

Aquatic habitat use of mole salamanders (*Ambystoma talpoideum*) in the Southern Appalachians

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INTRODUCTION



Figure 1. Terrestrial adult mole salamander from a high elevation population in Macon County, NC

- The mole salamander (Figs. 1,2,6) is listed as a species of Special Concern in the state of North Carolina where populations are disjunct and isolated. (1,6)
- Mole salamanders are facultatively paedomorphic (Fig. 2), meaning that they can forgo metamorphosis and retain aquatic larval features as adults. (9)
- High elevation populations found within the mountains are uncharacteristic for this species whose range is found mostly in the Coastal Plain. (7) (Fig. 2)
- At high elevations, these salamanders experience cooler water temperatures which can limit growth and slow development. (2)
- Deciduous tree canopy coverage is quite dense in mountain forests surrounding wetlands while pine forests and open canopy wetlands are more common in most of the range for this species. (7)
- Canopy cover can influence the distribution and performance of many “pond breeding” amphibians. (8)

METHODS

- This study focuses on a high elevation population of mole salamanders found within a wetland complex in the Nantahala National Forest. (Fig. 3)
- Stratified random sampling was used to select 16 2x2 m plots within three wetland sites on an elevational gradient: 48 plots total. Wetlands ranged from 1069 m to 1283 m in elevation.
- There were no detections at our highest elevation site.
- Plots were within a range of open and closed canopy areas.



Figure 3. Photos taken during a dip-net survey

- Water depth, temperature, and pH measurements were taken for each plot during each visit. Macro-habitat characteristics including percent vegetation cover and substrate composition were recorded for each plot.
- Canopy photos were taken at each plot using a digital camera with a fisheye lens. Photos were analyzed using Gap Light Analyzer software (3) to determine the percent of canopy coverage for each plot. (Fig. 4)
- Each plot was surveyed for 10 minutes using dip-nets to compare the occupancy of mole salamanders within a range of open and closed canopy areas.
- Plots were surveyed 3 times per site. Surveys took place June - October of 2023.
- Survey data was then used to fit an occupancy analysis using the “Unmarked” package in R. (4)



Figure 4. Fisheye photos of open canopy (top) and closed canopy (bottom)

RESULTS

- A single-season occupancy analysis showed that occupancy was higher in areas with more open canopies (Fig. 5). AIC scores for model results showed that the strongest model included canopy coverage with sample date as an observation covariate. (Table 1)

Table 1. Model results including AIC and Δ AIC for the occupancy and detection of mole salamanders in relation to canopy openness and sampling date

Model	AIC	Δ AIC
p(sample date + canopy openness), psi(sample date + canopy openness)	110.27	0.00
p(sample date), psi(.)	113.74	3.47
p(canopy openness), psi(canopy openness)	150.27	40.00

