

## Trophobiotic relationship of the jumping spider *Brettus cingulatus* (Araneae: Salticidae: Spartaeni) with mealybugs (Hemiptera: Pseudococcidae) in Karnataka

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**Summary.** The association of the jumping spider *Brettus cingulatus* with mealybugs (Hemiptera: Pseudococcidae) tended by ants, including tactile stimulation and feeding upon the secretions of these insects, is documented.

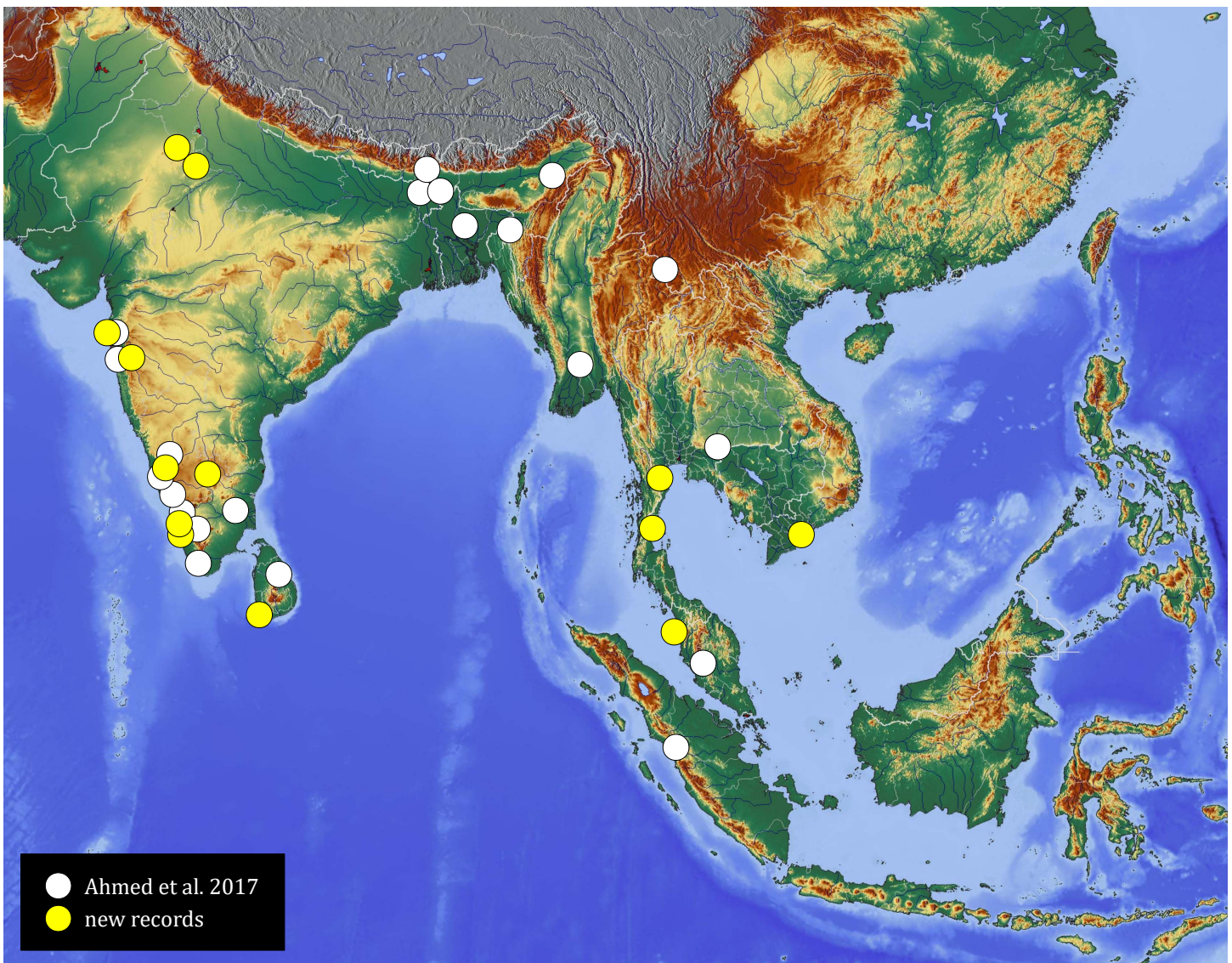
An amber fossil of an ant queen (Formicidae: Formicinae) carrying an mealybug (Coccoidea) in the Dominican Amber (Figure 1; Miocene, 15-20Ma) may represent the earliest record of a trophobiotic relationship between ants and Hemiptera that feed on plant juices, although there is evidence that relationships of this kind date back to the Eocene (Wheeler 1915; Johnson et al. 2001; LaPolla 2005; Nelsen, Ree & Moreau 2018). Today the trophobiotic relationships of these insects are widespread and well-known (Delabie 2001; Lehouck et al. 2004; Blüthgen, Mezger & Linsenmair 2006; Guerra et al. 2011).



