

Maratus nubilis, a new peacock spider in the chrysomelas group from southwestern Australia (Araneae: Salticidae: Euophryini)

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Abstract. *Maratus nubilis*, new species, is described from a single locality in Western Australia.

Keywords. courtship display, *Maratus chrysomelas*, *Maratus kiwirrkura*, *Maratus nigromaculatus*, *Maratus nimbus*, *Maratus purcellae*, *Maratus robinsoni*, *Maratus spicatus*, phylogeny

The *Maratus chrysomelas* group is comprised of seven endemic Australian species (Otto & Hill 2021), to which we now add an eighth, *M. nubilis*, new species, found at a single locality in southwestern Australia (Table 1, Figures 1-2). The fan that is elevated and displayed by males of this group does not have lateral flaps, but is heavily fringed, often with large setae or *spikes*. The sclerotized apices of the embolus of the pedipalps of these males are also distinctive in shape, with the heavier, outer apex and the inner apex forming two sides of a triangle. Unlike members of the related *fimbriatus* group, *chrysomelas* group males do not raise legs I during courtship, and these legs are not ornamented.

Table 1. Members of the *Maratus chrysomelas* group.

species	reference	type collectors	holotype locality	notes
<i>M. chrysomelas</i>	(Simon 1909)	H. H. R. Hartmeyer, J. W. Michaelsen	~S31.9°, E116.2°, Lion Mill	widely distributed across Australia
<i>M. kiwirrkurra</i>	Baehr & Whyte 2016	B. Baehr	S22.483°, E128.367°	one male collected in pitfall trap, no photo of living spider available
<i>M. nigromaculatus</i>	(Keyserling 1883)	E. C. F. Dämel	~S23.4°, E150.5°, Rockhampton	coastal Queensland, may intergrade with <i>M. chrysomelas</i>
<i>M. nimbus</i>	Otto & Hill 2017	J. C. Otto, A. Lance	S36.07585°, E144.72262°	interior southeastern Australia
<i>M. nubilis</i> , sp. nov.	this paper	J. McMulkkin, F. Prall	S34.67367°, E117.17865°	single locality near Perillup, WA
<i>M. purcellae</i>	Otto & Hill 2013	M. Purcell, I. Macaulay	S35.34913°, E149.03147°	southeastern Australia
<i>M. robinsoni</i>	Otto & Hill 2012	P. Robinson	S32.99734°, E151.70478°	southeastern Australia
<i>M. spicatus</i>	Otto & Hill 2012	D. Knowles	S31.84834°, E115.87628°	only found near Perth, WA

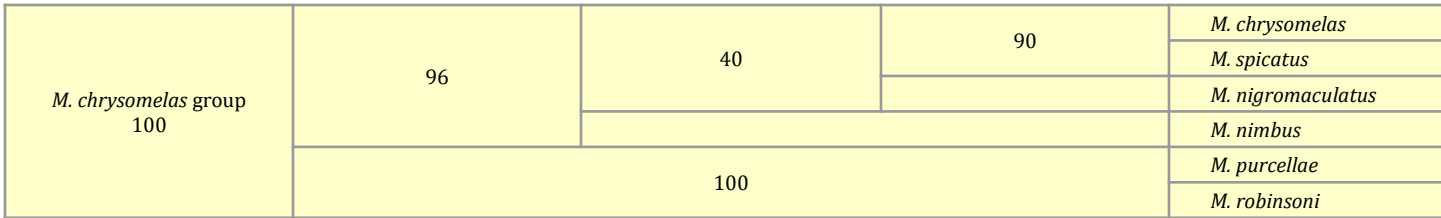


Figure 1. Hypothetical phylogeny of the *Maratus chrysomelas* group, as proposed by Girard et al. (2021) for six members of this group, with bootstrap values for sister groups provided by that DNA study. *M. kiwirrkurra* and *M. nubilis*, new species have not been sequenced. See Soltis & Soltis (2003) for a useful discussion of bootstrap values.

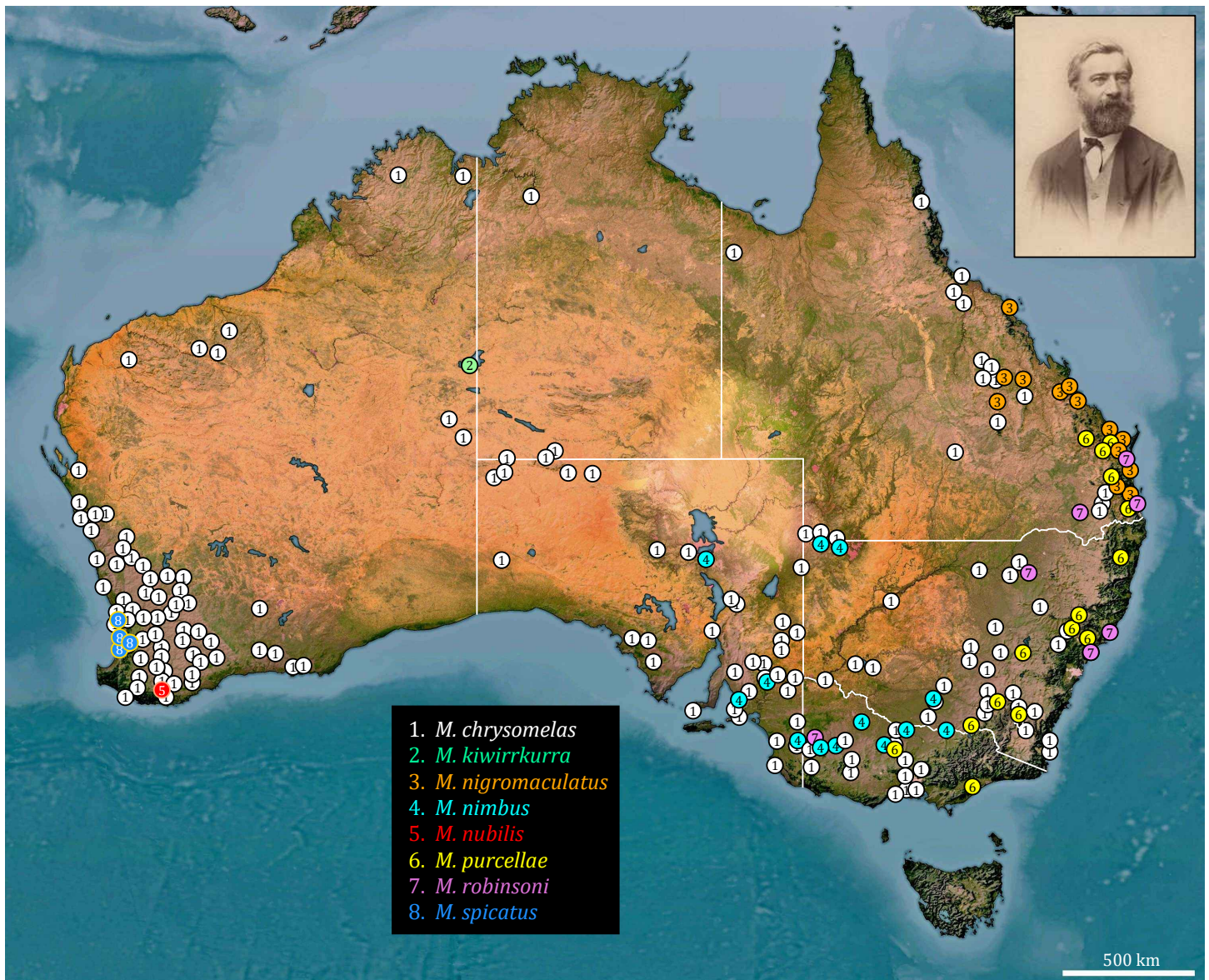


Figure 2. Known distribution of spiders in the *Maratus chrysomelas* species group. *M. nigromaculatus* was the first species in this group to be discovered and named. This species was first collected by Eduard C. F. Dämel (1821-1900; inset photograph at upper right), a German entomologist who collected specimens in Queensland during the 1867-1874 time frame for the Museum Godeffroy (Weidner 1967). No additional records of this species existed until we published photographs of a male found by Chris Martinez at Wynnum in 2008 (Otto & Hill 2012). The second species to be discovered was the widely-distributed *M. chrysomelas*, first collected near Perth and curated by the German zoologists Heinrich Hermann Robert Hartmeyer (1874-1923) and Johann Wilhelm Michaelsen (1860-1937). Julianne M. Waldock (2002) more recently redescribed this species. Hartmeyer and Michaelsen later published two volumes of *Die Fauna Südwest-Australiens, Ergebnisse der Hamburger südwest-australischen Forschungsreise 1905*. The other spiders in this group were only recently discovered. Records posted on *iNaturalist* and the *Atlas of Living Australia* are included here; some circles cover more than one record.

With transverse bands on the fan and banded pedipalps, *Maratus nubilis* generally resembles *M. nimbus* and *M. spicatus* (Figure 3). Unlike these species, however, *M. nubilis* males raise their fringed legs III as part of their courtship display, and their fringed fan resembles that of *M. nigromaculatus* (Figure 4). Apart from this fringe, *M. nigromaculatus* most closely resembles *M. chrysomelas*, and the courtship of the two species, including rapid stepping from side to side with extended legs III, is also very similar. The smaller *M. purcellae* and *M. robinsoni*, each unique, appear to be less related to the other members of this group as indicated by recent DNA studies (Figures 1,4; Girard et al. 2021). We know little about *M. kiwirrkurra*, known only from a single specimen captured in a pitfall trap.



Figure 3. Comparison of male *M. nubilis*, new species, with *M. nimbus* and *M. spicatus*.



Figure 4. Male representatives of other members of the *Maratus chrysomelas* group. **1-2**, Courtship display of two western forms of *M. chrysomelas*, (1) probably from the vicinity of Perth, (2) from Esperance. **3-4**, Courtship display of two different *M. nigromaculatus* from Queensland. **5**, *M. purcellae* display. Note the absence of leg III ornamentation in this species, which does not raise legs III during courtship. **6-7**, *M. robinsoni*, a small ground-dwelling species with both *super black* and iridescent scales that can reflect the entire visible spectrum, depending on respective directions of illumination and observation (Hsiung et al. 2104, 2017; McCoy et al. 2019). As shown here (6), *M. robinsoni* males do not raise legs III during courtship.

***Maratus nubilis*, new species**

Type specimens. The holotype male (♂ #1), three paratype males (♂ #2-4), and three paratype females (♀ #1-3) were collected in the Denmark Catchment State Forest near Perillup, Western Australia (S34.613671°, E117.178650°, 27 NOV 2021, coll. Flynn Prall and James McMulkin). All types will be deposited in the Western Australian Museum, Perth.

