

Two new peacock spiders in the *vespa* group from Western Australia (Araneae: Salticidae: Euophryini: *Maratus*)

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Abstract: Two new species, *Maratus tortus* and *Maratus unicip*, are described from Western Australia. Both species are placed in the *vespa* group of the genus *Maratus* with *M. cristatus* and *M. vespa*. All four species in this group are endemic to the Southwest Australia Ecoregion. The unique courtship of each new species is described.

Key words: jumping spider, *Maratus cristatus*, *Maratus tortus*, *Maratus unicip*, *Maratus vespa*.

Introduction

Of 68 described species of peacock spiders (*Maratus* Karsch 1878 and *Saratus* Otto & Hill 2017) the courtship display of 65 is known (Otto & Hill 2017a, 2017c, 2018). Four of these species, *M. cristatus* Otto & Hill 2017 (2017b), *M. electricus* Otto & Hill 2017 (2017b), *M. linnaei* Waldock 2008 and *M. vespa* Otto & Hill 2016, all endemics of the Southwest Australia Ecoregion (Figure 1), have a courtship display that differs from other species of *Maratus*. Males of these four species display to females at close proximity, with only several millimeters to separate them. During this display the female is intensely focused on the moving opisthosoma of the male, following its movement with rapid facing turns. The male often moves backwards and the female follows, somewhat reminiscent of a Spanish bullfight. The four species have been assigned to two groups, the *linnaei* group, with *M. electricus* and *M. linnaei*, and the *vespa* group, comprised of *M. cristatus* and *M. vespa*. Here we add two new species, also endemics of the Southwest Australia Ecoregion, to the *vespa* group (Figure 2), bringing the total number of known peacock spider species to 70.

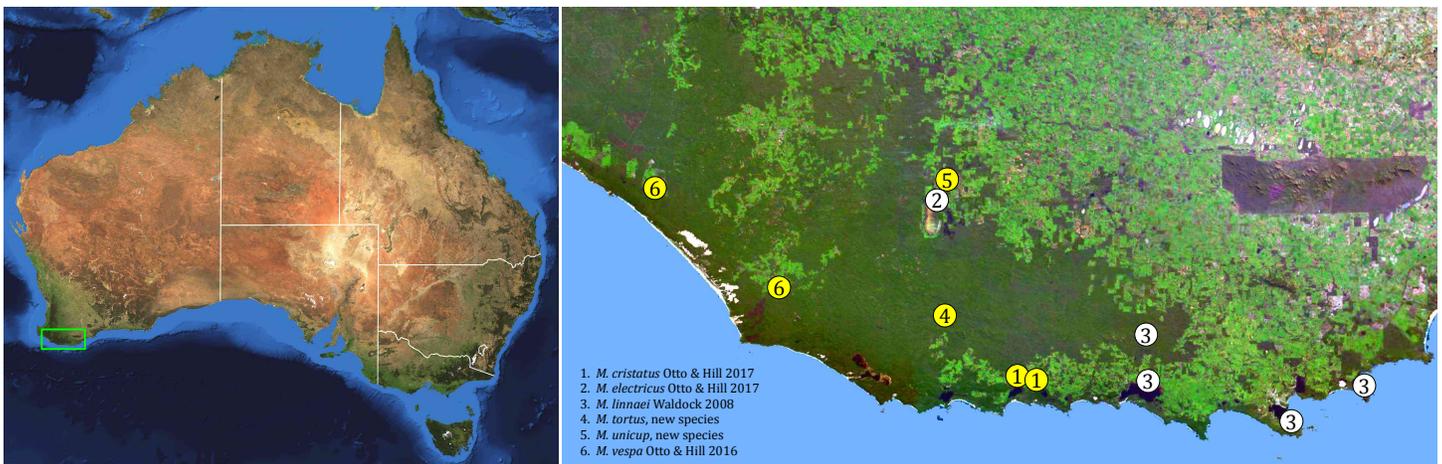


Figure 1. Known distribution of *Maratus* species of the *vespa* group (1, 4-6) and the related *linnaei* group (2-3) in the southwestern corner of Western Australia. Original Blue Marble (left) and Landsat (right) images courtesy of NASA.

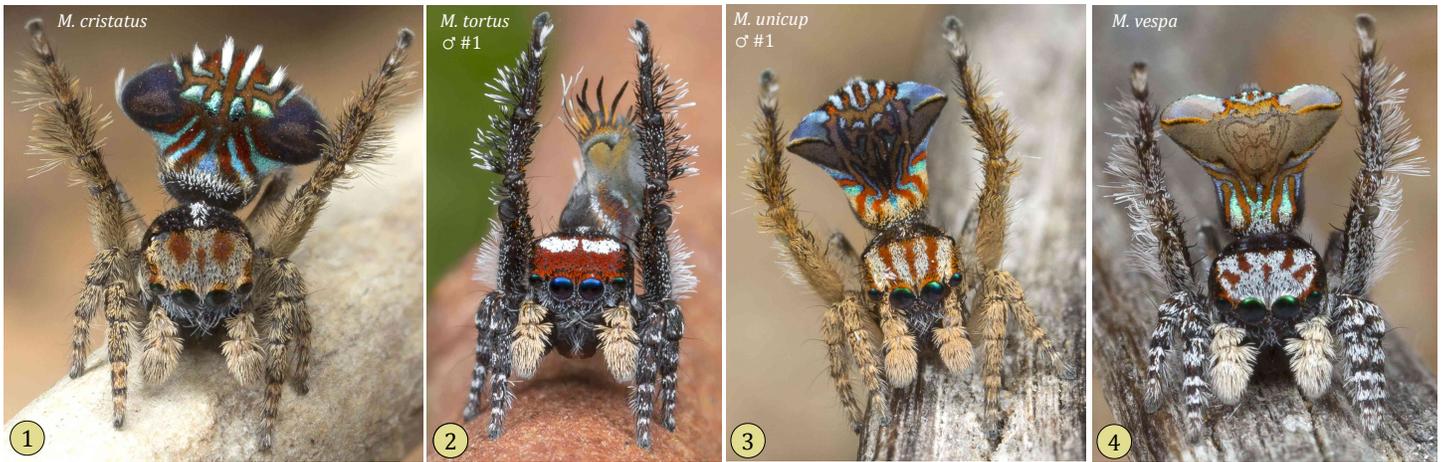


Figure 2. Courtship display by adult males of the *Maratus vespa* group. Although the male of each of these species is quite distinct with respect to ornamentation and courtship display, all move their elevated fan from side to side behind elevated legs III as females approach closely and turn to follow their movements. In this group legs III of males are heavily fringed and relatively uniform in colouration. Although the lateral flaps of each species are displayed when the fan is rotated to either side, only *M. tortus* (2) twists the opisthosoma to display a single lateral flap in a vertical position between legs III.

***Maratus tortus*, new species**

Type specimens. The holotype male (♂ #1), 13 paratype males (♂ #2-14), and 12 paratype females (♀ #1-12) were collected at Mount Frankland National Park (S34° 47.048', E116° 43.201', 12-19 OCT 2017, coll. J. Otto). All females and all males except ♂ #1 and ♂ #2 were collected as immatures and reared to adulthood. All types will be deposited in the Western Australian Museum, Perth.

Etymology. The species group name (*tortus*, Latin, m., adjective, English translation *twisted*) refers to the fact that males twist their elevated opisthosoma to display the elaborate ornamentation of either side (Figure 2:2).

Diagnosis. The male *Maratus tortus* shares the heavily fringed legs III with other species of the *vespa* group (Figure 2) but can be distinguished easily from all known *Maratus* by the very long white-tipped scales on either side of the opisthosoma or the two bright wide patches in the eye region on a background of dull red scales. Females of *M. tortus* however are very similar to other females in the *vespa* group and identification is problematic in the absence of males. The external structure of the female and male genitalia is of little or no use for distinguishing *M. tortus* from its relatives in the *vespa* group or other species endemic to the southwestern Australia, such as those in the *flavus*, *linnaei*, and *mungaich* groups (Otto & Hill 2014, 2016, 2017b, 2017c, 2018).

Description of male (Figures 3-6). Adult males were 3.3-4.1 mm in length (n=15). Chelicerae are black, with off-white setae near the midline. The carapace and articulating cuticle below this is black. The anterior eyes are bordered above by dull red scales, of the same colour as those that cover the anterior eye region. Below this the AME are bordered with light blue scales, and many off-white setae project forward from the face on either side of and below the AME. A broad arc of bright white scales covers most of the posterior eye region, curving forward at the midline where it is divided by a thin line of dull red scales. Dull red scales extend along the lateral margins of the eye region to surround the posterior eyes. Behind each PLE a patch of white scales may be present. The rest of the carapace, sloping steeply at the rear, is black and glabrous except for a median thoracic tract behind the eye region and a well-defined marginal band, both comprised of white scales. The PME are closer to the PLE than to the ALE.



Figure 3 (continued on next page). Living male types for *Maratus tortus*. **4**, Males are quite dark in general, but are boldly marked with bright white scales against a background of dull red scales across the eye region, and the light brown or yellow-brown setae of the pedipalps. **6-8, 12-13, 19-21, 25-27**, Very large, elongated and flattened scales (plumes) extend from each lateral flap of the dorsal opisthosomal plate.



Figure 3 (continued from previous page, continued on next page). Living male types for *Maratus tortus*.



Figure 3 (continued from previous page, continued on next page). Living male types for *Maratus tortus*.



Figure 3 (continued from previous page). Living male types for *Maratus tortus*.

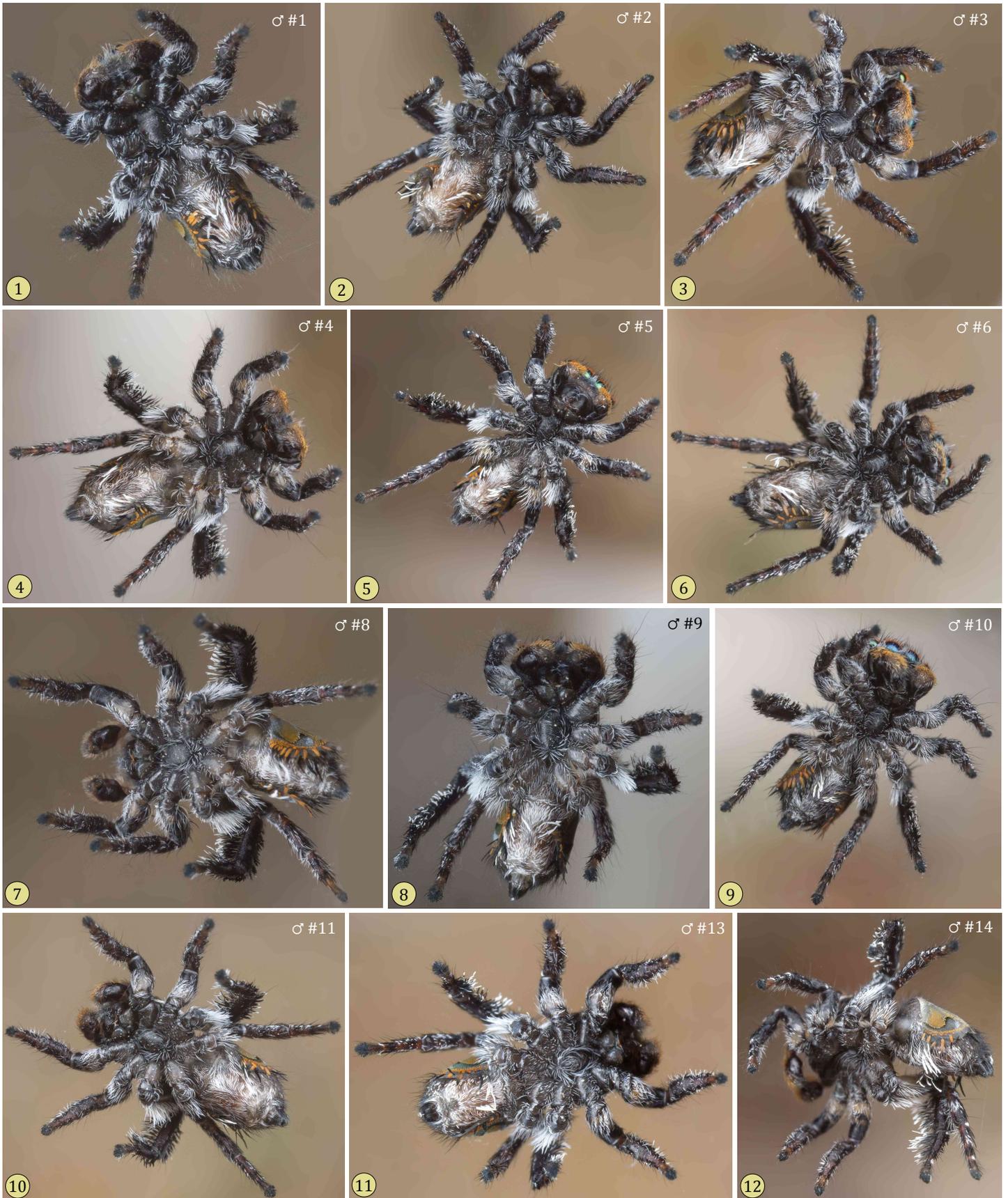


Figure 4. Living male types for *Maratus tortus*, ventral view. The venter of males is nearly black, except for the light brown to grey underside of the opisthosoma.

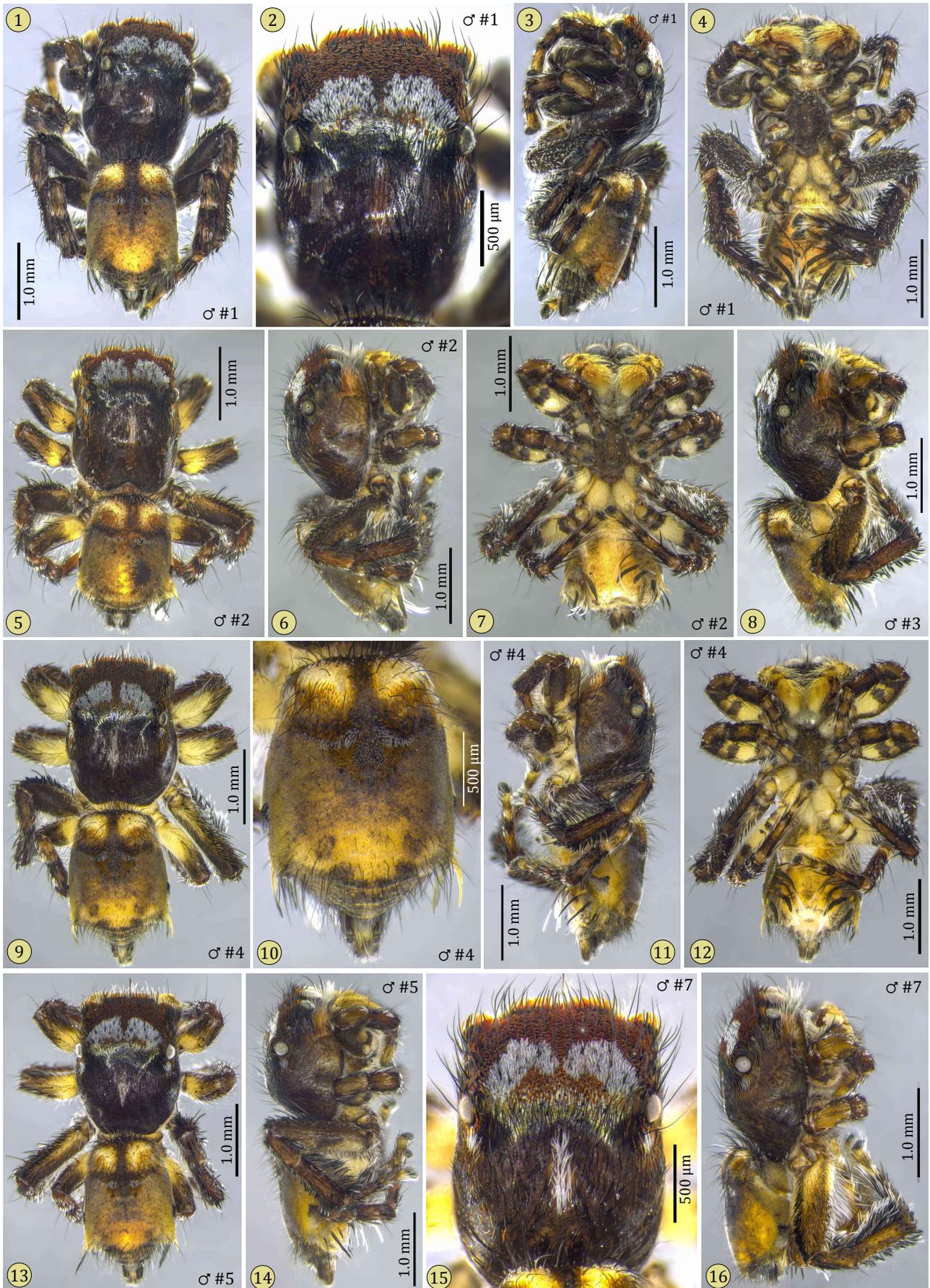


Figure 5 (continued on next page). Male type specimens for *Maratus tortus* in alcohol.



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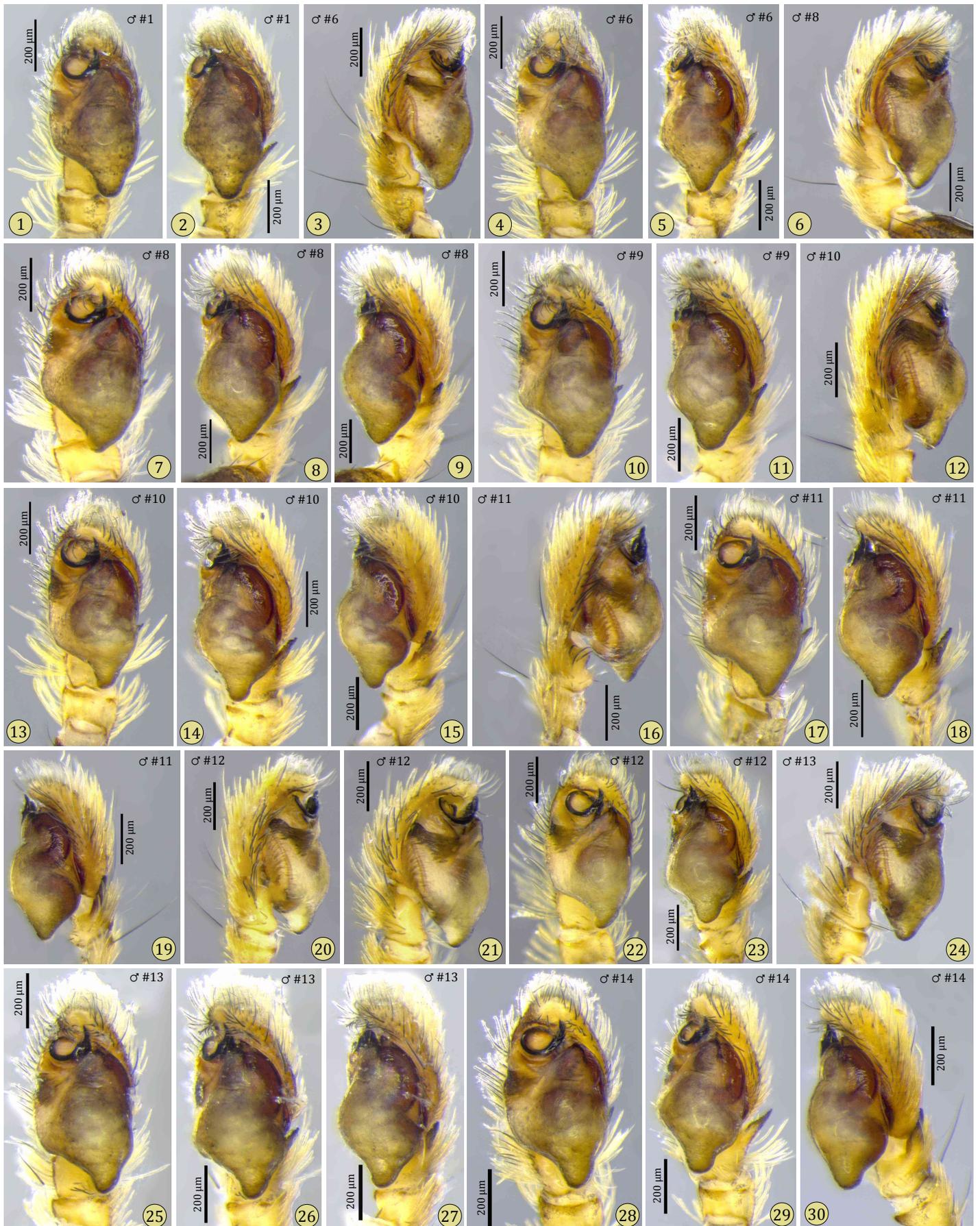


Figure 6. Medial to lateral views of the left pedipalp of male *Maratus tortus* types in alcohol.

The dorsal opisthosomal plate is covered with a distinct pattern of mostly grey scales, anteriorly with a pair of bright white scale patches and bordered to the rear with dull red scales, mirroring the colour scheme of the eye region. Areas of dull red scales are interrupted by two narrow transverse white bands that in some individuals fuse to form a single interrupted band. Lateral flaps are rounded, with large orange and long black marginal scales with white tips (Figure 3). The flaps are normally folded along the sides of the opisthosoma and extended only during courtship. Behind the dorsal plate the opisthosoma is grey-black and there is a small triangular patch of white setae just above the grey-black spinnerets. The ventral opisthosoma is light brown to grey, yellow in alcohol, with an incomplete cover of off-white setae.

The underside of all leg and pedipalp segments, the sternum, and labium are mostly black or grey-black. Each of the legs has a fringe of off-white setae below the femur. Legs I and II are shorter and about the same length. Legs III and IV are longer, with legs III by far the longest. Legs I, II and IV are black to grey-black with segmental bands (rings of white setae). Legs III are black or grey-black with a prominent fringe of long white setae below the femur, and a prominent fringe of long black, tipped with white, setae under the tibia and metatarsus (Figures 2:2, 19). Each tarsus III bears two small tufts of bright white setae, with the distal white tuft extending over the grey tenent setae of the foot pad. In details of shape and structure the pedipalp (Figure 6) is virtually identical with that of *M. unicum* and other members of the *vespa* group, with a pointed inner apex of the embolus tightly positioned beneath (in lateral perspective) the heavier outer apex. The outer apex bears a single projection or serration proximal to its pointed tip. The dorsal pedipalp has a dense cover of uniform light brown or yellow-brown setae.

Description of female (Figures 7-10). Adult females were 4.1-5.5 mm in length (n=12). The chelicerae, carapace, and the flexible cuticle below the carapace are light brown and translucent. The chelicerae are mostly glabrous with scattered off-white setae. The clypeus is covered incompletely with off-white setae, which also surround the lower part of the anterior eyes. Above, the anterior eyes are bounded by a mixture of red-brown and off-white setae that cover most of the eye region, and surround the PME and PLE. The PME are closer to the PLE than to the ALE. To the rear of the eye region the carapace is mostly black, with a distinct or indistinct, narrow median thoracic stripe of red-brown scales, and otherwise glabrous at the rear where it slopes steeply. On the sides the carapace has an incomplete cover of off-white setae, but is mostly glabrous along the anterolateral margins. The carapace has no marginal band.

The dorsal opisthosoma is dark brown to black with an incomplete cover of mixed off-white and red-brown setae. One or three small spots comprised of off-white setae may be seen at the center of the dorsum. A more-or-less distinct pattern of alternating black and brown chevrons may be visible toward the rear (Figure 7:18,26,33). The dorsum is bordered by a dark, irregular line on either side, and below this a broad band of off-white setae on light brown cuticle extends on either side to the venter. Above the spinnerets a small triangle comprised of bright white scales is present. The spinnerets are grey to light brown. Below, the opisthosoma is light brown or off-white with variable or indistinctly linear grey markings. The coxae and endites are light brown to grey, translucent, and mostly glabrous. The sternum is dark brown with scattered off-white setae around the rear margin. Pedipalps are light brown or brown and translucent with an incomplete cover of off-white setae.

Legs I and II are shorter and of the same length. Legs III and IV are longer and almost the same length. All legs are mostly dark brown, with distinct or indistinct segmental bands comprised of white setae. As in the males, there is a fringe of off-white setae below each femur. The epigynum (Figure 10) resembles that of other *Maratus*, with a septum of variable width and fossae (windows) of variable diameter ranging from half the diameter to nearly the same diameter as the large posterior spermathecae. Variably sclerotized and variably configured ducts may be seen through the posterior half of each fossa.



Figure 7 (continued on next page). Living female types for *Maratus tortus*.



Figure 7 (continued from previous page, continued on next page). Living female types for *Maratus tortus*.



