

Impact of brood parasitoids and oophagy on survival of *Asemonea tenuipes* (Araneae: Salticidae: Asemoneinae) broods in Karnataka

Abhijith A. P. C.¹ and David E. Hill²

¹ Indraprastha Organic Farm, Kalalwadi Village, Udboor Post, Mysuru-570008, Karnataka, India, *email* abhiapc@gmail.com

² 213 Wild Horse Creek Drive, Simpsonville SC 29680, USA, *email* platycryptus@yahoo.com

Abstract. Five extended (multiple day) observations of female *Asemonea tenuipes* and their broods, beneath the leaves of *Carica papaya*, *Ficus microcarpa* and *Morinda cytrifolia* in a Karnataka garden, are documented. These include 1) maturation and dispersal of one brood over a 33 day period, 2) emerging parasitoid wasps (Platygastridae: *Idris* sp.) and a feeding neuropteran larva (probably mantispid) associated with multiple broods of a single female *Asemonea*, 3) multiple broods of a single female attacked by *Idris* and one mantispid, 4) oophagy of *Asemonea* eggs by an unidentified sac spider (Clubionidae) and 5) one *Asemonea* female that remained in the vicinity of a cluster of moth (Arctiinae) eggs deposited on top of her nest but did not feed on either these eggs or the emergent caterpillars.

Key words. Arctiinae, *Carica papaya*, chironomidae, Clubionidae, *Ficus microcarpa*, *Idris*, India, jumping spider, *Morinda cytrifolia*, organic farming, Mantispidae, Neuroptera, parasitoid wasp, Platygastridae, Scelioninae

This paper represents the continuation of earlier field observations of *Asemonea tenuipes* (O. Pickard-Cambridge 1869) living on the farm of Abhijith A. P. C. (*Indraprastha Organic Farm*) at Mysuru, Karnataka, India. In our earlier paper (Abhijith & Hill 2018) we documented colour changes of adult female *A. tenuipes* as well as male cohabitation, and we confirmed their deposition of eggs in long strings as reported in earlier studies (Jackson & Macnab 1991; Hawes 2017). Here we document five extended (multiple day) observations of female *Asemonea* and their nest associates, including two very different parasitoids, a small wasp (Hymenoptera: Platygastridae: *Idris* sp.) and a larger mantispid or *mantis fly* (Neuroptera: Mantispidae).

1. Rearing a single brood (Figure 1)

This series of observations covered 33 days (5 MAY to 6 JUN 2019) in the life of a small brood tended by a female *Asemonea*. A light-green female was first observed tending her clutch of 9 eggs beneath a leaf of *Ficus microcarpa* on 5 MAY (Figure 1:1). Three weeks later (26 MAY, Figure 1:2) all 9 spiderlings (larvae or instar I) had just hatched and their legs were still undeveloped. The colour of the female had changed as her abdomen was now reddish with iridescent blue lines. Over the next five days (27-31 MAY, Figure 1:3-9) the young continued to develop and the female once again assumed her light-green colour. Four days later, or nine days after hatching (4 JUN, Figure 1:10-12) the spiderlings molted to the emergent phase (instar II), with eyes now developed. However only 7 of the 9 spiderlings remained at this time. Two days later (6 JUN, Figure 1: 13) the female and all of her spiderlings were gone, presumably dispersed.