Etymology. The species group name, *nubilis* (Latin, adjective) is a reference to the obscure or *beclouded* appearance of the transverse bands of the dorsal opisthosomal plate or fan of the male.

Diagnosis. Detailed structure of the male pedipalp (Figure 9) places *M. nubilis* in the *Maratus chrysomelas* group, but is not very different from other members of this group. However the pattern of scales and setae associated with the fan (dorsal opisthosomal plate) of the male (Figure 3:11) is quite different from that of any other *Maratus*.

Description of male (Figures 5-9). Males (n=4) ranged from 3.3-3.7 mm in length. The cuticle of the carapace is black in living males, yellow-brown in specimens preserved in alcohol. The subsequent description pertains to the living spider. The clypeus is mostly black and glabrous, with relatively few scattered brown setae. The chelicerae are black and glabrous, with only a few scattered setae near the medial margin. Dorsally (or from the front, in a normal position), each pedipalp is banded, with the tibia and cymbium both black proximally, bearing a thick cover of off-white setae for most of their length, and black distally. Brown or orange scales (varies by individual) surround the eyes and cover both the eye region and the sides of the carapace. The PME are closer to the PLE than to the ALE. A thin white band of scales is present along the lateral margins of the carapace, but there is no mediothoracic band behind the eye region.

Stout, mostly white setae project upward and forward at the anterior margin of the opisthosoma. The fan (dorsal opisthosomal plate) is covered with alternating transverse bands comprised of either light-iridescent-blue-green or white-to-grey scales. The color saturation of the iridescent bands varies according to the angle of illumination. On either side the opisthosoma is flanked with a prominent fringe of long, proximally grey, distally white setae or plumes. When fully expanded during courtship the fan, with these plumes, is about twice as wide as the opisthosoma itself. Although a small, triangular colular tuft is present, this is grey rather than white. The spinnerets are dark grey. Below, the opisthosoma is brown in colour, densely covered with off-white setae. From below, the coxae and sternum are brown, with many scattered white to off-white setae, longer around the posterior margin of the sternum. The labrum and endites are brown and glabrous.

Legs I and II are shorter and of similar length, legs III and IV longer, legs III the longest. All of the legs are banded, mostly black to dark brown but with a band of white to off-white setae or orange setae (varies by individual) around the distal end of each segment, from the patella to the metatarsus. On legs III these off-white setae are particularly long, also present on the distal end of each tarsus, and the femora are mostly black. The detailed structure of the pedipalp is similar to that seen in other members of the *chrysomelas* group, with a heavier outer apex converging at the tip with an inner apex (or sclerotized inside end of the apex) of the embolus, appearing as two sides of an acute triangle (Figure 9).



Figure 5 (continued on next page). Living male types for *Maratus nubilis*. 4-5, Note the extended fringes of the fan, and the exposed pedipalps of this male, during courtship. 6, Detail of left leg III during courtship, showing how it is often flexed to the rear at the tibiometatarsal joint.



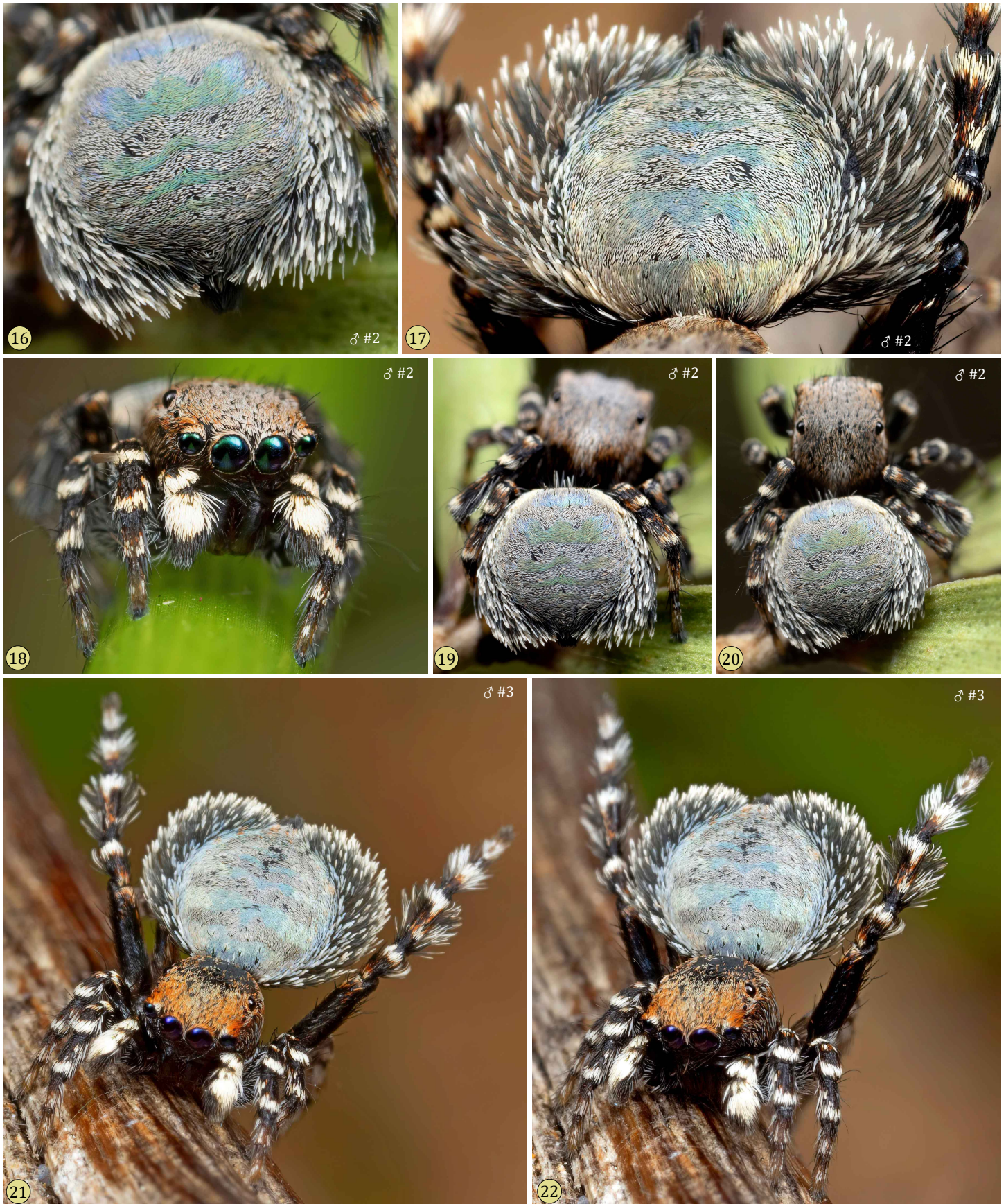


Figure 5 (continued from previous page, continued on next page). Living male types for *Maratus nubilus*. 16-17, Comparison of retracted fringe of the fan (16) with its appearance when fully extended during courtship display (17). 21-22, Male with elevated fan during courtship display.

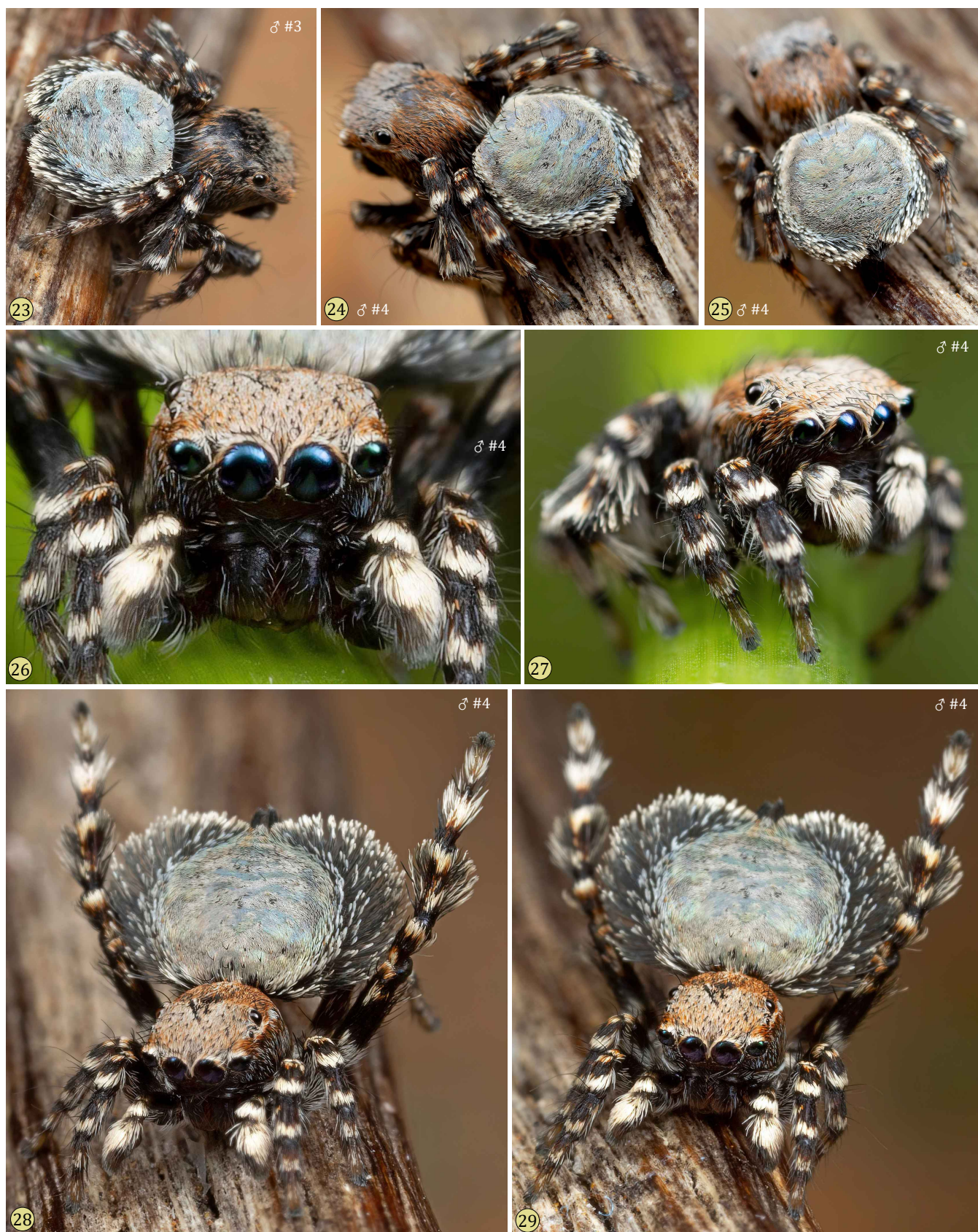


Figure 5 (continued from previous page). Living male types for *Maratus nubilis*. 28-29, Male with elevated fan during courtship display.



