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Cover: Nile Crocodile *Crocodylus niloticus* regulating body temperature on a warm day. Digital art on Procreate by © Aakanksha Komanduri.

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COMMUNICATION

Mating behavior of the Oaxacan Oak Anole *Anolis quercorum* (Squamata: Sauria: Anolidae) on a shade coffee plantation in Sierra Madre del Sur of Oaxaca, Mexico

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Abstract: Courtship and mating events in Mexican *Anolis* species have been reported mainly in captive conditions. Herein, we report a field observation of the mating behaviour of *A. quercorum* on a coffee plant, in the Sierra Madre del Sur, Oaxaca. Neck biting by the male, positioning on the female, head waving, copulation/intromission, as well as dislodging and retreat behaviours were observed in the wild. The mating duration was 25 minutes, which is within the reported period in the related *A. punctatus*. Future studies should improve and build on courting and mating observations to clarify if the observation duration reported here is part of the typical behavioural repertoire of *A. quercorum*.

Keywords: Anoles, behavioral signals, courtship, hemipenis, mating observation, reproductive.

Resumen: El cortejo y apareamiento en las especies de *Anolis* no ha sido reportada, excepto en experimentos de laboratorio. Aquí, reportamos una observación de campo del comportamiento de apareamiento de *A. quercorum* sobre una planta de café, en la Sierra Madre del Sur, Oaxaca, México. La duración del apareamiento fue de 25 minutos, lo cual se encuentra dentro del intervalo de tiempo reportado en otras especies como *A. punctatus*. Es importante reconocer que los futuros estudios incluyan más observaciones de cortejo y apareamiento para esclarecer si la observación reportada aquí es parte del repertorio típico de *A. quercorum*.

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Author contribution: JGG and GAAL contributes to data collection. Study conception, preparation, data collection and review were performed by JGG, ABS, GAAL, DANR and IPI. The first draft of the manuscript was written by JGG and all authors contributed to refining and revising the manuscript.

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INTRODUCTION

Under natural conditions, courtship and mating of anole lizards are rare to observe and document because most species usually mate perched on trees (Ribeiro et al. 2011; Oliveira & Moraes 2021). Particularly, this genus displays a variety of actions performed by males and females prior to copulation (Carpenter 1978). For example, diverse array of visual displays such as head bobbing, pushups, tail lifting, throat dewlap extension, and changing colour are performed by adult male anoles during nuptial season (Losos 2009; Driessens et al. 2014; Steffen & Guyer 2014; Beltrán et al. 2016), though these visual displays are also exhibited during territorial interactions (Losos 2009; Reedy et al. 2017; Horr 2019).

To date, studies on the ecology and life history of *Anolis* species have mainly focused on Caribbean islands (e.g., Losos 1996; Gianissi et al. 1997; Howard et al. 1999; Creer et al. 2001), and the North American mainland (e.g., Guyer 1988 a,b; Vitt et al. 1995). In Mexico, ecological studies of anoles are scarce compared to their diversity (e.g., Ramírez-Bautista et al. 2002), and most studies have been focused on taxonomy and systematics (e.g., Guyer & Savage 1986; Campbell et al. 1989; Nieto-Montes de Oca 1994, 1996; Köhler et al. 2014, 2019; Gray et al. 2016). Among Mexican anoles, behavioural data about mating duration has not been reported; however, information on these events is also of special interest because mating duration can differ among breeding events within a single anole species (Losos 2009) or in response to the presence of a predator or an observer (Beltrán et al. 2016). Most of the knowledge associated with reproductive events of anoles comes from laboratory experiments or captive animals (e.g., Stamps 1975; Lima & Souza 2006; Pandav et al. 2007, 2010; Driessens et al. 2014).

Some information has been documented for *Anolis quercorum*. For example, Ramírez-Bautista et al. (2002) conducted observations in laboratory conditions on egg development, size and volume, and relative clutch mass, and reproductive condition. However, the complete description of the duration of courtship and mating events in this species in the wild remains unknown. Herein, we report a field observation of mating behavior of *A. quercorum* on a coffee plant, in the Sierra Madre del Sur, Oaxaca, Mexico.

