

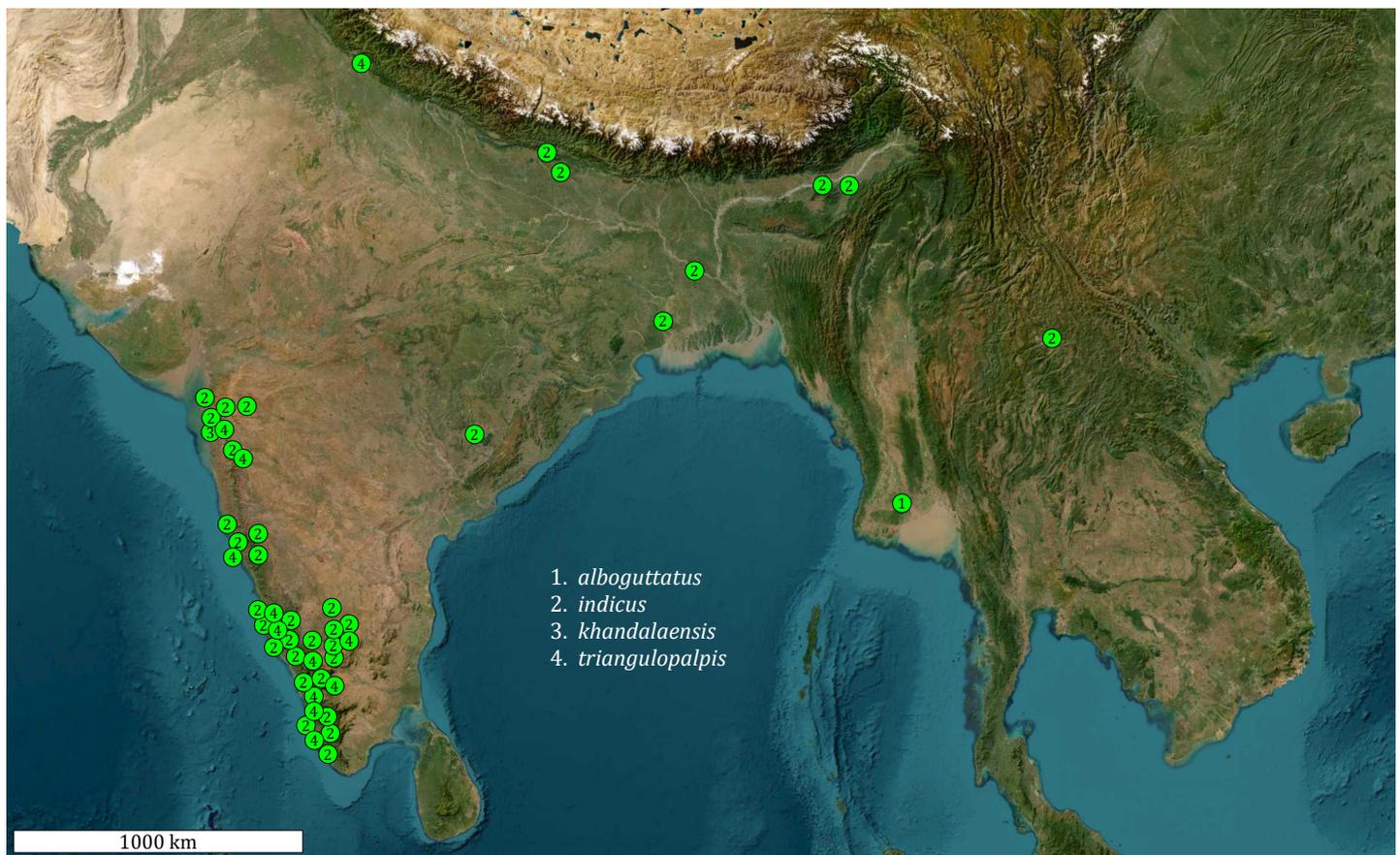
## Brood-rearing by the jumping spider *Epeus alboguttatus* in South India (Araneae: Salticidae: Plexippini: Plexippina)

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Until recently (Hill 2025), the jumping spider *Epeus alboguttatus* (Thorell 1887) was known by four different names, to include three junior synonyms: *E. khandalaensis* (Tikader 1977), *E. indicus* Prószyński 1992, and *E. triangulopalpis* Malamel et al. 2019. This white-spotted spider of moderate length (4.6-6.4 mm; Malamel et al. 2019) is widely distributed in South and Southeast Asia (Figure 1), and it is easy to identify in the field (Figure 2). Males and females are similar in appearance, and males lack the pointed crest at the rear of the eye quadrangle (between the PLE) seen in other *Epeus* species (Figures 5.1-5.3).



**Figure 1.** Distribution of *Epeus alboguttatus* in South and Southeast Asia, based on published records and validated records posted in *iNaturalist*. Numbers (1-4) indicate the species name associated with each respective record; note that there is only a single record for *alboguttatus* and for *khandalaensis*. The great majority of records are from southwestern India. Background map © OpenStreetMap.



**Figure 2.** *Epeus alboguttatus* from Karnataka. All except 8-9 are from Mysuru. **1-2**, Recently molted adult ♂ with exuvia, beneath a leaf. **3-5**, Adult ♂. **6**, Adult ♂ (at left) near a penultimate ♀ on the underside of a leaf. **7**, Immature with exuvia. **8-9**, Adult ♀. Photo credits: 8-9, iNat. obs. 95372255, © harshithjv, CC BY-NC 4.0.

Unless otherwise stated, our observations of *Epeus* took place at the Indraprastha Organic Farm of the senior author in the state of Mysuru, India.