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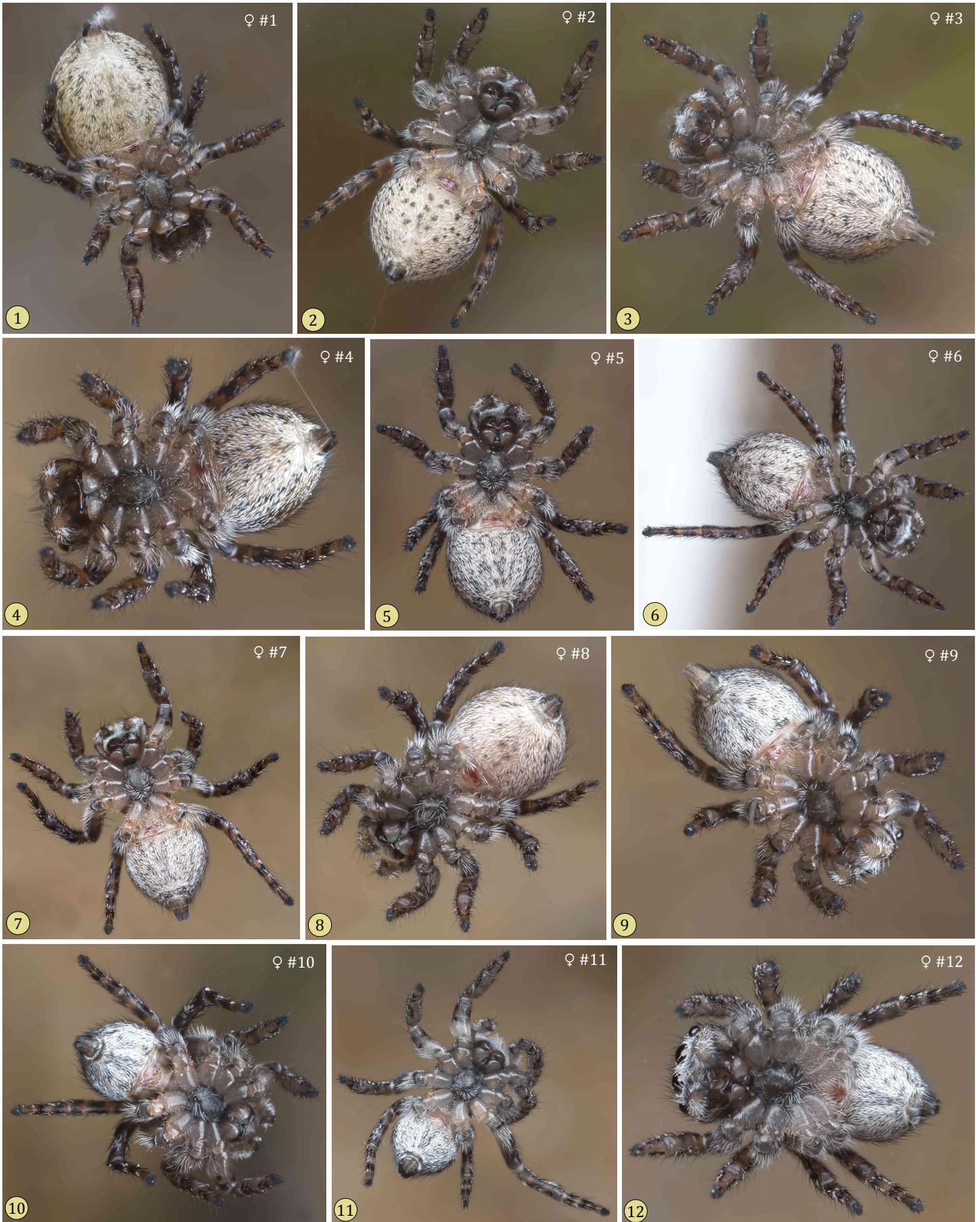


Figure 8. Ventral view of living female types for *Maratus tortus*.

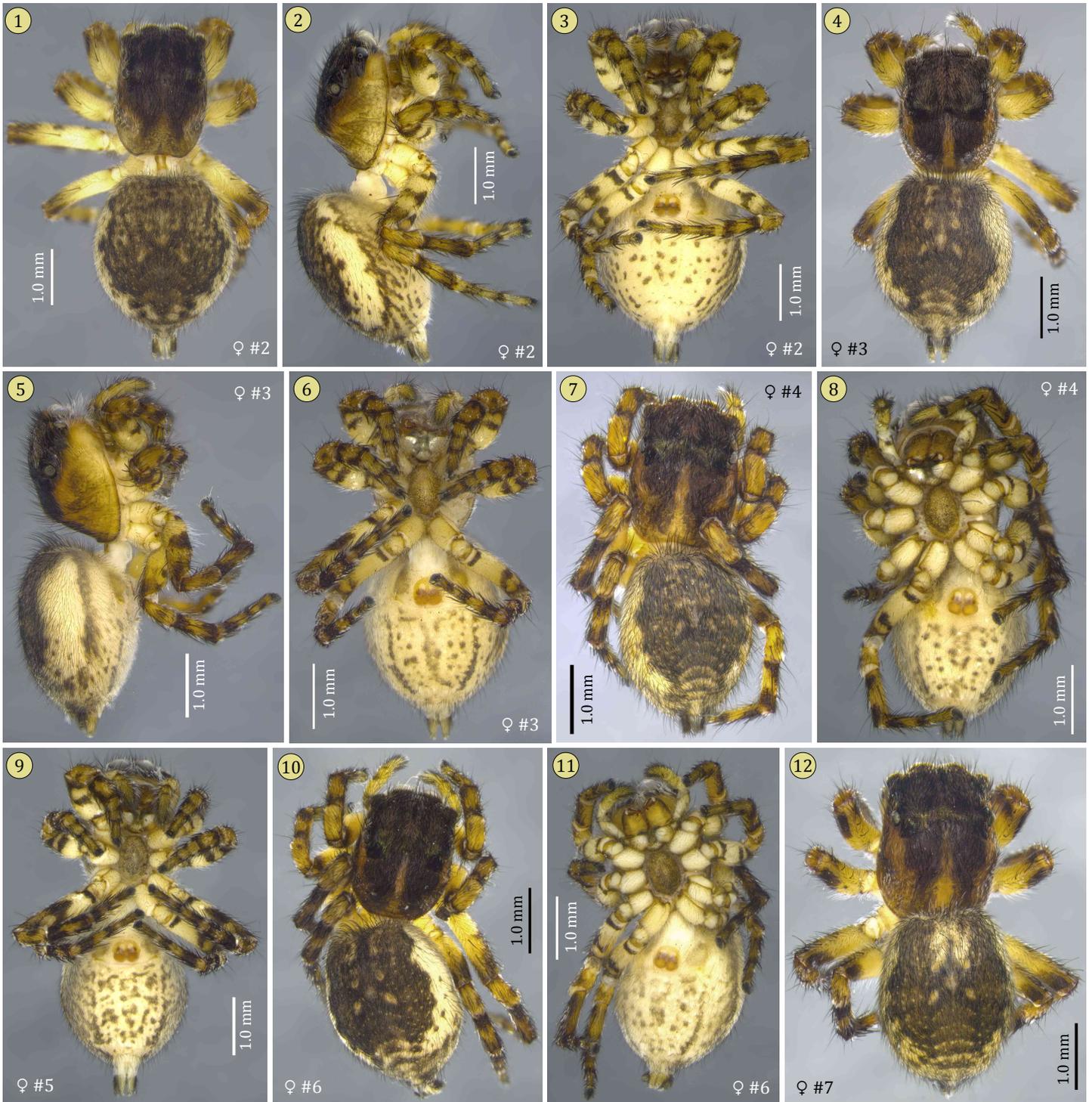


Figure 9 (continued on next page). Female type specimens for *Maratus tortus* in alcohol.

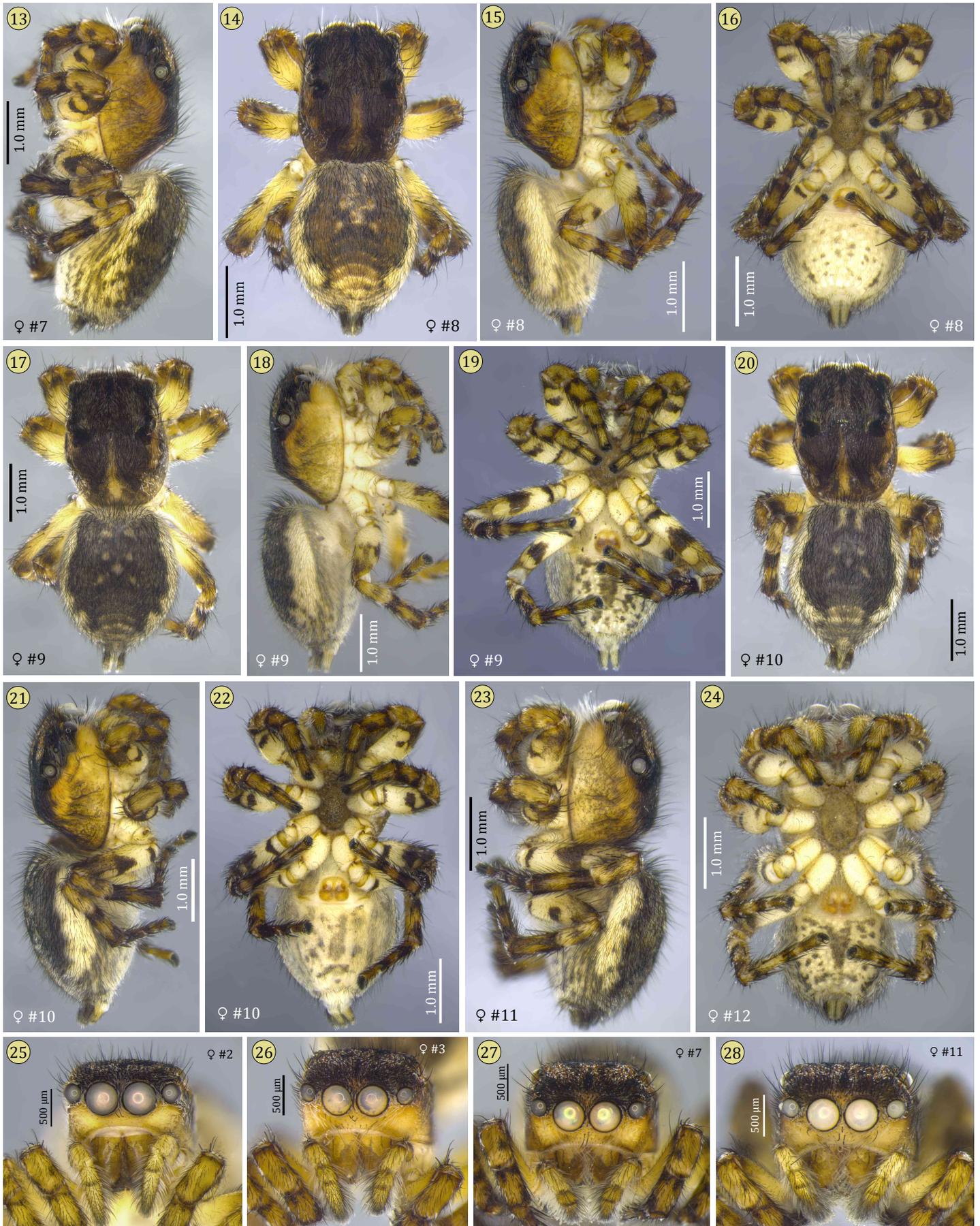


Figure 9 (continued from previous page). Female type specimens for *Maratus tortus* in alcohol.

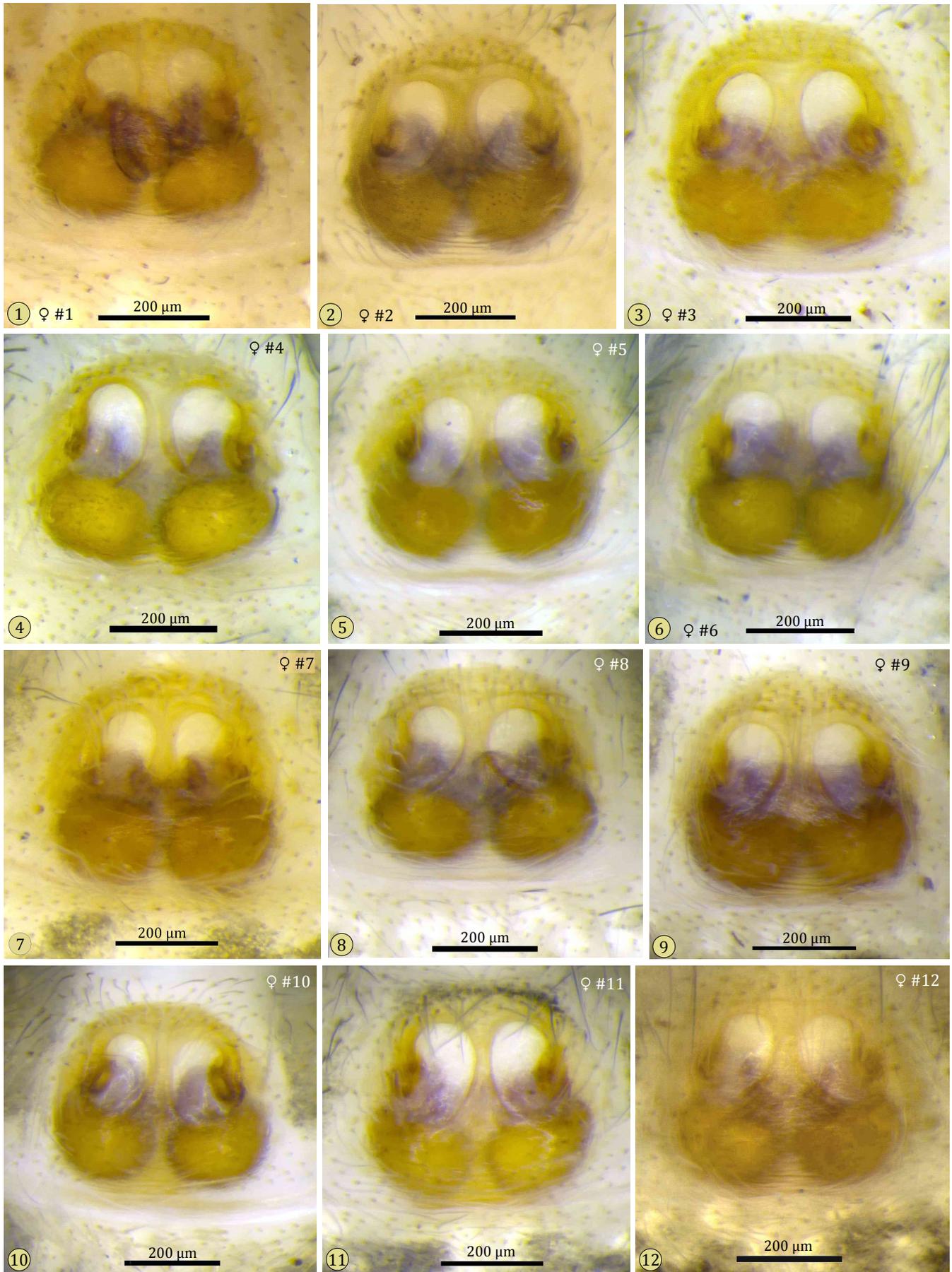


Figure 10. Epigyna of female type specimens for *Maratus tortus* in alcohol.

Immatures. Penultimate males (Figure 11) resemble females but are more boldly patterned, with distinct transverse stripes across the dorsal opisthosoma. Penultimate females (Figure 12) look much the same as adult females.



Figure 11. Living penultimate male *Maratus tortus*, identified by the adult specimen number in each case.



Figure 12. Living penultimate female *Maratus tortus*, identified by the adult specimen number in each case.

Courtship display (Figures 13-25). Observations of courtship behaviour are based on video recordings of males and females placed together in the laboratory, in a naturalistic setting. Otto (2018b) has posted an online video of this display. We have observed six different displays by courting male *Maratus tortus* (Table 1). The first of these (*unilateral leg wave*, Figure 13) may be performed when no female is in sight to elicit movement by a female in the vicinity, thus revealing her presence to the male. In this display one leg III extended laterally was moved up and down (~1-2 cycles/s) through about 10° of arc. Each downward movement took about 0.3s, followed by quicker upward movement (0.1-0.2s).

The *bilateral leg wave* display (Figure 14) involves maximum movement by the male at a moderate distance (several body lengths) from the female. This is usually performed after a series of fan movements and it always precedes mating. It may represent an invitation to mate. In this display both legs III were raised and lowered continuously and rapidly (~3 cycles/s), with a rapid step to one side or the other each time that the legs were raised. Two bilaterally symmetric *semaphore* displays of the extended legs III (*wide semaphore*, Figure 15, and *tall semaphore*, Figure 16) were also observed, differing primarily in the elevation of legs III. In these displays legs III were held in position and moved slightly, either together or alternately, through a low amplitude (<5°) arc. As in other displays by *M. tortus*, the yellow-brown pedipalps were held to either side during each semaphore display to expose the black chelicerae. These semaphore displays also apparently served to elicit the attention of a nearby female.

Males displayed their fan to females in one of two modes. In the first mode (*vertical fan twist*, Figures 17-18) the male displayed the extended flap of one side of the erect fan behind extended legs III, periodically twisting the fan to display the extended flap of the other side in the same position. In the second mode (*fan dance*, Figures 19-25) display of one lateral flap in a vertical position between and behind the raised and extended legs III (for ~5-30s) alternated with side-to-side waving and twisting of the fan (for ~1-3s). When displayed in the vertical position the fan was waved or vibrated in a low amplitude (~1-3°) arc. Each cycle of waving and twisting of the fan involved four successive positions. A cycle that began with display of the left flap above the spider (UL) would include the following stages in this order: left flap above the spider (UL), left flap exposed at the left side of the spider (LS), right flap above the spider (UR), and right flap exposed on the right side (RS). Each waving and twisting bout (~1-3s) involved a variable number of cycles, counted in half-integers. For example, beginning in the UL position, the male might complete 2.5 cycles of waving and twisting, resulting in a display in the UR position of the flap of the opposited side. Most often fractional cycle counts per bout (0.5, 1.5, 2.5 cycles) were observed, but whole number cycle counts per bout were also seen (2.0, 3.0 cycles). The *fan dance* is the primary display of *M. tortus* that is watched closely and apparently evaluated by females that approach to a distance of only a few millimeters, turning to follow every movement of the male as he waves and twists his fan. A bout of waving and twisting by the male may also be elicited by turns of a female to face away from that male.

Table 1. Display repertoire of the adult male *Maratus tortus*.

display	hypothetical function	description of behaviour	Figures
unilateral leg wave	elicit movement allowing male to detect female	alternately raise and lower single leg I extended to the side (~2 cycles/s, ~10° of arc)	13
bilateral leg wave	invitation to mate or to follow male to a mating position	continuously lower and then raise extended legs III to a vertical position, stepping quickly to one side or the other each time that the legs are raised (~3 cycles/s)	14
wide semaphore	elicit facing turn by nearby female	hold symmetrically extended legs III apart at a wide angle (~90°) and raise and then lower one leg (or sometimes both legs) through a low amplitude (<5°) angle	15
tall semaphore	elicit facing turn by nearby female	hold both extended legs III in a near-vertical position and raise or lower one or both legs through a low amplitude (<5°) arc	16, 18
vertical fan twist	elicit facing turn by <i>coy</i> female that has turned away (regain attention)	extend and display flap of one side, then twist the fan to display the flap of the other behind extended legs III held in a near-vertical position.	17-18
fan dance	impress and keep attending female engaged to secure acceptance	display flap of one side in a vertical position then wave/twist fan from one side to the other for a variable number of cycles before once again displaying the flap of one side in a vertical position behind the near-vertical legs III	19-25

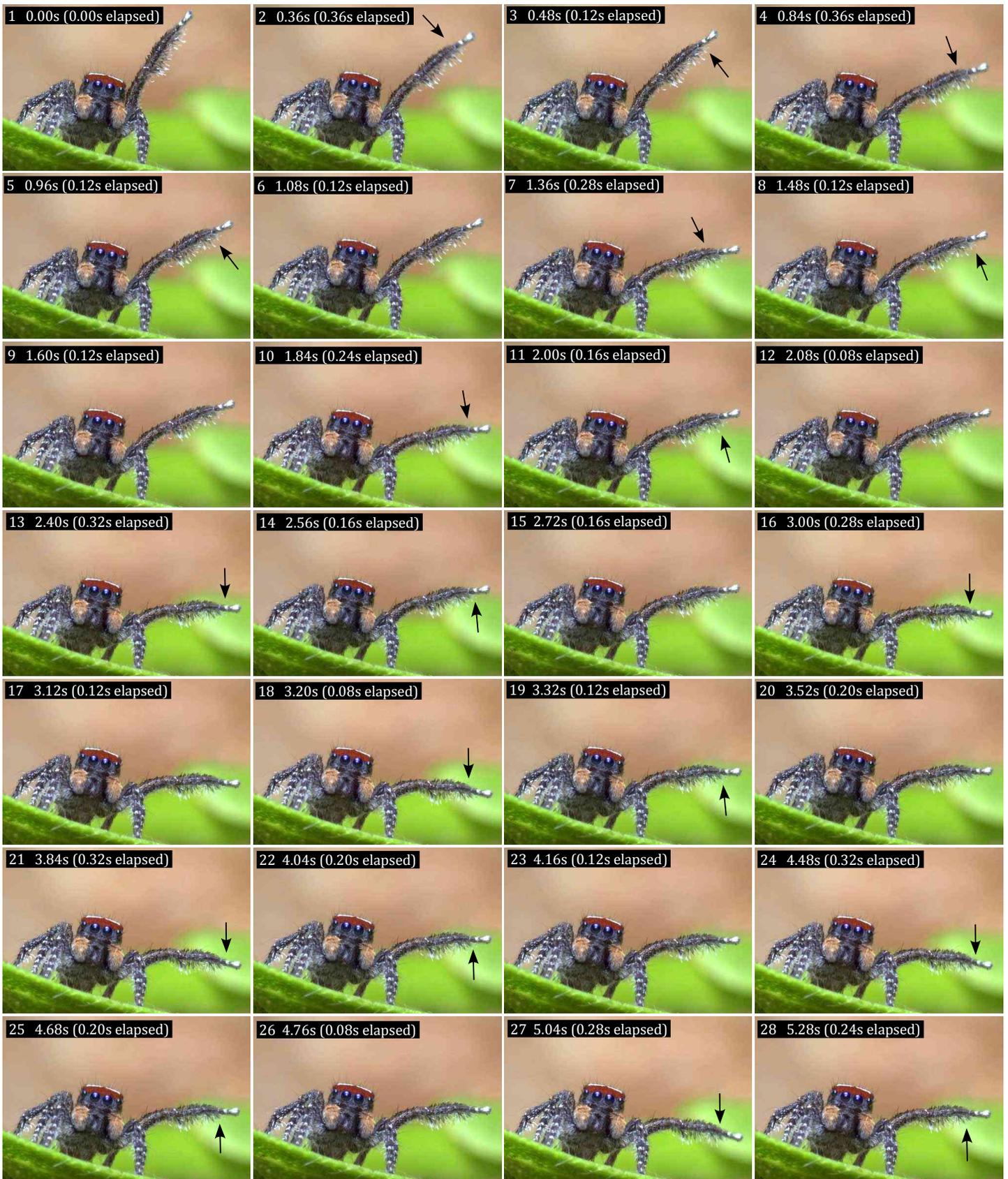


Figure 13. Selected sequential frames from a 25fps video of a male *Maratus tortus* waving one extended leg III (*unilateral leg wave*). Elapsed time indicates the duration of leg movement between successive frames. Amplitude and speed of leg movement in this display was moderate ($\sim 10^\circ$ of arc highlighted with arrows, ~ 2 up+down cycles/s). This display may serve to elicit movement of a female in the vicinity that may not have been seen by the male.

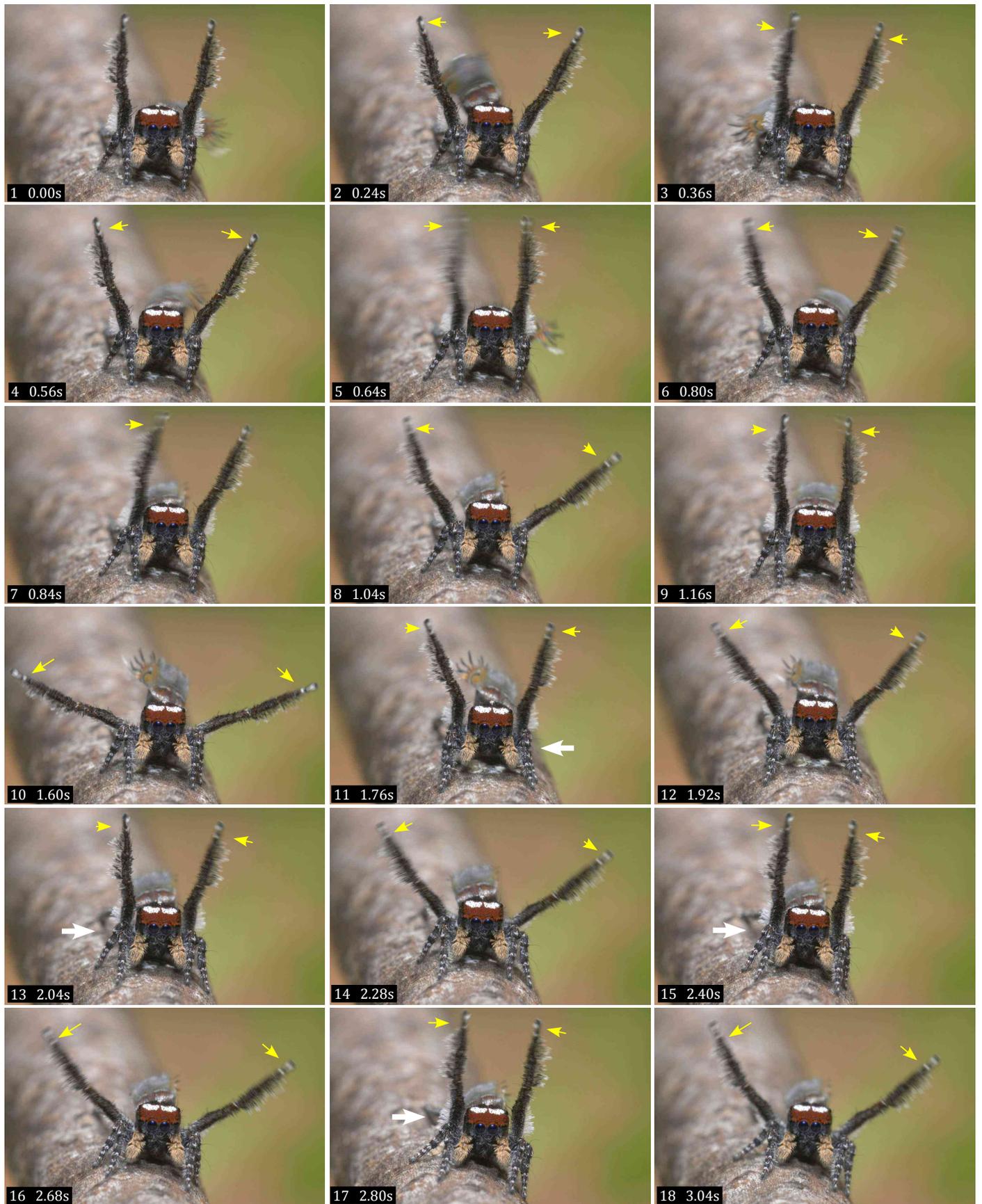


Figure 14. Sequential frames (from 25fps video) showing successive positions during the *bilateral leg wave* display of a male *Maratus tortus*. Legs III were moved up and down continuously through a relatively large amplitude ($\sim 30\text{-}60^\circ$ of arc highlighted by arrows, ~ 3 cycles/s). Each time that this male raised his legs he stepped quickly to one side (large arrows).

