

Two new peacock spiders in the *Maratus vespa* group of southwestern Australia (Araneae: Salticidae: Euophryini: Australphryni)

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Abstract. Two new species in the *vespa* group of the genus *Maratus*, from the biodiversity hotspot of southwestern Australia, are described: *M. astarte* and *M. manjimup*. Courtship display by males of both species is also documented.

Keywords. courtship behaviour, jumping spider, Fisherian runaway, narrow endemic, sexual selection

Previously 12 species, all endemic to the southwestern corner of Australia, have been assigned to the *vespa* group of the genus *Maratus* Karsch 1878. Here we describe two new species within this group, *M. astarte* and *M. manjimup*, each from a single locality (Table 1, Figure 1). We also describe courtship display by males of each new species, which resembles that of other members of the *vespa* group in that it features not only active advertisement and rapid movement at a distance, but also more subtle movement in the close proximity of, and direct observation by, a female.

Table 1. Members of the *Maratus vespa* group (updated from Otto & Hill 2022).

map#	species	reference	type collectors	type locality
1	<i>M. aquilus</i>	Schubert 2019	M. Duncan	34.85167S, 117.14833E
2	<i>M. astarte</i> , new species	Otto & Hill 2025 (this paper)	M. Brewer	35.03152S, 117.15418E
3	<i>M. azureus</i>	Schubert 2020	D. Harley, J. Schubert	34.09981S, 116.50479E
4	<i>M. combustus</i>	Schubert 2019	M. Duncan	34.85306S, 117.18667E
5	<i>M. cristatus</i>	Otto & Hill 2017	J. Otto	34.96797S, 116.97943E
6	<i>M. fletcheri</i>	Waldock 2020, in Waldock et al. 2020	A. Fletcher, M. Doe, M. Duncan	33.80972S, 115.21528E
7	<i>M. harveyi</i>	Waldock 2020, in Waldock et al. 2020	M. E. Blosfelds, M. S. Harvey, P. Irvine, C. O'Toole	33.98128S, 115.74944E
8	<i>M. icarus</i>	Otto & Hill 2019	J. Otto	34.91230S, 116.56745E
9	<i>M. manjimup</i> , new species	Otto & Hill 2025 (this paper)	F. Prall, J. Otto	34.42561S, 116.57650E
10	<i>M. noggerup</i>	Schubert 2020	D. Harley, J. Schubert	33.59623S, 116.15118E
11	<i>M. pinniger</i>	Otto & Hill 2022	P. Winthrop	33.94517S, 115.30256E
12	<i>M. tortus</i>	Otto & Hill 2018	J. Otto	34.78413S, 116.72002E
13	<i>M. unicum</i>	Otto & Hill 2018	J. Otto	34.37563S, 116.73133E
14	<i>M. vespa</i>	Otto & Hill 2016	D. Knowles, J. Otto	34.42018S, 115.69467E

Each of the two new species most closely resembles the *vespa* group species with the nearest type localities; their limited (*narrow endemic*) distribution also agrees with the previous observation that these species are parapatric (without overlapping ranges) with respect to other members of the *vespa* group (Figure 1; Otto & Hill 2022).

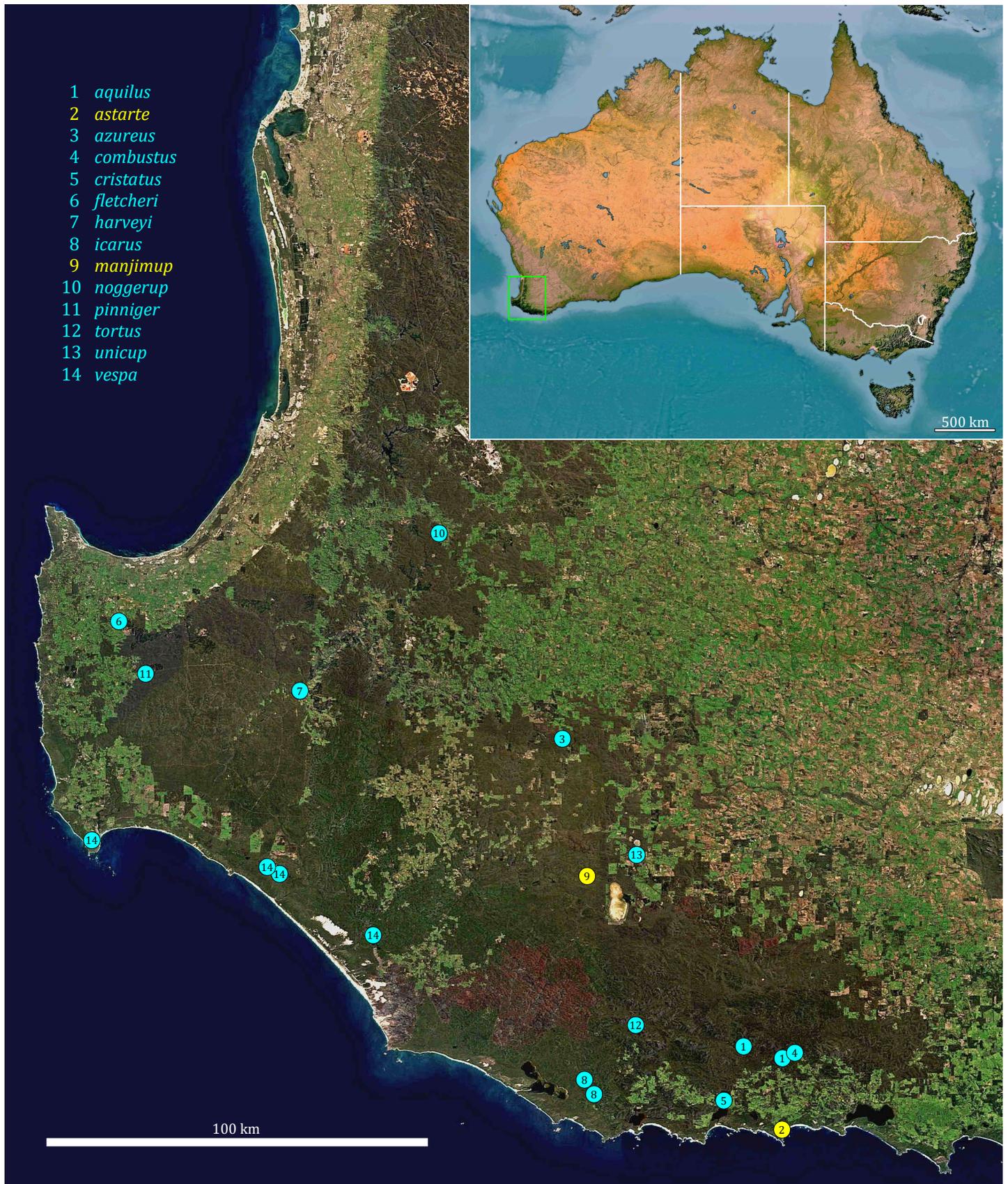


Figure 1. Known distribution of the 14 members of the *Maratus vespa* group in the global biodiversity hotspot of southwestern Australia (updated from Otto & Hill 2022). To date these species appear to be parapatric. *M. astarte* (2) is most similar to *M. cristatus* (5) and *M. icarus* (8); *M. manjimup* (9) is most similar to *M. unicup* (13) and *M. azureus* (3).

Maratus Karsch 1878type species *M. amabilis* Karsch 1878***Maratus astarte*, new species**

Type specimens. The holotype male (♂#1), two paratype males (♂#2-3), and one paratype female (♀#1) were collected along Astartea Glade, a road ca. 19 km WSW of Denmark, Western Australia (35.031516S, 117.154176E, 13 OCT 2024, coll. Matthew Brewer). All types will be deposited in the Western Australian Museum, Perth.

Etymology. The species group name, *astarte* (noun in apposition) refers to the fertility goddess *Astarte* of ancient Phoenicia, corresponding to Ishtar of Babylon and Aphrodite of Greece. This name was chosen because these spiders were found along a road called *Astartea Glade*; *Astartea* (Myrtaceae) is a genus of flowering plants endemic to Australia.

Diagnosis. This species is most similar to *Maratus cristatus* and *M. icarus*, but males can be identified by the distinctive pattern of scales and setae on their fan (Figure 2). As with other members of the *vespa* group, detailed structure of the male pedipalp and the female epigynum is not useful for identification to species, and the general appearance of females is also close to that of other members of the group.

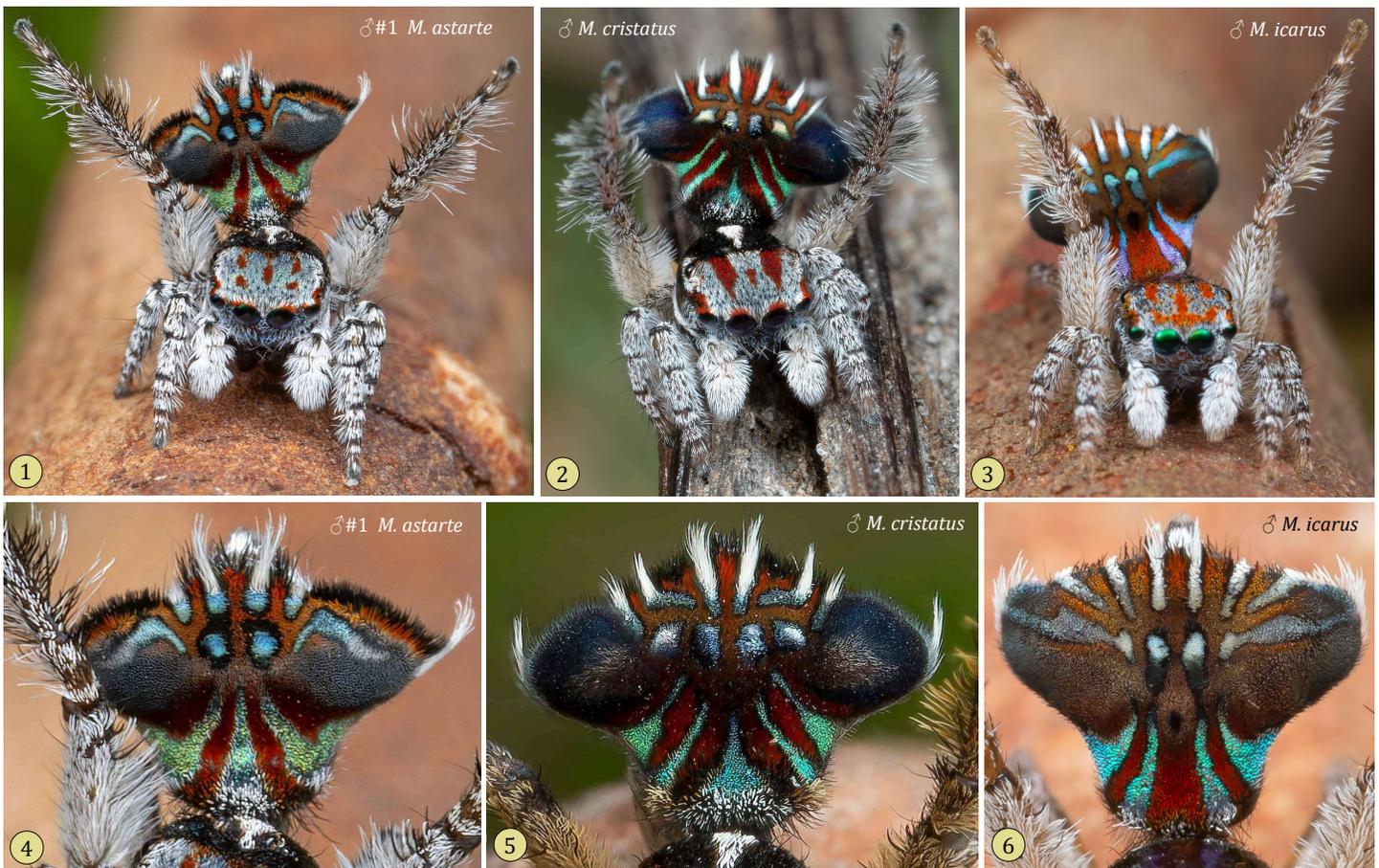


Figure 2. Comparison of a ♂ *Maratus astarte* (1, 4) to a ♂ *M. cristatus* (2, 5) and a ♂ *M. icarus* (3, 6). Although these are similar, there are many distinct differences, e.g., a light blue streak on each flap for *M. astarte* and *M. icarus*, compared to the more uniform colour of each flap of *M. cristatus*. The flaps of *M. astarte* are laterally acute with a thick posterior fringe of uniform black setae and a distal tuft of long, bright white setae; the other two species have rounded flaps.

Description of male (Figures 2.1, 2.4, 3-6). Males (n=3) ranged from 3.7-3.8 mm in length. The carapace of the living male is black. The face (vertical plane of anterior eye row) and clypeus have a cover of longer white setae, extending to either side to cover the carapace below the eye quadrangle. The chelicerae are black and glabrous. The dorsal surface of the pedipalps is densely covered with long, white setae. Above, the eye quadrangle (bounded by the four lateral eyes) has a flat cover of white to grey setae, interrupted by a broken stripe of dark red setae behind each AME, a middorsal or medial stripe of dark red setae at the rear, and a narrow, broken transverse line of dark red setae behind the anterior eyes. The PME are closer to the PLE than to the ALE. Behind the eye quadrangle the carapace is mostly black and glabrous, with scattered dark red to orange or white setae (scales) behind and below the PLE, a distinct marginal band of bright white scales, and a white middorsal (median) stripe (or elongated diamond shape) running from the rear of the eye quadrangle to the rear of the carapace.

The fan (dorsal opisthosomal plate) is covered with a distinctive pattern of scales, with red-orange stripes or figures on a background of (from front to rear) iridescent blue-green, grey, and iridescent light blue to white scales; lateral flaps of the fan have a tuft of bright white setae extending laterally from their acute distal end, and a long tuft of white setae extends to the rear on either side of the midline (see Figures 2.4, 3.3, 3.10, 3.13). At the rear of the opisthosoma, below the dorsal plate, there is a distinct small triangle of bright white setae, above the dark grey spinnerets. Below, the opisthosoma has a cover of longer white to off-white setae (Figure 4). From below, scattered white setae extend from the legs and the rear of the sternum, and the coxae, sternum, labium, chelicerae and pedipalps are mostly glabrous and dark grey in colour. Legs I and II are shorter and about the same length, legs III the longest with fringes of long setae extending from the dorsal femur, the dorsal and ventral tibia, and the ventral metatarsus (Figures 2.1, 3.3). Detailed structure of the pedipalp (Figure 6) is the same as that previously described for other members of the *vespa* group.

Description of female (Figures 7-9). The female (n=1) was 5.2 mm in length. The female resembles other *Maratus* species in all respects, with a generally brown colour, and a broad off-white band on either side of the opisthosoma. Longer off-white to white setae extend dorsoventrally below the front eyes and each proximal paturon; otherwise the chelicerae are brown and glabrous. The eye quadrangle has a cover of mixed red-brown and off-white scales, with many of these scattered to either side on the sides of the carapace. As is usual for *Maratus*, the carapace of the female lacks the marginal band seen in males. The PME are closer to the PLE than to the ALE. Above, the carapace is black, with a narrow middorsal (median) stripe of mostly off-white scales behind the eye quadrangle, and a wider stripe of mostly off-white scales (mixed with dull orange or red-brown scales) extending below and to the rear of each PLE.

The top of the opisthosoma is dark brown, with a narrow or indistinct median stripe of off-white scales near the front. Off-white scales cover the sides and venter of the opisthosoma, which is mottled (Figure 8). Like the male, the female has a distinct, small triangular tuft of bright white setae (Figures 7.10, 7.12) above the grey posterior spinnerets. Below, the coxae, sternum, endites, and chelicerae are grey or light brown and mostly glabrous, with scattered longer setae emerging from the rear of the sternum. Legs I and II are shorter and about the same length, Legs III and IV longer. All legs are similar in colour, with indistinct bands of mixed off-white and red-brown scales alternating with dark-brown to black sections, most evident on legs III and IV. The epigynum (Figure 9.6) is like that of other *Maratus* species, with relatively large windows at the front, larger spermathecae at the rear, and sclerotized (darker) copulatory ducts between these.



Figure 3 (continued on next page). Adult male types for *Maratus astarte*. 3, 10, 18, Fan elevated with extended flaps during courtship display. 11, Legs II elevated, in vertical position, during courtship display.



Figure 3 (continued from previous page). Adult male types for *Maratus astarte*.



Figure 4. Ventral views of adult male types for *Maratus astarte*.



Figure 5. Male type specimens for *Maratus astarte*, preserved in alcohol.

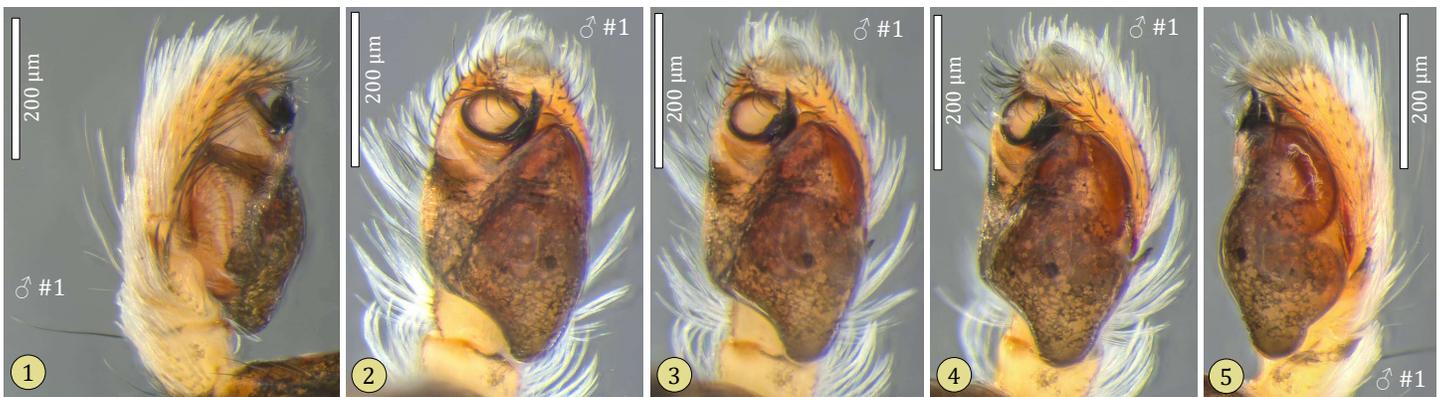


Figure 6. Medial to near lateral (retrolateral) views of the left pedipalp of the male holotype for *Maratus astarte*, in alcohol solution.



Figure 7. Adult female paratype for *Maratus astarte*.



Figure 8. Ventral views of adult female paratype for *Maratus astarte*.