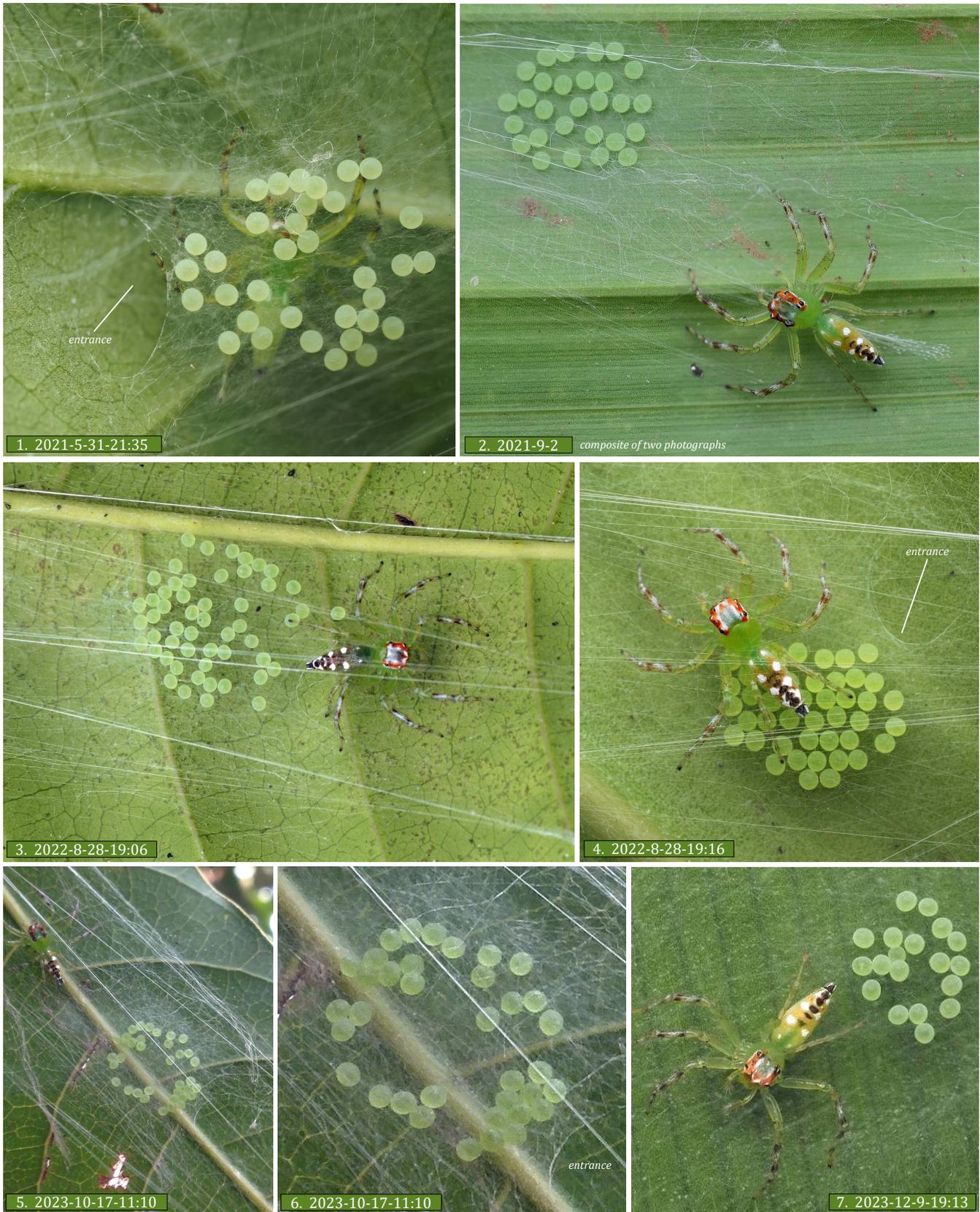
The female *Epeus alboguttatus* constructs a nest containing a single layer of ~14-53 round, green eggs, on the underside of a leaf (Figure 3). The degree of packing or spacing of the eggs varies. The number of eggs deposited may be a reflection of the feeding state of the female. We have not tracked successive broods by a single female, but this is likely given the limited seasonality of breeding in this species. Reinforced silk spans below the nest maintain the curvature and stability of the leaf used as a roof over the nest (Figures 3.10, 3.12). Previously we documented an instance in which a female *E. alboguttatus* produced silk spans to anchor the dying leaf containing her nest; after the petiole of that leaf detached, the female added more of these spans, stabilizing the rapidly drying leaf (Abhijith & Hill 2021).

As the embryos develop, the ♀ maintains close contact with her brood, and may enter and exit the nest through an entrance that she constructs (Figures 3.1, 3.4, 3.6, 3.8, 3.12). Once the nest is constructed, we have not observed any substantial modification in its design during the subsequent development of the embryos and early instars. This contrasts with the active conversion of the egg nest into a brood nest by the spartaeine *Brettus cingulatus* (Hill et al. 2022).