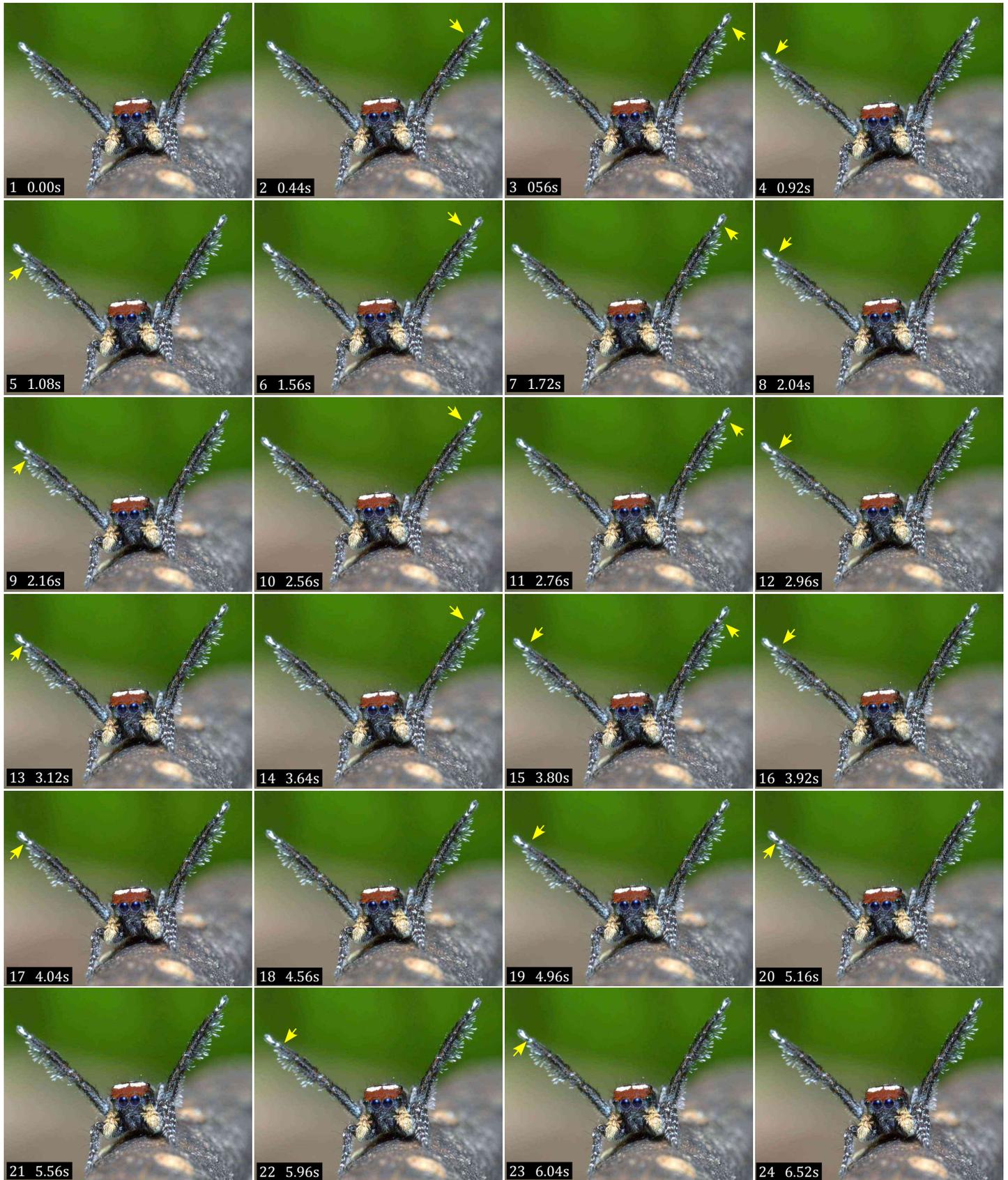


Figure 15. Sequential frames from a 25fps video of a *wide semaphore* display by a male *Maratus tortus*. In this display legs III were held apart (80-90° separation) and legs were alternately (and asynchronously) moved up or down through a small amplitude. Slight leg movement relative to each preceding frame is indicated with arrows. The subtle movement associated with this display contrasts with the much greater movement associated with the *bilateral leg wave* display (Figure 14).

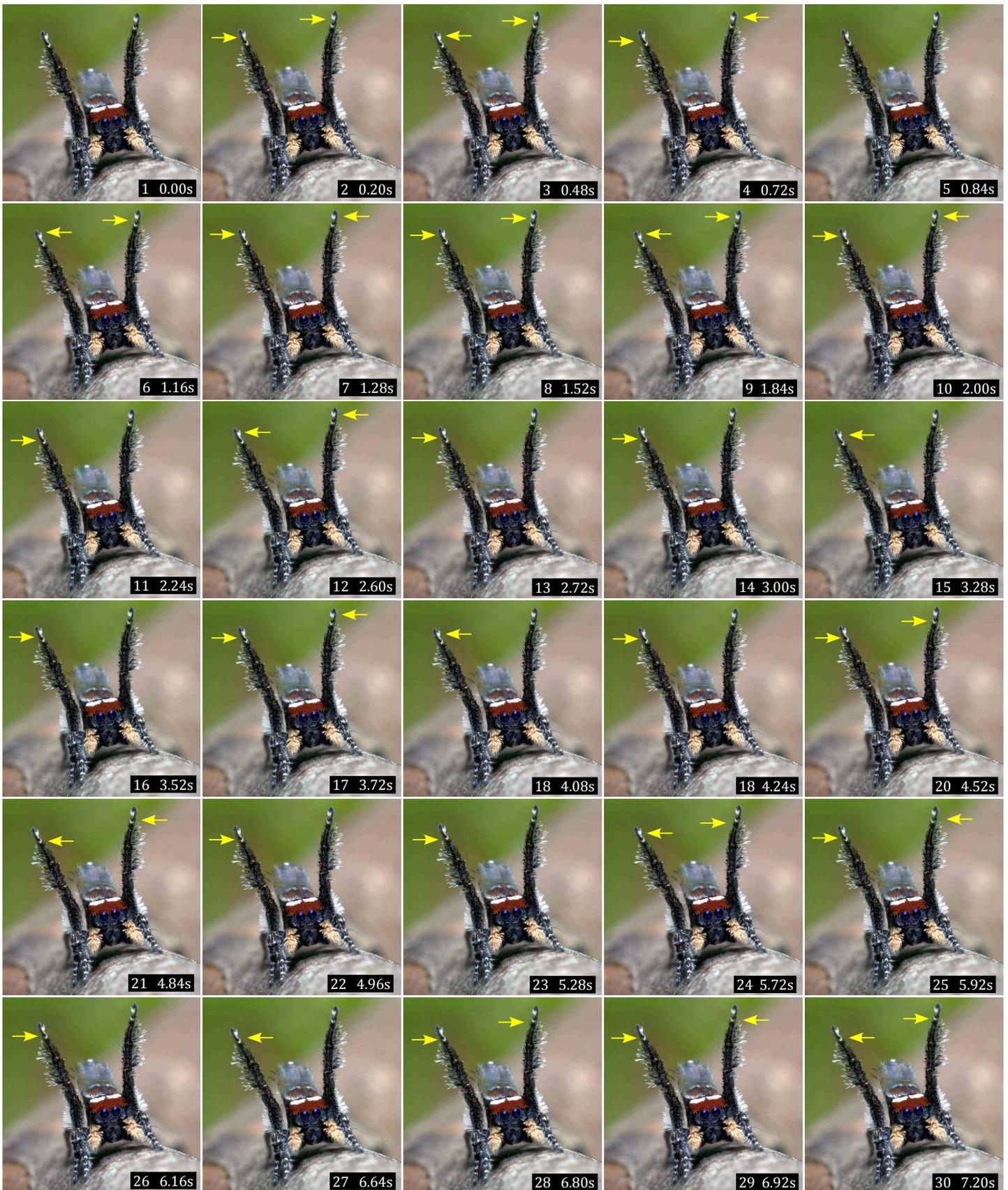


Figure 16. Sequential frames from a 25fps video showing the *tall semaphore* display of a male *Maratus tortus*. This display differed from the *wide semaphore* display only with respect to the near vertical position of legs III as they were moved slightly from side to side. If the female became attentive this display was followed by a series of fan twists. Arrows identify movement of legs III relative to the preceding frame.

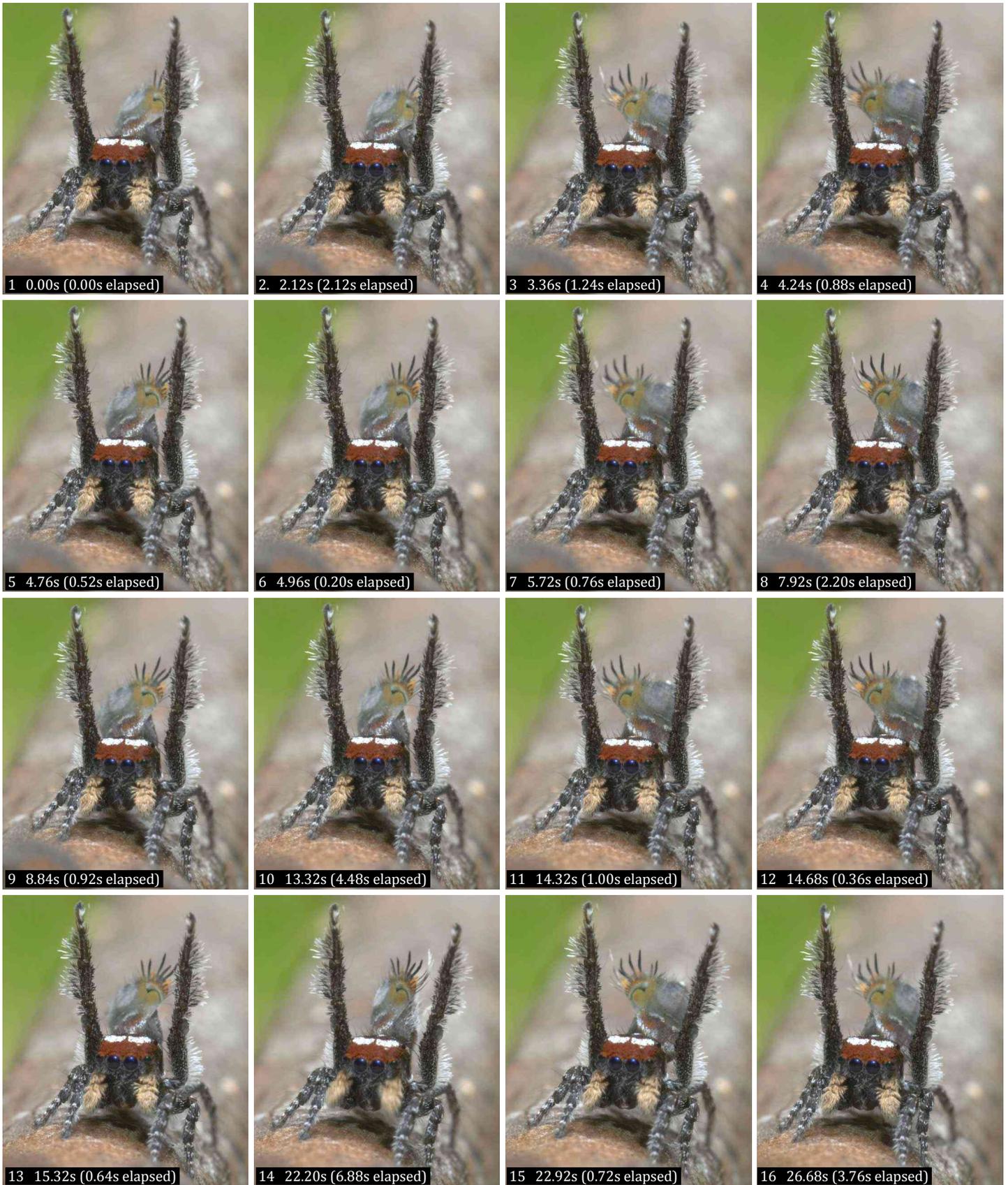


Figure 17. Sequential frames from a 25fps video showing 3.5 cycles of *vertical fan twist* display by a male *Maratus tortus*. In this display the prominent setae associated with the extended fan alternately displayed on the left side (UL) and the right side (UR) of the vertical opisthosoma at a relatively slow rate of ~ 0.13 cycles/s. This may represent an abbreviated form of the complete *fan dance*. The flap of the side that was not displayed was retracted (folded around the side of the opisthosoma).

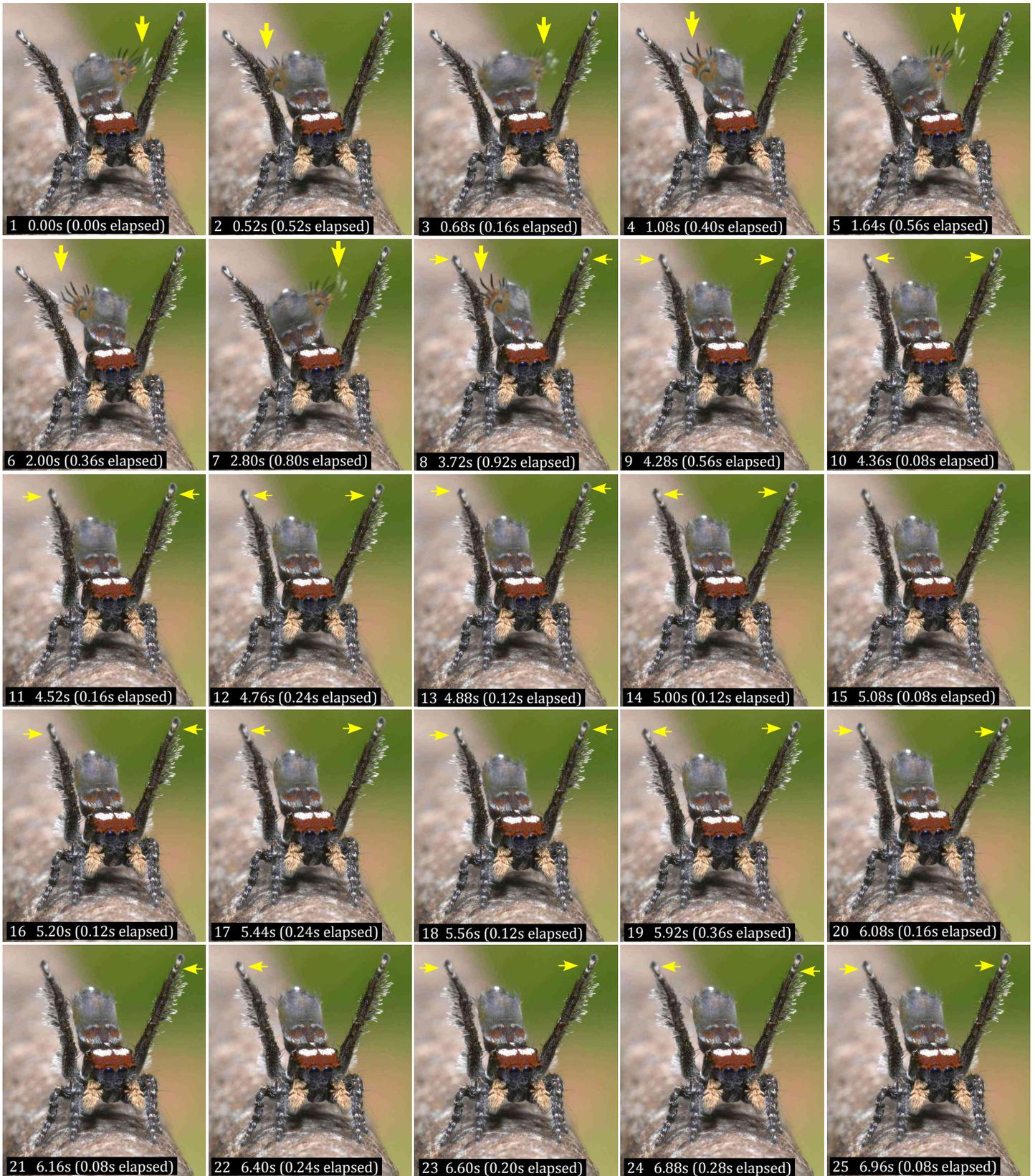


Figure 18. Sequential frames from a 25fps video of a male *Maratus tortus* showing 3.5 cycles of a faster vertical fan twist display (frames 1-8, 3.5 cycles, 0.94 cycles/s), followed by a tall semaphore display (frames 9-25) with the fan elevated and the flaps retracted.

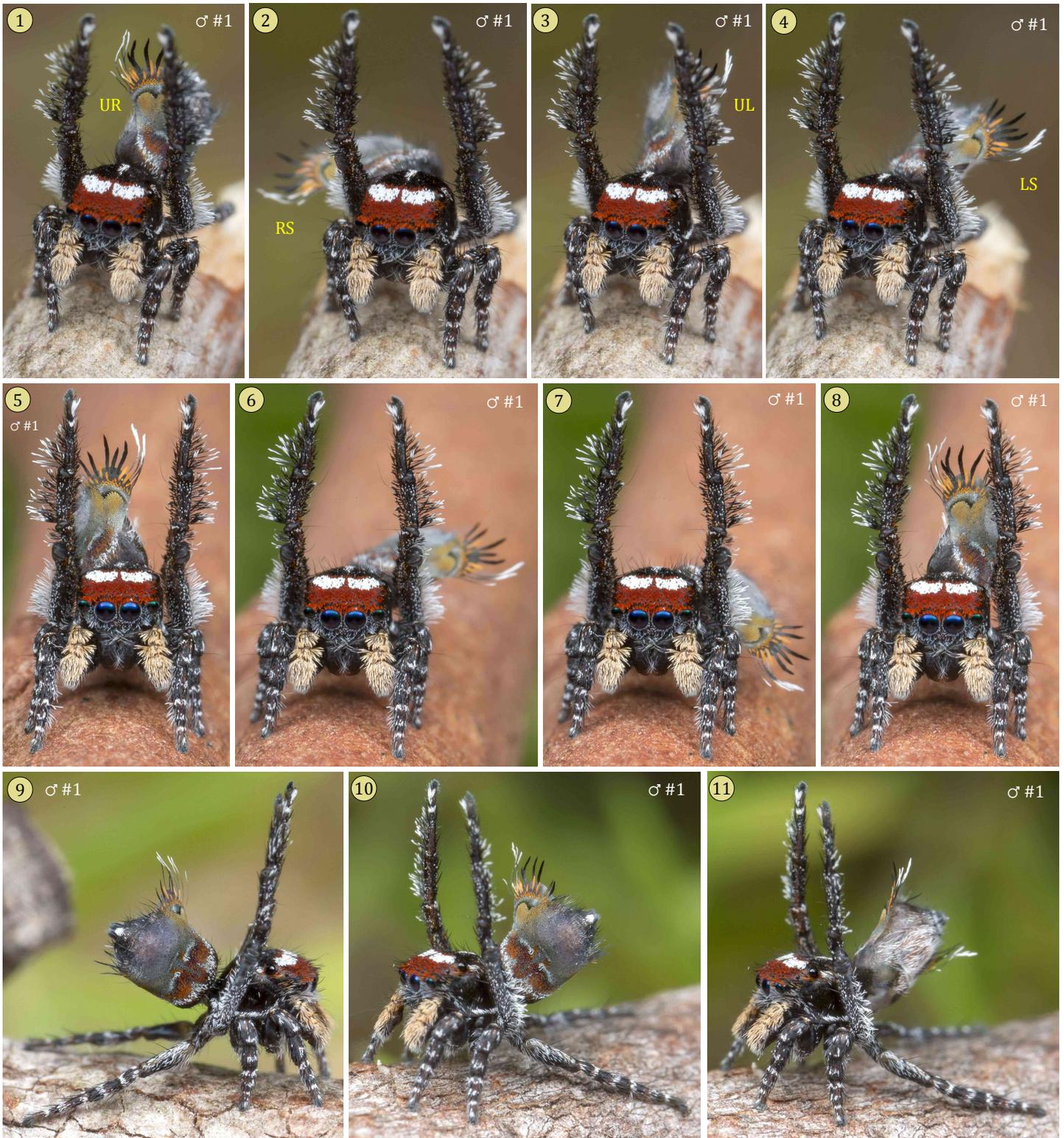


Figure 19 (continued on next page). Positions assumed during the *fan dance* display by the male types for *Maratus tortus*. **1-4**, Four sequential positions of the fan assumed during a single *waving and twisting cycle*. From the left side (LS, 4) position the fan would be moved back to the upper right (UR, 1) position. **5-8**, Photos selected to illustrate the transition from upper left (5) to left side (6-7) to upper right (8) positions during one-half of a *waving and twisting cycle*. **9-11**, During this display legs IV were extended far to the rear on either side, providing stability to the male, but also permitting free movement of the fan as it was waved and twisted from side to side. This position may also allow a male to make a quick retreat if necessary. Notice how each flap was retracted when it was not displayed. *M. tortus* males only display one flap at a time to a female.



Figure 19 (continued from previous page). Positions assumed during fan dance display by the male types for *Maratus tortus*. **24**, Note the twisted (rotated laterally) position of the elevated opisthosoma in this center position.

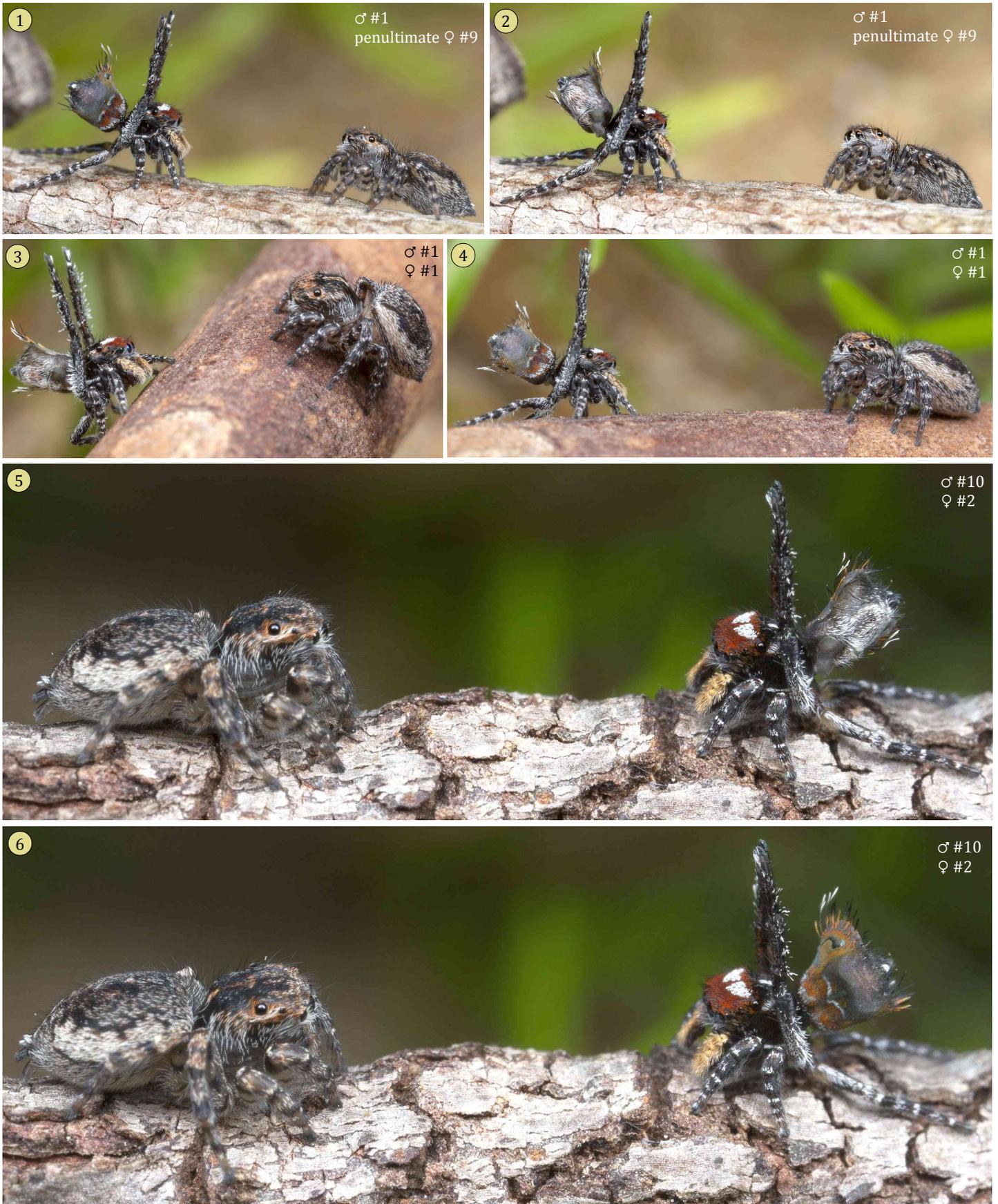


Figure 20. Female *Maratus tortus* attending to the fan dance of males. An attentive female turned to follow each movement of the flap that was displayed by the male.

