

Construction of orb webs as nocturnal retreats by jumping spiders (Araneae: Salticidae: cf. *Anarrhotus*) in southwestern India

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Abstract. An unidentified jumping spider (cf. *Anarrhotus*) from southwestern India constructs planar orb webs that serve as nocturnal retreats. These webs are not inhabited during the daytime and do not appear to play a role in prey capture by these spiders. Their construction, involving the attachment of silk lines radiating from a hub or platform that is occupied by the spider at night, resembles the early stages of web construction by orb-weaving spiders of the family Araneidae. Unlike most salticids these spiders molt while suspended from their dragline.

The retreats or shelters constructed by salticid spiders are diverse, ranging from a simple layer of silk fibers on the underside of a leaf in *Asemonea* (Abhijith A. P. C. & Hill 2018) to the irregular cob-webs of *Portia* (Jackson 1982; Ahmed et al. 2015), silk platforms suspended beneath or between leaves by *Hyllus* (Ahmed & Satam 2015) and *Telamonia* (Ahmed et al. 2019), and the more elaborate tubular shelters with multiple entrances of *Myrmarachne* (Hurni-Cranston & Hill 2018) and many marpissoid genera (Jackson 1979; Hill & Edwards 2013, fig. 33:4; Hill 2014, 2018).

Here we report the discovery of a small salticid that constructs an orb-web as a nocturnal shelter in southwestern India (Figures 1-10). This salticid (cf. *Anarrhotus*) has been tentatively identified as a relative of the Malaysian species *Anarrhotus fossulatus* Simon 1902, like *Hyllus* and *Telamonia* a member of the Plexippina (Maddison 2015). Nicky Bay has posted a photograph of a similar spider in its web in Singapore and this may represent the same species (Bay 2015). The orb-webs constructed by these spiders appear to be occupied only during the night, and we have seen no evidence to suggest that they play a role in the capture of prey. Both juveniles and adults have been observed in these orb-webs.

Each orb-web is comprised of a platform of silk laid down at the hub of a series of silk lines (radii) radiating from this hub in a largely vertical plane. At night these salticids rest on this platform. Construction of the hub and associated radii resembles the early stages of construction of an orb-web by an araneid spider (Zschokke & Fritz 1995; Zschokke 1996), corresponding to the *proto-hub* and *proto-radii* of the araneid, with successive radii formed by walking along a detour from the hub to position and attach each radius in turn (Figure 9). There are limited ways to efficiently build a structure of this kind and the similarity of this salticid orb-web, which appears to play no role in predation, to the orb-web of araneid spiders may simply reflect convergence on a common solution. Whereas an araneid may need to leave its web to find shelter from a predator, these salticids apparently benefit from the fact that they are more likely to be safe from nocturnal predators when suspended on these webs. Like araneids, they may also be able to detect the presence of nearby arthropods that might be dangerous through vibrations transmitted to the hub by the radii.

