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SHORT COMMUNICATION

Love on the rocks: first field recording of mating behavior described for the genus *Castianeira* Keyserling, 1879 (Araneae: Corinnidae) in the northern Rocky Mountains, Wyoming, USA

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Abstract. In this study, I provide the first description of mating behavior in the field for the genus *Castianeira* Keyserling, 1879 (Araneae: Corinnidae). Females have been observed building intricate mounds over their egg sacs; this study describes mating behavior *while* the female was building a mound—suggesting that females may have more than one clutch of offspring during the mating season or that she may store sperm for the next mating season. Analysis of my field footage and observational data revealed a simple mating behavior with little pre-or post-copulatory interaction. I compared my observations with laboratory observations by Montgomery (1909) of *Castianeira descripta* (Hentz, 1847) and *Castianeira longipalpa* (Hentz, 1847). The mating behaviors are similar in length but the sequence and duration of coupling differed. These observations create a starting point for better researching courtship and mating behavior of this spider, the number of egg sacs produced during a season, as well as the role of mound-making in the reproduction process.

Keywords: courtship behavior; mound-building; Greater Yellowstone Ecosystem; ground dwelling spider; Teton Mountains

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The family Corinnidae is a species-rich group of spiders with worldwide distribution and nearly 800 described species in 70 genera. The subfamily *Castianeirinae*—which has a worldwide distribution with species in parts of Africa, Asia, the Western Pacific, and the Americas—has been found widespread throughout North America (Reiskind 1969; Bonaldo 2000; Bosselaers & Jocqué 2002; Raven 2015; World Spider Catalog 2022).

Raboin & Elias (2021) reported that female *Castianeira sp*. mature and mate prior to the 2nd week of July, with egg sacs constructed between mid-July through early September. I observed females in the field begin egg sac construction around sunset, with some females finishing up at break of day. They then construct intricate, artful mounds over their egg sac between sunrise and sunset (pers. obs.; Raboin & Elias 2021; Fig. 1d, e) which was shown to increase the survivability of offspring (Raboin & Elias 2021). Spiderlings hatch inside the egg sac, overwinter as 1st or 2nd instars and emerge the following spring (Raboin & Elias 2021).

Spiders in the group Castianeirinae are fast-running, ground-dwelling animals with many species resembling ants. In animals like ground-dwelling spiders that spend most of their lives solitarily, little is known about their mating behavior and the factors that influence mate choice and courtship. In addition, little information on reproductive behavior in the Corinnid family exists in the scientific literature. I found no reports of mating occurring in field settings, and only two instances of mating are described for the genus *Castianeira*: mating of pairs of *Castianeira descripta* (Hentz, 1847) and *Castianeira longipalpa* (Hentz, 1847) that Montgomery (1909) observed in the laboratory. Structures related to mating have also been described, such as the presence of mating plugs in *Aetius decollatus* O. Pickard-Cambridge, 1897 (Sudhin et al. 2018).

This study was conducted in dry, open habitat in the Upper Snake River Canyon, Wyoming (Fig. 1a). The locality is at approx. 1,830 m in elevation in a mixed, open alpine habitat ranging from cobbled river shores to a canyon butte dominated by sagebrush steppe (*Artemesia tridentata*) and mixture of forbs such as lupine and alfalfa. This land is currently designated as part of the Bridger Teton National Forest.

To decrease impact on these sensitive animals and minimize influencing behavior, observations were typically made from at least a meter away, and observational data included a combination of photos and video recordings. Video was recorded using: Canon EOS 5D Mark IV, MP-E 65mm f/2.8, 1-5x Macro Lens, EF 100-400mm f/4.5-5.6L IS USM Lens, Extension Tube EF25, Extension Tube EF12. Videos of mating behavior were analyzed using BORIS (Behavioral Observation Research Interactive Software) (Friard & Gamba 2016) and Image J (MtrackJ) software (Schneider et al. 2012).

