PREDATORS, PARASITOIDS, HYPERPARASITOIDS AND DETRITIVORES - A STUDY OF THE ARTHROPOD FAUNA ASSOCIATED WITH NEST AGGREGATIONS OF *ROPALIDIA PLEBEIANA*, (THE WHITE-FACED BROWN PAPER WASP)

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Summary

This study outlines the inter-related components of the nest ecosystem associated with *Ropalidia plebeiana* Richards, 1978 (Vespidae: Polistinae: Ropalidiini), the white-faced brown paper wasp, including predators, parasitoids, hyperparasitoids and detritivores that were found in nests collected from a site on the New South Wales south coast. This study builds on an earlier paper that was focused on nesting behaviours of this paper wasp.

This study confirms an earlier finding that *Arthula plebeja,* Ubaidillah & Kojima, 2009 (Ichneumonidae: Cryptinae: Cryptini) is a parasitoid of *Ropalidia plebeiana*. No published photographs previously existed of the species, and this study adds detailed photographic records.

A hyperparasitoid that attacks *Arthula plebeja – Amoturoides breviscapus* Girault, 1932 (Torymidae: Monodontomerinae) – is also photographically recorded, both male and female. Again, no prior published photographs appear to have existed. This study expands on the description of that species.

The *Ropalidia plebeiana* nest aggregations are often impacted by spider encroachments. The identity of the spider was not previously known. Two possible candidates in *Intruda signata* Forster, 1979 (Gnaphosidae; Drassodinae) and *Badumna* sp. Thorell, 1890 (Desidae: Matachiinae) are suggested. Both these spiders have the behavioural characteristics to explain their ability to live amongst the nest aggregations of *Ropalidia plebeiana* and prey on the wasps, without themselves becoming the prey.

The various predator and parasitoids threats to *Ropalidia plebeiana* cast some further light on the evolutionary pressures that contribute to the innate behaviours of philopatry, centripetal nest building, site abandonment and the resulting nest aggregation behaviour that was the subject of our earlier behavioural study.

Keywords:: *Ropalidia plebeiana, Arthula plebeja, Amoturoides breviscapus*

INTRODUCTION

In an earlier behavioural study, we characterised the nesting behaviours of *Ropalidia plebeiana* Richards, 1978 (Vespidae: Polistinae: Ropalidiini), the white-faced brown paper wasp (Warburton & Copeland 2025) (Figure 1).

One of the characteristics of this species is that it forms aggregations of hundreds of nests (Figure 2). In the earlier study, we described the innate behaviours that lead to the nesting characteristics for this species. These innate behaviours are partially the product of selection pressures from predation and parasitisation as well as weather events. This second study examines the predators and parasitoids that contribute to this selection pressure as well as investigating the wider participants in the nest community.

Our first behavioural study identified spiders and their webs as being a threat to nests and perhaps even the whole aggregation, confirming the findings of a previous study which observed predation taking place (Itô 1987). However, nothing was previously known as to which spider species are responsible for this incursion into the nesting aggregation. This study aimed to find which species might be responsible.

Additional known threats to *R. plebeiana* include parasitoid wasps. Prior research has identified an ichneumonid wasp *Arthula plebeja* Ubaidillah & Kojima, 2009 (Ichneumonidae: Criptinae: Criptini) as a parasitoid of *R. plebeiana* (Ubaidillah 2009). This second study confirms the wasps' presence in the nests studied, establishes photographic records and determines details of the life history of the parasitoid wasps.

Figure 1 ***Ropalidia plebeiana*, the white-faced brown paper wasp (Photo credit: P. Warburton)**

Figure 2 ***Ropalidia plebeiana*** **nest aggregation at Nelligen Creek, New South Wales south coast (Photo credit: P. Warburton)**

Figure 3. Spiders had established webs around the nests before the wasp emerged from their dormant period – Nelligen Creek (Photo credit: P. Warburton)

METHODS AND MATERIALS

High winds, on 4th September 2025, resulted in some nests being blown down from an aggregation at Nelligen Creek, on the south coast of New South Wales. Twenty-four of these nests (Figure 4) were collected from the ground on 7th September and were stored in clear plastic boxes at ambient temperature. The boxes were checked daily for any arthropods that had emerged.