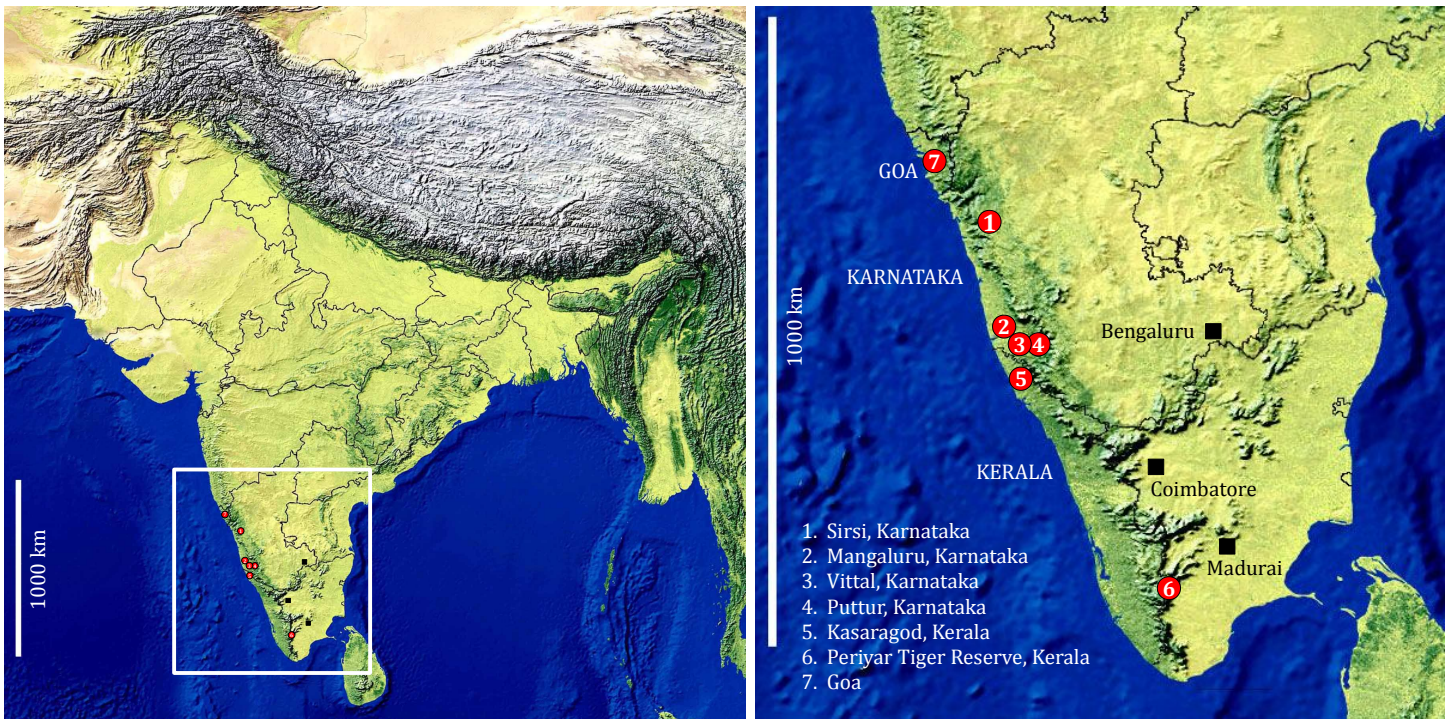


Figure 1. Localities where these salticids (cf. *Anarrhotus*) have been observed in their orb-webs. These sites (1-7) span a distance of about 900 km along the southwestern coast of India, in Goa, Karnataka and Kerala.



Figure 2. Salticid (cf. *Anarrhotus*) resting on its vertical platform at Vittal, Karnataka. **2**, Enhanced contrast version of (1) revealing extent of the vertical platform at the hub and several associated radii. **3**, Detail from (1). Photograph by Sanath Ramesh.

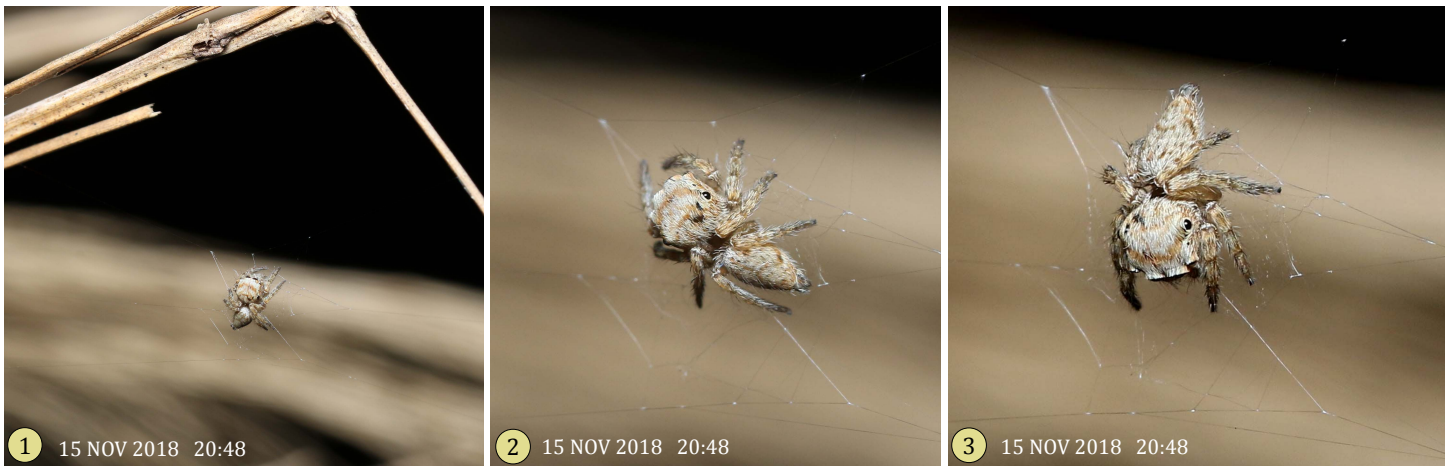


Figure 3. Salticid (cf. *Anarrhotus*) resting on its vertical platform between dry grass stems (straw) at Putturu, Dakshinakannada District, Karnataka. **2-3**, Detailed views of this spider resting at the hub. Initially this spider was facing down, but after it was disturbed it jumped away, still connected to the hub by its dragline. Photographed by Abhijith A. P. C.



Figure 4. Salticid (cf. *Anarrhotus*) resting on its vertical platform at night (1), and views of the empty platform on the next day (2-4), when the spider could not be found in the vicinity. **3-4**, Enhanced contrast images based on (2), showing details of the densely woven platform at the hub and associated radii. A small packet that might represent the remains of insect can be seen near the spider, attached to the hub, but there was no sign that the web, not sticky or adhesive, played a role in prey capture. This spider jumped and moved to nearby branches when the web was disturbed. Photographed in Kasaragod, Kerala by Prasantha Krishna.