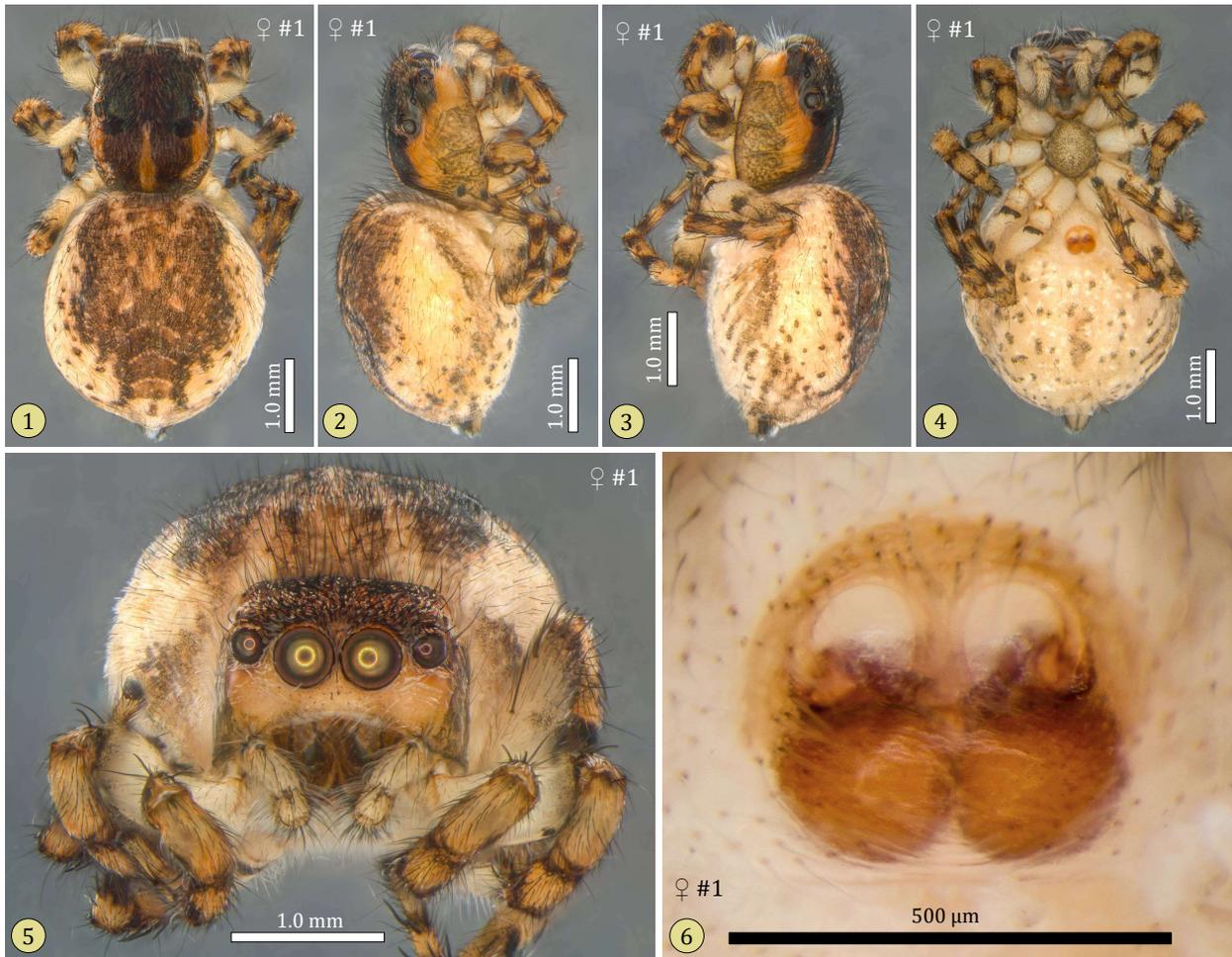


Figure 9. Adult female paratype for *Maratus astarte*, preserved in alcohol. 6, Detail of epigynum, ventral view.

Courtship display (Table 2, Figures 10-19). Five modes of display by the male *Maratus astarte* were observed in the proximity of the female in a laboratory-simulated natural setting (Table 2). These are grouped into three general categories. With *advertisement*, movements of the male may attract the attention of females in the vicinity, which may reveal themselves to the male with their own movement. *Attraction* displays are targeted at females at a distance from the male, apparently to entice the female to approach more closely (unless the male does this first). During the *examination* display side to side movement of the male (either stepping, or turning the fan) leads an attending female to turn to follow (or *examine*) that movement closely. As with other salticid species, it appears that the cessation of *facing turns* (turns to face the male) by the female provides the male with a sign that she is ready to mate. In the *vespa* group, females may approach the males to a distance of less than 1 cm during the examination display. Many published studies of salticid courtship (e.g., Elias et al. 2003; Girard et al. 2011) fail to consider interactions between males and females, and may rely on either a female model or an anesthetized female to elicit a male reaction. These studies reveal something about the *kinematics* of male movement. However, to understand the *dynamics* of salticid courtship, it is necessary to follow the male response to the behavior of the female that is being courted.

Table 2. Display modes observed for a courting male *Maratus astarte*.

ref#	category	display	description	Figures
1	advertisement	single leg wave	2 Hz wave of one leg III extended to side, regular or irregular	10.1, 10.2, 11
2	advertisement	two leg wave	1-3 Hz near-bilaterally symmetric semaphore wave of both legs III	12
3	attraction	low fan wave	wave low fan with posterior tufts visible above carapace at 2.8 Hz	13
4	attraction	high fan wave in place	fan fully elevated and extended, multiple waves to one side and then to the other at 5-6 Hz	10.3-10.21, 14-16
5	examination	high fan wave with side-stepping	very active: flaps of fan extended and fan elevated or slightly depressed, as side-stepping to one side then the other, fan wave, wave of both legs III at 4 Hz, and sometimes pedipalp flicker occur in a synchronous pattern	10.22-10.31, 17-19

Courtship display by *Maratus astarte* can be characterized as follows: Up-and-down movement of one or two extended legs III (Figures 10.1, 10.2, 11-12) may be either irregular, or rhythmic (1-3 Hz). If both legs III are involved, their movement tends to be loosely bilaterally symmetric. The timing is not tight, but when one leg III is raised or lowered, the other tends to move in the same way. This contrasts with the elaborate alternating leg III patterns (semaphore movement) seen in some other peacock spiders (e.g., *M. speciosus*, Hill & Otto 2014).

Without any lateral movement (stepping), the male may only slightly elevate the fan (*low fan wave*, Figure 13), or may fully elevate the fan with extended flaps (*high fan wave in place*, Figures 10.3-10.21, 14-16), and then wave this from side to side. The low fan wave is slower (~2.8 Hz), with low amplitude movement (~4°) at a centered position. During this display, the pair of bright white tufts at the rear of the fan is quite visible to a female in front of the male, but little else of the fan can be seen. During a high fan wave, the fan is fully elevated with expanded flaps. The amplitude of each wave during the high fan wave is much greater (can exceed 30°), and a series of waves (5-6 Hz, for about 1 sec) to one side may alternate with a series of waves to the opposite side. This movement may be interrupted by lower amplitude (~10-15°), slower (~2.5) waves of the elevated fan in a center position (Figures 14-16). It is noteworthy that, unlike some other members of the *vespa* group, flap folding is not important during the display of *M. astarte*.

During the most active display (*high fan wave with side-stepping*, Figures 10.22-10.31, 17-19), waving movement of the expanded and elevated fan, near-symmetric waving of the elevated legs III, and side stepping is synchronized at a rate of ~4 Hz. Up-and-down pedipalp movement (flicker) at the higher rate of ~12 Hz may also take place at the same time (Figure 17).

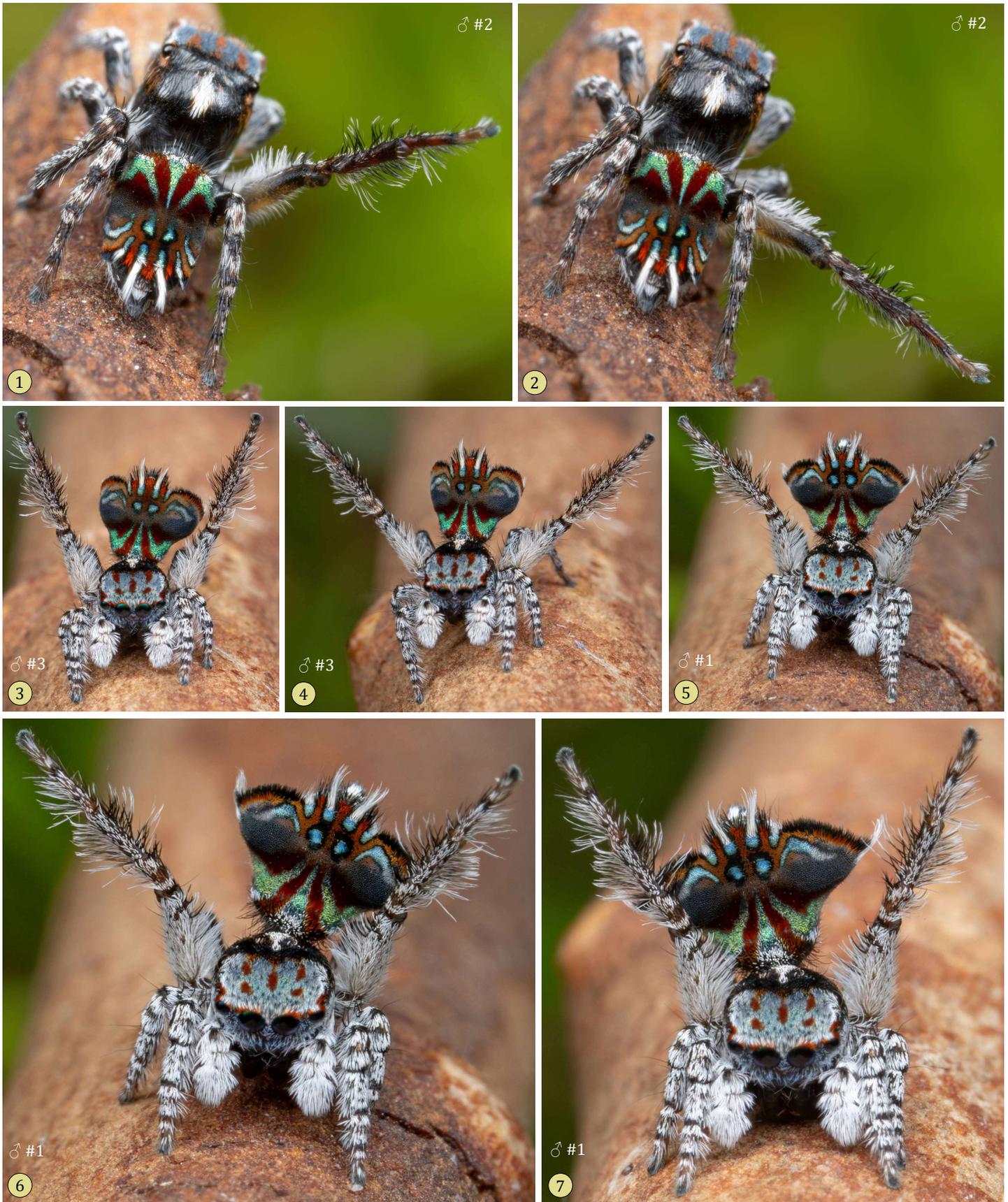


Figure 10 (continued on next page). Display positions of courting male *Maratus astarte*. 1-2, Single leg wave. 3-4, 5-6, 7, High fan wave in place, with legs III widely separated.



Figure 10 (continued from previous page, continued on next page). Display positions of courting male *Maratus astarte*. 8-9, 10, 11-12, 13-14, 15-17, Sequences showing the *high fan wave* in place display.



Figure 10 (continued from previous page, continued on next page). Display positions of courting male *Maratus astarte*. 18-21, Sequence showing the high fan wave in place display. 22-25, Sequence showing high fan wave with side-stepping in front of the female.



Figure 10 (continued from previous page). Display positions of courting male *Maratus astarte*. 26-31, Sequence showing high fan wave with side-stepping in front of the female. 32-33, Two views of a mating pair, showing the extreme rotation of the female opisthosoma typical of *Maratus* species.

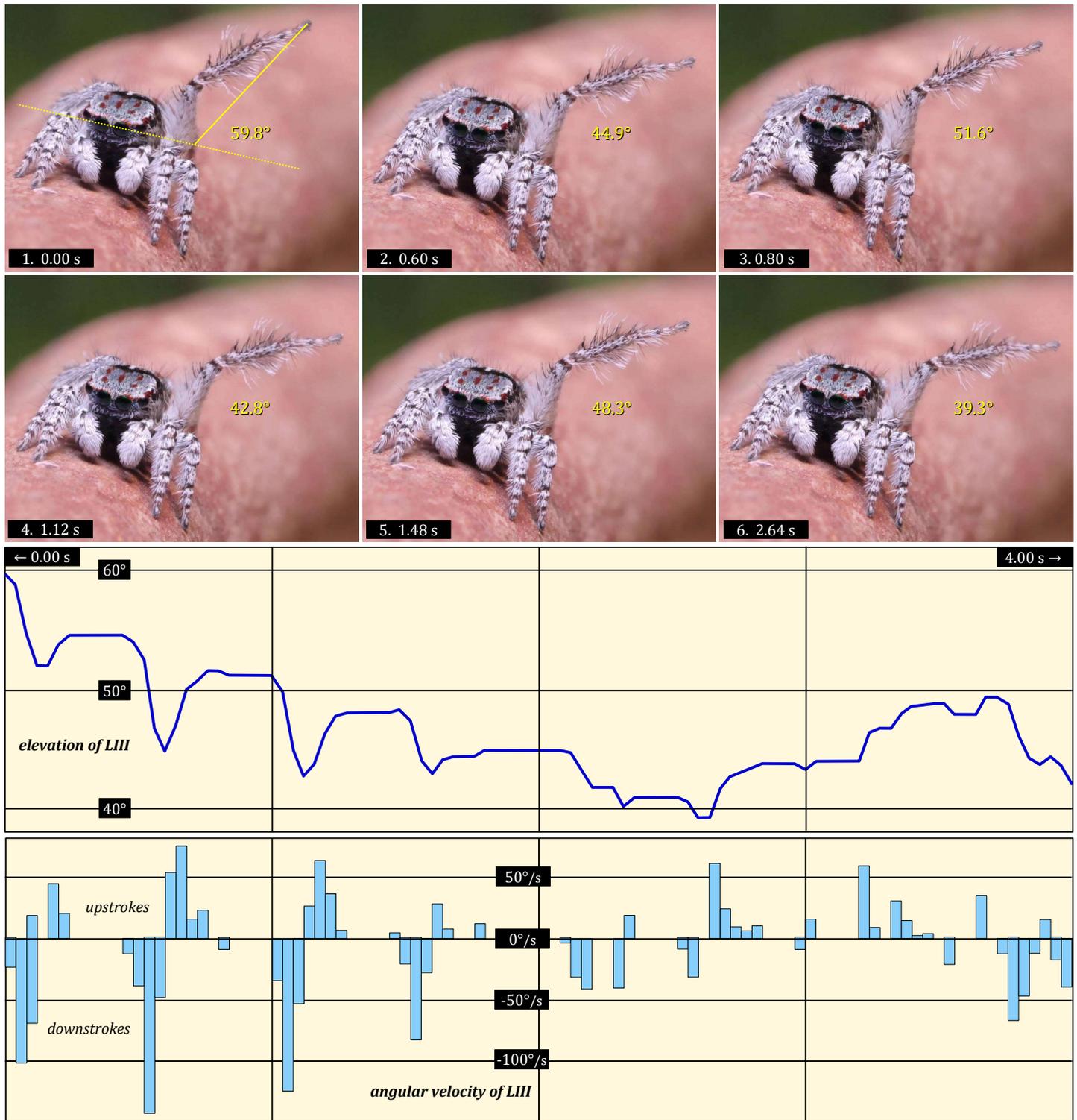


Figure 11. Single leg wave by a male *Maratus astarte* (based on 25 fps video, 4.00 s). **1-6**, Selected frames from the 4.0 second segment shown in the lower charts. **1**, A horizontal reference line for measurement of leg elevation was drawn through the center of the two ALE. Elevation of the leg was measured as shown, from the lateral side of the exposed femur to the tip of the left leg III. First chart: During the first two seconds of this interval the extended leg was waved at ~2 Hz as it was gradually lowered. Subsequently the extended leg was waved continuously, but irregularly over a smaller amplitude. Lower chart: Angular velocity of this leg III wave was much greater during the first two seconds.

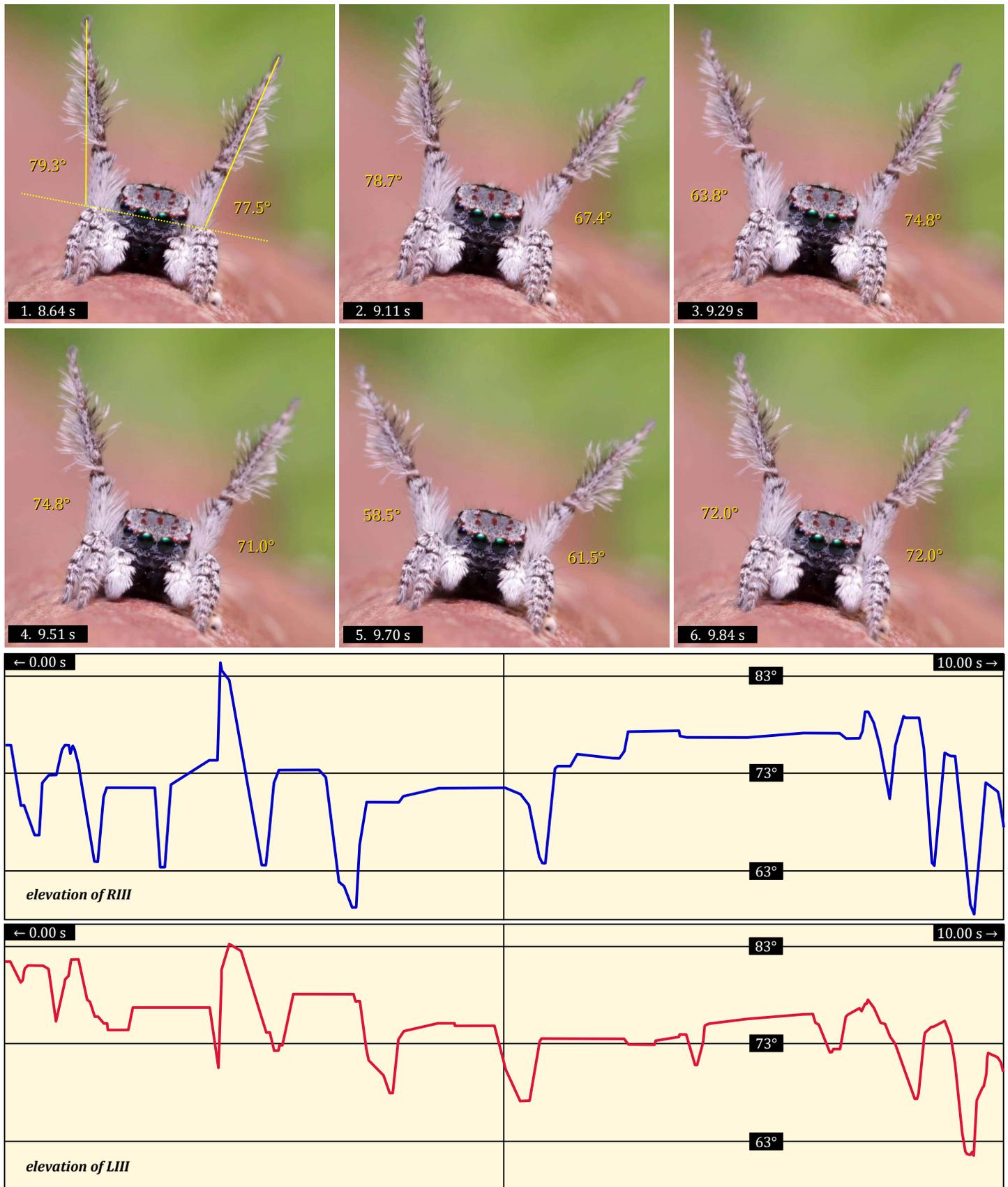


Figure 12. Two leg wave by a male *Maratus astarte* (based on 10.00 s from a 100 fps video). As shown by the charts, up-and-down movement of the two legs III, roughly (but not precisely) synchronous and bilaterally symmetric, ranged from 1 Hz at the onset to, after a pause, to ~2-3 Hz at the end of this sequence.