**Figure 1.** Dominican Amber fossil of an *Acropyga glaesaria* ant queen (paratype specimen SMFBE457B2) carrying an *Electromyrmococcus abductus* mealybug (Coccoidea). A detailed drawing of this fossil appears in LaPolla (2005). Photo credit: Vincent Perrichot from [www.antweb.org](http://www.antweb.org), used under a Creative Commons Attribution 4.0 International (CC BY 4.0) license.

We now know that many spiders, including salticids, feed on plant liquids (Jackson et al. 2001; Nyffeler 2016; Nyffeler, Olson & Symondson 2016; Painting et al. 2017). The chrysilline salticid *Orsima ichneumon* (Simon 1901) is even known to guard nectaries (Painting et al. 2017). The astioid, ant-mimicking salticids *Myrmarachne melanotarsa* Wesołowska & Salm 2002 and *M. foenisex* Simon 1909 are also known to drink liquids from plant-feeding Hemiptera that are usually tended by ants (Collart 1929a, 1929b; Salm 2005; Jackson, Nelson & Salm 2008). It is possible that this, as been hypothesized for the trophobiotic relationships of ants and Hemiptera (Nelsen, Ree & Moreau 2018), represents an evolutionary transition from feeding on plant liquids taken directly from plants, to feeding on similar liquids provided by plant-feeding insects.

Since the spartaeine *Brettus albolimbatus* Simon 1900 was identified as the female, and a synonym, of *B. cingulatus* Thorell 1895 by Ahmed et al. (2013), this species has become one of the better known salticids in the fauna of tropical Asia, with a range extending from western India to Sumatra (Figures 2-3; Abhijith A. P. C. & Hill 2019; Pai & Hill 2020; Harshith J. V. & Hill 2020; Tam et al. 2021).



**Figure 2.** Known distribution of *Brettus cingulatus* in south and southeast Asia. Modified after Ahmed et al. (2017), with additional records including spiders identified from photographs subsequently posted on the *iNaturalist* site.





**Figure 3.** Photos of male (1-2) and female (3-4) *Brettus cingulatus*, posted recently on the *iNaturalist* site. **4,** Female in typical posture, guarding her egg sac. Photo credits: 1-2, © Sunny Joseph (9 NOV 2020, Kollamkudimugal, Mundampalam, Kochi, Kerala, India), used under an Attribution 4.0 International ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)) license; 3, © Ian Dugdale (7 MAY 2021, Ban Song Pe Nong, Kaeng Krachen, Thailand), used under an Attribution 4.0 International ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)) license; 4, © Harshith J. V. (Sanoor village, Udipi district, Karnataka, India), used under an Attribution-NonCommercial 4.0 International ([CC BY-NC 4.0](https://creativecommons.org/licenses/by-nc/4.0/)) license.