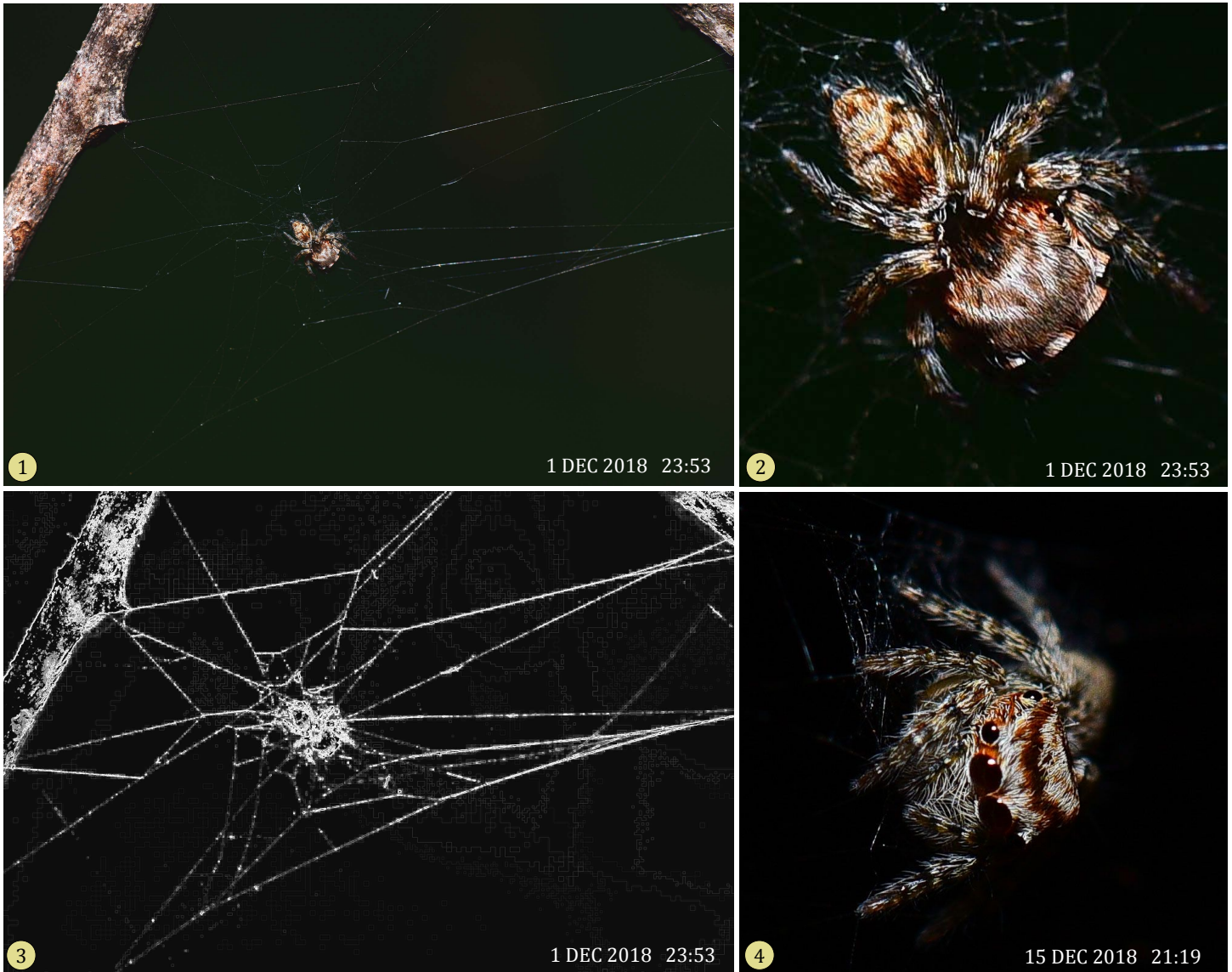


Figure 5. Salticids (cf. *Anarrhotus*) resting on their vertical platforms at night. **1-3**, Spider resting on its platform at night. **2**, Detailed view of this spider from (1). **3**, Enhanced contrast image based on (1), showing layout of the hub and radii. **4**, Detailed anterior view of salticid (cf. *Anarrhotus*) shown in Figure 4. Photographed in Kasaragod, Kerala by Prasantha Krishna.