Observations of the nest aggregations took place from September to November 2025 as part of the earlier study (Warburton and Copeland 2025). These included 28 visits to 15 nest aggregation sites, supplemented by citizen science observations of 42 nest aggregations and 94 solitary nest sites.

Figure 4. One of the nests collected for study (Photo credit: P. Warburton)

RESULTS AND DISCUSSION

Spiders – *Badumna* sp.

Most of the spider webs in the nesting aggregation were of irregular construction from thick silk with a funnel-shaped silken retreat for the spider to await prey. The webs had a dense woolly appearance (Figure 3). These characteristics indicate the webs were of *Badumna* sp. Thorell, 1890 (Desidae: Matachiinae) (Thorell, 1890; Australian Museum 2026).

Badumna spiders are passive in their strategy, awaiting prey in the entrance to their webs. They are nocturnal hunters, when the wasps are not active. They also spend the daytime in a thick protective web (Henderson 1999).
*Badumna s*piders are found throughout the year, but observation records on the Atlas of Living Australia indicate they are active in early spring, allowing them to establish their protective web retreat in August before the emergence of the wasps from dormancy.

Spiders – *Intruda signata*

A small spider, <2 mm body length, was observed to have emerged from one of the nests on 30th September – 23 days after the nests were collected. The small spider was identified by arachnologists on iNaturalist as *Intruda signata*, Hogg, 1900 (Gnaphosidae: Drassodinae) (Figure 5).

We cannot be certain that the spider is the offspring of spiders in the nesting aggregation; it could potentially have been introduced while the nest was on the ground after the wind event. However, the behavioural characteristics of *Intruda signata* certainly could explain how they might be able to successfully prey upon *Ropalidia plebeiana. Intruda signata* spiders produce thick sticky threads of web to help subdue their prey when hunting – often successfully entangling large and potentially dangerous insects. These spiders generally hunt at night when the wasps are not active and spend the day in a web retreat (Foelix 2010).

The wasps are in their dormant period during the months of June, July and August, but observational records on iNaturalist show *Intruda signata* spiders become active in early spring before the wasp numbers increase, again potentially allowing them to become established in the aggregations. It is therefore possible that there are at least two species of spider preying on the wasp aggregations: *Badumna* sp. and *Intruda signata*.

Figure 5. A spider, *Intruda signata*, found in one of the fallen nests (Photo credit: P. Warburton)

Wasps are formidable predators, and often prevail in predatory interactions between wasp and spider. This is known to be the case with many spider-hunting wasps including those in Pompiliidae, Sphecidae, Crabronidae and others (Naumann, 2019). Consequently, there are many Batesian mimics of wasps that take advantage of the predation danger that wasps represent (Pasteur 1982). When wasps are caught in a spider's web, the spider will often opt to cut the web to release the wasp, rather than risk going "fang to sting" (Eaton 2021). However, the relative size of the spider and the wasp is an important factor; small wasps may prevail against small or juvenile spiders but may not have an advantage over larger spiders (Araújo & Gonzaga 2007). For smaller, less well-defended wasps like the *Ropalidia*, being predated by spiders is not unique but is relatively poorly understood with most studies focusing on predation of spiders by wasps. Our first study showed considerable impact on the *Ropalidia plebeiana* wasp aggregations by the spider predators, which is consistent with previous observations of predation of the *Ropalidia* by spiders (Itô 1987). By extension, it can be surmised that other smaller insects in the nest ecosystem are also predated by the spiders.

The spiders were identified with the assistance of iNaturalist curators Ethan Yeoman and Ben Kurek.

Parasitoid wasps
Arthula sp. are known parasitoids of social wasps (Gauld 1984). This study confirms the presence of *Arthula plebeja,* Ubaidillah & Kojima, 2009 (Ichneumonidae: Cryptinae: Cryptini), impacting the *Roplaidia plebeiana* nesting site, as similarly observed by Ubaidillah et al. (Ubaidillah 2009).

An adult parasitoid wasp, of 7.5 mm body length, emerged from one of the nests on 7th October – 30 days after collection. This was followed by a further similar wasp from the same nest on 10th September - 33 days after collection. The wasps were identified as *Arthula plebeja*.

