

My Lower Digestive System Abandoned Me: A Short Tail

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García-Hernandez, S., and G. Machado. 2022. Short- and long-term effects of an extreme case of autotomy: does 'tail' loss and subsequent constipation decrease the locomotor performance of male and female scorpions? *Integrative Zoology* 17:672-688.

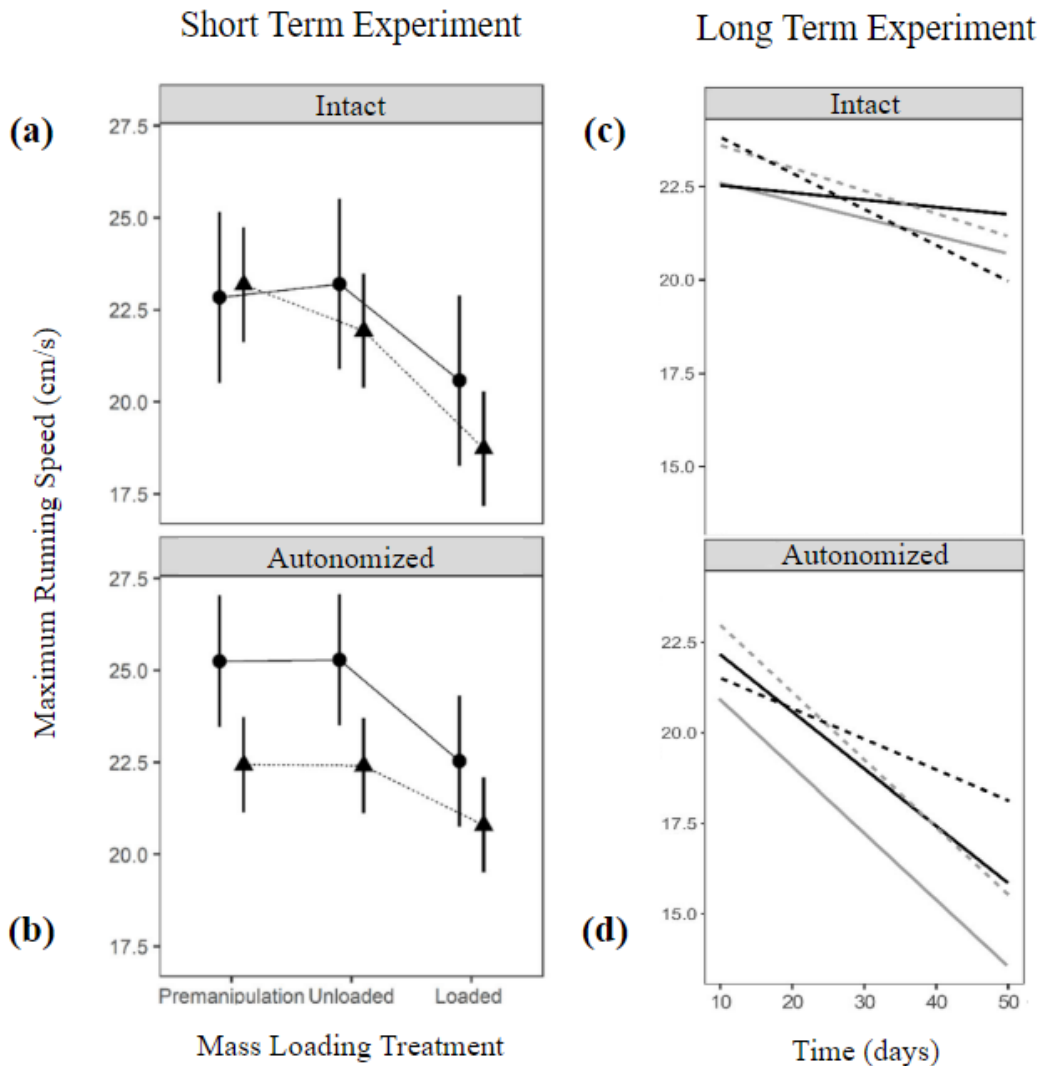
Autotomy is the process of detaching a body part when under predation risk. This unusual adaptation can increase the chance of escape from a predator but may be costly. Over time, autotomy can affect locomotion, resulting in decreased fitness. Scorpions engage in autotomy by detaching the metasoma, generally referred to as the tail. The tail contains their stinger, venom gland, and sections of the nervous, circulatory, and digestive systems, all of which are necessary for normal functioning. The loss of their tail includes a loss of their anus, meaning defecation becomes impossible. The scorpion's health eventually deteriorates due to constipation. Previously, scientists presented the weight loss hypothesis where weight negatively affects locomotor performance, therefore heavier individuals are predicted to be slower than lighter individuals. García-Hernandez and Machado (2022) sought to test this hypothesis on the scorpion species *Ananteris balzani* and study the short- and long-term effects of autotomy-induced abdomen loss on locomotor performance.

