Courtship displays vary greatly among lizard species. It plays an important role on mating success since, apart from being species-specific, it should signal and inform male individual quality to the female (Miles et al., 2007). These individual “quality” characteristics can be in terms of some intrinsic quality (such as better immune system, physiological condition, and physiological performance) or in terms of a visually accessible quality, such as secondary sexual traits (e.g., increasing showiness of morphological traits, such as colouration, or the display itself) (Andersson and Simmons, 2006). Such behaviours are often reported in visually oriented lizards, such as in Iguania (Schwenk, 1993).

The family Tropiduridae is widely distributed through South America (Frost, 1992). In regard of behavioural studies within this group, there are some reports for the genus *Microlophus* (Duméril and Bibron, 1837), inhabitant of the Galapagos’ Islands and mainland Ecuador (Carpenter, 1966, 1977; Stebbins et al., 1967; Werner, 1978), and for the genus *Tropidurus* (Wied-Neuwied, 1825) (Carpenter, 1977; Coelho et al., 2018), occurring in the Caatinga and Amazon Forest biomes. Regarding the reproductive behaviour, there are few reports describing the detection and approaching phases of *Tropidurus* mating, with the male performing head bob displays (Carpenter, 1977; Ávila and Cunha-Avellar, 2006; Vaz e Nunes et al., 2008; Vasconcelos et al., 2013; Lima et al., 2017). Copulation, however, did not occur in any of these reports, not allowing the description of the mating behavioural repertoire, as well as post-mating behaviours.

Along the coast of Brazil there is the restinga ecosystem, which is a coastal habitat with sand dunes that was formed by marine transgressions during the Quaternary. It consists of four types of vegetation, which includes beach vegetation, flooded plain, shrub vegetation, and restinga dry forest (Leão and Dominguez, 2000; Menezes et al., 2009).

*Tropidurus hygomi* is distributed from the north coast of Bahia to the state of Sergipe, in Brazil (Martins et al., 2010). It inhabits the restinga, being frequently observed in habitats of beach and shrub vegetation. *Tropidurus hygomi* is an heliothermic lizard, considered endangered and endemic to the open habitats of these coastal sand dunes (IBAMA, 2014). This lizard is a sit and wait forager that feeds on arthropods on the ground and on leaf litter (Travassos et al., 2015). The behavioural repertoire of *T. hygomi*, however, remains unknown. Here we describe the full court ritual and, for the first time, the full mating behaviour of *T. hygomi*.

**Materials and Methods**

On 6 May 2013 at 1528 h, during field observations towards a behavioural survey, we observed two individuals of *Tropidurus hygomi* engaging in interactions towards intercourse behaviour. The
observation took place at the restinga of Imbassai (12.4816°S, 37.9571°W; datum WGS84; 21 m elevation), Municipality of Mata de São João, State of Bahia, Northeast Brazil. The observed lizards were at shrub vegetation, on a sandy soil surrounded by herbaceous vegetation. Because characteristics of the environment may influence behavioural displays and reactions in lizards (Herrel et al., 2007), we recorded air temperature (33.7 °C), air humidity (57.4%), and substrate temperature (42.6 °C). During the whole observation, the observer (RM) kept a distance of about three meters from the two individuals. For the recordings, we used a Canon EOS Rebel T4i digital camera. We conducted the observation under ICMBio permit number 23355-4. For the description of behaviours, we use the terms according to Carpenter and Ferguson (1977). head bob displays are rapid up-and-down movements of the head performed by the lizard, while tail waving are movements of the lizard’s tail from side to side, often performed with an erect position of the tail (e.g., Coelho et al., 2018). Both behaviours can be signals to conspecifics and are often (e.g., tail waving) related to mating interactions.

