

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

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Abstract. Male and female *Maratus candens*, new species, are described and placed in the *linnaei* group of the genus *Maratus*. Courtship behavior of the male is also described.

Keywords. courtship display, *flavus* group, Jalbarragup, jarrah forest, *Maratus cuspis*, *Maratus electricus*, *Maratus felinus*, *Maratus laurenae*, *Maratus linnaei*, *vespa* group

With the recent addition of *Maratus pinniger* Otto & Hill 2022, there are now at least 93 species assigned to the genus group *Maratus* Karsch 1878, all endemic to Australia (Otto & Hill 2021, 2022). Within this large genus, 4 species, all endemic to the southwestern corner of Australia, have been assigned to the *linnaei* group (Table 1, Figures 1-2), unknown prior to 2008. Here we add one more species, *M. candens*, new species, and we also transfer *M. felinus* Schubert 2019, to this group.

Presently DNA sequencing has given us little resolution of the phylogeny of species within the *flavus*, *linnaei* and *vespa* groups, all endemic to the southwestern corner of Australia (Girard et al. 2021; Otto & Hill 2021). There is little interspecific variation in the structure of genitalia in these groups. Our present division of the 25 species assigned to the three groups is based on what we know of male ornamentation and display behavior. Male members of the *vespa* group bring their heavily fringed legs III together in a near-vertical position, and behind this they display the prominent, lobate and ornamented flaps of their fan to an attending female. Members of the *linnaei* group have greatly reduced flaps, if any, but their courtship display also involves movement of a more elongated fan, behind legs III in a near-vertical position. In some species in this group legs III are also heavily fringed. The *flavus* group contains species with a more uncertain relationship to either of the other two groups, several of which do not elevate or otherwise display the fan during courtship. Separation of species into these three groups is tentative, representing their hypothetical phylogeny.

Table 1. Members of the *Maratus linnaei* group. The type locality given with the description of *M. laurenae* is incorrect, and the correct locality for that species is shown here and in Figure 2 (Joseph Schubert, pers. comm.).

species	reference for description	type collectors	type locality
<i>M. candens</i> , new species	Otto & Hill 2022	M. Peak, P. Winthrop	S34.04600°, E115.61670°
<i>M. cuspis</i>	Otto & Hill 2019	J. C. Otto	S34.82433°, E116.96996°
<i>M. electricus</i>	Otto & Hill 2017	D. Knowles, J. C. Otto	S34.45060°, E116.68377°
<i>M. felinus</i>	Schubert 2019	M. Duncan	S34.37847°, E115.65775°
<i>M. laurenae</i>	Schubert 2020	J. Murray, S. Murray	S34.8569°, E117.396316°
<i>M. linnaei</i>	Waldock 2008	M. L. Moir, J. M. Waldock	S34.97917°, E118.18611°



Figure 1. Courtship display by adult males representing five species in the *linnaei* group. 7-9, Although each is distinct, the male *M. felinus* resembles *M. candens* with respect to the setation of legs III and the pattern of scales on the fan. Each of the two species is known from a single type locality to the west of other members of this group (Figure 2), and these may be sister species. Photo credit: 7-9, © Adam Fletcher, used with permission.

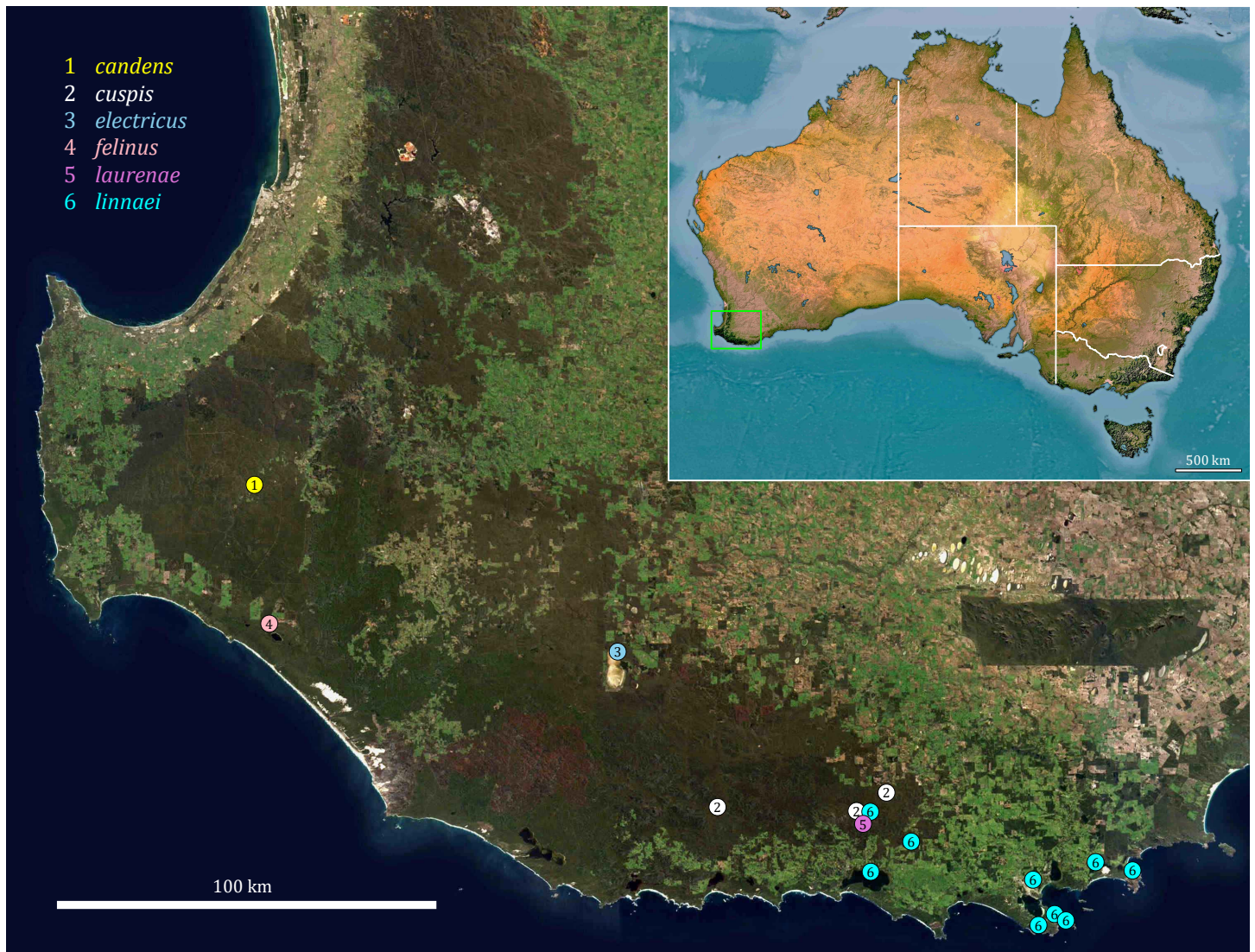


Figure 2. Known distribution of members of the *Maratus linnaei* group, all endemic to southwestern Australia. Two species (*M. cuspis*, *M. linnaei*) are known from multiple locations.

Maratus candens, new species

Type specimens. The holotype male (♂ #1), two paratype males (♂ #2-3), and two paratype females (♀ #1-2) were collected near Jalbarragup, Western Australia, in open jarrah (*Eucalyptus marginata*) forest with bull banksia (*Banksia grandis*) in the understory (Figure 2; S34.0460°, E 115.6167°, 14 NOV 2021, coll. Michelle Peak and Paul Winthrop). All types will be deposited in the Western Australian Museum, Perth.

Etymology. The species group name, *candens* (Latin, adjective, present active participle) is a reference to the *shining* or *glowing* scales that adorn the dorsal opisthosomal plate or fan of the male *M. candens*.

Diagnosis. Females resemble other females in the *linnaei* group, and in related *Maratus* groups from southwestern Australia, although some individuals (♀ #1) may have a greater number of orange-brown scales, particularly in the eye region. The pedipalps of males also resemble those of other *Maratus* from this area and are of little use for identification. However the tapering shape and distribution of scales on the fan of the male (Figure 1:1-2) is distinctive and easily separates this species from all of its known

relatives. Like *M. felinus* but unlike other members of this group, legs I of the male are not heavily fringed. Males have tufts of white setae projecting forward at the top of each paturon, below similar setae that project from the clypeus. Movement of the tuft-bearing chelicerae, not seen in other members of the *linnaei* group, plays an important part in the courtship of *M. candens*. These setae are also present in *M. felinus*, which we presently regard as the sister species of *M. candens*.

Description of male (Figures 1:1-2, 3-6). Males (n=3) ranged from 4.8-5.2 mm in length. The cuticle of the carapace and chelicerae is black. Short white setae extend from the lower margins of the AME. Below these, the clypeus is mostly glabrous, except for a line or tuft of longer white to grey-white setae projecting anteromedially above the chelicerae. A separate tuft of longer white to grey-white setae project anteromedially from the top of the chelicerae. The carapace is mostly glabrous, except for a band of dark red-orange scales extending across the eye region, to the rear behind each anterior eye as well as at the median. In the eye region these bands are separated by white to grey-white bands of setae or scales. The PME are closer to the PLE than to the AME. The front of each pedipalp, from the distal femur to the cymbium, is also densely covered with long white setae. The dorsomedian thoracic tract may be marked by only a small patch of white scales behind the eye region. Along each lateral margin of the carapace there is a tract of bright white scales or setae.

The opisthosoma tapers in the posterior half to end in a truncated apex, about half as wide as the anterior margin. The pattern of scales on the *fan* or dorsal opisthosoma (Figure 3:2,6,13) is unlike that of any other known species. Although the ornamented dorsal plate may be flattened and expanded laterally during courtship, this plate is otherwise curved around the sides of the opisthosoma and lateral flaps are minimal if present. The spinnerets are dark grey to black, and above these is a small triangular tuft of white setae that is not visible during courtship. Below the opisthosoma is dark brown (Figure 5:10-12), with a series of paired, light spots on either side of the midline, only visible in preserved specimens (Figure 5:7). The coxae, sternum, labium and endites are dark grey and mostly glabrous, except for scattered white setae along the rear margin of the sternum. Legs I and II are shorter and of similar length, legs III the longest. All legs are fairly uniform, dark brown in coloration, except for the light and translucent proximal and ventral aspects of the femora. Legs III have a several long white setae projecting ventrally (laterally when these legs are raised during courtship) near the distal end of each patella. This feature is shared with *M. felinus*. Other black and white setae comprise a relatively sparse, ventral (lateral during display) fringe beneath the tibia and metatarsus of each leg III. A more dense tuft of white setae is present on each tarsus III. The male pedipalp (Figure 6) closely resembles that of related *Maratus* species from southwest Australia, with a small projection near the apex of the outer embolus.

Description of female (Figures 7-8). Females (n=2) ranged from 5.9-6.1 mm in length. The general colour compares with that of related *Maratus* species, generally brown with black cuticle dorsally. One of the type females (♀ #1) is more orange-brown in colour. Below the anterior eye row, long white setae extend across the clypeus anteromedially. Fewer, shorter white or grey setae also extend ventrally from the base of each paturon. The lower parts of the carapace, chelicerae and pedipalps are translucent, light brown. White or grey setae partly cover the dorsal surface of each pedipalp, from the patella to the cymbium. The anterior eyes are surrounded by longer white setae below, light orange to brown setae above. The eye region is covered with orange to brown scales, which may be absent or sparse behind each AME. The PME are closer to the PLE than to the AME. Behind the eye region the carapace is dark, with an orange to brown median thoracic band. On the sides, the light brown and translucent cuticle of the carapace is covered with very light brown to orange scales or setae, but these do not extend all the way to the margins and a marginal band is absent.