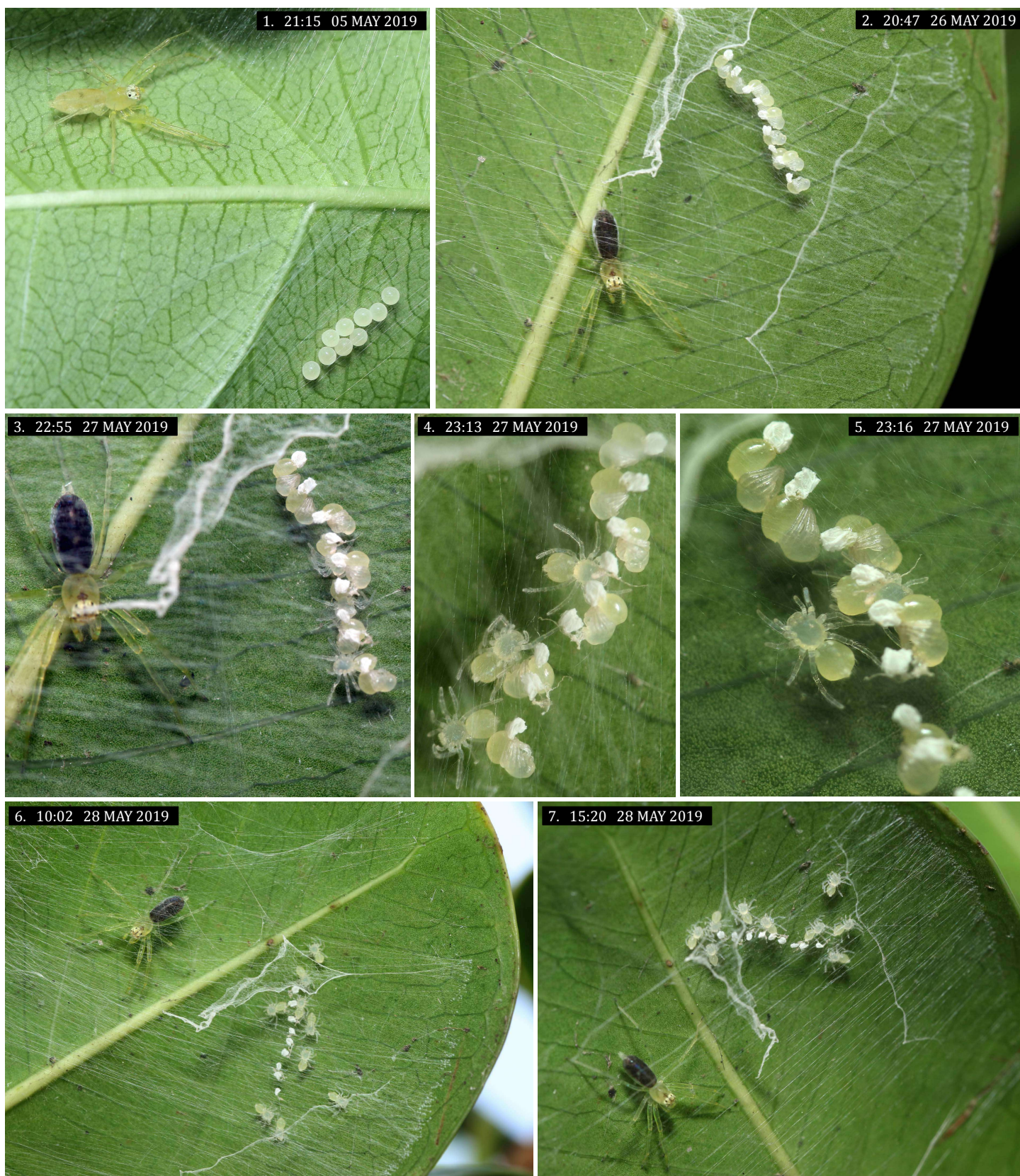


Figure 1 (continued on next page). 1, Light green Female *A. tenuipes* tending her clutch of 9 eggs beneath a leaf of *Ficus microcarpa*. 2, 9 newly hatched spiderlings (instar I) with short legs. Note that the female was now darker. 3-7, The 9 instar I spiderlings continued to develop.

