PECKHAMIA 201.1, 29 February 2020, 1—10 ISSN 2161—8526 (print)
LSID urn:lsid:zoobank.org:pub:76925684-1964-4C2C-9FCC-D483942F8415 (registered 28 FEB 2020) ISSN 1944—8120 (online)

Sticky floral stems and jumping spiders (Araneae: Salticidae)

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Abstract. Salticid spiders and other arthropods were observed in association with the sticky traps on floral stems of *Euphorbia milii, Euphorbia* cultivars and *Plumbago zeylandica* at Mysuru, Karnataka, India. Many insects, and ants in particular, were trapped by these plants. In addition some salticids, particularly smaller immatures, were trapped by *Euphorbia*, but none of these were found in the traps of *Plumbago*. Some ants and salticid spiders were nonetheless able to access the nectar of *Euphorbia* flowers. Salticids were able to safely access these flowers by walking over leaves that touched them, by jumping, or by climbing or descending on a dragline.

Keywords. *Carrhotus*, *Chrysilla*, *Crematogaster*, *Euphorbia*, *Hyllus*, Karnataka, India, *Madhyattus*, *Menemerus*, *Oecophylla*, *Plexippus*, *Plumbago zeylanica*, protocarnivory, *Rhene*, *Talicada*, *Tapinoma*, trichomes

Many plants are known to trap insects and other arthropods with sticky secretions or trichomes (specialized hairs) that cover their floral stems and thus block direct access to their flowers (Thomas 2003; Konno 2011; Kant et al. 2015; LoPresti et al. 2015; Krimmel & Wheeler 2015; Xing et al. 2017; Singh & Baijnath 2018; Galloway et al. 2019). Although these traps are generally thought to protect flowers from herbivorous insects, they can also keep non-flying insects that would be of little use for pollination from feeding on their nectar. Some plants, like *Plumbago*, while using their glandular trichomes for protection, may also obtain nitrogen from trapped insects that subsequently fall to the ground below (Panicker & Haridasan 2016; Chaudari & Chaudari 2017; Singh & Baijnath 2018). This practice has been termed *protocarnivory*. There is some experimental support for the hypothesis that, for at least some plants, trapped insects (*arthropod carrion*) can attract mutualist predators (see Figure 8) that provide even more protection from herbivorous arthropods (Thomas 2007; Krimmel & Pearse 2013; LoPresti et al. 2015; Wheeler & Krimmel 2015). One reduviid, the Neotropical resin bug *Heniartes stali* (Wygodzinsky), actually collects sticky exudate from these traps to facilitate its own prey capture (Avila-Núñez et al. 2017; Jiménez-Pomárico et al. 2019). Predators may also drop prey remains to the ground that provide even more nitrogen to a plant (Ellis & Midgley 1996), representing an indirect (predator-assisted) form of *protocarnivory*. However trichomes and other sticky traps can also trap these beneficial insects that would otherwise protect the plant by preying on herbivores (Eisner et al. 1998).

In Figures 1-8 we document the effects of these traps on salticid spiders and other arthropods, recorded by one of the authors (Abhijith) at his Indraprastha organic farm, Mysuru, Karnataka, India. The flowers and sticky flower stems of both *Euphorbia millii* Des Moul., *Euphorbia* cultivars and *Plumbago zeylanica* L. were observed at this site.