Note. psi=occupancy, p=detection

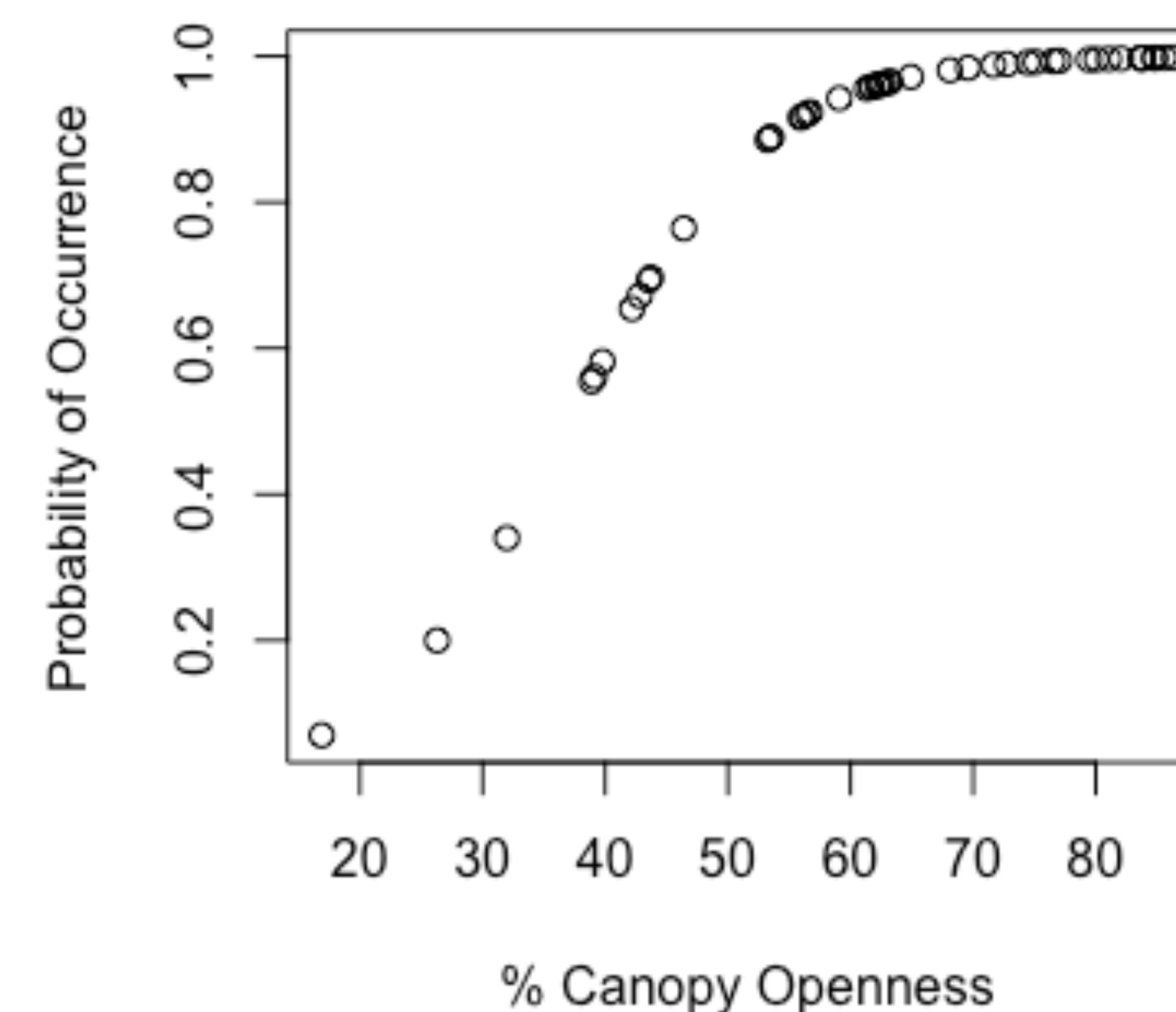


Figure 5. Probability of occurrence of mole salamanders in relation to the percent of canopy openness in wetlands

DISCUSSION/CONCLUSION

- There has been little research on the habitat use of paedomorphic individuals within their aquatic habitats.
- Mountain populations of mole salamanders are an important component of biodiversity in the Southern Appalachians, where terrestrial and stream-associated Plethodontid salamanders are most abundant. (7) These Plethodontid salamanders prefer closed canopies in contrast to open. (5)

- Better understanding the habitat preferences of mole salamanders and the niche they fill in the mountains will help to protect this species of Special Concern into the future.
- The availability of open canopy conditions within wetlands may be important for the presence and distribution of larval and paedomorphic mole salamanders at high elevations.