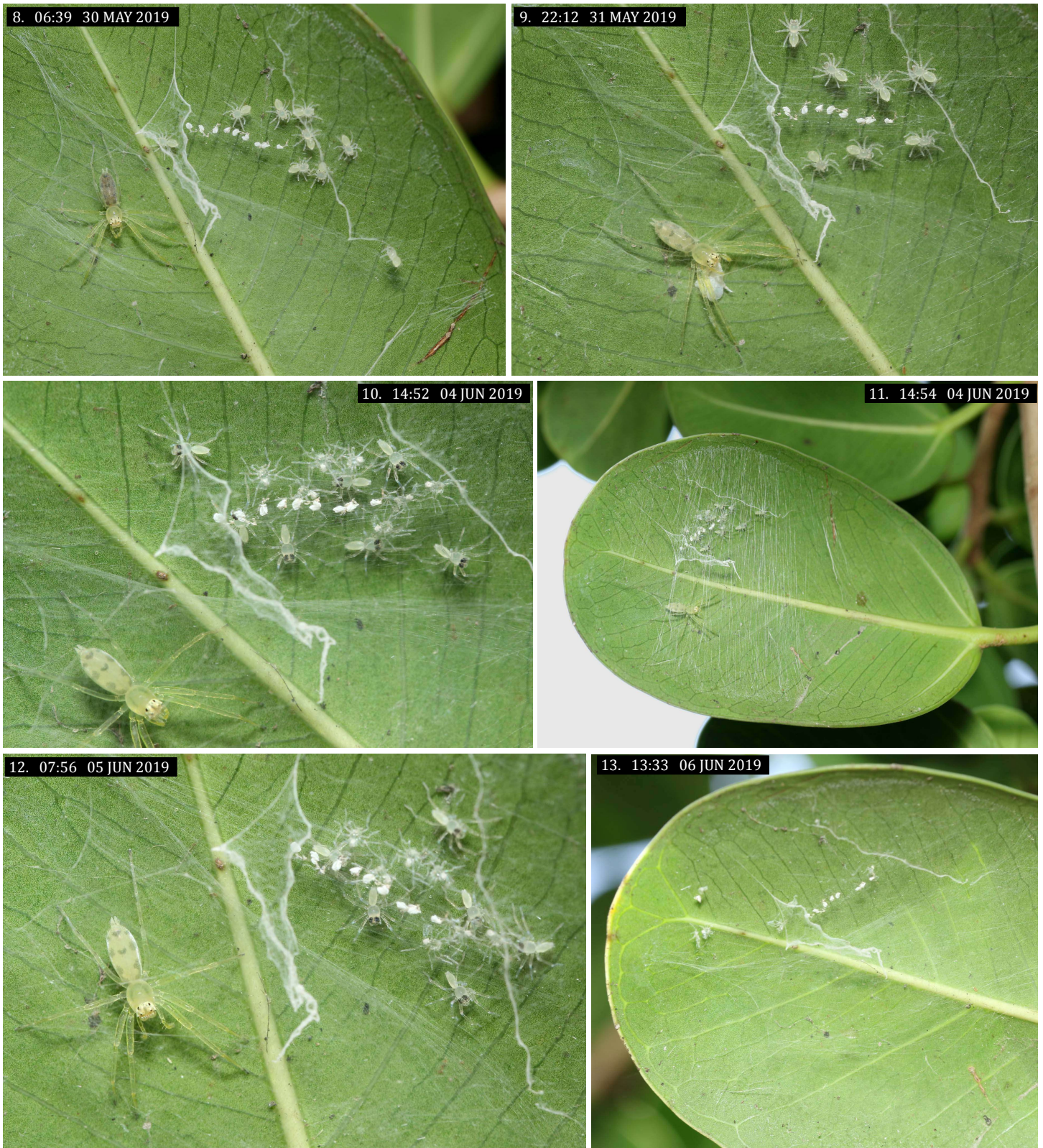


Figure 1 (continued from previous page). 8-9, The 9 instar I spiderlings continued to develop as the female returned to her original colour. 10-12, Still attended by the female, 7 remaining spiderlings molted to the emergent instar (instar II). 13, The female and all of her spiderlings were gone.

2. Two broods and their parasitoids (Figure 2)

A female *Asemonea tenuipes* with two broods was observed on the underside of a *Morinda cytrifolia* leaf over a period of 23 days (19 JUL-10 AUG 2019). When first observed (Figure 2:1-2, 19 JUL) two spiderlings and one small parasitoid wasp (Platygastridae: Scelioninae: *Idris* sp.) rested near the older brood of 12 eggs. The infestation of 10 eggs in this brood by wasps was indicated by a pair of dark eyes within each egg. The more recent brood of 14 eggs appeared normal at this time. After four days (Figure 2:3-6, 23 JUL) 5 parasitoid wasps could be seen near the female *Asemonea*, and the second brood was attacked by a neuropteran larva that might be a mantispid (Neuroptera: Mantispidae). Five days later (Figure 2:7-10, 28 JUL-1 AUG) this larva formed a cocoon and it appeared that some of the 9 remaining eggs in the more recent brood had been damaged or attacked by the wasps. Two days after this (Figure 2:11, 3 AUG) only 2 of these eggs, apparently not developed, remained. About two weeks after cocooning (Figure 2:12, 10 AUG) the neuropteran had emerged but the female *Asemonea* remained in her nest.