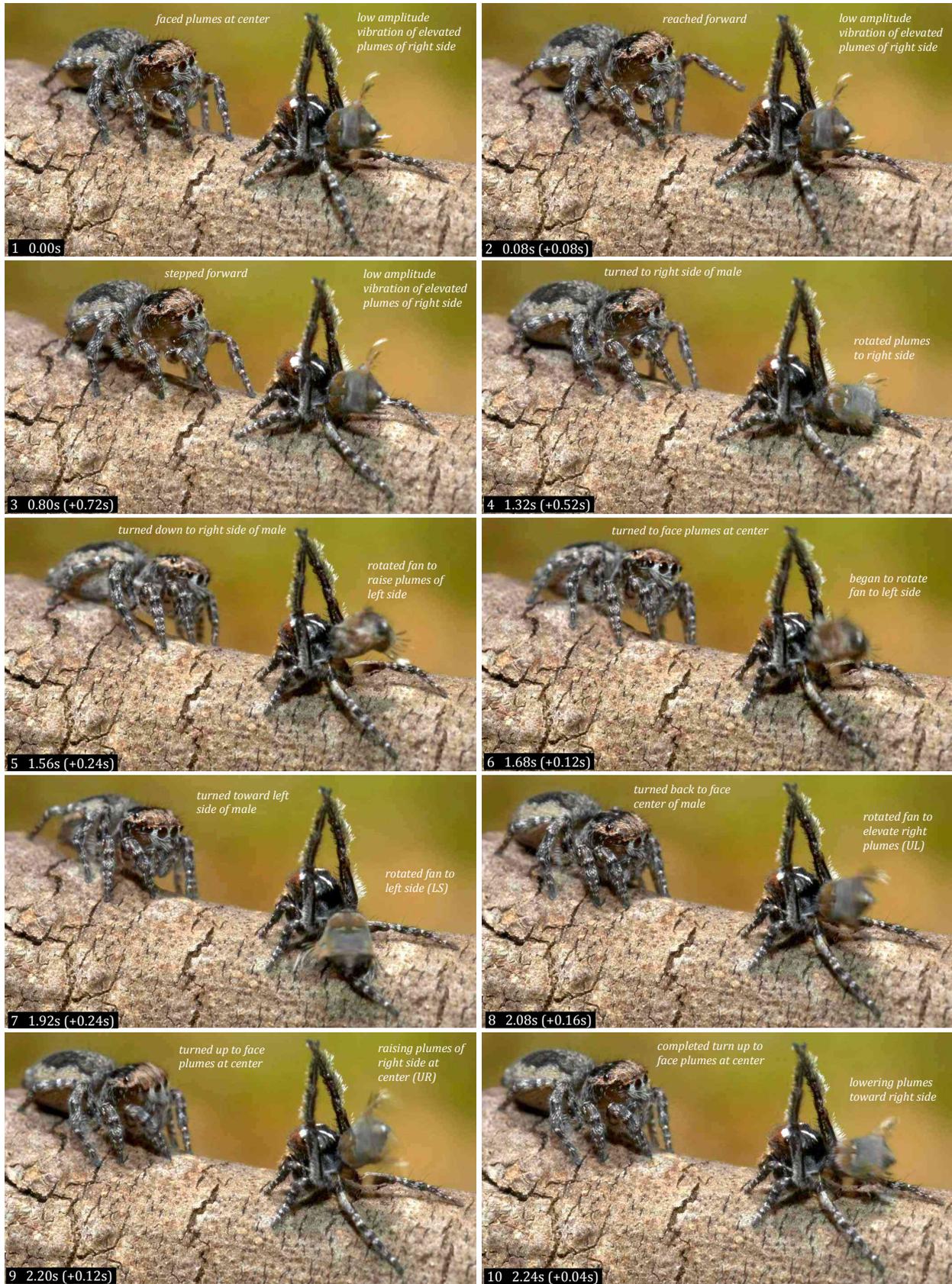


Figure 21. Sequential frames representing an interval of 2.24 seconds, from a 25fps video of a female attending to the fan dance of a male *Maratus tortus*. This female turned to follow the movement of each plumed lateral flap as it was displayed to the side or directly above the male. This was a very active process and the entire encounter that preceded mating spanned more than 5 minutes.

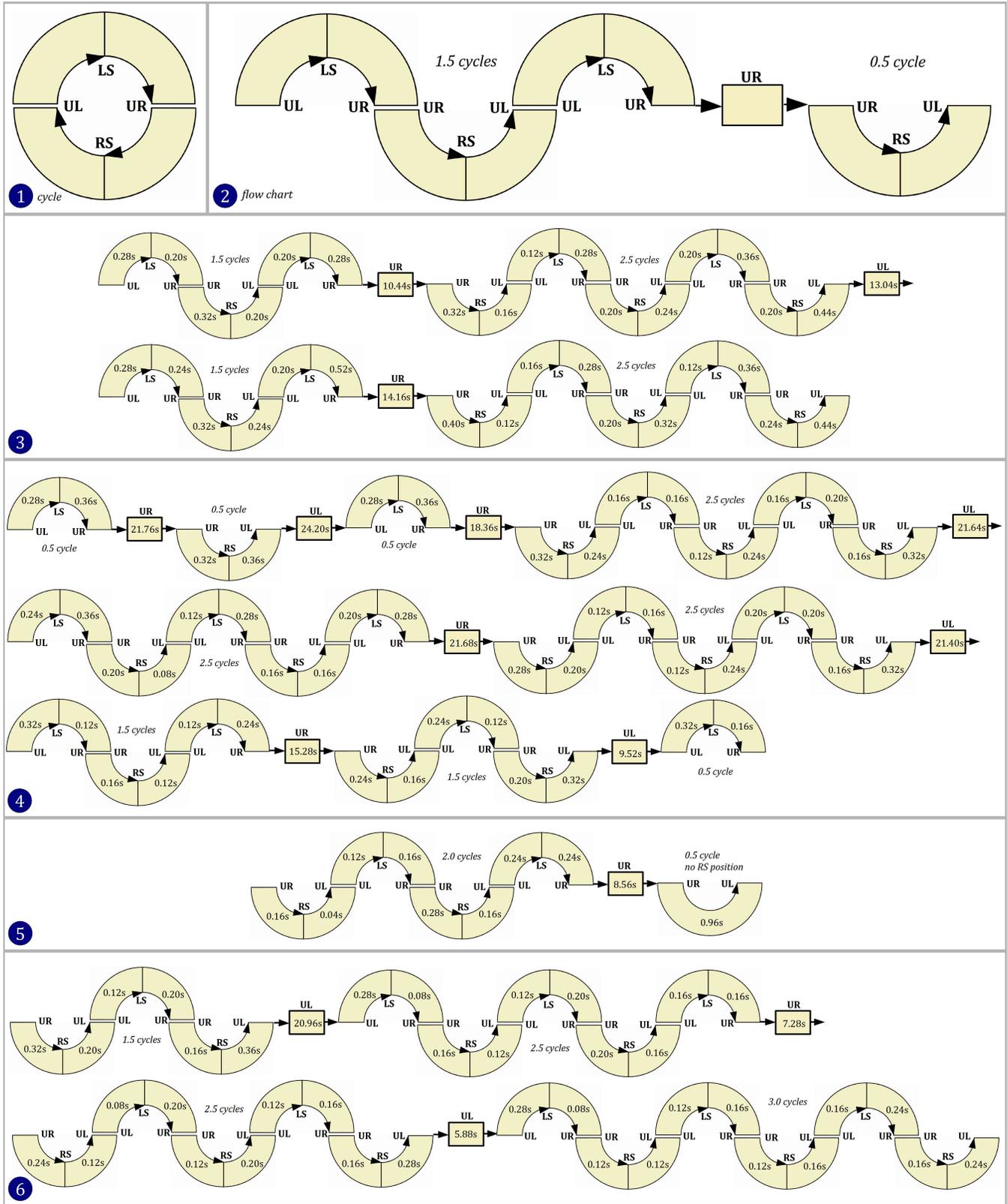


Figure 22. Flow charts depicting the fan dance of male *Maratus tortus*. During this display longer intervals in which one side of the fan was displayed above the spider, between the elevated legs (rectangles, positions UL and UR) alternated with a number of shorter cycles in which the fan was moved (*waved and twisted*) from side to side (curved sectors). **1**, Schematic view of fan position during each cycle of waving and twisting: left flap at center/front (UL), left flap at left side (LS), right flap at center/front (UR), and right flap at right side (RS). **2**, Cyclic display drawn as a flow chart, showing 1.5 cycles of waving followed by UR display, followed by 0.5 cycle of waving. **3-6**, Charts based on actual 25fps video records (0.04s resolution) of the fan dance.

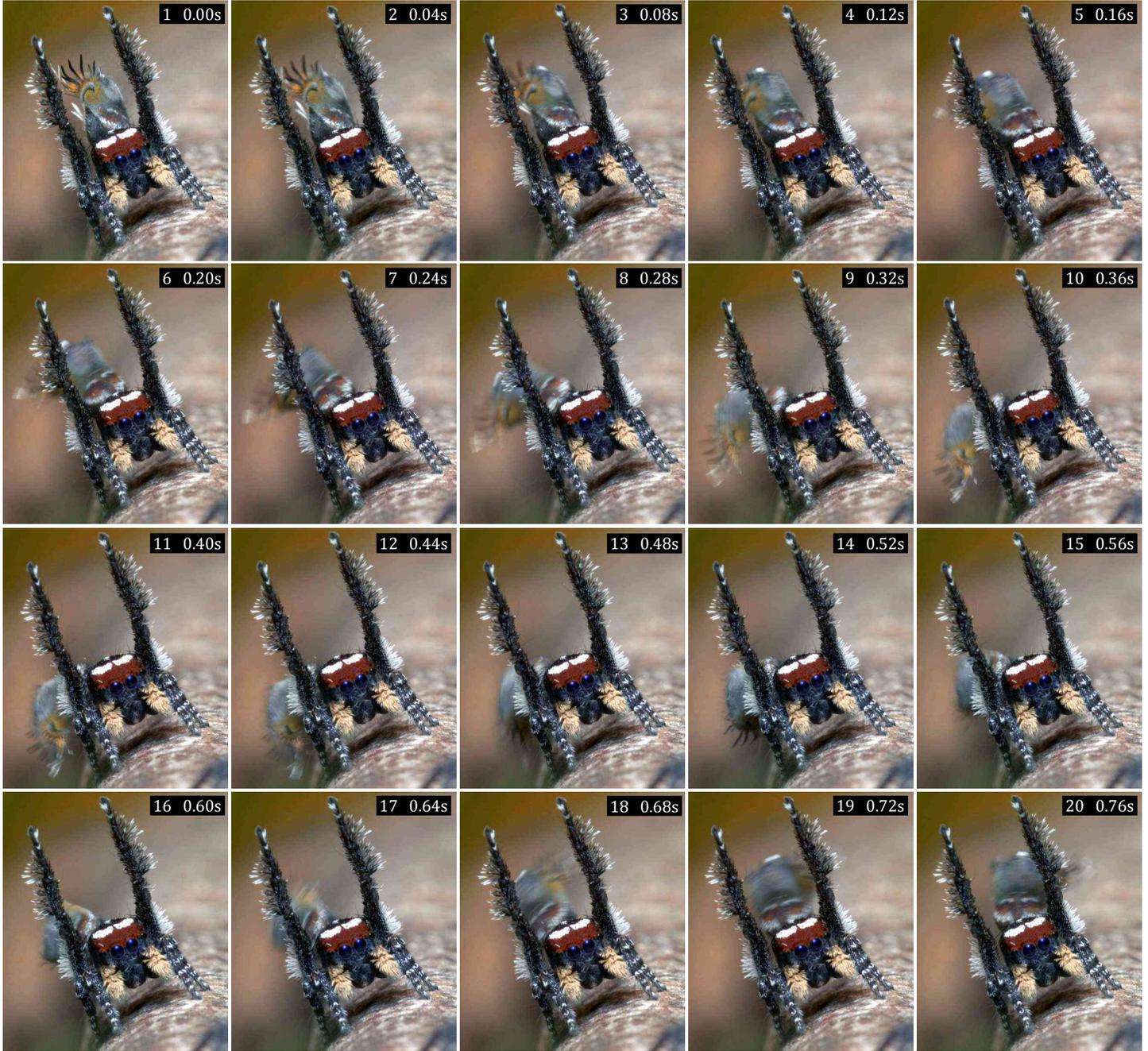
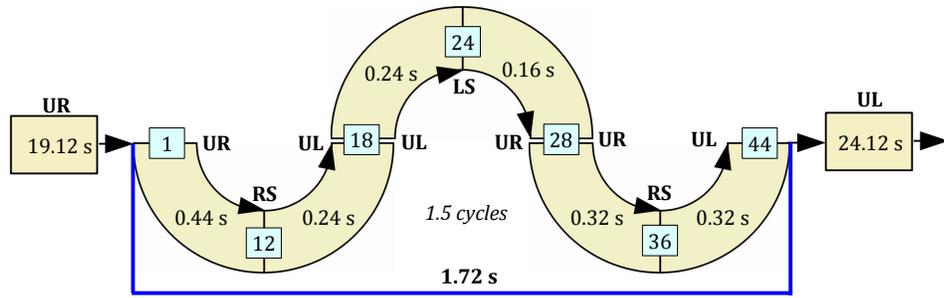


Figure 23 (continued on next page). Consecutive frames (1-45) from a 25fps video of a fan dance by a male *Maratus tortus*. The chart at the top identifies the frame associated with each position (in rectangles). This shows 1.5 cycles of continuous waving and twisting, leading from display in the UR position (frame 1) to display in the UL position (frame 44), completed in ~1.72s.

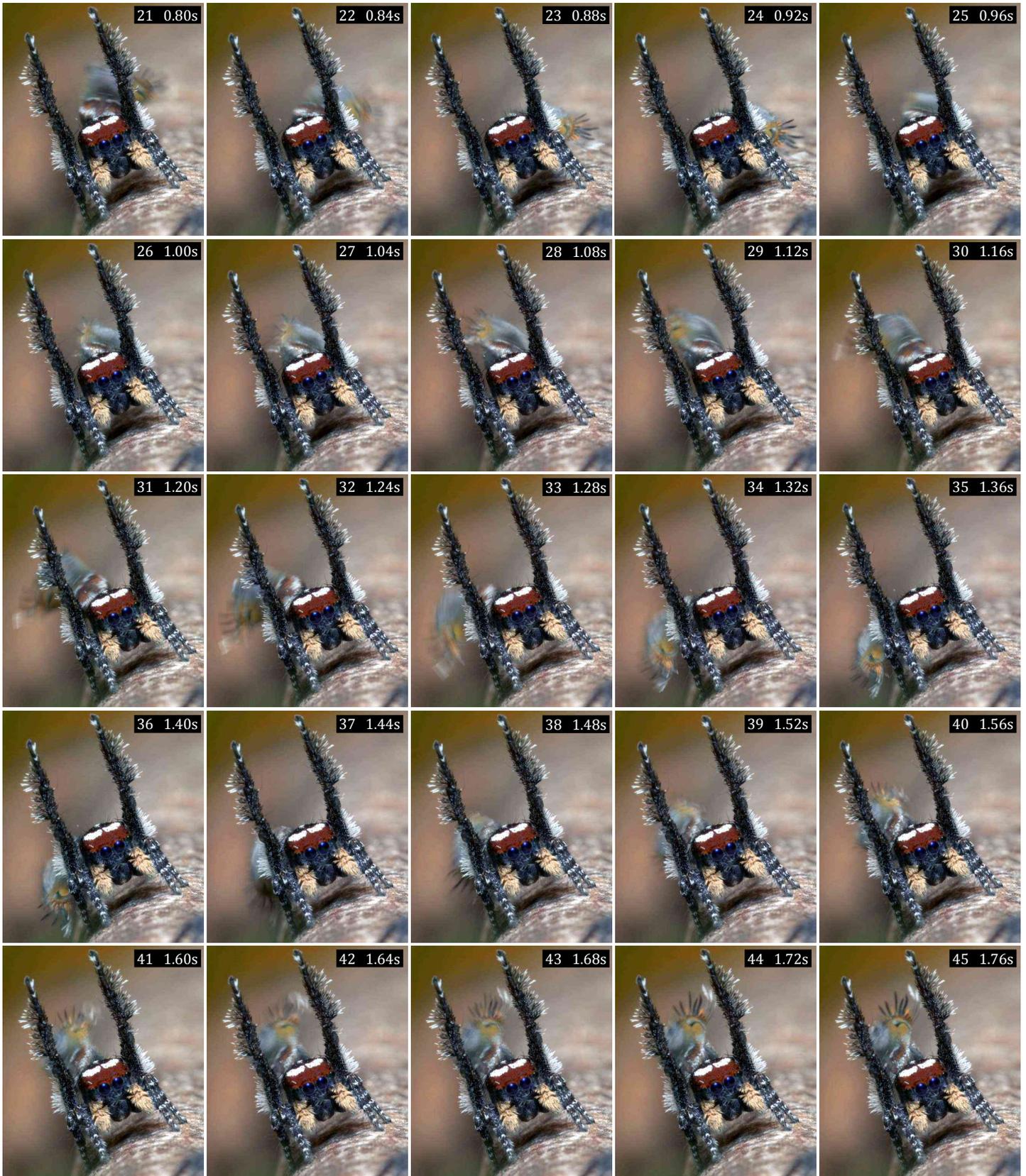


Figure 23 (continued from previous page). Consecutive frames (1-45) from a 25fps video of a fan dance by a male *Maratus tortus*.

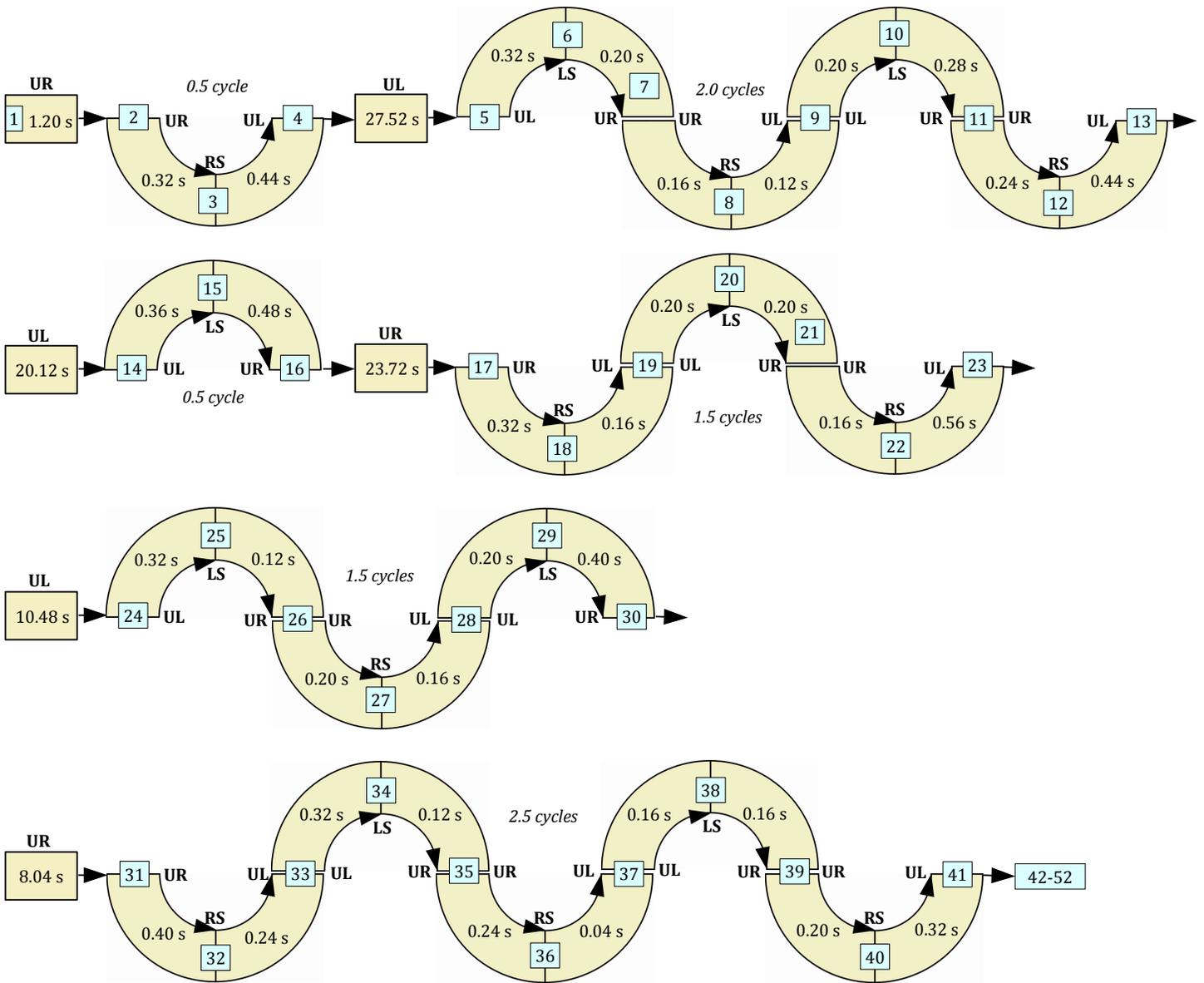


Figure 24. Flow chart depicting 99.84s (frames 1-41, identified in blue rectangles) of a *fan dance* by a male *Maratus tortus*, based on a 25fps video record. This was followed by a wide semaphore display (frames 42-52) with the fan held in an elevated (UL) position. Six sequential *waving and twisting* bouts are shown here, each interrupted by a much longer interval of display (large rectangles) in either a UL or a UR position directly above the spider (large rectangles). Display in the UL or UR position was not static, but involved continuous movement or vibration of the fan through a low amplitude. Respective frames (1-52, identified in small blue rectangles) are shown in Figure 25.

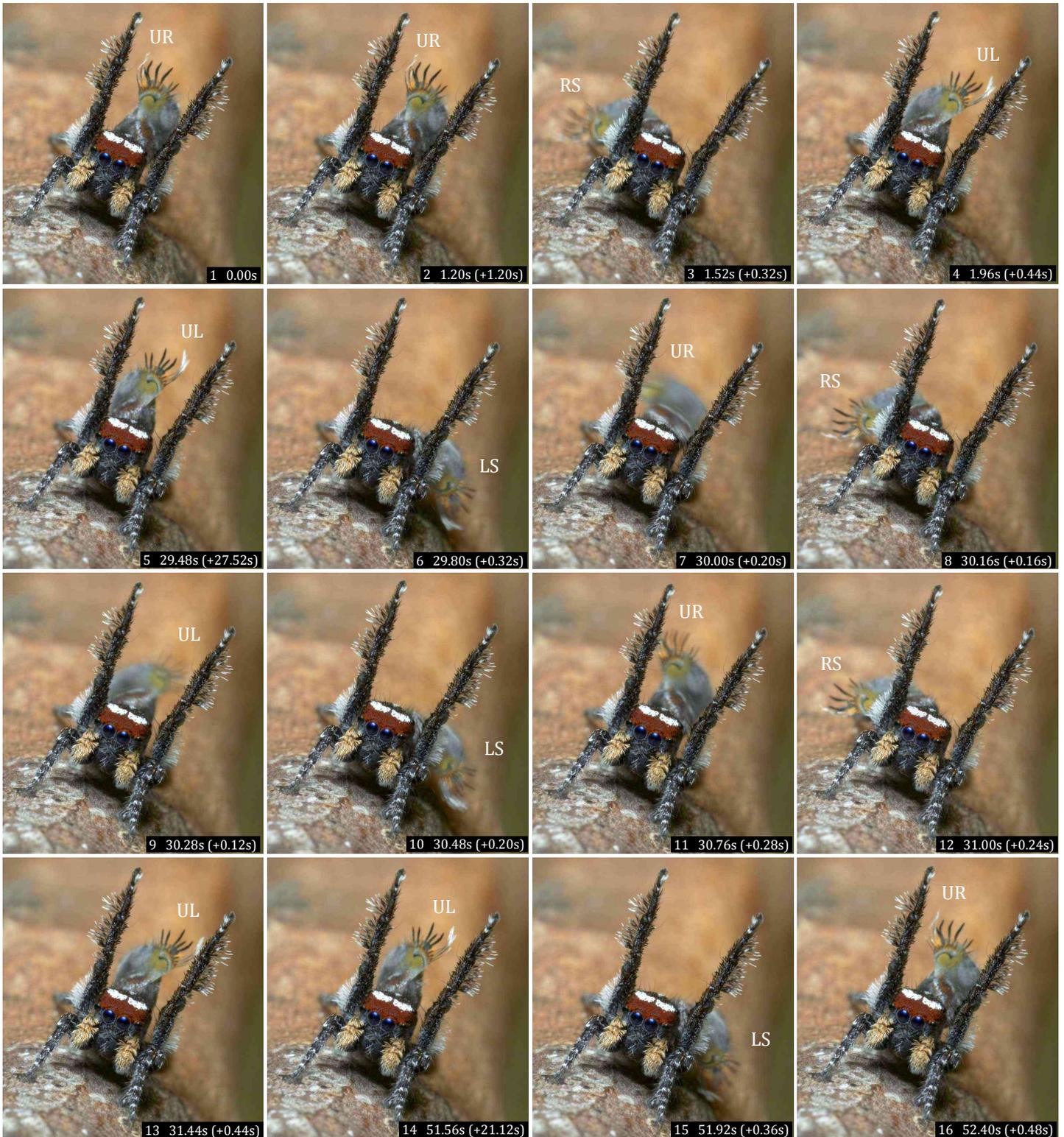


Figure 25 (continued on next page). Selected sequential frames from a 25fps video of *fan dance* by a male *Maratus tortus*, corresponding to the flow chart shown in Figure 24. **1-41**, Sequential positions in the *fan dance*. **41-42**, Transition to a *wide semaphore* position. **42-52**, *Wide semaphore* display with slight sideways movement (large arrows). The small arrows indicate low amplitude movement of legs III relative to the preceding frame.

