REPTILES & AMPHIBIANS

Ecological Notes on the Panamint Alligator Lizard, *Elgaria panamintina*

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The Panamint Alligator Lizard, *Elgaria panamintina* (Stebbins 1958), is endemic to several mountain ranges in the Mojave and Great Basin Deserts of eastern California. It occurs along riparian creeks and springs as well as within talus rock piles in open desert (Banta 1963). Due to the species' often remote and inaccessible habitat, basic information on its natural history is limited. We herein report the first direct evidence of predation on *E. panamintina*, along with novel information that doubles the known clutch size for the species.

Although no observations of predation on *E. panamintina* have been reported in the literature, multiple authors have speculated about potential predators. Mahrdt and Beaman (2002, 2009) identified several lizard-eating snakes (California Kingsnake, *Lampropeltis californiae*; Coachwhip, *Masticophis flagellum*; Striped Whipsnake, *M. taeniatus*; Long-nosed Snake,*Rhinocheilus lecontei*; and Western Patch-nosed Snake, *Salvadora hexalepis*) as possible predators. Marlow (1988) also listed Sidewinders (*Crotalus cerastes*) and "falcon" (no specific species identified) as potential predators. In addition, Marlow (1988) and Mahrdt and Beaman (2002) also listed three other species of birds (Red-tailed Hawk, *Buteo jamaicensis*; Greater Roadrunner, *Geococcyx californianus*; and Loggerhead Shrike, *Lanius ludovicianus*) and three mammals (Coyote, *Canis latrans*; American Badger, *Taxidea taxus*; and Kit Fox, *Vulpes macrotis*) as likely predators. Moreover, Cunningham and Emmmerich (2001) pointed out that the Common Raven (*Corvus corax*) and *Canis latrans* could pose a threat to *E. panamintina* as subsidized predators. Interestingly, Morafka et al. (2001) proposed invertebrate predation on juvenile *E. panamintina* from longhorn beetles (Cerambycidae), Jerusalem crickets (Stenopelmatidae), and scorpions (Scorpiones). We herein confirm predation of *E. panamintina* by two snake species, one never previously mentioned in the scientific literature, based on a review of museum records and personal fieldwork.

The first record originated from a Panamint Rattlesnake (*Crotalus stephensi*) (California Academy of Sciences, CAS 89618) collected by Benjamin H. Banta on 8 May 1960 in Grapevine Canyon, Nelson Mountains, Inyo County, California (36.53895, -117.56685; WGS 84; elev. ca. 1,580 m asl). Dissection of that specimen revealed a young adult *E. panamintina* (CAS 257335; Fig. 1) in the snake's stomach. We do not know when or by whom the specimen was dissected, but the removal of the lizard from the snake's stomach had gone overlooked and unreported in the scientific literature until now. This record represents the first confirmed predation by any animal on *E. panamintina.* It is also the first confirmed predation of any anguid lizard by *C. stephensi*, although this species has long been known to eat phrynosomatid and teiid lizards (Klauber 1956).

The other records of predation on *E. panamintina* originated from a radio-telemetry project on the species that led to the documentation of two *Lampropeltis californiae* that had eaten Panamint Alligator Lizards. In both cases, multiple days of uncharacteristic movements suggested that transmitter-mounted *E. panamintina* had been eaten, and efforts were then made to confirm this suspicion. On 21 June 2015 at 1025 h, AGC collected a gravid adult female *L.*

Figure 1. A young adult Panamint Alligator Lizard (*Elgaria panamintina*) (CAS 257335) recovered from the stomach of a Panamint Rattlesnake (*Crotalus stephensi*) (CAS 89618) collected from the Nelson Mountains, Inyo County, California, USA, on 8 May 1960. Measuring tape with numbered units in centimeters. Photograph by Noel Graham.