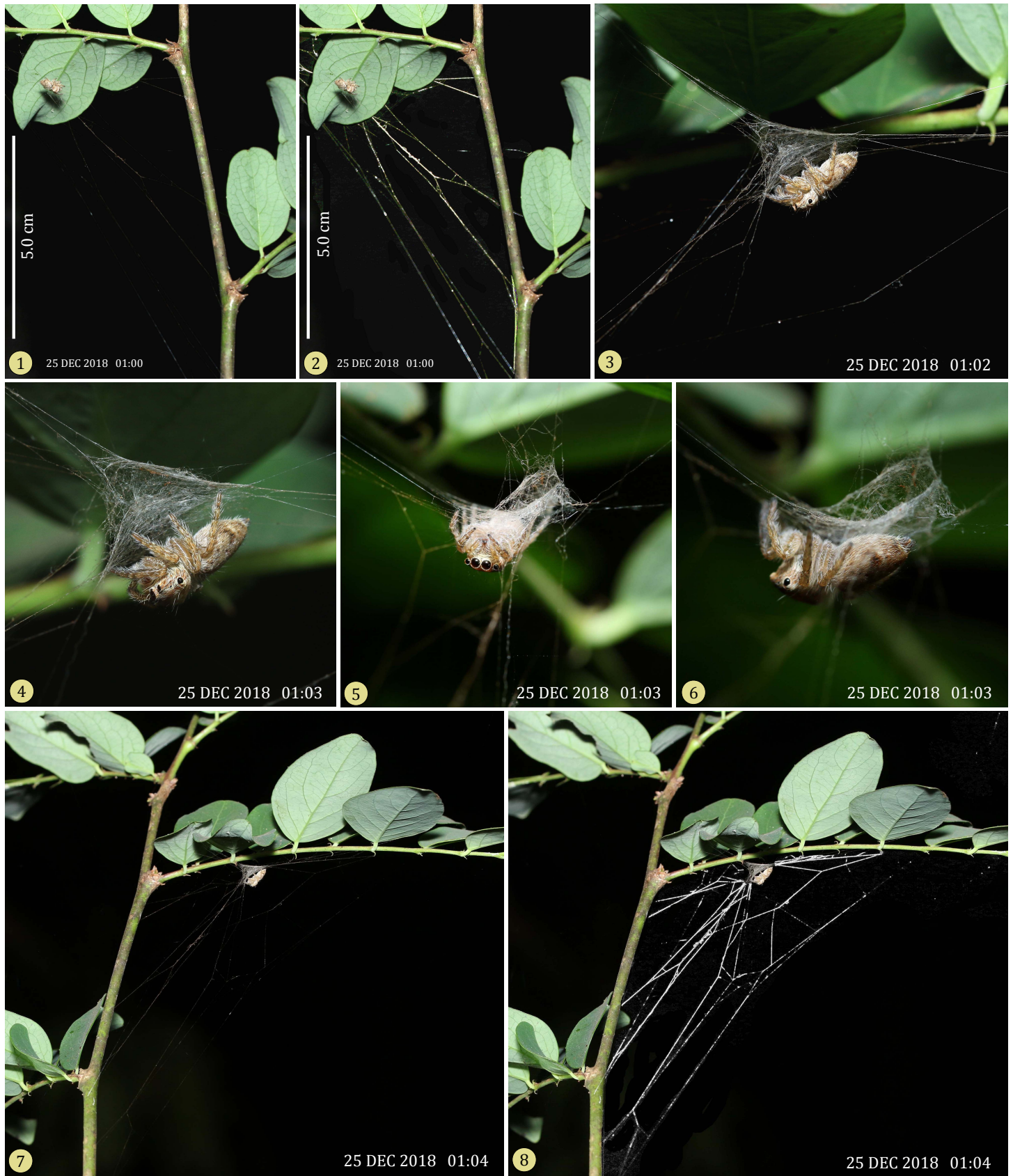


Figure 6. Views of a salticid (cf. *Anarrhotus*) resting at the hub of its nocturnal retreat in Sirsi, Uttarakannada District, Karanataka. Radii constructed on a plant of about 1.3 m in height spanned about 10 cm. Silk comprising this retreat was not sticky. When disturbed the spider took a long jump to a nearby branch, but returned to the hub in about an hour. On the next morning this spider left the retreat, apparently to search for prey on the same plant (Figure 7:1-4), but as confirmed by a local boy it returned to the same retreat that night. **2, 8**, Enhanced contrast views of (1) and (7). Photographs by Abhijith A. P. C.



Figure 7. Empty retreat (1-2) and close-up views of salticids (cf. *Anarrhotus*) that occupied these retreats. **1-2**, Empty retreat on the morning after it was occupied by one of these spiders (Figure 6). **3-4**, Detail of the spider shown in Figure 6 at night after it was disturbed and jumped away from its retreat. Photographs (1-4) by Abhijith A. P. C. in Sirsi, Uttarakannada District, Karnataka. **5**, Detailed view of spider that appeared to be hunting away from its web during the daytime. Photographed in Kasaragod, Kerala by Prasantha Krishna.



Figure 8. Salticid (cf. *Anarrhotus*) with retreat. **1-2**, Spider resting on its hub platform at night. **3**, Detail of (1). **4**, Empty hub on the next day. This retreat was constructed on a tree at a height of ~1.6-2 m above the ground and was only occupied at night. Photographed in Kasaragod, Kerala by Prasantha Krishna.