Figure 3. Living type males, *Maratus candens*. 6, Dorsal view of opisthosoma. 12, 14-15, Males engaged in courtship display. As in other *Maratus*, inflation and extension of a very flexible pedicel allows the opisthosoma to be rotated forward and then elevated in a vertical position (15).



Figure 4. Type males in alcohol, *Maratus candens*.



Figure 5. Type males, *Maratus candens*. 1-7, Detailed views of opisthosoma in alcohol. 8-9, Anterior views, in alcohol. 10-12, Ventral views of living type males.

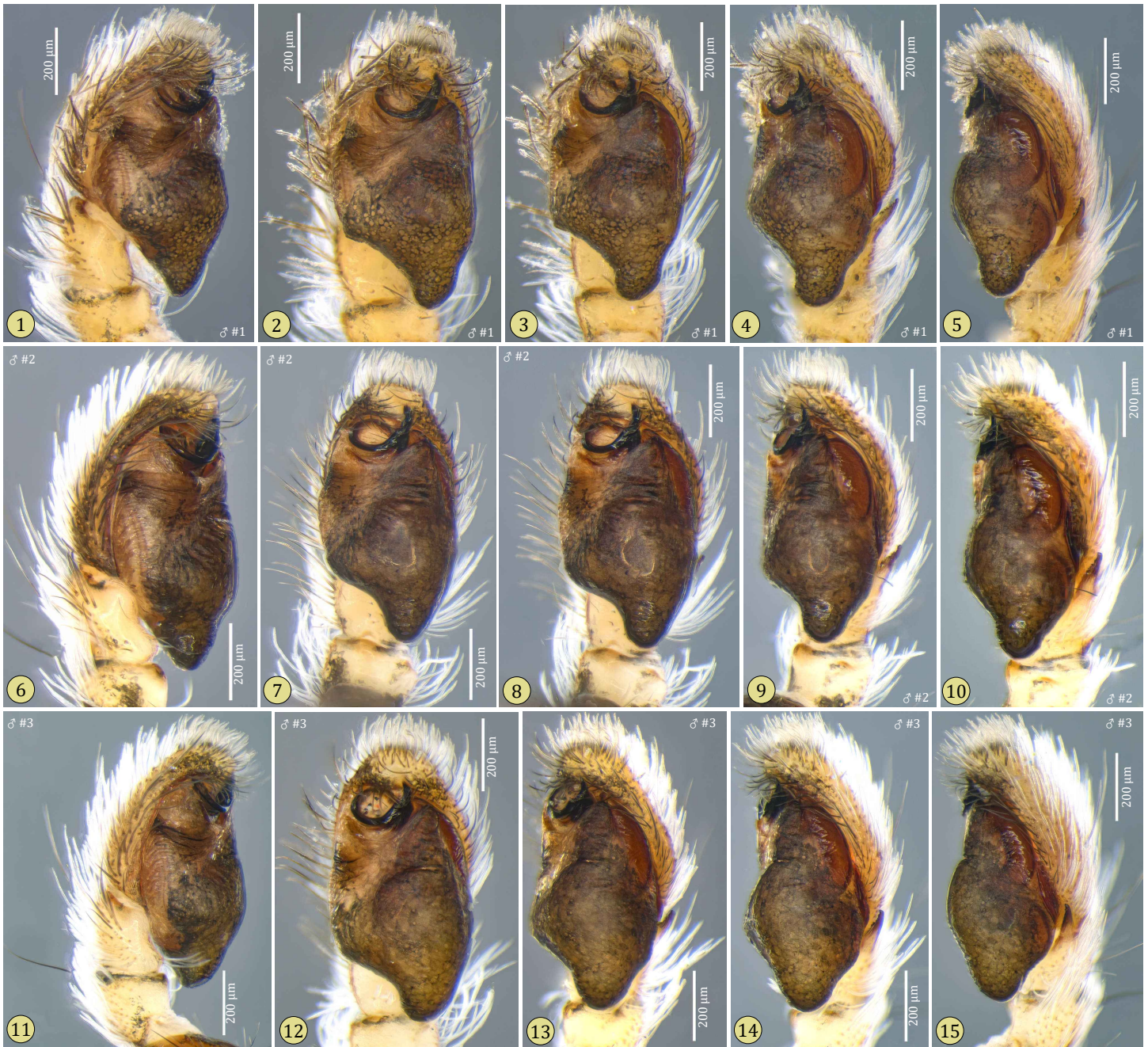


Figure 6. Medial to lateral views of left pedipalp for type males in alcohol, *Maratus candens*.

The dorsal opisthosoma of the female is dark with an indistinct midline of lighter scales, that may (♀ #1) or may not (♀ #2) be surrounded by a broad band of very light brown scales or setae on either side. The spinnerets are grey, below a small triangular tuft of white setae. Below, the opisthosoma is light brown with some light mottling of darker spots (Figure 8:11-12), more prominent in preserved specimens (Figure 8:4,8). The coxae, sternum, labium and endites are very light brown, translucent and glabrous, except for scattered setae along the posterior margin of the sternum. Legs I and II are of similar length and shorter, legs II and IV of similar length and longer. All legs are indistinctly banded with dark brown pigment near the joints, with a covering of off-white to orange or brown scales. The epigynum (Figure 8:13-14) is similar to that of related *Maratus* species, with large posterior spermathecae, larger than the fossae, and with sclerotized ducts visible through the posterior part of each fossa.



Figure 7 (continued on next page). Living female paratypes, *Maratus candens*.



Figure 7 (continued from previous page). Living female paratypes, *Maratus candens*.

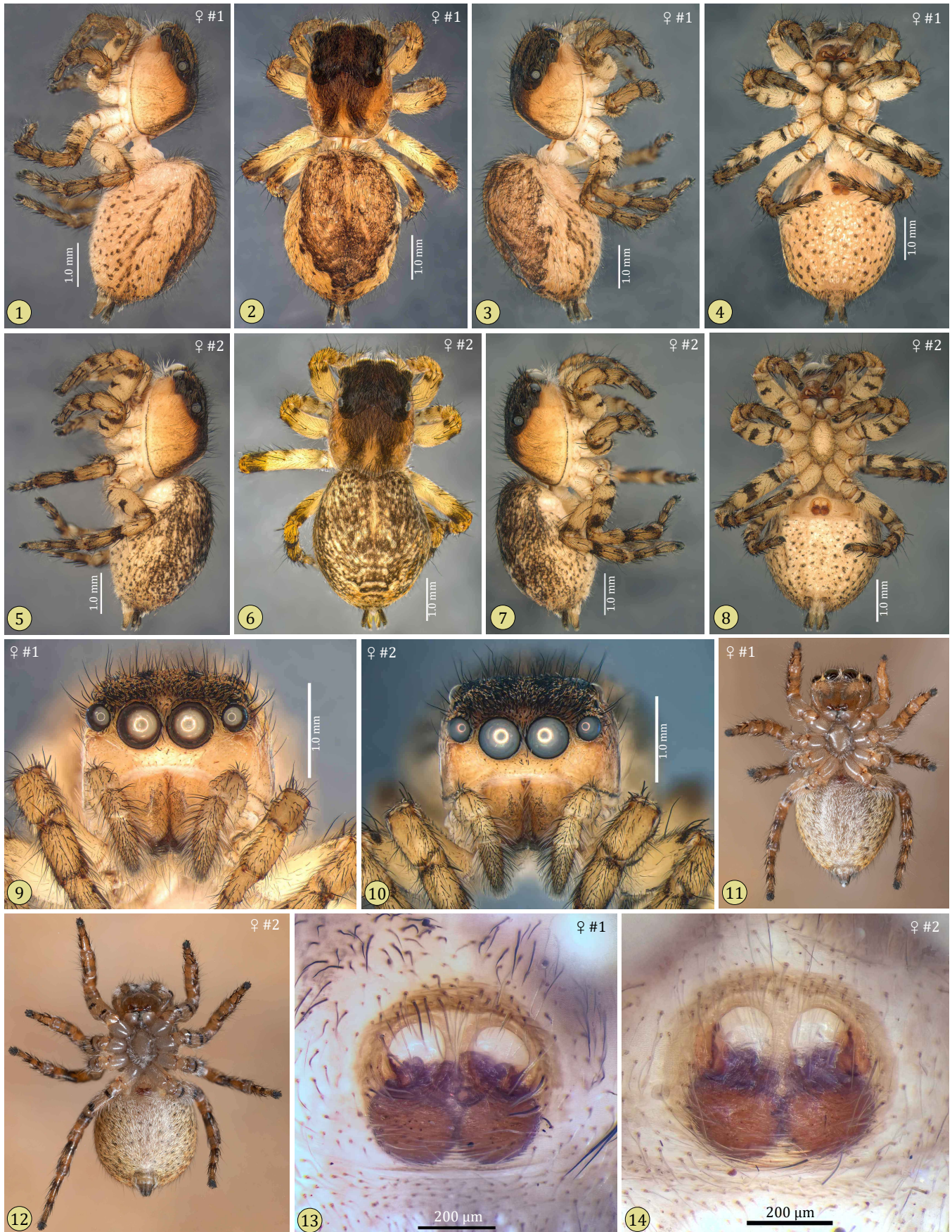


Figure 8. Female paratypes, *Maratus candens*. **1-10, 13-14,** Views of paratypes preserved in alcohol. **11-12,** Ventral views of living paratypes. **13-14,** Ventral views of epigynum (anterior toward top of page).

Courtship display (Table 2, Figures 9-30, 31:7-9). Based on laboratory observations, we have been able to document six different categories or stages of courtship display by the male *Maratus candens*. Males use a diverse repertoire of signals to gain the attention of a female in the vicinity (Table 2:1-5), with the mating decision of the female ultimately decided during her close examination of the *fan dance* of the male (Table 2:6). The fan dance of *M. candens* is quite unusual, incorporating two features not observed in any other *Maratus* species: 1) rotation of the opisthosoma in a sagittal plane with alternation between a high display of the elevated opisthosoma and a low display with the opisthosoma turned down to touch the underlying surface with the spinnerets, and 2) extension and continuous movement of the chelicerae, including extension of the fangs, as the opisthosoma is rotated (but not when it is elevated).

Table 2. Displays of the male *Maratus candens*.

display	position of female	description	interpretation	Figures
1. leg wave	may be in sight but not facing the male	in place, extended and elevated leg III waved at low amplitude (~1-3°) and low frequency (~1 Hz)	advertisement may elicit movement by a female in the vicinity, thus allowing the male to detect her presence	9, 23:4-5, 31:7-9
2. legs up	probably sighted to the front of the male	elevation of both legs III to a vertical position, usually with elevation of the fan that may be expanded laterally	appears to be preparation for a more active display depending on response of the female	23:6-7 24:9-11
3. wave and step	within sight	with elevated fan male alternately lowers extended legs III and then raises them while (often) stepping to the side in 1.8-3.0 Hz cycles	advertisement to gain attention of female in sight	10-11, 23:1-2 24:5-8
4. caliper dance	within sight and may be closer to the female	male alternately lowers extended legs III as fan is raised, then raises extended legs III to a vertical or caliper position and lowers the fan during a quick step to the side (1.0-1.9 Hz cycles)	advertisement to gain attention of female when closer to the male, appears to represent a transition to (6); similar to (3) except for movement of fan and more vertical position of legs III	12-13, 15
5. high fan	close to female, but female is not facing or following the male	male maintains an elevated position with only low amplitude (2-6°, 4.4 Hz left+right cycles) lateral movement of the elevated fan, with legs III held together in a vertical <i>calipers</i> position	advertisement to female that is nearby but facing away, not engaged in active examination of the male; appears to be a holding position while waiting for the female response	16
6. fan dance	facing and approaching the male, turning to follow each movement made by the male	male alternately holds fan in elevated position between legs III, held in a vertical, <i>calipers</i> position, and rotates the fan in a sagittal plane to a low position, touching the underlying surface; chelicerae moved from side to side as fan is rotated, not moved when fan is in an elevated position; up+down cycles 0.24-0.30 Hz	continued as long as female turns up and down to face and to follow each movement of the male; can result in mating if female stops turning to follow this movement	17-22, 25-30