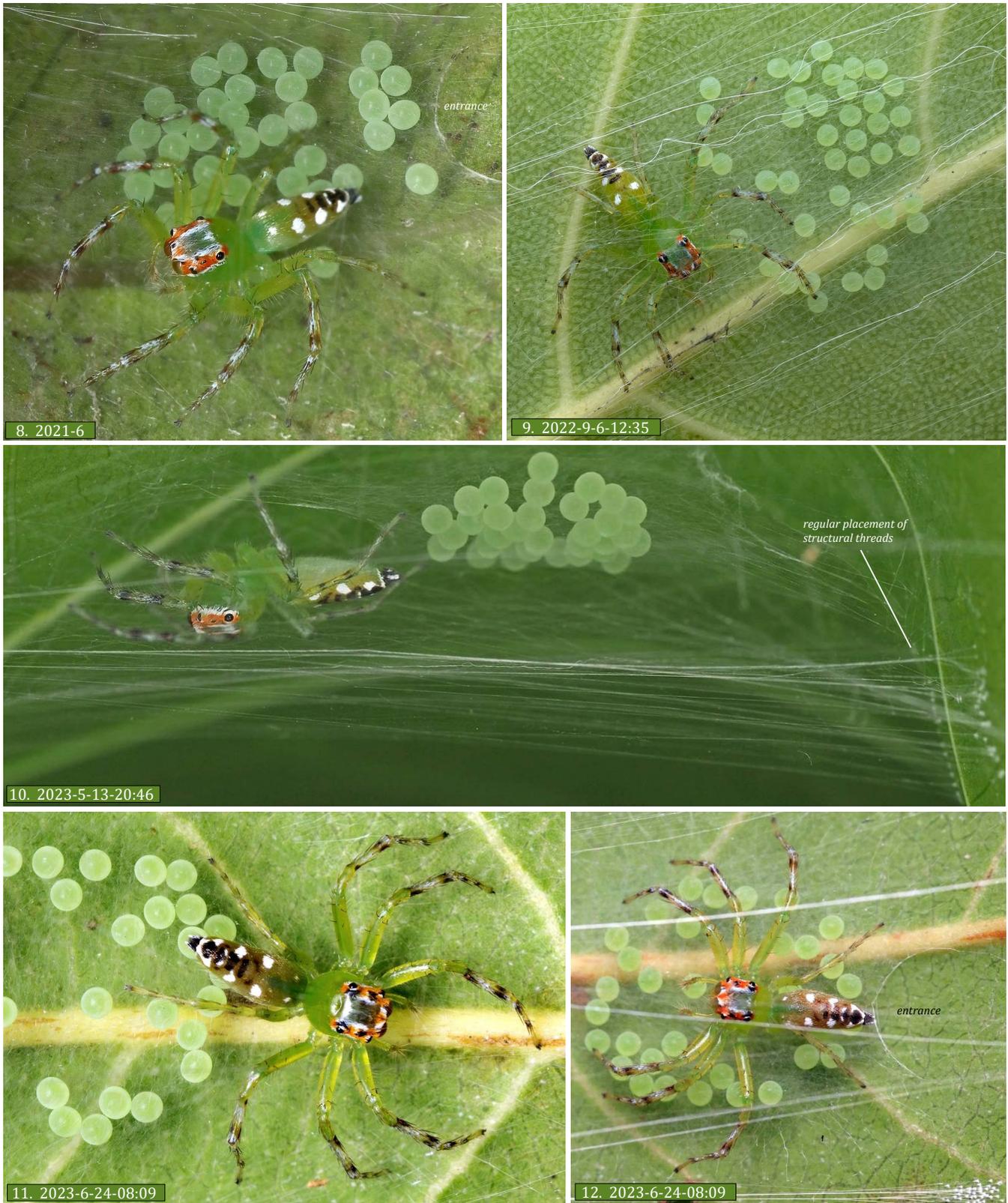
Hatched embryos, or embryos that have shed the chorion and vitelline membranes of the egg, are called postembryos (Figures 4.1-4.2). At this stage the membranes are still attached to the spinnerets. After the first molt, the membranes are dropped, and the first instar (instar 1) spiders are free to crawl about in the nest (Figures 4.3-4.12). At this time, the female appears to do some house-keeping, as the discarded membranes and exuviae are either gathered into a mass, or removed from the nest. We do not know if the female eats any of this material, or simply discards it. As in other salticids, the eyes of the instar 1 spiders become darker as they develop, and pigment is deposited in the retina and eye capsule, but no corneal lenses appear on the smooth carapace until the second molt. With completion of the second molt (Figures 4.13-4.16) the translucent instar 2 spiders appear to be equipped to emerge from the nest, to assume a free-living life-style. But they may remain in the nest for a number of days after this molt.

A second species of *Epeus* that is frequently encountered in India is shown in Figure 5. Since the field identification of this species is still somewhat uncertain, we refer to this species as *Epeus cf. albus* Prószyński 1992 (see Hill 2025). Males of this species (Figures 5.1-5.3) have a distinctive pointed crest between the PLE. and both males and females (Figure 5) have a light yellow line on either side of the dorsal opisthosoma. We have not studied this species in detail, but brooding behavior of the female appears to be similar to that of *E. alboguttatus*. For example, female *Epeus cf. albus* may place reinforced silk spans below the nest (Figures 5.4, 5.10), and after the first molt discarded membranes and exuviae are removed from the nest (Figures 5.9-5.10).