Figure 6. Ventral view of living male types for *Maratus nubilis*.

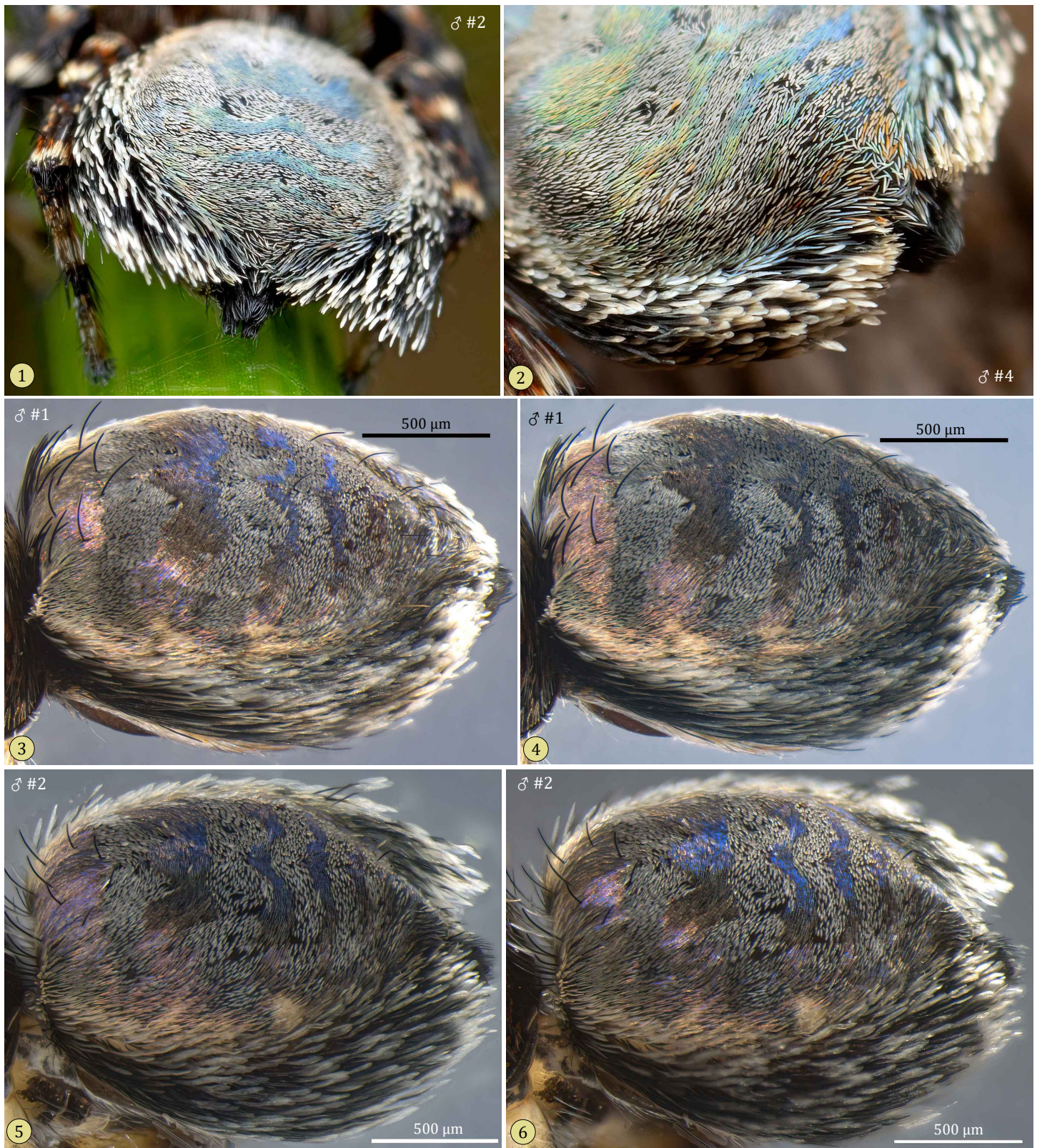


Figure 7. Detailed views of the scale cover and fringes of the fan of the male types for *Maratus nubilus*. **1-2**, Two views of the fan of living spiders. **3-4**, Two views of the fan of the holotype preserved in alcohol, showing the impact of illumination on the color saturation of the iridescent scales. **5-6**, Two views of the fan of a paratype, also showing the impact of illumination on color saturation.

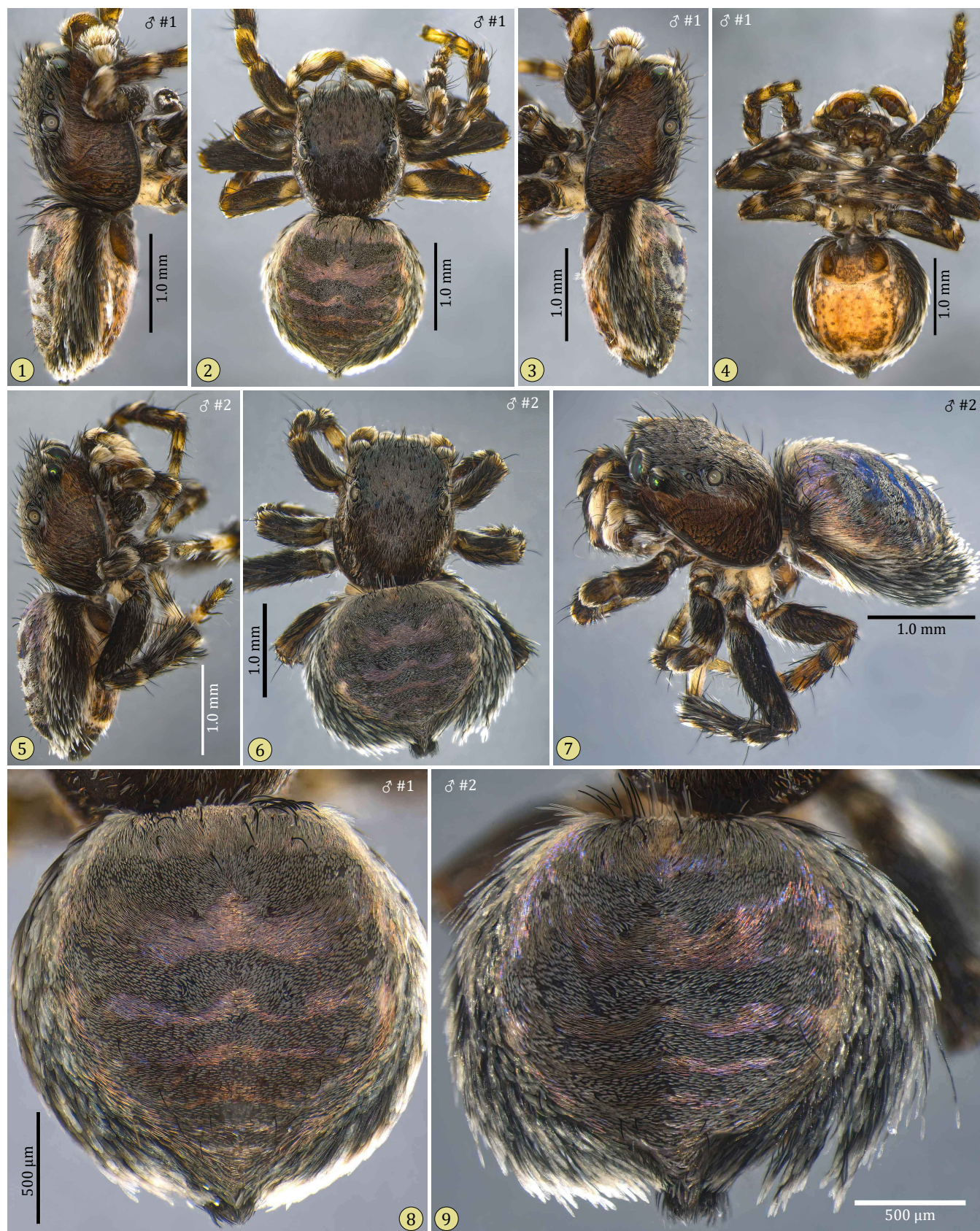


Figure 8. Views of the male types for *Maratus nubilis*, in alcohol.