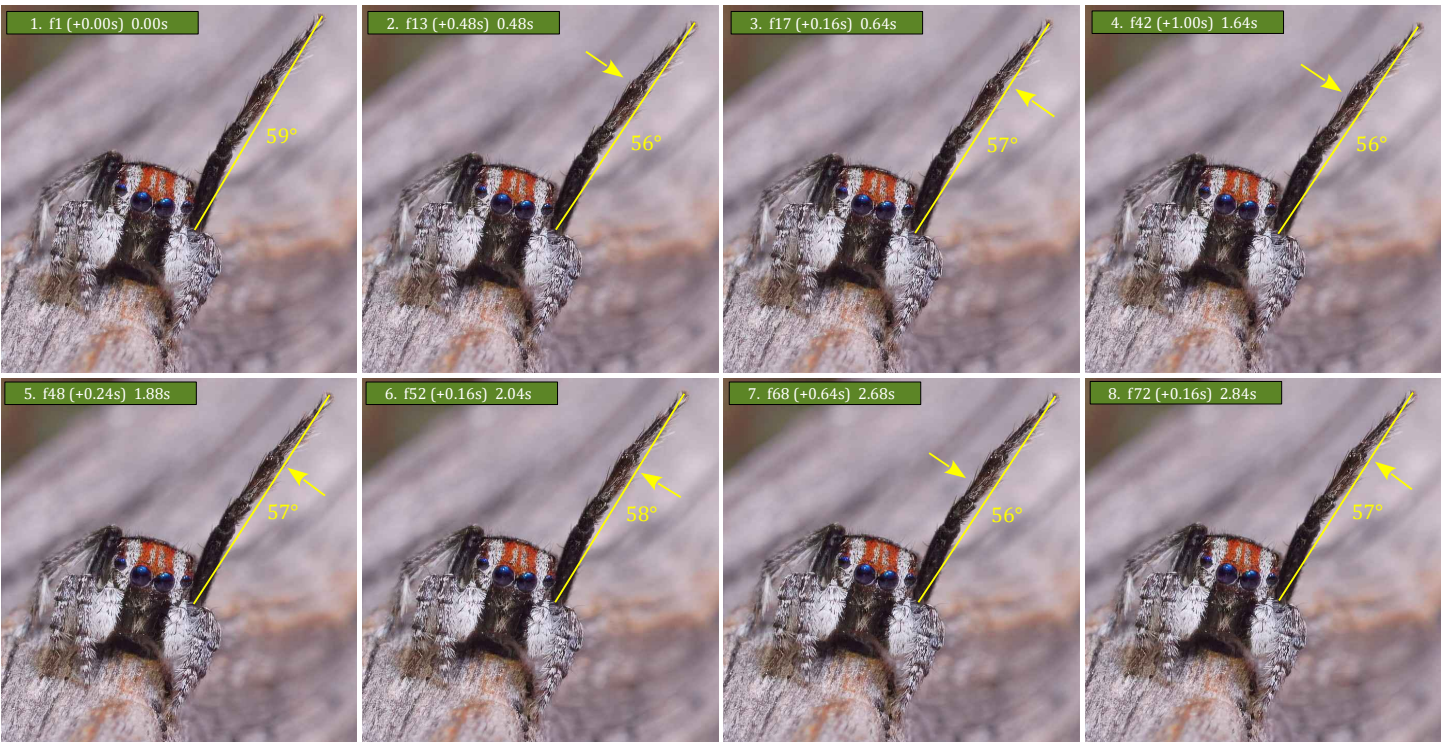


Figure 9. *Leg wave* by a male *Maratus candens*, from a 25 fps video. Position in the sequence of frames (f), elapsed time since the previous frame (+s) and total elapsed time (s) are shown for each frame. In this display one extended and elevated leg III was moved slowly (3 up+down cycles/2.84s or 1.06 Hz) over a very small amplitude (1-3°).



Figure 10. Wave and step display of a male *Maratus candens* based on a 25 fps video. For each frame in this sequence, frame number and total elapsed time (s) are shown. White arrows indicate alternation between slower lowering or separation of the extended legs III and more rapid raising of these legs to a more vertical position (7 raise+lower cycles/3.96s or 1.8 Hz). Raising of these legs is often accompanied by a quick step to one side or the other side (larger, red arrows), all the time facing the female. This display included some low amplitude (several degrees) movement of the fan from side to side.



Figure 11. Wave and step display of a male *Maratus candens* based on a 25 fps video. For each frame in the sequence, frame number and total elapsed time (s) are shown. The position of the female can be seen, at the lower right corner of each frame (♀). With 7 cycles/2.32s or 3.0 Hz, this display was somewhat faster than the previous example (Figure 10).

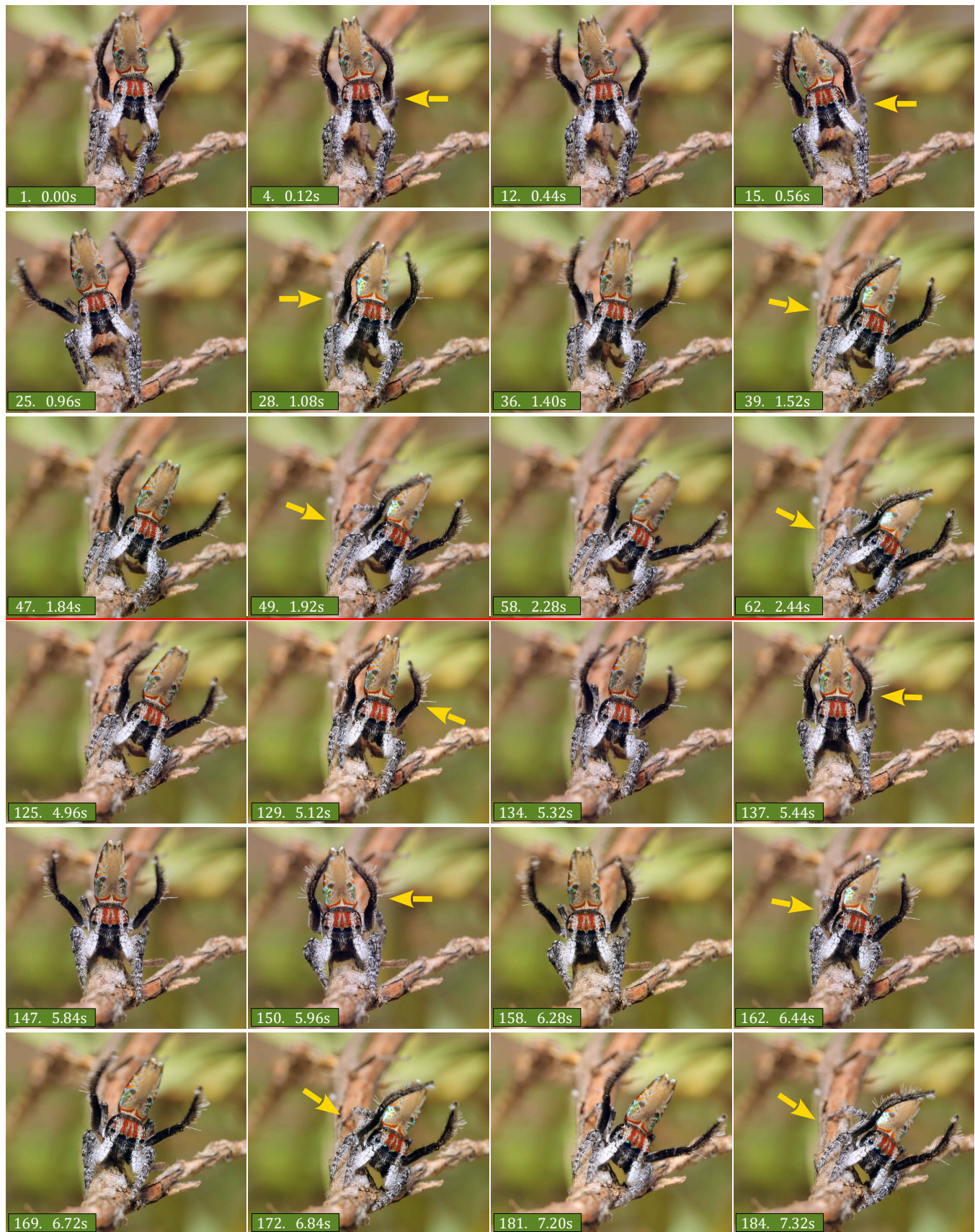


Figure 12. Caliper dance of a male *Maratus candens* based on a 25 fps video. Like the wave and step display, this involves (11 cycles/7.2s or 1.5 Hz) alternation between slower separation of legs III and faster side-stepping (yellow arrows) as these legs are brought together, but legs III are brought together in a calipers configuration to surround the lowered fan, and the fan is elevated each time that these legs are separated.

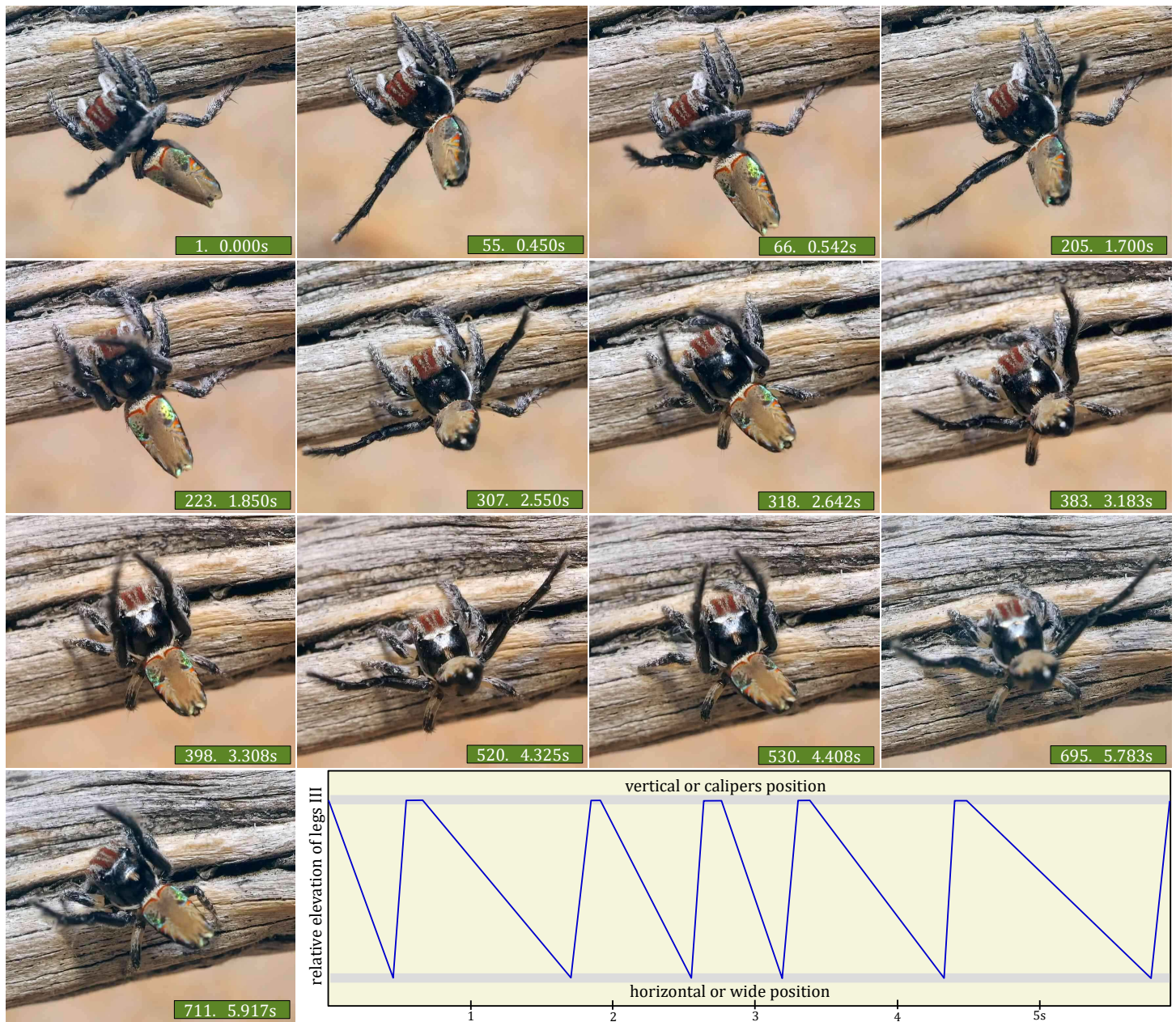


Figure 13. Caliper dance of a male *Maratus candens* based on a 120 fps video. Alternation between vertical (calipers) and horizontal (with fan elevated) positions of legs III is shown in the chart. During each cycle of this display, legs III were moved down, to the sides, over an average interval of 0.799s, immediately followed by elevation of legs III over an average of 0.108s. Legs were held in the vertical position for an average of only 0.095s. The total cycle time averaged 1.002s, or ~1.0 Hz.