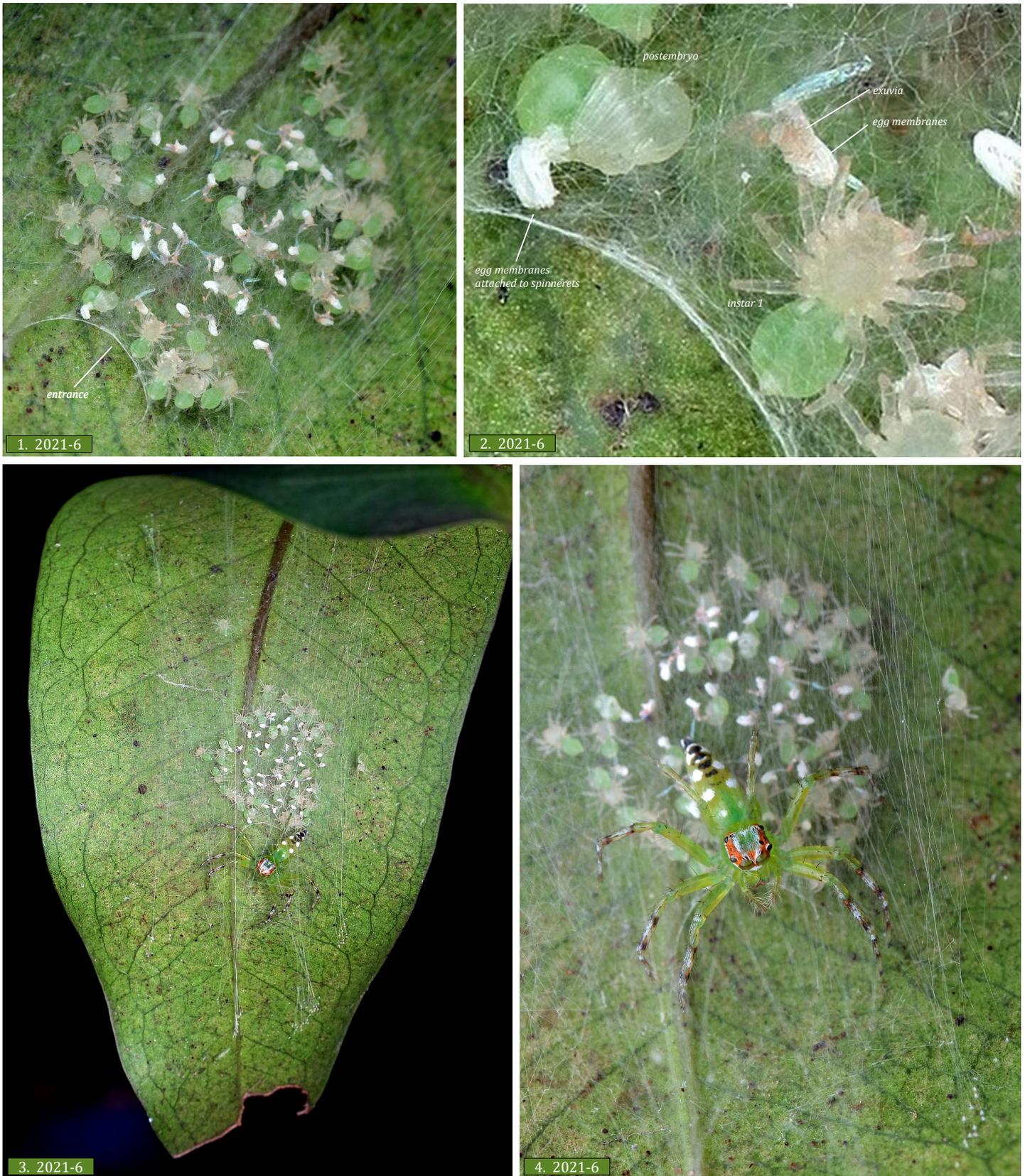
A small (14 egg) *Epeus alboguttatus* nest was followed over 28 days to document the timing of each stage of development of the brood (Figures 6-7). Embryos developed in the eggs for at least 8 days (Figures 6.1-6.5) before the first two hatched (Figures 6.6-6.9). Only two of the 14 embryos completely shed their egg membranes at the end of this interval, although a third embryo was apparently attempting to do so (Figure 6.7). Only the first two embryos to hatch successfully molted to instar 1 (Figures 6.10-6.16), and only two days after hatching most of the other eggs were gone (Figure 6.12). Three days later (Figures 6.17-6.21), only the two instar 1 spiders remained in the nest, and all remnants of the other eggs, egg membranes, and exuviae had been removed. The female may have fed on these, but we did not observe this. After 9-10 days in the nest as instar 1 spiders, the two survivors molted for a second time, emerging as instar 2 (Figures 6.22-6.28). These were followed in the nest for about four days (Figures 6.28-6.32), and several days later they were gone (Figure 6.33). Figure 7 documents the schedule of these events.