García-Hernandez and Machado (2022) collected 154 adult *A. balzani* (52 females and 102 males) from Southeastern Brazil. The scorpions were quarantined in the lab for 2 months to identify healthy individuals and acclimatize them to lab conditions. The researchers started with locomotion trials where max running speed (MRS) was measured for each individual over 4 trials. A camera was used to determine the fastest speed over a 10cm interval of racetrack. This measurement was the pre-manipulation MRS. Tail autotomy was then induced for 71 individuals by pulling on their last metasomal segment with forceps. As a control for handling, researchers pulled on the first metasomal segment (where tail autotomy is not possible) of the remaining 42 individuals. This split the *A. balzani* into two groups, autotomized and intact. All scorpions were allowed a rest period of three days, after which the researchers prepared two experiments. The first tested the short-term effects of autotomy, while the other tested the long-term effects. The MRS was measured following the same procedure as the pre-manipulation trials. Then, the short-term experiment began where individuals from both groups (autotomized and intact) were 'loaded' or 'unloaded'. Loaded autotomized individuals had their tail glued back onto their dorsum, while the loaded intact individuals had a weight of raw spaghetti (similar to their tail weight) glued onto their dorsum. Finally, the unloaded individuals (autotomized and intact) had a drop of glue placed on their back. Over a period of 12 days, each individual experienced both conditions and in the end, three separate MRS values were recorded for each scorpion. Then, the long-term experiment began where autotomized and intact individuals were assigned to either a normal diet or an over-fed diet. The MRS was measured using the same procedure every 10 days for 50 days to assess the effect of the feeding treatment. Body mass was measured at 10 days and once again at 50 days. If weight change affects locomotor performance, then the immediate positive effects of tail autotomy will be greater in males compared to females because males lose a greater percentage of body

mass. However, constipation will cause an increase in body mass over time, reducing running speed over time. For the long-term experiment, they predicted that the autotomized, over-fed individuals (both sexes) will have more pronounced negative effects than normally fed individuals.

As expected, there was initially no difference in MRS during the pre-manipulation trials (Focus Figure 1). The MRS for autotomized and intact individuals overall also showed no statistical difference (Focus Figure 1). However, in the short-term experiment, the presence of a load slightly slowed males' MRS, but there was no difference for females (Focus Figure 1). These results do not coincide with the weight loss hypothesis. In the long-term experiment, the normally fed individuals of both sexes showed no significant mass change. The over-fed females (autotomized or intact) showed a significant increase in body mass, but the increase was greater in autotomized females. Intact, over-fed males showed no significant increase in body mass but autotomized, over-fed males did show significant increase. Overall, the MRS of all individuals declined over time, but there were no consistent effects of either autotomy or diet treatments. Autotomy decreased MRS in males, but this was not correlated to diet (Focus Figure 1). These results do not support the weight loss hypothesis.

García-Hernandez and Machado (2022) found that tail loss was not correlated to changes in locomotor performance. Autotomized males showed a decreased MRS, but not due to an increased body mass. This opens several avenues for future research to determine what exactly causes locomotor performance changes in autotomized individuals. Researchers can study the effect of autotomization on body fluid balance and nitrogenous waste accumulation; both of which would negatively impact homeostasis, possibly affecting locomotor performance. Another explanation García-Hernandez and Machado (2022) present is an accumulation of by-products of anaerobic processes like lactate due to autotomization. Lactate can have negative effects when allowed to build up in the body, but it is still unclear whether autotomy causes lactate accumulation. Because this is still unknown, it creates an opening for future *A. balzani* autotomy research. Scientists interested in continuing autotomy research can also broaden their studies to include more species because other scorpions may react differently to tail autotomy.



Focus Figure 1. The short-term experiment (left panels) shows measures of maximum running speed (MRS) for both intact (a) and autotomized (b) *A. balzani* scorpions over a 12-day period. Triangles represent females and circles represent males. ‘Premanipulation’ indicates initial MRS, ‘Unloaded’ and ‘Loaded’ indicate subsequent manipulation trials. The long-term experiment (right panels) shows measures of maximum running speed (MRS) for both intact (c) and autotomized (d) *A. balzani* scorpions over a 50-day period. The grey lines represent a normal diet, and the black lines are over-fed individuals. Males are represented by solid lines and females by dashed lines.