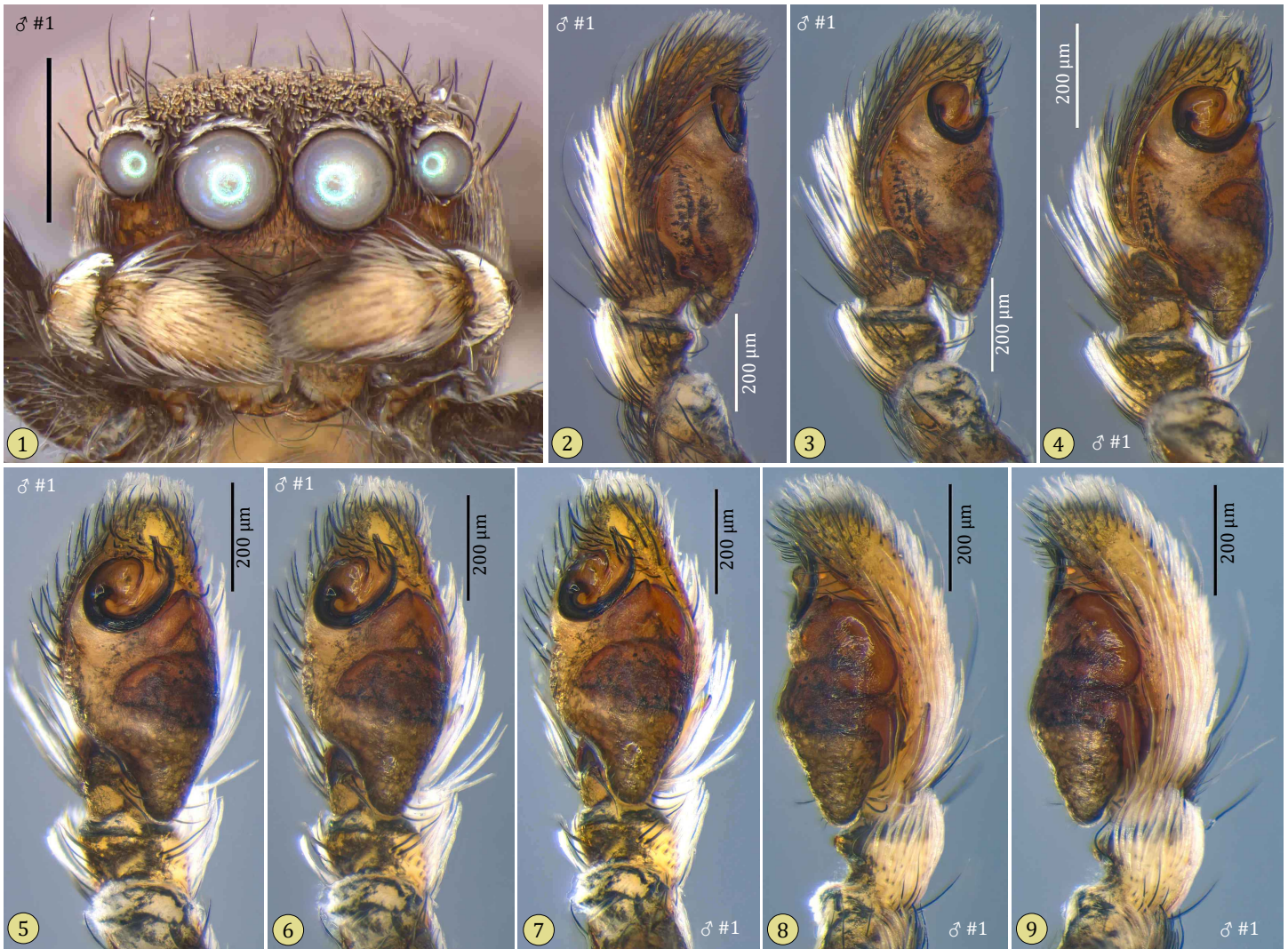


Figure 9. Views of the male holotype for *Maratus nubilis*, in alcohol. **2-9**, Medial to lateral views of the left pedipalp. Note how the longer, outer apex of the embolus meets a short and thin inner apex or sclerotized edge of the embolus at the tip, appearing as two sides of an acute triangle (5-7).

Description of female (Figures (10-13)). Females (n=3) ranged from 3.9-4.4 mm in length. This description pertains to the living female. The carapace of the female is dark brown. The clypeus is covered with stout, long white to off-white setae, some projecting anteromedially above the anterior margin of the carapace and the chelicerae. The chelicerae are mostly glabrous and dark brown. The PME are slightly closer to the PLE than to the AME. The margins of the carapace are wide, dark brown, and glabrous. The pedipalps are light brown, with a cover of long white to off-white setae. Above the margin the carapace has a relatively uniform cover of off-white to light brown or orange setae, with a regular row of white or off-white setae just above each lateral margin. Extending behind the eye region is a mediothoracic stripe of more densely-packed setae. At the front of the dorsal opisthosoma is a group of stout, mostly white, setae projecting forward. The dorsum, and lateral sides of, the opisthosoma is irregularly mottled with alternating areas of light-brown, off-white, and dark brown setae, variable by individual. The venter of the opisthosoma is lightly mottled, mostly uniformly covered with off-white setae. A small, triangular tuft of off-white colular setae is present, above the grey spinnerets.

Legs I and II are shorter and about the same length, legs III and IV longer and about the same length. All legs are uniform in colour and banded, with bands of off-white setae toward the end of each leg segment, separated by dark brown and more glabrous bands around each joint. From below, the coxae and

sternum are brown to dark brown, with scattered setae, and longer off-white setae projecting from the lateral and posterior margins of the sternum. The labium is dark brown and glabrous. The endites are lighter yellow-brown and glabrous. The epigynum (Figure 13) is typical for the group, with a large posterior spermatheca behind a fossa (window) on either side, and variably sclerotised ducts visible through the posterior part of each fossa.



Figure 10 (continued on next page). Living female paratypes for *Maratus nubilis*.



Figure 10 (continued from previous page, continued on next page). Living female paratypes for *Maratus nubilis*.



Figure 10 (continued from previous page). Living female paratypes for *Maratus nubilis*.



Figure 11. Ventral view of living female paratypes for *Maratus nubilis*.

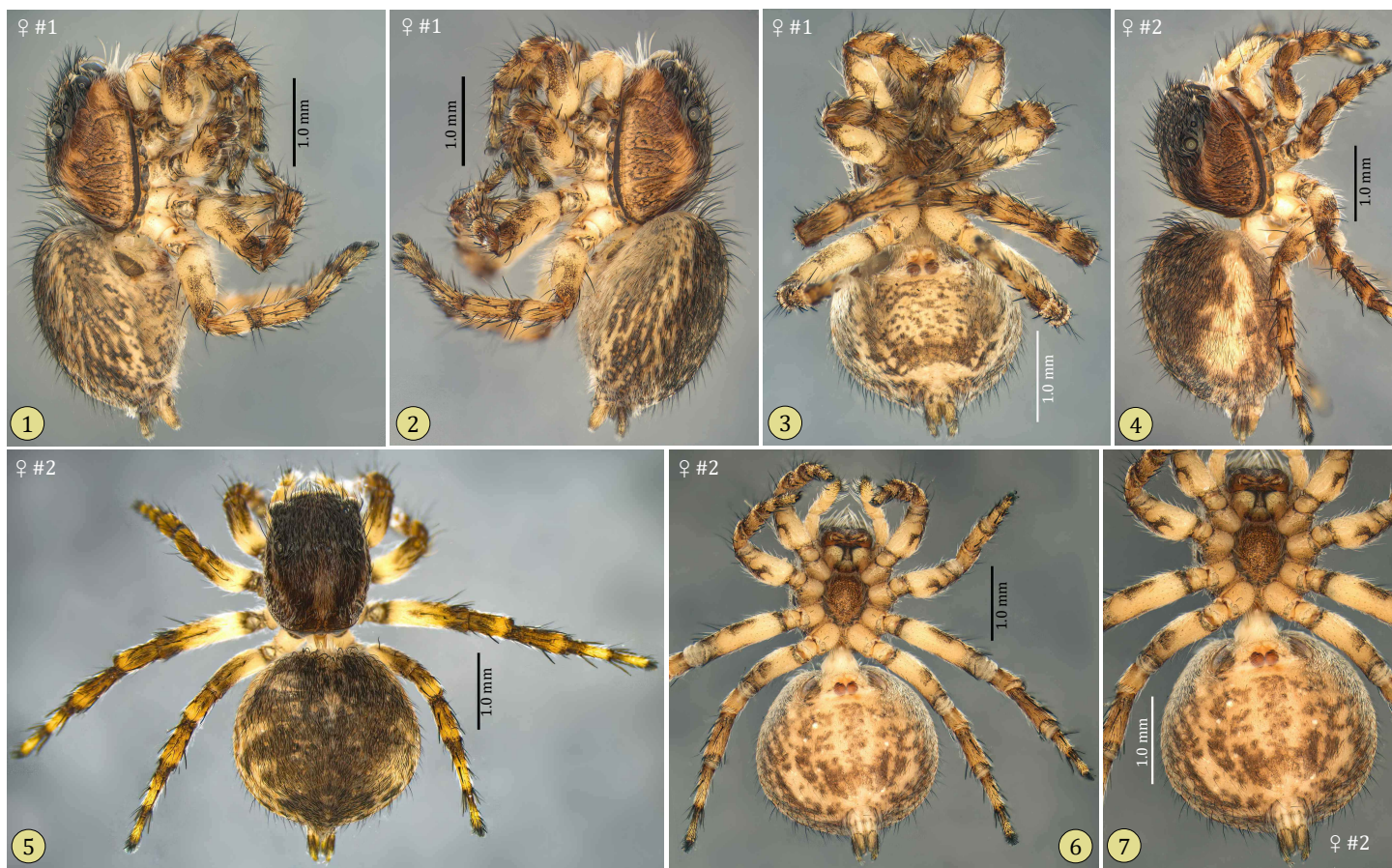


Figure 12 (continued on next page). Female paratypes for *Maratus nubilis* in alcohol.