Figure 14. Successive positions of the female *Maratus candens* during the courtship shown, in part, in Figure 13. This display, with legs III extended and elevated, and the opisthosoma elevated and bobbed from time to time, is a characteristic of *Maratus* females, apparently associated with rejection of a courting male.

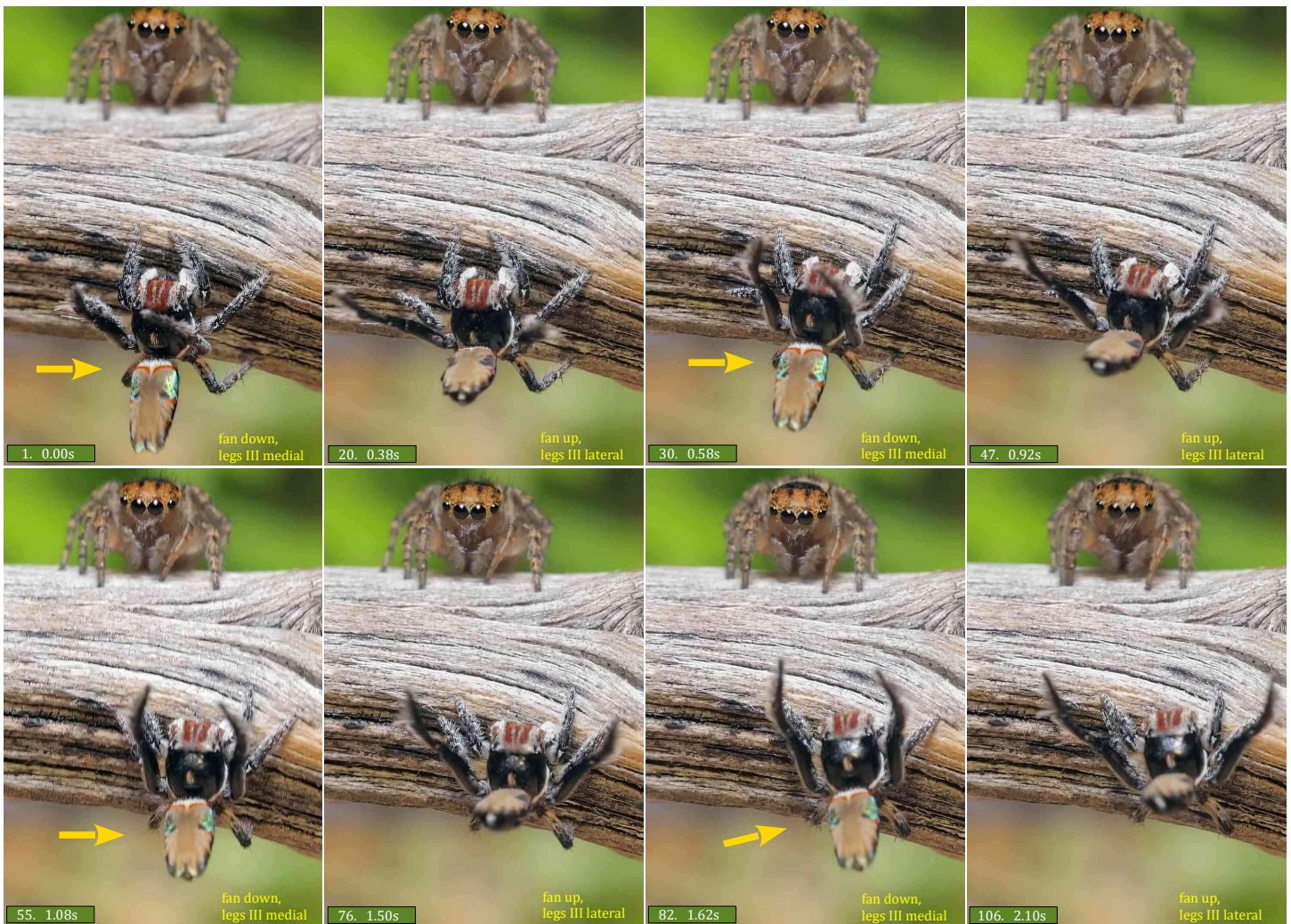


Figure 15. Caliper dance of a male *Maratus candens* based on a 50 fps video (3 cycles/1.62s or 1.9 Hz).

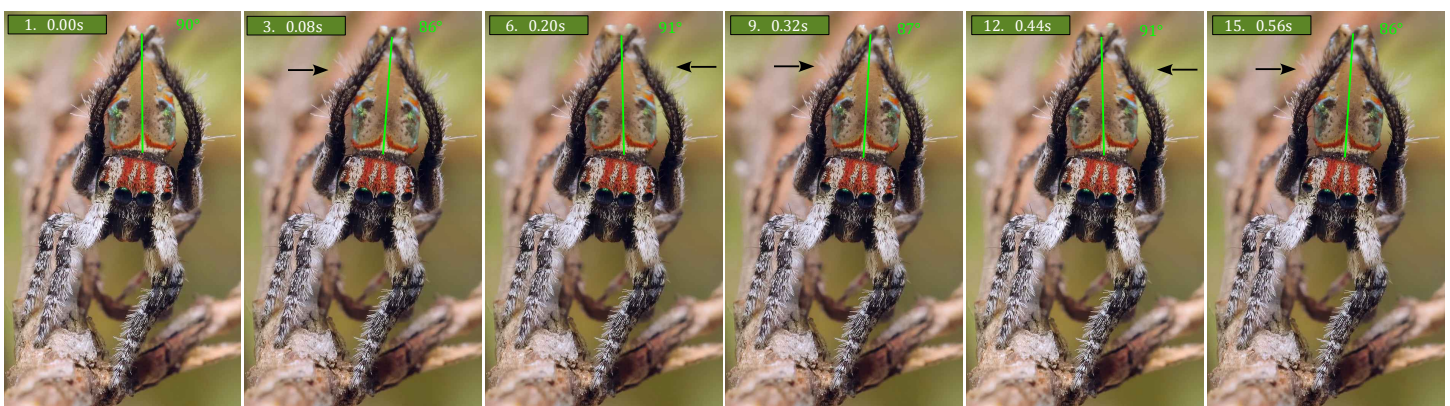


Figure 16 (continued on next page). High fan display of a male *Maratus candens* based on a 25 fps video. During this display the male held an elevated position in front of the female, with only low amplitude (2-6°) waves of the fan at a moderate frequency (14.5 left+right cycles/3.32s or 4.4 Hz). Nothing except the fan moved during this display.

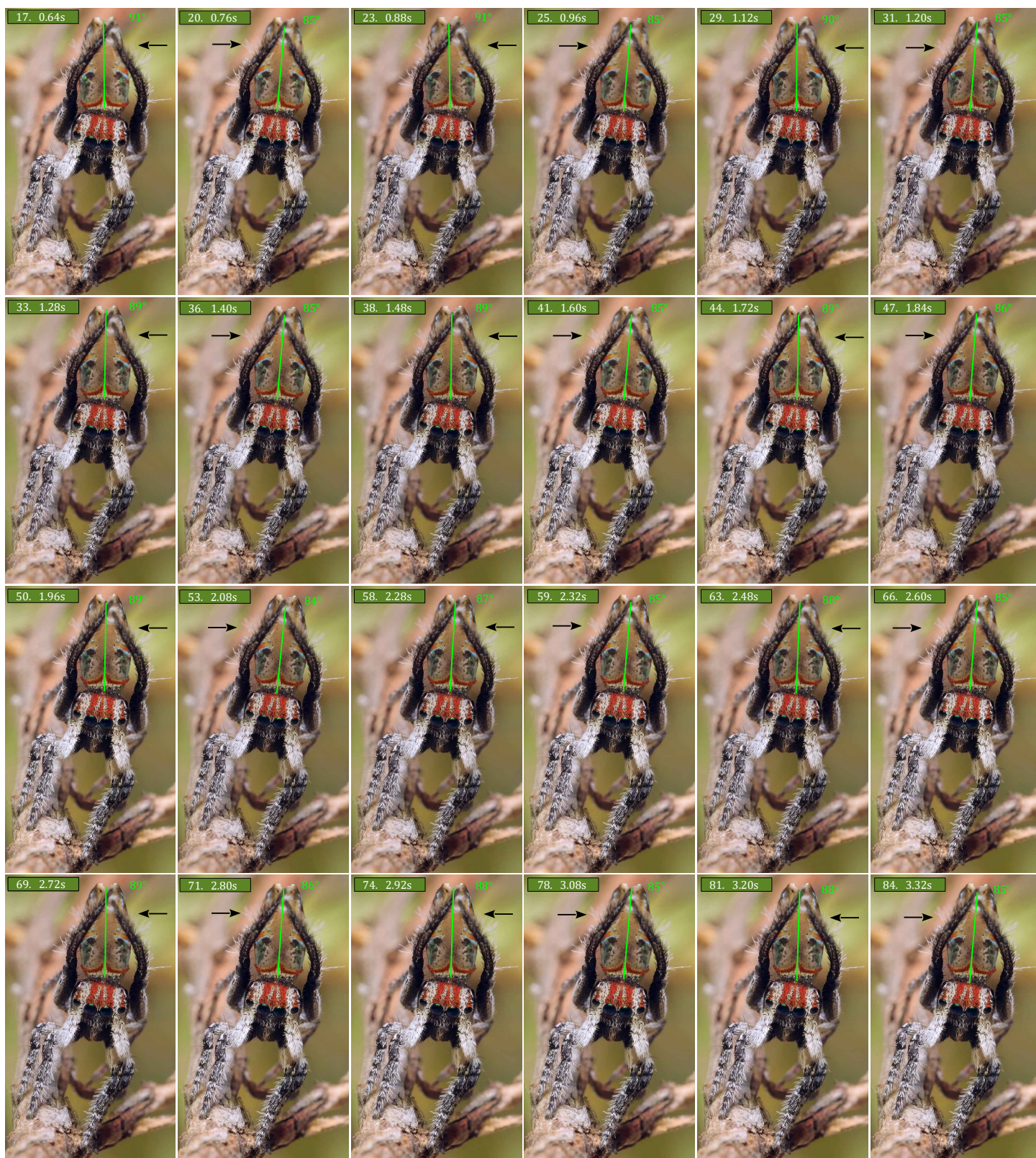


Figure 16 (continued from previous page). High fan display of a male *Maratus candens* based on a 25 fps video.