Here (Figures 4-8) we document the association of *Brettus cingulatus* with several different mealybug species (Hemiptera: Sternorhycha, Coccoidea: Pseudococcidae) at the Indraprastha Organic Farm of the senior author at Kalalwadi Village, Mysuru, Karnataka, India. Detailed photographs and video records of female *B. cingulatus* revealed that these spiders not only drank droplets of liquid produced by pseudococcids, but also used their pedipalps and legs for the tactile stimulation of these insects, presumably eliciting production of these droplets in the same way that this production is elicited by tending ants with their antennae. Survival of the pseudococcids in this case showed that this drinking was not incidental to predation by the spider (Figure 5:22-23).

Many other observations of *Brettus cingulatus* suggest that this trophobiotic relationship with pseudococcids is not obligate but facultative (opportunistic) for the spider, skilled at the capture of web spiders (Jackson & Hallas 1986; Jackson 2000; Abhijith A. P. C & Hill 2019), and also capable of conspecific oophagy (Harshith J. V. & Hill 2020). The tactile stimulation of these insects by *B. cingulatus* also suggests that this represents much more than an incidental response, but rather an indication that these salticids have evolved the ability to use these insects in parallel with the ants that are much better known for this behaviour.





**Figure 4.** Association of *Brettus cingulatus* with various pseudococcid species. **1**, Immature near a small pseudococcid covered with black spines and droplets. **2**, Detail of pseudococcids shown in (1). **3-4**, Immature with a different pseudococcid. Image (4) is a composite of two images. **5**, Adult male near a pseudococcid covered with waxy projections. **6-7**, Two views of an adult female near an isolated pseudococcid that she has been tending (also see Figure 6).





**Figure 5 (continued on next page).** Sequential photographs (1-23) documenting the association of an adult female *Brettus cingulatus* with a pseudococcid species (also see Figures 7-8). This pseudococcid conceals itself under a mass of waxy secretions, in this case beneath the leaves of a *Ficus benjamina* tree. **5**, Detail of the main cluster of pseudococcids tended by this *B. cingulatus*. **7-8**, Note an ant tending some of these pseudococcids, at the lower left.