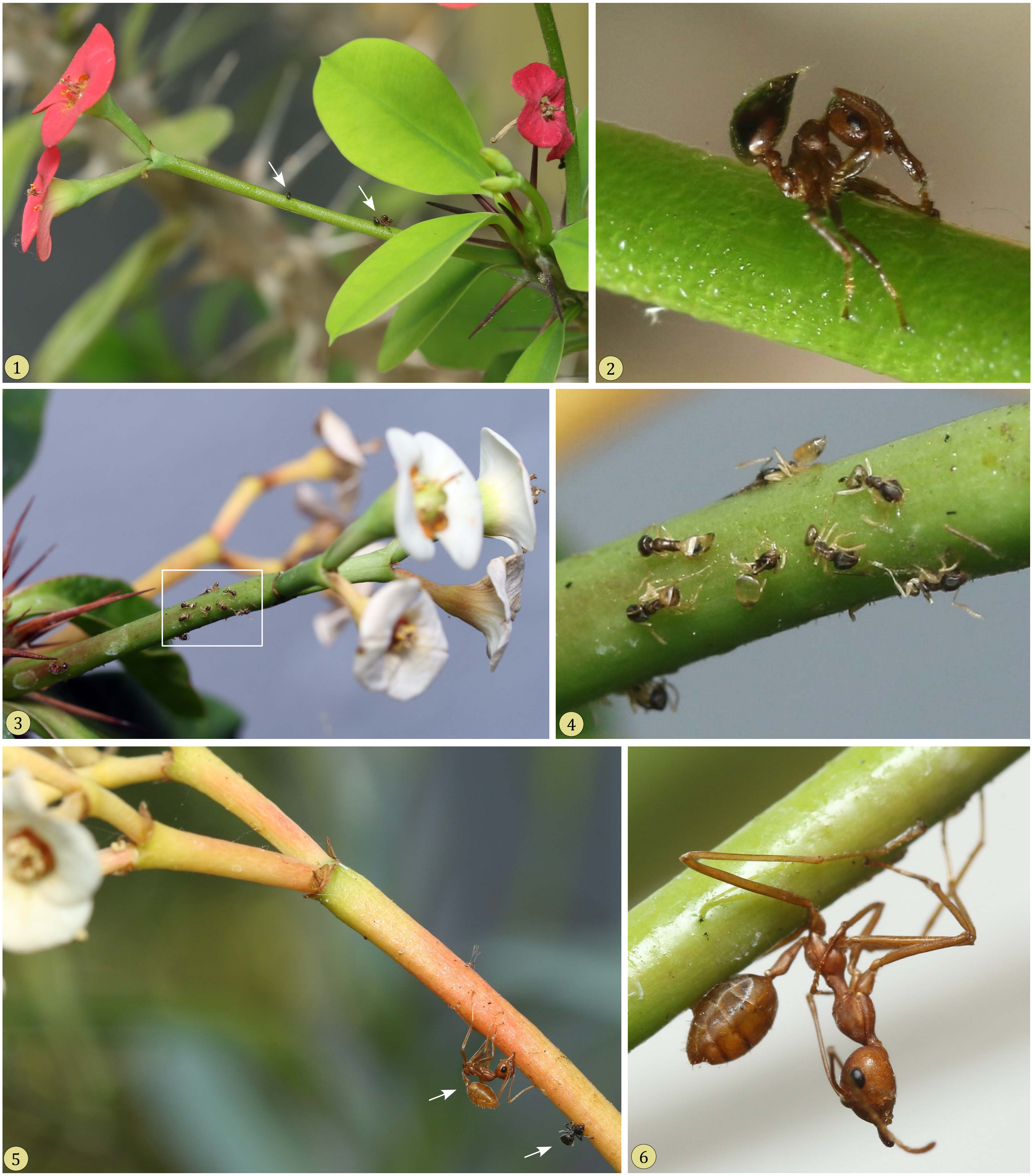

Figure 1. Capture of ants by *Euphorbia*. **1,** *Crematogaster* sp. trapped on sticky flower stem (arrows). **2,** Detail of captured *Crematogaster* sp. from (1). **3,** Ghost ants, *Tapinoma melanocephalum* (Fabricius 1793), trapped on sticky flower stem (inset rectangle). **4,** Detail of trapped ghost ants from (4). **5,** Two ants trapped on sticky flower stem (arrows). The larger ant is a weaver ant or green ant, *Oecophylla smaragdina* Fabricius 1775. **6,** Detail of another trapped weaver ant.