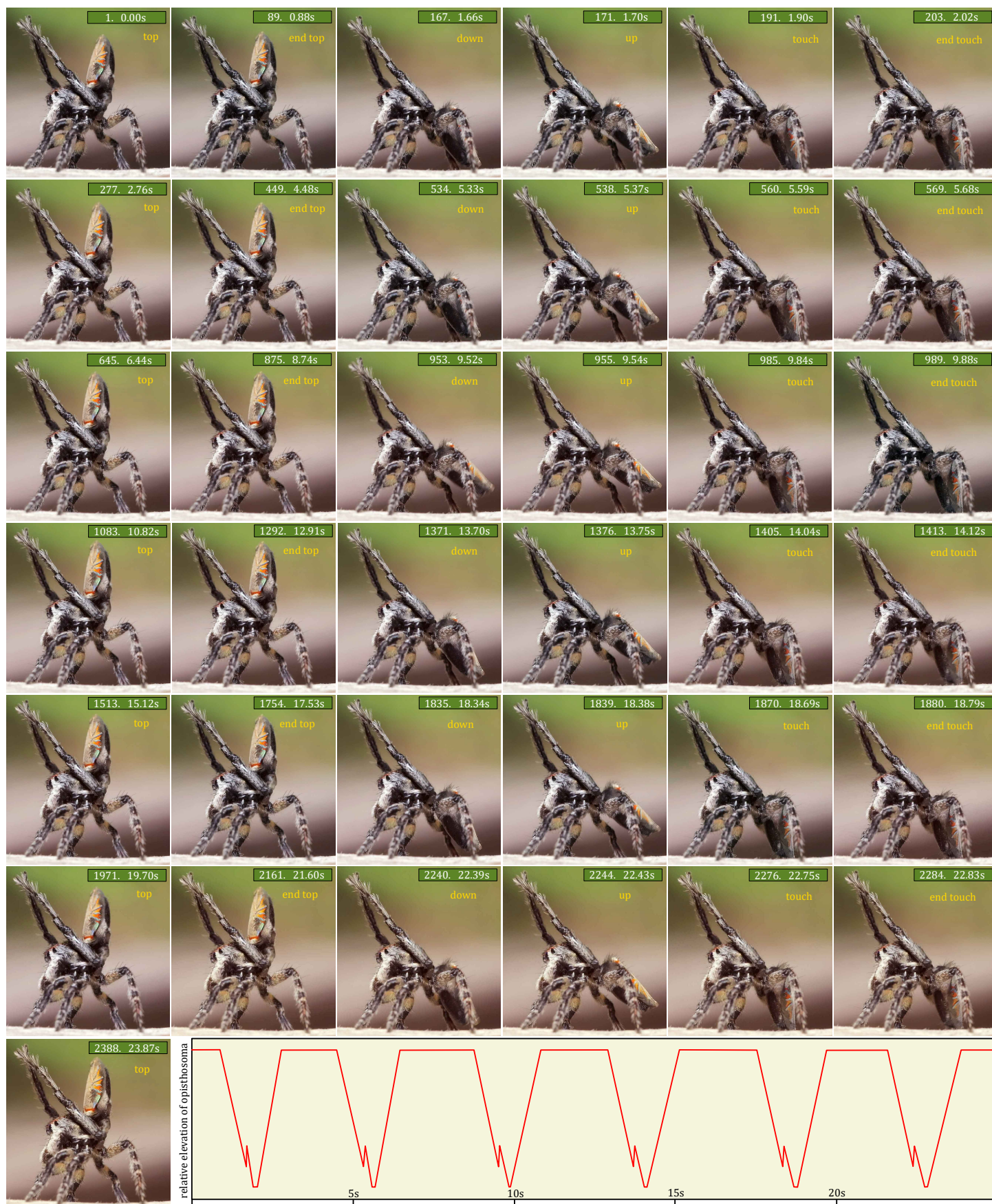


Figure 17. Lateral views of the fan dance of a male *Maratus candens* based on a 100 fps video. The chart at the bottom of this figure shows the regular timing of the entire sequence, as the opisthosoma was alternately depressed in several stages to touch the underlying surface, and then elevated to the upright position (5 down+up cycles/20.72s or 0.24Hz).

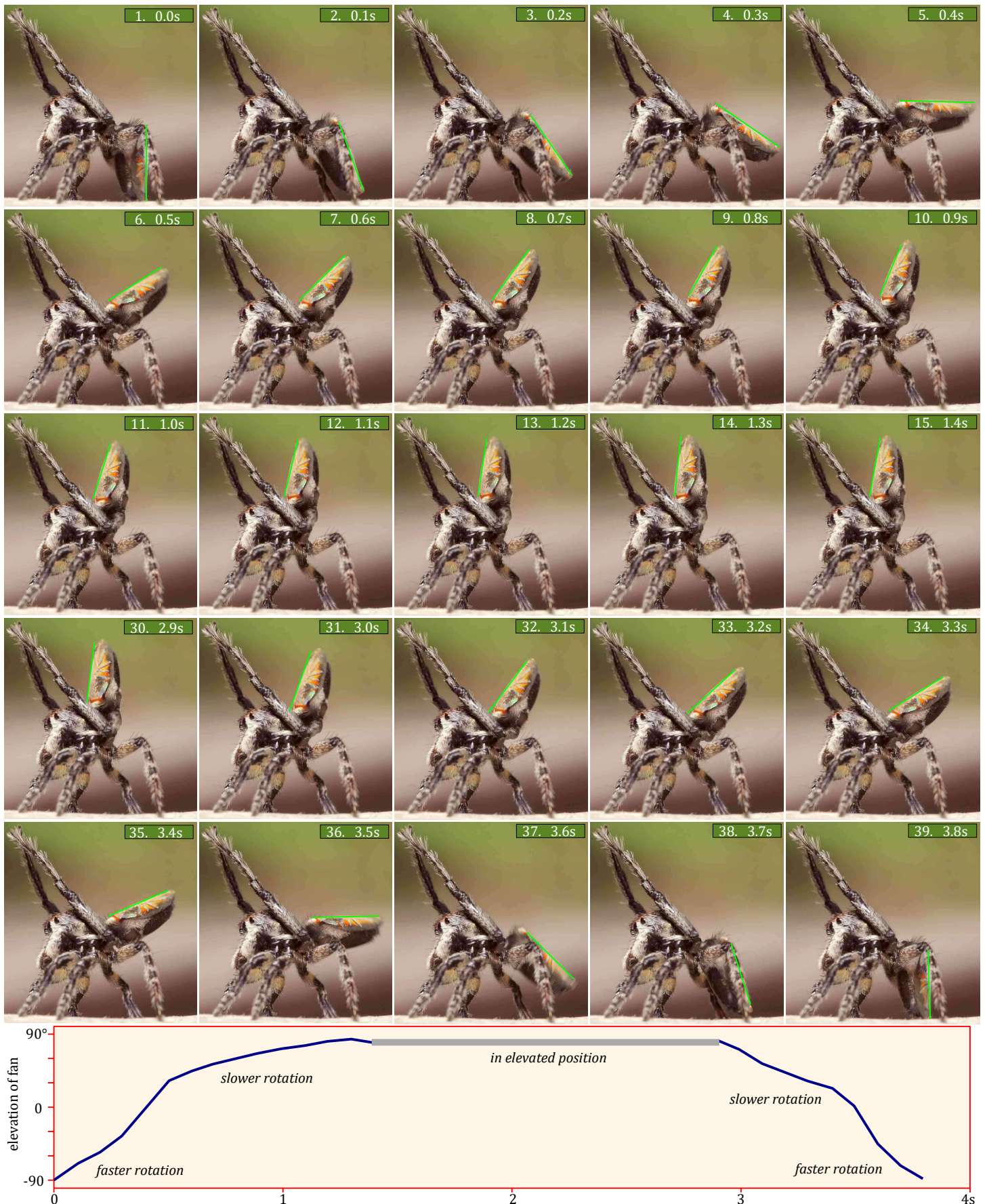


Figure 18. Lateral views of the *fan dance* shown in Figure 17, with sequential frames selected for a reduced resolution of 10fps. A green line in each frame corresponds to the elevation of the fan, with rotation in the sagittal plane charted below.

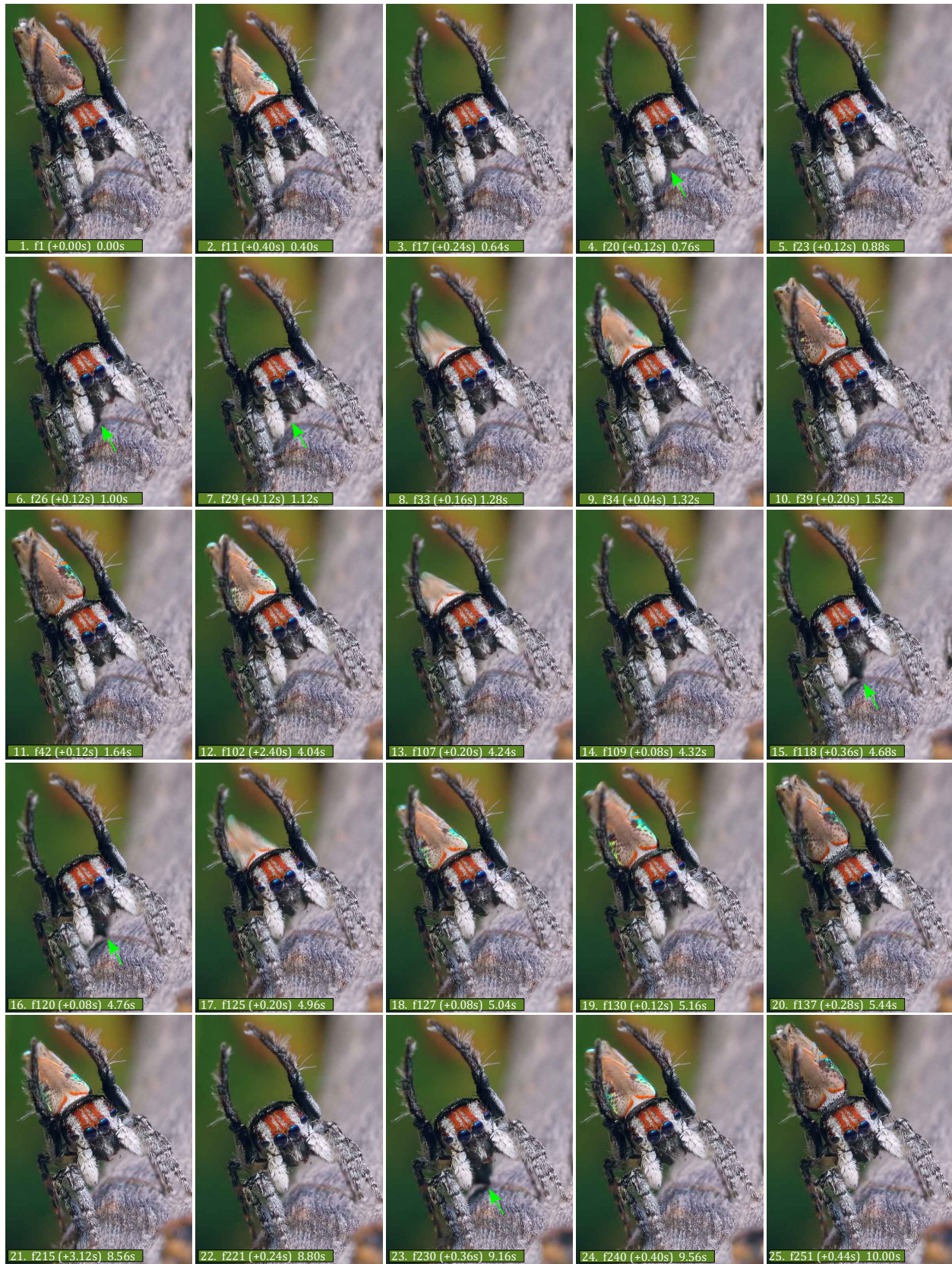


Figure 19. Selected sequential frames from a 25fps video of the *fan dance* of a male *Maratus candens* (3 down+up cycles/s or 0.3 Hz). During this display, the opisthosoma is rotated in the sagittal plane, down toward, or to touch, the underlying surface one or more times (green arrows), then raised to an elevated position. As the opisthosoma is moved, the chelicerae are projected forward and moved from side to side. When the chelicerae are moved, the fangs may be alternately extended and retracted (Figure 21).

