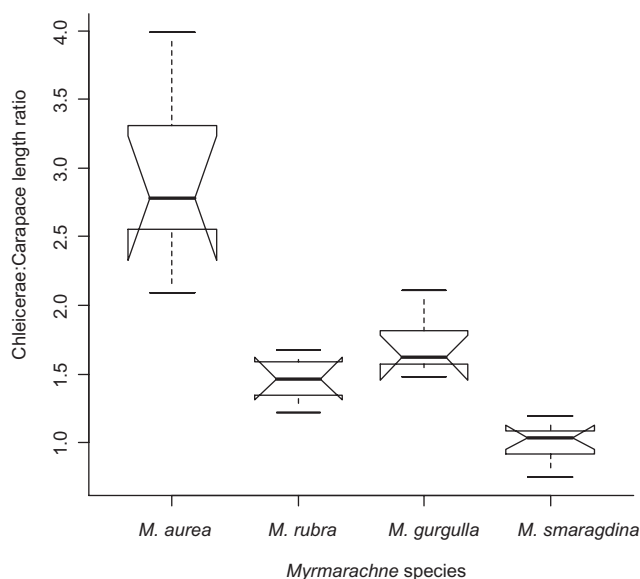


Fig. 37. Notched box plot of chelicera-to-carapace length ratio for the males of the four *Myrmarchne* species (ANOVA: $F = 39.25$, $P < 0.0001$)

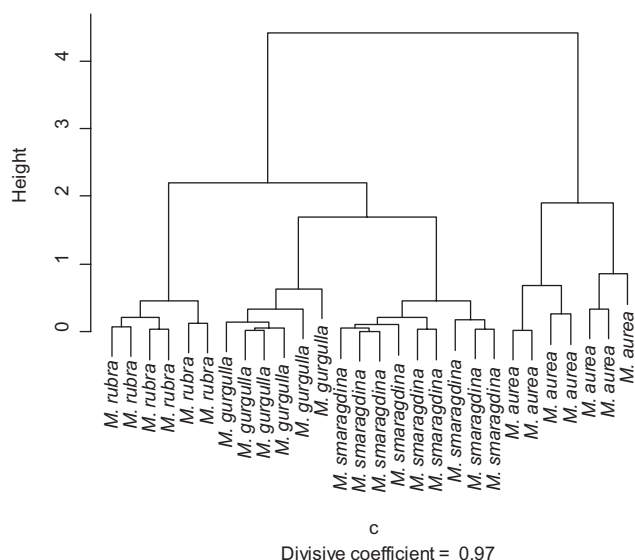


Fig. 38. Dendrogram showing the divisive properties of the chelicera-to-carapace length ratio of the four *Myrmarchne* species from Townsville.

the *Myrmarchne* species is not reflected in the length of the male chelicerae (in Ceccarelli & Crozier (2007), *Myrmarchne* form A and E are *M. rubra*, form B is *M. aurea*, form D is *M. gurgulla* and form F is *M. smaragdina*). This means that the lengthening of the male chelicerae in *Myrmarchne* species is most likely to have evolved independently to the *Myrmarchne* species evolution. For the females, epigynal structure is consistent within species while containing enough differences between species to be able to identify the species.

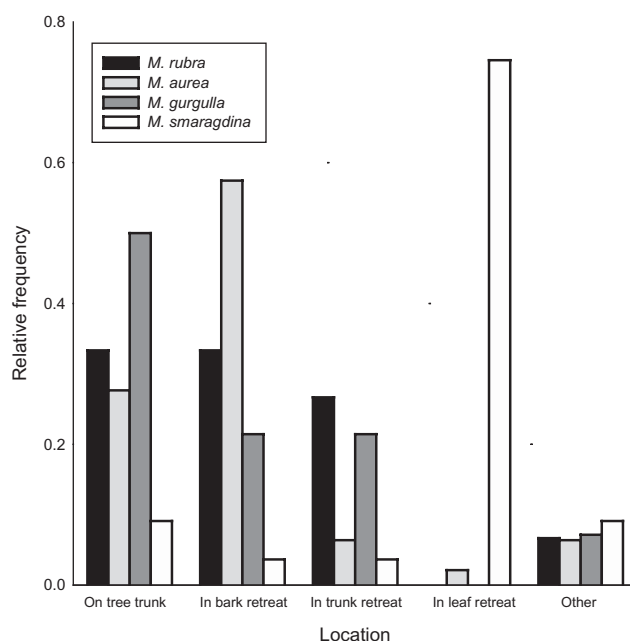


Fig. 39. Relative frequency of places where each *Myrmarchne* species was collected from in Townsville ('On tree trunk', found walking on the trunk of a tree; 'Inside bark retreat', was found inside a retreat it had built under a loose piece of bark; 'Inside trunk retreat', was found inside a retreat it had built in a depression on the tree trunk; 'Inside leaf retreat', was found inside a retreat built on a leaf; 'Other', was found walking on the ground, on the side of buildings and in other places) ($\chi^2_{12} = 112.75$, $P < 0.001$).

Ecological and behavioural differences

Although the four *Myrmarchne* species described here are almost exclusively arboreal, they display variations in their micro-habitats. This can be seen by looking at the different places where the individuals were collected from (see Fig. 39). For example, more than any other species *M. smaragdina* was found inside retreats on the surfaces of leaves, whereas *M. rubra* was found more frequently inside retreats built in depressions on tree trunks than the other species. *M. aurea* was found inside retreats built under loose pieces of bark more frequently than the other species. These ecological differences show that the *Myrmarchne* species in Townsville have differentiated not only in morphology and biology, but also in ecology, living in microhabitats preferred by their respective ant models. Even *Myrmarchne* species that preferentially build their retreats on leaves display subtle differences: *M. smaragdina* has – during the course of this study – been observed living in retreats on the upper surface of leaves, whereas *M. lupata* seems to build its retreats on the lower surface of leaves (Jackson 1982). Previous studies on the four *Myrmarchne* species described here have shown that they also display versatility and interspecific differences in behaviour. For example, despite their close association with their respective model ants, *Myrmarchne* species rarely come into contact with sympatric ant species, and mostly run away when

contact does occur (Ceccarelli 2007, where *Myrmarachne* sp. A is *M. rubra*, sp. B is *M. aurea*, sp. C is *M. gurgulla* and sp. D is *M. smaragdina*). These spiders also show interspecific differences in the way they carry out behavioural mimicry of their model ant species (Ceccarelli 2008, where *Myrmarachne* sp. A is *M. rubra*, *M.* sp. B is *M. aurea*, *M.* sp. D is *M. gurgulla* and *M.* sp. F is *M. smaragdina*).

CONCLUSION

There remain several Australian *Myrmarachne* species that need describing, and a revision of the genus is desirable. Although this paper focuses on a small number of species from a restricted geographical range, it is nevertheless a contribution (together with the papers by Bradley (1876), Hogg (1896), Koch (1879) and Simon (1900)) towards a better understanding of the Australian *Myrmarachne* fauna. The comparison between *Myrmarachne* species also shows how sympatric species have differentiated, probably because of strong selection pressure.

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