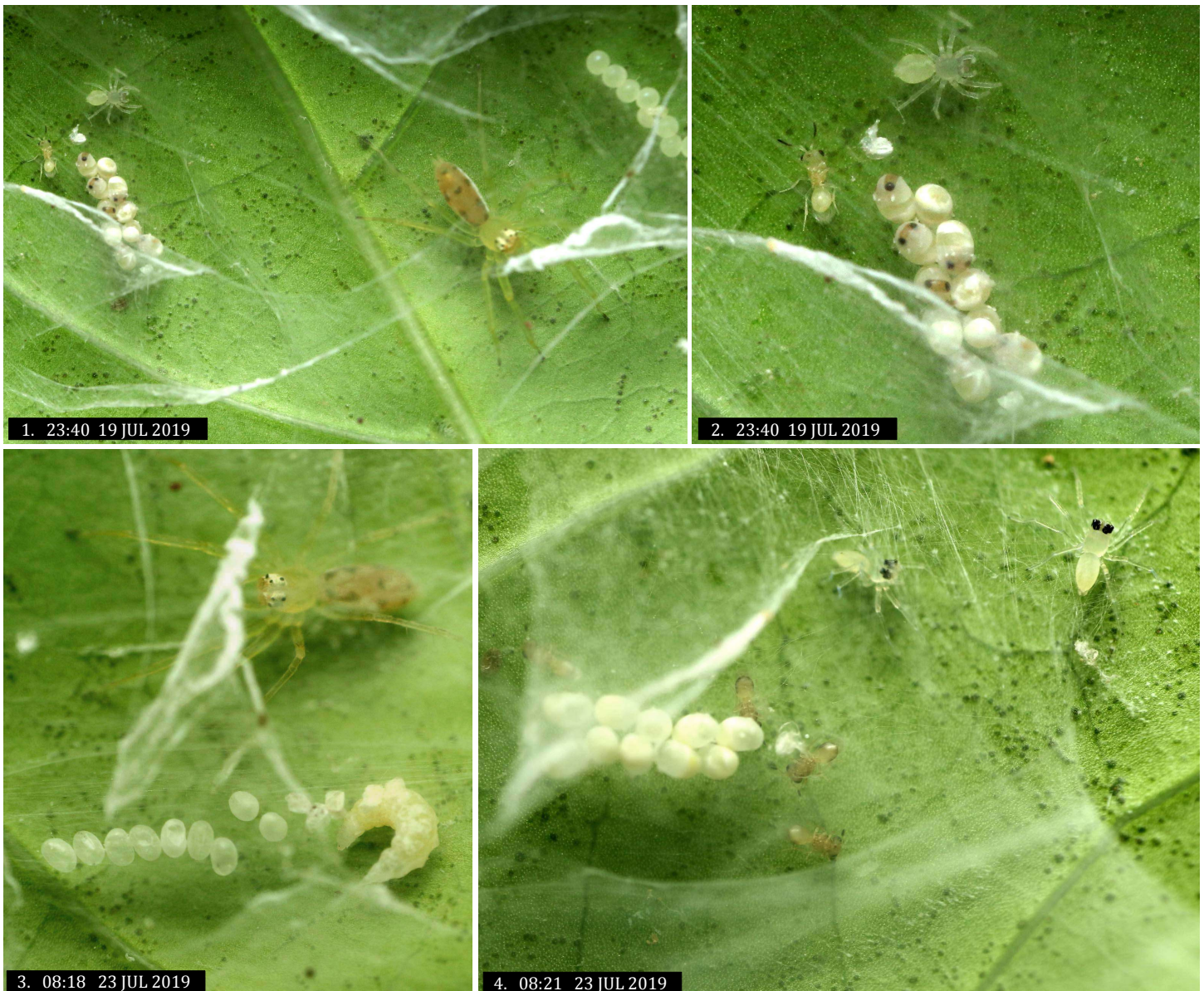


Figure 2 (continued on next page). 1-2, Female *A. tenuipes* with an older brood of 12 eggs infested with *Idris* parasitoids (at left), and one more recent brood of 14 eggs (at right). One wasp and one spiderling can be seen here. 3, Four days later a neuropteran larva attacked the newer brood. 4, *Idris* and two emergent spiderlings (instar II) near the older brood.



Figure 2 (continued from previous page, continued on next page). 5-6, Neuropteran larva (possibly mantispid) feeding on eggs in the more recent or second brood. 7-10, The female *Asemonea* continued to attend to her nest, now inhabited by the cocooning neuropteran and 7 eggs that may have been damaged or infested by *Idris*.



Figure 2 (continued from previous page). 1, Several days later only two eggs of the more recent brood, apparently undeveloped, remained near the neuropteran cocoon. 2, Almost two weeks after cocooning, the neuropteran had emerged, leaving only its final exuvium in place (to the right of the cocoon). The brooding female *Asemonea* was still in attendance.

3. A tale of four broods (Figure 3)

Over a period of 36 days (10 AUG-14 SEP 2019) four successive broods of a female *Asemonea tenuipes* were observed on the underside of two different *Ficus microcarpa* leaves. Initially (Figure 3:1-2, 10 AUG) this female was observed in her nest, occupied by a mantispid cocoon that had apparently replaced an older brood, and a newer brood of 19 eggs that appeared normal. Two days later (Figure 3:3-4, 12 AUG) the *Asemonea* left her two broods and moved to the underside of a nearby leaf. At this time eggs of the second brood were beginning to hatch. One day later the *Asemonea* deposited a third brood of 10 eggs on the second leaf, and the unattended second brood of 19 eggs continued to develop normally (Figure 3:5-14, 13 AUG-20 AUG). Subsequently (Figure 3:15-21, 20 AUG) the mantispid emerged, molted to the flying adult stage and moved near the developing spiderlings of the second brood, as the female *Asemonea* continued to attend her third brood. About one week later (Figure 3:22, 28 AUG) both the mantispid and the female *Asemonea* were gone, and several of the spiderlings from the second brood had apparently moved into the second nest near the third brood. Normally developing limb buds could be seen in the eggs of this brood at that time. Later in the day a female *Asemonea* (perhaps the original female) appeared in the nest near the third brood (Figure 3:23, 28 AUG). Three days later (Figure 3:24, 31 AUG) this female was observed feeding on a chironomid midge in her nest, and the third brood still looked normal. However, three days after this (Figure 3:25, 3 SEP) it was clear that the third brood was infested with developing *Idris* parasitoids. By the next day (Figure 3:26, 4 SEP) the female *Asemonea* had deposited a fourth brood of 18 eggs near the infected third brood. On successive days (Figure 3:27-30, 6-9 SEP) adult *Idris* emerged from the third brood and moved over to (most likely) infest the fourth brood. By this time (Figure 3:31, 9 SEP) all spiderlings from the second brood on the first leaf, the only successful brood of the four, had molted to the emergent stage (instar II) and dispersed. The original nest was occupied by a *Mrymarachne* sp. at that time. Five days later (Figure 3:32, 14 SEP) the female *Asemonea* was gone, and only scattered eggs from her third and fourth broods remained under the second *Ficus* leaf.