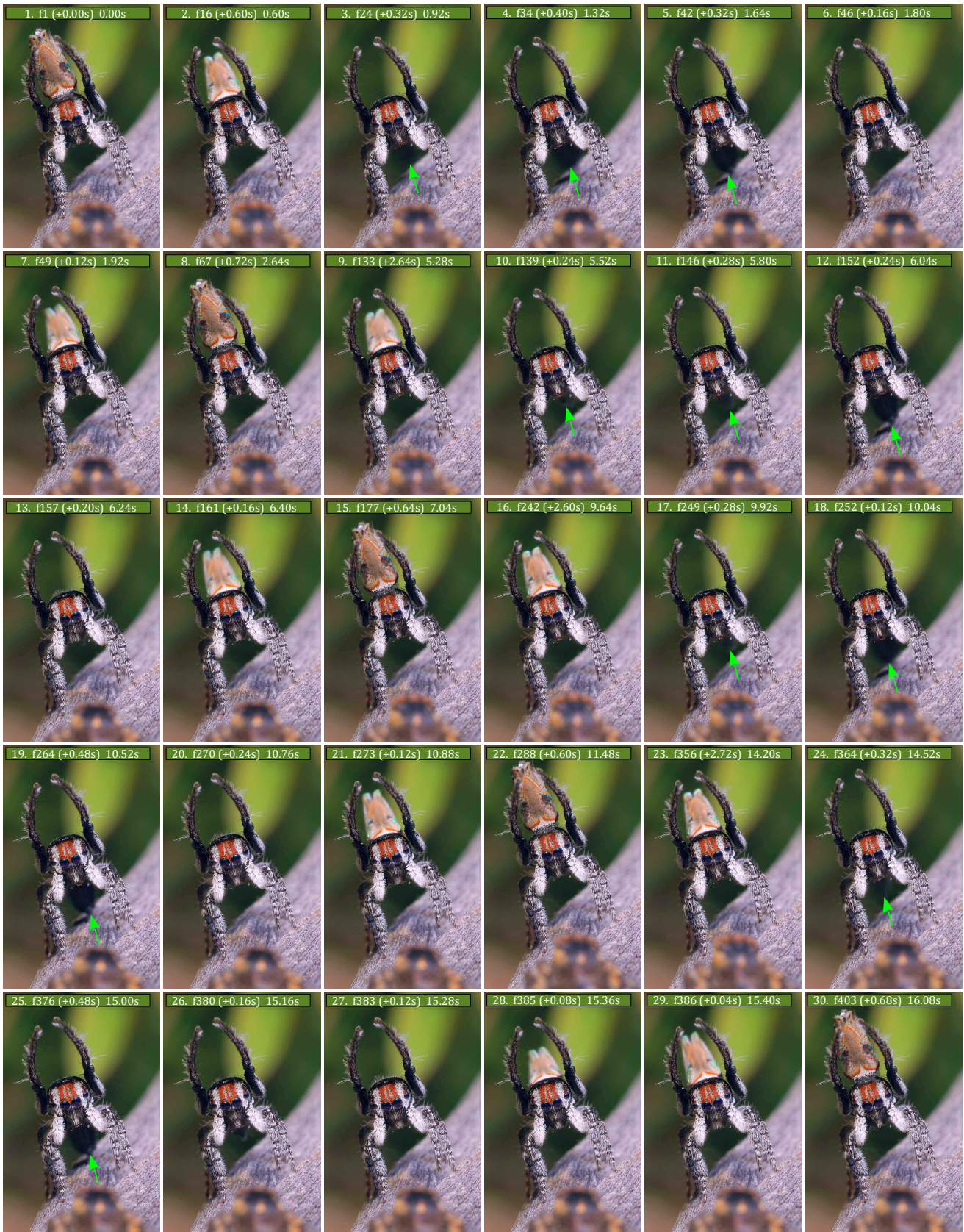


Figure 20. Selected sequential frames from a 25fps video of the *fan dance* of a male *Maratus candens*. As in Figure 16, green arrows indicate the lower positions of the opisthosoma, touching the underlying surface at least once per cycle (4 down+up cycles/16.08s or 0.25Hz). Movement of the opisthosoma is not completely smooth, but includes some low-amplitude waving or bobbing (Figure 22). The attentive female (♀ #1) can be seen in the foreground.



Figure 21. Detailed view of the face of the male during the *fan dance* shown in Figure 20, showing movement of the chelicerae (selected sequential frames from a 25fps video). When the opisthosoma is moved up or down both chelicerae are rotated to the front, making the long white setae that cover them more conspicuous. In general the chelicerae move together from one side to the other during this display, but the fangs are also extended and retracted during this movement.

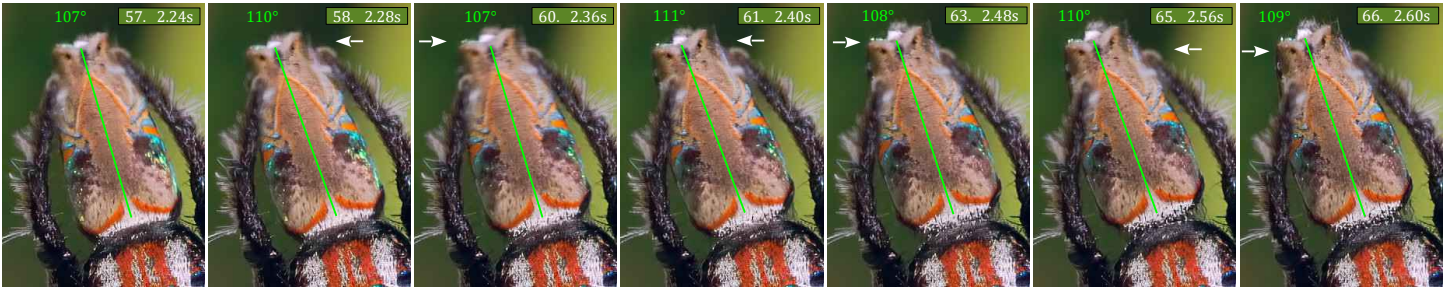


Figure 22. Detailed view of the elevated fan of the male during the *fan dance* shown in Figure 20, showing low amplitude lateral movement of the fan (1-4°, 3 left+right cycles/0.36s or 8.3 Hz), based on selected sequential frames from a 25fps video.

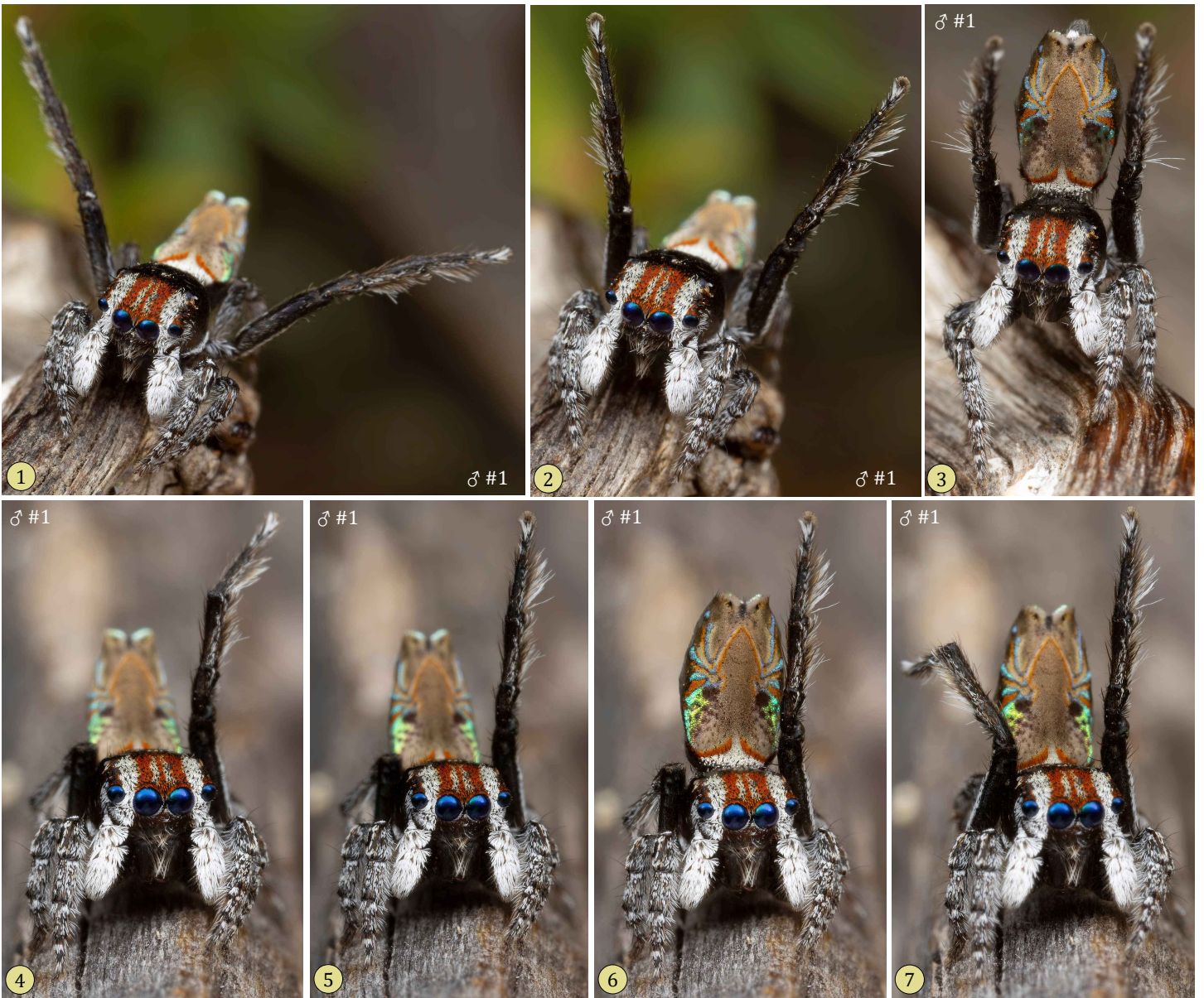


Figure 23. Display positions of a male *Maratus candens*. **1-2**, Two frames showing a *wave and step* sequence. Movement to the second position (2) was accompanied by a small step or movement to the right (left in the photograph) by this male. **3**, *Legs up* display with fan flattened or expanded in a vertical position. **4-7**, Sequence showing transition from a *leg wave* (4) to a *legs up* display. Note expansion of the fan (6).