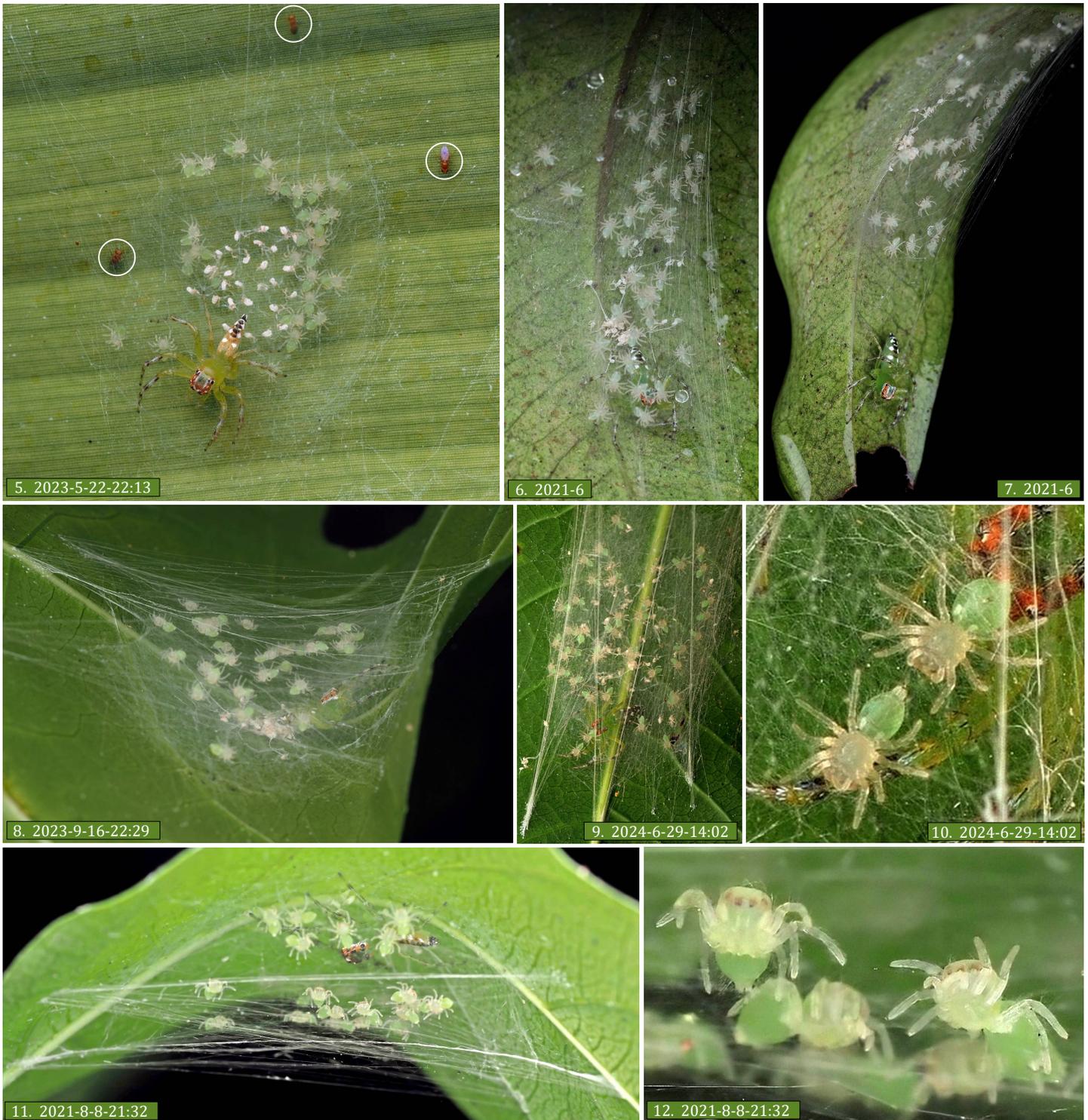
**Figure 3 (continued on next page).** Eggs deposited in the nests of *Epeus alboguttatus* females in southwestern India. **6**, Detail of (5). Although the female lays down silk lines over a large area under a leaf, the entrance of the nest is close to the brood. Photo credits: 2, iNat. obs. 95372255, Karnataka, © harshithjv, CC BY-NC 4.0; 5-6, iNat. obs. 187887924, Ernakulam, Kerala, © Kenz, CC BY-NC 4.0.



**Figure 3 (continued from previous page).** Eggs deposited in the nests of *Epeus alboguttatus* in southwestern India. **10**, Note the placement of reinforced structural threads below the nest. **12**, Reinforced structural threads, mostly parallel to the axis of the leaf, pass below this nest on the underside of a leaf. Photo credits: 8, iNat. obs. 81669983, Karnataka, © harshithjv, CC BY-NC 4.0; 9, iNat. obs. 147695257, Tumakuru, Karnataka, © Girish Gowda, CC BY-NC 4.0; 11-12, iNat. obs. 169525330, Bengaluru, Karnataka, © 360pixual, CC BY-NC 4.0.



**Figure 4 (continued on next page).** Later development of immature *Epeus alboguttatus* in the nest. **1**, Almost all of the young in this nest have molted to the first instar (instar 1) stage. **2**, Detail from (1), showing one spider (upper left) still in the *postembryo* (post-eclosion embryo) stage, near one that has already molted to *instar 1*. As shown here, the discarded egg membranes are white, the exuviae brown. **3-4**, Two more views of the female tending this nest. In (3) you can see the full extent of the nest. Photo credits: 1-2, iNat. obs. 83153471, and 3-4, iNat. obs. 80866574, both © harshithjv, CC BY-NC 4.0.



**Figure 4 (continued from previous page, continued on next page).** Later development of immature *Epeus alboguttatus* in the nest. **5**, Note the small flying insects around this nest (circles); if these were *Idris* sp. (egg parasitoids), they were late to the game. Here the young are all instar 1 and have moved away from the center of the nest, but the female has yet to collect the egg membranes and exuviae (debris). **6-7**, Two views of a nest showing the curvature of the leaf that supports it (**7**). **8**, View of a nest from below. This female has already collected the debris into a mass. **9**, Instar 1 spiders in a nest as viewed from below. The female (lower left) has yet to collect debris. **10**, Detail from (**9**), showing two instar 1 spiders in the nest, just below the female (upper left). **11**, Nest with female tending instar 1 spiders, after removal of all debris. Note how reinforced silk spans below the nest join distal (at left) and proximal (at right) parts of the leaf, maintaining its curvature. **12**, Detail from (**11**), showing development of eyes (brown spots under translucent carpace) during the instar 1 stage. Photo credits: 6-7, iNat. obs. 83159714, Karnataka, © harshithjv, CC BY-NC 4.0; 9-10, iNat. obs.242283252, Bengaluru, Karnataka, © kumarkv, CC BY 4.0.