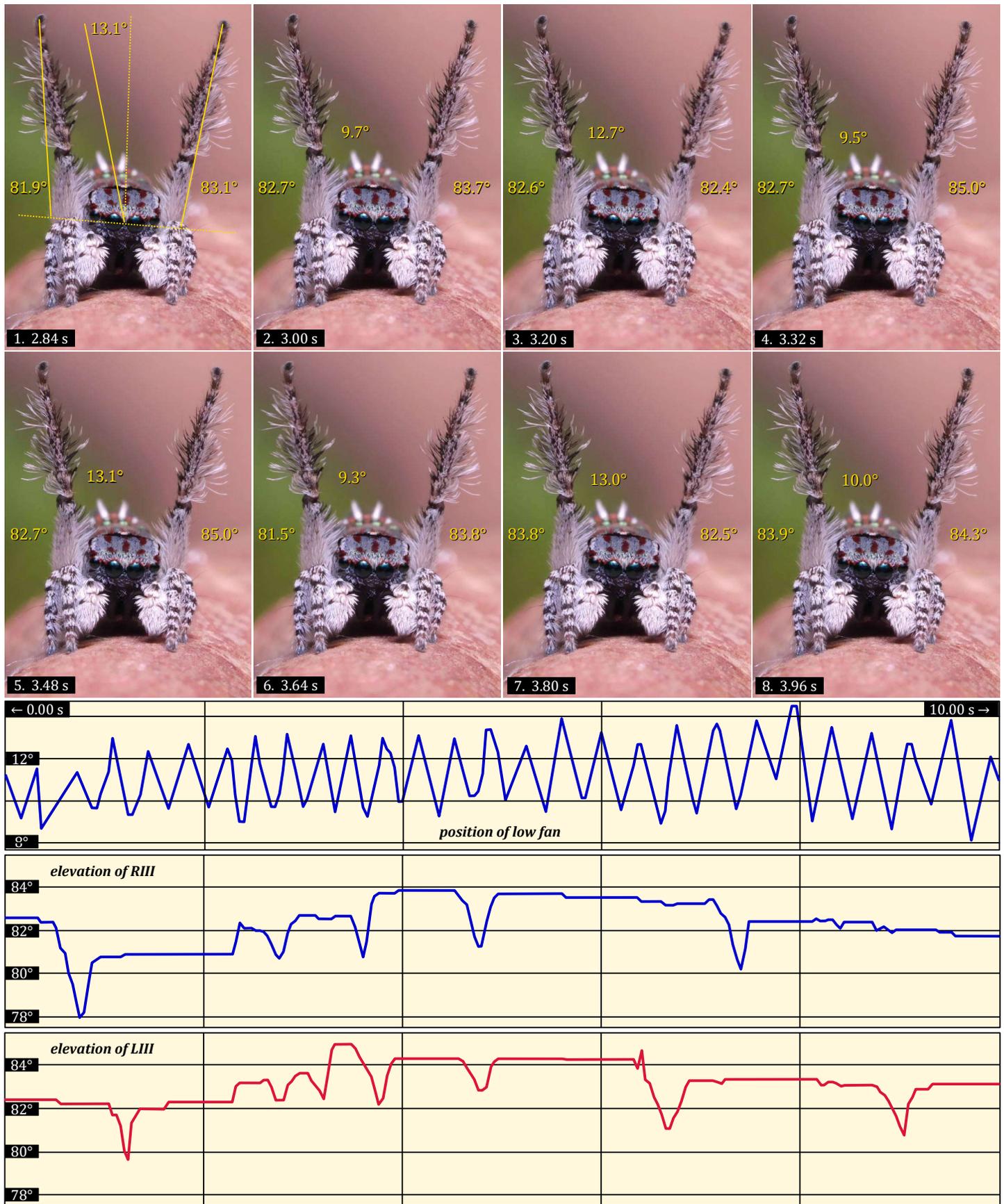


Figure 13. Low fan wave by a male *Maratus astarte* (based on 10.00 s from a 100 fps video). Legs III (lower two charts) were sometimes waved irregularly but near-synchronously, at other times held in place during this sequence, as the low fan, revealed by the two tufts of long white setae at the posterior, was waved near the median at a steady rate of ~2.8 Hz.

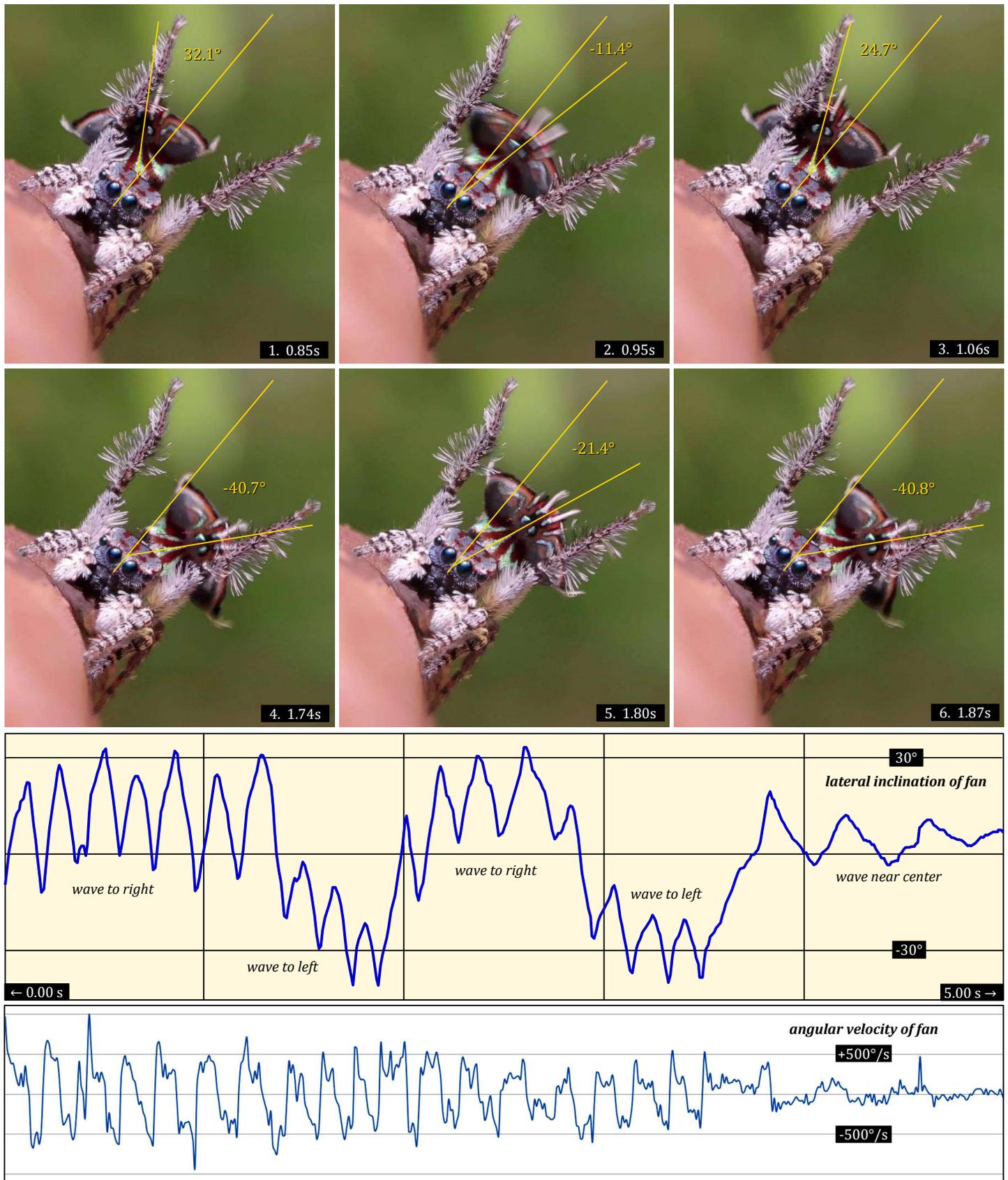


Figure 14. High fan wave in place by a male *Maratus astarte* (5.00 s from a 100 fps video). The fan was alternately waved through ~5 cycles for ~1 s (5 Hz) to one side, and then to the other, with a greater amplitude (~30°) when waving to the right side. At the end of this sequence the elevated and extended fan was waved more slowly (~2.5 Hz) at a lower amplitude (~10-15°) near the median (sagittal plane).

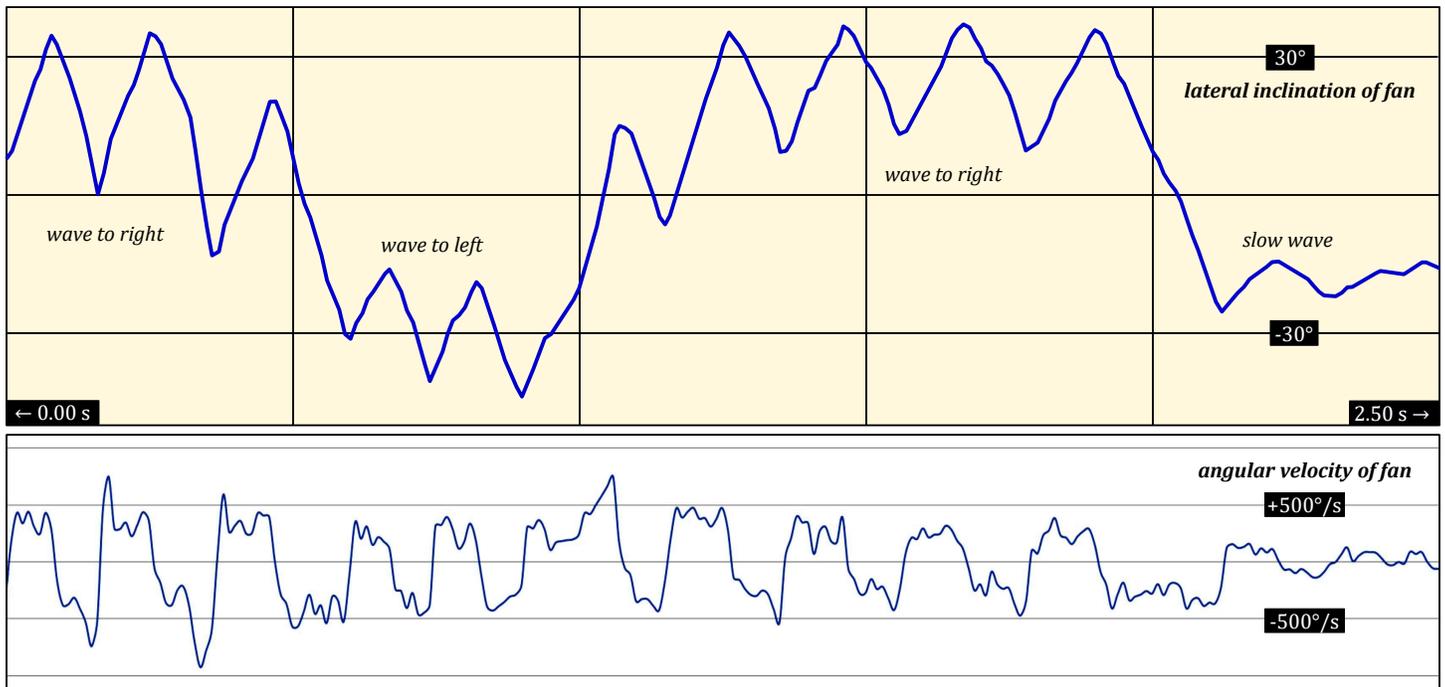


Figure 15. High fan wave in place by a male *Maratus astarte* (2.50 s from a 100 fps video). Like the sequence shown in Figure 14, the male also transitioned to a lower amplitude, slow wave after a series of waves to either side at ~5 Hz.

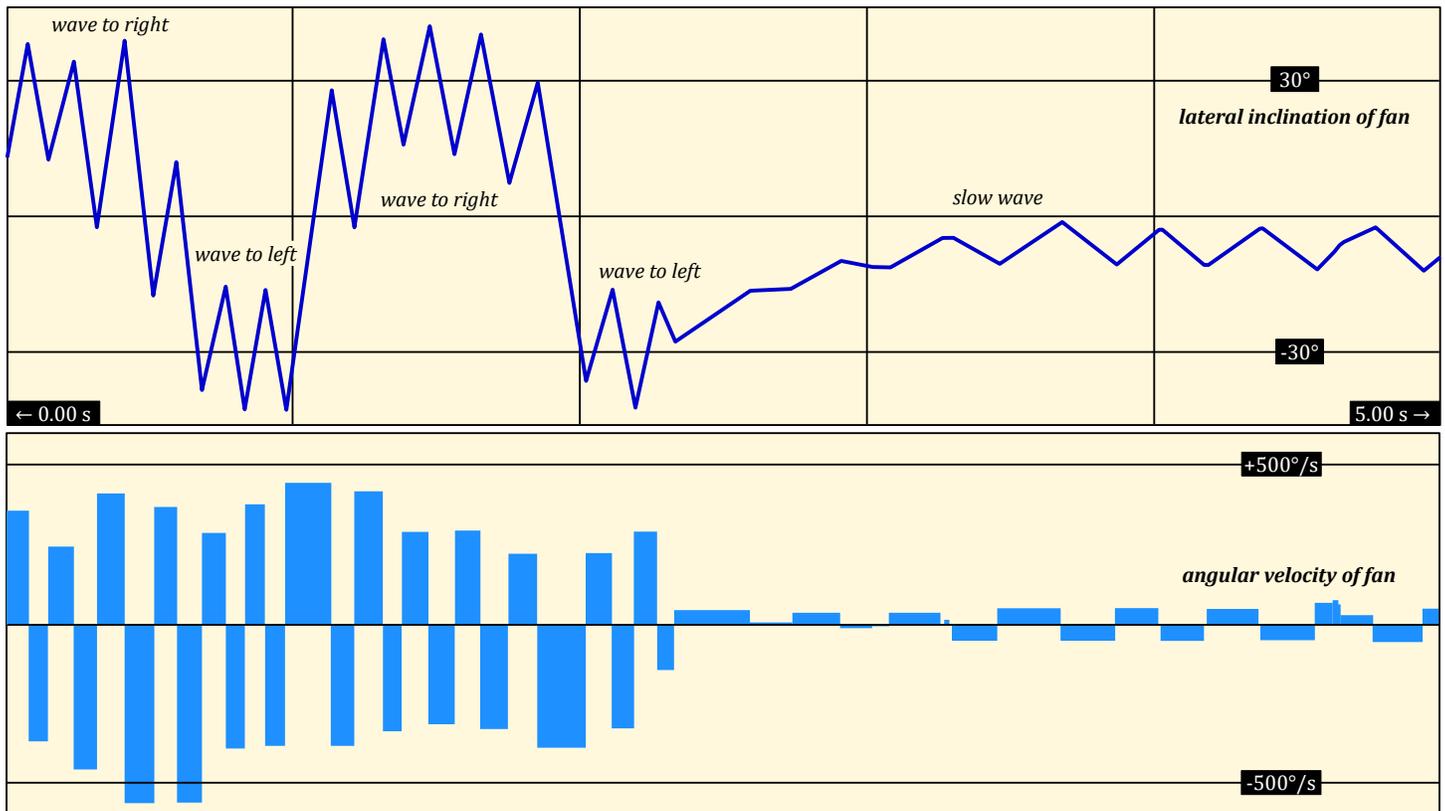


Figure 16. High fan wave in place by a male *Maratus astarte* (5.00 s from a 100 fps video). Like the sequences shown in Figures 14-15, the male also transitioned to a lower amplitude, slow wave (~3 Hz) after a series of waves to either side at ~5 Hz.

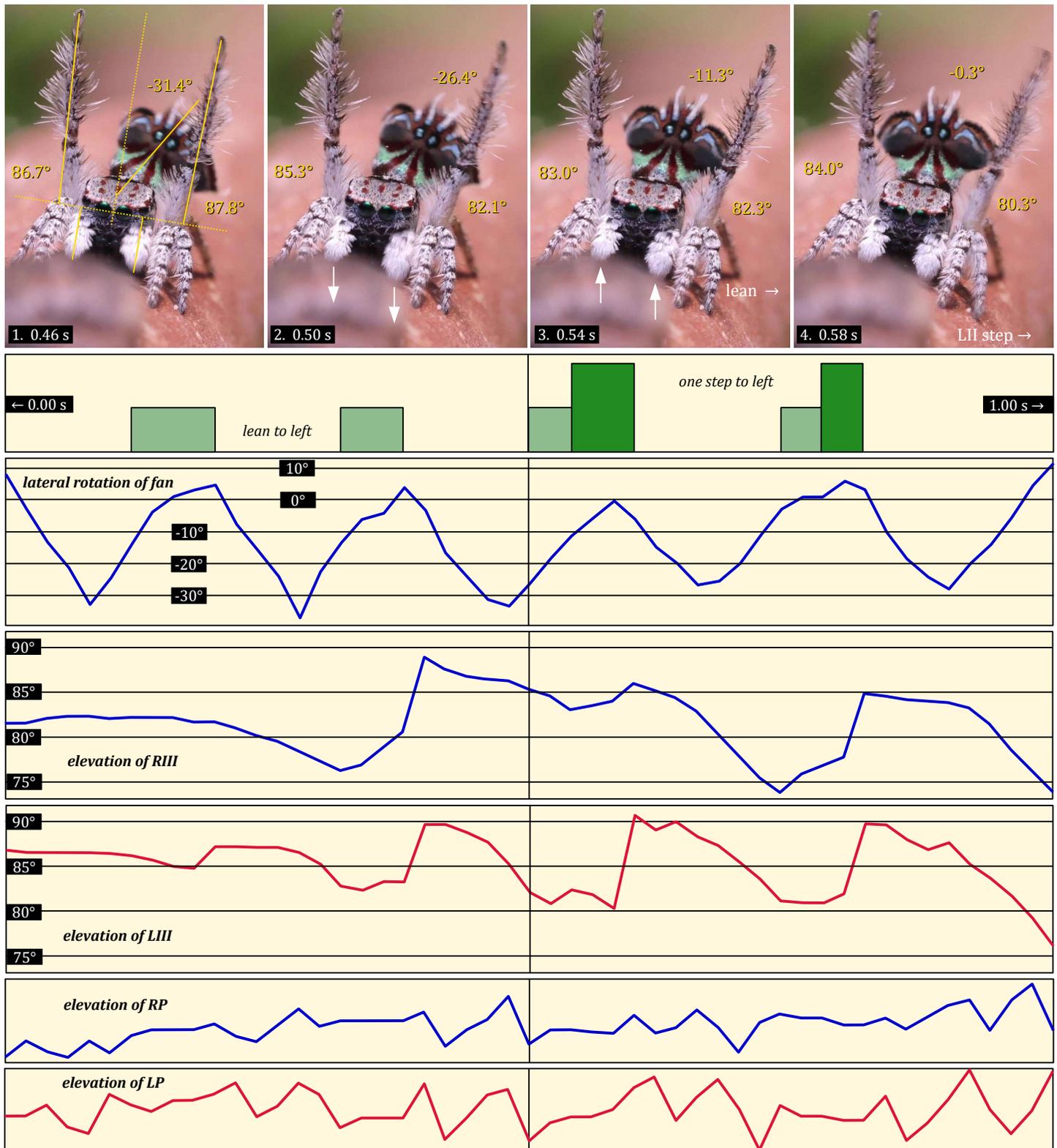


Figure 17. High fan wave with side-stepping by a male *Maratus astarte* (1.00 s from a 50 fps video). The top chart (just below the photographs) shows intermittent (~ 5 Hz) movement to the side, closely timed to rotation (or waving) of the elevated and extended fan at an amplitude of $\sim 40^\circ$. The low green bars indicate intervals during which the male was leaning, the higher green bars indicate intervals when the male was stepping (moving the position of its feet on the surface). Roughly symmetric raising and lowering of both legs III was also synchronized with lateral movement (second and third charts), but roughly synchronized up-and-down movement (flicker) of the right (RP) and left (LP) pedipalps was faster, ~ 12 Hz in this sequence.