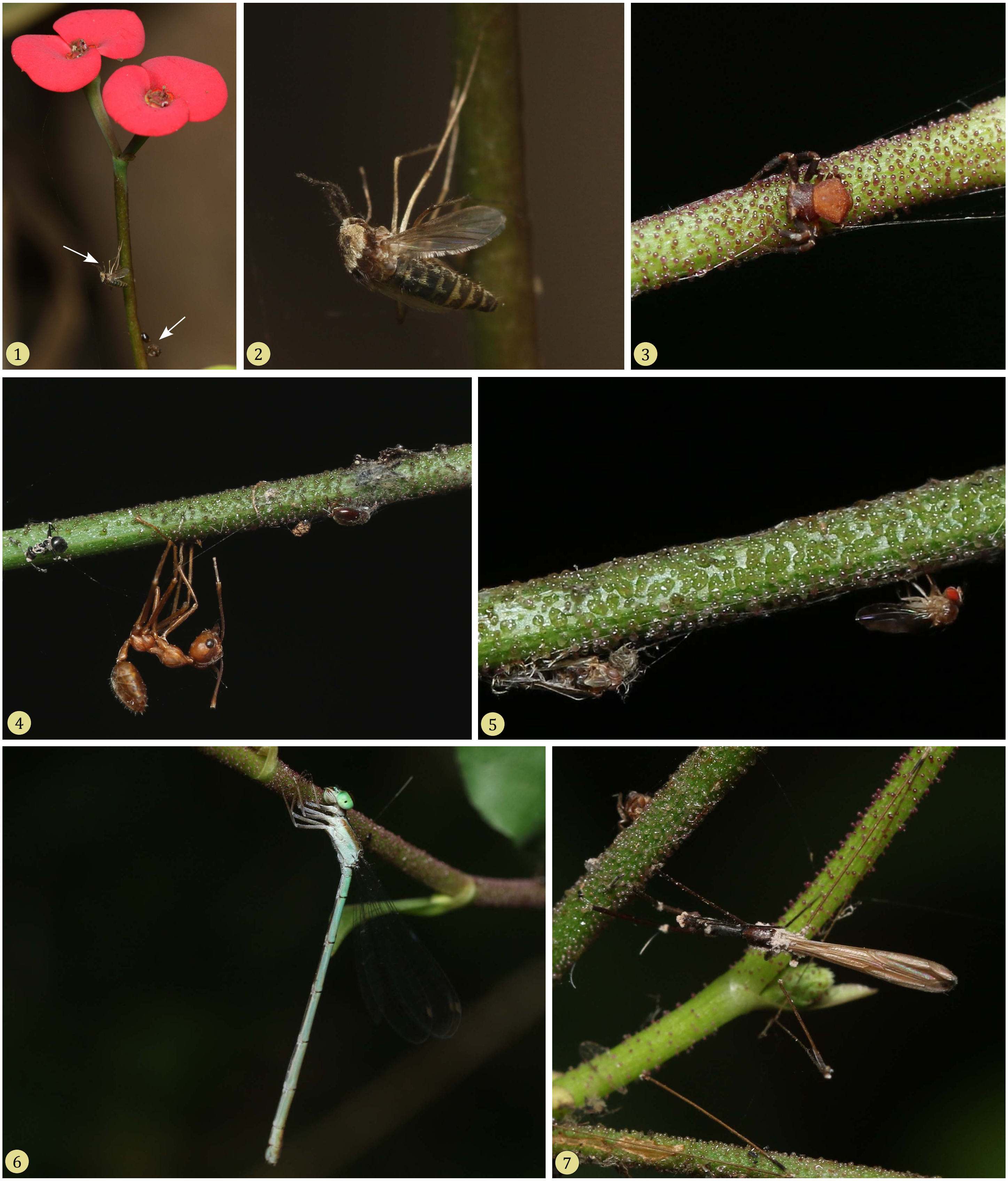

Figure 2. Capture of arthropods on sticky flower stems of *Euphorbia* (1-2) and *Plumbago zeylanica* (3-7). **1,** Trapped nematoceran fly. **2,** Detail of trapped nematoceran from (1). **3,** Trapped thomisid spider. **4,** Trapped weaver ant, *Oecophylla smaragdina.* **5,** Trapped brachyceran fly (at right). **6,** Trapped damselfly (Zygoptera). **7,** Trapped assassin bug (Reduviidae).