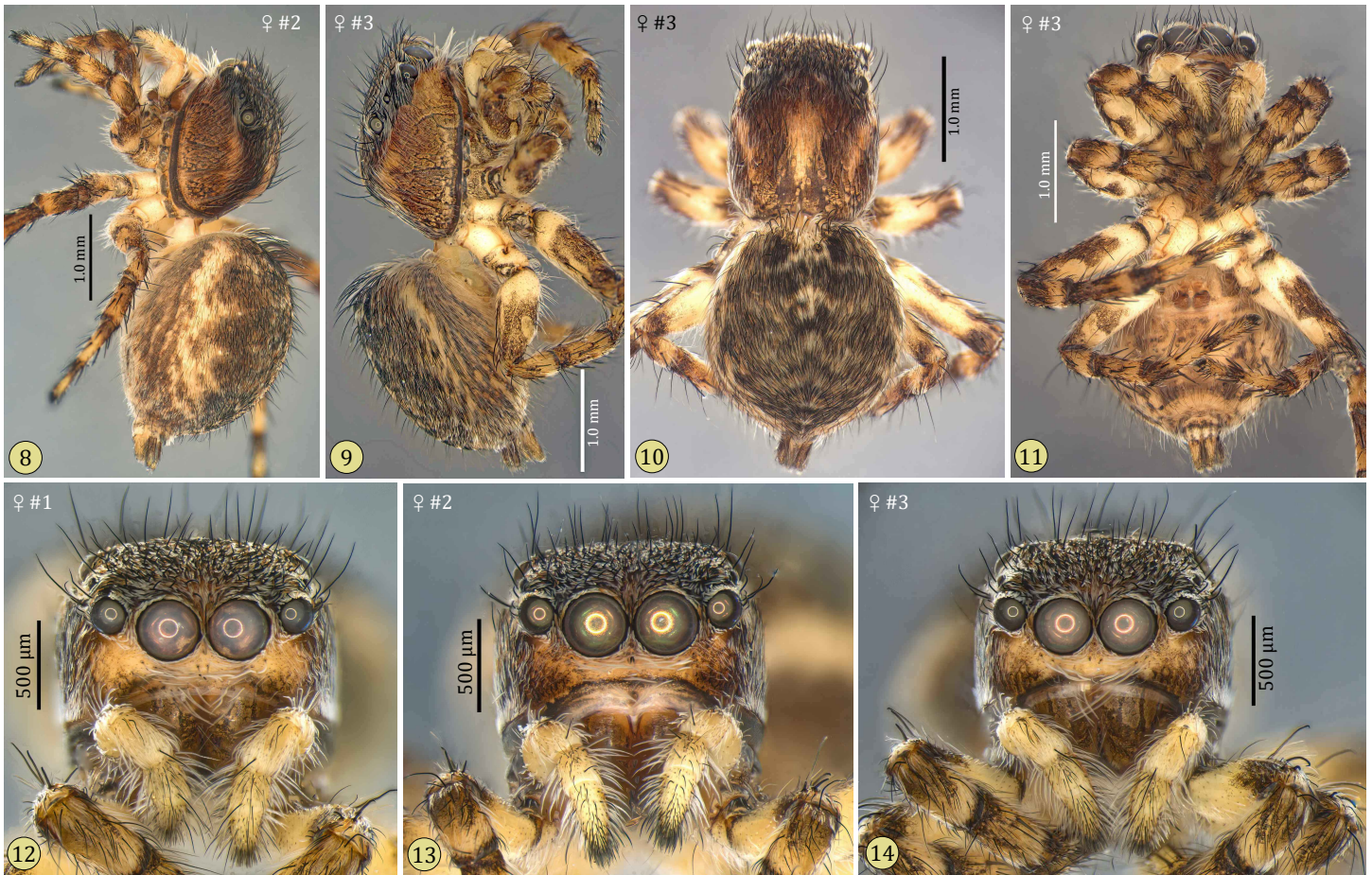


Figure 12 (continued from previous page). Female paratypes for *Maratus nubilis* in alcohol.

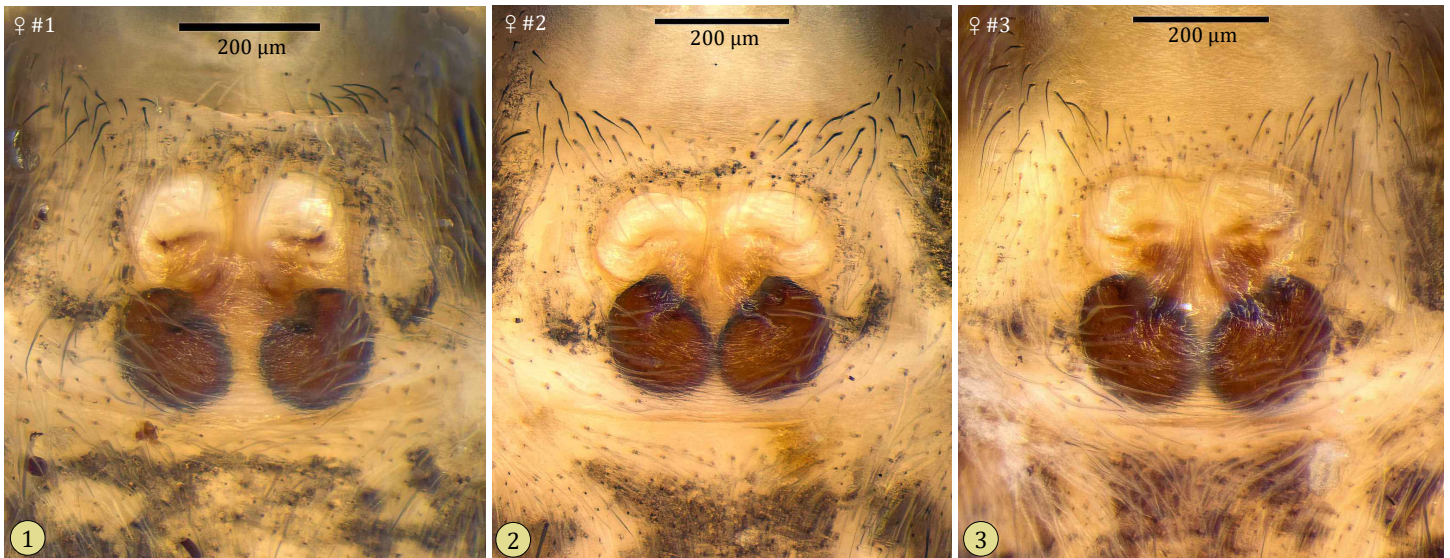


Figure 13. Ventral view of the epigynum of female paratypes for *Maratus nubilis* in alcohol. The anterior direction is toward the top of the page.

Immatures. An emergent (instar II, stage that emerges from the brood sac) *Maratus nubilis* is shown in Figure 14. The general colouration of this instar resembles that of the female, but with little pigmentation of the cuticle (except for the eye region) and far fewer setae. Older immatures (Figure 15) have distinct transverse tracts of off-white setae, or *chevrons*, on the dorsal opisthosoma.



Figure 14. Living emergent (instar II) *Maratus nubilis*.

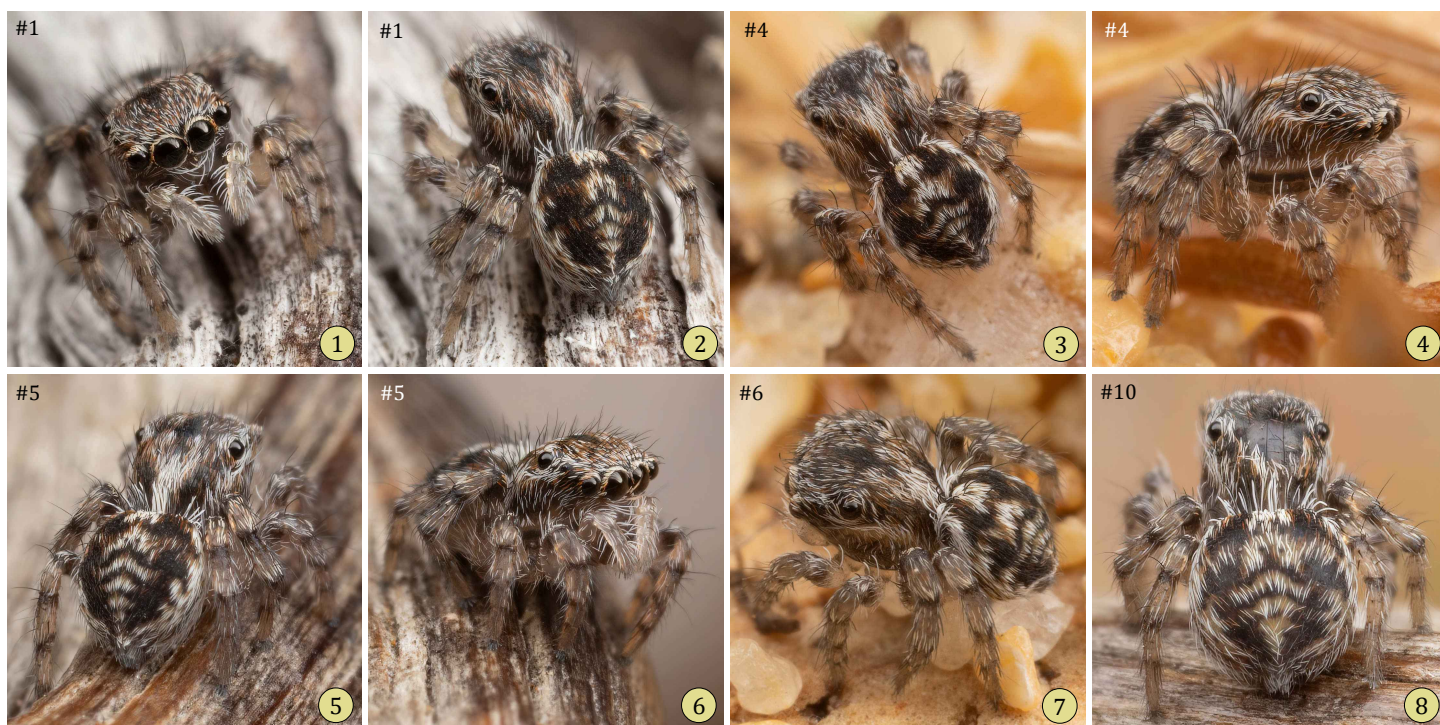


Figure 15 (continued on next page). Living immature (instar III or IV) *Maratus nubilis*. Different individuals are identified by number.



Figure 15 (continued from previous page). Living immature (instar III or IV) *Maratus nubilis*.

Courtship display (Figures 16-19). Our observations of courtship display by the male are based on video records of spiders on natural vegetation in the laboratory. When a female is sighted, a male may rear one leg and slowly wave the elevated fan over a small amplitude (Figure 16; ~2 Hz left-to-right cycles, ~4° amplitude). During this display the fringe of the fan is not expanded laterally, and the male remains in place, with some movement of the pedipalps. This appears to represent a form of advertisement, or at least "hesitancy" on the part of a male that is evaluating the response of a female.

Apart from this "advertisement," we have observed a single mode of courtship display, or *fan dance*, of the male (Figures 17-19). This display involves elevation of legs III, usually behind the fan and often flexed at the tibiometatarsal joint so that legs III are at least partly concealed behind the fan. In addition, the male may step slowly from side to side, in small increments, as the fan is waved continuously. The speed and amplitude of this dance can change dynamically. In one of the two examples charted here (Figure 17), a male switched from a slower pace with smaller amplitude in place (2 Hz, 3°) to a much faster pace with a larger amplitude (7 Hz, 12°), accompanied by side-stepping. In the second example (Figure 18), a male switched from a faster pace with an even higher amplitude (7 Hz, 20°) to a slower pace with a moderate amplitude (4 Hz, 11°). In addition to side-stepping, the pedipalps, held apart to expose the dark, glabrous anterior surface of the chelicerae, may also be moved (Figure 19).