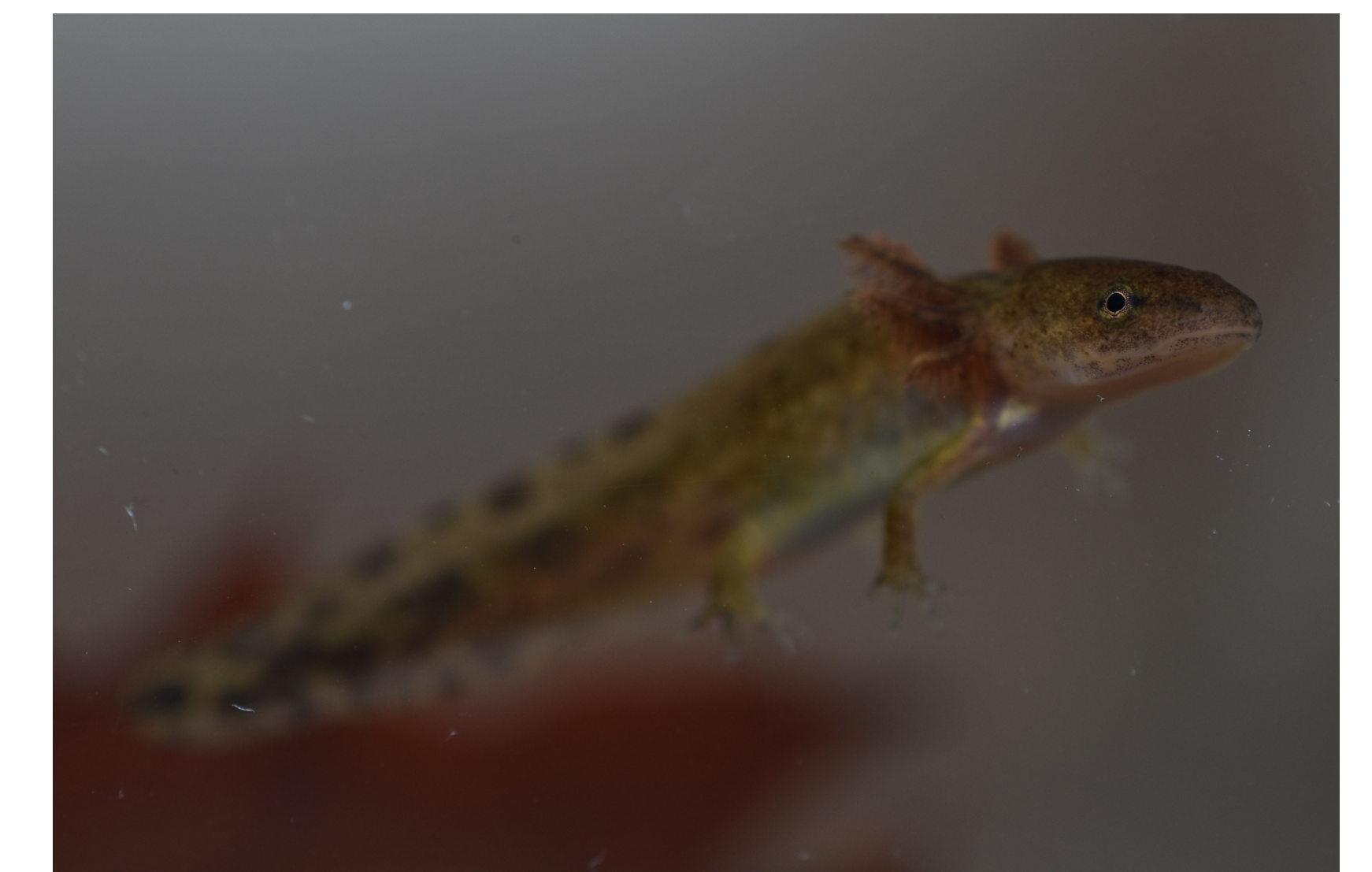


Figure 6. Photo of mole salamander larva (top) and newly metamorphosed terrestrial adult (bottom) from Macon County, NC

References

- Beane, J. C., Braswell, A. L., Mitchell, J. C., Palmer, W. M., & Harrison III, J. R. (2010). *Amphibians and Reptiles of the Carolinas and Virginia*. Univ of North Carolina Press.
- Berven, K. A., Gill, D. E., & Smith-Gill, S. J. (1979). Countergradient selection in the green frog, *Rana clamitans*. *Evolution*, 609-623.
- Frazer, G. W., Canham, C. D., & Lertzman, K. P. (1999). Gap Light Analyzer (GLA), Version 2.0: Imaging software to extract canopy structure and gap light transmission indices from true-colour fisheye photographs, users manual and program documentation. *Simon Fraser University, Burnaby, British Columbia, and the Institute of Ecosystem Studies, Millbrook, New York*, 36.
- Kellner KF, Smith AD, Royle JA, Kery M, Belant JL, Chandler RB (2023). The unmarked R package: Twelve years of advances in occurrence and abundance modelling in ecology. *Methods in Ecology and Evolution*, 14(6), 1408-1415.
- Moseley, K. R., Ford, W. M., Edwards, J. W., & Schuler, T. M. (2008). Long-term partial cutting impacts on *Desmognathus* salamander abundance in West Virginia headwater streams. *Forest Ecology and Management*, 254(2), 300-307.
- [NCWRC] North Carolina Wildlife Resources Commission. Protected wildlife species. (2021). <https://www.ncwildlife.org/Portals/0/Conserving/documents/Protected-Wildlife-Species-of-NC.pdf>
- Petranka, J. W. (1998). *Salamanders of the United States and Canada*. Smithsonian Institution Press.
- Werner, E. E., & Glennemeier, K. S. (1999). *Influence of Forest Canopy Cover on the Breeding Pond Distributions of Several Amphibian Species* (Vol. 5, Issue 1).
- Whiteman, H. H. (1994). Evolution of facultative paedomorphosis in salamanders. *The Quarterly review of biology*, 69(2), 205-221.