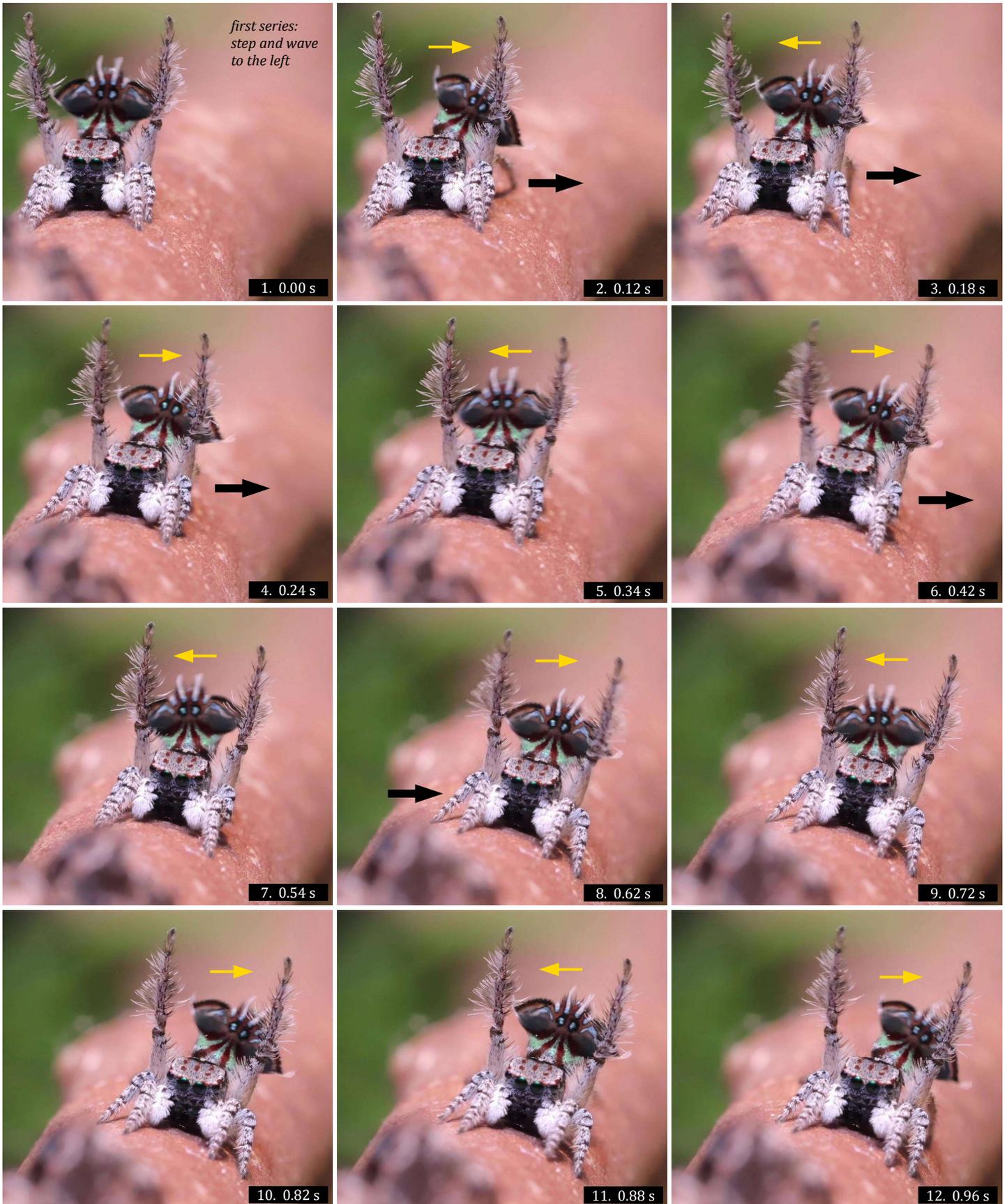


Figure 18 (continued on next page). High fan wave with side-stepping by a male *Maratus astarte* (selected frames spanning 3.0 s from a 50 fps video). Yellow arrows show movement of the fan relative to the previous frame, black arrows movement of the body or side-stepping.

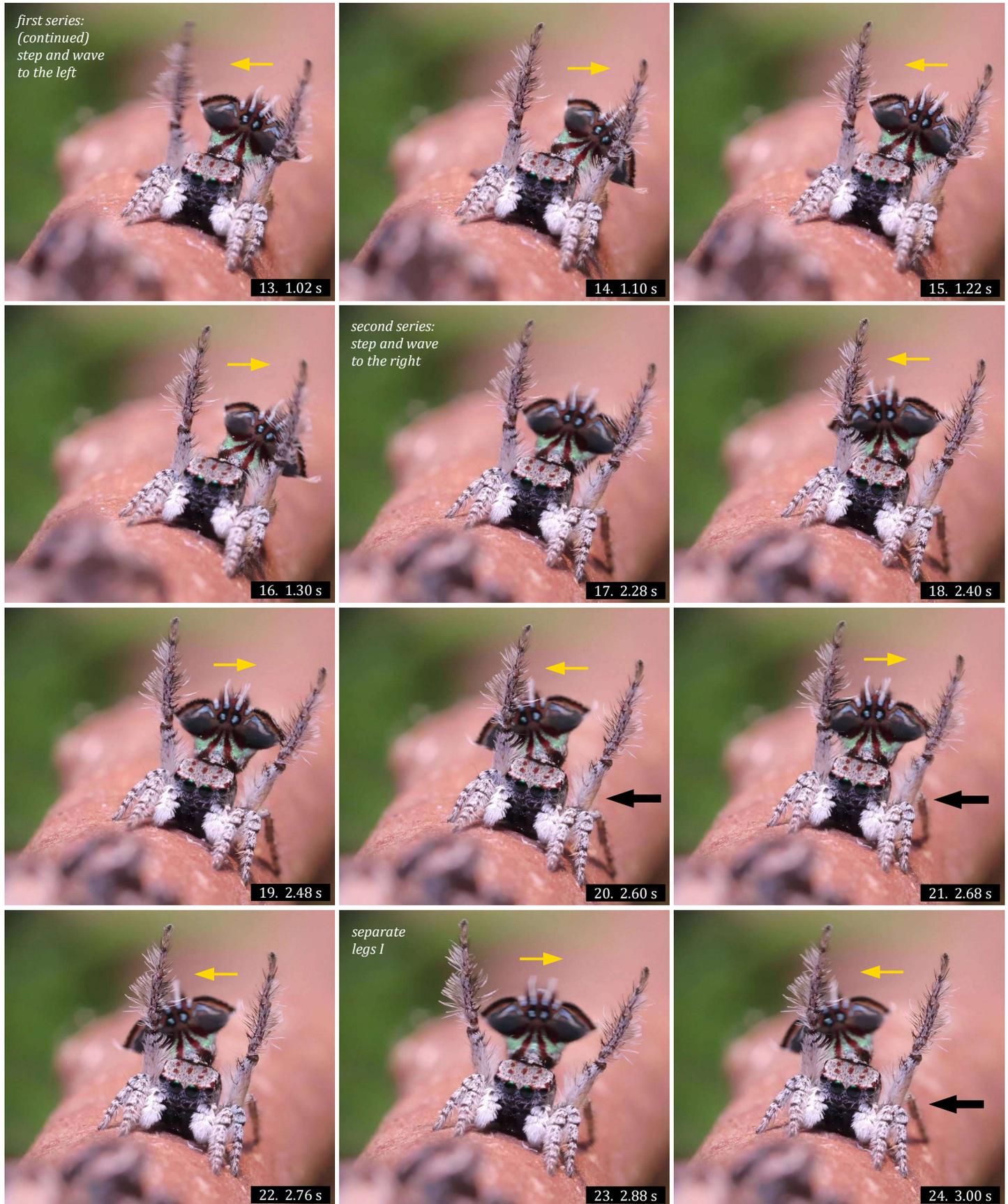


Figure 18 (continued from previous page). High fan wave with side-stepping by a male *Maratus astarte* (selected frames spanning 3.0 s from a 50 fps video).

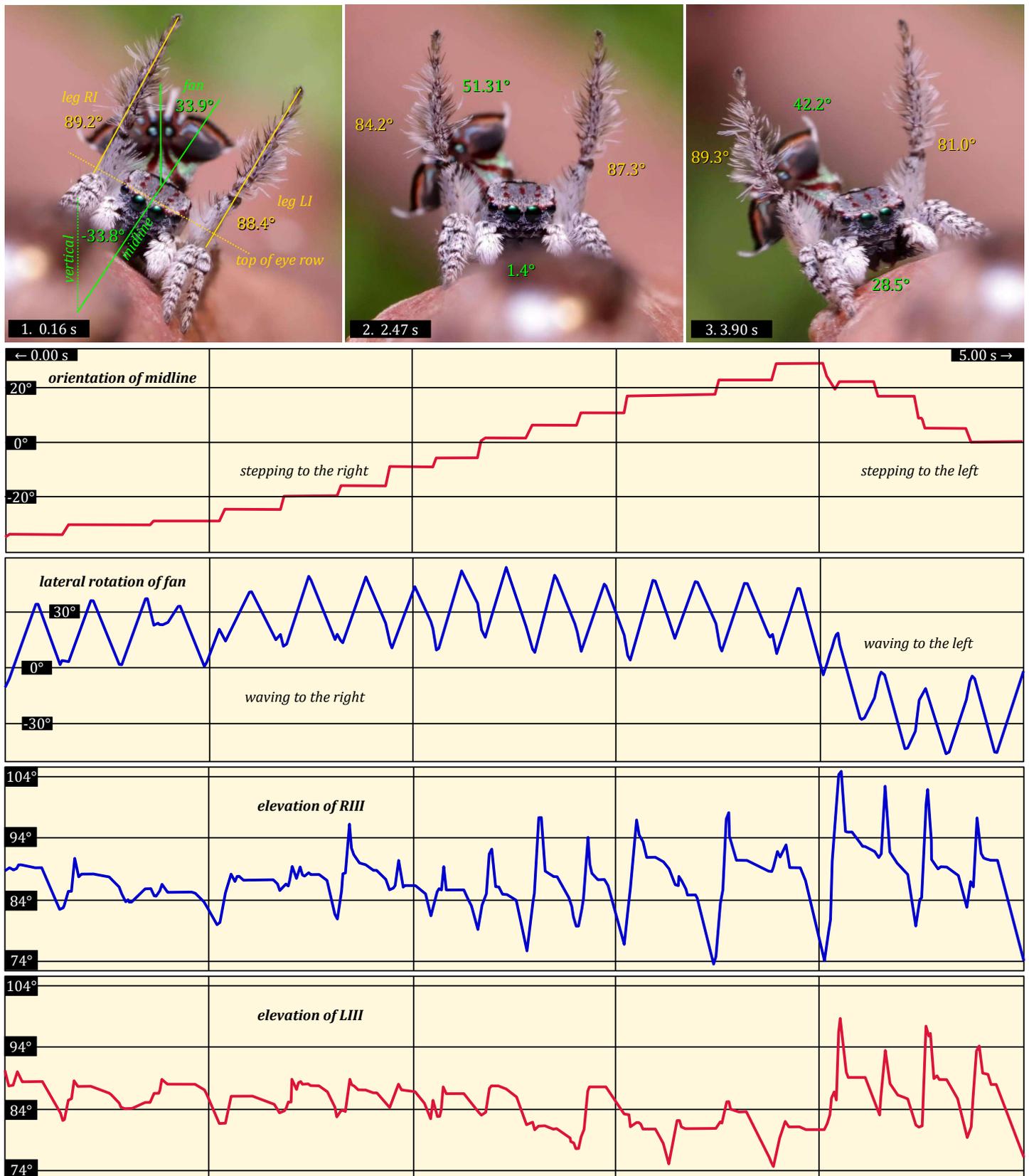


Figure 19. High fan wave with side-stepping by a male *Maratus astarte* (5.0 s from a 100 fps video). The charts show the synchrony (at ~ 4 Hz) of sudden body movement (stepping), fan, and nearly-synchronous bilaterally symmetric leg III movement during this display. In each case, the fan was waved in the direction (to the left or right) that the spider was stepping. The change in orientation of the midline (or sagittal plane) of the spider (top chart) was due to its side-to-side movement on a curved surface.

Habitat. *Maratus astarte* is only known from its type locality near Astarte Glade road ~19 km WSW of Denmark, Western Australia (Figure 20).



Figure 20. Open coastal habitat of *Maratus astarte*, near Astarte Glade road 19 km WSW of Denmark. **2,** A white-petaled *Astartea* (Myrtaceae) shrub can be seen in the foreground, at right. This genus is endemic to Australia. Photos © Matthew Brewer, used with permission.

***Maratus manjimup*, new species**

Type specimens. The holotype male (♂#7), two paratype males (♂#6,8), and three paratype females (♀#3-5) were collected ca. 7 km W of Lake Muir, Western Australia (34.425611S, 116.5765E, 28 SEP 2024, coll. Flynn Prall). Five paratype males (♂#1-5) and two paratype females (♀#1-2) were later collected at the same site (4-5 OCT 2025, coll. Jürgen Otto). All types will be deposited in the Western Australian Museum, Perth.

Etymology. The species group name, *manjimup* (noun in apposition), refers to the *Shire of Manjimup*, a government entity based in the town of Manjimup. The type locality for this species is located in this Shire. The name *manjimup* is also based on two Noongar words, *manjin* and *up*, referring to a location of the indigenous, edible Manjin reed (or *Yanjet*).

Diagnosis. This species is most similar to *Maratus unicip* and *M. azureus*, with scale pattern on the fan that is very close to *M. unicip* in particular (Figure 21). *M. manjimup* males can be separated from *M. unicip* by the darker figure on a background of blue-green iridescent scales at the rear of the fan, the lighter orange to red-orange scales covering the widest part of the fan, to include the flaps, and the white setae or scale cover of the carapace and legs. Structure of the male pedipalp, the female epigynum, and the general appearance of females, are not useful for identification to species in the *vespa* group.



Figure 21. Comparison of a ♂ *Maratus manjimup* (1, 4) to a ♂ *M. unicip* (2, 5) and a ♂ *M. azureus* (3, 6).

Description of male (Figures 21.1, 21.4, 22-26). Males (n=8) ranged from 3.7-3.9 mm in length. The carapace and chelicerae are black. Longer white setae extend forward beneath the anterior eye row, but the clypeus and chelicerae are mostly glabrous. Above, the pedipalps are covered with long, bright white setae. The eye quadrangle has a cover of white to grey setae, oriented mostly parallel to the surface, with scattered black setae projecting from that surface. This cover is interrupted by three dull red or red-brown stripes, one behind each AME and the third at the median. The lateral stripes are shorter and do not extend all the way to the front of the eye quadrangle; none of the three stripes extends beyond the posterior margin of the eye quadrangle. The rear of the carapace is almost entirely black and glabrous, with a short stripe of scattered white to grey setae at the median that does not extend all the way to the rear of the carapace. White to grey setae are also present just behind each PLE, and on the lower sides of the carapace. There is a distinct marginal band comprised of bright white setae on either side of the carapace. The PME are closer to the PLE than to the ALE.

The fan (dorsal opisthosomal plate; Figures 21.1, 21.4, 23) is roughly triangular, without any prominent fringes. Each lateral flap of the fan is acutely pointed ($\sim 80^\circ$) at the lateral margin, not rounded. Longer white to light-grey setae project forward from the anterior marginal band of the fan. Behind this there is a prominent figure comprised of dull red-orange pigmented scales, outlined in black, on a background of iridescent blue-green scales that extends to the curved rear margin of the fan. This figure resembles a winged insect, with a line of lighter orange scales extending along the rear margin of each "wing" to the rear margin of each lateral flap. Toward the rear, this figure is comprised of darker, brown pigmented scales, and it encloses four patches of iridescent blue-green scales at the rear margin. No tufts are present along the margins of the fan. Below and to the rear of the fan lies a small triangular group of pigmented white scales, just above the grey posterior spinnerets.

Legs I and II are shorter and of similar length; legs III are the longest. All legs are similar in colour, dark brown to black, with a cover of white scales and longer white setae. The metatarsus and tarsus of each leg, except leg III, are indistinctly banded with alternating red-brown and black bands representing the colour of the cuticle. Leg III has longer fringes of mostly white setae below the femur, patella, tibia, and metatarsus, and above the femur; there is a more uniform cover of bright white setae on the tarsi of leg III. Many longer, black setae, more isolated, extend from the top of these segments of leg III. The tenent setae of the pretarsal foot pads ("claw tufts") are grey.

Viewed from below (Figure 24) the coxae, sternum, and labium are mostly dark grey or dark brown and glabrous, with scattered white setae. The endites are lighter grey or brown and glabrous on the underside. The underside of the pedipalps is dark brown. The pedipalps (Figure 26) are very much those of other species of *Maratus* from southwestern Australia, with a distinct projection or "tooth" near the distal end of the coiled embolus. The RTA is also typical for *Maratus*, acute in shape but blunt at the tip, with small "teeth" or serrations on its ventral edge.



Figure 22 (continued on next page). Adult male types for *Maratus manjimup*.



Figure 22 (continued from previous page, continued on next page). Adult male types for *Maratus manjimup*.



Figure 22 (continued from previous page). Adult male types for *Maratus manjimup*.



Figure 23. Adult male types for *Maratus manjimup* with fully elevated and extended fan during courtship display.

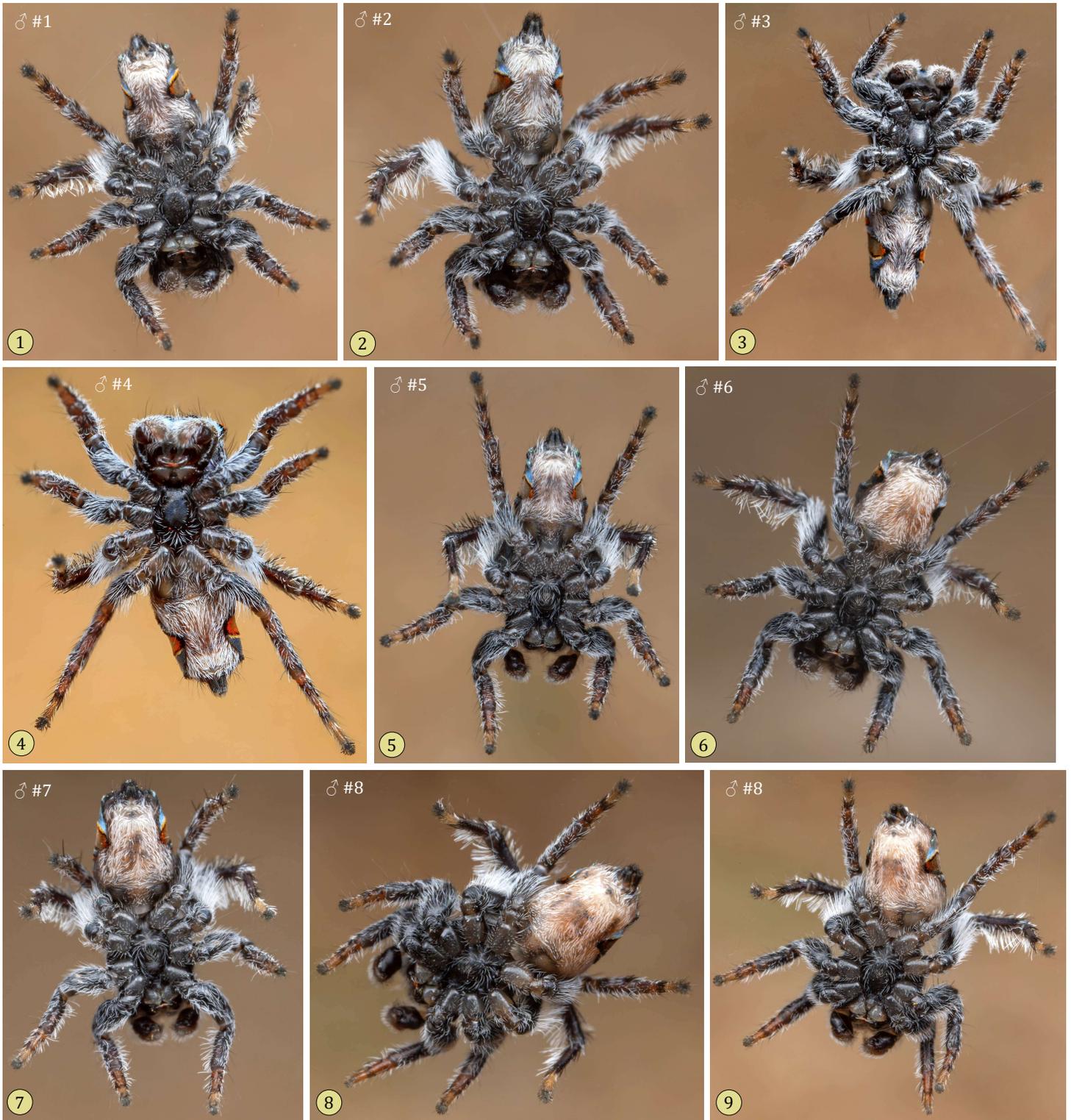


Figure 24. Adult male types for *Maratus manjimup*, ventral views.



