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ACTINEMYS MARMORATA (NORTHWESTERN POND TURTLE) FEEDING ON *DICAMPTODON TENEBROSUS* (COASTAL GIANT SALAMANDER)

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ABSTRACT—When unexpected predator-prey interactions are observed, abiotic conditions can reveal insights about the ecology of the species involved. During one of the warmest months of May in the last 30 y (2008), we observed an adult Northwestern Pond Turtle, *Actinemys marmorata,* preying upon a paedomorphic Coastal Giant Salamander, *Dicamptodon tenebrosus,* in the South Fork Eel River. Compiled records of temperatures when moribund, bitten, or dead *D. tenebrosus* were found in the sunny mainstem river highlight their vulnerability when facing thermal stress beyond their usual habitat in cool shaded tributaries.

Key words: climate change, predator-prey, temperature, thermal niche

We observed a predator-prey interaction between 2 ectotherms that usually occupy disparate thermal habitats in rivers and streams of the Pacific Northwest, the Northwestern Pond Turtle (*Actinemys [Emys] marmorata*)[1], found in low-gradient, sunny, alluvial channels, and the Coastal Giant Salamander (*Dicamptodon tenebrosus),* more frequently found in cooler, shaded headwater environments (Welsh and Hodgson 2011). On 18 May 2008 at 19:05, in the South Fork Eel River at the Angelo Coast Range Reserve, Mendocino County, California (UTM: Zone 10, Easting 445856, Northing 4400007, WGS84), we encountered an adult turtle and its prey, a live paedomorphic salamander, in a shallow edgewater pool (Fig. 1). The turtle was biting and consuming flesh from the salamander's tail near the junction with its body. There were large wounds behind the right hind leg of the salamander (Fig. 2). The salamander moved lethargically while the turtle actively bit its tail.

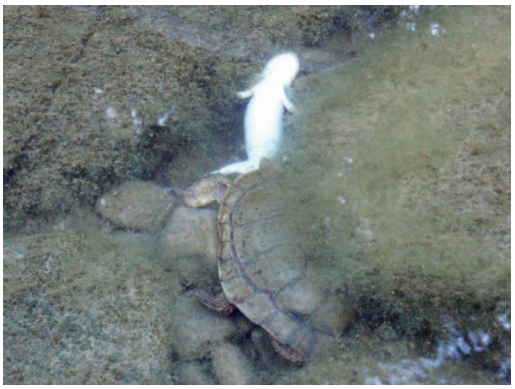

FIGURE 1. Western Pond Turtle (*Actinemys marmorata*) feeding on a Coastal Giant Salamander (*Dicamptodon tenebrosus*) at the margin of the South Fork Eel River, 18 May 2008. Photo by Ryan A Peek.

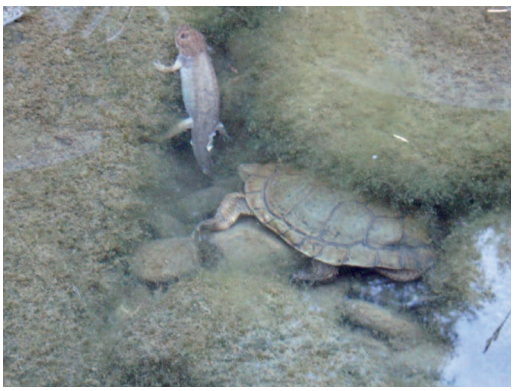

FIGURE 2. After initial observation, Coastal Giant Salamander (*Dicamptodon tenebrosus*) re-oriented and moving away from the Western Pond Turtle (*Actinemys marmorata*) in margins of South Fork Eel River, 18 May 2008. Photo by Ryan A Peek.

[1] According to the SSAR [Society for the Study of Amphibians and Reptiles] (SSAR 2021, https://ssarherps.org/cndb/#d2VzdGVybitwb25kK3R1cnRsZSZsb29zZT10 cnVlTwo, accessed 27 September 2021) 2 species have recently been recognized among the populations formerly described as the Western Pond Turtle: *Actinemys marmorata*, now the Northwestern Pond Turtle; and *Actinemys pallida*, the Southwestern Pond Turtle, a formerly recognized subspecies now supported as a separate species (Spinks and others 2010, 2014, 2016).