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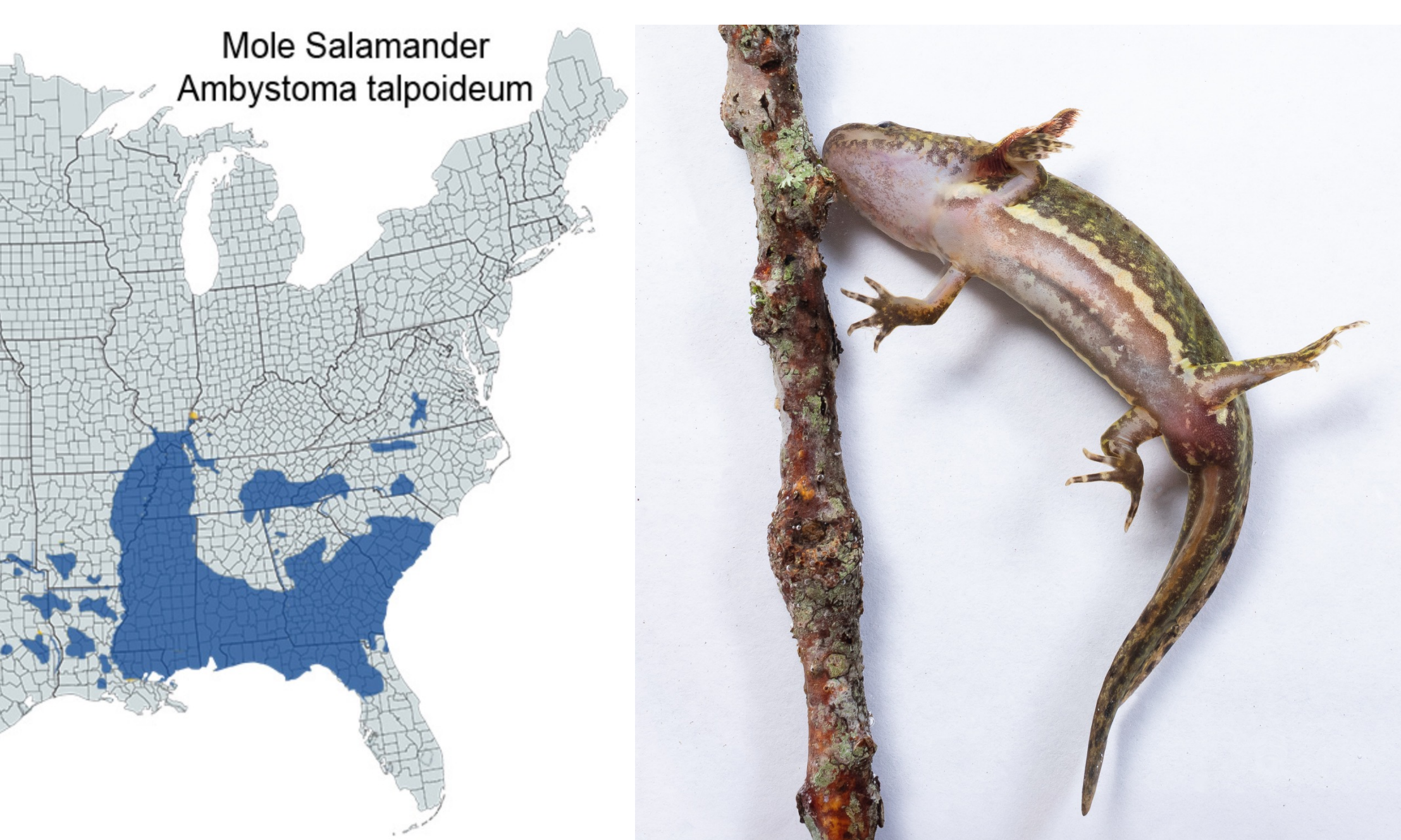


Figure 2. Range map of *A. talpoideum* (left) and a paedomorphic adult from Macon County, NC (right)