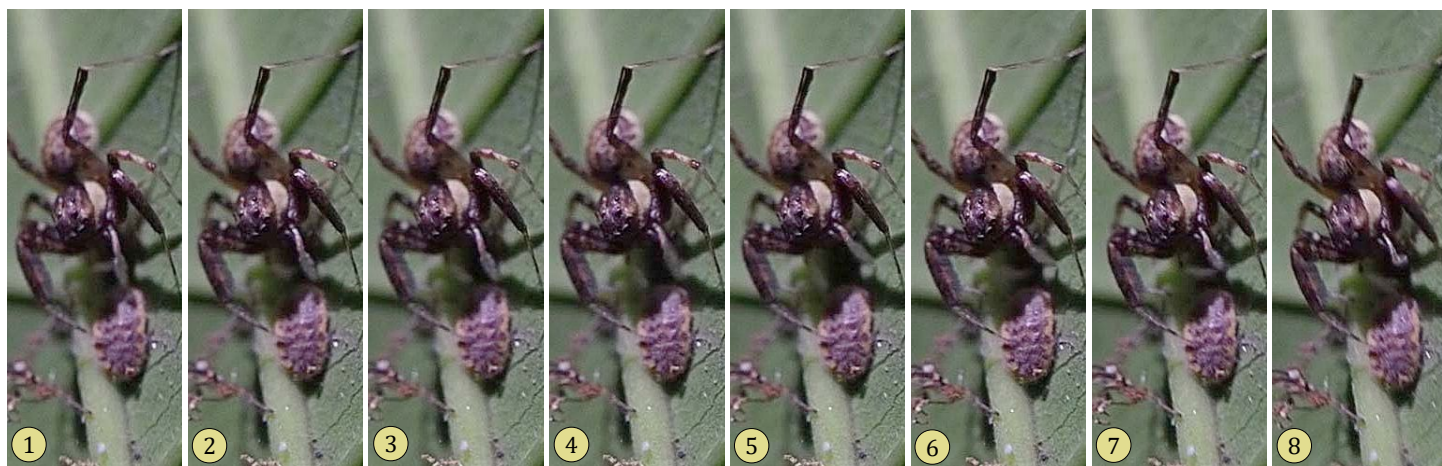


**Figure 5 (continued from previous page, continued on next page).** Sequential photographs (1-23) documenting the association of an adult female *Brettus cingulatus* with a pseudococcid species (also see Figures 7-8). **9-11**, Arrow shows position of droplet that was subsequently (12) imbibed by this spider. **13-14**, Sequence shows this spider lowering her mouthparts to reach the pseudococcid. **15**, After the spider pulled back, a small droplet can be seen here, where she had pressed her mouthparts to the pseudococcid. **17-18**, Tactile stimulation of the pseudococcid with the pedipalps and legs of this spider.



