Assessing the relationship between parasite loads and limb deformities in Small-mouthed Salamanders (Caudata: Ambystomatidae).

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Abstract

The various factors implicated in the observed declines in the population sizes of many amphibian species can operate synergistically. The relatively high probability of exposure to agricultural pesticides experienced by Small-mouthed Salamanders (*Ambystoma texanum*) in the Midwest means that these populations might also exhibit greater susceptibility to other environmental stressors. We investigated the link between parasitism in members of a Small-mouthed Salamander population and the occurrence of limb deformities in that population. We trapped salamanders in two ponds during consecutive breeding seasons and determined the presence and location of limb deformities and parasitic cysts. We compared the incidence of both phenomena as a function of gender, body size, year, and pond of origin. We used a relationship between snout-vent length and mass to establish an index of body condition and compared that index to the parasite loads for each subject. Parasitic cysts were more common in collected salamanders than limb deformities, and the latter was much more likely to affect the posterior limbs. Multiple cysts were found on a majority of the animals affected, and cysts were found in differing proportions over the regions of the body. Male and female salamanders did not show differences in frequency or pattern of cysts, or of limb deformities. Already stressed by reproductive demands, the salamanders might be experiencing higher parasitism rates because decreased water quality is further compromising the functioning of their immune system. Salamanders having either cysts or limb deformities likely experience reduced individual fitness, which could negatively impact long-term population health.

Introduction

- Although many reasons have been suggested as proximate causes for amphibian population declines (1), efforts to quantify these causes remain sparse.
- Limb deformities that reduce individual survival and reproductive success (5) have been attributed to parasitic flatworms (Fig. 1) that find their way into an inappropriate host (4).
- Lower water quality in ponds might exacerbate parasitism rates of salamanders by compromising their immune system at a time when they are already stressed due to breeding efforts (3).
- We documented the extent of parasitism and limb deformities in a population of Small-mouthed Salamanders (*Ambystoma texanum*) that breeds in ponds affected by agricultural run-off.

Methods

- Warbler Woods Nature Preserve (WWNP) is 82 ha of successional field and deciduous forest habitat in southeastern Coles Co., Ill., and was established as a protected area in 1999 (Fig. 2).
- We placed minnow traps in two ponds (A and B) to collect *A. texanum* during breeding events in each of two years. We checked the traps every 48 h.
- For all collected specimens we sexed, measured, and marked them to indicate year and pond. Preliminary dissections revealed that 1 cyst = 1 trematode.
- We scored the presence of cysts (Fig. 3a) or limb deformities (Fig. 3a-c) based on the type, placement on the body, and co-occurrence with other anomalies.
- After processing, we released all subjects at their sites of capture.
- We used appropriate analyses to assess the influence of pond, year, or gender on the presence of either cysts or deformities. We also examined the influence of parasite load on body mass.

Fig. 1: A digenean flatworm (Trematoda: *Ribeiroia*) that causes cysts in amphibians.

Fig. 2: Schematic overlay of the southeast portion of Warbler Woods Nature Preserve.

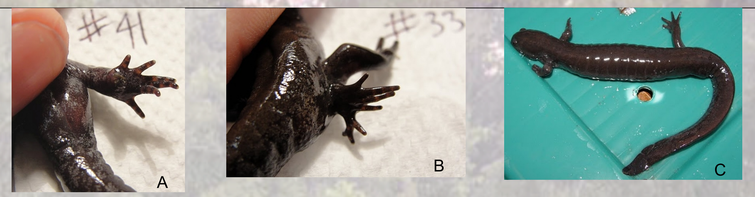

Fig. 3: Examples of deformities in Small-mouthed Salamanders – (a) cyst at limb base and extra digits; (b) extra right posterior limb; and, (c) missing left posterior limb.

Results

- 150 *A. texanum* had some form of limb deformity or cyst (19.1 % of all captures).
- Salamanders having cysts weighed less than those without (Fig. 4; $\chi^2 = 6.95$, $p < 0.01$). The occurrence of either cysts or deformities was similar when comparing across subject gender ($\chi^2 = 1.25$, $p = 0.54$) and pond of origin (Table 1).
- More salamanders had limb deformities in 2011 than in 2010 (Table 1), but the mean number of deformities per individual was greater in 2010 (Fig. 5; $F = 8.77$, $p = 0.003$).
- The number of salamanders having cysts was similar in both years (Table 1); however, the mean number of cysts per individual was greater in 2010 in comparison to 2011 (Fig. 5; $F = 44.3$, $p < 0.001$, $r^2 = 0.11$).
- Multiple (>1) cysts were found on the majority of affected specimens (Fig. 6). Cysts were more likely to be found on the trunk of the affected salamander (Fig. 7; $\chi^2 = 12.5$, $p = 0.006$).