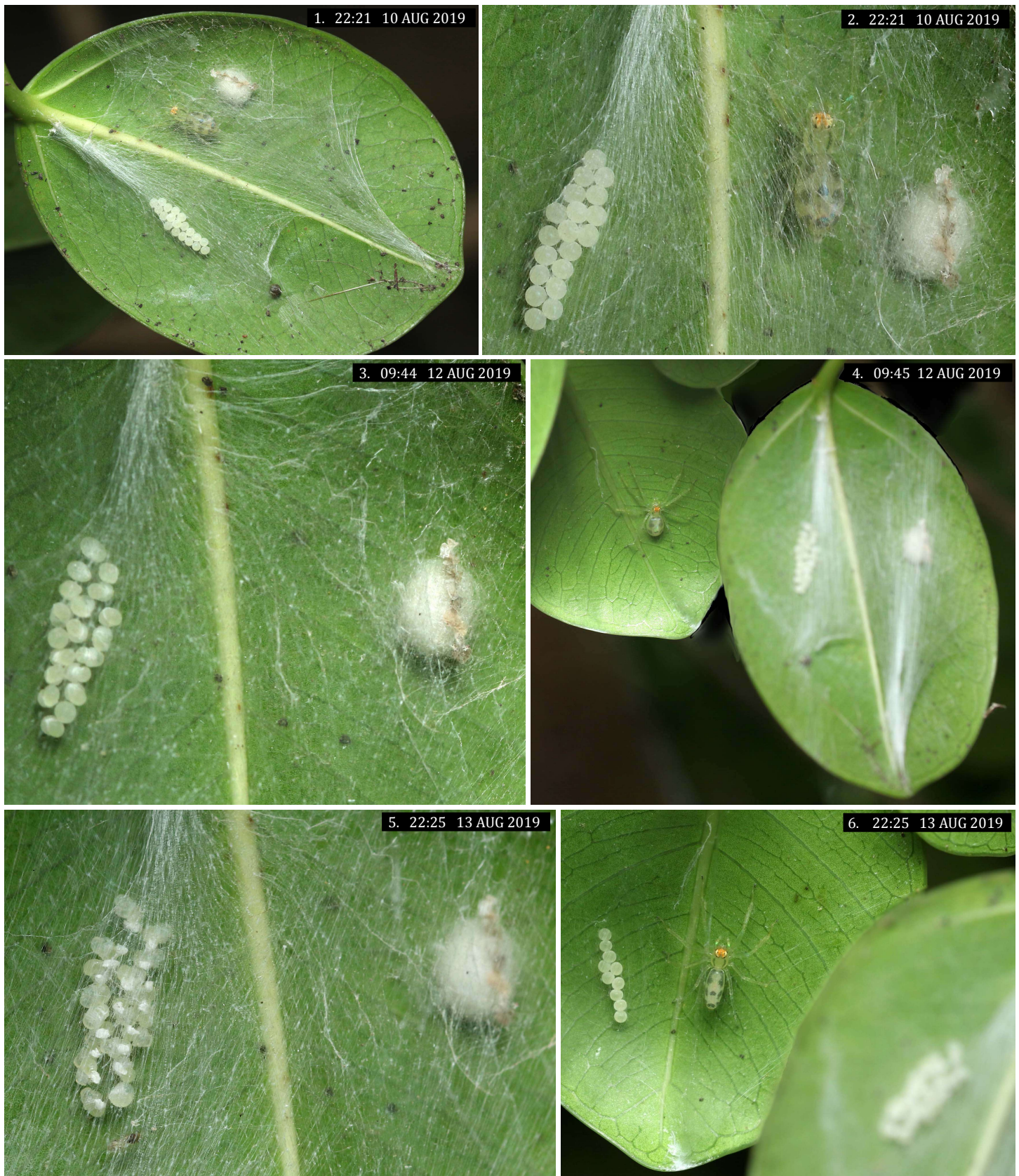


Figure 3 (continued on next page). 1-2, Female *Asemonea tenuipes* attending her nest including a mantispid cocoon and a normal brood of 19 eggs on the underside of a *Ficus microcarpa* leaf. 3-8, Eggs of the second brood of 19 eggs were hatching (3) as the female *Asemonea tenuipes* moved to a nearby leaf and deposited a new brood of 10 eggs (6).



Figure 3 (continued from previous page, continued on next page). 7, Developing second brood (instar I) under the first leaf. 8, Female *Asemonea* with third brood under the second leaf (upper left) with cocoon that replaced the first brood and the developing second brood under the first leaf. 9-11,14, Cocoon and developing second brood. 12, Detail of small insect (Heteroptera) near the mantispid cocoon, from (10). 13, Female *Asemonea* attending her third brood of 10 eggs on the second leaf.



Figure 3 (continued from previous page, continued on next page). 15-16, The mantispid emerged from its cocoon (apparently remnant of first brood) and molted. 17, Detail of empty mantispid cocoon. 18, Mantispid near spiderlings of the second brood. 19, Female *Asemonea* tending her third brood. 20, View of mantispid and second brood beneath lower leaf, and female attending third brood beneath upper *Ficus microcarpa* leaf.