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californiae (Natural History Museum of Los Angeles County, LACM 187152; SVL 790 mm, 169 g) from a rock crevice in upper Silver Canyon, southwestern White Mountains, Inyo County, California (37.40232, -118.22417; WGS 84; elev. 2,150 m asl). The snake contained a radio transmitter and the undigested regenerated tail of an adult male *E. panamintina* (Fig. 2). When originally captured on 15 June 2015, this individual measured 116 mm SVL and weighed 30.5 g. Six days later, on 27 June 2015 at 1010 h, AGC collected an adult female *L. californiae* (LACM 187153; SVL 867 mm, 175 g) from Toll House (Batchelder) Spring, extreme southwestern White Mountains, Inyo County, California (37.24399, -118.19482; WGS 84; elev. 1,860 m asl). This snake contained a radio transmitter and the undigested hindlimbs and tail of an adult *E. panamintina* that measured 99 mm SVL and weighed 17.4 g when captured on 1 June 2015. All *E. panamintina* remains and other gut contents (except for the radio transmitters) are preserved and housed with the snake specimens at the LACM. In both cases, the orientation of the transmitters and tails indicated that the *E. panamintina* were eaten head-first, consistent with previous data on ingestion of prey by *L. californiae* (Wiseman et al. 2019). Although our data are novel, confirmation that *L. californiae* preys on *E. panamintina* is unsurprising because these snakes are known to prey on *E. kingii*, *E. multicarinata*, and potentially *E. coerulea* (Wiseman et al. 2019).

In addition to the relative lack of published information on predation of *E. panamintina*, reproductive biology is another poorly documented aspect of the natural history of this species. Banta (1963) reported the presence of twelve "developing eggs" measuring 2.4–4.4 mm in diameter in specimen CAS 88135, which was collected on 1 May 1959. Goldberg and Beaman (2003), however, re-examined this specimen and noted that the ovarian follicles "had not yet started yolk deposition" and hence were not technically eggs. Goldberg and Beaman (2003) went on to report four oviductal eggs in an *E. panamintina* specimen (MVZ 150329), which was collected on 25 June 1974 (collection date mistakenly listed as "September" by those authors). Overlooked by Goldberg and Beaman (2003) was an unpublished report by Morafka et al. (2001) that recorded a four-egg clutch laid in May 2001 at the San Diego Zoo by a wild-caught *E. panamintina*. As such, four is the currently published maximum clutch size for this species.

On 11 July 2020 at 2335 h, AGC captured a female *E. panamintina* (LACM 190974; SVL 116 mm, tail length [never broken] 212 mm, 21.4 g) during an exploratory survey of an unnamed canyon between French Spring and Union Wash, southwestern Inyo Mountains, Inyo County, California (36.69102, -118.0116; WGS 84; elev. 1,565 m asl). The lizard was perched motionless 2 m above the ground in a horizontal position on dead branches of an Arroyo Willow (*Salix lasiolepis*) in complete darkness at an ambient air temperature of 27 °C. The body was distended and the lateral fold was fully expanded (Fig. 3). The lizard was collected as a voucher for this new locality record for the species, and subsequent dissection revealed the presence of eight eggs (two in the left and six in the right ovary), all measuring 8–10 mm in length. This new maximum clutch size matches that for the similarly poorly known San Lucan Alligator Lizard (*E. paucicarinata*, eight eggs; Goldberg and Beaman 2004), but is far from the maximum clutch sizes reported for the species' more well-documented congeners, the Southern Alligator Lizard (*E. multicarinata*, 55 eggs; Langerwerf 1981) and Madrean Alligator Lizard (*E. kingii*, 15 eggs; Stebbins 1958). This variation in clutch sizes among *Elgaria* underscores the need for additional studies of *E. panamintina* and *E. paucicarinata* reproductive biology to determine whether their smaller documented clutch sizes are representative or an artifact of uneven sampling.

Figure 2. Remains of two radio-transmittered Panamint Alligator Lizards (*Elgaria panamintina*) removed from the stomachs of two California Kingsnakes (*Lampropeltis californiae*) (LACM 187153 and LACM 187152, respectively) collected from the southwestern White Mountains, Inyo County, California, USA in June 2015. Visible *E. panamintina* remains include tail (left) and hind limb plus tail (right). Photographs by Adam G. Clause.

Figure 3. An adult female Panamint Alligator Lizard (*Elgaria panamintina*) (LACM 190974) with an unlaid clutch of eight eggs collected from the southwestern Inyo Mountains, California, USA on 11 July 2020. Photograph by Adam G. Clause.

