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NEST-GUARDING BY FEMALE AGASSIZ'S DESERT TORTOISE (*GOPHERUS AGASSIZII*) AT A WIND-ENERGY FACILITY NEAR PALM SPRINGS, CALIFORNIA

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ABSTRACT—We observed behavior consistent with nest-guarding in Agassiz's desert tortoise (*Gopherus agassizii*) at two nests in a large wind-energy-generation facility near Palm Springs, California, locally known as the Mesa Wind Farm. As researchers approached the nests, female desert tortoises moved to the entrance of their burrows and positioned themselves sideways, directly over their nests. One female stretched her limbs outward and wedged herself into the burrow (her plastron directly above the nest). Guarding of nests is rarely observed in Agassiz's desert tortoise but can occur as a result of attempted predation on eggs by Gila monsters (*Heloderma suspectum*) or in direct response to the perceived threat posed by researchers. This is the first report of nest-guarding for *G. agassizii* in the Sonoran Desert ecosystem of California.

RESUMEN—Observamos el comportamiento de las tortugas del desierto (*Gopherus agassizii*) que parece vigilar a sus nidos. Observamos este comportamiento en dos nidos que estuvieron ubicados en las instalaciones para la generación de energía eólica, cerca de Palm Springs, California, conocida localmente como Mesa Wind Farm. Cuando los investigadores se acercaron a los nidos, las tortugas hembras se desplazaron hacia la entrada de su madriguera y se posicionaron a los lados directamente sobre sus nidos. Una hembra estiró sus extremidades hacia fuera asegurándose ella misma dentro de la madriguera (dejando el plastrón directamente encima del nido). Es muy raro observar la vigilancia de nidos en las tortugas del desierto, pero puede ocurrir como resultado de intentos de depredación de huevos por el monstruo de Gila (*Heloderma suspectum*) o como respuesta directa al percibir a los investigadores como una amenaza. Este es el primer reporte del comportamiento de vigilancia de nidos de la tortuga *G. agassizii* en California en el ecosistema del desierto de Sonora.

Any oviparous reptile demonstrating post-ovipositional behavior that increases the survival or fitness of its offspring is considered to be exhibiting parental care (Shine, 1988). Post-ovipositional behavior such as nest guarding or defense of nests is rare in turtles but not unreported (Iverson, 1990; Kuchling, 1999; Somma, 2003a). After oviposition, many species of turtles display limited or no maternal behavior and leave the nest and the eventual hatchlings to fend for themselves (Bonin et al., 2006; Ernst and Lovich, 2009). Perhaps the earliest observation of possible parental care in turtles involved female East African leopard tortoise (*Geochelone pardalis*) attending their eggs (Loveridge, 1923). Since then, various forms of parental care have been reported in four families of turtles (*Emydidae*, *Kinosternidae*, *Podocnemididae* and *Testudinidae*), and it is entirely maternal (Somma, 2003b). An overview of published observations of defense of nests and parental care in turtles is given in Table 1.

Most observations of turtles defending nests involve tortoises (Testudinidae: Barrett and Humphrey, 1986; McKeown, 1999; Henen, 2000; Grosse et al., 2012). Both species of desert tortoises (*G. agassizii*, Agassiz's desert tortoise, and *G. morafkai*, Morafka's desert tortoise: *sensu*, Murphy et al., 2011) are reported to exhibit defensive behavior of passive resistance when approached by potential predators (Miller 1932; Woodbury and Hardy, 1948; Grover and DeFalco, 1995). However, previously published reports described an aggressive interaction between Morafka's desert tortoise and a Gila monster (*Heloderma suspectum*), where a female tortoise was observed attacking a Gila monster that tried to raid her nest and eat her eggs (Vaughan, 1984; Barrett and Humphrey, 1986; Zylstra et al., 2005). Morafka's desert tortoise also has been observed defending nests in direct reaction to a perceived human predator, in this case a researcher. In response to human intrusion, the female

TABLE 1—Summary of literature on defense of nests and parental care in turtles.

Taxa	Behavior	Location	Reference
<i>Gopherus agassizii</i>	Defense of nest: human interaction	Goffs, California	Henen, 2000
	Defense of nest: Gila monster interaction	Clark County, Nevada	Gienger and Tracy, 2008
	Defense of nest: Gila monster interaction	Southwestern Utah	Beck, 1990
<i>Gopherus morafkai</i>	Defense of nest: Gila monster interaction	Picacho Mountains, Pinal County, Arizona	Barrett and Humphrey, 1986; Vaughan, 1984
	Defense of nest: Gila monster interaction	Saguaro National Park, Arizona	Zylstra et al., 2005
	Defense of nest	Sonoran Desert, Arizona	Averill-Murray et al., 1996
<i>Gopherus berlandieri</i>	Defense of nest: human interaction	Sonoran Desert, Arizona	Averill-Murray et al., 2002
<i>Gopherus flavomarginatus</i>	Defense of nest	Davisboro, Texas	Strecker, 1929
	Defense of nest: human interaction including aggressive approach	Captivity	Appleton, 1986
<i>Gopherus polyphemus</i>	Defense of nest: human interaction including aggressive approach	Southeastern Chihuahua, Mexico	Morafka, 1982
	Defense of nest: human interaction including aggressive approach	Aiken County, South Carolina	Grosse et al., 2012
<i>Geochelone pardalis</i>	Parental care: attendance of nest by female	Morogoro Region, Tanzania	Loveridge, 1923
	Defense of nest	—	Ernst and Barbour, 1989
	Defense of nest: captive, intraspecific interaction	Mexico	Turner, 1988
<i>Manouria emys</i>	Defense of nest and attendance of nest	Captivity	McKeown et al., 1982, 1991
	Defense of nest: perceived predator interaction in captivity	Captivity	McKeown, 1992, 1993-1999
	Defense of nest: in captivity	Wassenaar Zoo, Netherlands	Louwman, 1982
	Defense of nest: in captivity	Seattle, Washington	Slavens and Slavens, 1990
<i>Kinostemon flavescens</i>	Defense of nest	Captivity	Eggenschwiler, 2003
	Parental care: mud turtle remained buried with nests to cover and protect eggs	Garden County, Nebraska	Iverson, 1990
	Parental care: posthatching acoustic communication	João Pessoa, Brazil	Ferrara et al., 2013
<i>Trachemys stejnegeri malonei</i>	Parental care: loosening ground around nests for emerging hatchlings.	Cat Island, Bahamas	Hodsdon and Pearson, 1943