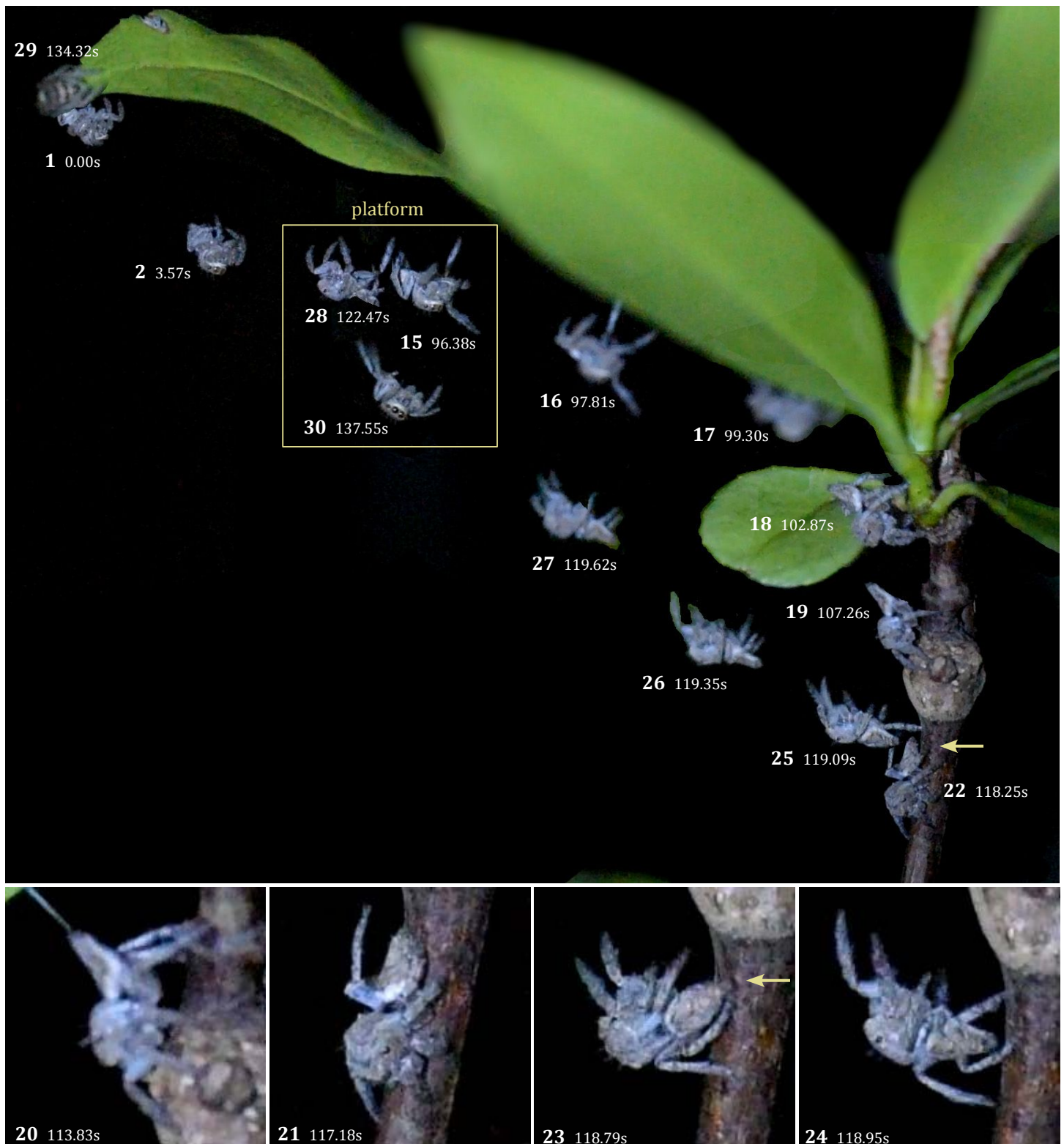


Figure 9 (continued on next page). Sequential positions (1-34) occupied by a salticid (cf. *Anarrhotus*) as it constructed its retreat in Kasaragod, Kerala, taken from a 59.94 fps video record produced by Prasantha Krishna. At top selected frames from this sequence are composited to show movement from the end of one radius down to the hub (1-15), then movement down and to the stem from the hub with a trailing dragline (15-19), attachment of the dragline to anchor a new radius (22, arrow), followed by return to the hub while climbing beneath the new radius (25-28). **20-24**, Individual frames showing trailing dragline as it was extended from the hub (20), hold on that dragline with the claws of leg RIV (21), first movement onto the attached (arrow) dragline (23), and the beginning of a rapid climb back to the hub (24).