Observations were made over the course of four field seasons; only one mating event was recorded in the observation of over a hundred mounds in this and other study sites. This mating event was seen in the same locality and during the same time frame as the study of Raboin & Elias (2021). The observations were made on 15 July 2017 over the course of four hours and 18 minutes after first seeing a male. Five couplings were observed and documented between the same male and female. This was one of two observations of males—the second was on 18 July 2017, though no mating was recorded before sunset on that day.

I began recording a female at 09:02 after she had constructed her egg sac and was positioned between a tangle web and on top of the silken egg sac. Between 10:22 (when the egg sac appears without any objects on top) until 13:20 (when mating was observed), the female made hundreds of trips gathering and carrying objects to create a mound over her egg sac. I observed her carrying small stones sometimes the size of her cephalothorax, small and large sticks the length of her body (approximately 6mm or slightly longer than a pencil eraser), a dry leaf (at least sixteen times her size), seeds, exoskeletons of invertebrates, cricket legs, flower blossoms, and small balls of soil. The male was observed near the mound for periods of time from 14 to 37 seconds, approaching the female twice approximately two hours and fifteen minutes apart: At 10:55 a male was observed on a nearby rock (approximately 30 cm away), staying there for 37 seconds before he ran off, and then again at 10:59 for 14 seconds. When the female left the mound, the male ran over the mound she was building. After the female returned at 11:04, the male approached her while she was on her mound. The female left and when she returned the male ran off. At 13:20 the male was observed