The ecology of many lizard species remains severely under-documented (Meiri et al. 2018), and the predator-prey dynamics of terrestrial herpetofauna are rarely well resolved (Maritz et al. 2020). Our work highlights the need for further research on these fronts. This study also emphasizes the value of employing a multifaceted approach that combines fieldwork (Wilson 2017) with the use of natural history museum collections (Miller et al. 2020, Nachman et al. 2023) to address the ongoing deficiencies in our knowledge of biodiversity (Hortal et al. 2015). We invite researchers to delve deeper into unraveling the life history of *E. panamintina* and other enigmatic species.

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Literature Cited

Banta, B.H. 1963. Remarks on the natural history of *Gerrhonotus panamintinus* Stebbins. *Occasional Papers of the California Academy of Sciences* 36: 1–12.

Cunningham, L. and K. Emmerich, 2001. Panamint alligator lizard (*Elgaria panamintina*) pilot study: Preliminary report on the multidisciplinary first assessment of the environmental status of the Panamint alligator lizard. Unpublished report to David J. Morafka, CSU Dominguez Hills, Carson, California, and Steve Parmenter, California Department of Fish and Game, Sacramento, California.

Goldberg, S.R. and K.R. Beaman. 2003. *Elgaria panamintina* (Panamint Alligator Lizard). Reproduction. *Herpetological Review* 34: 143.

Goldberg, S.R. and K.R. Beaman. 2004. Reproduction in the San Lucan Alligator Lizard, *Elgaria paucicarinata* (Anguidae) from Baja California Sur, Mexico. *Bulletin of the Southern California Academy of Sciences* 103: 144–146.

Hortal, J., F. de Bello, J.A.F. Diniz-Filho, T.M. Lewinsohn, J.M. Lobo, and R.J. Ladle. 2015. Seven shortfalls that beset large-scale knowledge of biodiversity. *Annual Review of Ecology, Evolution, and Systematics* 46: 523–549. https://doi.org/10.1146/annurev-ecolsys-112414-054400.

Klauber, L.M. 1956. *Rattlesnakes: Their Habits, Life Histories, and Influence on Mankind.* Volume I. University of California Press, Berkeley and Los Angeles, California, USA.

Langerwerf, B. 1981. The Southern Alligator Lizard, *Gerrhonotus multicarinatus* Blainville 1935: Its care and breeding in captivity. *British Herpetological Society Bulletin* 2: 21–25.

Mahrdt, C.R. and K.R. Beaman. 2002. Panamint alligator lizard, *Elgaria panamintina*. Species account for the West Mojave Management Plan, Riverside, California, USA.

Mahrdt, C.R. and K. R. Beaman. 2009. Panamint alligator lizard *Elgaria panamintina* (Stebbins, 1958), pp. 488–491. In: L.L.C. Jones and R.E. Lovich (eds.), *Lizards of the American Southwest: A Photographic Field Guide*. Rio Nuevo Publishers, Tucson, Arizona, USA.

Marlow, R. 1988. Panamint alligator lizard, *Gerrhonotus panamintinus*, pp. 172 –173. In: D.C. Zeiner, W.F. Laudenslayer, Jr., and K.E. Meyer (eds.), *California's Wildlife. Volume 1. Amphibians and Reptiles.* California Wildlife Habitat Relationships System, California Department of Fish and Game, Sacramento, California, USA.

Maritz, B., E.P. Hofmann, R.A. Maritz, H.W. Greene, M.C. Grundler, and A.M. Durso. 2021. Challenges and opportunities in the study of snake diets. *Herpetological Review* 52: 769–773.

Meiri, S., A.M. Bauer, A. Allison, F. Castro-Herrera, L. Chirio, G. Colli, I. Das, T.M. Doan, F. Glaw, L.L. Grismer, M. Hoogmoed, F. Kraus, M. LeBreton, D. Meirte, Z.T. Nagy, C. d. C. Nogueira, P. Oliver, O.S.G. Pauwels, D. Pincheira-Donoso, G. Shea, R. Sindaco, O.J.S. Tallowin, O. Torres-Carvajal, J.-F. Trape, P. Uetz, P. Wagner, Y. Wang, T. Ziegler, and U. Roll. 2018. Extinct, obscure or imaginary: The lizard species with the smallest ranges. *Diversity and Distributions* 24: 262–273. https://doi.org/10.1111/ddi.12678.