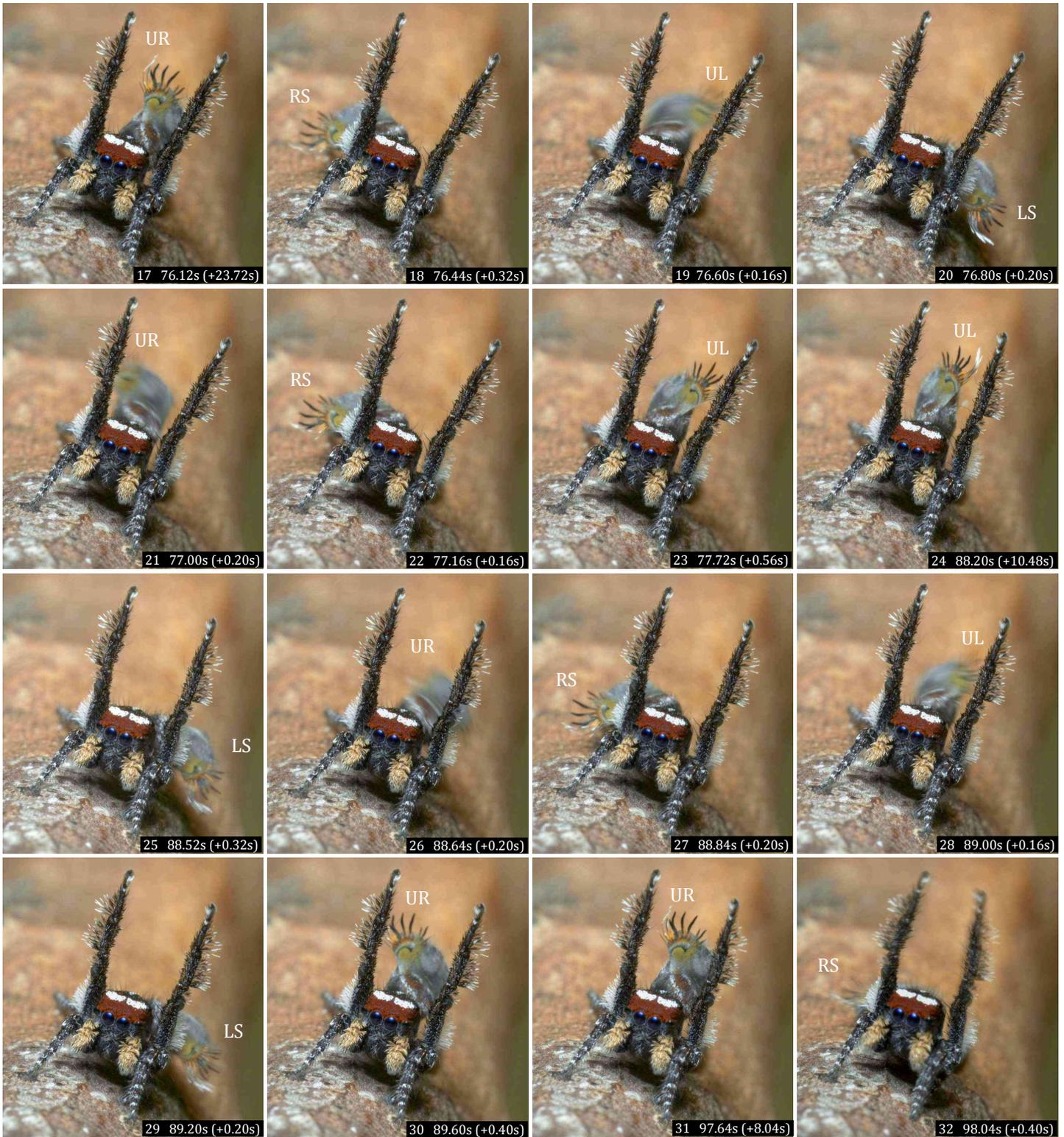


Figure 25 (continued from previous page, continued on next page). Selected sequential frames from a 25fps video of *fan dance* by a male *Maratus tortus*, corresponding to the flow chart shown in Figure 24.

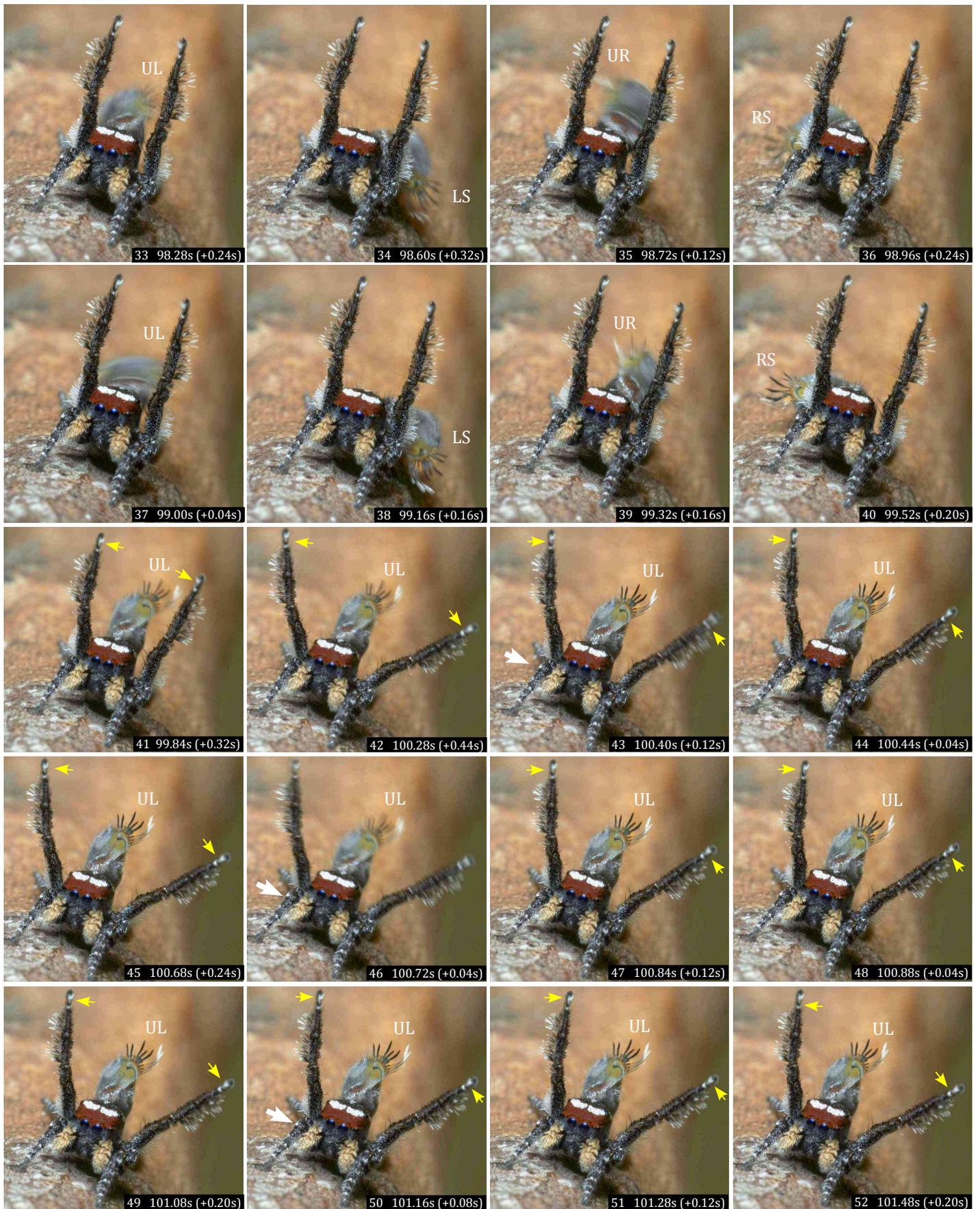


Figure 25 (continued from previous page). Selected sequential frames from a 25fps video of *fan dance* by a male *Maratus tortus*, corresponding to the flow chart shown in Figure 24.

Mating. Mating *Maratus tortus* are shown in Figure 26.



Figure 26. Two mating pairs of *M. tortus*. As in other *Maratus*, females can rotate their opisthosoma by 180° as they mate. Mating males also raise their opisthosoma.

Habitat. *Maratus tortus* were found on twigs or low vegetation on a saturated peat flat in Mount Frankland National Park near Walpole (Figure 27). At the time of the visit in mid- October it was flooded in places as a result of frequent showers. The area was dominated by *Gahnia* (saw sedge) and *Lepidosperma* (sword sedge) tussocks, with scattered *Nuytsia floribunda* (Western Australian Christmas Tree) and thickets of *Taxandria linearifolia* (Swamp Peppermint).



Figure 27. Habitat of *Maratus tortus* in Mount Frankland National Park.

***Maratus unicum*, new species**

Type specimens. The holotype male (♂ #1), 14 paratype males (♂ #2-15), and 14 paratype females (♀ #1-14) were collected at Unicum Nature Reserve (S34° 22.538', E116° 43.880', 14-16 OCT 2017, coll. J. Otto). Two females (♀ #8, ♀ #10) were collected as immatures (penultimates) and reared to adulthood. All types will be deposited in the Western Australian Museum, Perth.

Etymology. The species group name (*unicup*, noun in apposition) is taken from Lake Unicum where these spiders were found.

Diagnosis. *Maratus unicum* males resemble other members of the *vespa* group with respect to their heavily fringed legs III and general features of their courtship display, but also have many distinguishing features. Overall the colour pattern of the dorsal opisthosomal plate (fan) of *M. unicum* resembles that of both *M. cristatus* and *M. vespa*, however each of the lateral flaps is triangular and not rounded as in those species. As in *M. vespa* the dorsal pattern on each lateral flap is divided by a transverse line, and as in *M. cristatus* a figure of five lines joined by a transverse band, comprised of dull red scales separated by lighter scales or setae can be seen at the rear of the fan. However *M. unicum* lacks the prominent tufts of long white setae that project from the rear of the fan of *M. cristatus* (Figure 2).

Description of male (Figures 28-32). Adult males were 3.8-4.8 mm in length (n=15). The chelicerae, carapace, and articulating, flexible subclypeal cuticle are mostly black (Figure 28:10). Scattered off-white setae are present along the anteromedial margin of each paturon. The clypeus and subclypeal cuticle are glabrous medially, with scattered light yellow-brown setae laterally. The AME are bordered with grey scales below, light yellow-brown scales laterally, and dull red-orange scales dorsally. A dense cover of grey scales is present in the eye region, interrupted by distinct stripes of dull red-orange scales behind each anterior eye, and at the median. The PME are closer to the PLE than to the ALE. On either side of the carapace light yellow-brown scales extend most of the way down to the margin, and a well-defined marginal band comprised of off-white to light yellow-brown scales is present. Directly behind the eye region the carapace is mostly black and glabrous, except for a median thoracic band of white scales.

The fan has a complex pattern of six red-orange anterior lines separated by dull yellow or iridescent blue-green joined to five dull red posterior lines bordered by black, also joined transversely toward the rear, and separated by blue or light blue (Figure 29). Triangular posterolateral flaps are divided by a curved transverse line, dull orange at the front and blue at the rear. Behind and below the dorsal opisthosomal plate (fan) the dorsal opisthosoma is dark grey to black, with a median patch of bright white scales. Just behind this a small triangular patch of white scales is present just above the grey spinnerets. The venter of the opisthosoma (Figure 30) is light brown with a cover of off-white setae. From below, the coxae are light brown to grey, mostly glabrous, and translucent. The sternum and endites are grey. Scattered off-white setae are present around the posterior margin of the sternum.

Legs I and II are shorter and covered with light yellow-brown setae, banded distally. Legs III and IV are longer and leg III is by far the longest (Figure 30:11). Legs III are mostly light-yellow brown, but are heavily fringed with off-white setae below the femur, tibia and metatarsus. White setae cover the dorsal tarsus of legs III. Legs IV differ in that they are covered with lighter, off-white setae and are indistinctly banded. The pedipalps are black but uniformly covered with long light yellow-brown setae above. The detailed structure of the embolus (Figure 32) is similar to that of many other *Maratus* species, including other species placed in the *vespa* group. Behind (above) the heavier outer apex of the embolus is a closely bound, shorter, more pointed apex. The outer apex has a single projection or serration that can be seen in a lateral view.



Figure 28 (continued on next page). Living male types for *Maratus unicip*.



Figure 28 (continued from previous page, continued on next page). Living male types for *Maratus unicup*. 22, Lateral view of opisthosoma showing folded or retracted flap.



Figure 28 (continued from previous page, continued on next page). Living male types for *Maratus unicus*.



Figure 28 (continued from previous page). Living male types for *Maratus unicus*.

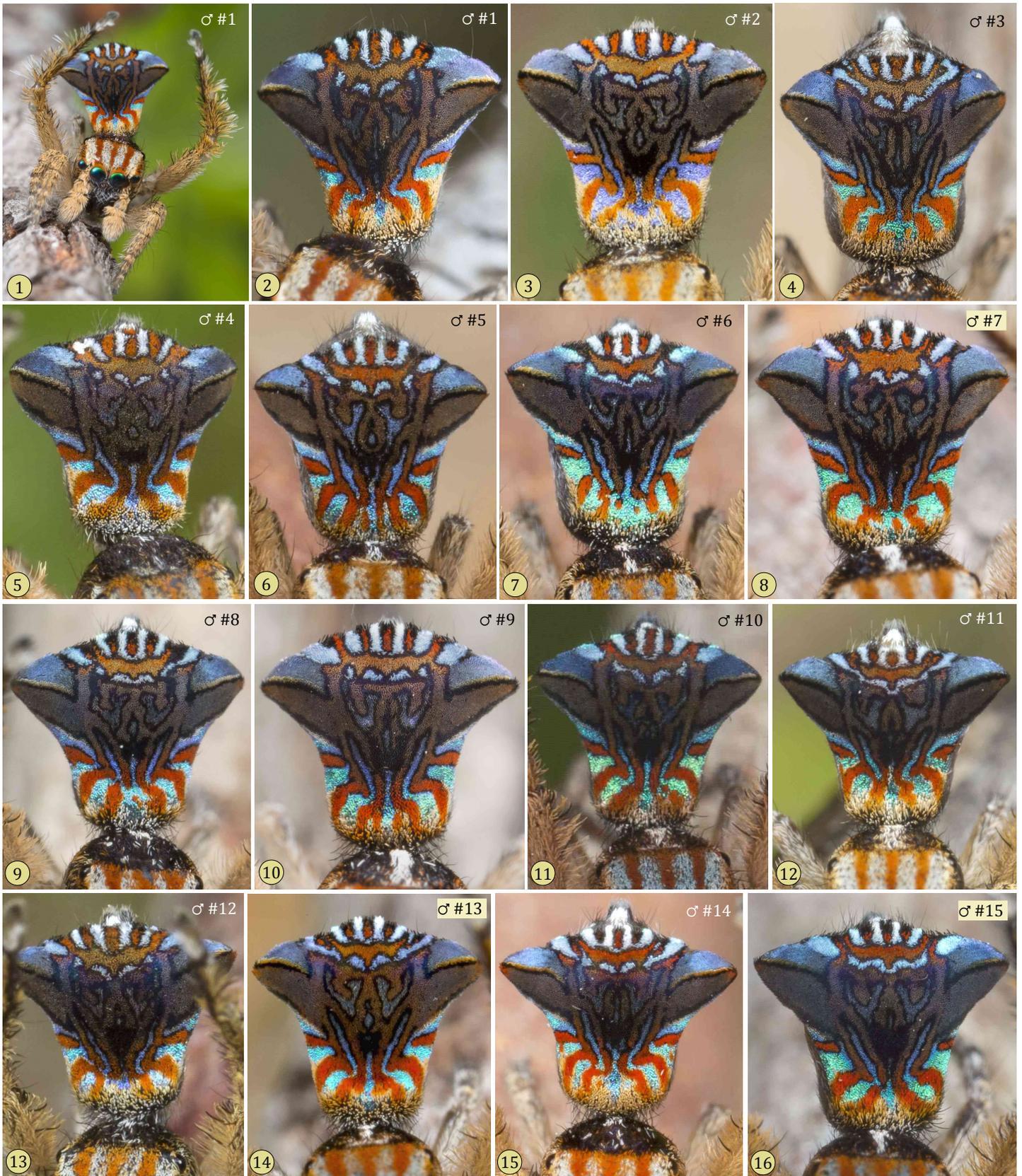


Figure 29. Elevated fan with expanded flaps of the male types for *Maratus unicum*. The general pattern of scale cover was quite consistent, although each male was also unique with respect to details.

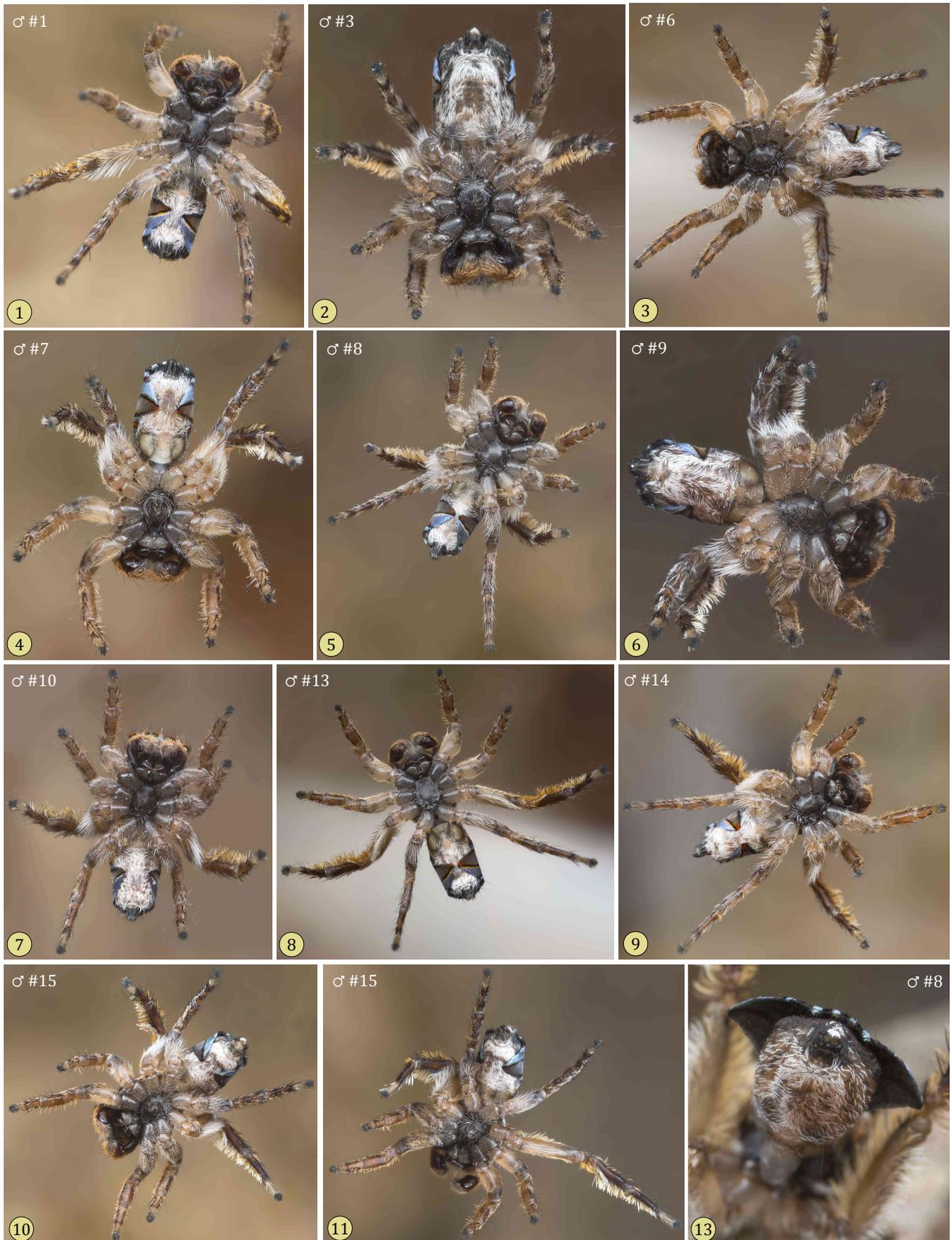


Figure 30. Ventral view of the living male types for *Maratus unicip*. **13**, Ventral view of the elevated opisthosoma during courtship display, showing the dark underside of the expanded lateral flaps.

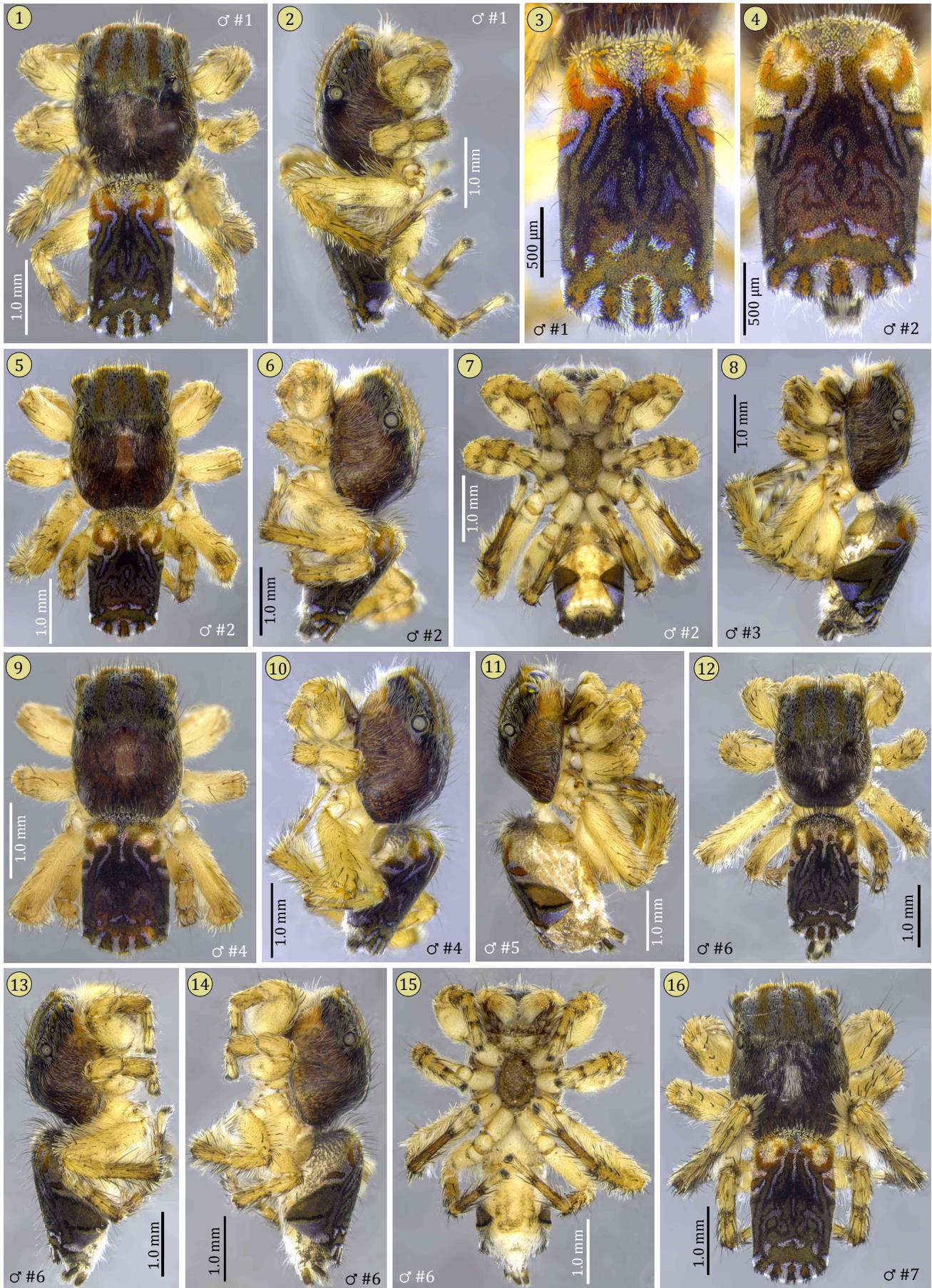


Figure 31 (continued on next page). Male type specimens for *Maratus unicus* in alcohol.

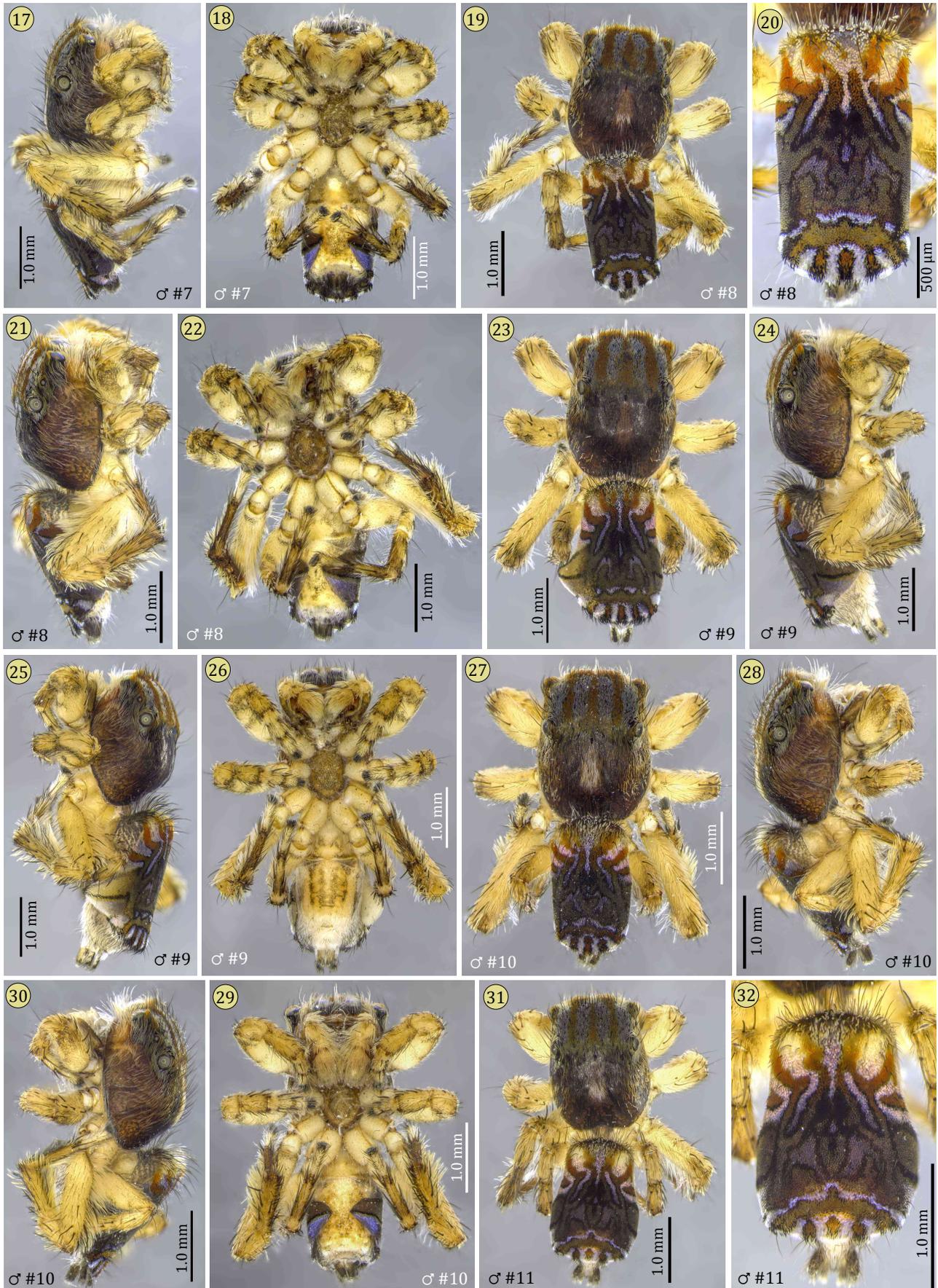


Figure 31 (continued from previous page, continued on next page). Male type specimens for *Maratus unicip* in alcohol.



Figure 31 (continued from previous page). Male type specimens for *Maratus unicus* in alcohol.