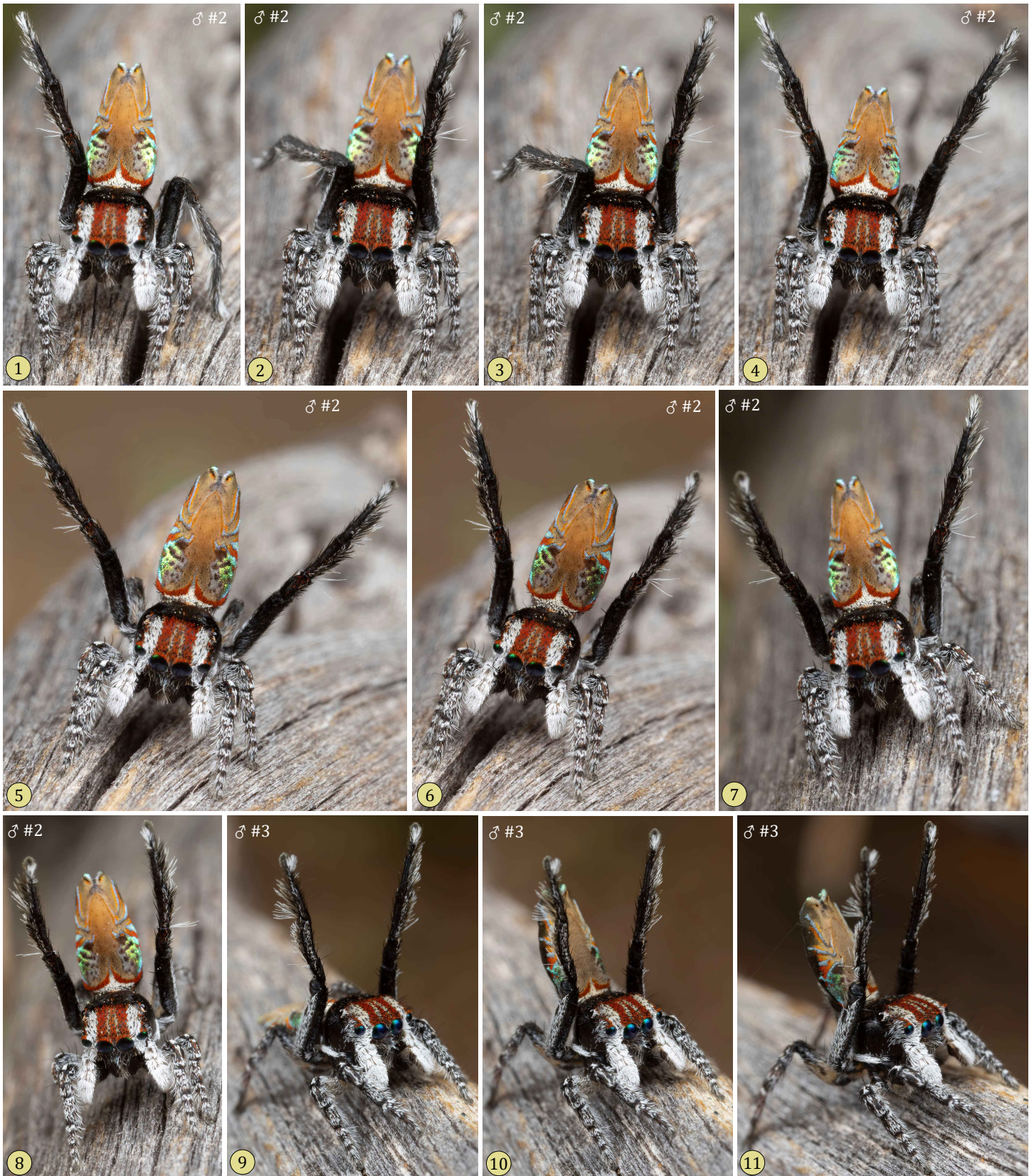


Figure 24. Display positions of a male *Maratus candens*. 1-4, Sequence showing transition to a *legs up* display. 5-6, Sequential positions during a *wave and step* display. 7-8, Two positions during a *wave and step* display. 9-11, Sequential positions during a *legs up* display.

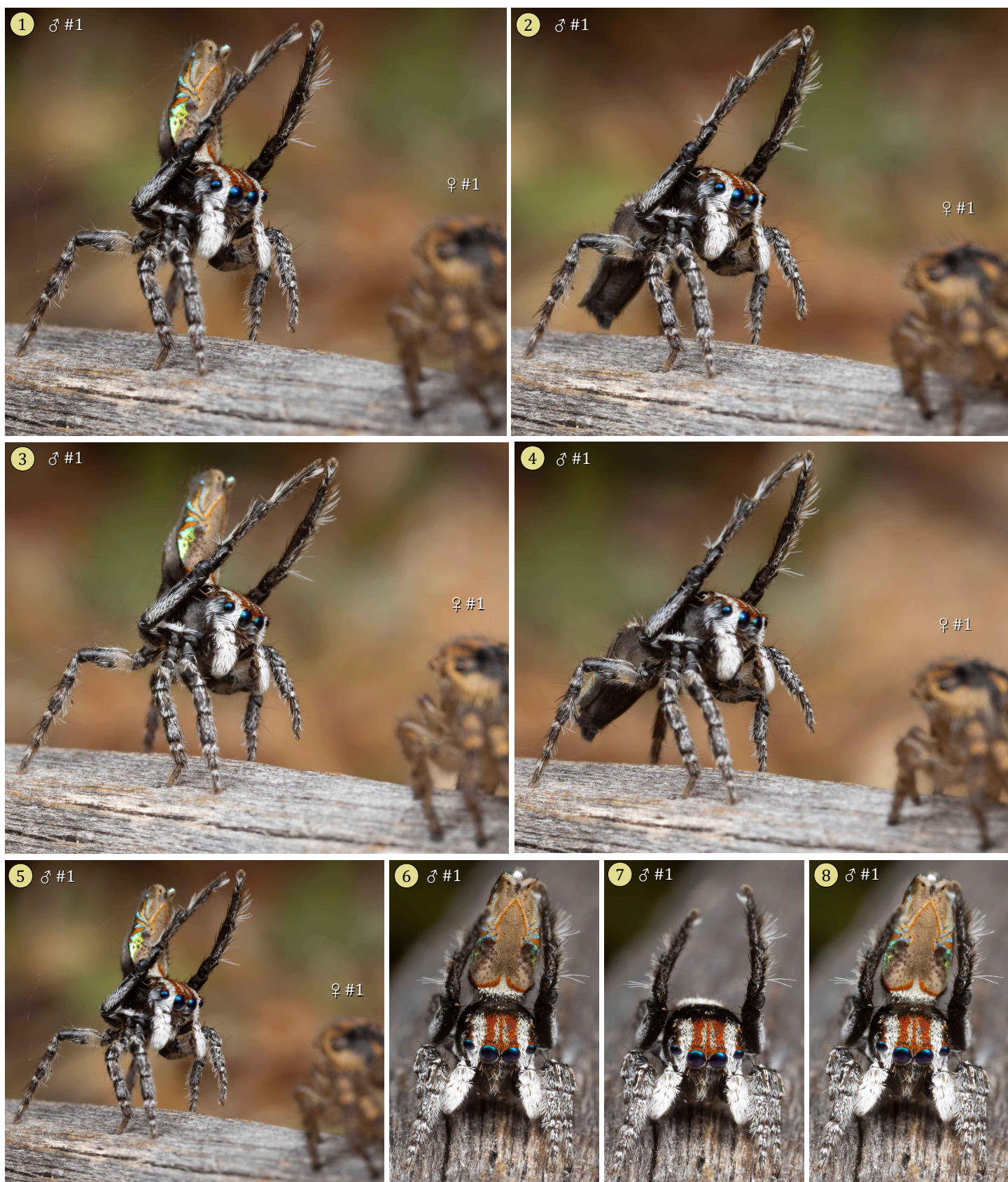


Figure 25. Two different fan dance sequences (1-5, 6-8). 1-5, Note the close position of the attending female.



Figure 26. Sequential photographs of a single fan dance.

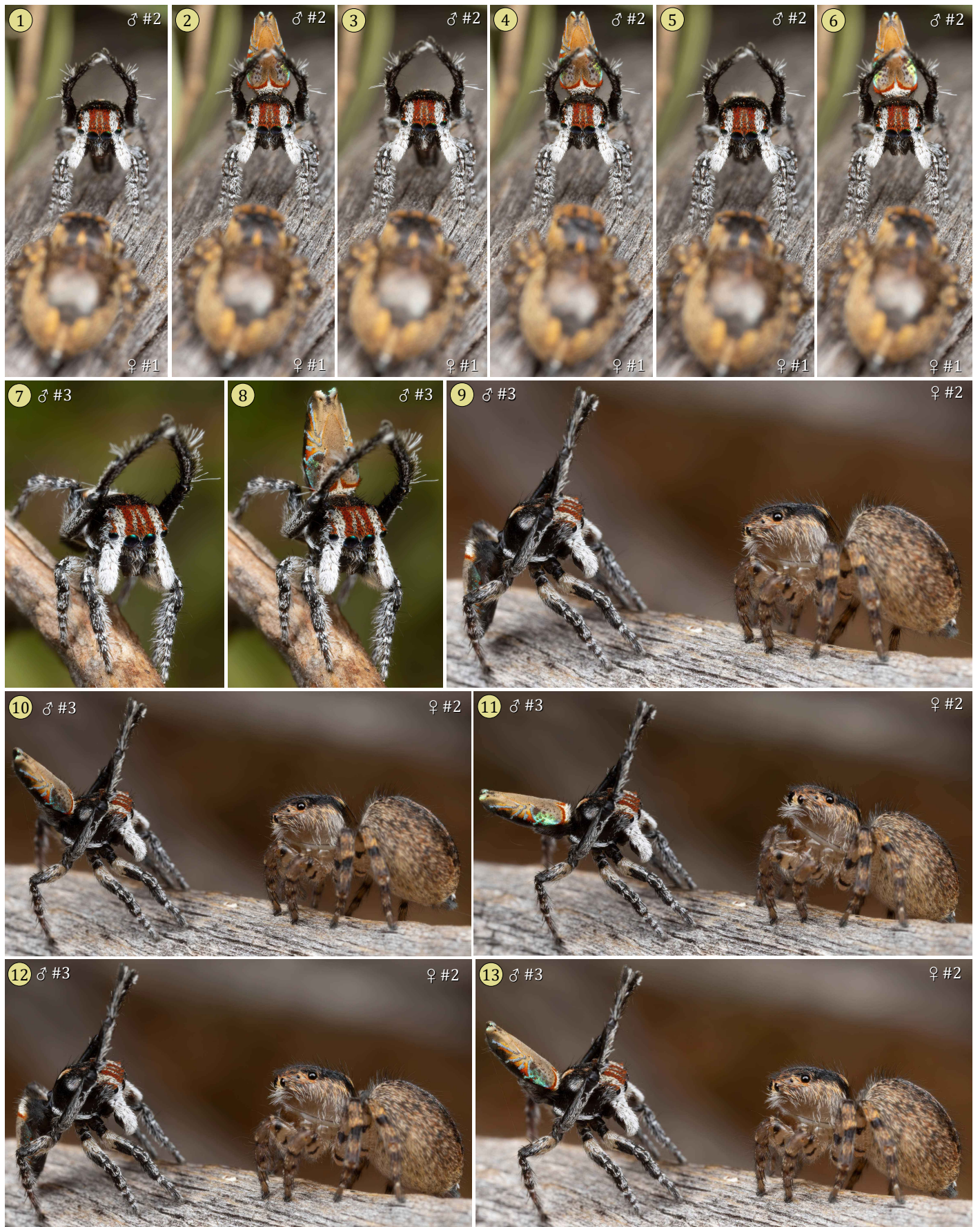


Figure 27. Sequential photographs of three different (1-6, 7-8, 9-13) fan dance displays. 9-13, Note the turns of this female to follow the up and down movements of the male opisthosoma.