Miller, S.E., L.N. Barrow, S.M. Ehlman, J.A. Goodheart, S.E. Greiman, H.L. Lutz, T.M. Misiewicz, S.M. Smith, M. Tan, C.J. Thawley, J.A. Cook, and J.E. Light. 2020. Building natural history collections for the twenty-first century and beyond. *BioScience* 70: 674–687. https://doi.org/10.1093/biosci/biaa069.

Morafka, D.J., K. Emmerich, and L. Cunningham. 2001. Preliminary Annual Report. Panamint Alligator Lizard (*Elgaria panamintina*). Environmental Assessment of Species at Risk. U.S. Geological Survey, Reston, Virginia, USA.

Nachman, M.W., E.J. Beckman, R.C.K. Bowie, C. Cicero, C.J. Conroy, R. Dudley, T.B. Hayes, M.S. Koo, E.A. Lacey, C.H. Martin, J.A. McGuire, J.L. Patton, C.L. Spencer, R.D. Tarvin, M.H. Wake, I.J. Wang, A. Achmadi, S.T. Álvarez-Castañeda, M.J. Anderson, J. Arroyave, C.C. Austin, F. K. Barker, L.N. Barrow, G.F. Barrowclough, J. Bates, A.M. Bauer, K.C. Bell, R.C. Bell, A.W. Bronson, R.M. Brown, F.T. Burbrink, K.J. Burns, C.D. Cadena, D.C. Cannatella, T.A. Castoe, P. Chakrabarty, J.P. Colella, J.A. Cook, J. L. Cracraft, D.R. Davis, A.R. Davis Rabosky, G. D'Elía, J.P. Dumbacher, J.L. Dunnum, S.V. Edwards, J.A. Esselstyn, J. Faivovich, J. Fjeldså, O.A. Flores-Villela, K. Ford, J. Fuchs, M.K. Fujita, J.M. Good, E. Greenbaum, H.W. Greene, S. Hackett, A. Hamidy, J. Hanken, T. Haryoko, M.T. Hawkins, L.R. Heaney, D.M. Hillis, B.D. Hollingsworth, A.D. Hornsby, P.A. Hosner, M. Irham, S. Jansa, R.A. Jiménez, L. Joseph, J.J. Kirchman, T.J. LaDuc, A.D. Leaché, E.P. Lessa, H. López-Fernández, N.A. Mason, J.E. McCormack, C.D. McMahan, R.G. Moyle, R.A. Ojeda, L.E. Olson, C.K. Onn, L.R. Parenti, G. Parra-Olea, B.D. Patterson, G.B. Pauly, S.E. Pavan, A.T. Peterson, S. Poe, D.L. Rabosky, C.J. Raxworthy, S. Reddy, A. Rico-Guevara, A. Riyanto, L.A. Rocha, S.R. Ron, S.M. Rovito, K.C. Rowe, J. Rowley, S. Ruane, D. Salazar-Valenzuela, A.J. Shultz, B. Sidlauskas, D.S. Sikes, N.B. Simmons, M.L.J. Stiassny, J.W. Streicher, B.L. Stuart, A.P. Summers, J. Tavera, P. Teta, C.W. Thompson, R.M. Timm, O. Torres-Carvajal, G. Voelker, R.S. Voss, K. Winker, C. Witt, E.A. Wommack, and R.M. Zink. 2023. Specimen collection is essential for modern science. *PLoS Biology* 21: e3002318. https://doi.org/10.1371/journal.pbio.3002318.

Stebbins, R.C. 1958. A new alligator lizard from the Panamint Mountains, Inyo County, California. *American Museum Novitates* 1883: 1–27.

Wiseman, K.D., H.W. Greene, M.S. Koo, and D.J. Long. 2019. Feeding ecology of a generalist predator, the California kingsnake (*Lampropeltis californiae*): Why rare prey matter. *Herpetological Conservation and Biology* 14: 1–30.

Wilson, E.O. 2017. Biodiversity research requires more boots on the ground. *Nature Ecology & Evolution* 1: 1590–1591. https://doi.org/10.1038/s41559-017-0360-y.