Results

Prior to their interaction, the lizards were about 1.5 meters away from each other. We could only determine their sex after the copulation because sexual dimorphism is not evident in this species, and, henceforth, we treat each lizard by their respective sex. The male, bigger and more robust, was steady in its place and interacting with the female, performing head bobs. Then, it moved short distances approaching the female. During its locomotion, every time the male stopped, it performed tail waving and head bobs with its body positioned laterally towards the female. This sequence was repeated for approximately one minute until it reached the female when both performed head bobs in front of each other. Before the male approached the counterpart, the female’s tail was still and parallel to the ground. The female then lifted its body from the ground while keeping its limbs steady. The male approached from behind and climbed on the female, keeping the forelegs around the female’s body and turning its own body slightly to the side, while biting the female’s neck (Fig. 1A). Both lizards moved forward together (Fig. 1B), until the female raised the tail, allowing the male to assume copulation position, lowering its head, arching its body over the female, arranging the cloacal openings, and inserting its right hemipenis (Fig. 1C). The lizards remained in that position for 20 seconds. After detaching from the female, the male slowly moved in circles around the female until the female moved towards the right direction, while the male remained in the same location (Fig. 1D). The male kept walking very slowly while performing pelvic rubbing on the substrate, for approximately one minute (Fig. 1E). Shortly after, the male moved towards the female’s direction and restarted head bobbing (Fig. 1F). The female then proceeded with short sprints while the male chased the female until both lizards distanced themselves from the observer among the bushes. The observation ended at 1532 h. So, the entire event with the court behaviours, copulation, and post-mating behaviours, lasted about four minutes.

Discussion

Life-history traits, such as mating repertoire, present differences among families, but often present minor variation among phylogenetic related species in lizards (Brattstrom, 1974). Our report demonstrates that, except for lowering the head and arching the body, the mating repertoire of Tropidurus hygomi is similar to other species of iguanians (sensu Tonini et al., 2016). Beginning with the perception of the female presence, the male approaches and performs courtship displays (Clarke, 1963; Carpenter, 1966; Mesquita et al., 2016). Head bob is a social display that varies even among populations, according to morphology, life history traits, age, sex, and the context of which it is used (e.g., in agonistic or mating behaviours) (Labra et al., 2007; Macedonia et al., 2015). The male invited the female for courtship by bobbing its own head, which is a common display in other tropidurids, as well as biting the female’s neck before the ritual (Carpenter, 1966). This male behaviour is also reported as a method to pacify the mate and successfully achieve copulation (Crews, 1987). Our observation showed T. hygomi biting the female’s neck after she accepted the court. For the Galapagoan tropidurids, biting was done onto the collarbones region when the courtship was successful, while it was done at the tail when the court was rejected (Carpenter, 1966).

In another courtship observation of T. hygomi, even though it was rejected, the male did not bite the female. The female, on the other hand, raised its tail during such observation, which is a sign of no receptivity within the species court repertoire (Carpenter, 1966; Vasconcelos et al., 2013). In our observation, female tail rising was not performed, and the copulation attempt was successful, which reinforces the signal of no receptivity emitted by this behaviour.
During copulation, the arched position – or “doughnut posture” – assumed by the male occurs when the male protrudes its hemipenis into the mate, ceases biting its neck, and then bites its pelvic region, which indicates ejaculation (Crews, 1987). In our observation, the male ceased biting the female right after climbing on its dorsum and did not bite it while on arched position. Possibly, it is a variation within T. hygomi species, which should be verified by further studies. Clarke (1963) and Greenberg (1977) reported copulations from two to 20 seconds for Holbrookia maculata Girard, 1851, and Sceloporus cyanogenys Cope, 1885,
respectively. Such reports are similar to our findings of T. hygomi’s 20 seconds-lasting mating, which we believe was a successful copulation. Pelvic rubbing after copulation was not described to the species in the Galapagos Islands, but was reported by Jenssen (1970) to the iguanians Anolis nebulosus (Wiegmann, 1834), and by Greenberg (1977) to Sceloporus cyanogenys. Such behaviour is similar to the behaviour of post-evacuation, and is suggested by the authors as a likely way of depositing chemical signals. On Ameivula (Spix, 1825) species (Teiidae), this behaviour occurs before the copulation as an auto-stimulation of the male, or as intersexual communication (Carpenter, 1962; Ribeiro et al., 2011). Moving in circles around the female was also reported by Lima et al. (2017) in Tropidurus hispidus (Spix, 1825). However, males of T. hispidus performed this behaviour prior to mounting the female, and not after, as we report here for T. hygomi.

Our observation on T. hygomi mating repertoire shows some similarities with other iguanian families, possibly consisting of phylogenetically shared features. This is novel information for the natural history of this endangered species with a restricted distribution, and possibly consisting of phylogenetically shared features.

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References


Full mating repertoire of Tropidurus hygomi on a coastal sand dune

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