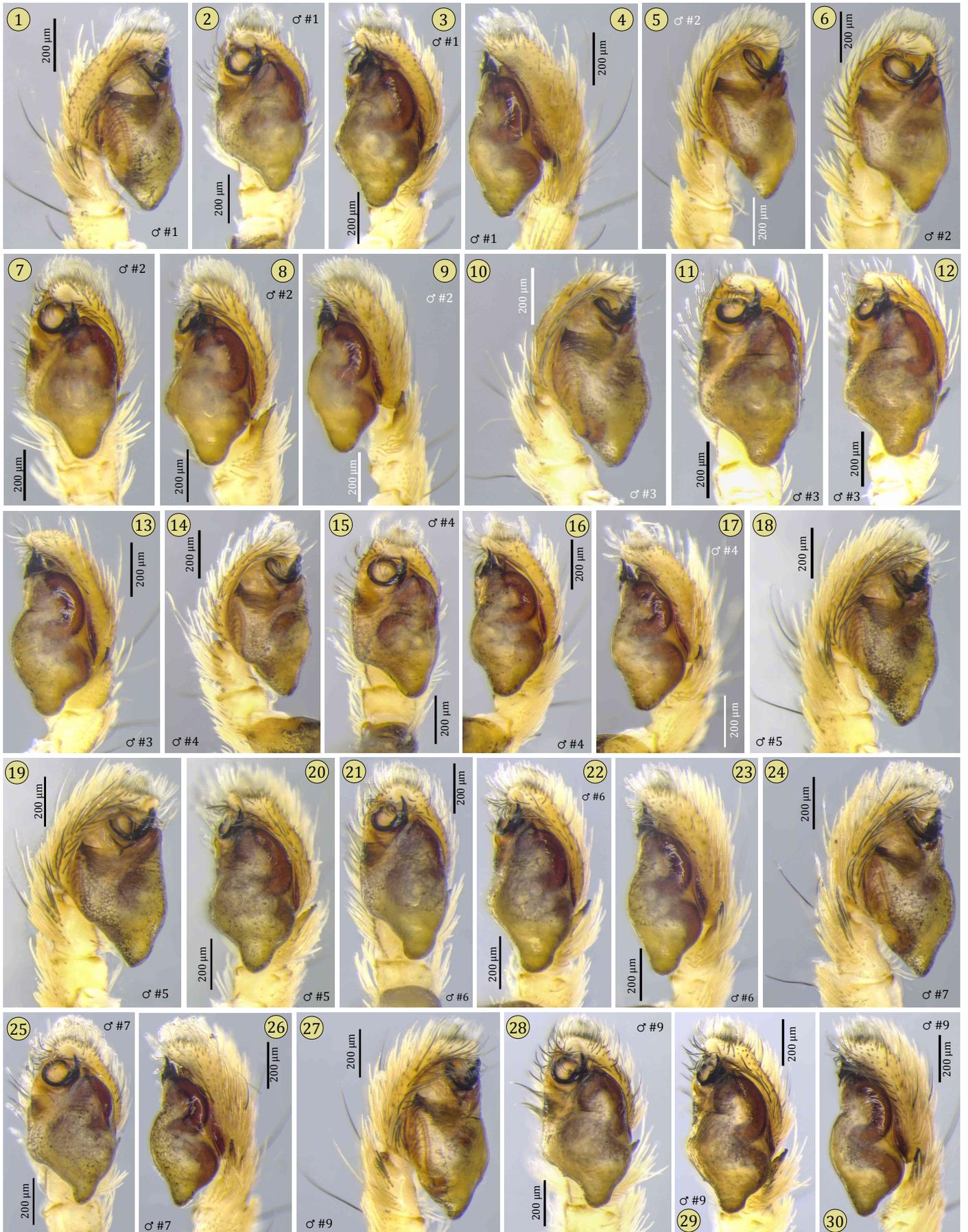


Figure 32 (continued on next page). Medial to lateral views of the left pedipalp of male *Maratus unicus* types in alcohol.



Figure 32 (continued from previous page). Medial to lateral views of the left pedipalp of male *Maratus unicum* types in alcohol.

Description of female (Figures 33-36). Adult females were 4.3-5.9 mm in length (n=14). The chelicerae are brown and mostly glabrous, with scattered off-white setae toward the median. A band of long off-white setae extends ventromedially from below each ALE, covering most of the brown clypeus. The AME are surrounded by off-white scales at the bottom and sides. The eye region has a cover of mixed off-white to orange-brown scales, with an indistinct band of orange-brown scales extending behind each anterior eye. Each PME is closer to the PLE than to the ALE. Toward the rear scale cover of the eye region varies and this area tends to be black and glabrous. This black area may be interrupted at the median by an indistinct median thoracic band of off-white to orange-brown scales. The sides of the carapace have a variable cover of long, off-white to light brown or orange-brown scales. No marginal band is present.

The dorsal opisthosoma is mostly black to dark brown or dark red-brown, with a variable cover of off-white to light brown or orange-brown setae. This may be bounded on either side by an irregular black line like that seen in female *M. tortus*. On the sides and below the opisthosoma is lighter, with a cover of off-white setae. The venter is lightly mottled with darker spots. At the rear a small triangular tuft of white setae is present, above the grey to brown spinnerets. From below (Figure 34) the coxae and endites are light brown to grey, translucent and mostly glabrous. The sternum is grey and glabrous except for scattered off-white setae around the posterior margin.

Legs I and II are shorter and about the same length. Legs III and IV are longer and legs III are the longest. All legs are similar in colouration and brown, with indistinct segmental banding as a result of alternation between dark, exposed cuticle and bands of off-white scales. The pedipalps are brown with a cover of long off-white setae. The epigynum (Figure 36) is variable with respect to the width of the septum, the size of the fossae (windows) relative to the large posterior spermathecae, and the extent and degree of sclerotization of ducts visible through the posterior half of each fossa. This general appearance and variability of the epigynum agrees with what we have observed in other members of the *vespa* group.



Figure 33 (continued on next page). Living female types for *Maratus unicip*.



Figure 33 (continued from previous page, continued on next page). Living female types for *Maratus unicus*.



Figure 33 (continued from previous page, continued on next page). Living female types for *Maratus unicip.*



Figure 33 (continued from previous page). Living female types for *Maratus unicus*.

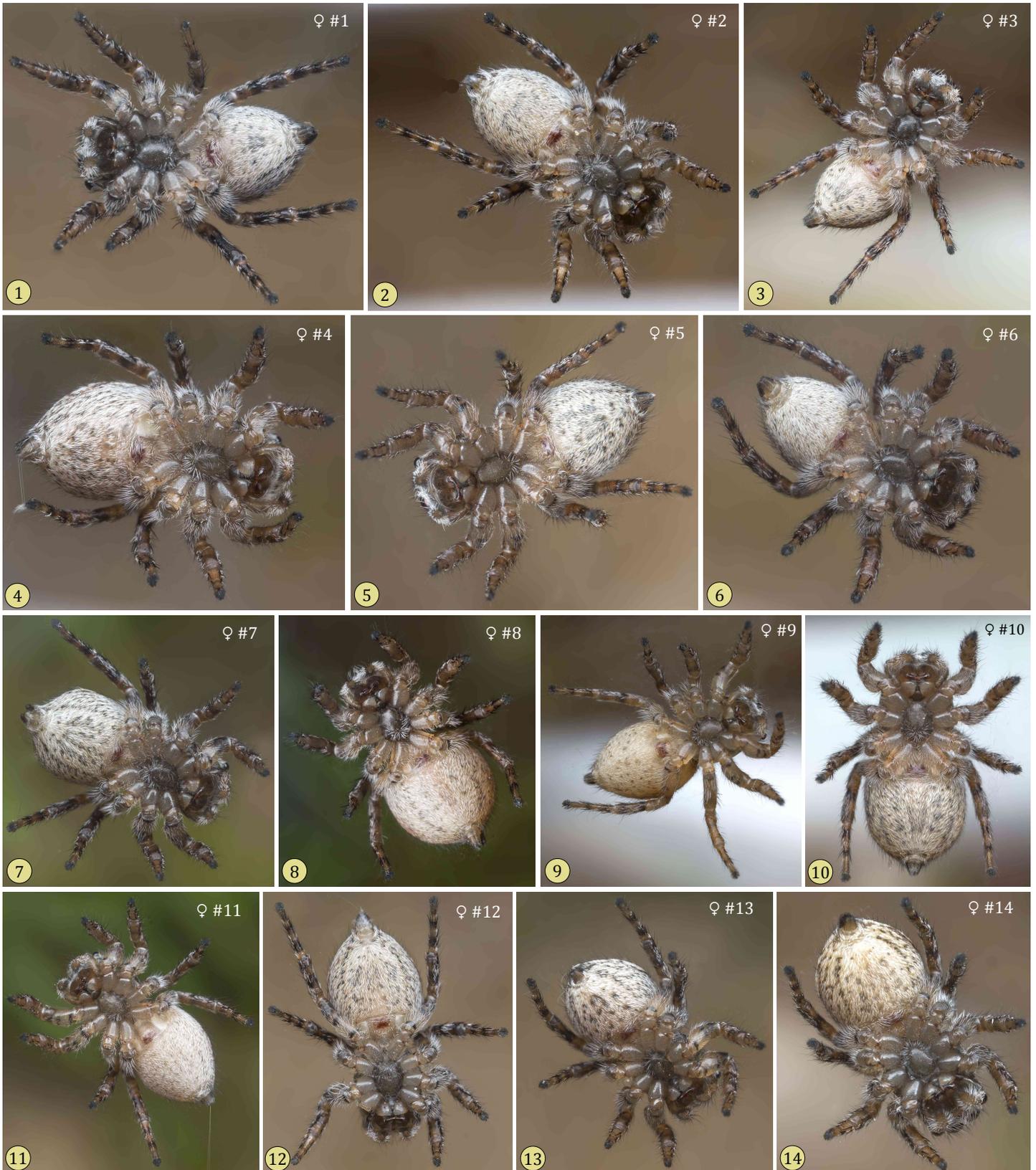


Figure 34. Ventral view of living female types for *Maratus unicip*.

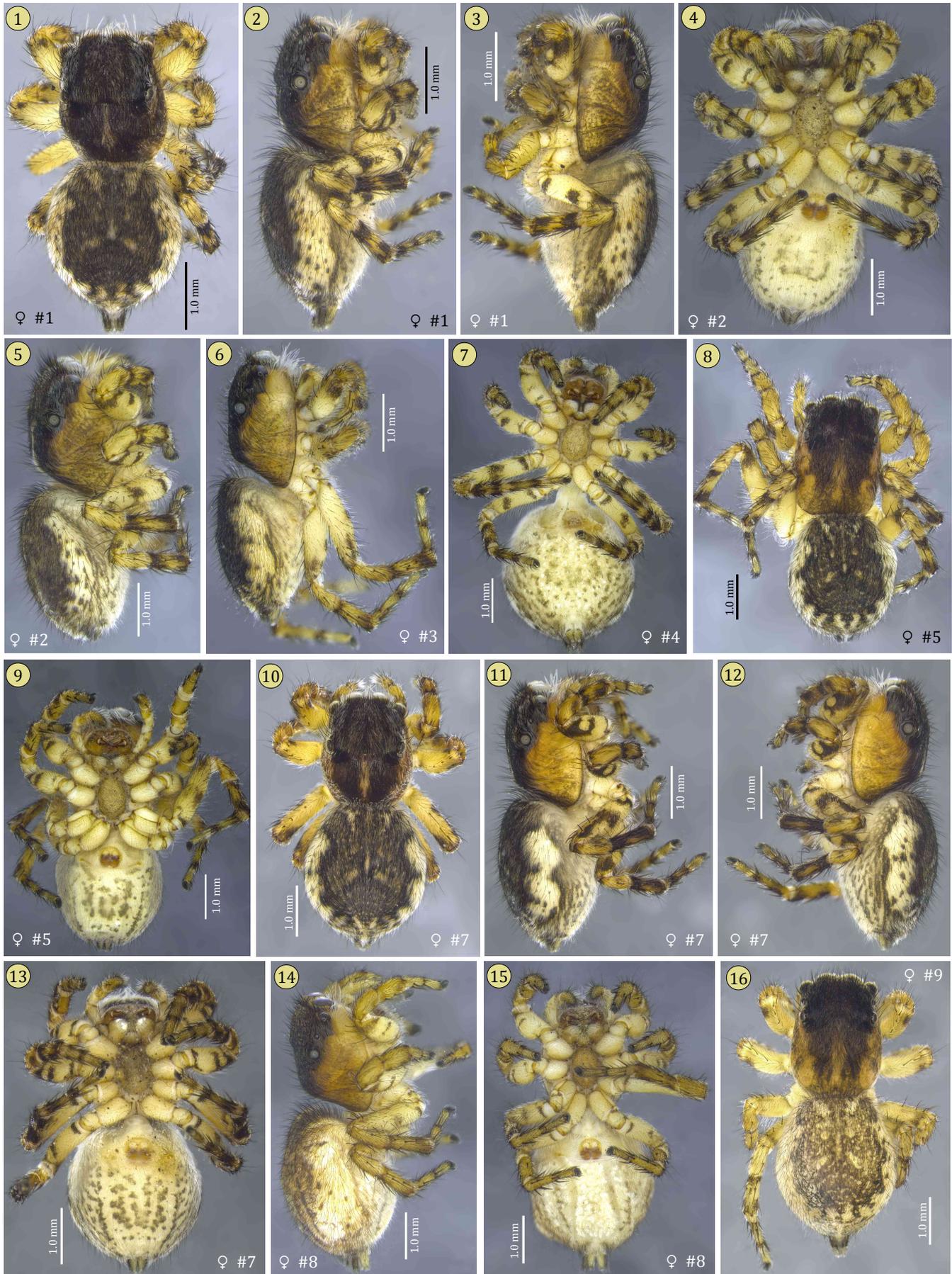


Figure 35 (continued on next page). Female type specimens for *Maratus unicip* in alcohol.



Figure 35 (continued from previous page). Female type specimens for *Maratus unicus* in alcohol.

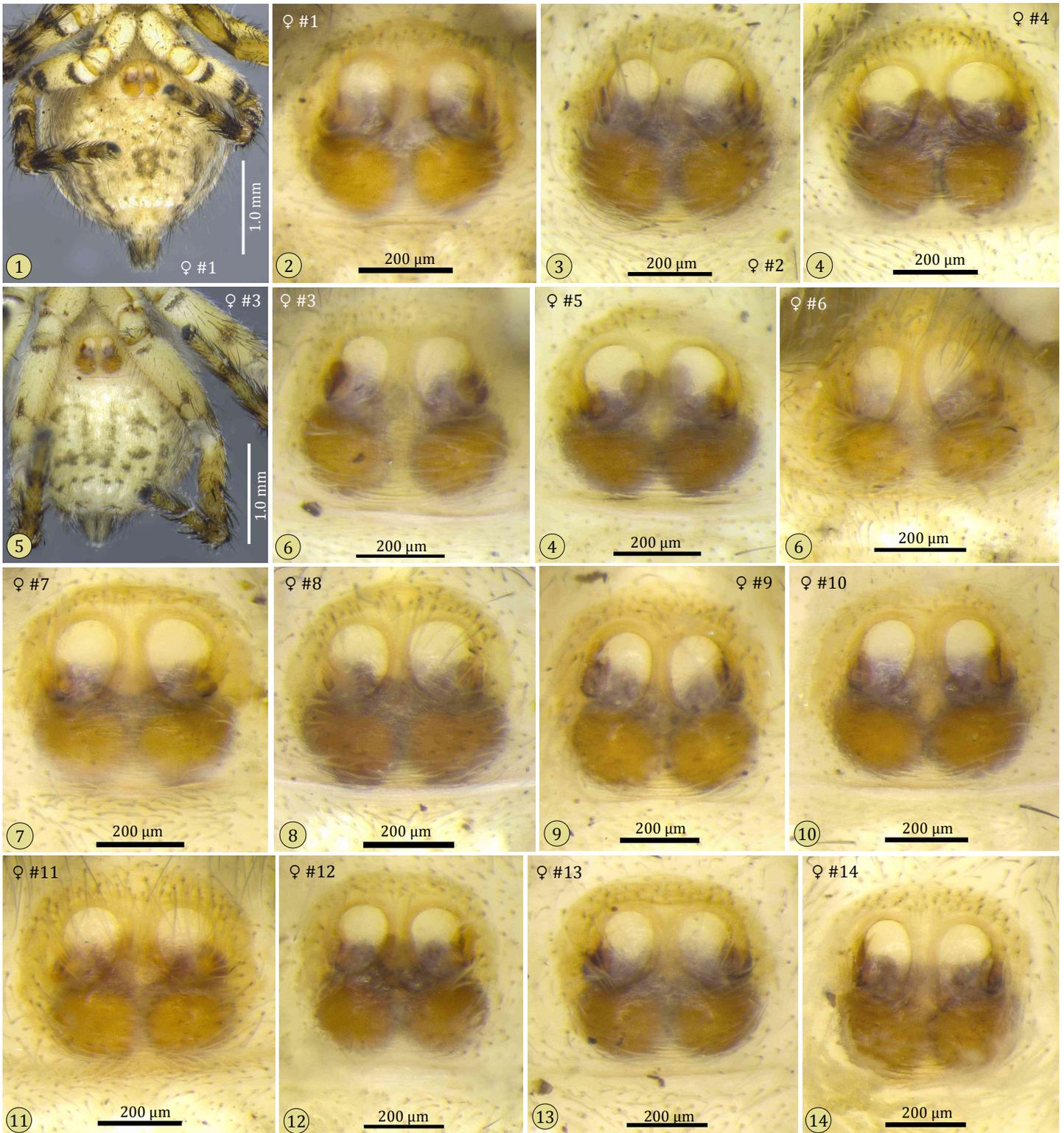


Figure 36. Epigyna of female type specimens for *Maratus unicus* in alcohol.

Immatures. Penultimate females (Figure 37) closely resemble the adults.

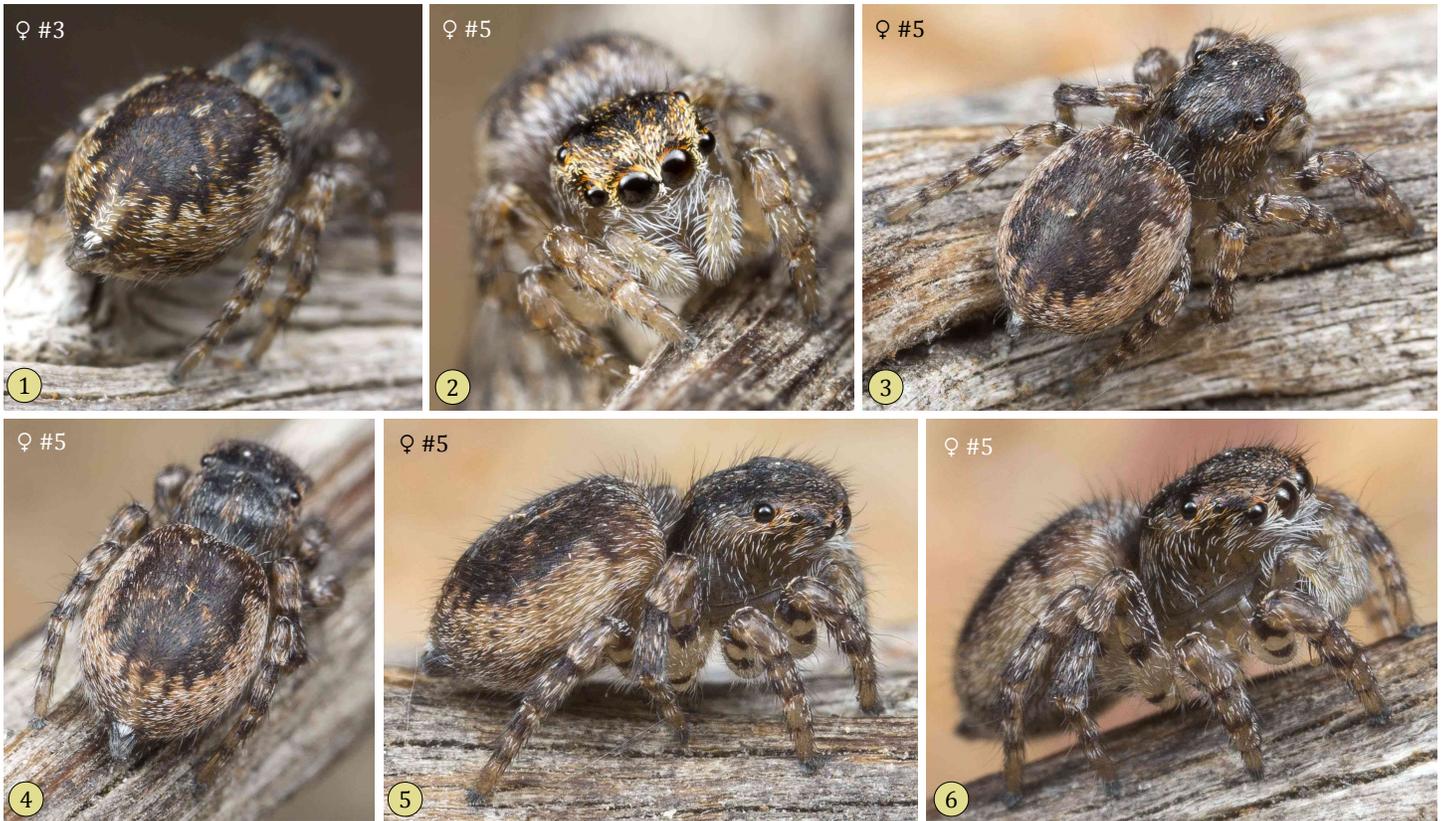


Figure 37. Two of the female types for *Maratus unicip* in the penultimate stage.

Courtship display (Figures 38-47). Our study of courtship is based on video recordings of the behaviour of males and females placed together in a naturalistic setting in the laboratory. Otto (2018a) also posted an online video of this display. We have observed four different displays by male *Maratus unicip* (Table 2). The *wide semaphore* and *tall semaphore* displays appear to be used to elicit the attention of a nearby female, as in *M. tortus*, but we have not studied these in detail.

During the *fan wave* display males displayed their fully expanded and elevated fan behind an incompletely closed bracket of the two legs III, flexed to bring the tarsi close together. In this position the fan was held vertically and waved from side to side through a low amplitude (~2-10° of arc) at 6-9.5 cycles/s. As in other members of the *vespa* group, the *fan dance* was performed with the female in close attention, following each move of the male. In each cycle of this display (~10-40s in duration, Figure 43) the fan was rotated and twisted from an elevated position at center to display the flap on one side, then moved back to the center, then rotated and twisted to display the flap of the other side before returning to the center, usually behind a closed bracket of legs III. Low amplitude movement of the fan was continuous and complex during all phases of this display. High speed (180fps) video revealed very high speed (~62 cycles/s) alternation between lowering and rotating/twisting of the fan followed by very high speed (~57 cycles/s) up-and-down movement of the fan as one flap was displayed at the side (Figure 45).

Table 2. Display repertoire of the adult male *Maratus unicip*.

display	hypothetical function	description of behaviour	Figures
wide semaphore	elicit facing turn by nearby female	hold symmetrically extended legs III apart at a wide angle (~90°)	38:1
tall semaphore	elicit facing turn by nearby female	hold both extended legs III in a near-vertical position	42
fan wave	elicit facing turn by nearby female	low amplitude (~2-10° of arc) wave of elevated and expanded fan from side to side behind incompletely closed (open to a variable degree) bracket of legs III (6-9.5 cycles/s)	38 (in part), 40-41
fan dance	engage and impress female to secure acceptance	behind usually closed bracket of legs III, alternating from display of expanded fan at center to display of flap at one side, to display of expanded fan at center, to display of flap at opposite side	38 (in part), 39, 42-47

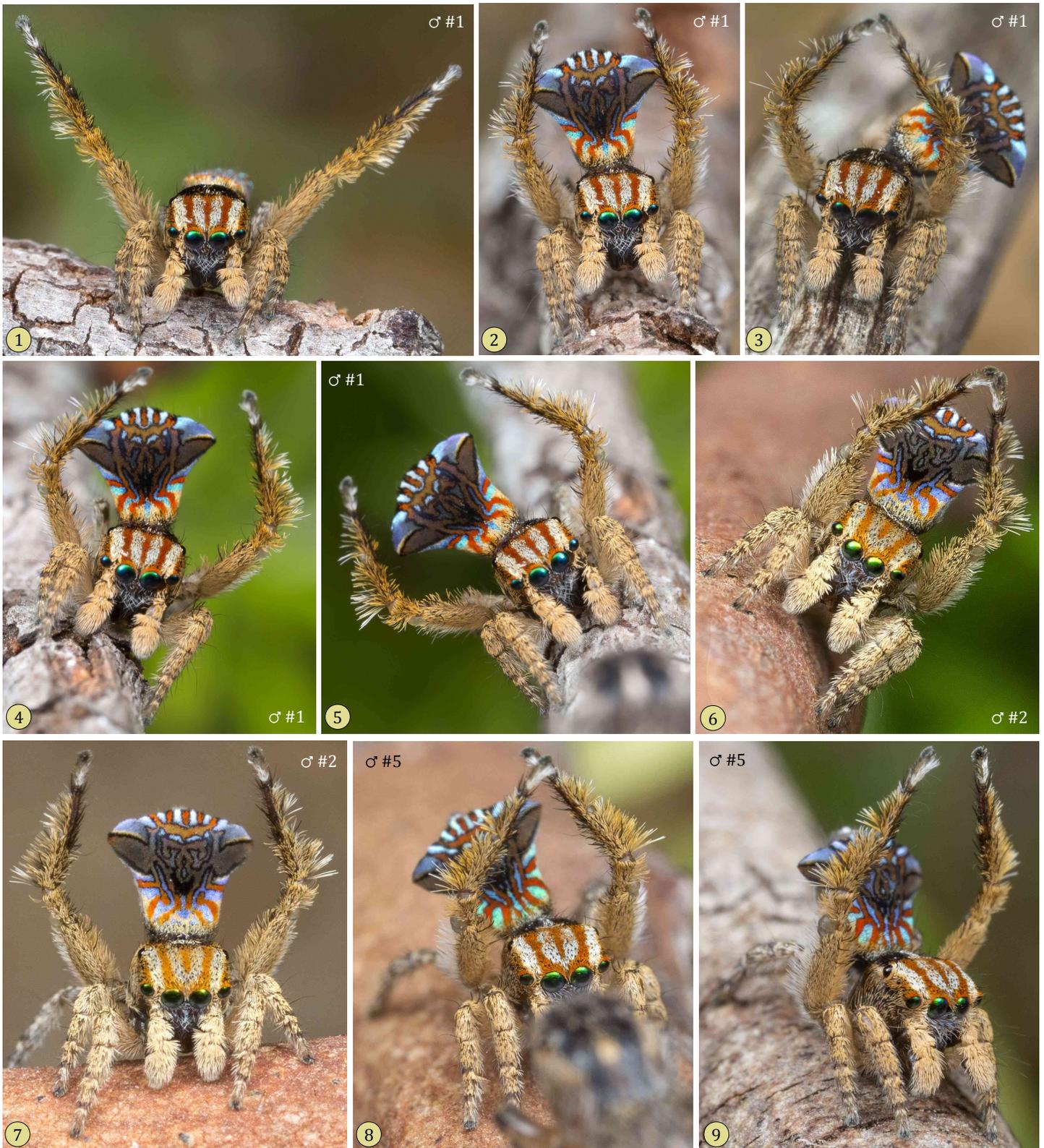


Figure 38 (continued on next page). Positions assumed by male *Maratus unicus* as they displayed to females. **1**, *Wide semaphore* display. **2, 4-5, 7, 9**, Positions typically assumed during a *fan wave* display, with variable separation of the bracketed legs III. **3, 6, 8**, Positions typically assumed during a *fan dance*, with the tarsi of legs III in contact to form a closed bracket.