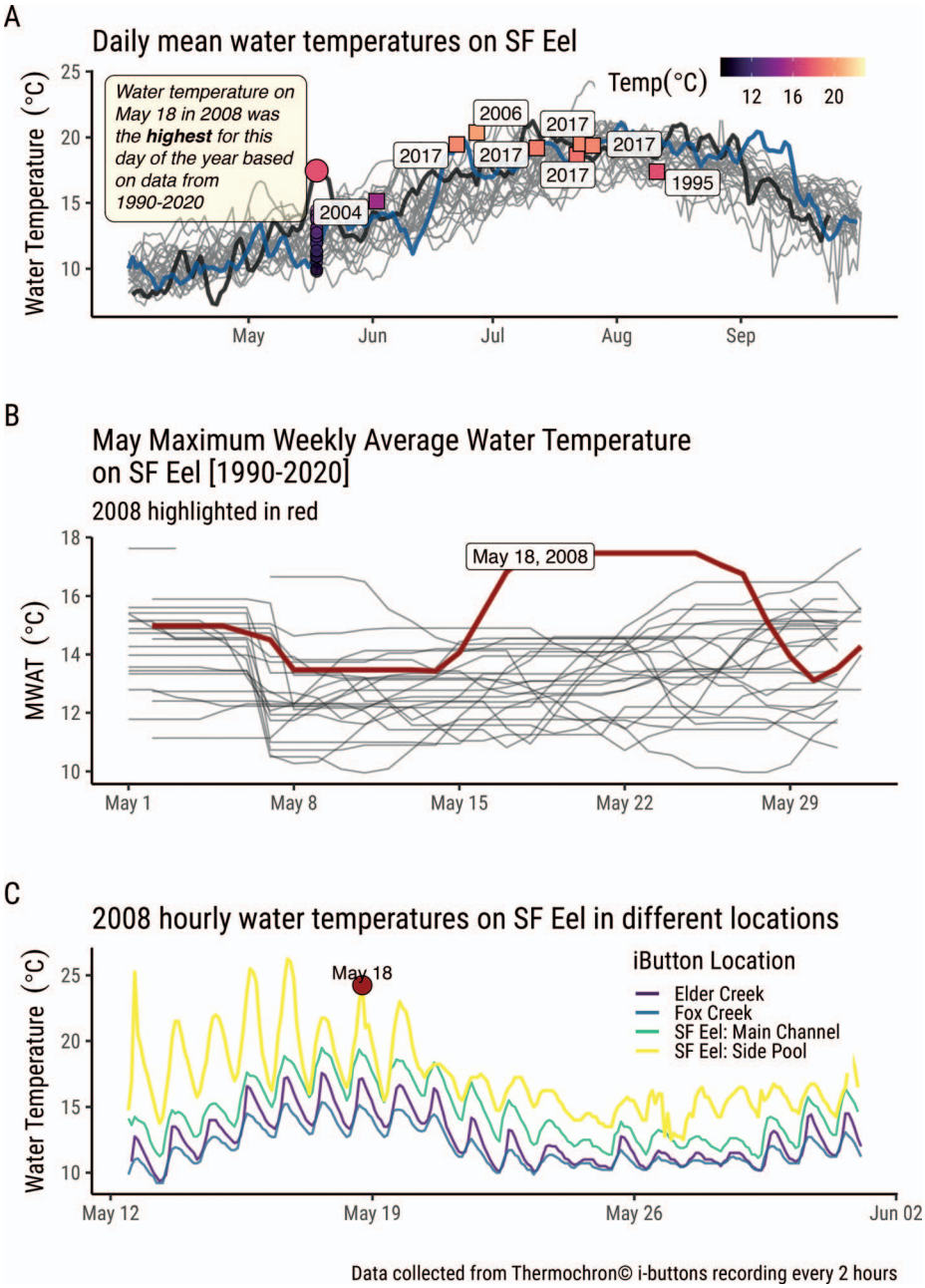

FIGURE 3. Streamwater temperatures at the Angelo Coast Range Reserve, California. A dot in each plot highlights the date of the predation event in 2008. Circles mark May 18 across all years, and are colored by the daily mean water temperature. Squares, colored by the water temperature, indicate dates when dead, injured, or sick Coastal Giant Salamanders were observed during the course of conducting other field studies. Daily mean (A) and maximum (B) temperatures of the 7-d rolling average in May on the South Fork Eel, 1990–2020; and continuous (C) water temperature (habitats typically frequented by Western Pond Turtles in the mainstem of the South Fork Eel River = green, and side pool = yellow; by Coastal Giant Salamanders in tributaries = blue, purple).