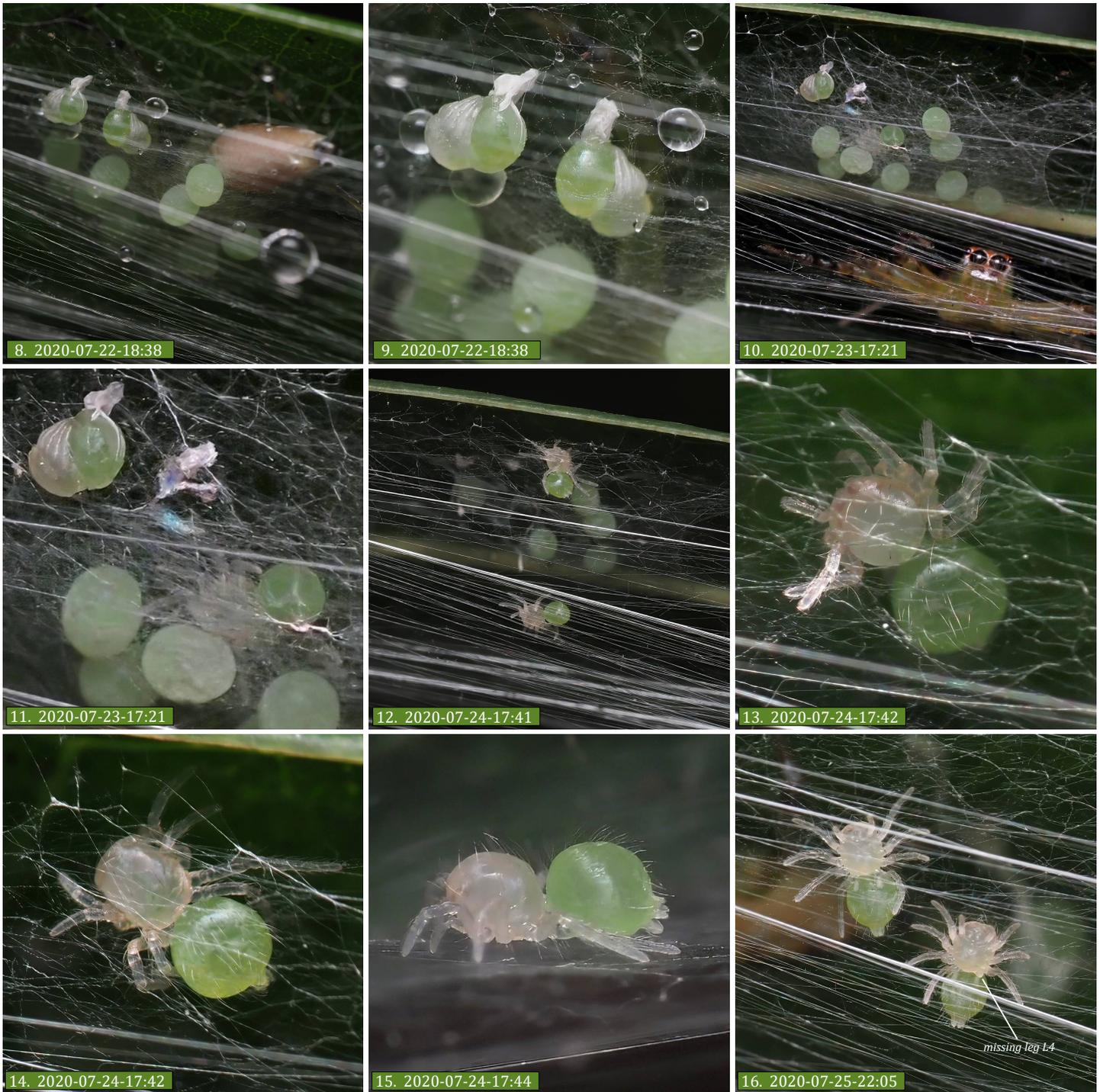
**Figure 4 (continued from previous page).** Later development of immature *Epeus alboguttatus* in the nest. **13**, View of female (lower right) tending a nest of mixed instar 1 and instar 2 spiders. Note the reinforced silk spans below this nest. A collected mass of debris from eclosion and the first molt can be seen near the center of the nest. Instar 2 spiders have longer legs and a thinner opisthosoma than do the instar 1 spiders. **14-15**, Female tending her instar 2 brood (detail in 15). Note the scattered exuviae. **16**, Another female tending an instar 2 brood. Photo credits: 14-15, iNat. Obs. 147836664, Bengaluru, Karnataka, © Vikrant Kumar, CC BY-NC 4.0; 16, iNat. Obs. 259052363, Guddekeri, Karnataka, © Girish Gowda, CC BY-NC 4.0.



**Figure 5.** *Epeus cf. albus* beneath leaves, in Karnataka. **1**, Male, Thannirpantha. **2-3**, Two views of a male feeding on a captured araneid. **4-5**, Two views of a female guarding her developing eggs. **6**, Female guarding eggs, Thannirpantha. It appears that female *E. cf. albus* pack their eggs more tightly than do female *E. alboguttatus*. **7-8**, Female and her brood, now in the postembryo stage. **9-10**, Females, Puttur (9) and Thannirpantha (10), with instar 1 broods. Note that debris has been removed. **11**, Another female with her instar 2 brood and exuviae from their second molt in nest.



**Figure 6 (continued on next page).** Series of sequential photographs of an *Epeus alboguttatus* and her brood. **1**, First record of this female on the underside of a leaf. Note that reinforced silk spans are already in place. **2-3**, Small nest of only 14 eggs deposited under the leaf. **4**, Female guarding her brood. Note the nest entrance at right. **5**, Detail of (4), showing distinctive field marks used to identify *E. alboguttatus*. **6**, Detailed view of the two embryos that hatched. The one at left is about to hatch (eclosion or escape from egg membranes); the one on the right is already emerging as a postembryo. **7**, By the next morning the two spiders that hatched were in the postembryo stage, with egg membranes still attached. Another embryo (at bottom) was in the process of eclosion, but was not observed to complete this process. From their shape, it appears that the other eggs were developing at this time, but none survived long enough to hatch.