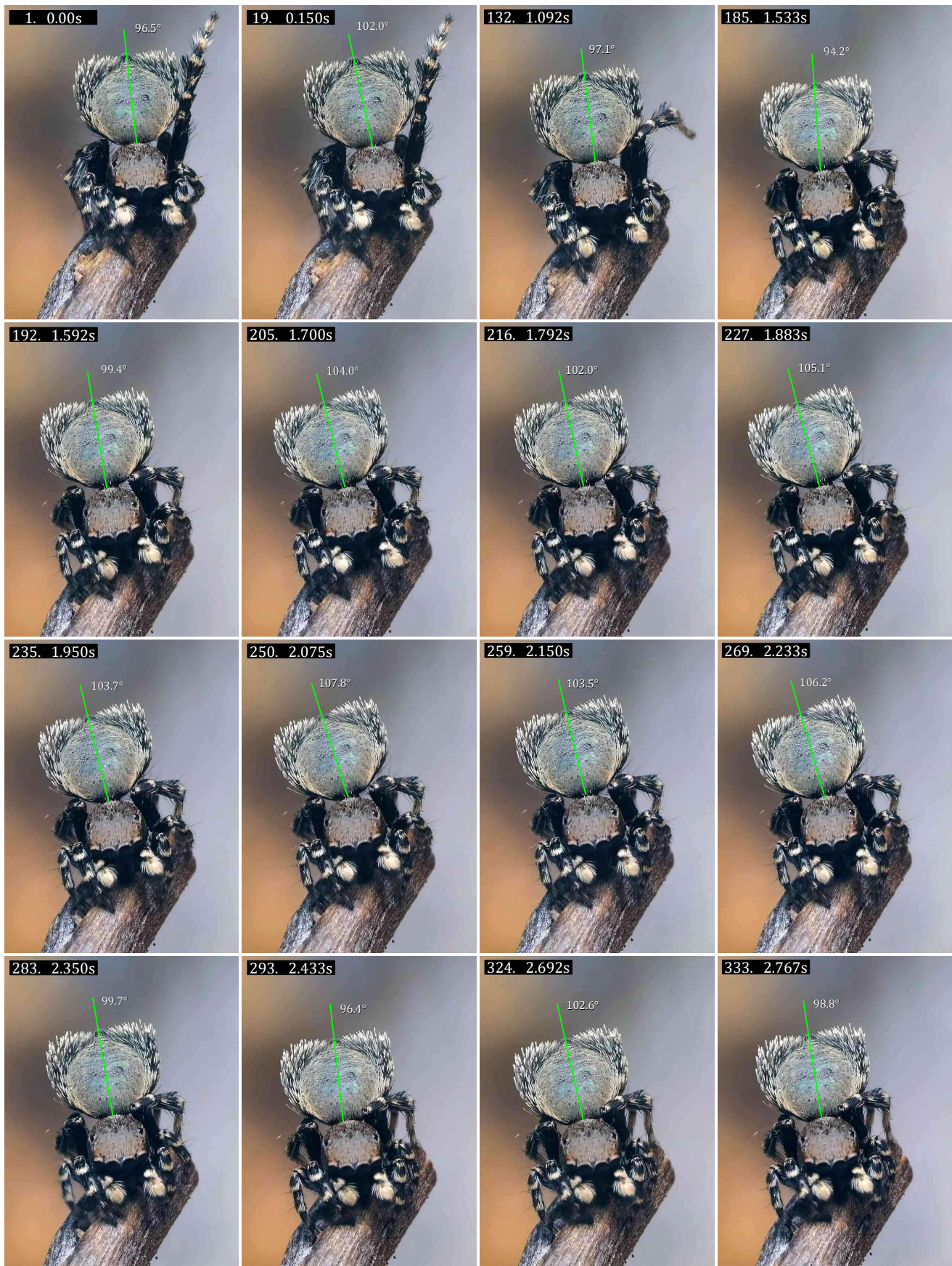


Figure 16. Sequential frames from a 120 fps video of a male *Maratus nubilis* displaying in front of a female. This advertisement or tentative display included extension of one leg III (frames 1, 19) and slow, low amplitude left-to right waves (~ 2 Hz, $\sim 4^\circ$) of the elevated, but not extended fan.

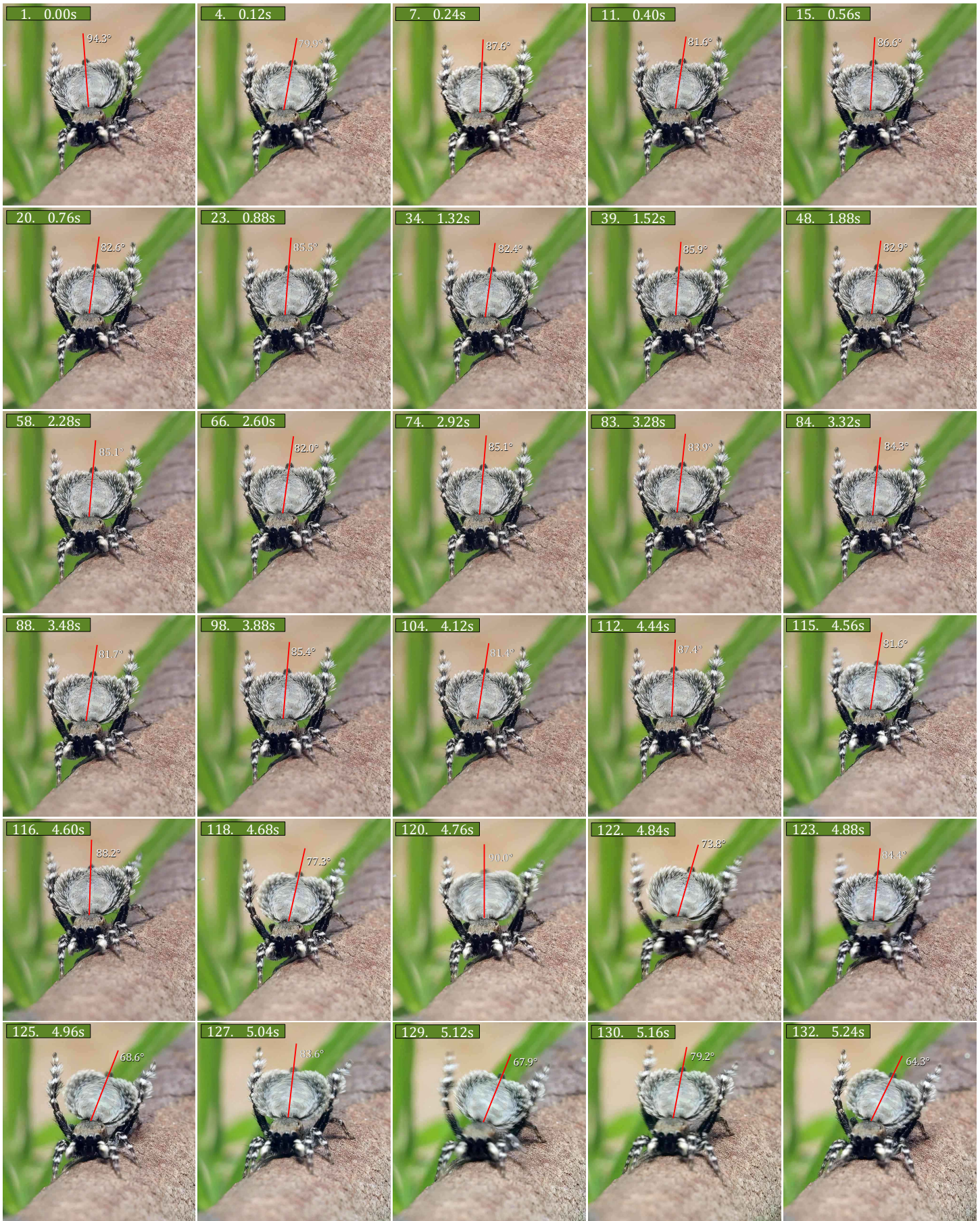


Figure 17 (continued on next page). Sequential frames from a 25 fps video of the fan dance of a male *Maratus nubilis*.

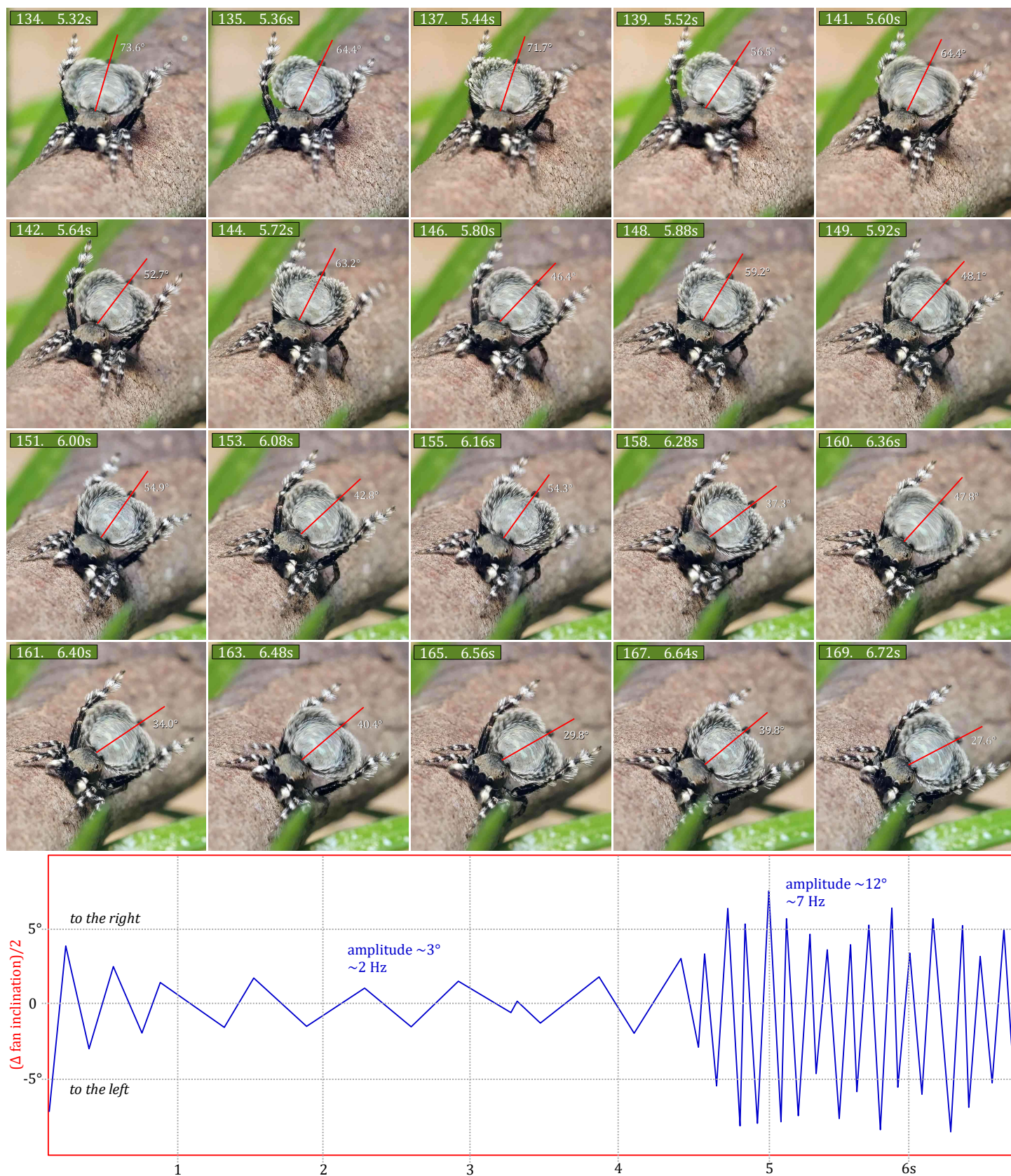


Figure 17 (continued from previous page). Sequential frames from a 25 fps video of the fan dance of a male *Maratus nubilis*. As shown in the chart, this male switched from low speed, low amplitude fan waving in place to a much faster and higher amplitude display while side-stepping.