Figure 38 (continued from previous page, continued on next page). Positions assumed by male *Maratus unicum* as they displayed to females. **10, 15, 17**, Positions typically assumed during a *fan wave* display, with variable separation of legs III. **11**, Position assumed during a *fan dance*, with the tarsi of legs III separated. More often these were in contact during this display. **12-14, 16, 18**, Positions typically assumed during a *fan dance*, with the tarsi of legs III in contact.



Figure 38 (continued from previous page, continued on next page). Positions assumed by male *Maratus unicus* as they displayed to females. **19-22, 27**, Positions typically assumed during a *fan wave* display, with variable separation of legs III. **23-26**, Positions typically assumed during a *fan dance*, with the tarsi of legs III in contact.

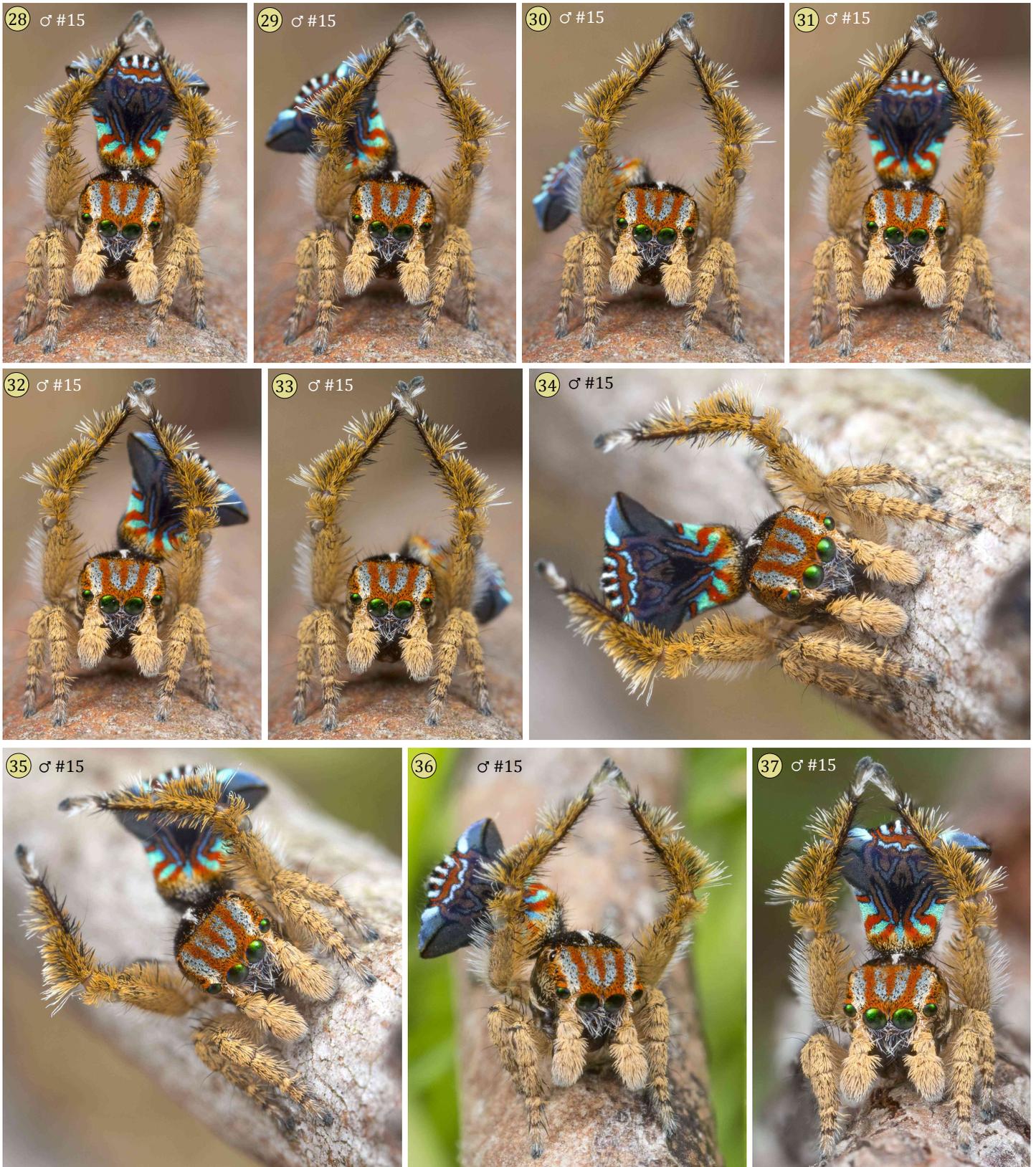


Figure 38 (continued from previous page). Positions assumed by male *Maratus unicip* as they displayed to females. **28-33**, This sequence illustrates succession of positions during 1.5 cycles of the *fan dance*: fan displayed at center (28), fan rotated to right side (29), fan rotated and twisted to display flap at right side (30), fan displayed at center (31), fan rotated to left side (32), and fan rotated and twisted with flap in view at left side (33). During the fan dance, legs III were flexed *dorsally* at the femuropatellar joint to bring the tarsi of the two legs into close proximity or contact at the midline, forming a closed bracket in front of the fan. When walking, this joint is normally flexed *ventrally*. **34-37**, Most likely *fan dance* positions.



Figure 39. Females attending to male *Maratus unicip* during the *fan dance*. **3-8**, During this sequence the female advanced toward the male and then moved back. Notice how this female raised herself to a higher position as she followed movement of the fan by the male. As in other members of the *vespa* group, legs IV of the male were extended far to the rear on either side during the *fan dance*. This position provides a clear field for unimpeded movement of the fan in either direction.

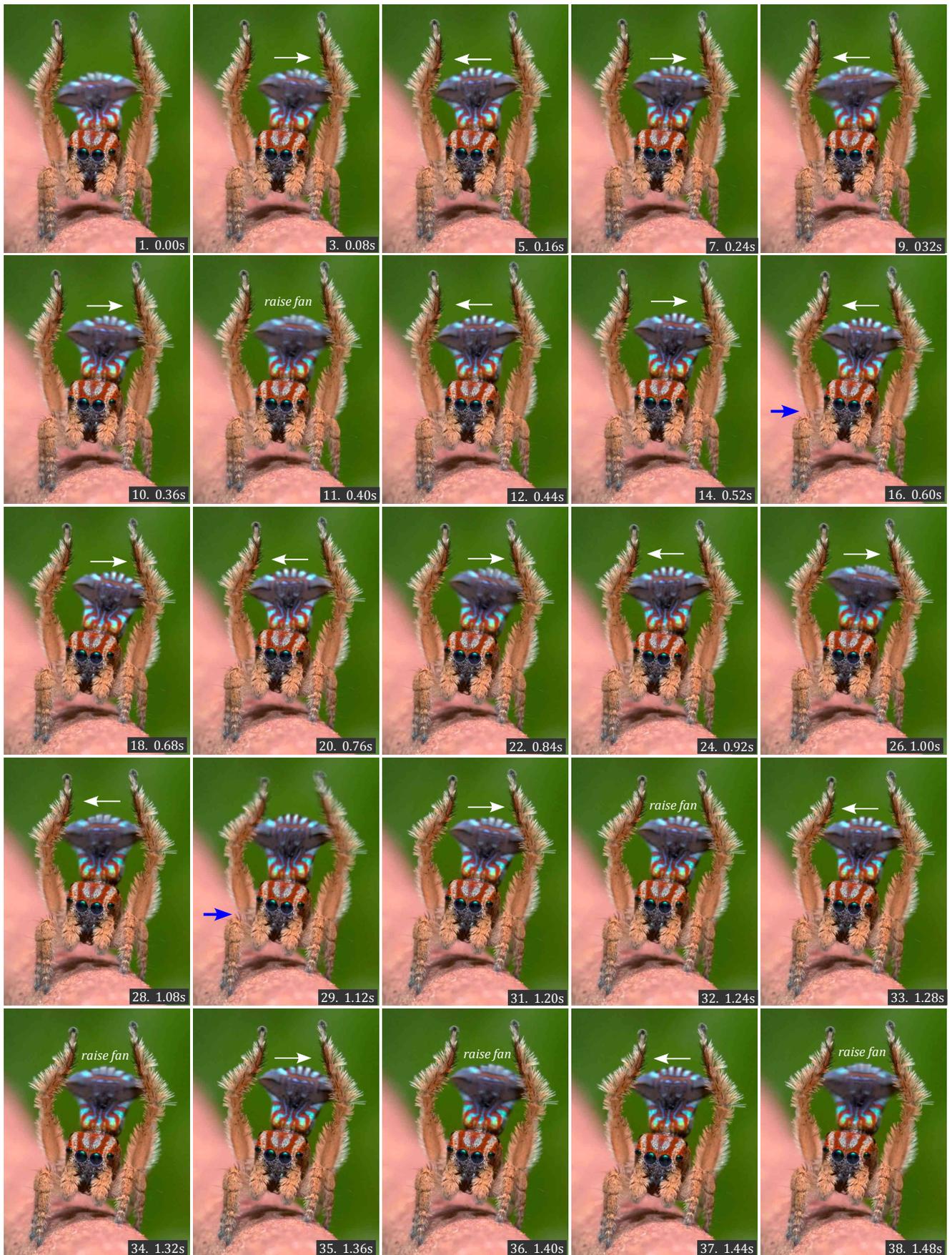


Figure 40. Sequential video frames from 25fps video showing the *fan wave* display (9 L+R cycles in 1.48s, or ~6 cycles/s) of a male *Maratus unicup*. Arrows indicate low amplitude (~2-10° of arc) movement of the fan.

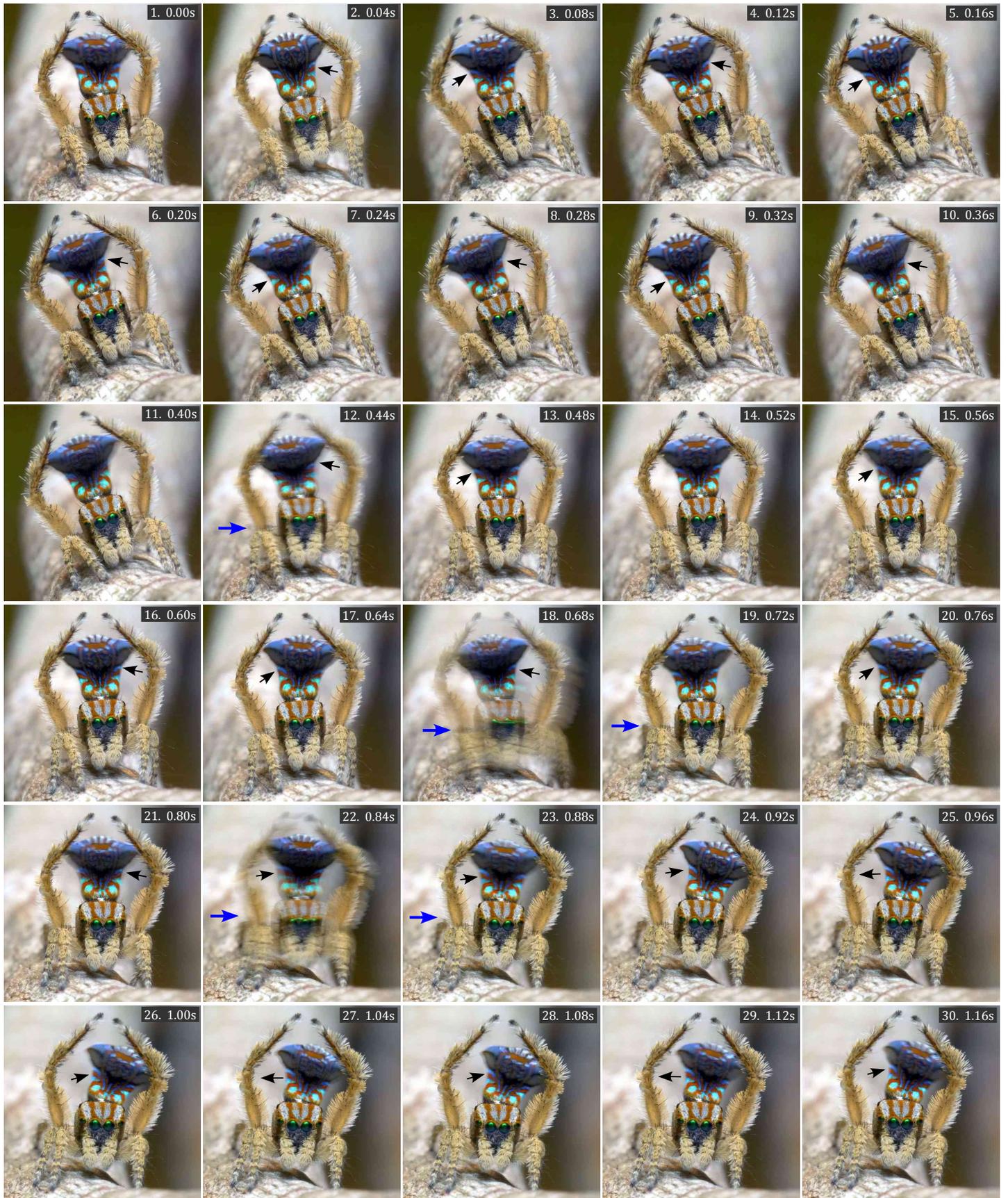


Figure 41. Consecutive video frames from 25fps video showing the *fan wave* display (11 L+R cycles in 1.16s, or ~ 9.5 cycles/s) of a male *Maratus unicup*. Small arrows indicate continuous low amplitude ($\sim 2\text{-}10^\circ$ of arc) movement of the fan relative to the preceding frame. Blue arrows at the side of the spider indicate rapid side-stepping during this display.

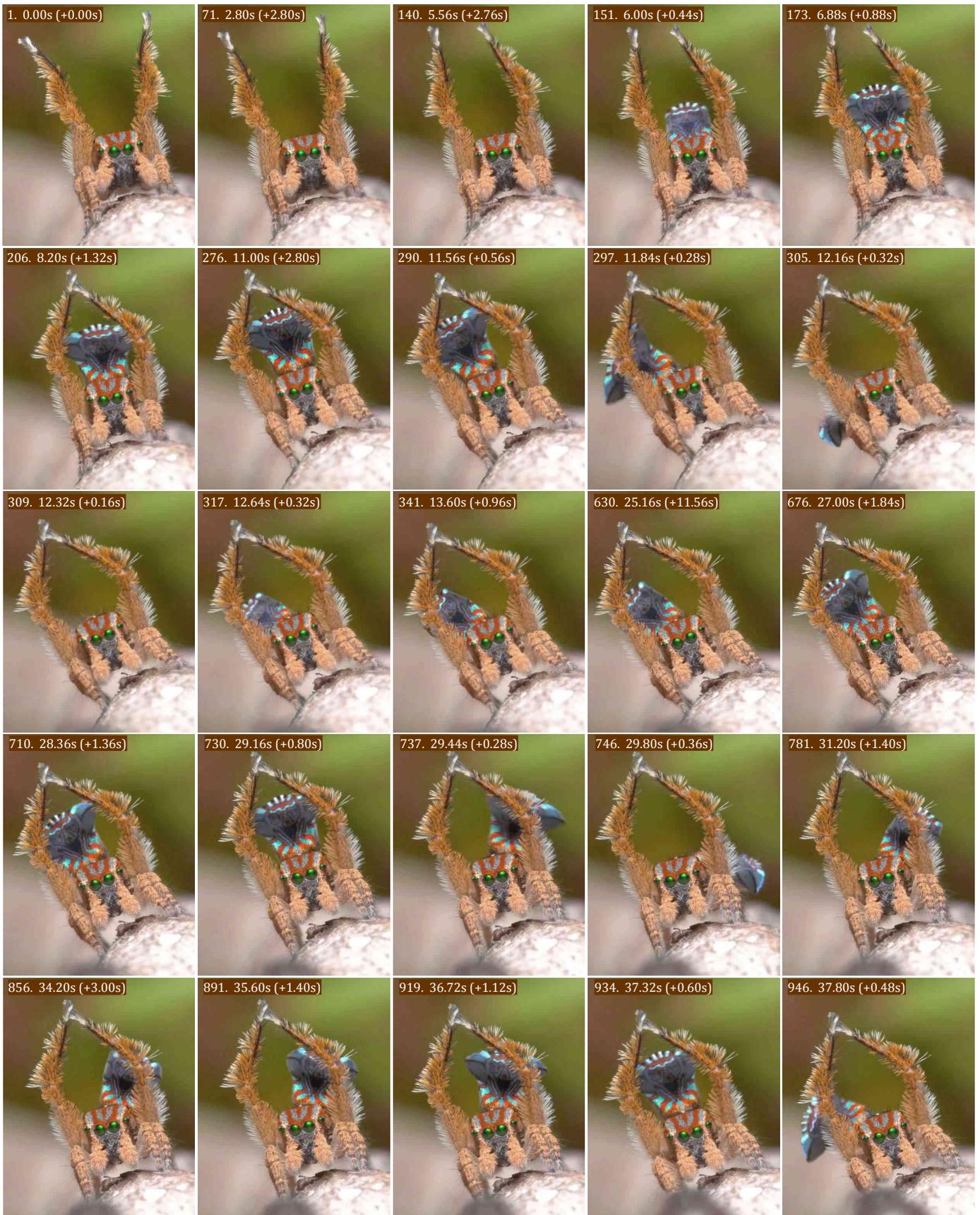


Figure 42. Sequential video frames from 25fps video showing transition (frames 2-206) from a *tall semaphore* display (frame 1) to a *fan dance* display (frames 207-946). **276-934**, Single cycle of the *fan dance* (~26.32s). During this cycle lowering of the fan to the right and left sides took only ~1.80s. Most of the time the fan was being raised.

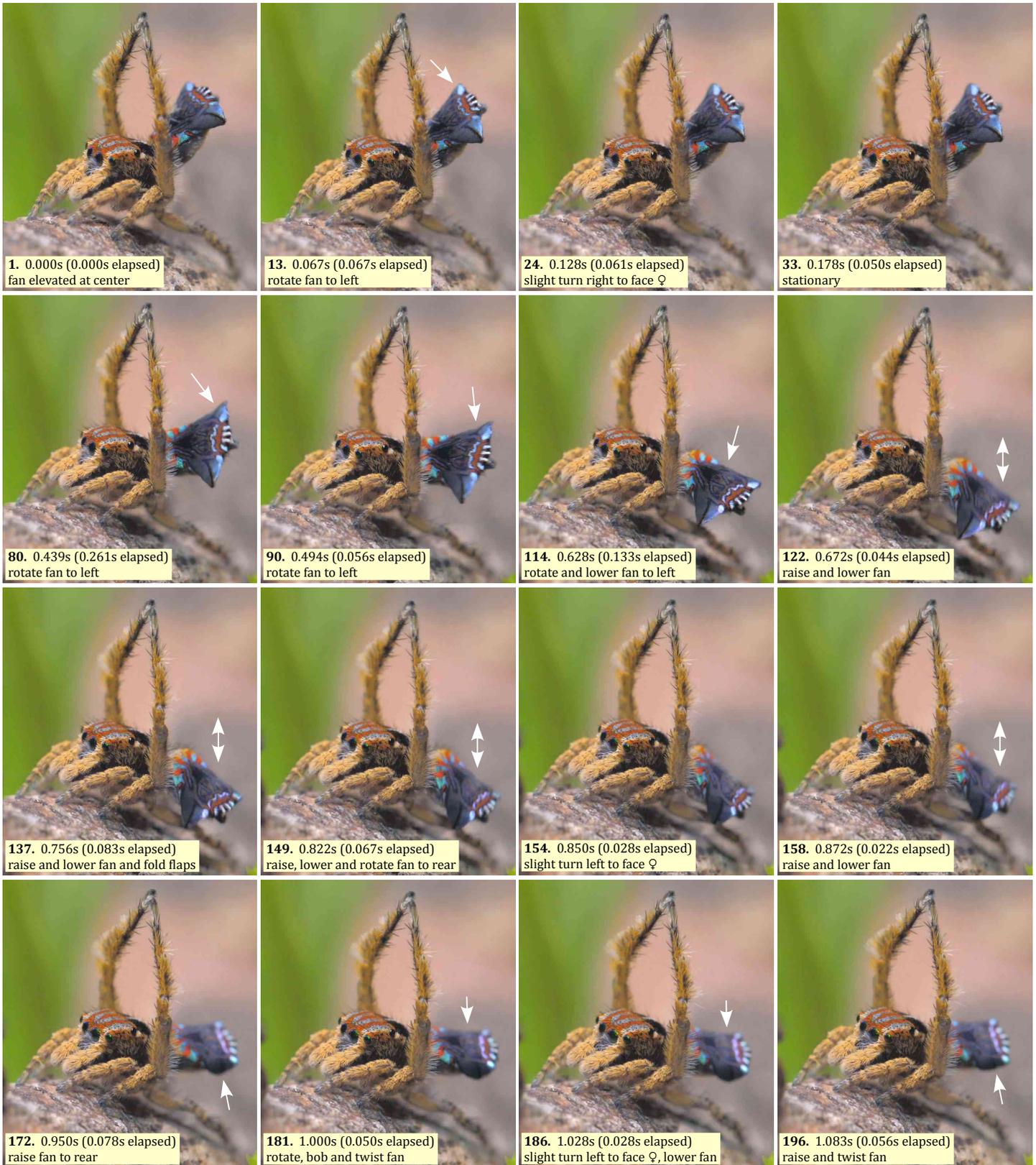


Figure 44 (continued on next page). Sequential frames from a high-speed (180fps) video of a *fan dance* performed by a male *Maratus unicus*. Arrows indicate movement of the fan relative to the preceding frame. See Figure 43:1 for a diagram of this display sequence.

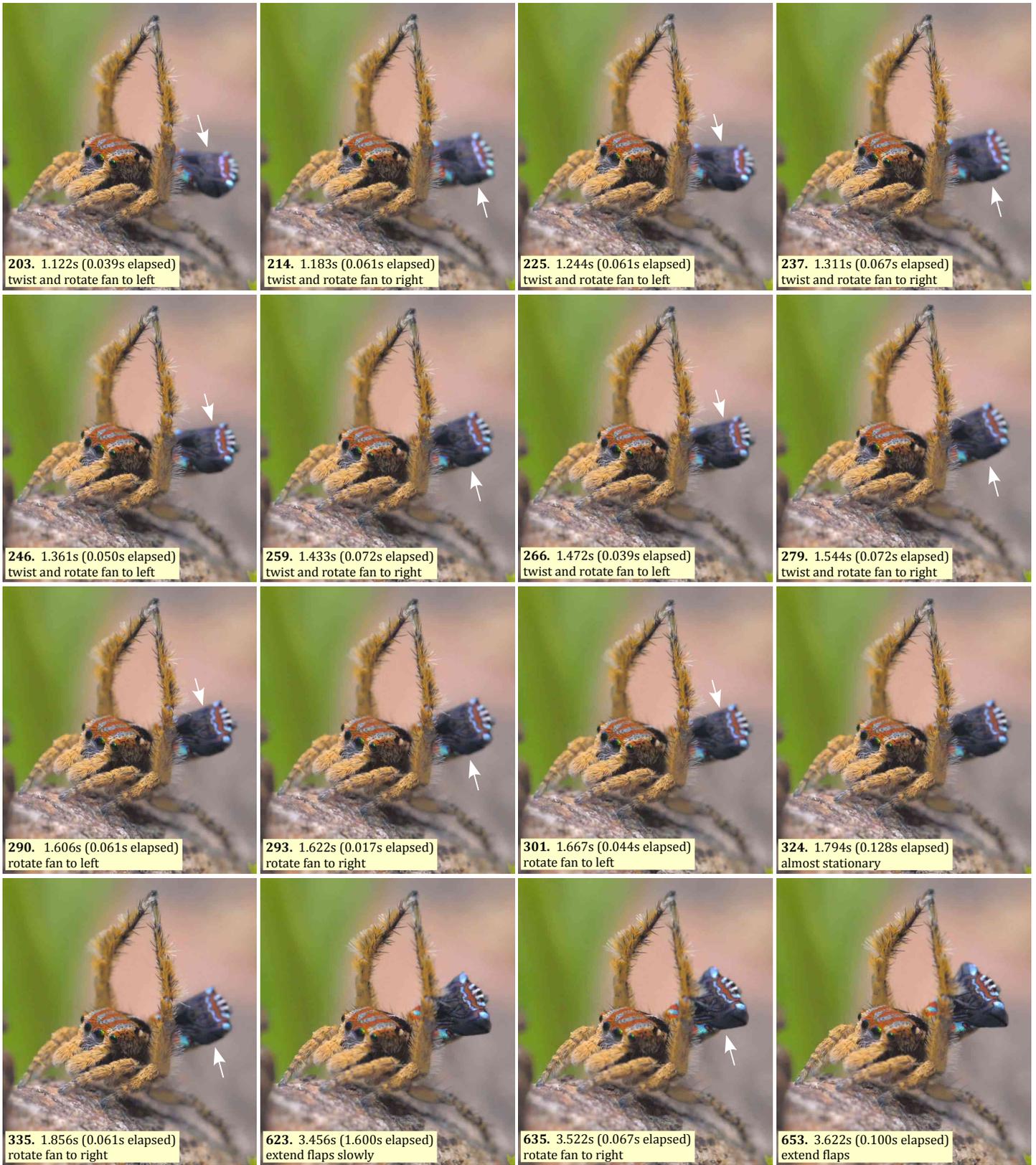


Figure 44 (continued from previous page, continued on next page). Sequential frames from a high-speed (180fps) video of a fan dance performed by a male *Maratus unicup*.