MATERIALS AND METHODS

We observed the reproductive event of the Oaxacan Oak Anole *Anolis quercorum* while assessing the biodiversity in a shade-grown coffee in Las Nieves farm, located in the municipality of San Juan Lachao (16.193° N, 97.058° W; elevation 1,450 m), in the state of Oaxaca, Mexico. The observation occurred in Finca Cafetalera Las Nieves of the Sierra Sur de Oaxaca; this is a ranch with rustic shade plantations that grow under the canopy of humid mountain forests. The climate in this region is subhumid temperate with annual air temperatures ranging from 12–20 °C and annual precipitation ranging from 1,000–3,500 mm (De Santis et al. 2018).

To avoid interfering with the displayed behavioural signals, we remained silent and at least 2 m from the individual during the entire reproductive event. Digital images and video were obtained using an iPhone (XR Model, 12 MP resolution) and a digital camera (Canon Eos Rebel) with a telephoto lens (Canon EF 70–300 mm). We recorded the start and end time of the event, as well as notes on the deployment of behaviours.

OBSERVATIONS

On 15 June 2024, at 1248 h we observed a female *A. quercorum* perched horizontally on top of the leaves of a coffee plant (*Coffea arabica*, Image 1A) at approximately 95 cm from the ground. She was constantly moving her head laterally to the left, and then returning it to its initial position. Five minutes later (1252 h), from a nearby tree, a male jumped over the female's dorsum and immediately positioned himself on her body and started biting the back of the neck (Image 1B). Because the male was outside our initial range of vision, we were unable to obtain information on the entirety of the displays exhibited by the male prior to mating or on the behaviours that triggered the observed mating position.

During the next 10 minutes, the male remained in the same position, taking quick bites over the back and side of the neck (Image 1C). Both right extremities (front and back) of the male were propped on the trunk, giving him support. At 1303 h, the male began to shift his hip to the left side of the female with the intention of joining the cloacas, while she began to raise the base of the tail (Image 1D).

Assuming his position, the male was most likely inserting its right hemipenes into the female (13.04 h). Both individuals remained almost immobile during the entire mating event (1304–1312 h), suggesting insertion