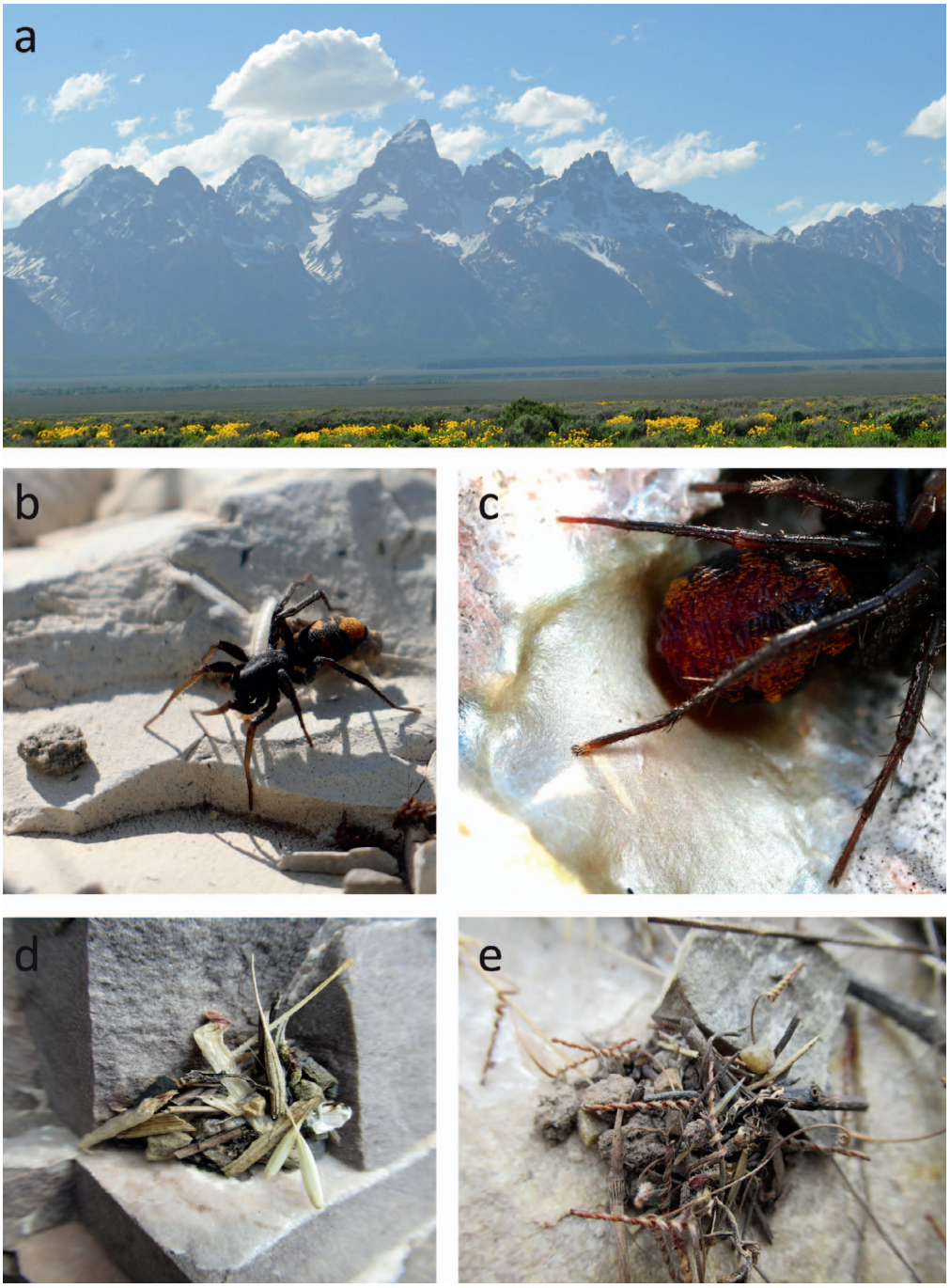

Figure 1 a-e.—*Castianeira sp*. habitat and natural history: a. dry, open habitat, approx. 1,830 m elev. in the Greater Yellowstone Ecosystem in northwestern Wyoming, USA. b. *Castianeira sp*. c. *Castianeira sp*. creating egg sac. d-e. Mounds created by *Castianeira sp*.

approaching the female on her mound. At first, he raised his legs I in the air before turning and approaching the female. He positioned himself over her with his ventral surface next to her dorsal surface, and aligned himself so that his cephalothorax was oriented a little to one side of the anterior portion of her abdomen when inserting his palpus (Fig. 2). The female appeared to elevate her abdomen. The male inserted his pedipalps 6 times with insertions lasting between 5–76 seconds and ran away between insertions. Leg IV extension and leg tapping and quivering were observed during insertions. After the final insertion, the male quickly departed and did not engage in any observable mound making contributions.

Through analyzing field footage and observational data, this study reveals simple behaviors that were observed over multiple, brief couplings (ex. leg tapping, raising abdomen) with short palpal insertions and little pre- or post-copulatory interaction. During interludes between couplings, I observed the female carry and place objects (an empty silken egg sac, seeds and small stones) and sometimes remove objects from her mound after silking them in previously.

There were both similarities and differences between these findings and the laboratory observations of *Castianeira descripta* (Hentz, 1847) and *Castianeira longipalpa* (Hentz, 1847) by Montgomery