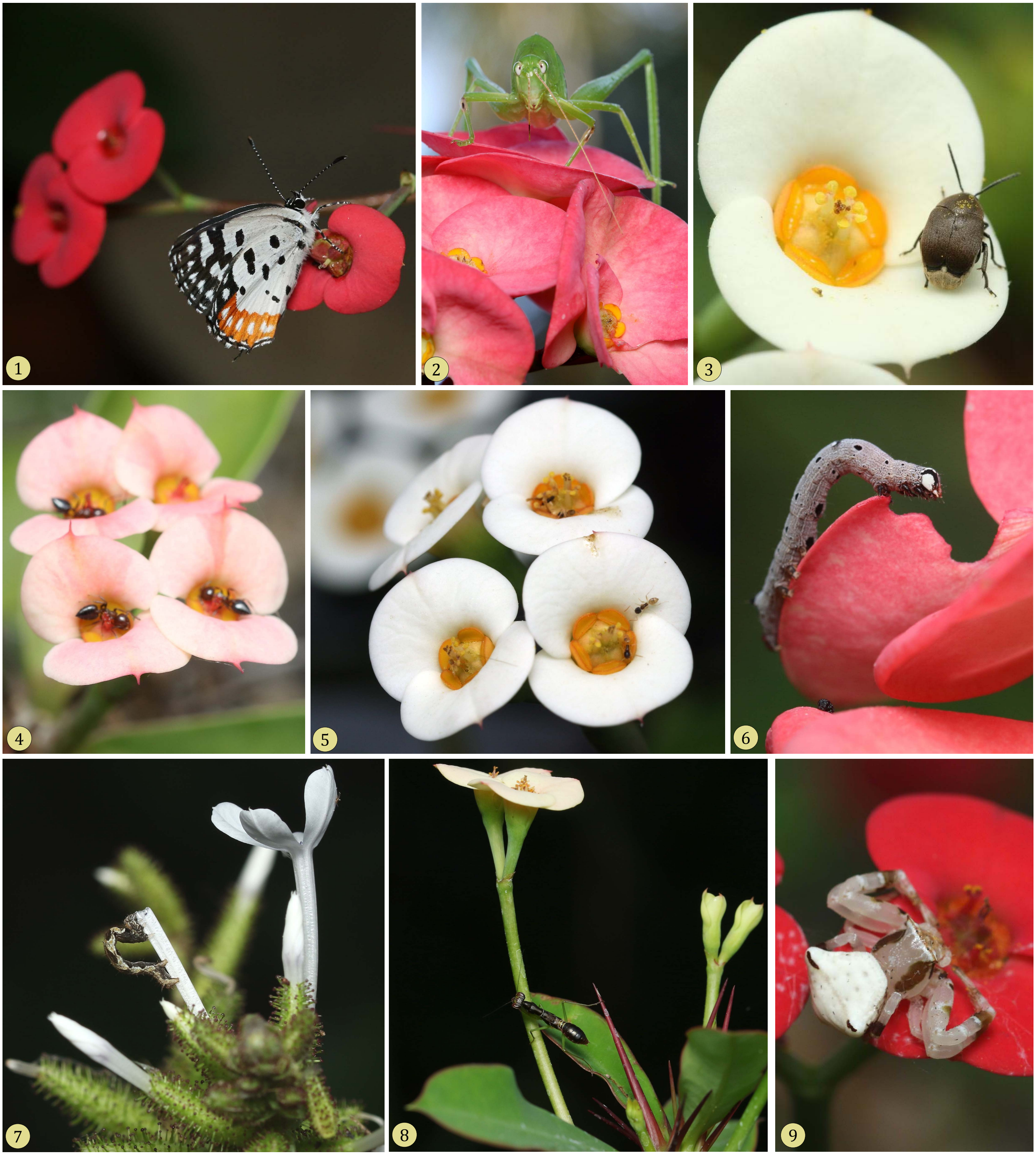

Figure 3. Arthropods that were able to avoid traps of *Euphorbia* (1-6, 8-9) and *Plumbago zeylanica* (7). **1,** Red Pierrot butterfly, *Talicada nyseus* (Lycaenidae). **2,** Tettigonid. **3,** Bruchine beetle carrying pollen. **4,** *Crematogaster* ants taking nectar. **5,** Ghost ants, *Tapinoma melanocephalum*, taking nectar. **6,** Geometrid caterpillar feeding on flower. Smaller geometrid caterpillars were also trapped on the sticky flower stems of *Euphorbia*. These caterpillars descend on silk lines (Sugiura & Yamazaki 2006) allowing some to avoid the sticky traps on flower stems. **7,** A different geometrid caterpillar feeding on a *Plumbago* flower. This caterpillar was able to avoid the many mucilaginous trichomes surrounding each flower calyx. **8,** Small mantid resting on a flower stem, possibly in danger of being trapped. **9,** Thomisid spider resting on a *Euphorbia* cyathophyll.

Figure 4. Salticid spiders trapped on the sticky flower stems of *Euphorbia*. **1,** Trapped cf. *Menemerus* (arrow). **2,** Detail of cf. *Menemerus* from (1). **3,** Small salticid. **4,** Detail of small salticid from (3). **5,** Small salticid (arrow). **6,** Small salticid (arrow) near mantid, **7,** Detail of small salticid from (6). **8,** Small salticid.

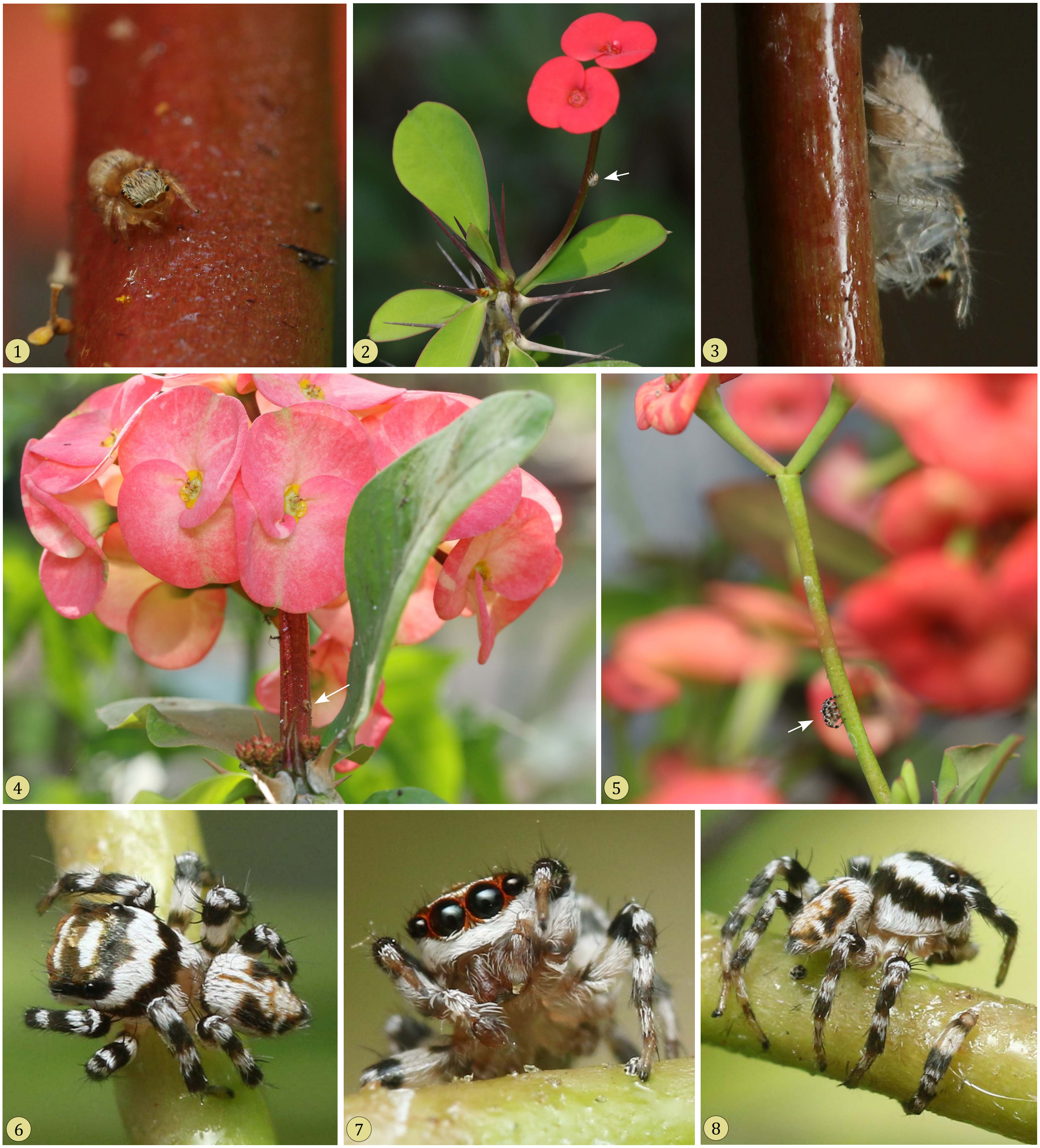

Figure 5. Salticid spiders trapped on the sticky flower stems of *Euphorbia*. **1-4,** Small salticids (arrows in 2, 4). **5,** Male cf *Orientattus aurantius* (Kanesharatnam & Benjamin 2018). This spider was 3-4 mm in length. **6-8,** Sequential, detailed views of trapped cf. *Orientattus aurantius* from (5). Leg autonomy (8) could not save this spider from the trap.