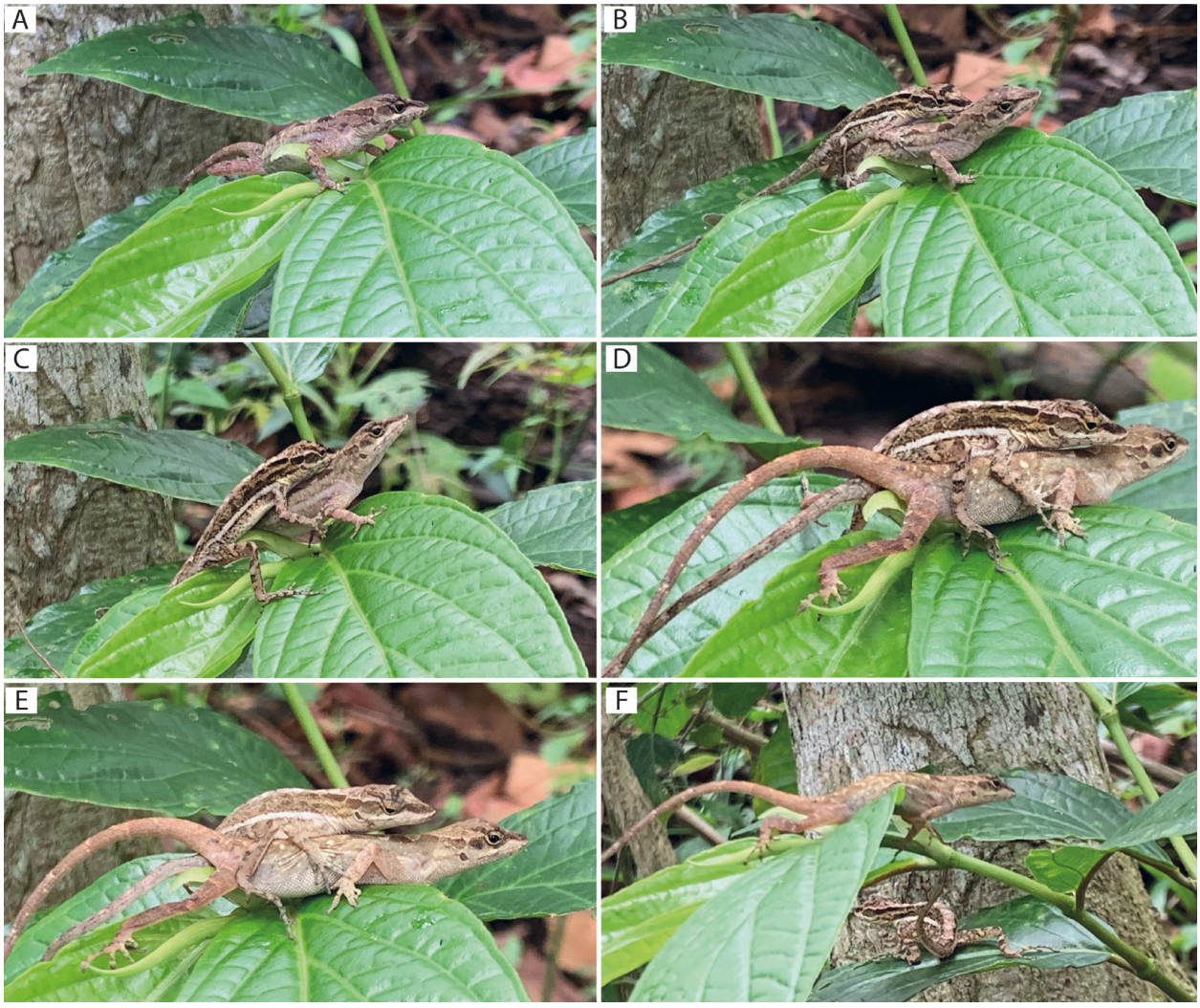

Image 1. Mating behavior of Oaxacan Oak Anole *Anolis quercorum* in a shade coffee plantation of Sierra Sur de Oaxaca, Mexico: A—Female perched horizontally on top of the leaves of a coffee plant | B—Male over the female back and biting the neck | C—Male taking short-lasting bites over the back of the neck | D—Male bringing the cloacas together for copulatory phase | E—Copulatory phase | F—End of the mating. © Jesús García Grajales.

of the hemipenis and insemination (copulatory phase), except for subtle movement of the female's head. During that time, the male stopped biting the female (Image 1E). After about eight minutes, the female became agitated and displayed side movements of the body and head to the left, apparently trying to disengage herself from the male. A few seconds later, both individuals moved separately for a short distance, then the male jumped to the nearest leaves, and the female stayed in the same location (Image 1F), thus ending the mating event at 1313 h.

After disengaging, the male returned to the same tree from which he jumped at the beginning of the event. Both individuals remained immobile (1313–1337 h) until the end of the observation period. During the mating event, both the anoles remained in the same constant body colour without any change.

DISCUSSION

Our present report is the first mating event observation of these anoles horizontally on coffee plant leaves in Mexico, as there are no such earlier reports. According to literature, the behaviour and positioning as well as the chosen substrate, of the mating individuals varied among anole species (Losos 2009; Oliveira & Moraes 2021). Silva-Neto et al. (2019) reported courtship behaviour of the Spotted Amazonian Green Anole *Dactyloa philopunctata* taking place on the vertical trunk

of an introduced tree species (*Syzygium cumini*) in the central Brazilian Amazonian. Oliveira & Moraes (2021) reported a courtship event on a vertical tree of Southern Amazonia, Brazil. During our observations, we did not record evasion by the female, but we documented nape biting by the male on the female. In a similar way, Silva-Neto et al. (2019) and Oliveira & Moraes (2021) reported these aggressive behaviours prior to the hemipenial insertion (copulatory phase). Unfortunately, we were unable to observe the nuptial display behaviour of the male (head bobbing, push-ups, and extending dewlaps) prior to mating, because it was not sighted until it approached the female.

We did not observe a colour change during this mating event. In fact, Silva-Neto et al. (2019) also did not report colour change during mating in *D. philopunctata*. Although Olivera & Moraes (2021) hypothesized that the colour change in males of *Anolis* may be result of combined effect of its excitement during copulation and insemination that progressively intensifies during mating. However, this hypothesis must be evaluated in greater detail in future studies.

Due to the potential exposure of the breeding pair to greater predation risk, mating events of anole species range from 10 minutes (Losos 2009; Beltrán et al. 2016) to up to 64 minutes (Alfonso et al. 2014). Here, the mating duration was 25 minutes, which is within the reported duration for other similar species such as *A. punctatus* (Silva-Neto et al. 2019; Moraes & Oliveira 2021). This study broadens our knowledge on mating behaviour in another anole species. Future studies should improve documenting the courting and mating observations to clarify if the mating duration reported here is part of the typical behavioural repertoire of *A. quercorum*.

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