**Figure 6 (continued from previous page, continued on next page).** Series of sequential photographs of an *Epeus alboguttatus* and her brood. **8**, The two postembryos, after a rainstorm. Note the position of the female, above them. **9**, Detail of (8). **10**, By this time one of the postembryos had molted to emerge as an instar 1. It appears that four of the eggs that were deposited are already gone. **11**, Detail from (10), showing the postembryo (upper left) and the instar 1 (lower right). Here embryonic development of several of the other eggs can be seen. **12**, The two young spiders (now both instar 1) moving on the fine silk fibers within the nest. At this time seven of the eggs were missing. **13-16**, Detailed views of the two instar 1 spiders. In this early stage the developing eyes, beneath the smooth carapace, had little pigment. Note (16) that one of the instar 1 spiders was missing leg L4; this did not regenerate when this spider later molted to instar 2.



**Figure 6 (continued from previous page, continued on next page).** Series of sequential photographs of an *Epeus alboguttatus* and her brood. **17-21**, Views of the female and her two surviving instar 1 spiders. By this time (17) no sign of the other 12 embryos remained in the nest. **22-23**, The instar 1 with intact legs (at left in 22) molted first to the instar 2 stage. **24**, By the next day, both young spiders had molted. Here the two exuviae can be seen, at right. **25**, Underside of the intact instar 2 spider.

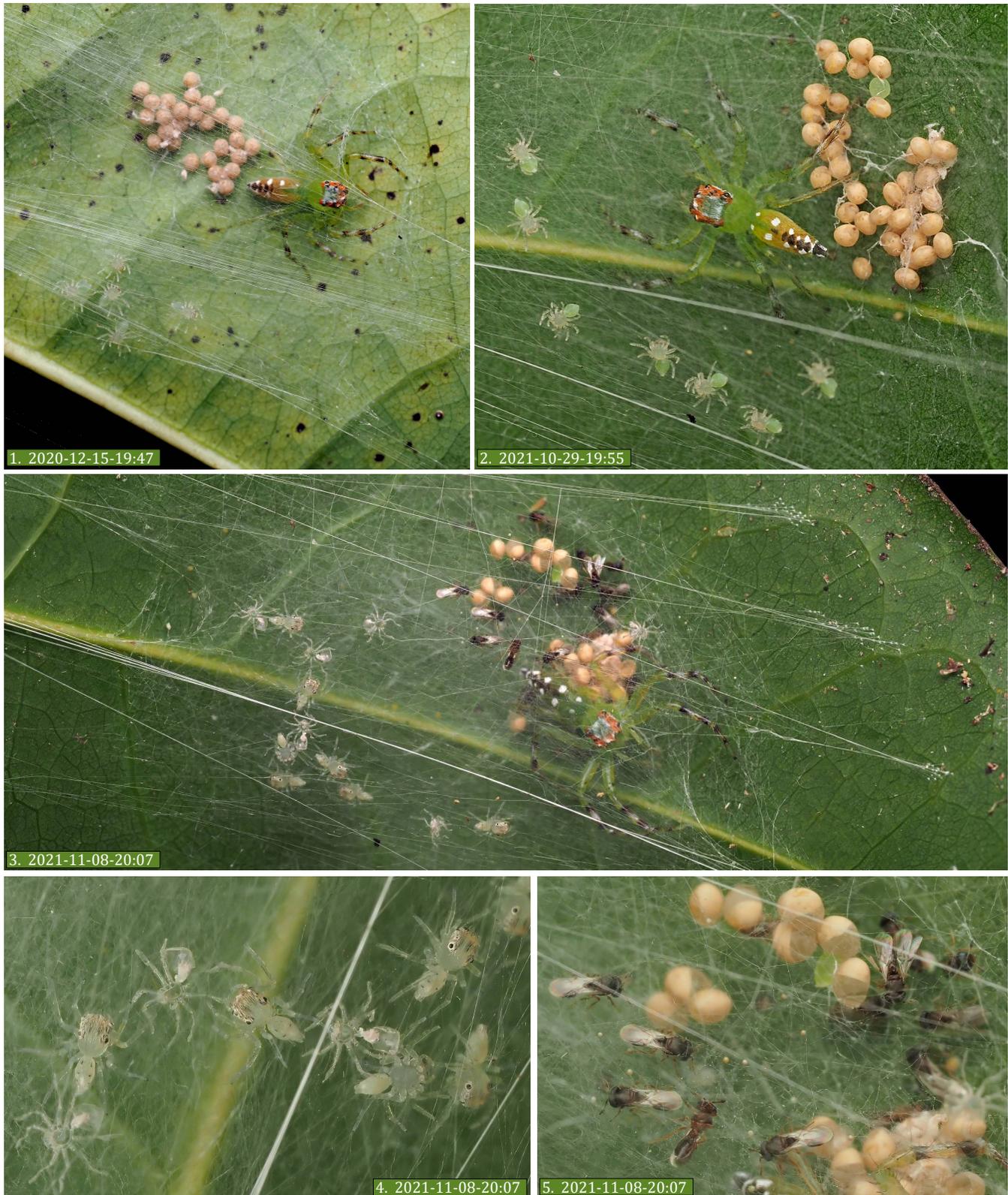


Filial oophagy (a female feeding on her own eggs) is known in salticids (e.g., *Asemonea*, Abhijith & Hill 2018; *Neobrettus*, Banerjee et al. 2019). This may occur when food is scarce and survival of the female to breed again is more important than survival of the immediate brood. In our study the small size of the brood that was followed, less than  $\frac{1}{3}$  of the size of other broods that have been observed in this species, supports this interpretation. With an extended tropical breeding season, survival of a single brood may not be so important. But we also have no information about the fertility of the eggs that were lost, discarded, or eaten, and removal of those "slow" eggs may have just represented *basic housekeeping* for the attending female. In any case, we have many records of much larger *Epeus alboguttatus* broods that were reared successfully (Figures 3-4, 11).