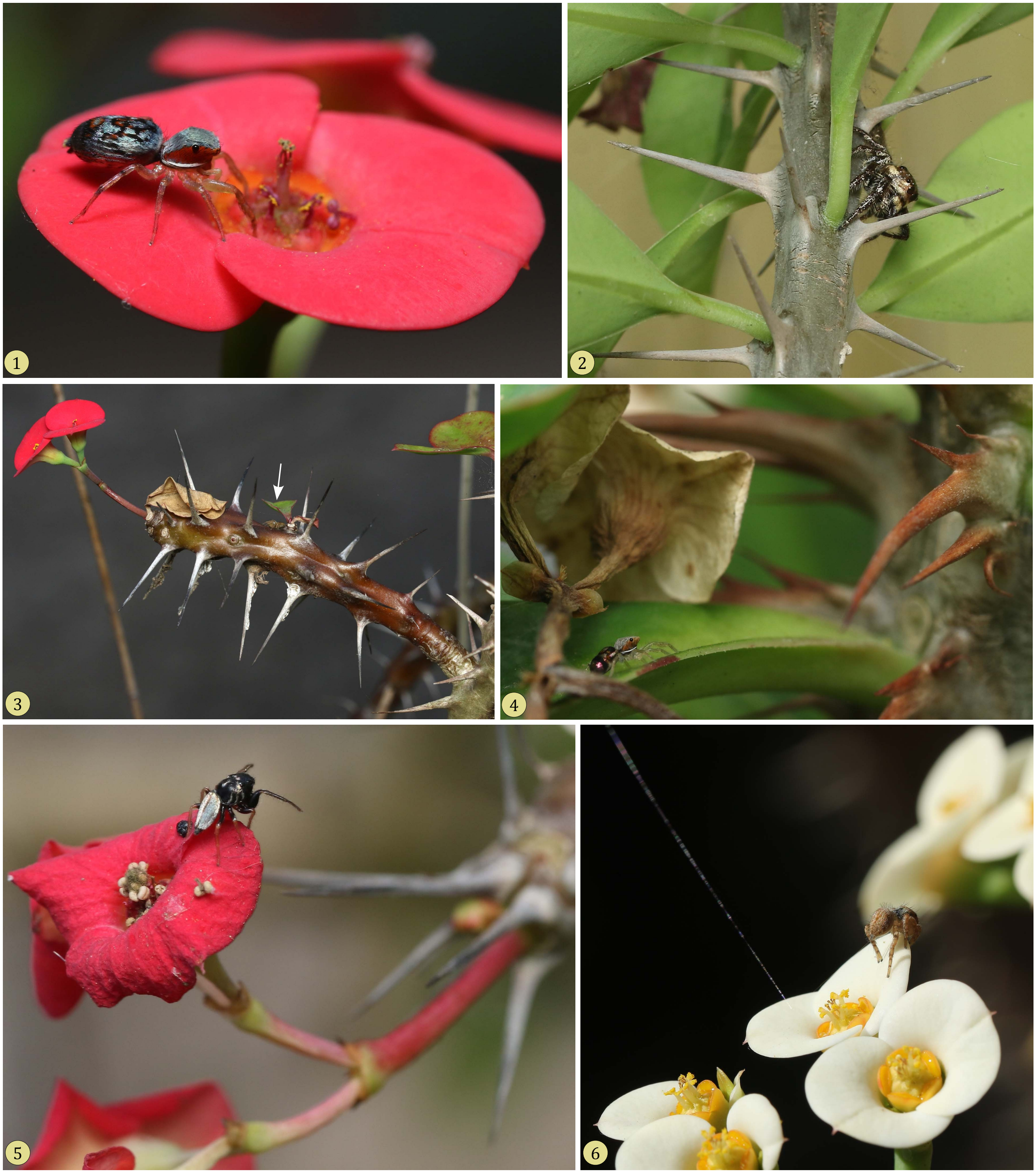

Figure 6. Salticid spiders that avoided the sticky flower stems of *Euphorbia*. **1,** Female *Chrysilla volupe* (Karsch 1879) resting on one of two red cyathophylls that surround a small flower. **2,** Male cf. *Hyllus semicupreus* (Simon 1885) on lower stem. **3,** cf. *Carrhotus* sp. (arrow) resting on stem below flower. **4,** Female *Chrysilla volupe* (Karsch 1879) resting on lower leaf. **5,** Male cf. *Madhyattus jabalpurensis* Prószyński 1992 on red cyanthophyll near dry or inactive flower. **6,** cf. *Carrhotus* sp. on white cyathophyll near active (nectar-producing) flowers. Note the silk line extending to the upper left.