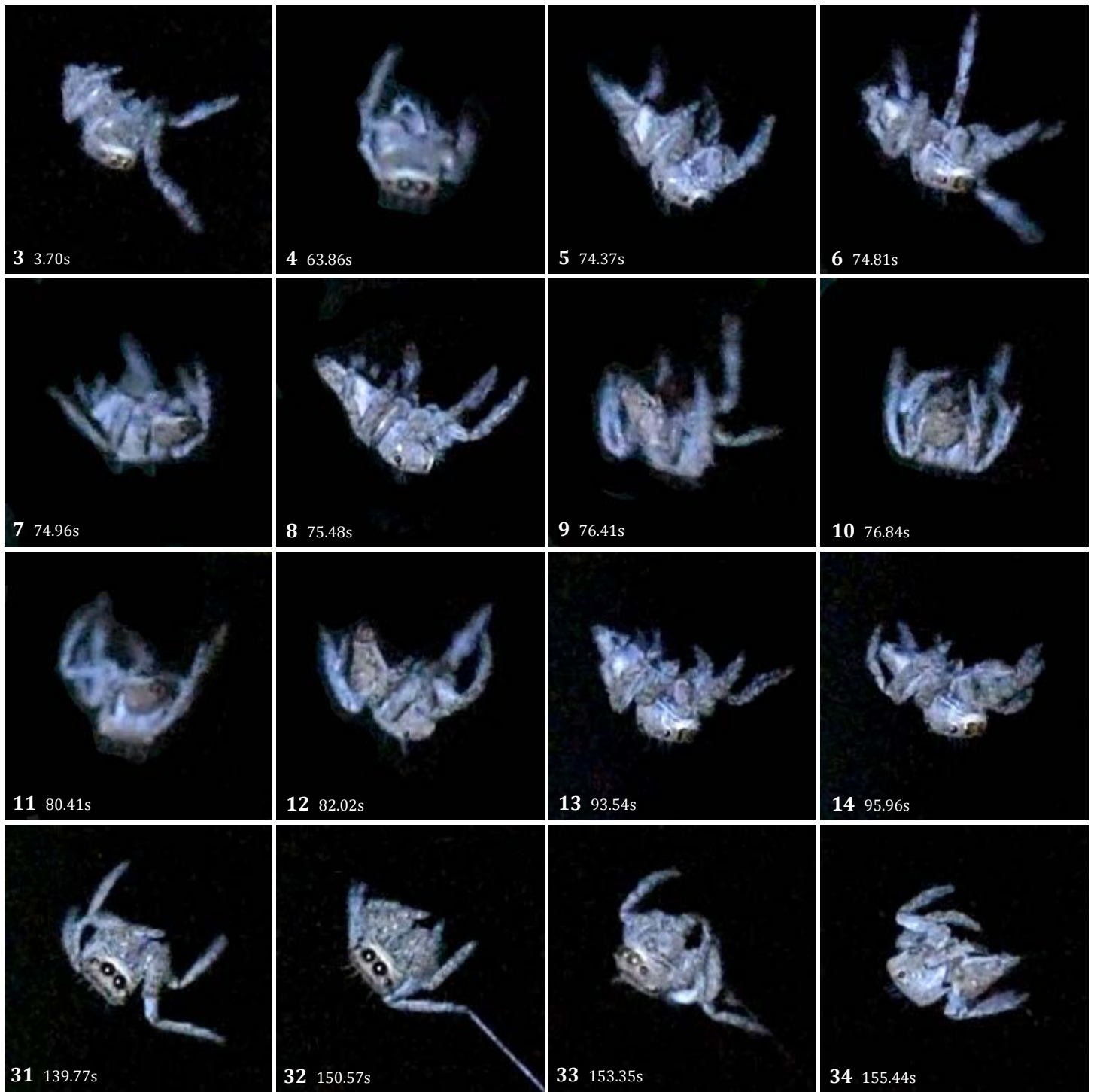


Figure 9 (continued from previous page). 3-14, 31-34, Two sets of sequential frames showing how this spider turned around the hub of its orb-web to deposit the silk that comprised its resting platform (only visible in 32). Extension of the spinnerets can be seen in some of these frames (6, 8, 10, 12). This construction activity resembles the early stages of construction of an araneid orb-web (*proto-hub* and *proto-radial*).

Since the retreat of a salticid is usually used as a moulting sac it is noteworthy that this cf. *Anarrhotus* moults while hanging on its dragline in the manner of many wandering and web spiders (e.g. Pascoe 1980; Uhl et al. 2015; Figures 10-12). This moulting process does not appear to differ substantially from the process observed by a salticid protected by a thick molting sac (Figure 11:1), but suspension allows the spider to use gravity to continue to lower itself on the dragline as it separates from the exuvium. Although moulting has been associated with mating in some orb-weavers (Araneidae; Figure 12), we presently have no information on the courtship and mating of this *Anarrhotus* sp. We also do not know what this cf. *Anarrhotus* does to protect its brood, but like most wandering and web spiders they may still produce a protective sac for this purpose.

