

DIPSOSAURUS DORSALIS DORSALIS (Northern Desert Iguana). **DIPLOCHORY.** Diplochory or “two-phase dispersal” is a seed dispersal mechanism in which the seed of a plant is moved sequentially by more than one dispersal mechanism or vector. The most well-known examples of lizard diplochory involve lizards which feed on seeds then are subsequently predated by birds which act as the secondary seed dispersers (Nogales et al. 2007. *J. Ecol.* 95:1394–1403). *Dipsosaurus dorsalis dorsalis* is a large, omnivorous iguanid lizard species found in the southwestern United States and northwestern Mexico and although their diet is primarily herbivorous and includes seeds, they have been known to consume a wide variety of invertebrates, including ants (Dibble et al. 2008. *West. N. Am. Nat.* 68:521–523). Here we present a description *D. d. dorsalis* collecting and consuming seeds from the mound of a Rough Harvester Ant (*Pogonomyrmex rugosus*) nest.

On 26 May 2024 at 0933 h we observed a juvenile *D. d. dorsalis* (ca. 15 cm SVL) feeding on seeds near the entrance of a large *P. rugosus* nest mound near Ocotillo, Imperial County, California, USA (32.7168°N, 116.0767°W; WGS 84; 114 m elev.). The ants were inactive during the time the *D. d. dorsalis* was foraging, presumably due to the high surface temperature of the soil. The *D. d. dorsalis* was actively foraging, consuming what appeared to be seeds at a refuse heap, from the exterior edges of the ant mound where discarded objects are often left by ants (Rissing 1986. *Oecologia* 68:231–234). Upon using a long-range camera lens to focus on the *D. d. dorsalis* from a distance of ca. 15–20 m, we observed the lizard foraging on seeds, as well as seeds stuck to its face. The seeds were identified as those belonging to the Strawberry Hedgehog Cactus (*Echinocereus engelmannii*), which was prevalent in the area and whose seeds have a sticky coating. On the same day, a second juvenile *D. d. dorsalis* (ca. 21 cm SVL) was captured in the same general area and we found these same cacti seeds inside the lizard’s mouth, although it is unclear whether these consumed seeds came from the ant nest or directly from the plant.

To our knowledge, this is the first description of *D. d. dorsalis* foraging and consuming seeds from the refuse heap of harvester ants. We have yet to find an example of diplochory in the literature involving live lizards as secondary seed dispersers. Further investigation may provide insights into whether



FIG. 1. Juvenile *Dipsosaurus dorsalis dorsalis* consuming seeds from the nest mound of Rough Harvester Ants (*Pogonomyrmex rugosus*).

the *D. d. dorsalis* were also engaging in kleptoparasitism. Kleptoparasitism is defined as a form of feeding in which one animal deliberately takes food from another. Kleptoparasitism is well-documented in many types of organisms, including lizards (Iyengar 2008. *Biol. J. Linn. Soc.* 93:745–762). Because the ants were inactive during our observation, it is impossible to know whether the *D. d. dorsalis* were also taking both the ants and the seeds while foraging, taking seeds directly from ants, or simply taking discarded seeds (as observed).

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HELODERMA SUSPECTUM (Gila Monster). **FIRST RECORD OF MATING IN THE WILD.** There is little documentation of the reproductive and copulatory behaviors in wild *Heloderma suspectum* outside a single observation of probable courtship and mating attempts that occurred outside of a rock shelter (Zylstra et al. 2015. *Herpetol. Rev.* 46:258–259). Most of what is known on the species mating and copulation behaviors is from observing captive animals (Gates 1956. *Herpetologica* 12:184; Beck 2005. *Biology of Gila Monsters and Beaded Lizards*. University of California Press, Berkeley, California. 211 pp.; Schwandt 2019. *The Gila Monster, Heloderma suspectum: Natural History, Husbandry, and Propagation*. Frankfurt am Main, Germany. 272 pp.), but these may not reflect behaviors in the wild. Herein, we report on mating and copulation of wild *H. suspectum* in a rock shelter at Red Cliffs National Conservation Area, Utah, USA (1051 m elev.; coordinates withheld).