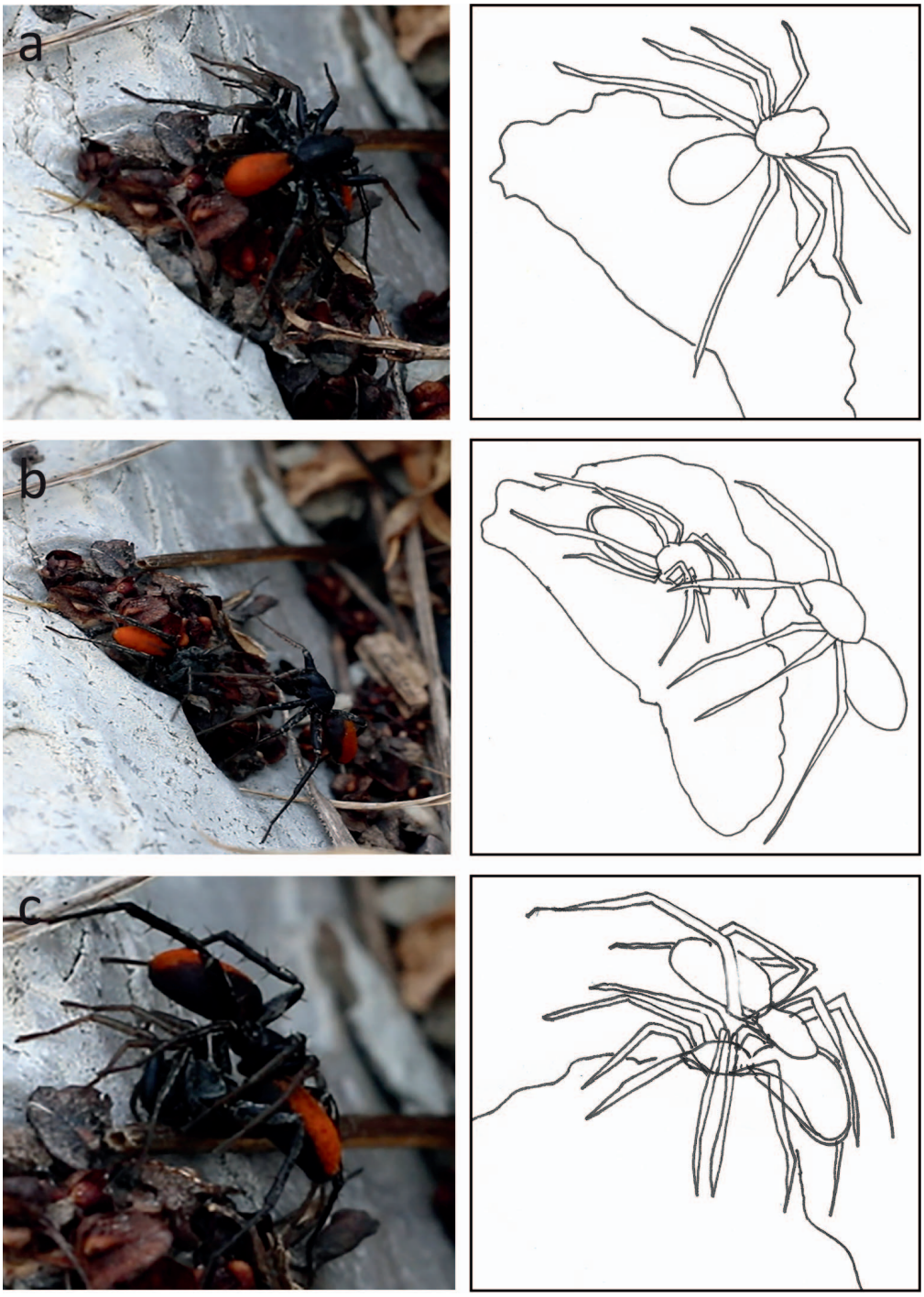

Figure 2 a-c.—Mating behavior of *Castianeira sp.*: a. Male approaches Female with front legs (Leg I) outstretched in a V-shape. b. Female stays still while Male* moves into a head-to-head position. c. Female elevates abdomen and male inserts pedipalps; male was observed to extend leg IV during insertion. Insertion lasts between approx. 5–76 sec. Male may return multiple times to the same mound. *legs II-IV on the righthand side of the male removed in drawing B for clarity.

(1909). Montgomery's laboratory observations of the orientation of the pair's body axes, approach, and body positioning during palpal insertion were similar. He reported putting more than one male in with a female including one with a missing palp (versus my field observation of one male and female), and the female ate one of the males in lab conditions (in the field the male was not eaten). We both observed one palp inserted at a time, although the duration of palpal insertions was longer in the lab, ranging from 60–120 seconds. The differences might be due to field versus laboratory conditions as well as species differences.

Mating *while* the female is in the process of covering her egg sac raises several questions about their mating system. First, could the

mound be a means of attracting additional males, a bet-hedging tactic of the female to maximize the success of her offspring? Second, in this alpine habitat the reproductive season is short; late-maturing males may have little opportunity to find virgin females. Are males using the mounds to find mated females? Third, do *Castianeira sp*. have multiple clutches? This study is unique in that these observations were made in their natural environment and not in a laboratory. Further studies should be performed to better understand the mating behavior of this spider. This could include video-recorded mating experiments under full laboratory conditions with several specimens of this spider—although catching males of this species has been especially difficult—and using laboratory-raised individuals is different than observing free ranging animals developed in their natural habitat. These rare observations from the field offer a starting point for further research to better understand these eight-legged architects' reproductive behaviors from the ground up.

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