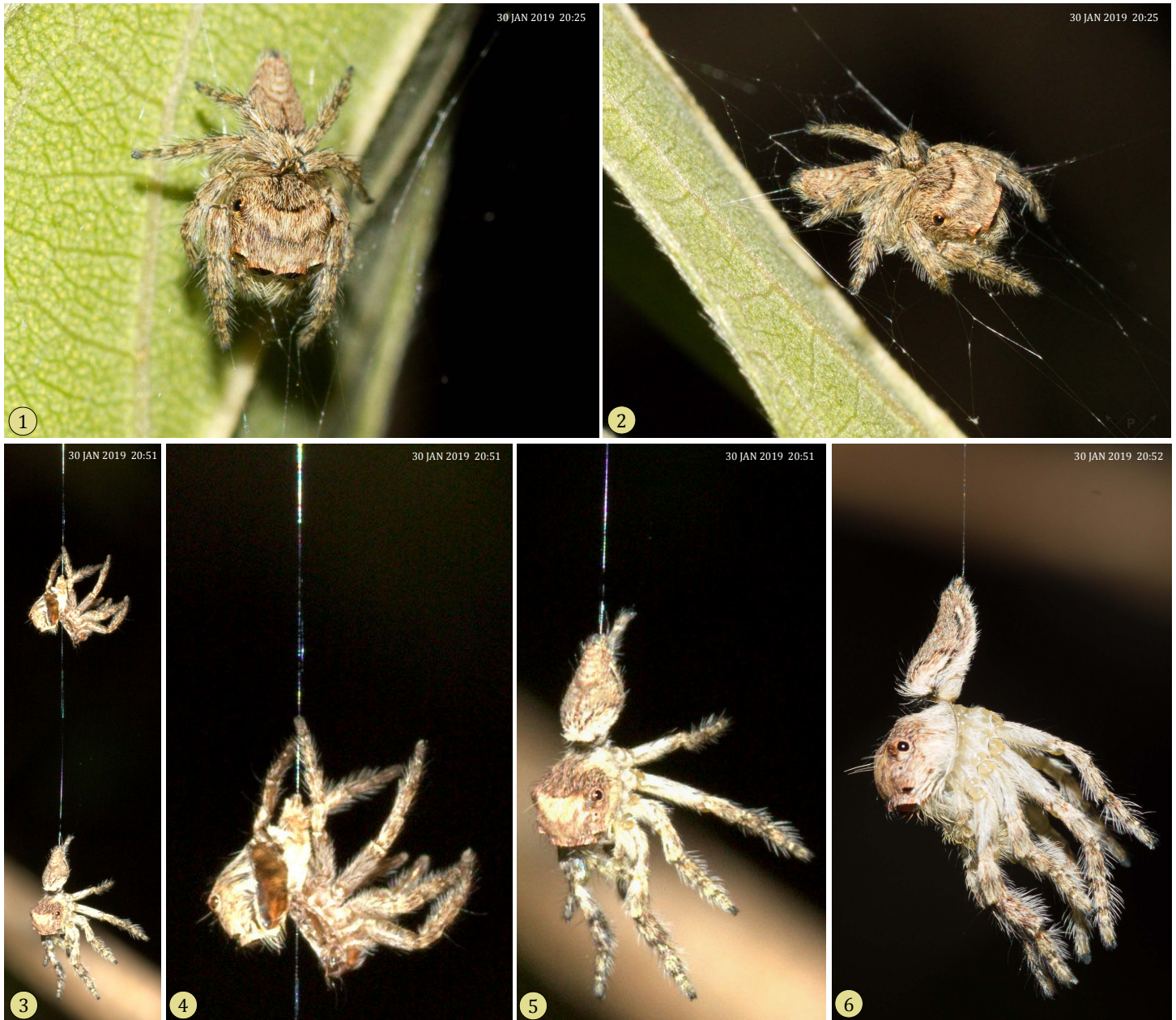


Figure 10. Observations of cf. *Anarrhotus* in Goa. **1-2**, Two views of spider resting on its silk platform. **3**, cf. *Anarrhotus* after it has separated itself from the exuvium by descending on its dragline. The exuvium maintained its hold on the dragline with legs IV. **4-5**, Closer views from (3). **6**, Detail showing this spider extending and inflating its legs while suspended. All observations and photographs by Aditya Naik, used with permission.



Figure 11. Molting by wandering spiders. **1**, Female *Phidippus putnami* (Peckham & Peckham 1883) (Salticidae). The thick molting sac was opened to observe this spider. **2**, cf. *Carrhotus* Thorell 1891 (Salticidae) with exuvium in thin molting sac. **3-4**, Two different *Epeus* Peckham & Peckham 1886 (Salticidae) with exuviae, in thin molting sacs under leaves. **5**, *Heteropoda* Latreille 1804 (Sparassidae) molting from dragline. **6**, *Olios milleti* (Pocock 1901) (Sparassidae) molting from dragline. **7**, *Hamadruas* Deeleman-Reinhold 2009 (Oxyopidae) with exuvium beneath leaf. **8-11**, Sequence showing *Oxyopes shweta* Tikader 1970 (Oxyopidae) molting from dragline. Photo (1) by David E. Hill (South Carolina). Photos (2-11) by Abhijith A. P. C. (Karnataka).