At 0902 h on 21 May 2024, we located an adult male *H. suspectum* (hereafter, the male) and began following it as part of a long-term study on the species’ ecology and habitat use. At 1737 h, the male entered a shallow, northeast-facing rock shelter and dug soil out to enlarge an interior hole that was 32.7 cm straight in from the shelter entrance, which he entered. At 1832 h we observed the male and an adult female *H. suspectum*, (hereafter, the female), seeming to rest their heads pressed together at the entrance of the enlarged dirt hole in the back of the shelter. It was unknown whether the female was present in the shelter prior to the male entering, or if she had entered the shelter after the male (undetected by us) via one of two known (or an unknown) connected shelter entrance. From 1832 h to 1855 h, the male repeatedly “stroked” the female’s head and upper body by moving his head with lateral movements, that we interpreted as courtship behaviors, of which she was receptive, until they separated and moved out of view. At 1858 h, the male followed the female to the shelter entrance, where she laid down for 14 s and appeared receptive to the male’s attempts to mount her from behind, which he was unable to do because of the low ceiling of the shelter. During a 4-min period, from 1900–1904 h, the female slowly turned around as the male continually repositioned himself on, and next to her, until he followed her into the interior of the dirt hole out of view. During the 1858–1904 h activity, the male tongue flicked repeatedly at, and on the female’s body and tail, and not directly at her; while the female also tongue-flicked occasionally at the male’s head as he approached, and mostly not directly at the male, when he tried to mount or maintain a position on top of her.

At this time, at 1948 h, we installed four infrared-equipped Browning Dark Ops HD Pro X trail cameras 0.25 m above the

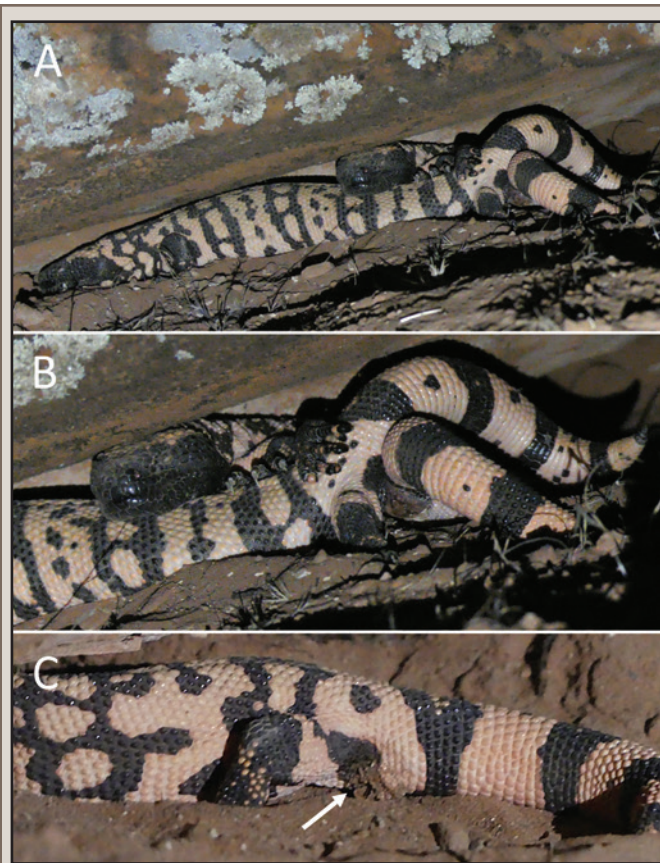


FIG. 1. Sequence of mating events of a pair of wild *Heloderma suspectum* in a rock shelter at Red Cliffs National Conservation Area, Utah, USA: A) mating position, with the hind limb of male clasp the base of the female's tail during copulation; B) male pressing his cloaca (with left hemipenis inserted) against the female cloaca in thrusting movement during copulation; C) probable wet semen remnants stuck to the male's cloaca and tail region with dirt partially adhered to it following copulation (white arrow).

ground and 1.0 m from (and facing) the entrance of the shelter to further document this event. We programmed the cameras to record eight photographs for each trigger event, with a 2-s delay between photos and 1-s between trigger events, continuously every 24 h. We also remained at the shelter to continue our monitor.

From 2109 h to 2113 h, we heard loud breathing and body against rock “scratching” sounds from within the shelter, indicative of probable male mating attempts, but the pair was out of view and we can't confirm this. During a 3-min period, from 2126–2129 h, the male followed the female to the shelter entrance where he again “stroked” the female's head and upper body with his head, and they both repeatedly tongue-flicked at each other with their heads in close proximity. This mutual tongue flicking lasted until the female repositioned her body and laid mostly still, while the male continued to tongue flick while nudging her body and tail with his head, and trying to mount her backwards (i.e., with his head above her tail) and from the rear, until he separated and reentered the dirt hole. At 2134 h, the male reentered the shelter entrance where the female was laying, and repeatedly nudged and “stroked” her head with his head for 49 s, while also repeatedly tongue-flicking at, and on her head, as she laid mostly still. During a 2-min period, from 2135–2137 h, the male mounted the female backwards, and from the rear

while clasp a hind limb around the base of her tail, apparently trying to rotate her pelvis towards him, with the male repeatedly tongue-flicking and female only occasionally. Though the female now exhibited signs of resistance, she appeared to be receptive to the male's movements, except on two occasions when the male mounted her backwards and struggled to maintain his position on top of her body. When this occurred, the female opened her mouth and “jerked” her head towards the male but did not bite.