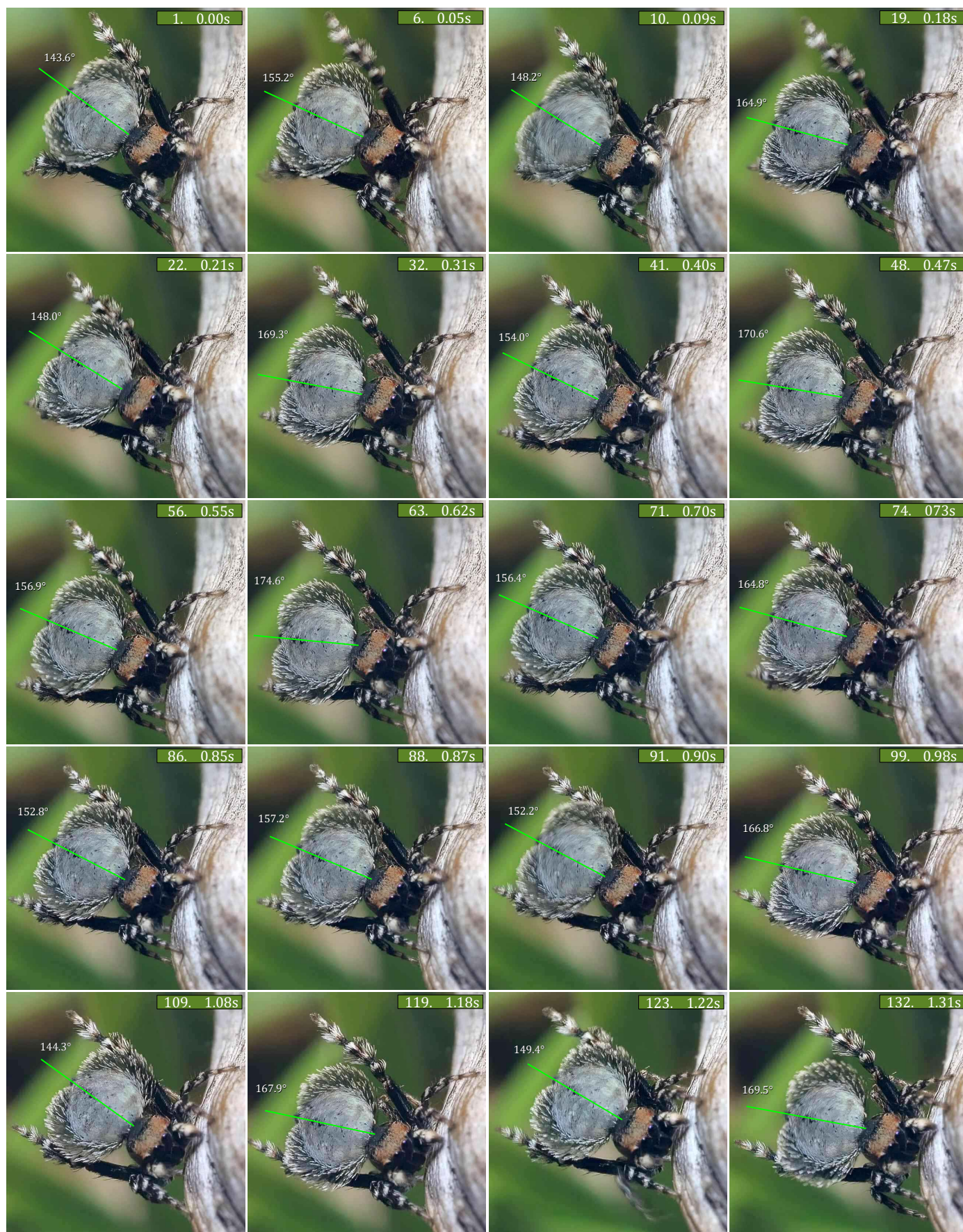


Figure 18 (continued on next page). Sequential frames from a 100 fps video of the fan dance of a male *Maratus nubilis*.

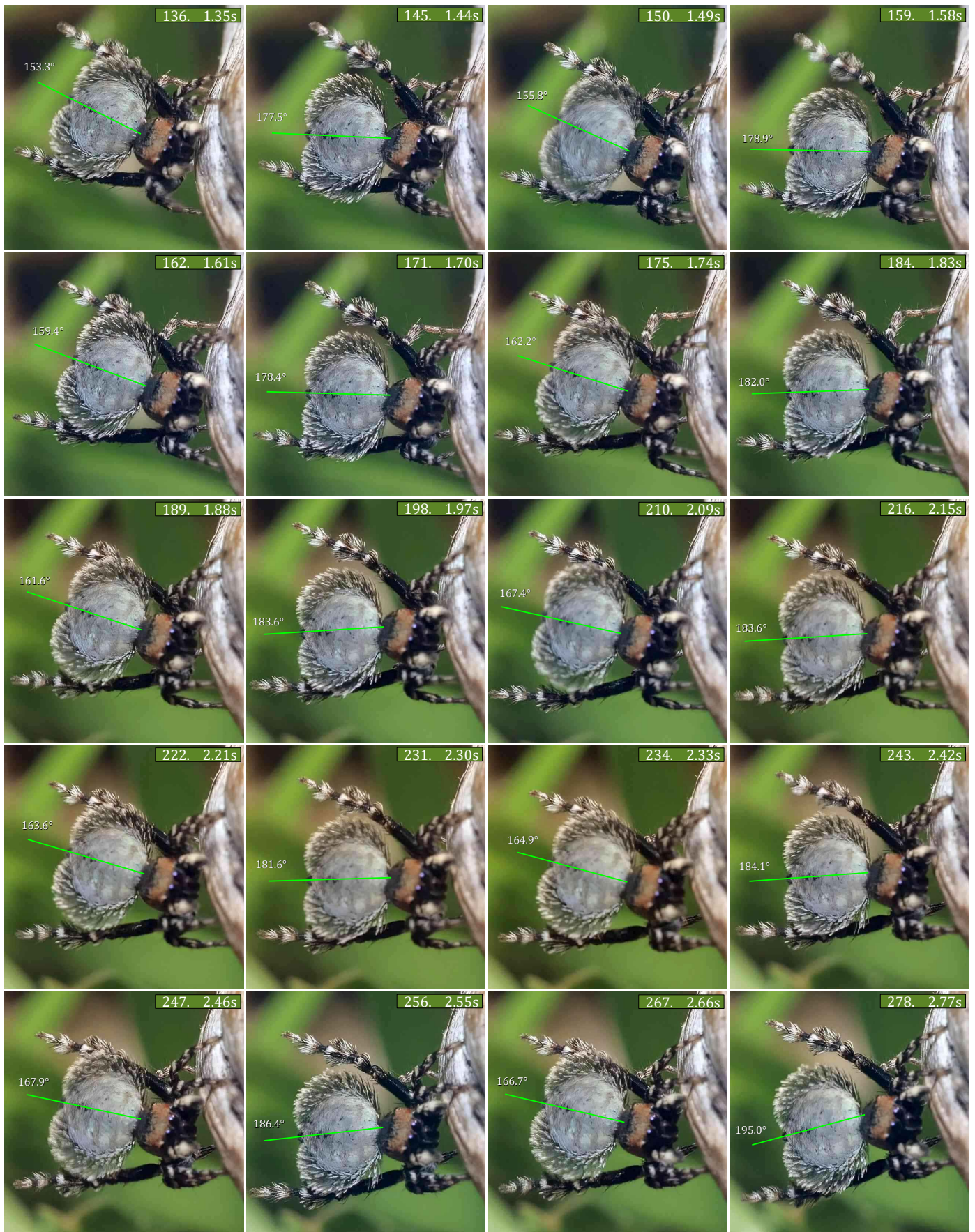


Figure 18 (continued from previous page, continued on next page). Sequential frames from a 100 fps video of the fan dance of a male *Maratus nubilis*.