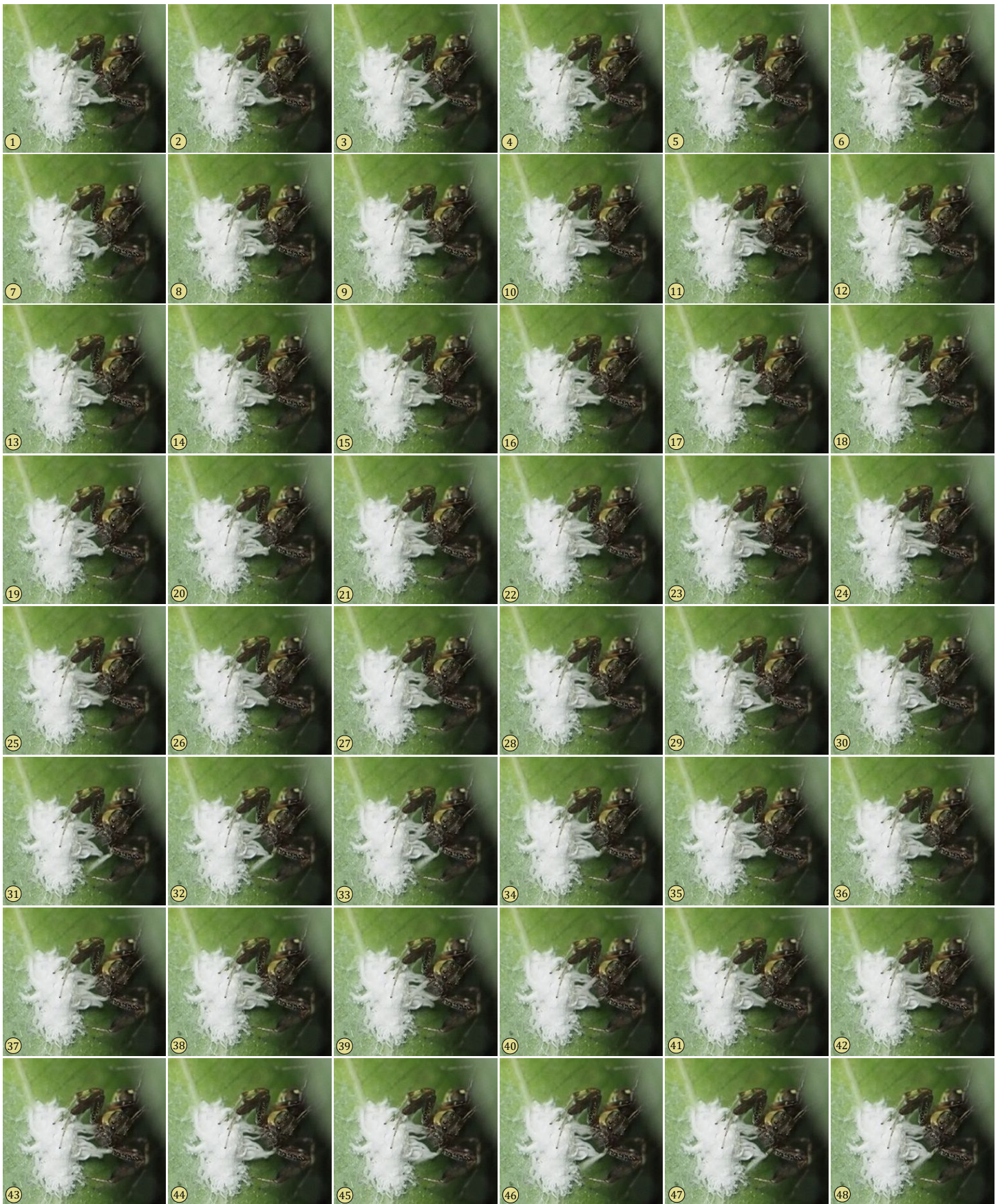


**Figure 5 (continued from previous page).** Sequential photographs (1-23) documenting the association of an adult female *Brettus cingulatus* with a pseudococcid species (also see Figures 7-8). **19**, Detail showing pseudococcids moving beneath their waxy accretions. **22**, Two views