Figure 12. Molting by orb-weaver spiders (Araneidae). **1**, Female *Nephila* Leach 1815 molting from dragline. **2**, Detail of (1) showing smaller male in mating position. The genus *Nephila* is sometimes placed in the Nephilidae. **3-4**, *Neoscona* Simon 1864 molting from dragline. **5-6**, *Parawixia* F. O. Pickard-Cambridge 1904 molting from dragline. **7-8**, Male *Argiope bruennichi* (Scopoli 1772) waiting for a molting female (**7**) and then mating with that female (**8**) as she was hanging beneath her exuvium before her cuticle darkened or hardened. The condition of a newly-moulted female may reduce the vulnerability of the male to her attack (Uhl et al. 2015). Photos 1-2 by Vipin Baliga (Karnataka). Photos 3-6 by Abhijith A. P. C. (Karnataka). Photos 7-8 by Uhl et al. (2015), adapted and used under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

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REFERENCES

- Abhijith A. P. C. and D. E. Hill. 2018.** *Asemonea cf. tenuipes* in Karnataka (Araneae: Salticidae: Asemoneinae). Peckhamia 172.1: 1-8.
- Ahmed, J., R. Khalap, S. Kumbhar, D. E. Hill, R. J. Pearce and K. Mohan. 2019.** Field notes on the jumping spider *Telamonia dimidiata* in Maharashtra (Araneae: Salticidae: Plexippina). Peckhamia 181.1: 1-6.
- Ahmed, J. and Y. Satam. 2015.** The structure and utilization of silk constructs by *Hyllus semicupreus* (Simon, 1885) (Araneae: Salticidae). Peckhamia 125.1: 1-3.
- Ahmed, J., Y. Satam, R. Khalap and K. Mohan. 2015.** First record of *Portia albigana* (Simon, 1900) from Maharashtra, Mumbai (Araneae: Salticidae: Spartaeinae). Peckhamia 129.1: 1-6.
- Bay, N. 2015.** Jumping spider (*Anarrhotus* sp.). Photograph posted online at <https://www.flickr.com/photos/nickadel/19918594619>
- Hill, D. E. 2014.** Notes on the jumping spider *Phidippus clarus* Keyserling 1885 (Araneae: Salticidae: Dendryphantinae). Peckhamia 113.1: 1-32.
- Hill, D. E. 2018.** Jumping spiders of the *Phidippus princeps* group in the southeastern United States (Araneae: Salticidae: Dendryphantina). Peckhamia 169.1: 1-72.
- Hill, D. E. and G. B. Edwards. 2013.** Origins of the North American jumping spiders (Araneae: Salticidae). Peckhamia 107.1: 1-67.
- Hurni-Cranston, T. and D. E. Hill. 2018.** Notes on the jumping spider *Myrmarachne exasperans* (Araneae: Salticidae: Astioidea: Myrmarachnini) in Bali, a possible mimic of parasitoid wasps (Hymenoptera: Ichneumonidae: Cryptini: Goryphus). Peckhamia 176.1: 1-26.
- Jackson, R. R. 1979.** Nests of *Phidippus johnsoni* (Araneae, Salticidae): characteristics, pattern of occupation, and function. Journal of Arachnology 7: 47-58.
- Jackson, R. R. 1982.** The biology of *Portia fimbriata*, a web-building jumping spider (Araneae, Salticidae) from Queensland: utilization of webs and predatory versatility. Journal of Zoology 196 (2): 295-305.
- Maddison, W. P. 2015.** A phylogenetic classification of jumping spiders (Araneae: Salticidae). Journal of Arachnology 43: 231-292.
- Pascoe, F. H. 1980.** A study of *Neoscona oaxacensis* (Araneae: Araneidae) in commercial avocado orchards in San Diego County, California. California Avocado Society Yearbook 64: 153-186.
- Simon, E. 1902.** Etudes arachnologiques. 31e Mémoire. LI. Descriptions d'espèces nouvelles de la famille des Salticidae (suite). Annales de la Société Entomologique de France 71: 389-421.
- Uhl, G., S. M. Zimmer, D. Renner and J. M. Schneider. 2015.** Exploiting a moment of weakness: male spiders escape sexual cannibalism by copulating with moulting females. Scientific Reports 5: 16928: 1-7, doi: 10.1038/srep16928
- Zschokke, S. 1996.** Early stages of orb web construction in *Araneus diadematus* Clerck. Revue suisse de zoologie; annales de la Société zoologique suisse et du Muséum d'histoire naturelle de Genève H.S. 2: 709-720.
- Zschokke, S. and F. Vollrath. 1995.** Web construction patterns in a range of orb weaving spiders (Araneae). European Journal of Entomology 92: 523-541.