The salamander was inverted with the head approximately 5 cm below the water surface and unable to right itself or orient vertically. At approximately 19:08, the turtle may have become sensitive to our presence, and ceased movement. Until approximately 19:13, the salamander moved only its front legs and head. After this period of minimal movement, the salamander righted itself and began to slowly turn, facing in the downstream direction where the water was deeper. By 19:14 the salamander moved out of view and the turtle did not pursue it.

The timing of this observation in the hour prior to sunset coincided with the daily maximum water temperature (Fig. 3A) during an unseasonably warm period; 2008 was the warmest May of the last 30 y (Fig. 3A, B). Over the week preceding our observation, the average daily maximum water temperature in similar side-pool habitats monitored with Thermocron iButtons (DS1921G®, ± 0.5°C accuracy, recording every 2 h) was 23.8°C (range 21.5–26.3°C). Moribund, bitten, or dead *D. tenebrosus* have occasionally been observed during summer months at the Angelo Reserve when the South Fork Eel is similarly warm (Fig. 3A). These daily mean temperatures are below the critical thermal maximum of 29°C when *D. tenebrosus* can no longer right themselves (Bury 2008), but could be sufficient to induce stress, as higher stress-inducing body temperatures tend to be markedly lower than lethal maximum temperatures. Brattstrom (1963) reported body temperatures of larval individuals ranging from 12.0–16.2°C ($n = 6$), whereas adults had a mean of 13.1°C ($n = 12$), and the upper limit of thermal preference among Oregon populations is presumed to be between 21 and 25°C (Wagner 2014). Lethargy and difficulty righting are also symptoms of infection (Voyles and others 2011), so factors other than heat stress may have contributed to the behavior of the salamander we observed.

Although Northwestern Pond Turtles are considered dietary generalists that forage opportunistically, we are not aware of previous reports that they eat *D. tenebrosus*. Salmonids and conspecifics, along with North American River Otters (*Lutra canadensis*) and garter snakes (*Thamnophis* spp.) are likely the dominant predators of these salamanders (Lannoo 2005). Bury (1986) and Holland (1994) found that the turtle's food items include aquatic insect larvae, crustaceans, annelids, and small vertebrates such as tadpoles of the Foothill Yellow-legged Frog (*Rana boylii*) and their egg masses. It is not known if vertebrate prey are generally eaten alive or as carrion (Ernst and Lovich 2009). In the geographic area of the Angelo Reserve, turtles have been reported to return from upland winter habitat to permanent streams in April and May when water temperatures and air temperatures rise above 11–12°C (Bondi and Marks 2013). Thus, our observation coincided with the time when *A. marmorata* expectedly have a caloric deficit after winter hibernation.

Northwestern Pond Turtles and Pacific Giant Salamanders have only a partial overlap in their thermal niches and habitat preferences (Welsh and Hodgson 2011). In the South Fork Eel River watershed, *D. tenebrosus* is at the southern limit of the species' range (Steele and Storfer 2006), but tributaries shaded by coniferous forest have cool temperatures (blue and purple lines in Fig. 3C), and the salamanders reach high densities (Munshaw and others 2014). In contrast, *A. marmorata* in the South Fork Eel River favor warmer waters downstream (yellow and green lines Fig. 3C) where *D. tenebrosus* density is low. This preference mirrors turtles in other northern California rivers including the Trinity River, where juveniles were found in water 12–33°C, adults at 10–17°C (Reese and Welsh 1998), and the Mattole River where channel types with turtles have median spot water-temperature measurements of 24–25°C (Welsh and Hodgson 2011). Owing to the limited overlap and opportunity for predation, our observation was likely a rare encounter.

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