At 2137 h, the female lifted her tail, the first time we saw this, so the male could more easily align his cloaca with hers, but due in part to the low shelter ceiling, the male was unable to make prolonged cloacal contact in this position. The pair continued to reposition themselves at the shelter entrance for 9 min, and at 2146 h the female again raised her tail, this time with the male using his left fore and hind limb to clasp the base of the female's trunk and tail (respectively). In this more stable position, the male moved his cloaca over the female's and inserted his left hemipenis into her cloaca (Fig. 1A). The pair remained mostly motionless in this position for 26 min, from 2147–2213 h, with their eyes closed; the only visible activity were regular periods of thrusting movements as the male further pressed his cloaca against the female's cloaca (Figs. 1A, B). We documented 77 total male thrusting movements during 17 distinct thrusting periods. The thrusting periods ($N = 17$) had a relatively consistent number of male thrusts (mean = 4.5 ± 1.1 SD; range: 3–6 thrusts), duration (seconds; mean = 9.8 ± 1.7 SD; range: 6–12 s), and frequency (seconds; mean = 90.1 ± 23.9 SD; range: 65–178 s). Each thrusting period consisted of a series of relatively quick thrusts followed by a final prolonged thrust with the male firmly pressing his cloaca against the female's cloaca. We also observed apparent minor contractions of the male's cloacal region immediately following some thrusting periods, which lasted for several seconds. At 2213 h, after 27 min, the pair separated and we observed what appeared to be wet semen remnants stuck to the male's cloaca and tail region, with some dirt partially adhered to it, suggesting successful intromission (Fig. 1C). The female then moved deeper into the shelter out of view, with the male following. We continued monitoring the shelter until 0030 h with no further activity observed on this night. We left the trail cameras at the shelter entrance until 30 June 2024 and captured images of the male *H. suspectum* basking and digging at the shelter on 22 May 2024, the female, then the male, exiting the shelter on 23 May 2024, the male entering and exiting the shelter on 25 May 2024, and a different male *H. suspectum*, confirmed by his unique dorsal patterns and prior male-male combat behavior (Beck 2005, *op. cit.*), was at the shelter 1–2 June 2024. No additional activity was recorded at the shelter entrance through 30 June 2024. A 4-min video recorded by DTP of our *H. suspectum* copulation observations can be viewed at <https://doi.org/10.26153/tsw/55866>.

To our knowledge this is the first observation of mating and copulatory behaviors in wild *H. suspectum*, and we confirmed Beck's (2005, *op. cit.*) hypothesis that these behaviors take place in shelters, accounting for the rarity of such observations. We suspect our ability to observe this rare event was due in part to the shallow rock shelter ceiling being taller at the entrance, and the location and positions of the male and female in the shelter, which allowed an unobstructed view of the mating activity. The sequence of events and behaviors exhibited by this mating pair were surprisingly consistent with those documented in captive *H. suspectum* (Gates 1956, *op. cit.*; Beck 2005, *op. cit.*; Schwandt 2019, *op. cit.*), including duration. The entire mating event we

observed took 27 min, which is also consistent with those under captive conditions which can last a few minutes to 2.5 h (Gates 1956, *op. cit.*; Beck 2005, *op. cit.*; Schwandt 2019, *op. cit.*).

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OPHISAURUS VENTRALIS (Eastern Glass Lizard). SEXUAL MATURITY. *Ophisaurus ventralis* is a common, yet secretive legless lizard that occurs in the southeastern United States (Palmer and Braswell 1995. Reptiles of North Carolina. University of North Carolina Press, Chapel Hill, North Carolina. 104 pp.). Despite *O. ventralis* being one of the more commonly encountered species within the genus *Ophisaurus*, little is known about its life history, including the age at which individuals become sexually mature. Meshaka and Layne (2015. Herpetol. Conserv. Biol. Monogr. 5:1–535) suggested that individuals in southern Florida may reach sexual maturity within one year, however, this represents the southern limit of their range which may not be representative of populations in other regions. The age at which a lizard reaches sexual maturity is important for determining growth rates, longevity, reproductive output, and other variables used to understand the population dynamics of a species (e.g. Brooks 1967. Ecol. Monogr. 37:71–87). Here, we assessed sexual maturity and the relative age of road-killed *O. ventralis* individuals from North Carolina.