A photograph of a male *A. plebeja* reported in our earlier study, seems to be the first published photograph of the species (Figure 6). More detailed images are included in Appendix 1.

All *Ropalidia plebeiana* larvae that had over-wintered in the nests had already eclosed by the time the *Arthula plebeja* eclosed. The time lapse between the two emergences was about 5 weeks. Thus, the *Arthula plebeja* would mate and be ready to lay eggs by about the sixth week after the emergence of the host wasps. This indicates that the egg-laying of the parasitoid occurs very early in the life cycle of the host; at six weeks, the first host larvae may have emerged from the eggs but are still quite immature. This early parasitising is consistent with the bivoltine life cycle proposed in the initial study of the species (Ubaidillah, 2009), which suggested that a second parasitisation cycle will occur in the *Ropalidia plebeiana* larvae; the parasitoids overwintering in the nest as pupae.

The identification of the *Arthula plebeja* was confirmed by iNaturalist curator Simon Taylor.

Figure 6. A male *Arthula plebeja* reared from parasitized *Ropalidia plebeiana* larvae in one of the fallen nests (see also Appendix 1) (Photo credit: P. Warburton)

Hyperparasitoid wasps

The parasitoid *Arthula plebeja* was itself the target of a hyperparasitoid - *Amoturoides breviscapus* Girault, 1932 (Torymidae: Monodontomerinae) (Figures 7 and 8) (Girault 1932, Bouček 1978, Bouček 1988, Ubaidillah 2009). *Amoturoides breviscapus* emerged in large numbers (62 individuals) about 8 weeks after the fallen nests were collected. This large emergence contrasts with the small number of *Arthula plebeja* hosts that successfully reached adulthood (2 individuals). The *Amoturoides breviscapus* wasps were short lived and most died within 3 days of emerging. Previous studies also indicated that this hyperparasitoid attacks *Arthula plebeja* rather than *Ropalidia plebeiana* (Ubaidillah 2009). The overwhelming number of the torymid wasps relative to their host numbers suggests the importance of this hyperparasitoid in preventing the ichneumonid wasp numbers becoming a greater threat to their own host, the *Ropalidia plebeiana*.

Amoturoides breviscapus appears not to have been previously photographed; no published photographs could be found in any online databases.

Figure 7. Torymid wasp *Amoturoides breviscapus* – female (Photo credit: P. Warburton)

Figure 8. Torymid wasp *Amoturoides breviscapus* – male (Photo credit: P. Warburton)

The prior published descriptions of the species were brief and lacked some details of the differences between the sexes. *Amoturoides breviscapus* wasps have a body length of about 2.5 mm. The sexes are similar in appearance but can be distinguished by the antennae; males have thinner and slightly longer antennae than the females (Bouček 1978). In males the colouration of the antennae is testaceous except for the scape which is a lighter fulvous at the base and black distally (Appendix 2: Figures A2.1 and A2.2). Males have a slightly smaller, slimmer metasoma than females. In females, the antennae are black, except for the base of the scape which is a lighter fulvous. Females have short ovipositors (making them one of the exceptions in Torymidae where long ovipositors are more usual). In Figure 7 the ovipositor can be seen protruding at the apex of the metasoma.

The *Amoturoides breviscapus* was identified by Jeong Yoo, Royal Ontario Museum.

Dermestid beetles

Other insects associated with the nests included an adult dermestid beetle, *Anthrenus verbasci* Linnaeus, 1767 (Dermestidae: Megatominae: Anthreninae), which was found in a fallen nest. (Figure 9).

Although the presence of the dermestid beetle in the fallen nest is not proof of their activity in active nests, such activity in social hymenopteran colonies is common (Miyazaki 2009). Beekeepers for example sometimes see dermestid beetles attacking honeycombs, eggs and even larval bees, particularly if the hive has been weakened or is depleted (Graham 1992). Other studies into the fauna associated with social insect nests and even spider webs have also noted the presence of dermestid beetles (e.g., Motyka 2022). The degree of threat to the *Ropalidia plebeiana* presented by these beetles is unknown but threats in the form of damage to cells in the nest and predation of larvae are a possibility.