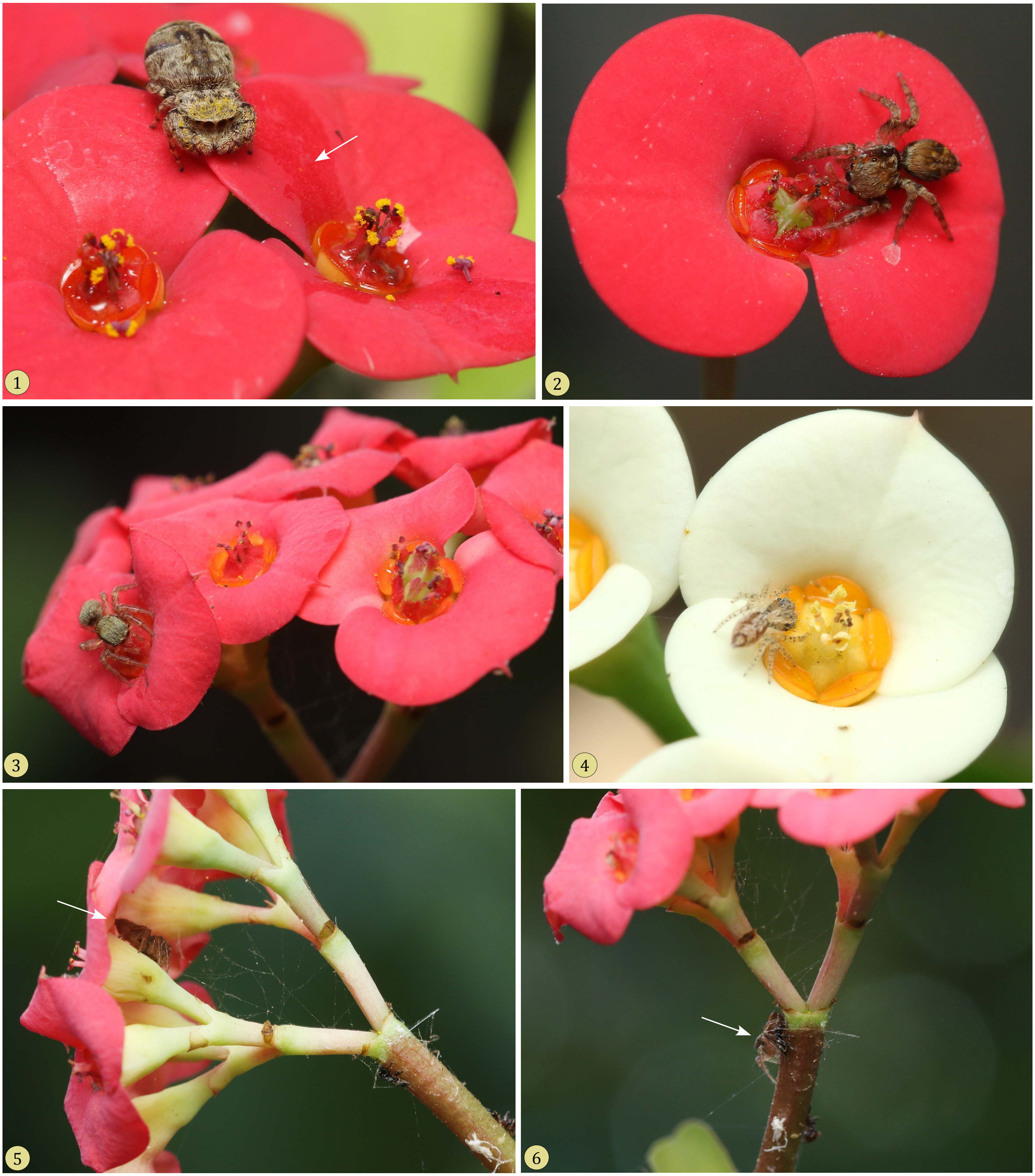

Figure 7. Salticid spiders that avoided the sticky flower stems of *Euphorbia*. **1,** *Rhene* sp. resting on red cyathophylls near two active male flowers. Pollen on the carapace and legs of this spider, as well as a track of nectar leading from one of the flowers (arrow), indicate that this male had been feeding on nectar and collected pollen in the process. **2,** Immature cf. *Plexippus* sp. at flower. **3-4,** Salticids at flowers. **5-6,** Two views of salticid (arrows) resting below flowers. Several ants were trapped on the sticky stem beneath these flowers.