Figure 25. Male type specimens for *Maratus manjimup*, preserved in alcohol.

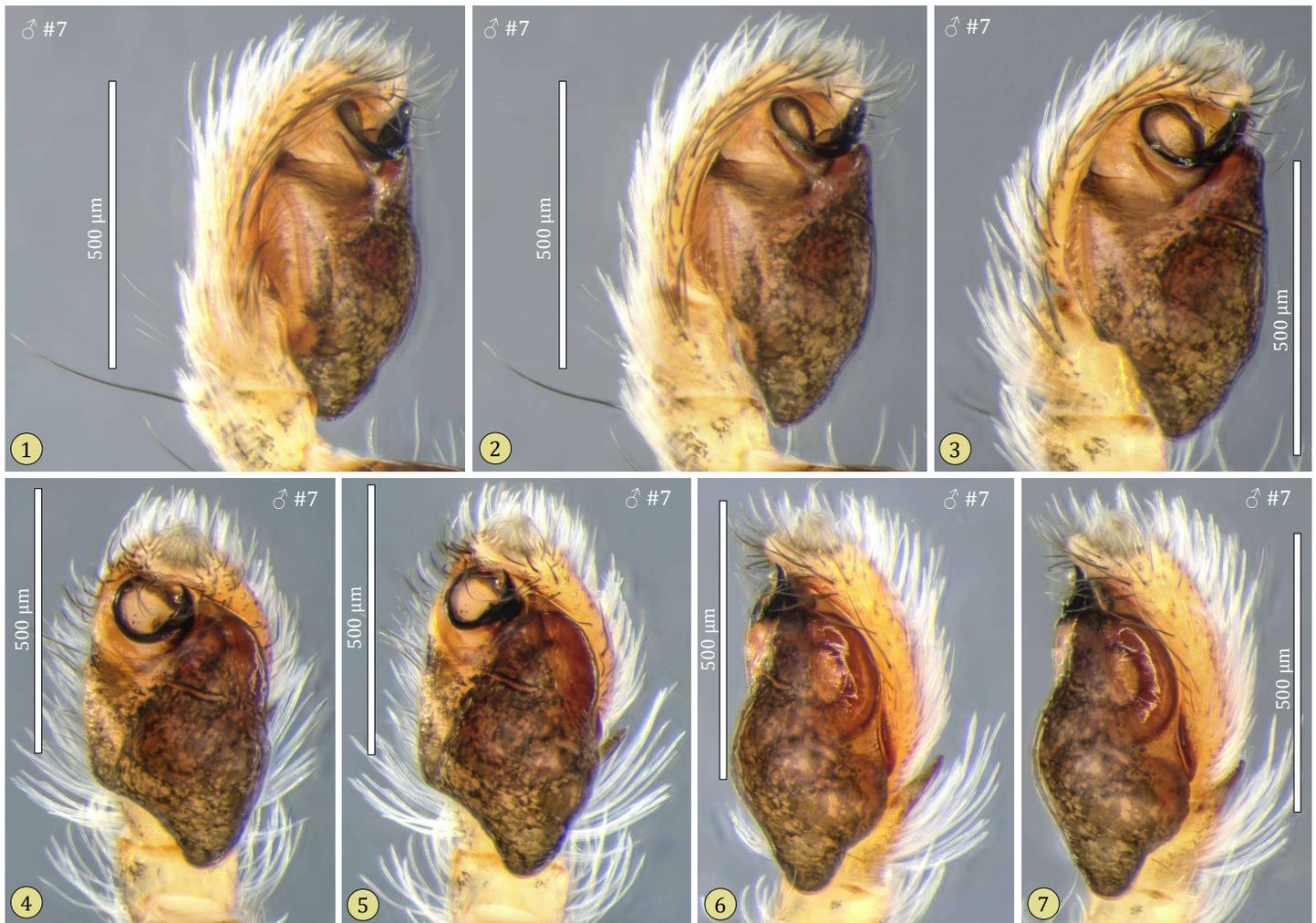


Figure 26. Medial to lateral (retrolateral) views of the left pedipalp of the male holotype for *Maratus manjimup*, preserved in alcohol.

Description of female (Figures 27-29). Females (n=5) ranged from 4.7-5.9 mm in length. Colouration is similar to that of other *Maratus* females, with dark brown cuticle dorsally and lighter, or translucent brown, cuticle elsewhere. Long off-white setae extend medioventrally on the face, below the anterior eyes. The chelicerae are mostly glabrous, with a few off-white medial setae. The pedipalps have a uniform, but not dense, cover of off-white setae. Scale cover over much of the body is comprised of mixed off-white and dull orange to brown scales. In the eye quadrangle, this cover is interrupted by three narrow and somewhat indistinct stripes of dark brown. The PME are closer to the PLE than to the ALE. The sides of the carapace have mixed scale cover, but there is no marginal band and near the margin the carapace is mostly glabrous. Behind the eye quadrangle the carapace is dark and mostly glabrous, and may have a short, narrow medial stripe of white scales.

The opisthosoma is dark above with mostly brown or dull-orange scales, and the sides are lighter with more off-white scales in the mix, sometimes mottled. A very indistinct and narrow median stripe of lighter scales may be seen on the front half of the dorsum. The venter (Figure 28) is lightly mottled with a cover of off-white scales. At the rear is a small triangular tuft of white setae, above the grey anterior spinnerets. The posterior spinnerets are light brown. Legs I and II are of similar length and shorter, legs III and IV also of similar length but longer. Legs I and II are dark amber in colour with scattered off-white setae, legs III and IV are darker with dark brown bands near the joints and a heavier cover of off-white setae. Below, coxae, sternum, endites, labium, and chelicerae are mostly grey to light brown, glabrous,

and translucent, with scattered off-white setae projecting from the rear of the sternum and the coxae of legs III and IV. The epigynum (Figure 29.10) is similar to that of other *Maratus*, with large anterior windows and a pair of large posterior spermathecae, but one female also had an anomaly (Figure 29.11) that may represent an injury, at the rear of the otherwise normal epigynum.



Figure 27 (continued on next page). Adult female paratypes for *Maratus manjimup*.



Figure 27 (continued from previous page). Adult female paratypes for *Maratus manjimup*.

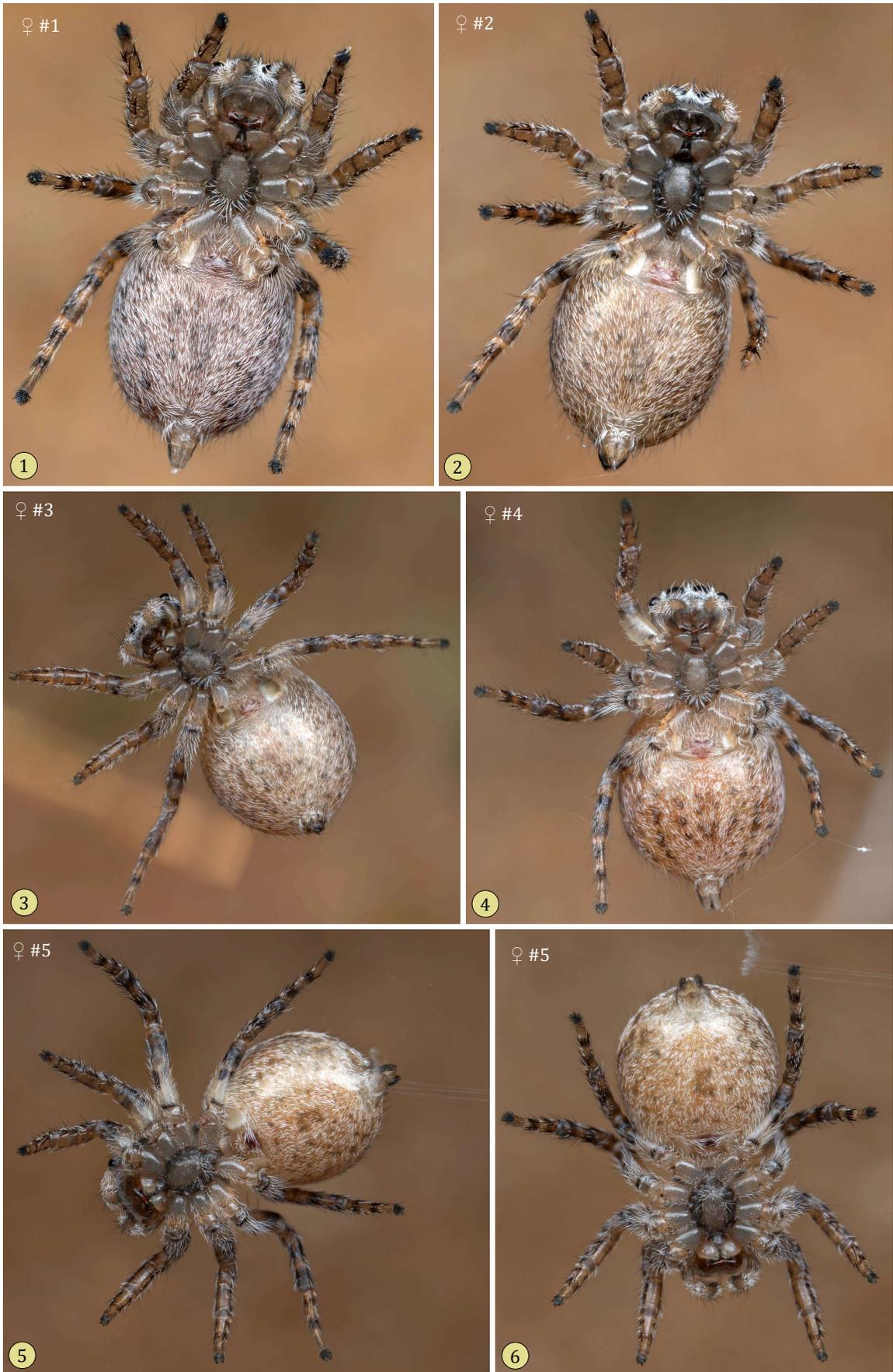


Figure 28. Ventral views of adult female paratypes for *Maratus manjimup*.

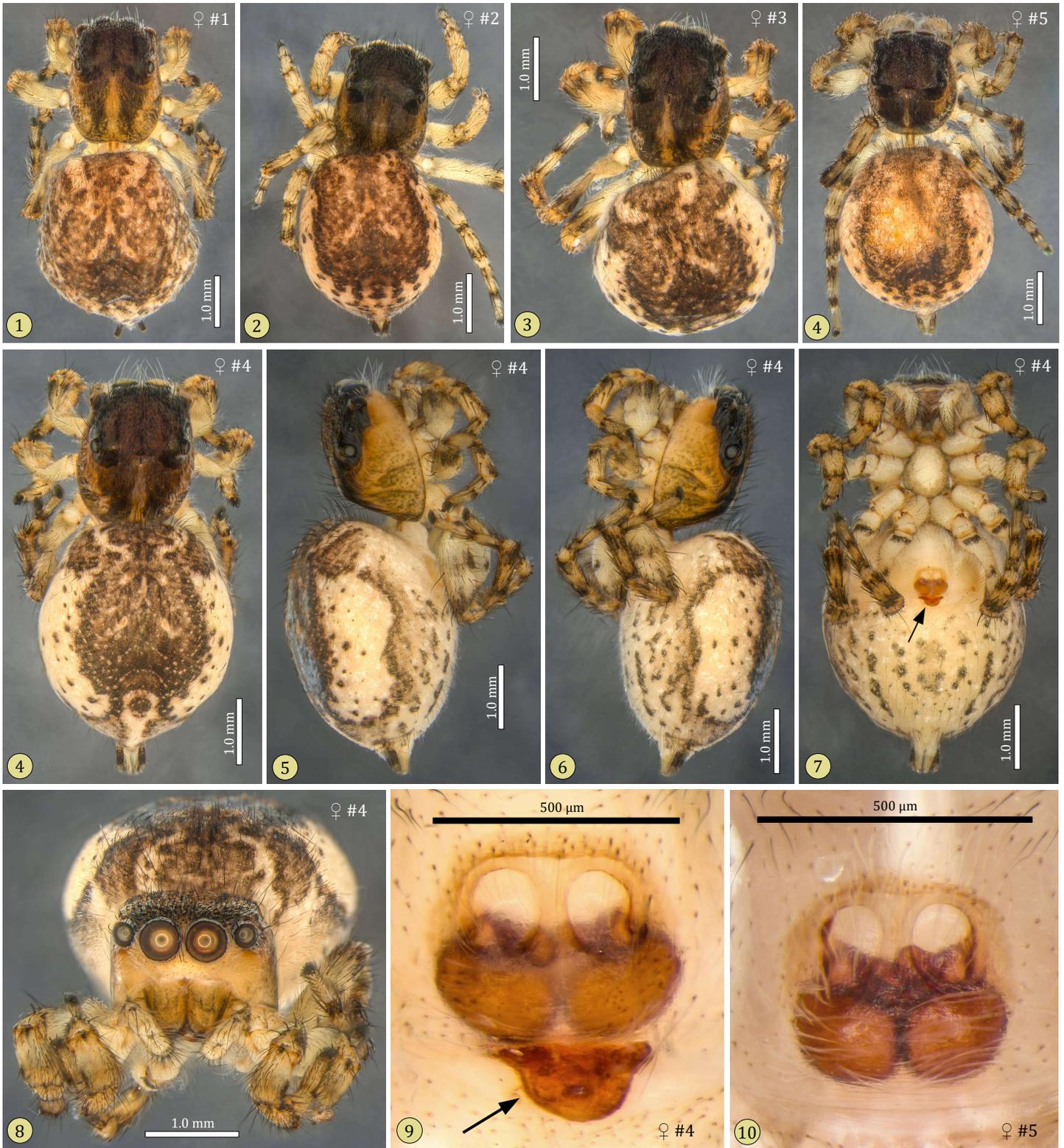


Figure 29. Adult female paratypes for *Maratus manjimup*, preserved in alcohol. 9-10, Ventral views of epigynum. One female had an anomalous area of dark cuticle just behind the epigynum (9, arrow), extending past the epigastric groove. This may have been the site of an injury.

Courtship display (Table 3, Figures 30-42). Based on laboratory observations of male/female encounters in a simulated natural environment, it has been possible to document a wide variety of different displays by the male *M. manjimup*. It is important to recognize that, in studies of this kind, we cannot claim to have documented all possible variations on male display or courtship. With more video records, of more males, even more displays may be found. When compared to *M. astarte*, it appears that one more mode of *close examination* by the female (Table 3, 11) has been added to the display of *M. manjimup* (and several other species, to include *M. unicip* and *M. vespa*; see Table 4).

Table 3. Display modes observed for a courting male *Maratus manjimup*.

ref#	category	display	description	Figures
1	advertisement	single leg wave	irregular wave of one elevated leg III	30.1-30.3, 32
2	advertisement	two leg wave	1-2 Hz near bilaterally symmetric semaphore wave of both legs III	30.4-30.6, 31, 33
3	attraction	two leg wave with depressed fan	widely extended legs III waved as a near bilaterally symmetric semaphore when the fan is depressed with flaps retracted	30.7
4	attraction	two leg wave with elevated fan	widely extended legs III waved as a near bilaterally symmetric semaphore with the fan fully elevated and expanded	30.8-30.13
5	attraction	low fan wave in place	0-4 Hz wave of low fan with retracted flaps near center	34
6	attraction	high fan wave in place	8 Hz wave of elevated fan with extended flaps near center	30.14-30.19, 35
7	attraction	low fan wave with side-stepping	4 Hz wave of low fan with retracted flaps while side-stepping	36
8	attraction	high/low fan wave with side-stepping	7 Hz wave of fan as it is raised with extended flaps and lowered with retracted flaps in synchrony with 2-3 Hz side-stepping, legs III elevated and separated but not waved	37
9	attraction	high fan wave with side-stepping	6 Hz wave of fully extended and elevated fan in synchrony with 2 Hz side-stepping, legs III elevated and separated but not waved	38
10	attraction	high fan/two leg wave with pedipalp flicker and side-stepping	very active: 6 Hz wave of fully extended and elevated fan and 6 Hz bilaterally symmetric wave of elevated but separated legs III in synchrony with 3 Hz side-stepping, with 9 Hz bilaterally symmetric pedipalp flicker	39
11	examination	high/low fan wave with display of flaps behind bracketed legs III	with female close (~1 cm or less) to male, slow rotation and depression of elevated and expanded fan to display one flap outside of a rigid bracket of legs III touching in a vertical position, followed by 8-10 Hz waving/bobbing (vibration) of the fan with retracted flaps as it is elevated and returned to the center position where the flaps are once more extended	30.20-30.39, 40-42

As in other *Maratus* species, males may extend and slowly (1-2 Hz) wave one or both legs III, apparently to make themselves more visible to a female in the vicinity (Figures 30.1-30.6, 31-33). Many different displays under the category of *attraction* have been observed (Figures 30.7-30.19, 34-39), to include various combinations of fan elevation and flap extension, waving of legs III, and side stepping in front of the courted female, or even all of these at the same time (ref# 10 in Table 3, Figure 39). During close examination by the female (Figures 30.20-30.39, 40-42), the male "slowly" moves the expanded and elevated fan down to one side, where it is depressed and the flap on that side is displayed. This display may include 40 Hz up-and-down movement (vibration) of the flap (Figure 41). Then the fan, with flaps retracted, is waved and, at first, bobbed (raised and lowered) rapidly (8-10 Hz) as it is slowly returned to a center position. During the final stage of this return the fan is simply rotated intermittently without waving. From the center position, the male may then continue this display by slowly rotating the expanded fan to the opposite side.



Figure 30 (continued on next page). Courtship displays by male *Maratus manjimup*. 1-3, Single leg wave. 4-6, Two leg wave. 7, Two leg wave with depressed fan. 8, Two leg wave with elevated fan.



Figure 30 (continued from previous page, continued on next page). Courtship displays by male *Maratus manjimup*. 9-13, Two leg wave with elevated fan. 14, 15-16, High fan wave in place (complete sequence 15-19).