Between 2006 and 2023 we collected nine road mortality *O. ventralis* from Bladen, Moore, Richmond and Sampson counties in the Coastal Plain and Sandhills of southeastern North Carolina that were sampled for use as museum specimens and later shared for this research study (Table 1). We measured and dissected each lizard and examined their sex organs under a compound microscope to determine their state (present or absent) and level of development, where male lizards were considered sexually mature if spermatozoa were present and females by the presence of vitellogenic ovarian follicles. Mean SVL measurements are present with standard deviations.

Of the nine lizards dissected, four had detectable sex organs, two males (mean SVL = 14.05 ± 3.47 cm) and two females (mean SVL = 13.9 ± 1.56 cm), while sex organs, and therefore sex, was

not discernable for five lizards (mean SVL = 12.38 ± 3.21 cm; Table 1). The lack of sex organs in most individuals can likely be attributed to the organs being destroyed or lost when the animals were crushed by automobiles.

The male collected in June 2022 had what appeared to be sperm within the vas deferens, despite its small size (11.6 cm SVL) and the small female (12.8 cm SVL) collected in late May 2007 appeared to have at least one vitellogenic ovarian follicle. Factors such as the cause of death and age of the specimens could have interfered with the perceived condition of the sex organs, although the placement of material within the male's vas deferens and the relatively large size of the female's ovarian follicle suggest that the organs in both were mature and capable of reproduction. This would make these two individuals the smallest ever recorded to be capable of reproduction.

Palmer and Braswell (1995, *op. cit.*) detailed the seasonal habits of this species in North Carolina and noted that hatchlings appear by late summer in August and September. Assuming that our smaller male and female hatched around this time, and given they were found the following spring, this would suggest that both individuals were less than a year old when they died. Indeed, Fitch (1989, *op. cit.*) created a distribution of sizes for different age classes of the closely related and similarly sized *O. attenuatus* from a population in Kansas and, when compared with the age classes mentioned, also puts these animals within their first year of life. This is in line with the suggested age of maturity of *O. ventralis* in southern Florida (Meshaka and Layne 2015, *op. cit.*). However, since the smaller female in our sample only had one follicle that could be considered vitellogenic, it may be more likely that females wait to reproduce until their second spring. This may be supported by the larger female in our sample (15 cm SVL; Table 1), which had multiple vitellogenic ovarian follicles and, in theory, would be just over a year old. Overall, it seems that females attain sexual maturity somewhere in the range of 12–15 cm, while males appear to reach maturity at a slightly smaller size, but more field studies for *O. ventralis* are needed. Our sample, to our knowledge, includes the smallest individuals of *O. ventralis* yet recorded to be capable of reproduction and thus helps further our understanding of the life history of this species.

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TABLE 1. Road-killed *Ophisaurus ventralis* specimens with collection details and sex organ condition. Coordinates are in WGS 84.

| Date Collected | Sex | SVL (cm) | Sex organs visible | Organ condition | County | Coordinates | Elev (m) |
|-------------------|---------|----------|--------------------|--|----------|-------------------|----------|
| 6 October 2021 | Female | 15.0 | Yes | Several vitellogenic ovarian follicles | Bladen | 34.6661, -78.3385 | 13 |
| 20 September 2017 | Unknown | 17.3 | No | – | Sampson | 34.7767, -78.3840 | 40 |
| 23 June 2006 | Unknown | 9.3 | No | – | Moore | 35.0698, -79.5543 | 97 |
| 5 October 2023 | Male | 16.5 | Yes | No sperm | Sampson | 34.6634, -78.2683 | 23 |
| 6 April 2022 | Unknown | 11.0 | No | – | Bladen | 34.6315, -78.3270 | 10 |
| 13 October 2022 | Unknown | 10.5 | No | – | Sampson | 34.6465, -78.2359 | 11 |
| 16 May 2023 | Unknown | 13.8 | No | – | Bladen | 34.5811, -78.2856 | 9 |
| 26 May 2007 | Female | 12.8 | Yes | One vitellogenic ovarian follicle | Richmond | 35.0171, -79.5448 | 100 |
| 1 June 2022 | Male | 11.6 | Yes | Sperm in vas deferens | Bladen | 34.6642, -78.3365 | 12 |