Figure 3 (continued from previous page, continued on next page). 21, Mantispid near its empty cocoon and exuvium, also near the developing second brood. 22, About one week later the female *Asemonea* was gone but the third brood was developing normally. The emergent (instar II) spiderlings shown here most likely came from the second brood. 23, A female *Asemonea*, perhaps the original female, moved into the nest near the third brood. 24, Same female *Asemonea* feeding on a chironomid midge in her nest near the second brood. 25, Gravid female *Asemonea* near the third brood, now clearly infected with *Idris* sp. parasitoids. 26, Same female after depositing a fourth brood of 18 eggs near the infected third brood.



Figure 3 (continued from previous page). 27-30, Views of *Idris* sp. parasitoids emerging from the third brood and, as adult wasps, moving over to the fourth brood, still attended by the female *Asemonea*. It is likely that this brood will also be infected. 31, View of cocoon (remnant of first brood) and exuviae remaining in second brood, the only successful brood of the four, under the first leaf. Note the presence of a *Myrmarachne* sp. (arrow) in this *Asemonea* nest. 32, Five days later the female *Asemonea* was gone, leaving only scattered eggs from her third and fourth broods on the underside of the second *Ficus* leaf.

4. Oophagy by a sac spider (Figure 4)

A brooding female *Asemonea tenuipes* beneath a *Ficus microcarpa* leaf was observed over a nine day period (12 AUG-20 AUG 2019). Initially (Figure 4:1-2, 12 AUG) this female was observed in her nest with three broods (strings of eggs), two of which were infected with *Idris* parasitoids, and one new brood with 11 eggs. During the next two days (Figure 4:3-9, 13 AUG-14 AUG) this female *Asemonea* remained at a distance under the *Ficus* leaf as an unidentified sac spider (Clubionidae) fed on at least 4 of the eggs in the new brood. The sac spider was disturbed by the observer and it fled. Almost one week later (Figure 4: 10-11, 20 AUG) an *Asemonea* that appeared to be the original brooding female returned to the depleted nest, deposited a fresh string of 13 eggs, and fed on a chironomid. An *Idris* wasp was also seen nearby.



Figure 4 (continued on next page). 1, Female *Asemonea* with a new brood flanked by two wasp-infested broods under a *Ficus microcarpa* leaf. 2, Detail from (1). 3-8, Unidentified sac spider feeding on eggs in the new brood with the female *Asemonea* at a distance. 5-6, Detail from (4). 8, Detail from (7). 9, Detailed view of this sac spider.



Figure 4 (continued from previous page). 10, Almost one week later this female *Asemonea*, apparently the original female, laid a new brood of 13 eggs (at left) in the original nest and was observed feeding on a chironomid midge (Diptera: Nematocera: Chironomidae). Only 3 eggs remained from one of the original broods (upper right). An *Idris* parasitoid was also observed near the nest. 11, Detail of this female *Asemonea* feeding on a chironomid inside of her nest.

5. Tending moth eggs and caterpillars (Figure 5)

A female *Asemonea* was observed for 3 days in her nest comprised of thin silk under a *Carica papaya* leaf (1 AUG-2 AUG 2019). She appeared to tend a cluster of 48 unhatched arctiid (Lepidoptera: Arctiidae) eggs, similar to her own eggs in size and colouration, and suspended upon the silk above her nest (Figure 5:1-4, 1 AUG). The *Asemonea* was not observed to feed on these eggs, and when they subsequently hatched (Figure 5:5-7, 3 AUG) she remained near the cluster of hairy caterpillars but did not attack them.