Even in the nest, adult female *Epeus* are subject to predation by other hunting spiders (Figure 8). Egg parasitoids may represent a greater danger to the brood. Several years ago (Abhijith & Hill 2019) we described infestation of an *Asemonea tenuipes* nest by parasitoid wasps (Scelionidae: *Idris* sp.). Here we document infestation of two *E. alboguttatus* nests by a different *Idris* species (Figure 9).



**Figure 8.** 1-4, Attack on a brooding female *Epeus* cf. *albus* by a hunting spider of the genus *Cheiracanthium* (Cheiracanthiidae: species not determined; Puttur; after Abhijith et al. 2021). The fate of this brood is not known. 5, Group of ants disassembling a female *E. alboguttatus*.



**Figure 9.** Infestation of two *Epeus alboguttatus* nests by parasitoid wasps (Scelionidae: *Idris* sp.). **1**, This nest contained the pupae of 26 wasps and 5 instar 1 spiders. Note that the female *Epeus* had not removed the egg membranes and exuviae of her five offspring, and these can still be seen in the mass of wasp pupae. **2**, A second nest containing 36 wasp pupae, 7 instar 1 spiders, and 1 undeveloped egg (upper left). **3**, Later view of the second nest, showing the parasitoid wasps emerging from their pupae. By this time all 7 spiders had completed their second molt to become instar 2 spiders. **4**, Detail from (3) showing some of the instar 2 spiders. Three of the exuviae of these spiders can also be seen. **5**, Detail from (3) showing the parasitoid wasps, now adults, emerging from their pupae.

Scelionid wasps of the genus *Idris* are known as egg parasitoids (or *idiobiont endoparasitoids*, after Rajmohana et al. 2025) of spiders, and many infest the nests of salticids (Figure 10). Each egg so attacked is devoured by a single larvae, and is replaced in the nest by the pupa produced by that larva. One might think that a female tending a brood would attack these parasitoids, as either pupae or adults, but it may be that the female's guarding of her own brood extends to these invaders as well, as they are of similar size. Recently the importance of *Idris* has received more attention from specialists, and the description of many new species is underway (e.g., Rajmohana et al. 2025; Sushama et al. 2025).



**Figure 10.** Parasitoid wasps (Scelionidae: *Idris*). **1.** Wasp from Oklahoma, USA. **2.** Emerging wasps in the brood of a salticid spider, Tainan, Taiwan. The female wasp that infested this brood was apparently able to get into this nest even though it was protected by thick layers of silk. Photo credits: 1, iNat. obs. 256601086, © Thomas Shahan, CC BY-NC. 2, iNat. obs. 39910544, © 大肚魚, CC BY-NC.

*Early life stages of spiders.* Although the naming of the early stages of spider growth and development can vary, as can details related to the timing of these stages, it appears that all spiders follow a similar pattern of development. These stages are summarized in Table 1.

**Table 1.** Early stages of spider development and growth (*ontogeny*) according to various authors (Palanichamy & Pandian 1983; Downes 1988; Hallas 1988; Wolff & Hilbrant 2011; Romero et al. 2022; Trabalon et al. 2017; Pechmann 2020). The many names used to describe the same stages can be confusing. In *Epeus* and other salticids, the *postembryo* stage is very brief, and both egg membranes and the very small first exuvia are discarded at the same time.

stage	name	alternative names	description
1	embryo	can be further divided into 14 (Pechmann 2020) or 20 (Hilbrant et al. 2012) embryonic stages	stage that begins with fertilization of the egg and ends with eclosion (hatching, or removal of egg membranes)
2	postembryo	first prelarva; second prelarva; stage 1 larva; juvenile; eclosed embryo; can be further divided into a variable number of postembryonic stages (see Hallas 1988; Huber & Haug 2021; Romero et al. 2022)	immobile stage that lacks sensory hairs and begins with eclosion and ends with the first molt; timing of development of post-embryonic cuticle (pre- or post- eclosion, or both) may vary; development of nervous system and other internal organs continues during this stage
3	instar 1 or first instar	larva; first instar larva; second prelarva; third incomplete stage; stage 2 larva; juvenile 1 instar; first instar juvenile; stage IV; postembryo; stage 4 postembryo, stage 5 postembryo	stage between the first and second molts; salticids are generally blind at this time, with claws that permit movement in the nest; some spiders may leave the cocoon in this stage but remain with the female
4	instar 2 or second instar	first complete stage; second instar larva; stage 3 larva; spiderling; juvenile 2 instar; second instar juvenile; stage V; stage 6	stage between the second and third molts; generally the first free-living (or emergent) stage in salticid spiders
5	instar 3 or third instar	stage 7; stage 8	stage between the third and fourth molts; some spiders remain with the female until this stage

In many spiders, the eggs are enclosed or encapsulated in a manner that does not permit observation of their development *in situ*. But even when the eggs are exposed and easy to observe, the delicate exuvia from the first molt can be difficult to observe. With magnification these can be seen as light brown fragments attached to the white egg membranes in an *Epeus* nest, prior to their removal (Figure 11).



**Figure 11.** **1**, Recently emerged instar 1 spiders in an *Epeus alboguttatus* nest, prior to removal of discarded egg membranes and exuviae by the female. **2**, Detail from (1), showing the light brown exuviae attached to the white egg membranes. The eyes of instar 1 spiders develop quickly, as shown by the appearance of dark pigment, to become fully functional after the second molt.

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