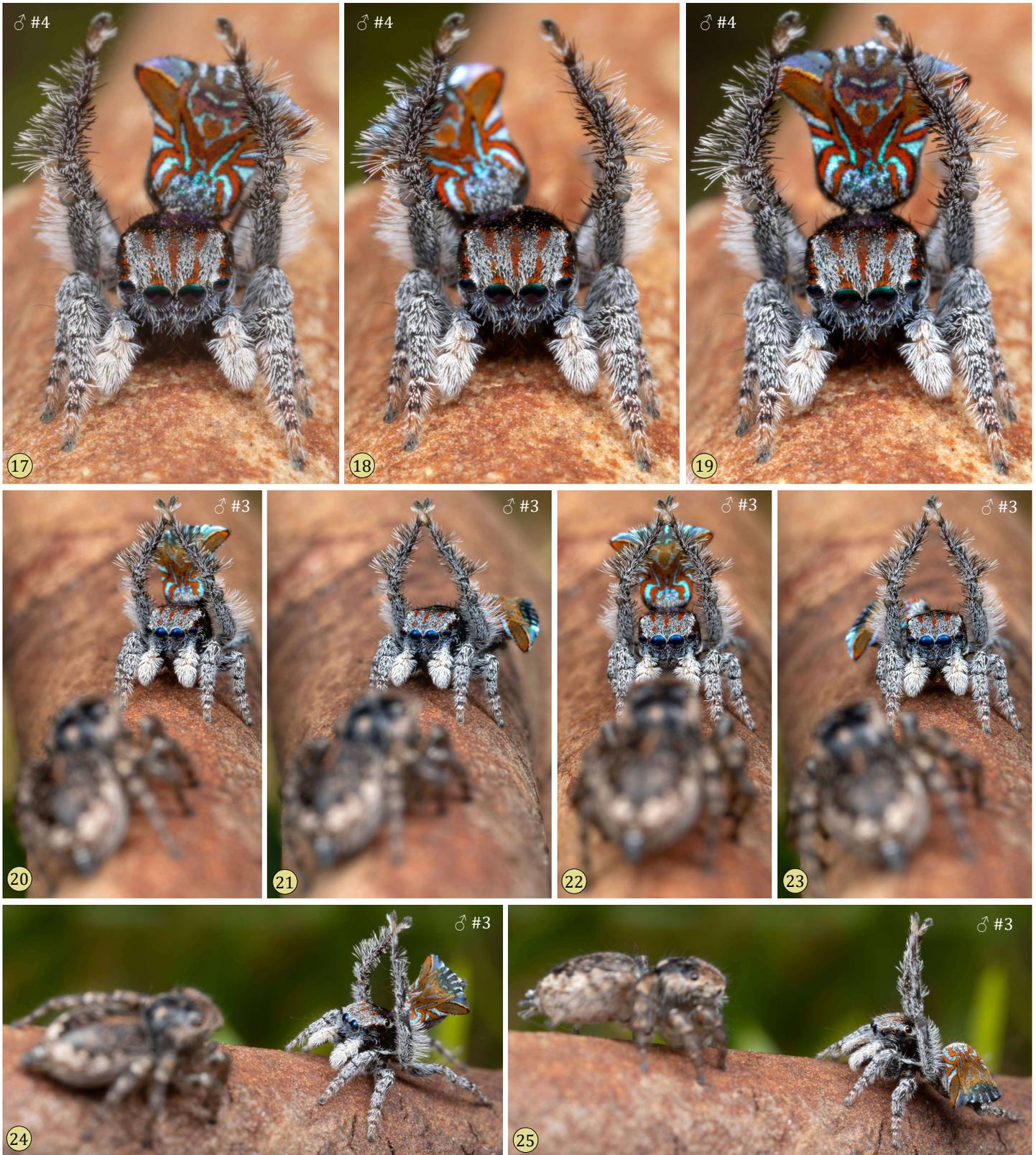


Figure 30 (continued from previous page, continued on next page). Courtship displays by male *Maratus manjimup*. 17-19, High fan wave in place (complete sequence 15-19). 20-23, Examination sequence. The female (foreground) turned to closely follow each successive position of the fan. Note depression of the fan and display of a lateral flap in each lateral position (21, 23). After this display, the flap is retracted and the fan is slowly returned to the elevated position (20, 22), where the flaps are extended. 24-25, Sequential, lateral views of a different examination, showing the female turning to follow the fan of the male.



Figure 30 (continued from previous page, continued on next page). Courtship displays by male *Maratus manjimup*. 26-29, 30-32, 33-34, Sequential views of examination displays.

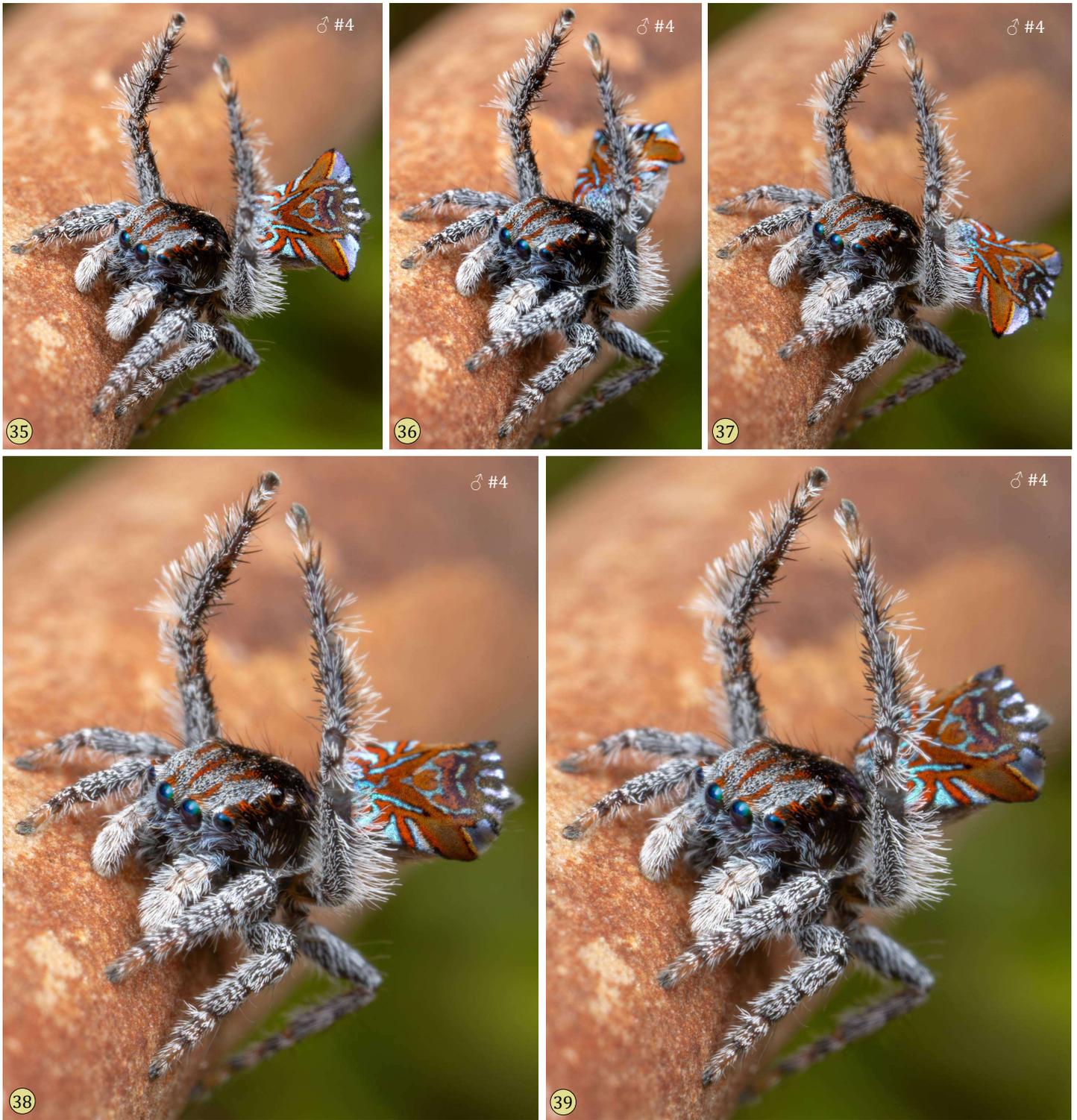


Figure 30 (continued from previous page). Courtship displays by male *Maratus manjimup*. 35-39, Sequential views of an examination display, during which the male assumed a low position at the side of a branch.

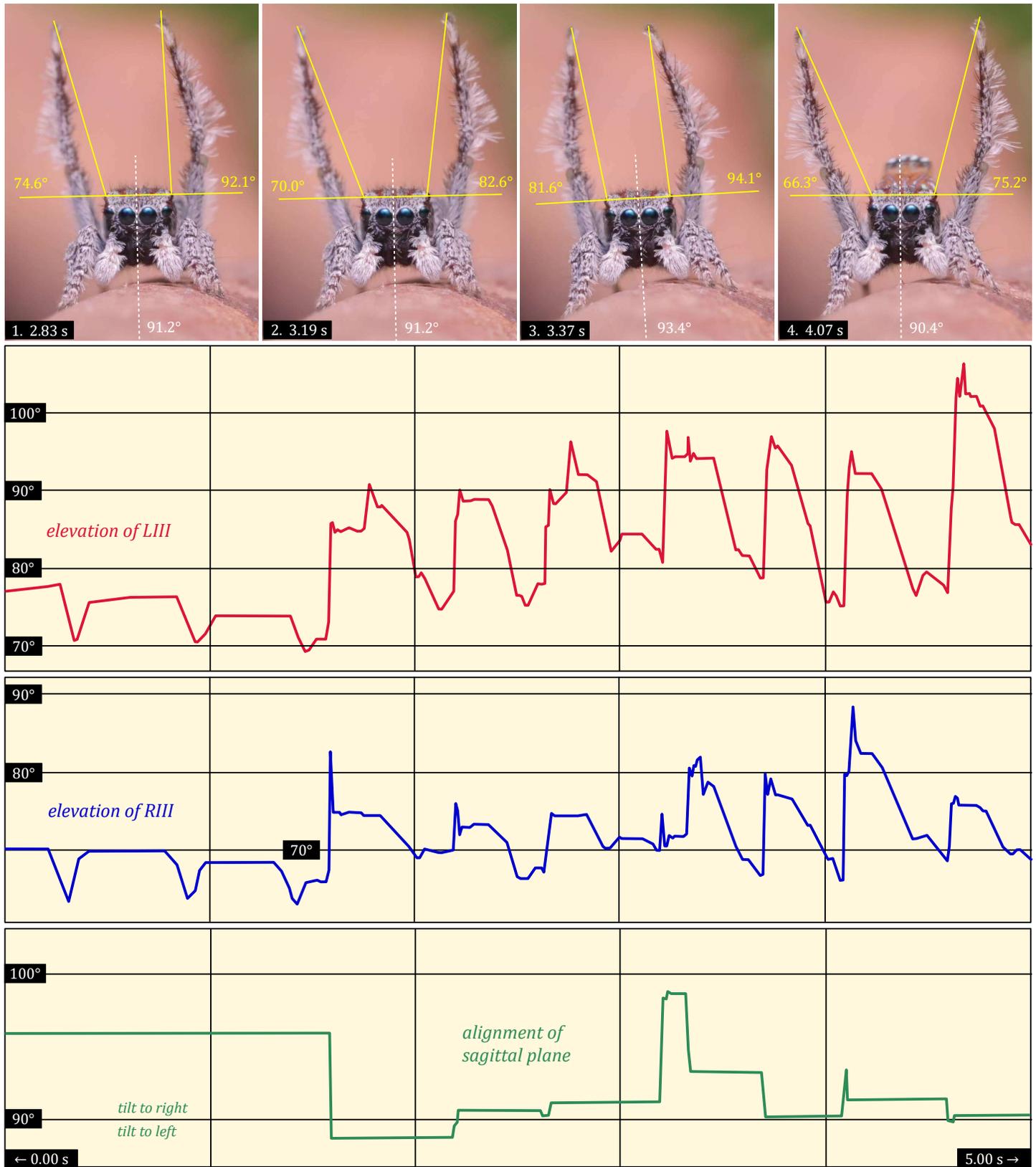


Figure 31. Bilaterally symmetric wave of extended and elevated legs III by a male *Maratus manjimup* (5.00 s from a 100 fps video). The male waved both legs together at a regular rate of ~2 Hz, beginning with a series of lower amplitude waves. Note change in alignment of the carapace during this sequence (lower chart). The elevation of legs III relative to a horizontal plane defined by a line through the centers of the PLE (photos 1-4) was charted here.



Figure 32. Low amplitude wave of the extended and elevated leg LIII by a male *Maratus manjimup* (1.00 s from a 100 fps video). During the latter part of this interval (2, shaded in the chart), leg RIII was raised to a near-symmetric, vertical position.

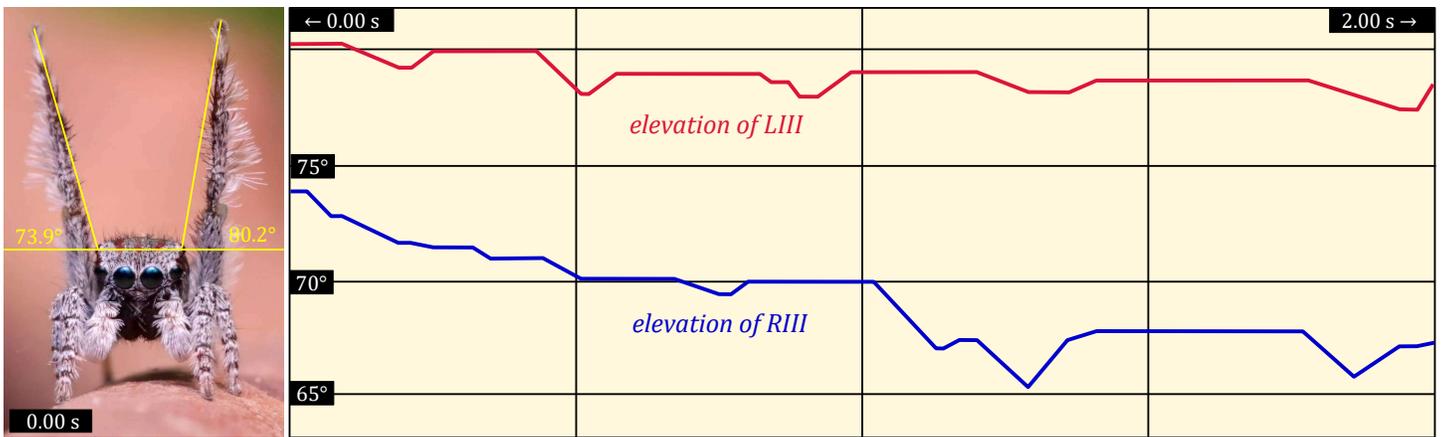


Figure 33. Slow, low amplitude wave of elevated legs III by a male *M. manjimup* (2.00 s from a 100 fps video).

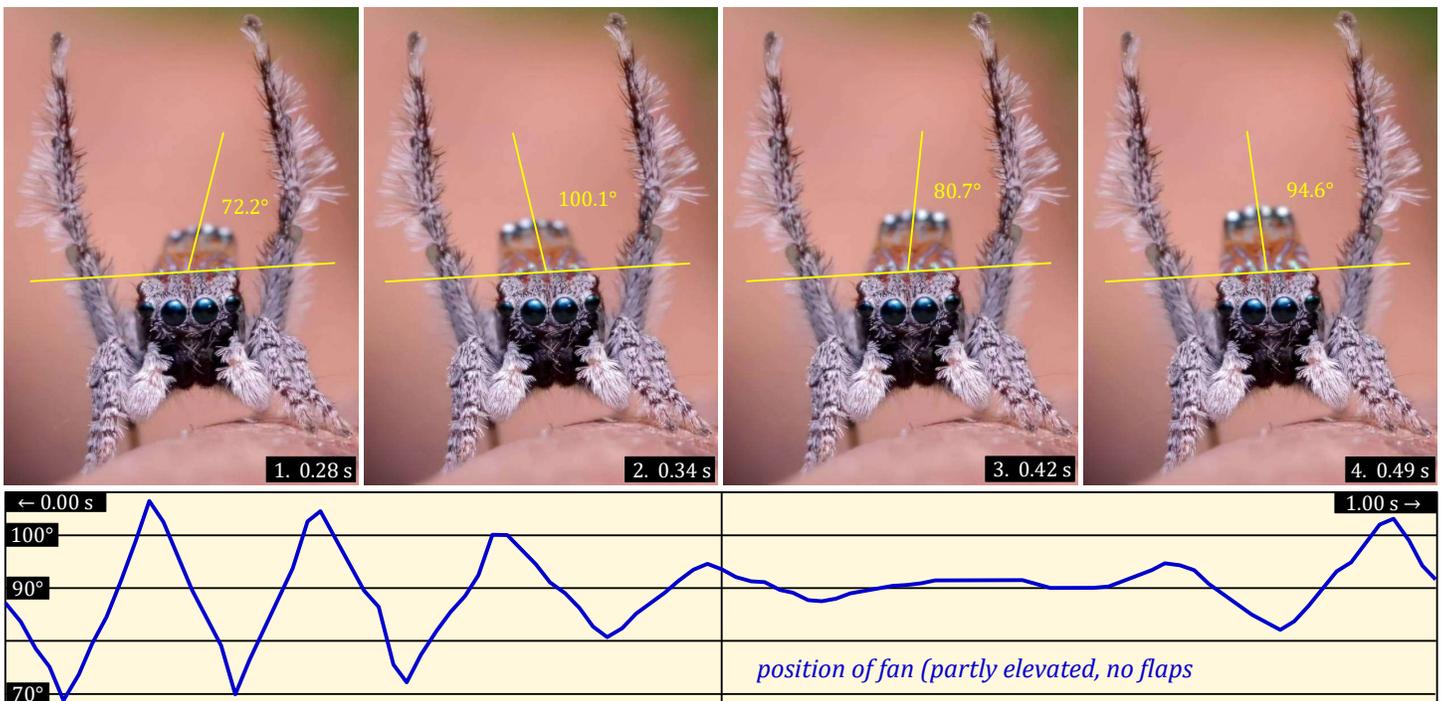


Figure 34. Low fan wave in place by a male *M. manjimup* (1.00 s from a 100 fps video). Initially the fan, with flaps retracted and only partly elevated, was waved at ~8 Hz. Note the four bright spots of iridescent scales at the rear of the fan.