tortoise positioned herself in an orientation that blocked the entrance to a burrow with eggs, thus limiting exposure of the nest (Averill-Murray et al., 2002). Various instances were noted of female tortoises protecting nests with aggressive behavior such as charging and biting the researcher (R. C. Averill-Murray, pers. comm.).

Defense of nests also has been noted in Agassiz's desert tortoise. For example, Gienger and Tracy (2008) and Beck (1990) observed Gila monsters attempting to raid nests of *G. agassizii*. At Goffs, California, Henen (2000) observed agonistic maternal behavior in a female Agassiz's desert tortoise when it rammed the investigator's leg in an apparent effort to protect her nest from the perceived predator.

We conducted research on Agassiz's desert tortoise (*G. agassizii*) at nesting sites at a large wind-energy-generation facility near Palm Springs, California, locally known as the Mesa Wind Farm. We examined nesting sites by monitor-

ing gravid females daily using thread trailing (Claussen et al., 1997) and radio-telemetry. Additional details are given by Lovich et al. (1999, 2011) and Ennen et al. (2012). At the sites of two known nests, we observed behavior previously reported (Table 1) as nest-guarding. Ours is the first report of nest-guarding by *G. agassizii* in the Sonoran Desert ecosystem of California.

On 5 July 2011, an adult female tortoise was tracked by radio telemetry to an established burrow. The tortoise was X-rayed on 28 June 2011 revealing a second clutch of four eggs. Her burrow was located on a hillside with rocky soil, dominated by California sage brush (*Artemisia californica*). When the first author (MA) approached the burrow, the shell of the tortoise was visible, and the tortoise faced the inside of the burrow. After the investigator suspected that a nest was located in the burrow, an attempt was made to remove the tortoise from the burrow. The female tortoise charged towards the investigator in an aggressive manner

with her carapace prodding the boots of the investigator and then positioned herself sideways at the entrance of the burrow (her plastron was directly above where thread had been buried and where a layer of dirt was removed by the investigator). This behavior was only observed at the study site after a female had nested. The investigator tried to make the tortoise release her grip by scratching the side of her carapace with a stick (Medica et al., 1986), but she did not move. Within 1 min, the female tortoise began pushing dirt on both sides of the entrance of the burrow, partially collapsing the walls around her. After 3 min, she remained at the entrance of the burrow in an alert position with her head slightly extended outward and appeared to be ready to advance. When the investigator tried to remove dirt from around her, she re-positioned herself and wedged her limbs into the sides of the burrow maintaining her position at the entrance of the burrow over the assumed nest, protecting a small patch of area with her body. On the final attempt to pull the female tortoise from the burrow (ca. 8–10 min), she pulled her head inward, releasing a long hiss, and retreated into her shell as the investigator finally extracted her from the burrow. While tortoises frequently resist attempts to remove them from a burrow, it is unusual for them to position themselves sideways near the opening. Instead, they usually retreat deeper into the burrow.

After we placed her outside of the burrow, the female tortoise tried to re-enter and moved towards the hands of the investigator, where the nest was located. After this, the investigator moved the female tortoise away from the burrow temporarily. We found a clutch of four eggs at a depth of 17.8 cm and 10.7 cm behind the lip of the burrow exactly where the female tortoise wedged herself sideways in the burrow. We carefully covered the eggs with dirt and placed the female back at the entrance of the burrow where she remained motionless within ca. 0.3 m of the nest. After 2 min, she turned toward the burrow, moved 0.1 m towards the nest, and did not move any further. We returned to the site the following day and radio-tracked the female tortoise to a location ca. 14.0 m from her nest. She was basking in the sun and did not react visibly to our presence.

A second instance of behavior consistent with nest-guarding was observed on 16 July 2011. When the investigator (MA) approached the mouth of the burrow, the tortoise abruptly moved toward the entrance of the burrow, turned sideways, and performed similar behavior to that of the previous tortoise for ca. 4 min. After we removed her from the entrance of the burrow, a clutch of three eggs was discovered at a depth of 23.6 cm, directly under where she had positioned her plastron flat with limbs extended, 15.9 cm behind the lip of the burrow.

Based on previously published reports on nest-guarding in tortoises and turtles, we conclude that female *G. agassizii* observed at our study area were exhibiting nest-guarding in a direct response to our (human) intrusion at nesting sites as a perceived predator. We do not know the

extent to which prior human interaction (daily recaptures) may have instigated the reaction of the tortoises and altered their behavior. We do know that such behavior has not been observed at the site for longer-term, post-ovipositional females or in males. Evidence of nest-guarding reinforces the notion that tortoises remain with their nests and guard them from potential predators shortly after their eggs are deposited (Zylstra et al., 2005). The behavior we observed appears to be one of the few observed examples of nest-guarding in a natural population of the species.

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