Figure 9. Dermestid beetle, *Anthrenus verbasci*, found in a fallen nest from the aggregation at Nelligen Creek (Photo credit: P. Warburton)

Vase-cell mud-dauber wasps

Numerous mud wasp nests, including those of vase-cell mud-daubers, *Sceliphron spp.*, were often found close to the paper wasp aggregations. (Figure 10). Two species of *Sceliphron* were seen in the area of the nest aggregations: *Sceliphron laetum* Smith, 1956 (Sphecidae: Sceliphrinae: Sceliphrini) and *Sceliphron formosum* Smith, 1956 (Sphecidae: Sceliphrinae: Sceliphrini).

To be clear, such mud wasps are found frequently on such structures – whether there are *R. plebeiana* aggregations or not. However, locations close to the *Ropalidia* aggregation appear to be favoured by the vase-cell mud daubers. For example, at Sheep

Station Creek, the small *Ropalidia* aggregation was accompanied by 17 mud clusters of dauber nests in close proximity (within 3m) whereas an adjacent identical section of bridge, that lacked a *Ropalidia* aggregation, had only 3 clusters of mud-dauber nests. Spider webs were in evidence at this aggregation site. Similarly, at Nelligen Creek, about 21 clusters of mud wasp nests were observed. At a similar bridge near Mogo that lacked an aggregation only 5 such clusters were seen.

The presence of spider-predating vase-cell mud-dauber wasp nests in the immediate vicinity of the *Ropalidia* nests seems to indicate a possible role in the interconnected ecosystem of the nest aggregations. Whilst their presence may simply corollate with the incidence of spider prey in the aggregation, there may be an incidental mutualism in the relationship with the paper wasp. The mud wasps may gain some protection for their larvae by the presence of the *Ropalidia plebeiana*; social wasps attempt to repel hyperparasitoids and predators that approach their nests (Starr 1990) and the *Sceliphron* wasps are very much at risk from such threats (Yuan 2022). In turn, the *Sceliphron* wasps, as specialist spider hunters, presumably exert a downward pressure on spider populations to the benefit of the *Ropalidia plebeiana* (Nauman 2019). There is a possible problem with this hypothesis however, in that there is no prior evidence that *Sceliphoron* wasps predate on the spider families of the species that were found in the aggregation, Gnaphosidae and Desidae. Studies have shown that *Sceliphron laetum* predates primarily on orb weaver spiders of the family Araneidae. A 2022 study of *S. formosum* in the Australian Capital Territory, showed a much wider range of prey preferences that include seven spider families and several unidentified species (Yuan 2022). However, there seem to be no records of *S. formosum* predating on Gnaphosidae and Desidae. Further study might clarify the extent to which the *Sceliphron* wasps participate in the nest ecosystem as possible predators of the spiders.

Figure 10. Vase-cell mud-dauber wasp, *Sceliphron* sp., nests in proximity to the aggregations at Nelligen Creek, NSW (Photo credit: P. Warburton)

Other elements to the nest community

Looking forward, there is more to discover and learn about this inter-dependent community. For example, the nymph of a red bug, *Dindymus* sp. Stål, 1861 (Pyrrhocoridae), was found in a fallen nest Figure 11). Most members of the Pyrrhocoridae family are seed and fruit feeders but are sometimes predatory and some feed on dead animal matter. Further investigation may reveal a role played by these bugs in this ecosystem.

It should be noted that there is at least one other known parasitoid of *Ropalidia plebeiana*, that was not observed in this study, the tachinid fly *Koralliomyia portentosa* Mensil, 1950 (Tachinidae: Goniinae; Anacamptomyiini). It is known that this parasitoid fly is also the target of the hyperparasitoid

Amoturoides breviscapus (Bouček 1988; Grissell 1995).

This study casts some light on the identity of the arthropods that are part of the nest ecosystem, highlighting the critical inter-relationships between predators, parasitoids and hyperparasitoids in the nest aggregations (Figure 12).