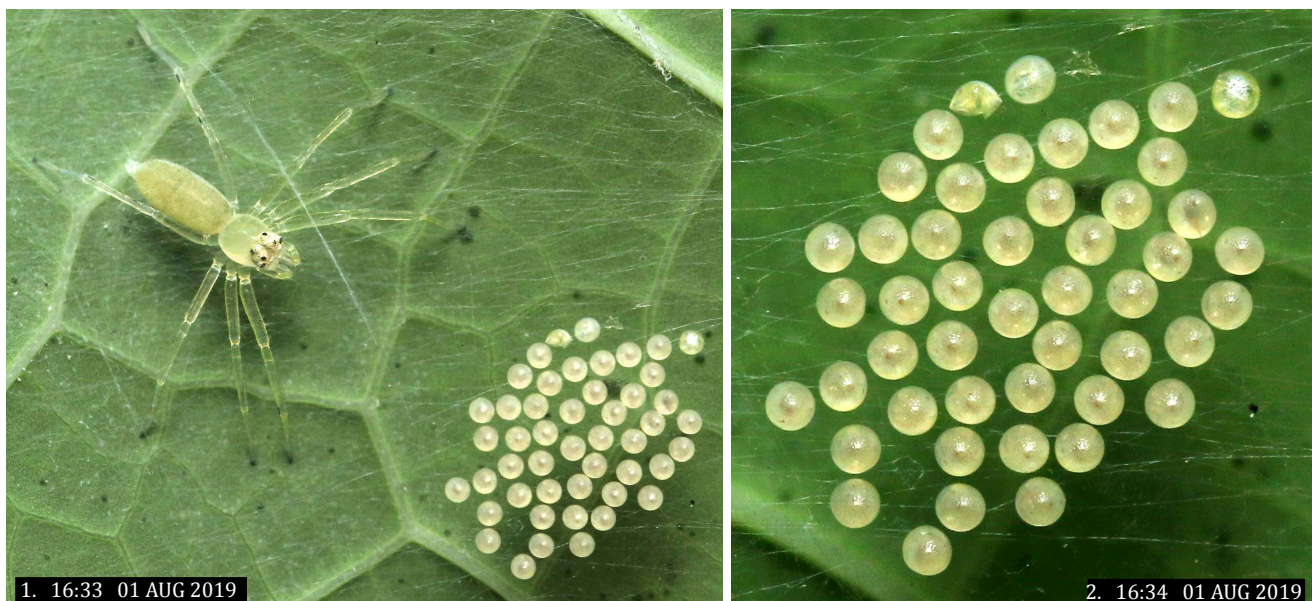


Figure 5 (continued on next page). 1, Female *Asemonea* near a cluster of 49 arctiid eggs laid on top of her nest. 2, Detailed view of the arctiid eggs, of which one was damaged.

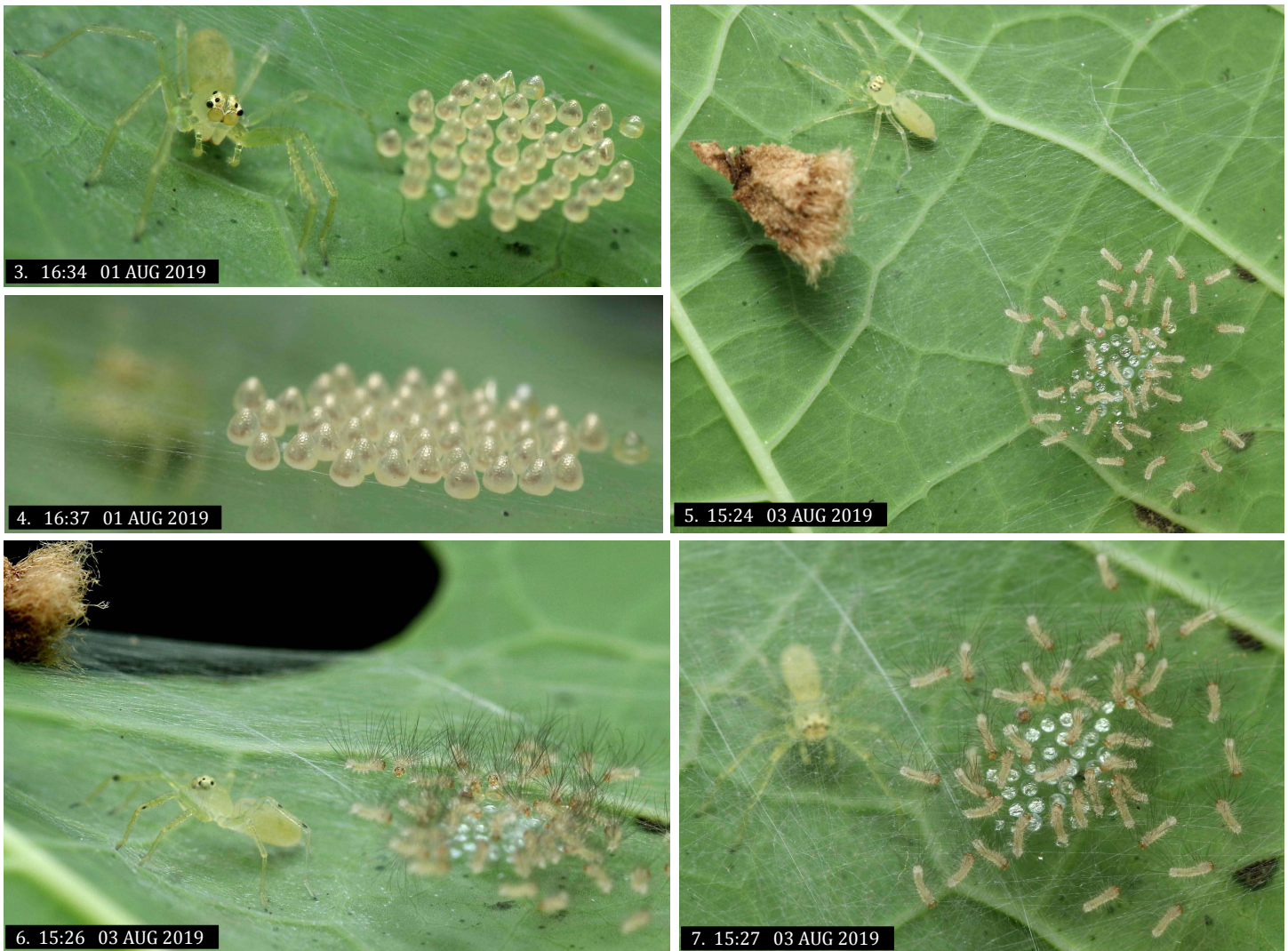


Figure 5 (continued from previous page). 3-4, Two perspective views of the nesting female *Asemonea* with eggs of arctiid moth suspended on the thin silk layer covering her nest. 5-7, Female *Asemonea* tending nest near newly hatched arctiid caterpillars. These caterpillars were covered with long hairs that can be seen in the lateral view (6), and the *Asemonea* did not attack them. All of the caterpillars dispersed later in the day (3 AUG).