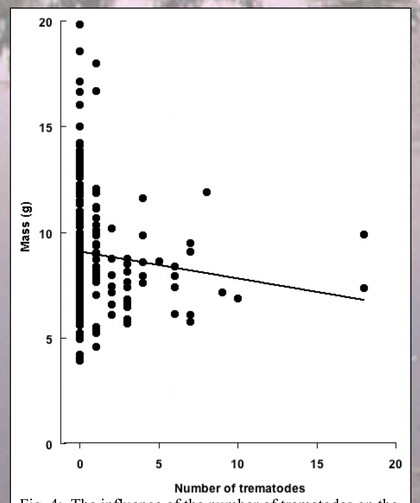

Fig. 4: The influence of the number of trematodes on the body condition (reported as mass) of *A. texanum* collected from 2010-'11. Subjects were heavier (by an average of 0.63 g) if they were free of trematodes.

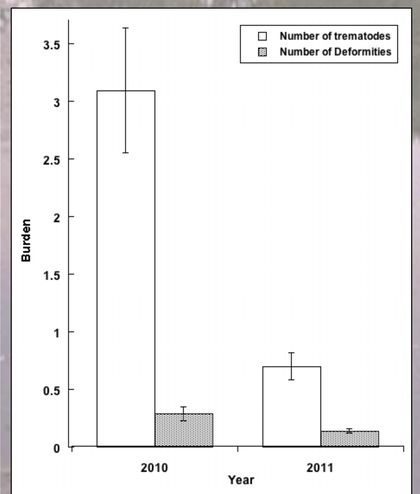

Fig. 5: The influence of collection year on the per-individual averages of either number of trematodes or number of limb deformities. Both types of burden were greater for *A. texanum* collected in 2010.

Table 1. The number of Small-mouthed Salamanders collected from two breeding ponds at WWNP in 2010 and 2011 (total $N = 786$), and the percent occurrence of specimens with either limb deformities or cysts.

	2010		2011	
	Pond A	Pond B	Pond A	Pond B
% w/ deformities	5.5	5.8	13.1	13.3
% w/ cysts	26.0	20.2	22.5	14.7
Total caught	339	136	236	75

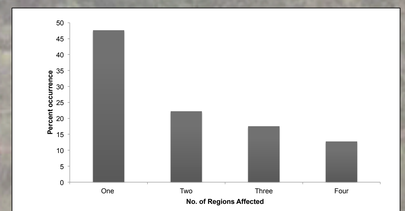

Fig. 6: The occurrence of cysts on one or more regions of the body of Small-mouthed Salamanders.

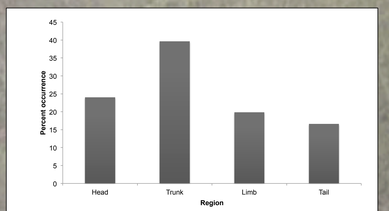

Fig. 7: The occurrence of cysts as a function of region of the body of Small-mouthed Salamanders.

Discussion

- In central Illinois, habitat quality (measured in either water and soil samples; *e.g.*, [2]) in nearly all areas is impacted by agricultural practices. As such, reference sites were not available for our study.
- Limb deformities can negatively impact a salamander's ability to navigate through the environment. Decreased mobility can reduce fitness by interfering with mate-searching and breeding behaviors (5).
- Atrazine, a water-soluble herbicide applied to fields adjacent to WWNP, has been linked to a variety of problems associated with amphibian growth and survival, including decreased immune system functioning (3).
- Although the *A. texanum* population at WWNP appears to be stable (6), continued exposure to chemical contaminants could further exacerbate parasitism rates and associated limb deformities. This would represent an additional threat to this species associated with the local application of atrazine.

Future Directions

Additional research should examine the nature, and intensity, of any causal relationships between environmental stressors and parasite burdens in this, and other, amphibian species. Isolating WWNP from further influence of adjacent agricultural practices might improve the fitness of amphibians using the wetland habitats at this site.

References

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