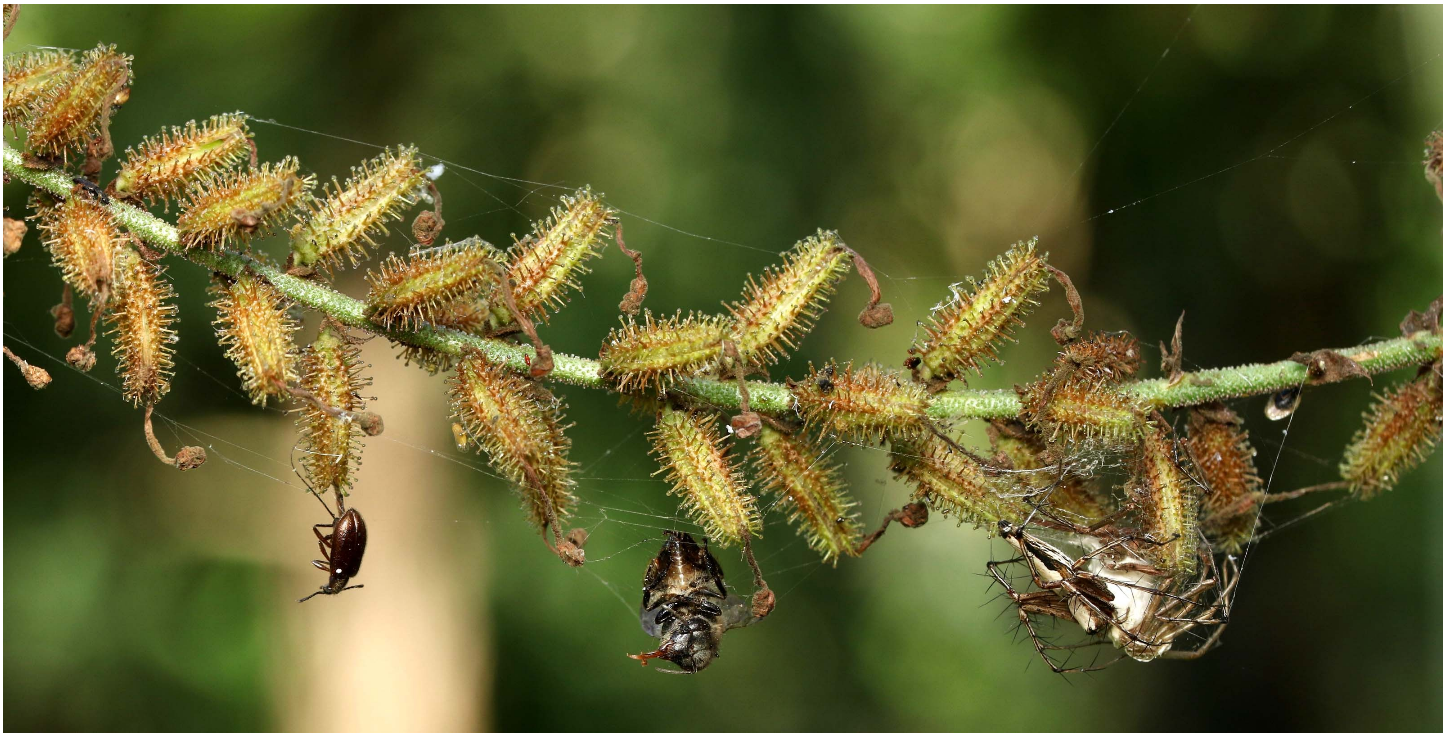

Figure 8. This nesting female lynx spider (Oxyopidae, lower right) was able to use a framework of silk lines to live safely among the mucilaginous trichomes of a *Plumbago zeylanica*. Two trapped beetles were not so fortunate and this oxyopid may have fed on them. A predatory spider like this may enhance the protective or protocarnivorous functions of the trichomes.

The nectar of these *Euphorbia* flowers attracted many Red Pierrot butterflies, *Talacada nyseus* (Guerin-Méneville 1843), and other flying insects (Figure 3:1-3). Flying insects, because of their dispersal and ability to reach flowers without encountering their sticky flower stems, are probably their most important pollinators. Ants and other insects were trapped in large numbers on stems (Figures 1-2), but some ants managed to reach the flowers and feed on the nectar (Figure 3:4-5). In some instances this access may have been facilitated by access via leaves that came into contact with the cyathophylls that surround each flower. A number of predatory arthopods, including mantids and oxyopid or thomisid spiders, could also be seen near these flowers, and they may have been attracted to trapped arthropod carrion (Figures 3:8-9).

At the Indraprastha organic farm (Mysuru, Karnataka, India), many salticids were observed on *Euphorbia*. These included representatives of the genera *Afraflacilla*, *Carrhotus*, *Chrysilla*, *Hyllus*, *Madhyattus*, *Menemerus*, *Myrmarachne*, *Phintella*, *Plexippus*, *Rhene* and *Siler* (hunting *Crematogaster* ants). Curiously, no salticids were observed on ornamental *Euphorbia* planted along the roadside at Bangalore. Most but not all of the trapped salticids were small and immature (Figures 4, 5). On *Plumbago zeylanica*, a plant with many mucilaginous trichomes on the calyx of each flower, many insects but no salticids were trapped. Salticids were observed to safely access the flowers of *Euphorbia* directly from leaves that came into contact with them, by jumping, and by descending or climbing on draglines (Figures 6-7). Some salticids were seen to move down to the sticky floral stem of these plants, and then to retreat safely without getting trapped (Figure 7:5-6). Many salticids are known to feed on the floral or extrafloral nectaries of plants (Jackson et al. 2001; Nyffeler 2016; Nyffeler et al. 2016), and the active (nectar-producing) flowers of *Euphorbia* provide them with a rich supply if these can be accessed safely (Figure 7:1-4). Although salticids, like ants and other predatory insects, can fill the *protective predator role* encouraged by the extrafloral nectaries of many plants, this role is not so apparent with regard to floral nectaries, particularly those (like *Euphorbia* and *Plumbago*) guarded by sticky flower stems that limit access.