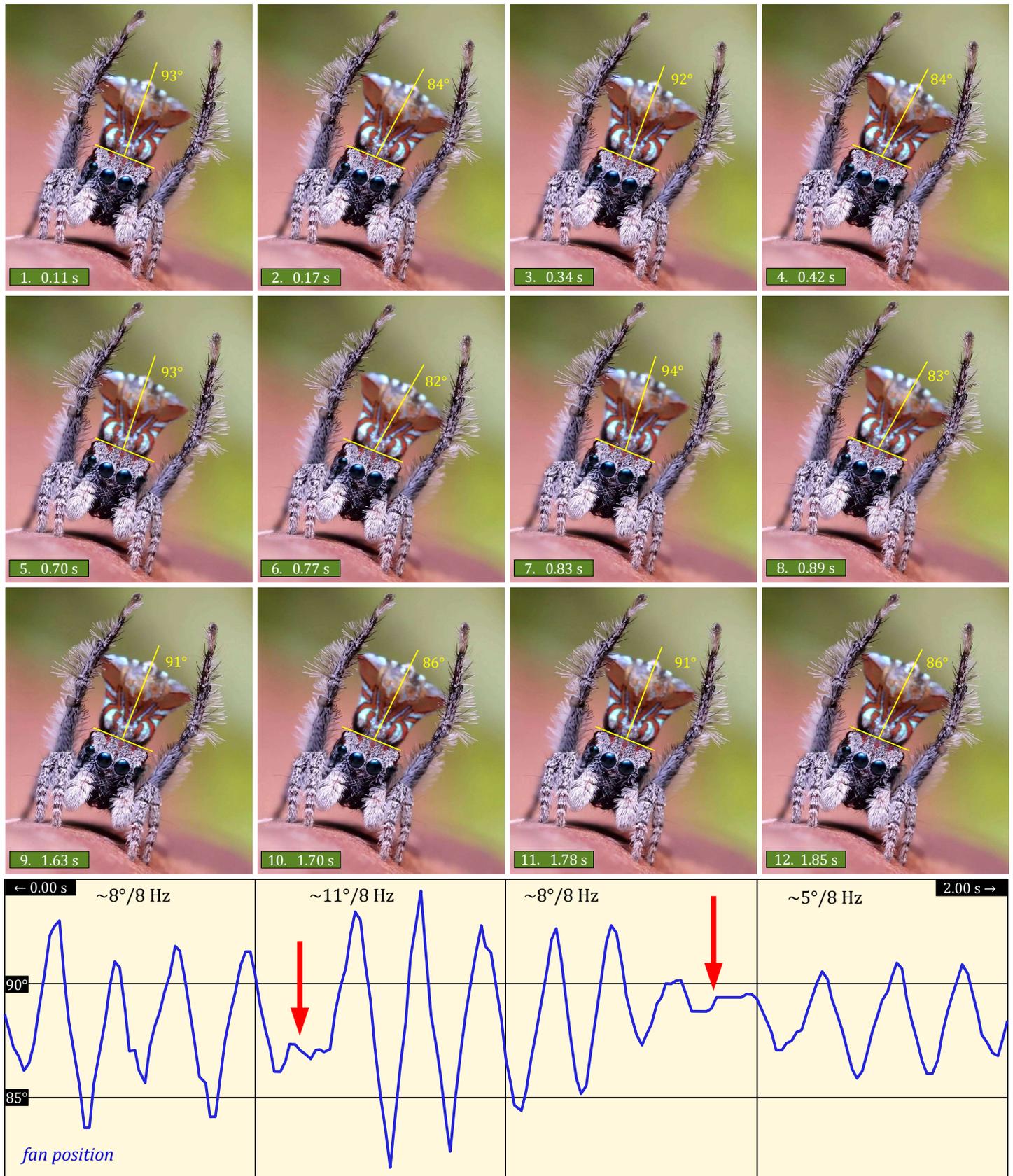


Figure 35. High fan wave in place by a male *M. manjimup* (2.00 s from a 100 fps video). Only the fully elevated and expanded fan was moved during this display, as it was waved through a relatively low amplitude ($\sim 5\text{--}10^\circ$) between the vertical legs III. This male shifted between three different amplitudes of display during this sequence, with a brief pause between each set of waves (indicated by red arrows in the chart).

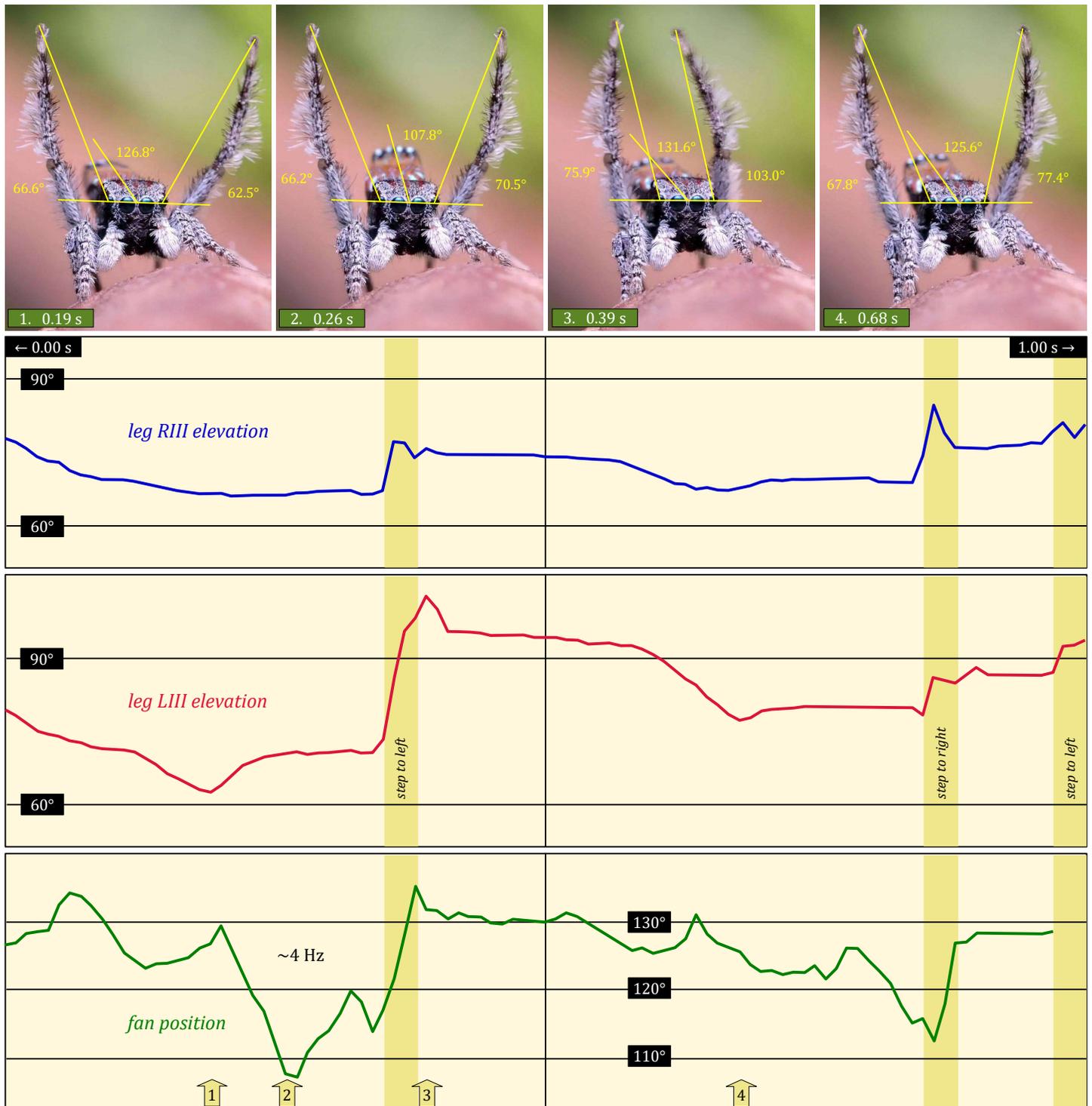


Figure 36. Low fan wave with side-stepping by a male *M. manjimup* (1.00 s from a 100 fps video). Vertical bars in the charts indicate brief intervals of rapid side-stepping during this sequence. This movement was synchronized with both the bilaterally symmetric wave of extended legs III, and side-to-side movement of the depressed fan, with flaps retracted.

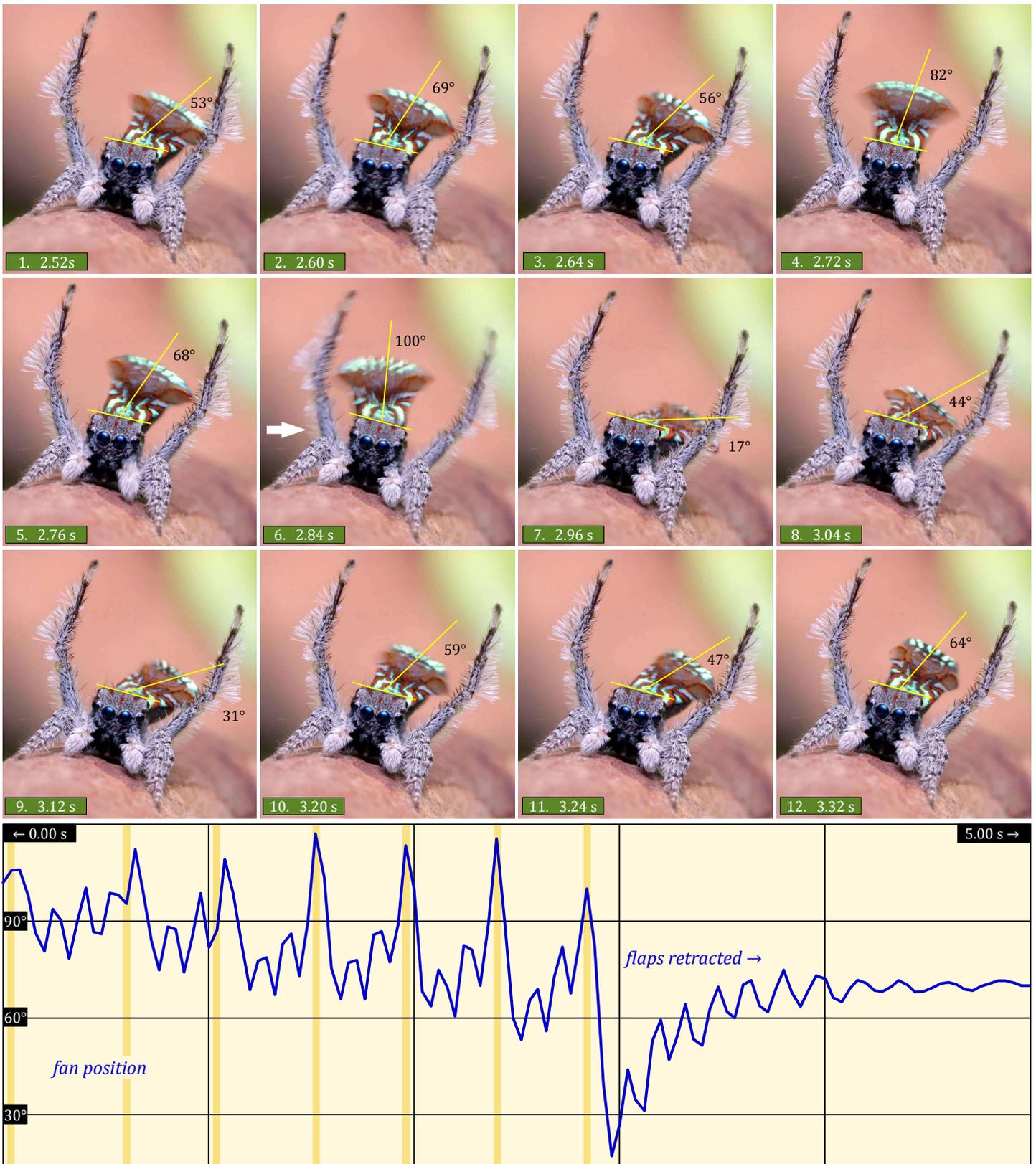


Figure 37. Combined high/low fan wave with side-stepping by a male *M. manjimup* (5.00 s from a 25 fps video). Vertical bars in the chart indicate brief intervals of rapid side-stepping to the left. The elevated and partly flexed (*hyperflexed dorsally* at the patella-tibia joint) legs III were not moved during this sequence, which began with a regular series of ~7 Hz waves of the fan, synchronized with the intermittent steps. As stepping ceased, the flaps were retracted, and the amplitude of each wave declined.

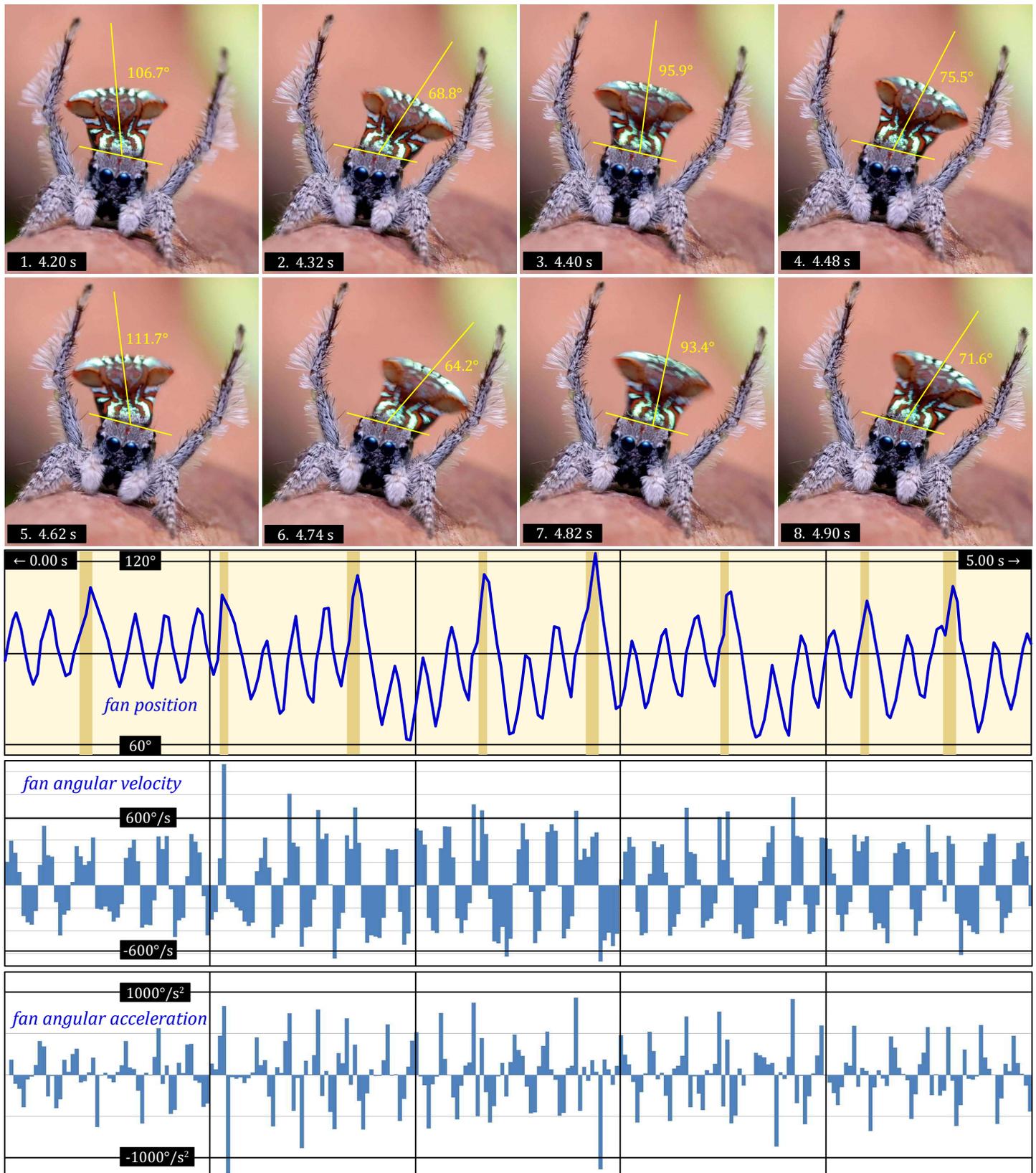


Figure 38. High fan waving with side-stepping by a male *M. manjimup* (5.00 s from a 50 fps video). As in previous charts, brief intervals associated with each side-step (to the left in this example) are indicated with vertical bars in the top chart. Each sequence of 2-4, ~6 Hz waves was synchronized with a step to the left, and legs III were held in place (not waved). Lower charts show the calculated angular velocity and angular acceleration of fan rotation during this sequence.

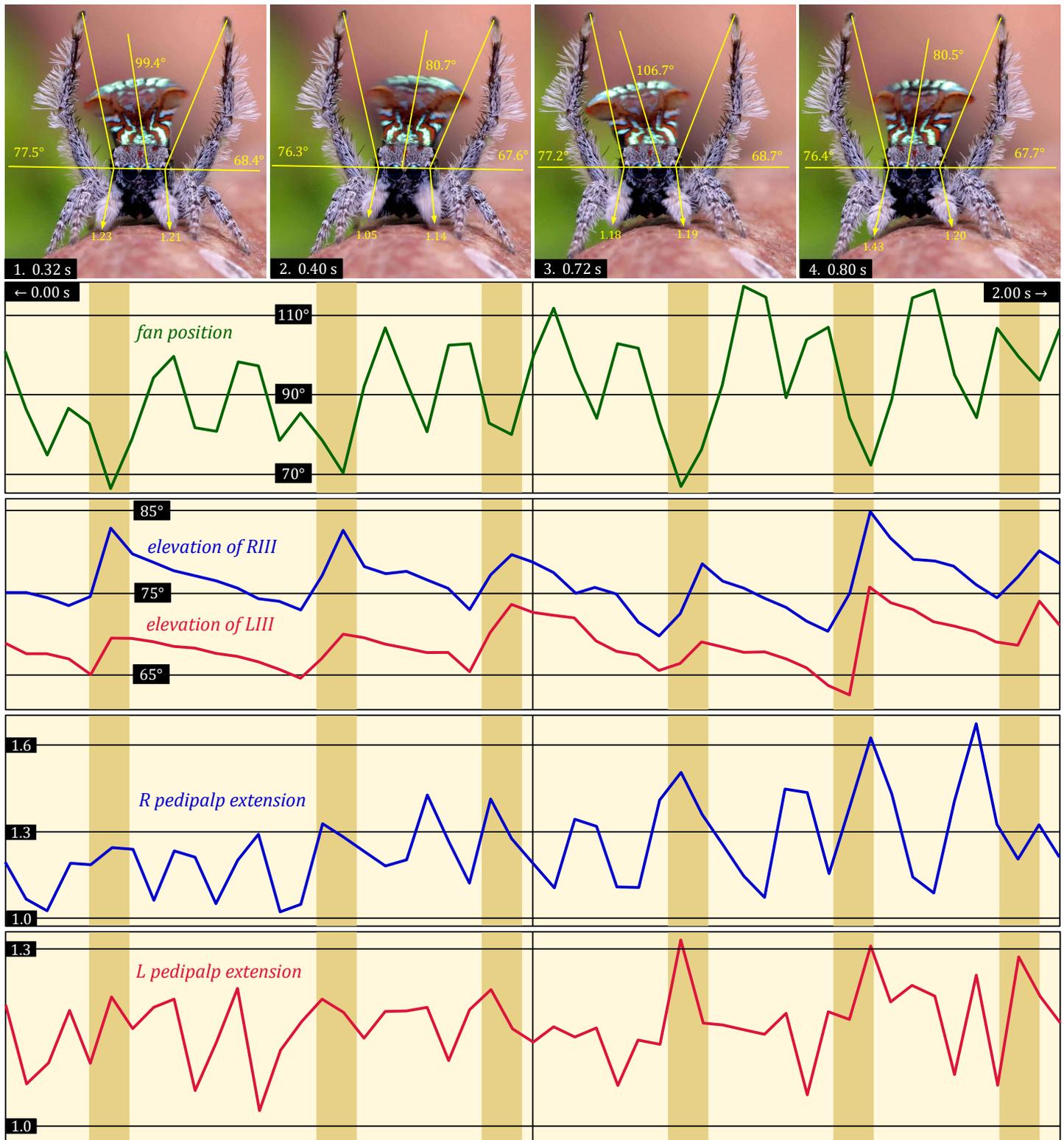


Figure 39. High fan/two leg wave with pedipalp flicker and side-stepping by a male *M. manjimup* (2.00 s from a 25 fps video). With respect to the fan waving (~6 Hz, or two waves per step) this display resembled that shown in Figure 38, but bilaterally symmetric waving of legs III (second chart) was also synchronized with each step, both at ~3 Hz. In addition, both pedipalps, in synchrony (lower two charts), were rapidly (~9 Hz) moved up and down (*flicker*, measured as extension as shown in photos 1-4).