Figure 11. Red bug nymph, *Dindymus* sp. (Photo credit: P. Warburton)

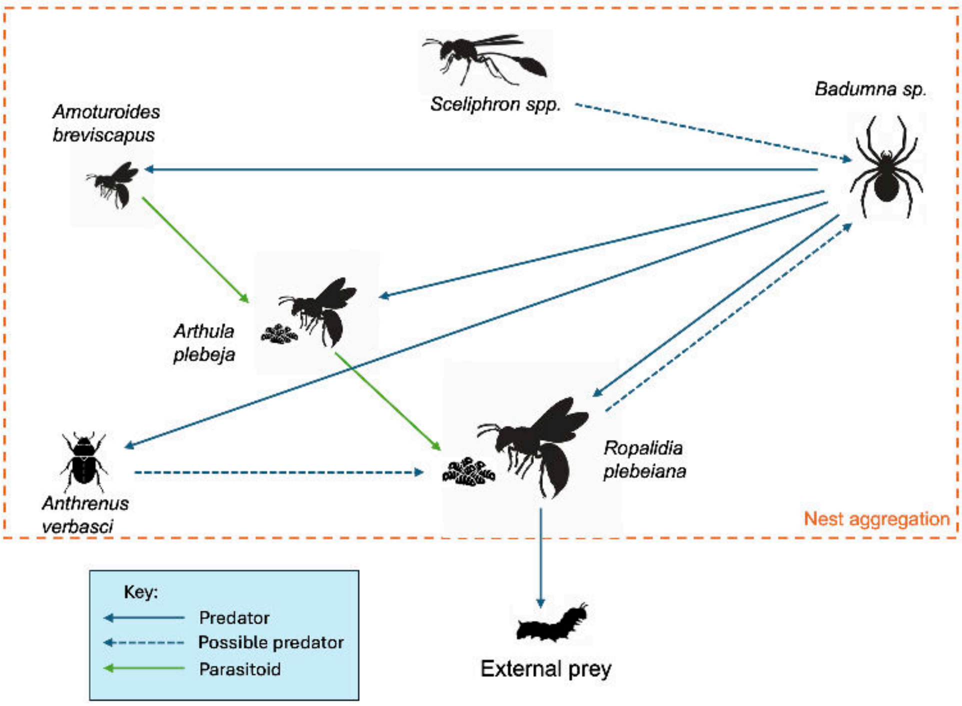

Figure 12. Proposed trophic roles in the nest community.

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Appendix 1 **(Photo credit: P. Warburton)**

Arthula plebeja (male)

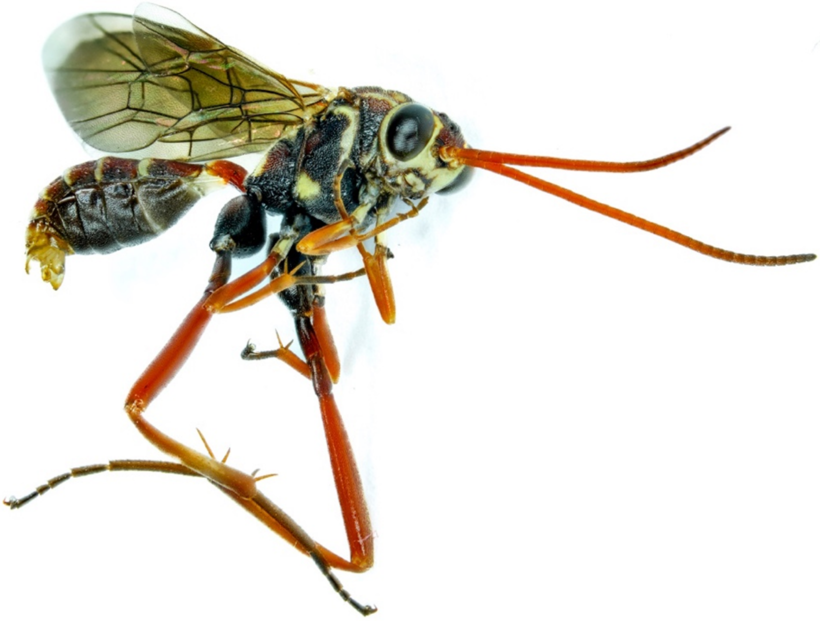

Figure A1.1

Figure A1.2

Figure A1.3

Appendix 2 (Photo credit: P. Warburton)

Amoturoides breviscapus

Figure A2.1 Female antennae *Amoturoides breviscapus*

Figure A2.2 Male antennae *Amoturoides breviscapus*