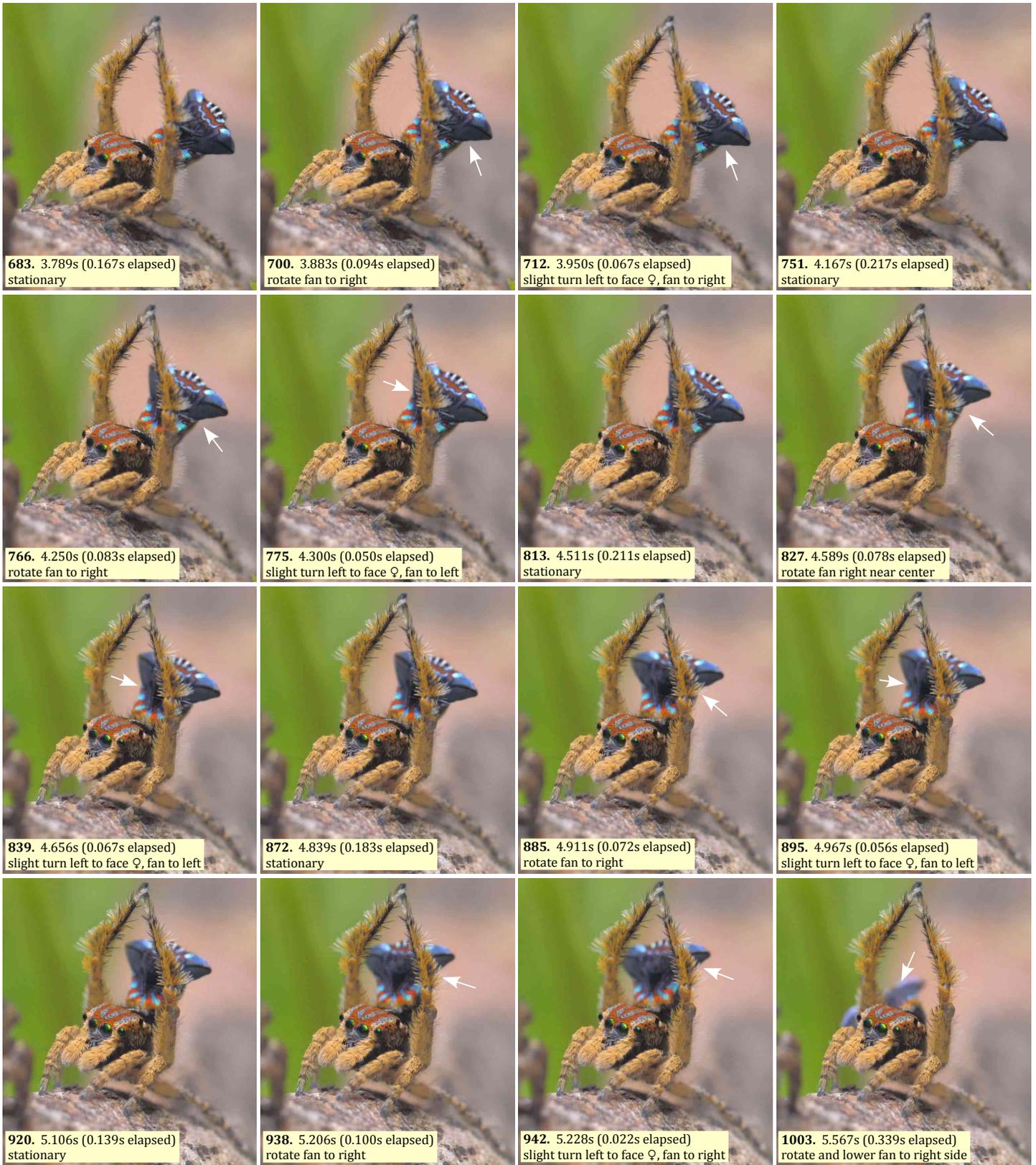


Figure 44 (continued from previous page, continued on next page). Sequential frames from a high-speed (180fps) video of a fan dance performed by a male *Maratus unicip*.

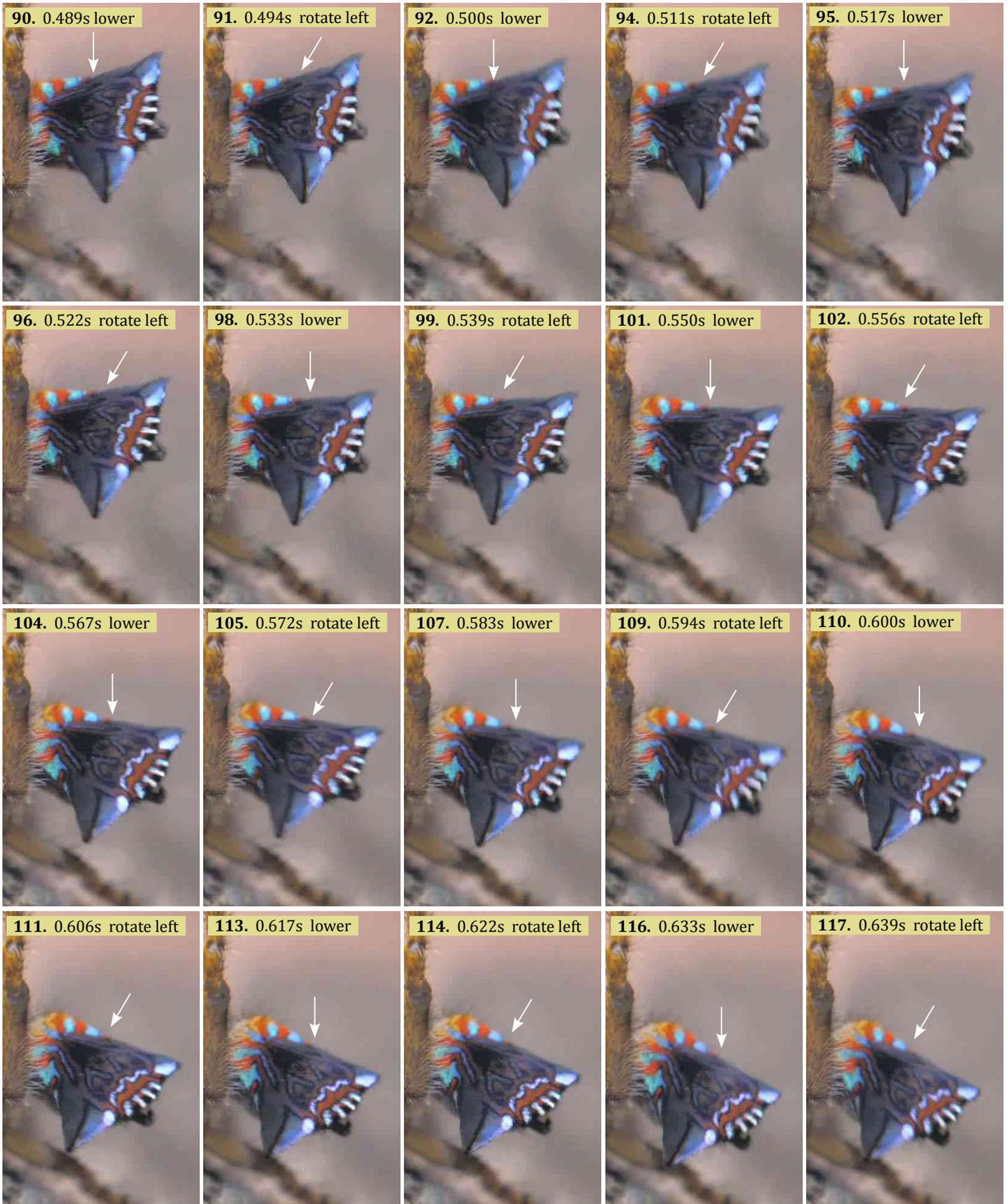


Figure 45 (continued on next page). Detail from sequential frames from a high-speed (180fps) video of a *fan dance* performed by a male *Maratus unicus*. **90-119**, Lowering and twisting the fan to display the left flap on the left side. Rotation to the front (diagonal arrows) alternated with lowering (vertical arrows) at a very high speed (10 cycles in 1.61s, 62 cycles/s).



Figure 45 (continued from previous page). Detail from sequential frames from a high-speed (180fps) video of a *fan dance* performed by a male *Maratus unicup*. **119-149**, Rapid up and down movement (9.5 UP+DOWN cycles in 0.167s, 57 cycles/s) of fan as the left flap was displayed at the left side.

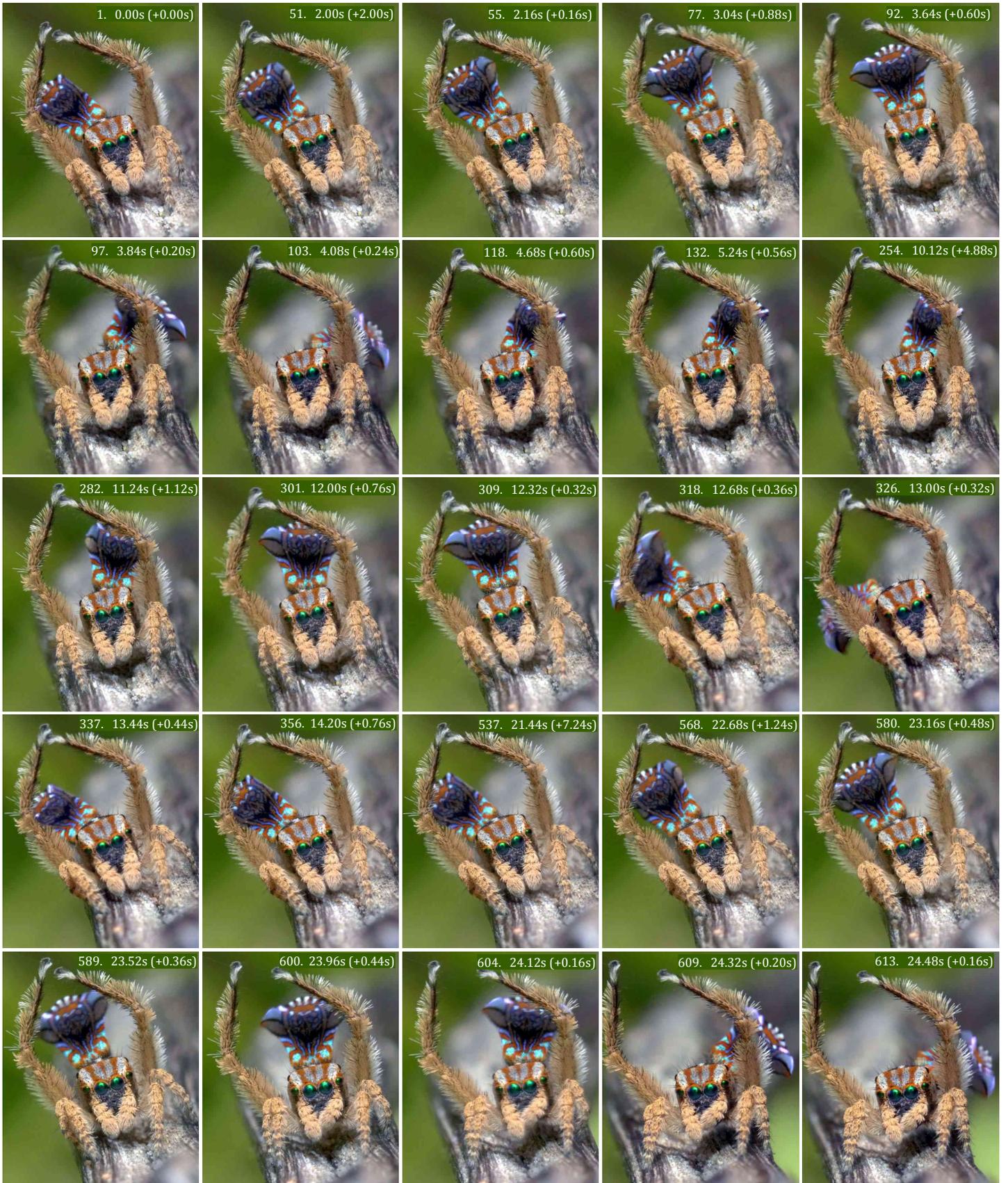


Figure 46. Sequential frames from a 25fps video of a *fan dance* performed by a male *Maratus unicip*. See Figure 43:2 for a diagram of this display sequence.



Figure 47 (continued on next page). Sequential frames from a 25fps video of a fan dance performed by a male *Maratus unicup*. This male was feeding on a small insect as he displayed to a nearby female. This is a good demonstration of the multi-tasking ability of salticids. See Figure 43:3 for a diagram of this display sequence.

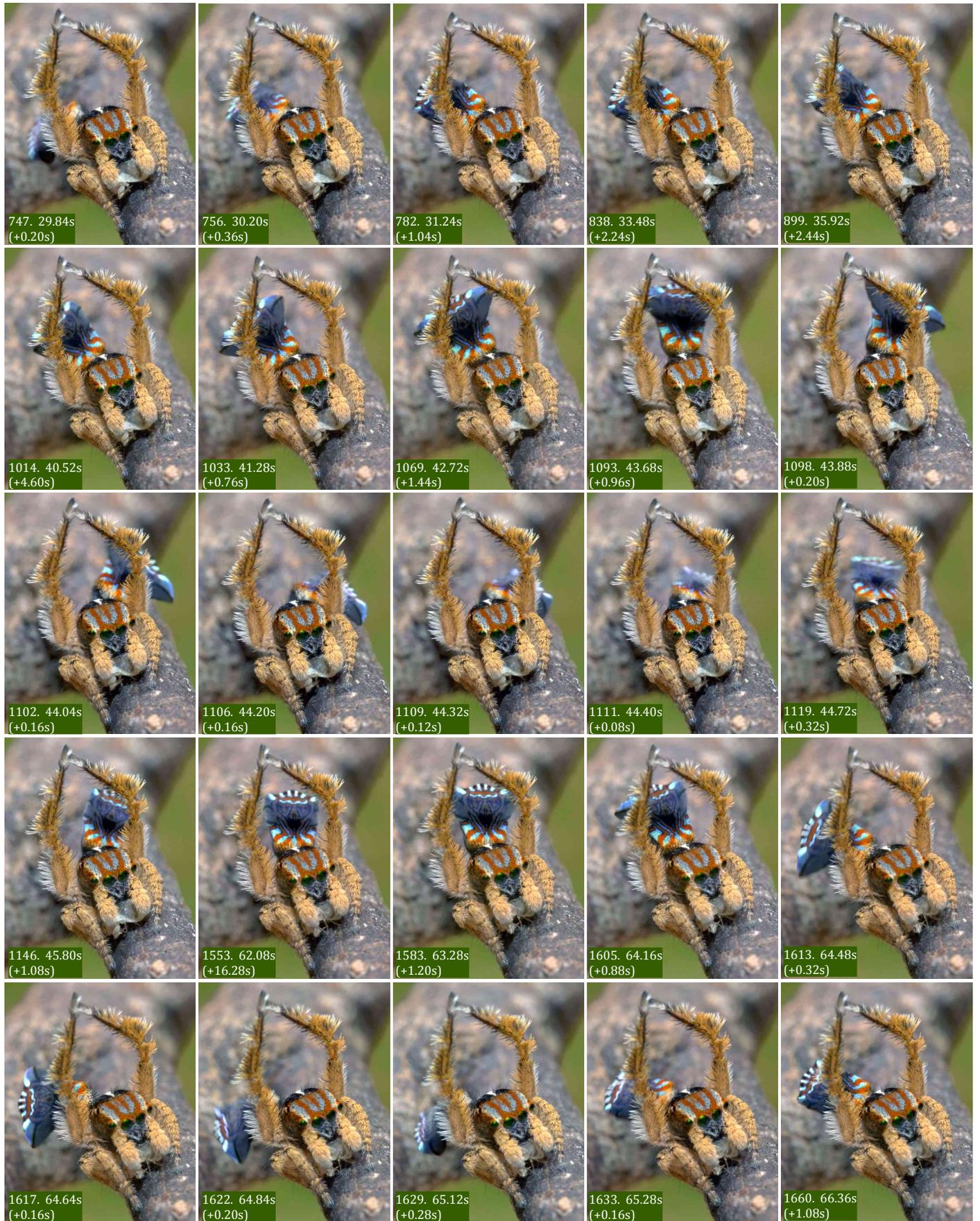


Figure 47 (continued from previous page). Sequential frames from a 25fps video of a *fan dance* performed by a male *Maratus unicus*.

Mating (Figures 48-51). The final approach of a courting male to contact and mount a female is shown in Figures 48 and 50. As is usual in *Maratus* species, legs III of the male were extended at the sides until he made contact with the carapace of the female with his legs I. Rotation of the opisthosoma of the female from side to side during mating was guided by the male (Figures 50:918-1042, 51). Males also bobbed (vibrated) their elevated opisthosoma as they mated.



Figure 48. Contact of courting male *Maratus unicip* with females.



Figure 49. Mating *Maratus unicip* pairs. Males elevated their opisthosoma as they mated.

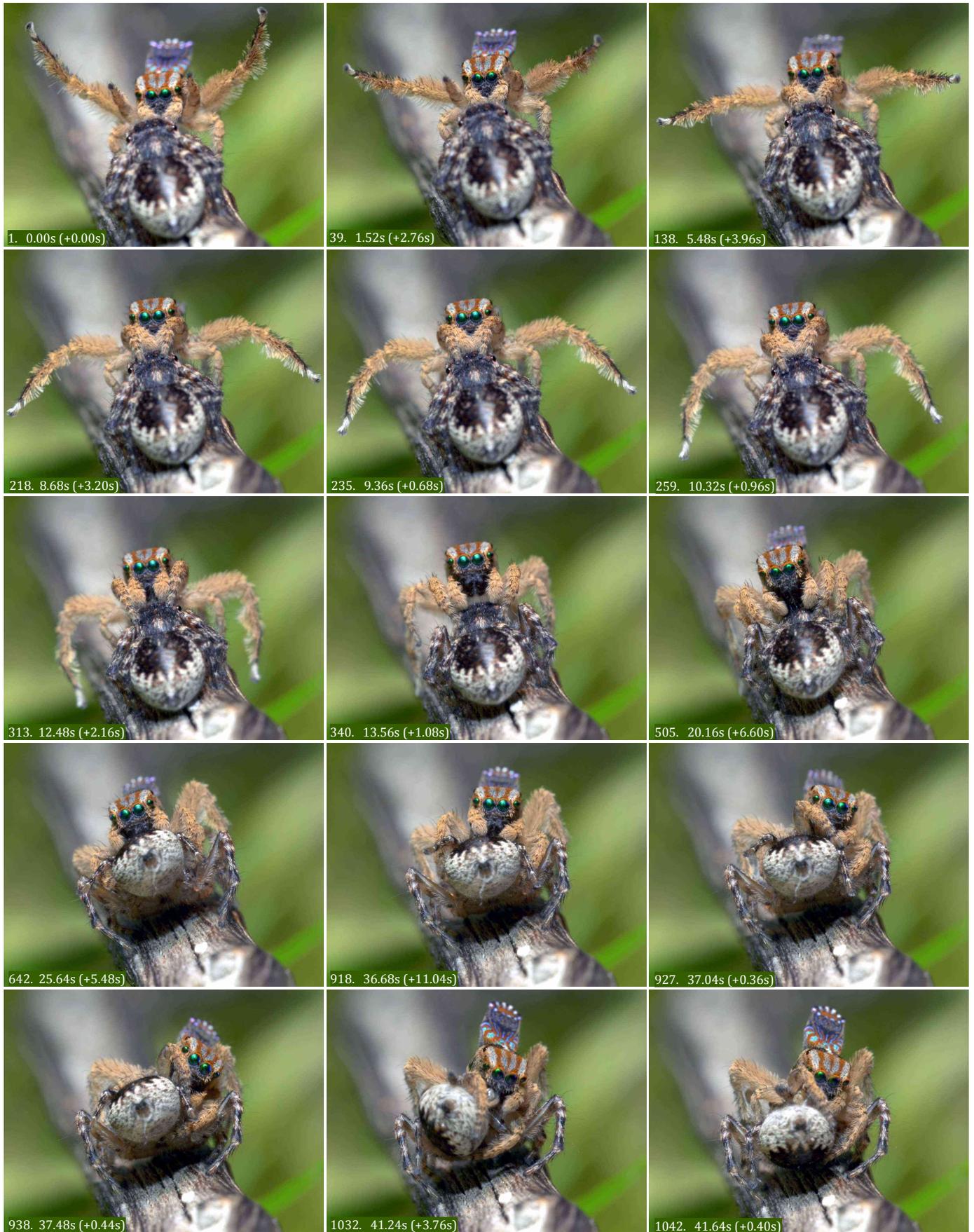


Figure 50. Sequential frames (frame numbers from a 25fps video) showing contact, mounting and mating on the right side by a *Maratus unicip* pair.

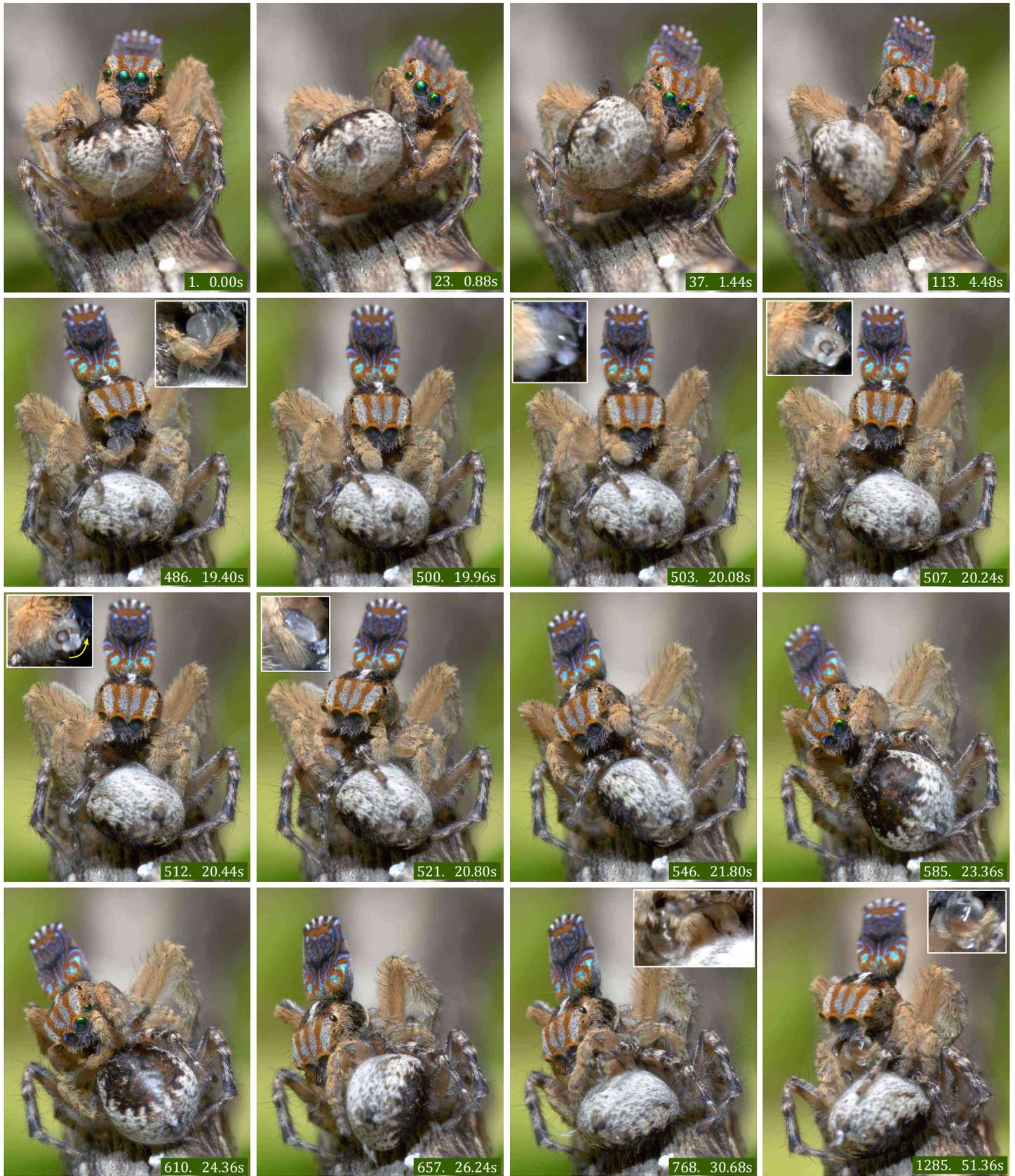


Figure 51. Sequential frames (frame numbers from a 25fps video of *M. unicum*) showing rotation of the female opisthosoma by $\sim 160^\circ$ on the right side followed by rotation of $\sim 340^\circ$ to mate on the left side. **486**, Inflated right tegulum (detail shown in inset rectangle). **503**, Sperm droplet attached to the tegulum after the right pedipalp was lifted from the epigynum. **507-512**, After it was withdrawn the circular embolus of the right pedipalp was rotated in a counter-clockwise direction as shown here. **768**, Inflated left tegulum. **1285**, Inflated left tegulum bearing sperm droplet after it was lifted from the epigynum.

Habitat. *Maratus unicip* were found on or near the ground at the Unicip Nature Reserve (Figure 52). The vegetation on this site included open woodland species such as Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*), but also plants more characteristic of swampland/dampland such as *Hibbertia* sp., Red Swamp Banksia (*Banksia occidentalis*) or Sundew (*Drosera* sp.). At the time of the visit the ground was relatively dry but lush and much of the surrounding area was inundated.



Figure 52. Habitat of *Maratus unicip* at the Unicip Nature Reserve in Western Australia.

Acknowledgments

We thank David Knowles for his role in the discovery of *Maratus tortus*, and for contributing habitat information. We also thank the Parks and Wildlife Service, Western Australia. All photographs, except the map backgrounds in Figure 1, are Copyright © Jürgen C. Otto.

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