Acknowledgments

We are thankful to Shrilatha Abhijith and A.P Chandrashekhar, respectively the wife and father of Abhijith, who assisted with photography. Without their support these events could not have been documented. We also thank Dr. Sampath Kumar, Senior Botanist, Davanagere, Karnataka, for information about the *Euphorbia* cultivars, Mr. Sankararaman H. for identification of a bruchine beetle, and Dr. John T. D. Caleb for identification of *Orientattus*. All photographs are Copyright © Abhijith A. P. C.

References

Avila-Núñez, J. L., M. Naya, L. D. Otero and M. E. Alonso-Amelot. 2017. Sticky trap predation in the Neotropical resin bug *Heniartes stali* (Wygodzinsky) (Hemiptera: Reduviidae: Harpactorinae). Journal of Ethology 35: 213-219.

Chaudari, S. S. and G. S. Chaudari. 2017. Comparative LM and SEM studies of glandular trichomes on the calyx of flowers of two species of *Plumbago* linn.

Eisner, T., M. Eisner and E. R. Hoebeke. 1998. When defense backfires: Detrimental effect of a plant's protective trichomes on an insect beneficial to the plant. Proceedings of the National Academy of Sciences, USA 95: 4410-4414.

Ellis, A. G. and J. J. Midgley. 1996. A new plant-animal mutualism involving a plant with sticky leaves and a resident hemipteran insect. Pecologia 106: 478-481.

Galloway, A. F., P. Knox and K. Krause. 2019. Sticky mucilages and exudates of plants: putative microenvironmental design elements with biotechnological value. New Phytologist (doi: 10.1111/nph.16144): 1-9.

Kant, M. R., W. Jonckheere, B. Knegt, F. Lemos, J. Liu, B. C. J. Schimmel, C. A. Villarroel, L. M. S. Ataide, W. Dermauw, J. J. Glas, M. Egas, A. Janssen, T. Van Leeuwen, R. C. Schuurink, M. W. Sabelis and J. M. Alba. 2015. Mechanisms and ecological consequences of plant defence induction and suppression in herbivore communities. Annals of Botany 115: 1015-1051.

Konno, K. 2011. Plant latex and other exudates as plant defense systems: Roles of various defense chemicals and proteins contained therein. Phytochemistry 72: 1510-1530.

Krimmel, B. A. and I. S. Pearse. 2013. Sticky plant traps to enhance indirect defence. Ecology Letters 16: 219-224.

Krimmel, B. A. and A. G. Wheeler Jr. 2015. Host-plant stickiness disrupts novel ant–mealybug association. Arthropod-Plant Interactions 9: 187-195.

LoPresti, E. F., I. S. Pearse and G. K. Charles. 2015. The siren song of a sticky plant: Columbines provision mutualist arthropods by attracting and killing passerby insects. Ecology 96 (11): 2862-2869.

Jackson, R. R., S. D. Pollard, X. J. Nelson, G. B. Edwards and A. T. Barrion. 2001. Jumping spiders (Araneae: Salticidae) that feed on nectar. Journal of Zoology 255 (1): 25-29.

Jiménez-Pomárico, A., J. L. Avila-Núñez, A. Oliveros-Bastidas, F. R. Márquez, M. Avendaño, D. Uzcátegui, R. V. Mendoza-Briceño, D. Dávila-Vera, L. B. Rojas and R. Aparicio. 2019. Chemical and morpho-functional aspects of the interaction between a Neotropical resin bug and a sticky plant. Revista de Biología Tropical 67 (3): 454-465.

Nyffeler, M. 2016. Phytophagy in jumping spiders: The vegetarian side of a group of insectivorous predators. Peckhamia 137.1: 1-17.

Nyffeler, M. , E. J. Olson and W. O. C. Symondson. 2016. Plant-eating by spiders. Journal of Arachnology 44: 15-27.

Panicker, S. and V. K. Haridasan. 2016. A glimpse on insect capturing glandular hairs of *Plumbago zeylanica* Linn. and *Plumbago auriculata* Lam. European Journal of Experimental Biology 6 (3):75-79.

Singh, K. and H. Baijnath. 2018. A comprehensive review on the genus *Plumbago* with focus on *Plumbago auriculata* (Plumbaginaceae). African Journal of Traditional, Complementary and Alternative Medicines 15 (1): 199-215.

Sugiura, S. and K. Yamazaki. 2006. The role of silk threads as lifelines for caterpillars: pattern and significance of lifeline-climbing behaviour. Ecological Entomology 31 (1): 52-57.

Thomas, P. A. 2003. Sticky exudates on the infloresces of *Cirsium discolor* (Asteraceae) and *Penstemon digitalis* (Scrophulariaceae) as possible defense against seed predators. The Great Lakes Entomologist 36 (3-4): 112-121.

Thomas, P. A. 2007. Arthropods utilizing sticky inflorescences of *Cirsium discolor* and *Penstemon digitalis*. The Great Lakes Entomologist 40 (3-4): 169-176.

Wheeler, A. G. Jr. and B. A. Krimmel. 2015. Mirid (Hemiptera: Heteroptera) specialists of sticky plants: adaptations, interactions, and ecological implications. Annual Review of Entomology 60: 393-414.

Xing, Z., Y. Liu, W. Cai, X. Huang, S. Wu and Z. Lei. 2017. Efficiency of trichome-based plant defense in *Phaseolus vulgaris* depends on insect behavior, plant ontogeny, and structure. Frontiers in Plant Science B (2006): 1-8.