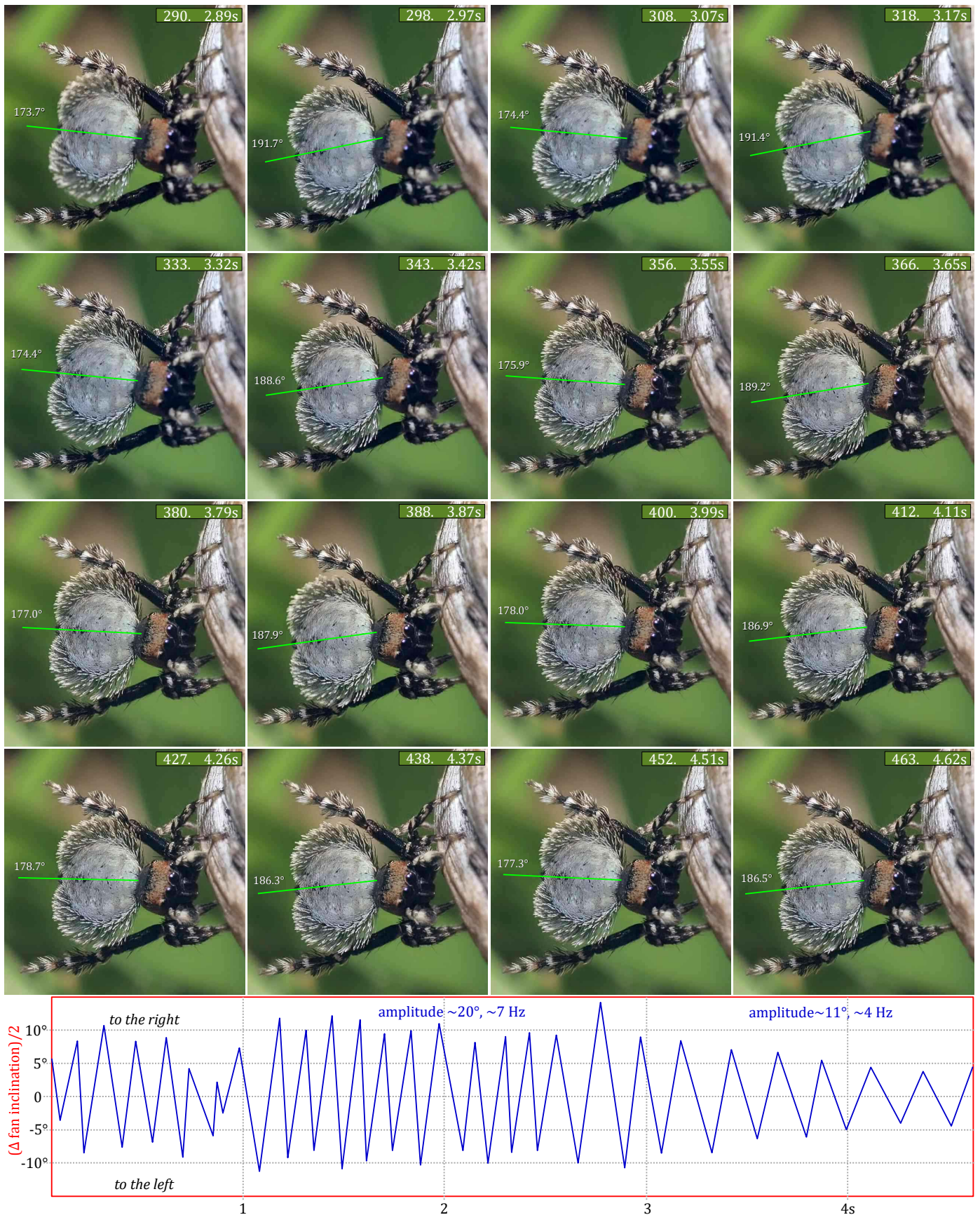


Figure 18 (continued from previous page). Sequential frames from a 100 fps video of the fan dance of a male *Maratus nubilis*. This male switched from a faster, higher amplitude mode of display with side-stepping to a slower, lower amplitude display in place.

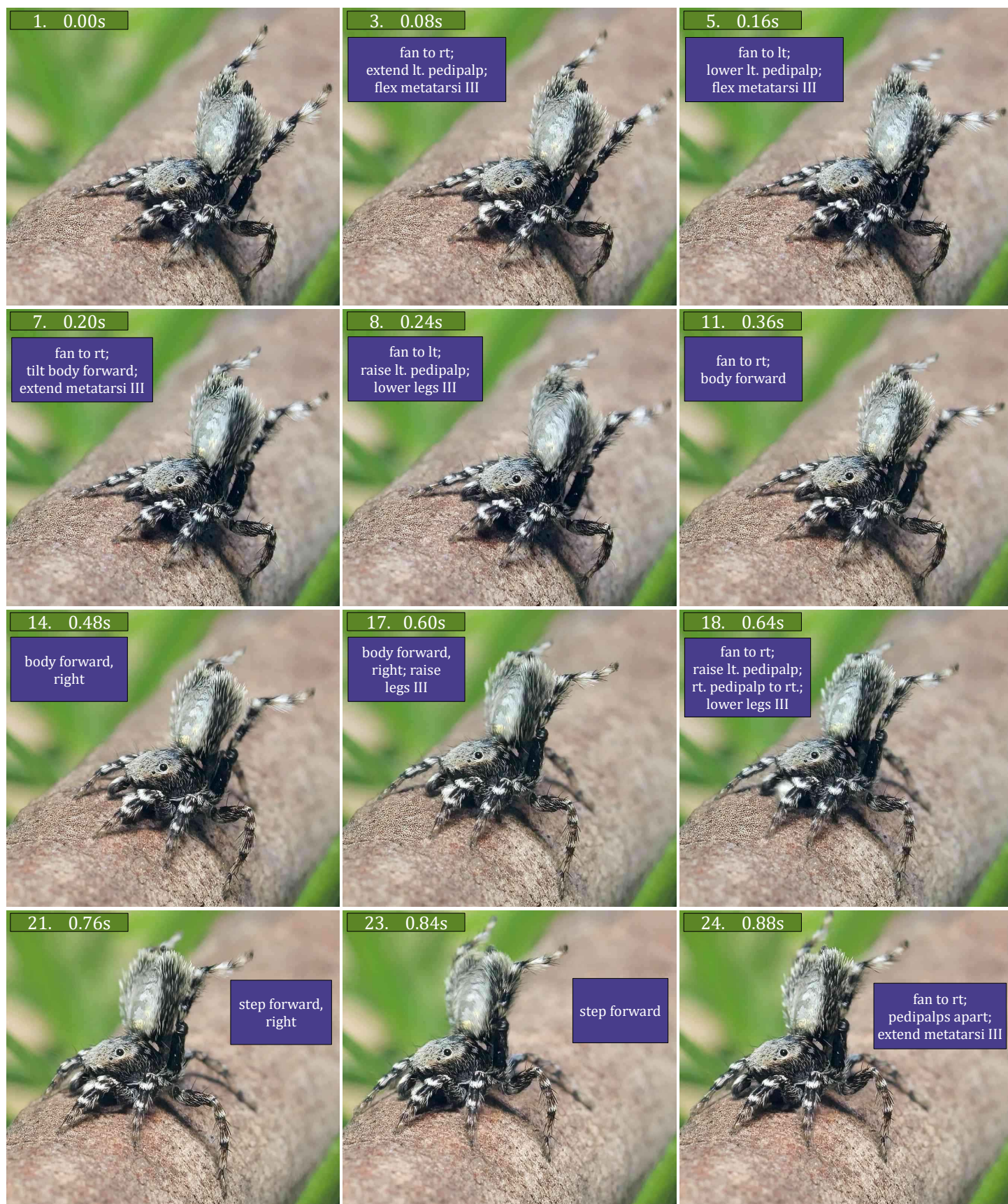


Figure 19. Sequential frames from a 25 fps video of the fan dance of a male *Maratus nubilis*. These frames illustrate slight movements of pedipalps and the flexion of legs III to the rear, at the tibiometatarsal joint, during this dance. One or both legs III may be flexed and at least partly concealed behind the fan, as shown here.

Habitat. *Maratus nubilis* was found in the Denmark Catchment State Forest in southwestern Australia, in open areas of sandy-clay soil, within a winter-wet shrubland dominated by *Melaleuca* (Figure 20).



Figure 20. Habitat of *Maratus nubilis* in the Denmark Catchment State Forest. Photographs © James McMulkin, used with permission.

Acknowledgements

We thank James McMulkin and Flynn Prall for sharing their discovery of *Maratus nubilis* with us, for their collection of type specimens, and for providing habitat photographs and related information. We also thank David Knowles for supplying us with a western *M. chrysomelas*, and the Department of Biodiversity, Conservation and Attractions of Western Australia for issuing collecting and export licenses. Unless otherwise indicated, all photographs are © Jürgen C. Otto.

References

- Baehr, B. C. and R. Whyte. 2016.** The peacock spiders (Araneae: Salticidae: *Maratus*) of the Queensland Museum, including six new species. *Zootaxa* 4154 (5): 501-525.
- Girard, M. B., D. O. Elias, G. Azevedo, K. Bi, M. M. Kasumovic, J. M. Waldock, E. B. Rosenblum and M. Hedin. 2021.** Phylogenomics of peacock spiders and their kin (Salticidae: *Maratus*), with implications for the evolution of male courtship displays. *Biological Journal of the Linnean Society* 20: 1-24.
- Hsiung, B.-K., T. A. Blackledge and M. D. Shawkey. 2014.** Structural color and its interaction with other color-producing elements: perspectives from spiders. In: *The Nature of Light: Light in Nature V*, ed. R. Liang and J. A. Shaw. *Proceedings of SPIE* 9187, 91870B: 1-20.
- Hsiung, B.-K., R. H. Siddique, D. G. Stavenga, J. C. Otto, M. C. Allen, Y. Liu, Y.-F. Lu, D. D. Deheyn, M. D. Shawkey and T. A. Blackledge. 2017.** Rainbow peacock spiders inspire miniature super-iridescent optics. *Nature Communications* 8: 2278: 1-8, DOI: 10.1038/s41467-017-02451-x
- Keyserling, E. 1883.** *Die Arachniden Australiens*. Nürnberg. 1: 1421-1489, pl. 120-123.
- McCoy, D. E., V. E. McCoy, N. K. Mandsberg, A. V. Shneidman, J. Aizenberg, R. O. Prum and D. Haig. 2019.** Structurally assisted super black in colourful peacock spiders. *Proceedings of the Royal Society B, Biological Sciences* 286 (1902): 1-9. [20190589]. <https://doi.org/10.1098/rspb.2019.0589>
- Otto, J. C. and D. E. Hill. 2012.** Notes on *Maratus* Karsch 1878 and related jumping spiders from Australia, with five new species (Araneae: Salticidae: Euophryinae). *Peckhamia* 103.1: 1-81.
- Otto, J. C. and D. E. Hill. 2013.** A new peacock spider from Australia displays three 'sapphire gems' on a field of gold (Araneae: Salticidae: Euophryinae: *Maratus* Karsch 1878). *Peckhamia* 105.1: 1-8.

- Otto, J. C. and D. E. Hill. 2017.** Two new peacock spiders from southeastern Australia (Araneae: Salticidae: Euophryini: *Maratus* Karsch 1878). *Peckhamia* 153.1: 1-34.
- Otto, J. C. and D. E. Hill. 2021.** Catalogue of the Australian peacock spiders (Araneae: Salticidae: Euophryini: *Maratus*), version 4. *Peckhamia* 148.4: 1-35.
- Simon, E. 1909.** Lief. 12. Araneae, 2me partie. In: *Die Fauna Südwest-Australiens. Ergebnisse der Hamburger südwest-australischen Forschungsreise 1905 herausgegeben von Prof. Sr. W. Michaelson und Dr. R. Hartmeyer.* Band II, Lieferung 9-13. Verlag von Gustav Fischer in Jena. 155-212.
- Soltis, P. S. and D. E. Soltis. 2003.** Applying the bootstrap in phylogeny reconstruction. *Statistical Science* 18 (2): 256-267.
- Waldock, J. M. 2002.** Redescription of *Lycidas chrysomelas* (Simon) (Araneae: Salticidae). *Records of the Western Australian Museum* 21: 227-234.
- Weidner, H. 1967.** Geschichte der Entomologie in Hamburg. *Abhandlungen und Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg, N. F.* 9 (Supplement): 5-387.