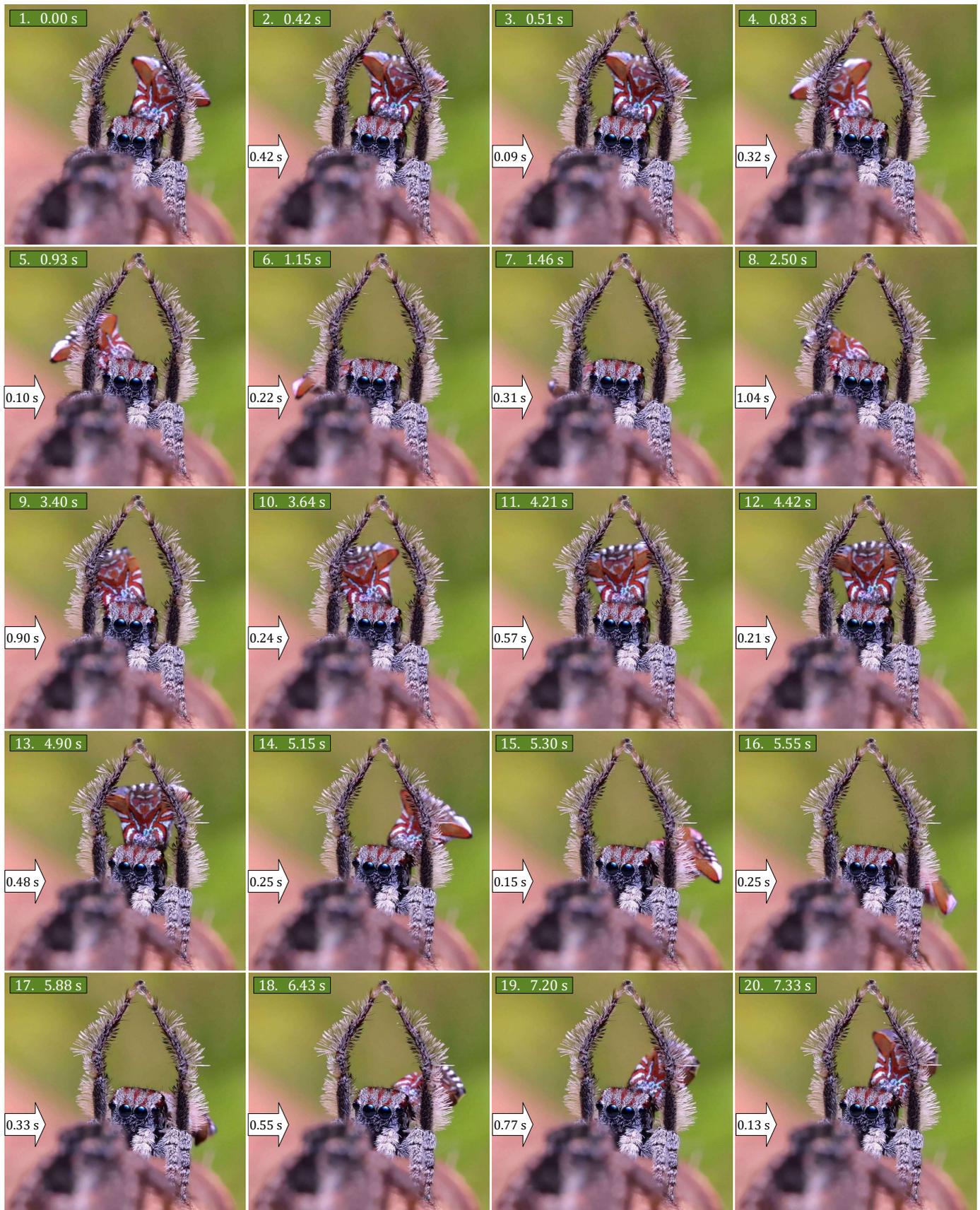


Figure 40. Close attention to display by a female (in foreground) *M. manjimup* during an examination display (selected frames spanning 7.33 s from a 100 fps video). **6, 16**, Display of flap with fan depressed to the side of the bracket formed by legs III. In this position the fan may be moved rapidly (or vibrated) up and down (Figure 41). White arrows show elapsed time between successive frames.

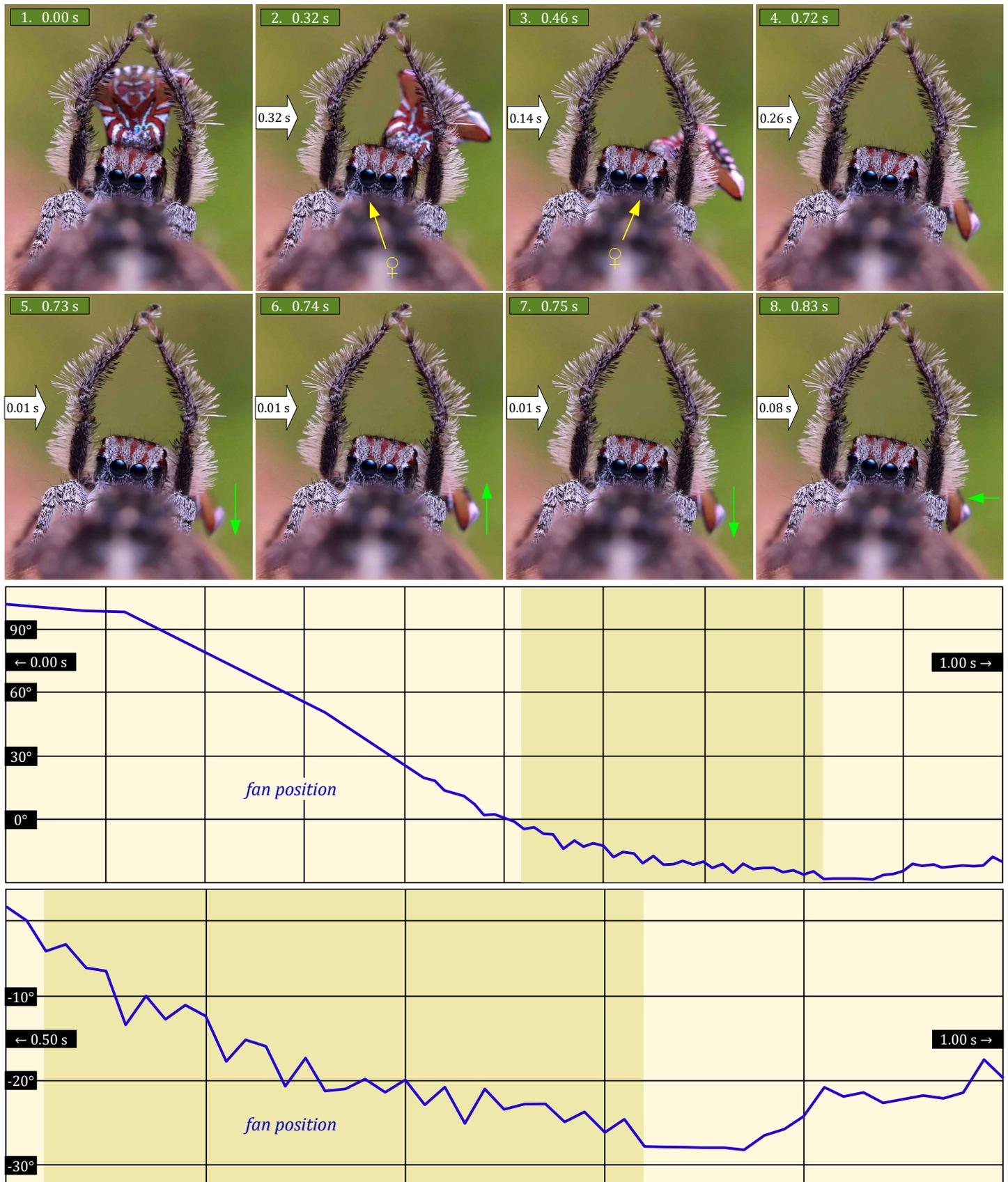


Figure 41. Close attention to male display by a female (in foreground) *M. manjimup* during an examination display (1.00 s from a 100 fps video). The lower chart provides a detailed view of the last 0.5 s of the sequence shown in the upper chart. *Fan position* represents elevation of the fan above the horizontal plane of the carapace. **5-7**, With the fan depressed, the retracted left flap was moved up and down (arrows) at ~40Hz for ~0.30 s. **8**, After this lateral display, the flap was further retracted.

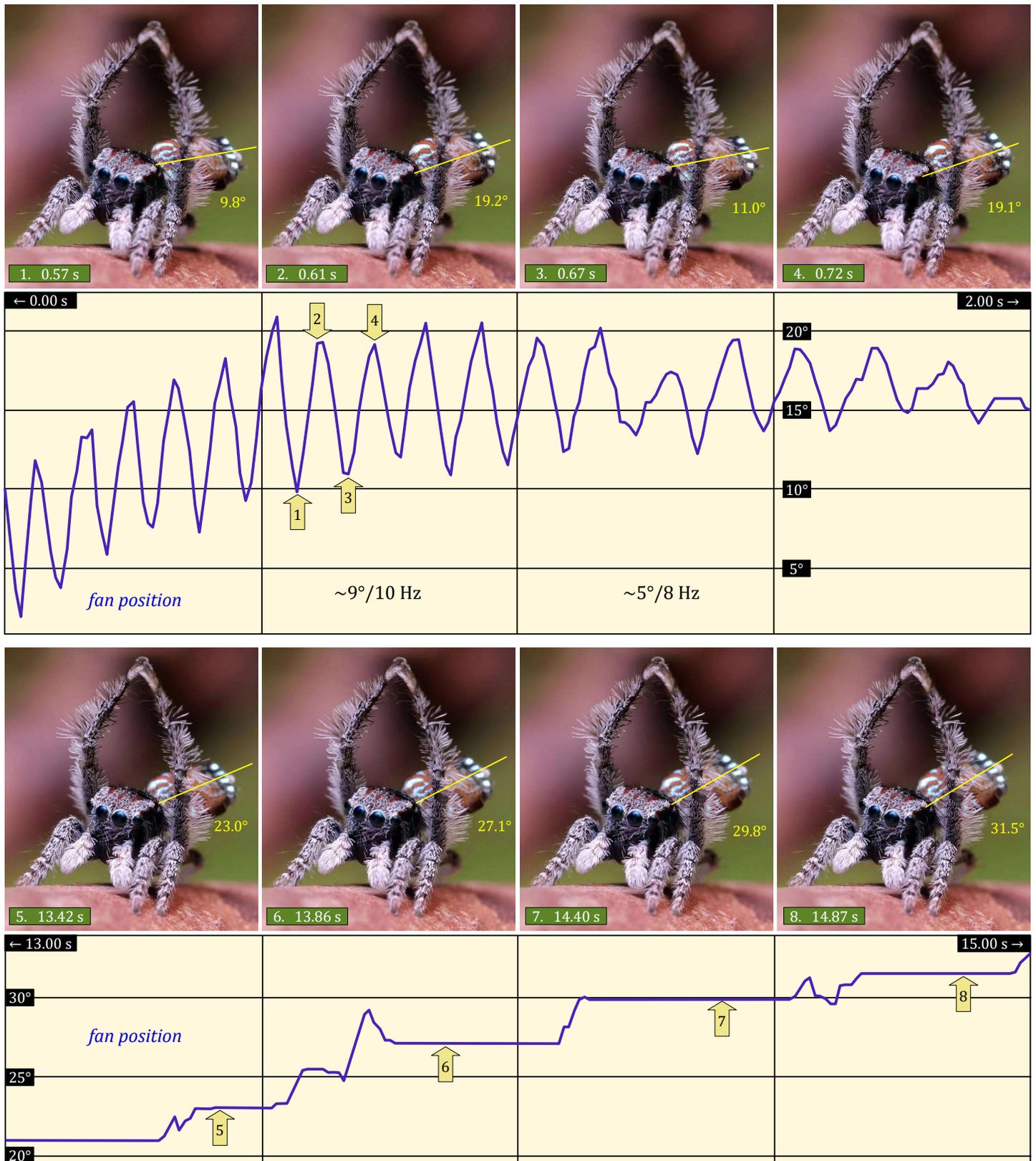


Figure 42. Examination display by a male *M. manjimup*, showing the slow return of the depressed fan with retracted flaps to the center after display of the left flap at the left side (two sequential 2.00 s segments from a 100 fps video). **1-4**, (upper chart) For more than one second, the rising fan was waved with an amplitude of $\sim 9^\circ$ (as measured from this perspective) at about 10 Hz. This amplitude and rate of movement was subsequently reduced. **5-8**, (lower chart) Subsequent movement of the fan back to the center position took place in rapid increments with little waving, spaced at intervals of about 0.4 s.

Habitat. *Maratus manjimup* was found on low plants or shrubs west of Lake Muir (Figure 43). Like the rest of southwestern Australia, this area has a mediterranean climate with warm, dry summers and wet winters.



Figure 43. Two views of the type locality for *Maratus manjimup*, about 7 km W of Lake Muir in Western Australia. Most specimens were found on the pineapple bush (*Dasyogon bromelifolius*), the clumpy, grass-like plant in the foreground (just left of center) of photo (1). However they were also seen on taller shrubs like the one in the left foreground of photo (2).

Courtship in the *vespa* group

Courtship display by males in the *Maratus vespa* group is characterized by display of the fan, often bearing prominent lateral flaps or tufts of bright white setae, moved alternately to either side behind a visual barrier or bracket formed by extension and elevation of the heavily fringed legs III (Figure 44). Table 4 provides a summary of what is known about courtship display by members of this group. For many we have only a brief text description for one or two of their displays. The display of *Maratus tortus* is unique with respect to the extent to which they twist the fan, to display each lateral flap in a center position (Figure 44.12; Otto & Hill 2018).

As noted previously, male courtship display can only be understood as part of an interaction between a male and a female. We may ask, why are there so many variations in the display of some species, particularly in the *attraction* stage? Why are males so versatile in their approach to females? There are several key factors to consider here. First, based largely on their genes, females within a local population may vary greatly with respect to their preferences. The assumption that only *average* male behavior (subject to female sexual selection) is relevant probably represents an error on our part. There may not be a single "fits all" approach that is most effective for all females. After all, variation in alleles or genes that drive courtship display by males and sexual selection by females is a prerequisite for rapid, Fisherian selection of complex display elements. This also suggests that we should find variation in the courtship display of *males* within a population if we look for it.



Figure 44. Courtship display by *vespa* group males. This includes all named and described species in the group (1-14, see also Table 1), as well as two species yet to be described (15-16).

Table 4. Summary of published descriptions of courtship display by members of the *vespa* group. In some cases there may be little or no difference between an *attraction* (at a distance) and an *examination* (up close) display, i.e., they may be largely the same. All species in this group may advertise with legs III in the same manner.

#	species	reference	advertisement	attraction	examination
1	<i>M. aquilus</i>	Hill & Otto 2019	one or both legs III waved	waving of extended fan, partly or fully elevated, with or without waving of extended legs III; may include side-stepping	behind extended legs III in near vertical position, ♂ displays partly elevated fan with retracted flaps at center, then extends and display one flap to the side
2	<i>M. astarte</i> , n.s.	Otto & Hill 2025	one or both legs III waved	low amplitude wave of near-vertical legs III with low amplitude wave of lower fan with retracted flaps; also larger amplitude wave of fan to one side and then to the other	wave elevated and expanded fan behind near-vertical legs III, with synchronized side-stepping, calipers movement of legs III, and pedipalp flicker; in lateral position fan is still fully elevated and expanded
3	<i>M. azureus</i>	Schubert 2020	unknown	fan raised with flaps partly or completely extended between extended legs III	♂ continues to wave elevated fan, extending and retracting flaps
4	<i>M. combustus</i>	Schubert 2019	unknown	fan with extended flaps waved behind vertical legs III	♂ continues to wave elevated fan, extending and retracting flaps
5	<i>M. cristatus</i>	Otto & Hill 2017	unknown	elevated and expanded fan waved from side to side at low or high amplitude behind extended, near vertical, legs III	elevated and extended fan waved from side to side at low or high amplitude behind elevated legs III, which are flexed at the patella- tibia joint with tarsi closer but not touching
6	<i>M. fletcheri</i>	Waldock et al. 2020	one or both legs III raised	behind extended legs III, fan raised and flaps extended, fan <i>shaken</i> , fan lowered	♀ follows extended flap on one side and then the other behind extended legs III
7	<i>M. harveyi</i>	Waldock et al. 2020	unknown	unknown	unknown
8	<i>M. icarus</i>	Otto & Hill 2019	wave extended legs III	fan, either elevated with extended flaps (higher amplitude), or depressed with partly retracted flaps (lower amplitude), waved to alternating sides behind extended legs III, fan also moved up and down; may include pedipalp flicker and/or low amplitude leg waving	elevated and extended fan waved, but intermittently depressed and rotated to display flap on one side of the extended legs III
9	<i>M. manjimup</i> , n.s.	Otto & Hill 2025	one or both legs III waved	wave elevated and expanded fan, or lower fan with retracted flaps, between extended legs III while in place, or when stepping from side to side; may include calipers movement of legs III and pedipalp flicker	behind closed (touching) bracket of legs III, ♂ displays expanded and elevated fan at center, then waves and lowers fan to display flap at one side, then retract flaps, return to center and extend flaps, then repeat cycle; during display at one side flap <i>may be</i> vibrated at 40 Hz
10	<i>M. noggerup</i>	Schubert 2020	unknown	fan elevated with flaps partly or completely extended between extended legs III	♂ continues to wave elevated fan, extending and retracting flaps
11	<i>M. pinniger</i>	Otto & Hill 2022	one or both legs III waved	wave elevated and extended fan between extended legs III	♂ rotates extended fan to each side in turn behind bracket of elevated legs III, displays flap when fan is depressed to the side
12	<i>M. tortus</i>	Otto & Hill 2018	one leg III waved	wide and tall versions of symmetrical semaphore with both legs III, may include partly elevated fan with flaps retracted; vertical fan twist of fan to display one flap and then the other behind elevated and extended legs III	twist to display one flap at center, then wave and twist fan from side to side before returning to display a flap at the center position behind vertical legs III; rapid side-stepping with symmetrical waving of both legs III also precedes mating
13	<i>M. unicum</i>	Otto & Hill 2018	unknown	wide and tall versions of symmetrical semaphore with both legs III; also low amplitude wave of elevated and expanded fan behind partly flexed (not completely closed) bracket of legs III as ♂ steps from side to side	behind closed (touching) bracket of legs III, ♂ displays expanded and elevated fan at center, then wave and lower fan to display flap at one side, then retract flaps, return to center and extend flaps, then repeat cycle
14	<i>M. vespa</i>	Otto & Hill 2016	unknown	unknown	♂ rotates extended fan to each side in turn behind bracket of elevated legs III (in contact), displays flap when fan is depressed to the side

Supernormal display elements may be of considerable advantage, as long as they do not detract too much from the survival of the male, or the ability of the female to find a mate. Secondly, based on complex factors to include experience, condition, weather conditions, microenvironment, or even time of day, the response of a female may vary, as may the behaviour of a male. In looking only for the average, we miss what could be a very informative study of variation and versatile behavior with a population.

Where this has been studied (e.g., *Habronattus*, Rivera et al. 2021), inter-population variation in the courtship display of salticids has been found. One interesting possibility is that the display of a male from

a parapatric population (or even from a different species) could be more effective than the display of a local male, if that population had evolved display elements that were supernormal with respect to a local population. There are still many intermediate populations and species to be discovered and studied in the *vespa* group, given the limited number of sites where these have been found (Figure 1).

Acknowledgements

We thank Matthew Brewer (*astarte*) and Flynn Prall (*manjimup*) for sharing their discoveries, and for collecting these new species. We also thank Matthew Brewer for providing us with habitat photos for *astarte* near the Astartea Glade road, as well as David Knowles, Michelle Peak, Flynn Prall, Joseph Schubert, Jonah Walker and Paul Winthrop for collecting several other species illustrated in this paper. We acknowledge the assistance of the Department of Biodiversity, Conservation and Attractions (DBCA) of Western Australia in granting the permits required for this work. Unless otherwise indicated, all photographs in this paper are © Jürgen C. Otto.

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