of an ant later attending the same pseudococcids.



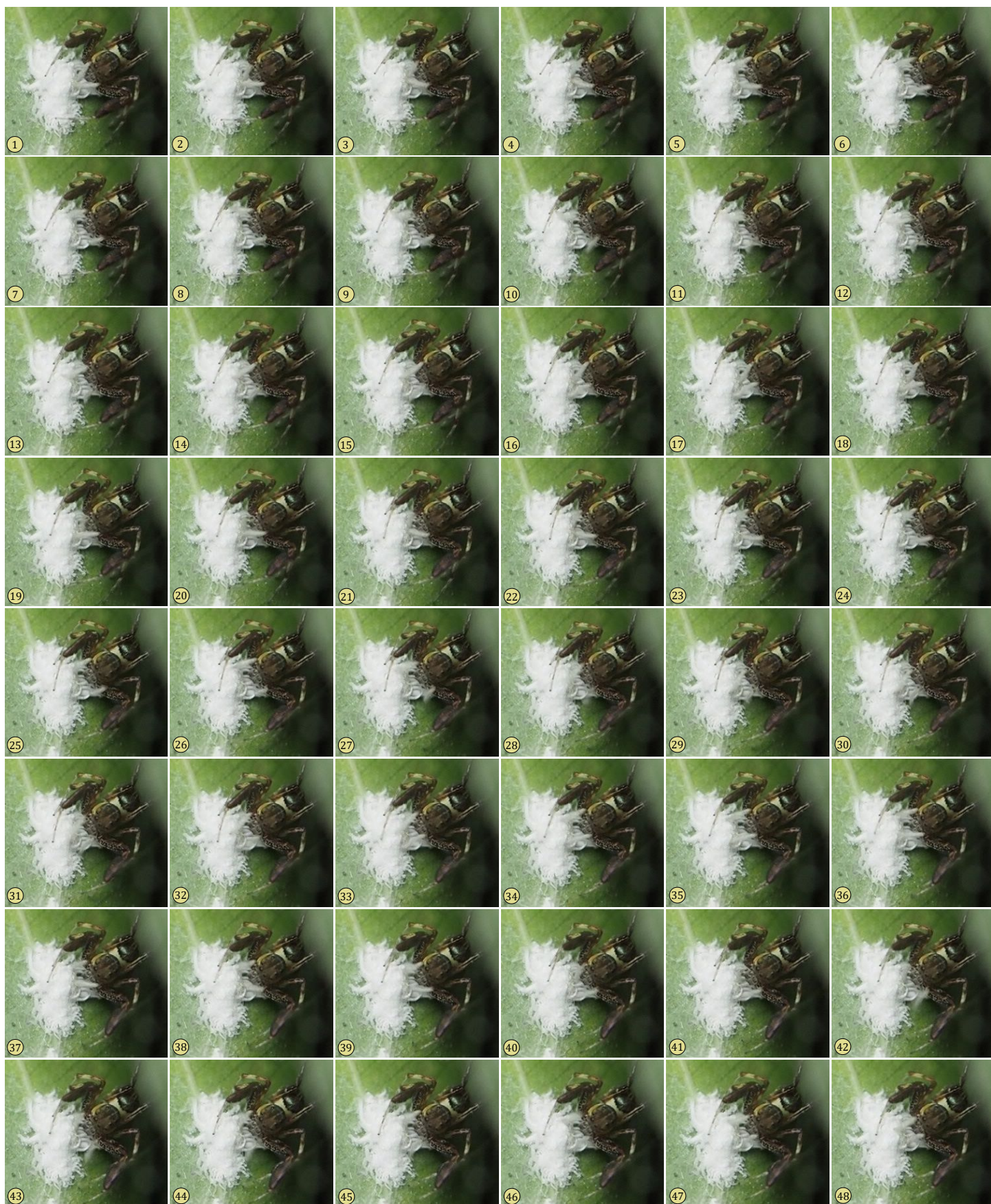
**Figure 6.** Consecutive (1-8) frames from a 30fps video of the adult female shown in Figure 4:6-7. By carefully comparing adjacent frames you can see the continuous movement of both pedipalps in contact with this pseudococcid.