Discussion

The overlapping production of multiple strings of eggs (broods) by *Asemonea* is of particular interest. This suggests a strategy of coping with abundant parasitoid infestations through the continuous production of eggs. As shown here, some of those broods can manage to survive as others are taken by parasitoids. Many baeine wasps (Hymenoptera: Platygasteridae: Scelioninae: tribe Baeini) are parasitoids with larvae that feed on spider eggs (Austin et al. 2005; Mukundan et al. 2014; Kamalanthan et al 2015). *Idris* Förster 1856 is a large genus of small baeine wasps, well-adapted to develop rapidly in the confines of a single *Asemonea* egg (Kamalanthan et al 2015; Margaría et al. 2015). Many mantispids (Neuroptera: Mantispidae) are also parasitoids with larvae that devour the broods of spiders, including salticids (Brushwein et al. 1992, Hill 2011). Just why a brooding *Asemonea* would remain near the arctiid eggs and caterpillars on top of her nest (Figure 5) is not known, but in this case the similarity of the arctiid eggs to those of the *Asemonea* may have elicited her brooding behavior. Many arctiid moths have caterpillars that are well-defended by a covering of long, stout and toxic hairs (Villas-Boas et al. 2016).

Field observations of spiders are difficult and usually anecdotal in nature, yet they can provide us with a realistic appraisal of spider ecology that cannot be obtained through more systematic laboratory studies of behaviour. These field studies may also motivate others to pursue more extensive work. As shown here and in our previous paper on the subject (Abhijith & Hill 2018), the life of *Asemonea* can be complicated by a bewildering series of interactions with the other inhabitants of their world.

Acknowledgements

We thank Mr. Ken Ito for identification of the *Idris* sp. parasitoids and Mr. Sankararaman K for confirming this identification and for identifying the moth caterpillars as members of the Arctiidae. We also thank Mr. Rachit Pratap Singh for confirming the identity of these caterpillars, and Mr. Debomay Chanda and Mr. Prasanna Parab for confirming the identity of the sac spider. All photographs are copyright © Abhijith A. P. C.

References

- Abhijith A. P. C. and D. E. Hill. 2018.** *Asemonea* cf. *tenuipes* in Karnataka (Araneae: Salticidae: Asemoneinae). Peckhamia 172.1: 1-8.
- Austin, A. D., N. F. Johnson and M. Dowton. 2005.** Systematics, evolution and biology of scelionid and platygastriid wasps. Annual Review of Entomology 50: 553-582,
- Brushwein, J. R., K. M. Hoffman and J. D. Culin. 1992.** Spider (Araneae) taxa associated with *Mantispa viridis* (Neuroptera: Mantispidae). The Journal of Arachnology 20: 153-156.
- Hawes, T. C. 2017.** A jumping spider that lays eggs like an insect. Invertebrate Reproduction & Development 61(4): 265-273.
- Hill, D. E. 2011.** Notes on *Hentzia mitrata* (Hentz 1846) (Araneae: Salticidae: Dendryphantinae). Peckhamia 91.1: 1-15.
- Jackson, R. R. and A. M. Macnab. 1991.** Comparative study of the display and mating behaviour of lyssomanine jumping spiders (Araneae: Salticidae), especially *Asemonea tenuipes*, *Goleba puella*, and *Lyssomanes viridis*. New Zealand Journal of Zoology 18 (1): 1-23.
- Kamalanathan, V., P. Mohanraj and F. R. Khan. 2015.** 'The adikeshavus-group': A new species group of *Idris* Förster (Hymenoptera, Platygastriidae) from India, with descriptions of five new species. Deutsche entomologische Zeitschrift 62 (2): 247-260).
- Margaría, C., M. Loíacono, M. O. Gonzaga and D. Aquino. 2015.** Two new species of *Idris* Foerster (Hymenoptera: Platygastriidae) from Southeastern Brazil, parasitoids of *Argyrodes elevatus* Walckenaer (Araneae: Theridiidae) and *Scytodes* sp. (Araneae: Scytodidae). Revista del Museo Argentino de Ciencias Naturales, new series 17 (2): 159-166.
- Mukundan, S., Rajmohana K and Bijoy C. 2014.** A biosystematic account on Baeini wasps (Hymenoptera: Platygastriidae), the little known natural enemy complex of spiders in India. Proceedings of 26th Kerala Science Congress, Pookode, Wayanad, 28-31 Jan. 2014: 3654-3662.
- Pickard-Cambridge, O. 1869.** Descriptions and sketches of some new species of Araneida, with characters of a new genus. Annals and Magazine of Natural History 4 (3): 52-74.
- Villas-Boas, I. M., M. P. Alvarez-Flores, A. M. Chudzinski-Tavassi and D. V. Tambourgi. 2016.** Envenomation by caterpillars. Clinical Toxicology in Asia Pacific and Africa, Springer Science, DOI 10.1007/978-94-007-6288-6_57-1: 1-17.