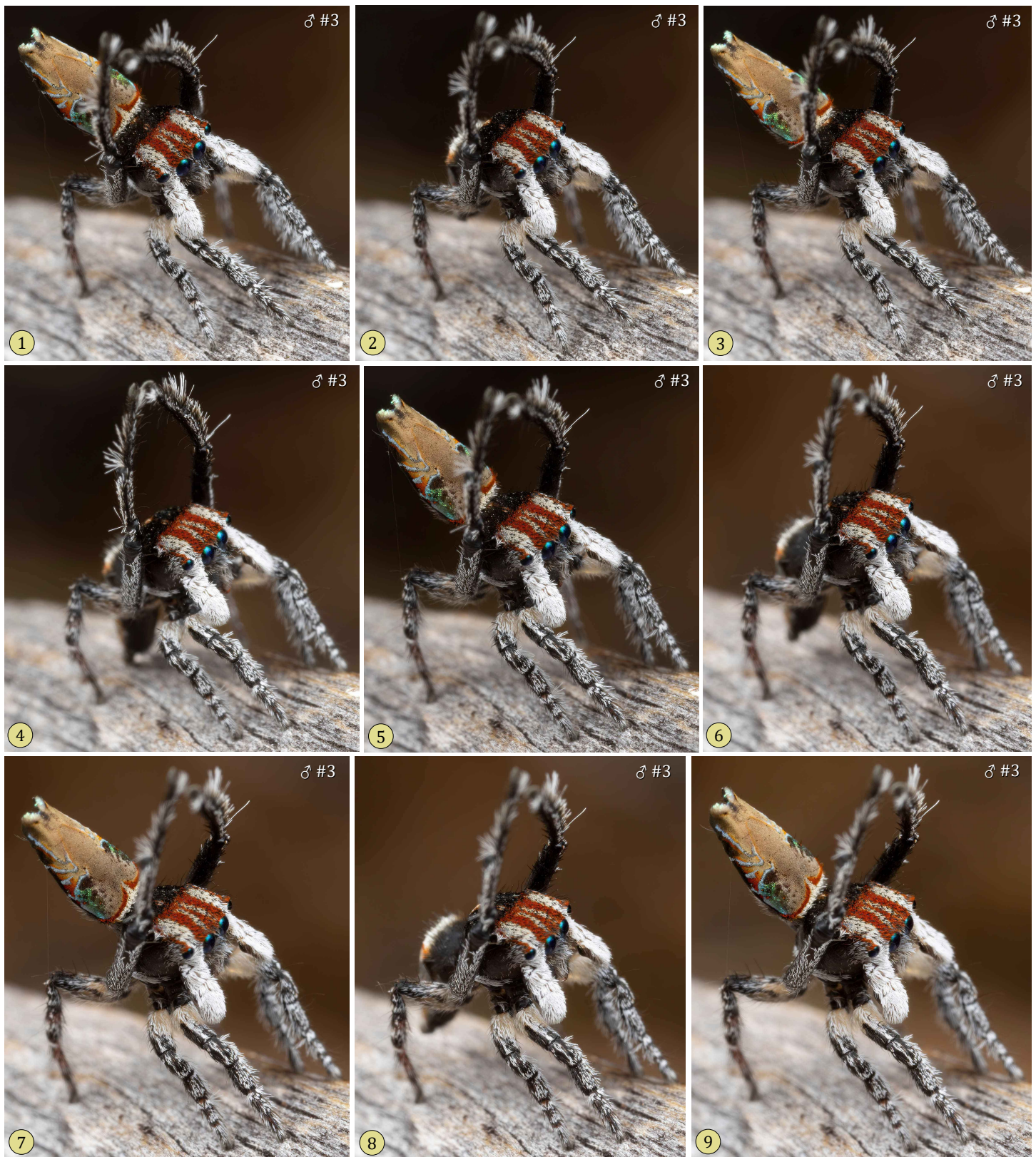


Figure 28. Sequential photographs of a single *fan dance*.

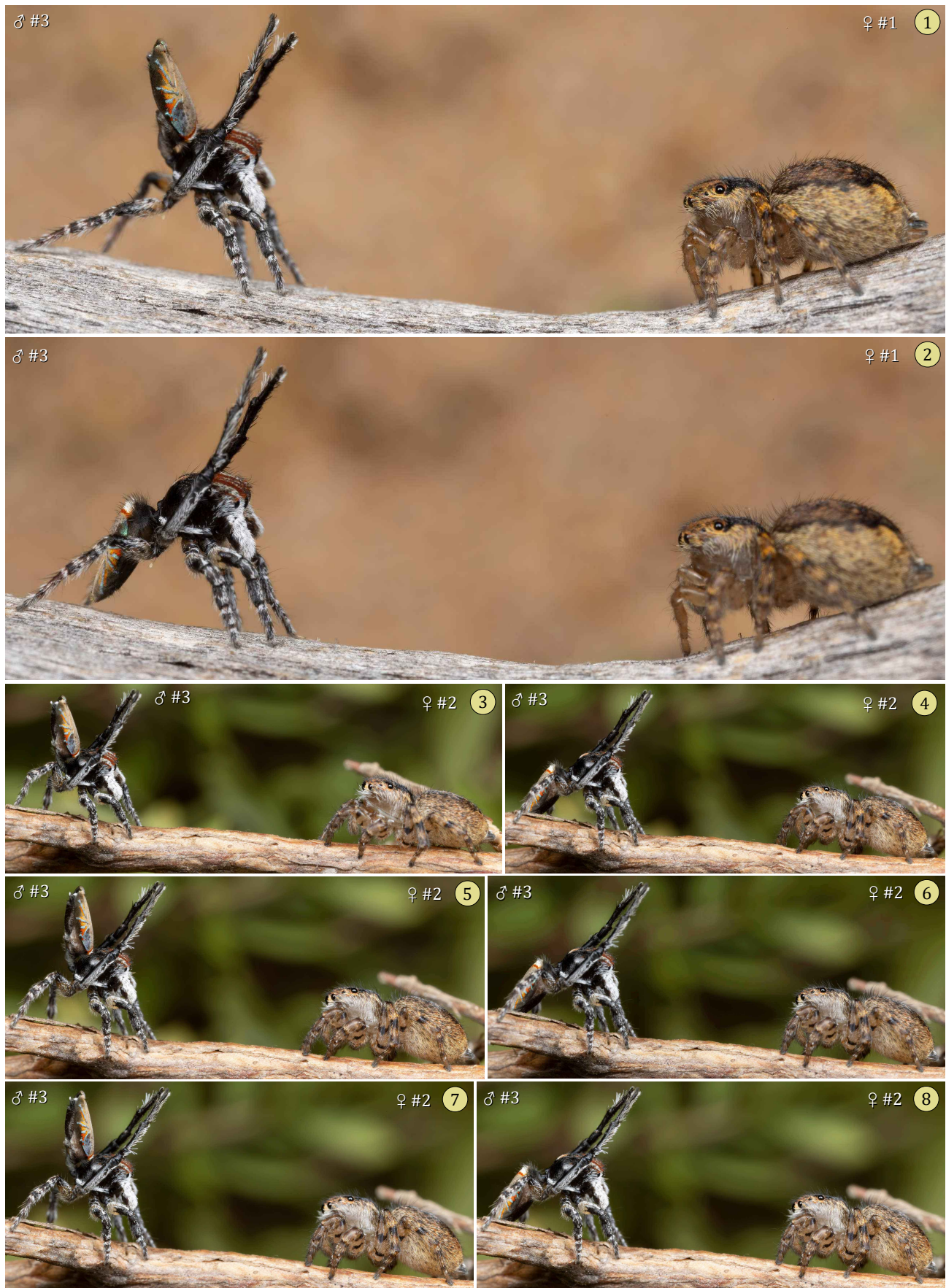


Figure 29. Sequential photographs of two different (1-2, 3-8) *fan dance* displays showing the attending female.

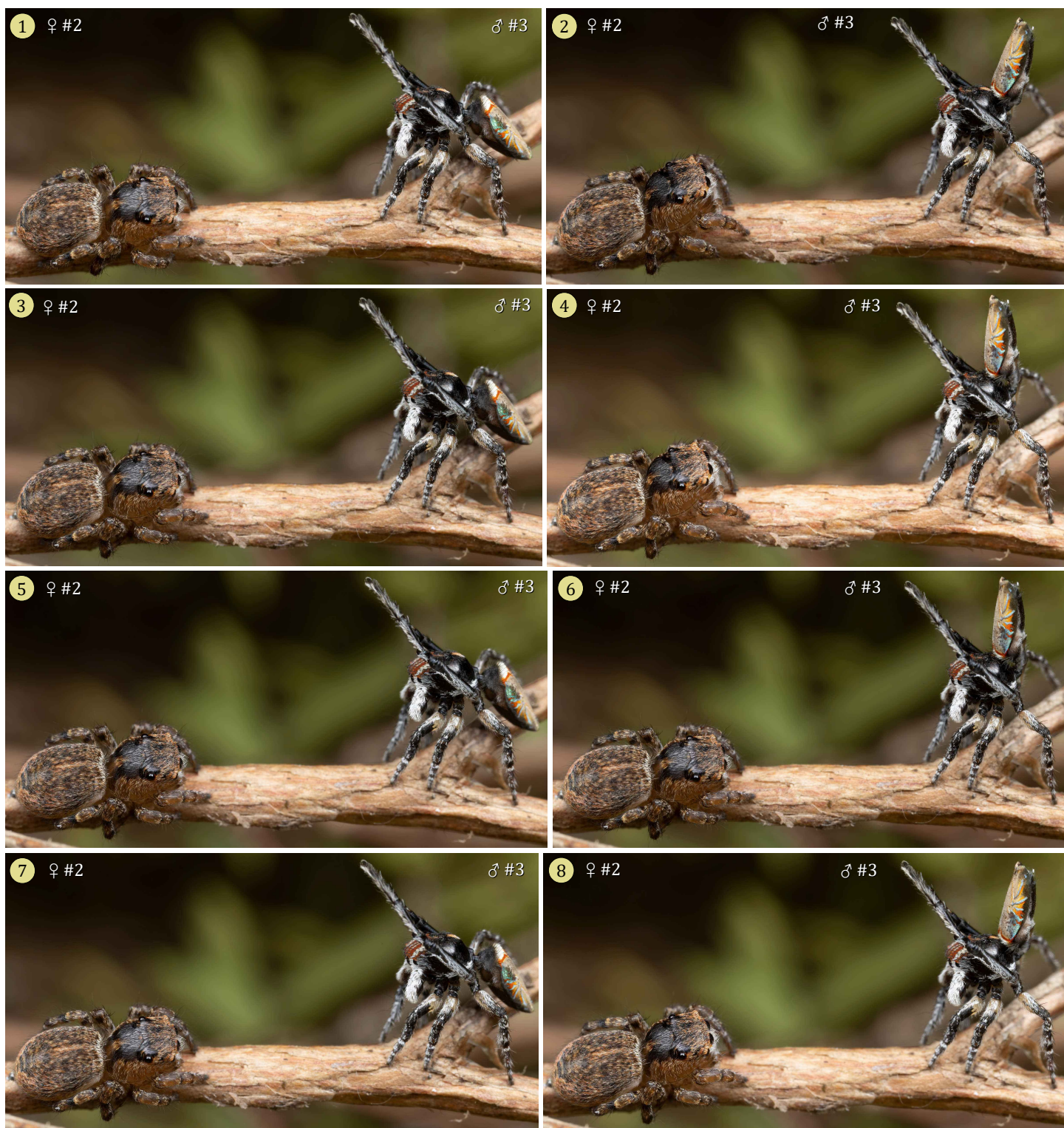


Figure 30. Sequential photographs of a single *fan dance* display showing the attending female.

Habitat. *Maratus candens* was collected from leaf litter in open jarrah (*Eucalyptus marginata*) forest near Jalbarragup in the southwestern corner of Western Australia (Figure 31).



Figure 31. Vegetation and *Maratus candens* in the jarrah forest near Jalbarragup, Western Australia. 6-9, Adult male *M. candens* in the leaf litter. Photographs © Michelle Peak, used with permission.

Acknowledgements

We thank Michelle Peak for sharing her discovery of *Maratus candens* with us and for providing habitat photographs and related information, Ray Walker for facilitating our communication, and both Michelle Peak and Paul Winthrop for collecting the type specimens. We also thank Adam Fletcher for allowing us to include his photographs of *M. felinus*, 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.

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