**Figure 7.** Consecutive (1-48) frames from a 30fps video of the adult female shown in Figure 5. By carefully comparing adjacent frames you can see the continuous movement of both pedipalps in contact with this pseudococcid. Bouts of activity like this continued for more than two minutes.





**Figure 8.** Consecutive (1-48) frames from a 30fps video of the adult female shown in Figures 5 and 7. Here continuous movement of the pedipalps was accompanied by some movement of legs I and II.



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## References

- Abhijith A. P. C. and D. E. Hill. 2019.** Notes on the jumping spider *Brettus cingulatus* in Karnataka (Araneae: Salticidae: Spartaeni). *Peckhamia* 186.1: 1-14.
- Ahmed, J., R. Khalap, D. E. Hill, Sumukha J. N. and K. Mohan. 2017.** First record of *Brettus cingulatus* from India, with a review of *Brettus* in South and Southeast Asia (Araneae: Salticidae: Spartaeni). *Peckhamia* 151.1: 1-13.
- Blüthgen, N., D. Mezger and K. E. Linsenmair. 2006.** Ant-hemipteran trophobioses in a Bornean rainforest – diversity, specificity and monopolisation. *Insectes Sociaux* 53: 194-203.
- Collart, A. 1929a.** Quelques observations sur une araignee mimetique. *Revue de Zoologie et de Botanique Africaines* 18 (2): 147-161.
- Collart, A. 1929b.** Quelques notes sur les *Myrmarachne* araignees oecophylliformes. *Bulletin du Cercle Zoologique Congolais* 5: 117-118.
- Delabie, J. H. C. 2001.** Trophobiosis Between Formicidae and Hemiptera (Sternorrhyncha and Auchenorrhyncha): an Overview. *Neotropical Entomology* 30 (4): 501-516.
- Guerra, T. J., F. Camarota, F. S. Castro, C. F. Schwertner and J. Grazia. 2011.** Trophobiosis between ants and *Eurystethus microlobatus* Ruckes 1966 (Hemiptera: Heteroptera: Pentatomidae) a cryptic, gregarious and subsocial stinkbug. *Journal of Natural History* 45 (17/18): 1101-1117.
- Harshith J. V. and D. E. Hill. 2020.** Conspecific oophagy by the jumping spider *Brettus cingulatus* (Araneae: Salticidae: Spartaeni) in Karnataka, India. *Peckhamia* 217.1: 1-5.
- Jackson, R. R. 2000.** Prey preferences and visual discrimination ability of *Brettus*, *Cocalus* and *Cyrba*, araneophagic jumping spiders (Araneae: Salticidae) from Australia, Kenya and Sri Lanka. *New Zealand Journal of Zoology* 27: 29-39.
- Jackson, R. R. and S. E. A. Hallas. 1986.** Predatory versatility and intraspecific interactions of spartaeni jumping spiders (Araneae: Salticidae): *Brettus adonis*, *B. cingulatus*, *Cyrba algerina*, and *Phaeacius* sp. indet. *New Zealand Journal of Zoology* 13: 491-520.
- Jackson, R. R., X. J. Nelson and K. Salm. 2008.** The natural history of *Myrmarachne melanotarsa*, a social ant-mimicking jumping spider. *New Zealand Journal of Zoology* 35: 225-235.
- 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: 25-29.
- Johnson, C., D. Agosti, J. H. Delabie, K. Dumpert, D. J. Williams, M. von Tschirnhaus and U. Maschwitz. 2001.** *Acropyga* and *Azteca* Ants (Hymenoptera: Formicidae) with Scale Insects (Sternorrhyncha: Coccoidea): 20 Million Years of Intimate Symbiosis. *American Museum Novitates* 3335: 1-18.
- LaPolla, J. S. 2005.** Ancient Trophophoresy: A Fossil *Acropyga* (Hymenoptera: Formicidae) from Dominican Amber. *Transactions of the American Entomological Society*. 131 (1/2): 21-28.
- Lehouck, V. S., D. B. Bonte, W. Dekoninck and J.-P. E. Maelfait. 2004.** Trophobiotic relationships between ants (Hymenoptera: Formicidae) and Tettigometridae (Hemiptera: Fulgoromorpha) in the grey dunes of Belgium. *European Journal of Entomology* 101: 547-553.
- Malm, S. 2005.** Cooperation and conflict: sociality in salticid spiders. Ph.D. Dissertation, University of Canterbury: i-vi, 1-191.
- Nelsen, M. P., R. H. Ree and C. S. Moreau. 2018.** Ant-plant interactions evolved through increasing interdependence. *Proceedings of the National Academy of Science* 115 (48): 12253-12258.
- 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.
- Pai, M. J. and D. E. Hill. 2020.** Cohabitation and mating by *Brettus cingulatus* (Araneae: Salticidae: Spartaeni) in Karnataka. *Peckhamia* 210.1: 1-5.
- Painting, C. J., C. C. Nicholson, M. W. Bubern, Y. Norma-Rashid and D. Li. 2017.** Nectary feeding and guarding behavior by a tropical jumping spider. *Frontiers in Ecology and the Environment* 15 (8): 469-470.
- Simon, E. 1900.** Etudes arachnologiques. 30e Mémoire. XLVII. Descriptions d'espèces nouvelles de la famille des Attidae. *Annales de la Société Entomologique de France* 69: 27-61.
- Simon, E. 1901.** Descriptions d'arachnides nouveaux de la famille des Attidae (suite). *Annales de la Société Entomologique de Belgique* 45: 141-161.
- Simon, E. 1909.** Arachnides recueillis par L. Fea sur la côte occidentale d'Afrique. 2e partie. *Annali del Museo Civico di Storia Naturale di Genova* 44: 335-449.
- Tam, T. V., L. N. Q. Huy, N. T. Phuc, V. H. Nhan and L. V. Khang. 2021.** First record for *Brettus cingulatus* in Vietnam (Araneae: Salticidae: Spartaeni). *Peckhamia* 229.1: 1-2.
- Thorell, T. 1895.** Descriptive catalogue of the spiders of Burma. London. 1-406.
- Wesołowska, W. and K. Salm. 2002.** A new species of *Myrmarachne* from Kenya (Araneae: Salticidae). *Genus, Wrocław* 13 (3): 409-415.
- Wheeler, W. M. 1915.** The ants of the Baltic amber. *Schriften der Physikalisch-Ökonomischen Gesellschaft zu Königsberg*. 55: 91.