Peer Community In Ecology

An experimental approach for understanding how terrestrial isopods respond to environmental stressors

Aniruddha Belsare *based on peer reviews by* ***Aaron Yilmaz*** *and* ***Michael Morris***

Charlotte Depeux, Angele Branger, Theo Moulignier, Jérôme Moreau, Jean-Francois Lemaitre, Francois-Xavier Dechaume-Moncharmont, Tiffany Laverre, Hélène Paulhac, Jean-Michel Gaillard, Sophie Beltran-Bech (2022) Deleterious effects of thermal and water stresses on life history and physiology: a case study on woodlouse. bioRxiv, ver. 3, peer-reviewed and recommended by Peer Community in Ecology.
https://doi.org/10.1101/2022.09.26.509512

Submitted: 28 September 2022, Recommended: 28 December 2022

Cite this recommendation as:
Belsare, A. (2022) An experimental approach for understanding how terrestrial isopods respond to environmental stressors. *Peer Community in Ecology*, 100506. https://doi.org/10.24072/pci.ecology.100506

Published: 28 December 2022

In this article, the authors discuss the results of their study investigating the effects of heat stress and moisture stress on a terrestrial isopod *Armadilldium vulgare,* the common woodlouse [1]. Specifically, the authors have assessed how increased temperature or decreased moisture affects life history traits (such as growth, survival, and reproduction) as well as physiological traits (immune cell parameters and $beta$-galactosidase activity). This article quantitatively evaluates the effects of the two stressors on woodlouse. Terrestrial isopods like woodlouse are sensitive to thermal and moisture stress [2; 3] and are therefore good models to test hypotheses in global change biology and for monitoring ecosystem health.

An important feature of this study is the combination of experimental, laboratory, and analytical techniques. Experiments were conducted under controlled conditions in the laboratory by modulating temperature and moisture, life history and physiological traits were measured/analyzed and then tested using models. Both stressors had negative impacts on survival and reproduction of woodlouse, and result in premature ageing. Although thermal stress did not affect survival, it slowed woodlouse growth. Moisture stress did not have a detectable effect on woodlouse growth but decreased survival and reproductive success. An important insight from this study is that effects of heat and moisture stressors on woodlouse are not necessarily linear, and experimental approaches can be used to better elucidate the mechanisms and understand how these organisms respond to environmental stress.

This article is timely given the increasing attention on biological monitoring and ecosystem health.

References:

[1] Depeux C, Branger A, Moulignier T, Moreau J, Lemaître J-F, Dechaume-Moncharmont F-X, Laverre T, Pauhlac H, Gaillard J-M, Beltran-Bech S (2022) Deleterious effects of thermal and water stresses on life history and physiology: a case study on woodlouse. bioRxiv, 2022.09.26.509512., ver. 3 peer-reviewd and recommended by PCI Ecology. https://doi.org/10.1101/2022.09.26.509512

[2] Warburg MR, Linsenmair KE, Bercovitz K (1984) The effect of climate on the distribution and abundance of isopods. In: Sutton SL, Holdich DM, editors. The Biology of Terrestrial Isopods. Oxford: Clarendon Press. pp. 339–367.

[3] Hassall M, Helden A, Goldson A, Grant A (2005) Ecotypic differentiation and phenotypic plasticity in reproductive traits of Armadillidium vulgare (Isopoda: Oniscidea). Oecologia 143: 51–60. https://doi.org/10.1007/s00442-004-1772-3

Reviews

Evaluation round #2

DOI or URL of the preprint: https://doi.org/10.1101/2022.09.26.509512
Version of the preprint: 1

Authors' reply, 16 December 2022

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Decision by Aniruddha Belsare, posted 15 December 2022, validated 15 December 2022

Minor revisions required

The autors have provided a satisfactory response to reviewer comments from round 1. The following minor issues should be addressed before a decision is made:

1) Line 50: 'as increasingly reported' doesnt read well. Rephrase or remove.

2) Line 50: 'Thus, in Lepidoptera, too high tempratures prevent hatching" - Check punctuation and readability.

3) Consider using the terms you have used in the title, thermal stress (for increased temperature) and water stress (for decreased moisture) throughout the manuscript after defining these terms early on. This will imporve the readability of the manuscript.

4) Consider changing For the experiment 1 (Line81) to In experiment 1...Same for Line 85.

5) Line 87 isnt much of a prediction ("We predicted that a rise in temperature and a loss in moisture should be stressful and should induce changes in life history and physiological traits.")

6) Line 135: check for grammar: effect of a loss of moisture...

7) Line 137: check grammar: also aged of 7 months old

8) Lines 158-165 should be moved to Results.

Evaluation round #1

DOI or URL of the preprint: https://doi.org/10.1101/2022.09.26.509512
Version of the preprint: 1

Authors' reply, 05 December 2022

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Decision by Aniruddha Belsare, posted 02 November 2022, validated 02 November 2022

Revision recommended

Your preprint "Deleterious effects of thermal and water stresses on life history and physiology: a case study on woodlouse" has been reviewed by two reviewers. Reviewer 2 has major concerns about the novelty of this work. He/She has also raised the issue of ethical committe approval for this experimental work.

I invite you to respond to the reviewer comments and revise your manuscript. Please provide a detailed response to each comment.

I look forward to receiving your revision.

Sincerely,

Aniruddha Belsare

Download recommender's annotations

Reviewed by Aaron Yilmaz, 28 October 2022

In this article by Depeux *et al.*, the effects of stressful temperature and humidity regimes are tested on adult terrestrial isopods in order to ascertain what effect these stressful environmental conditions may have on isopod reproductive, growth, immune system, and survival metrics. The study was conducted in two parts in two different years–the temperature experiment in 2019, and then separately, the humidity experiment in 2021. The study found that increased temperature and decreased moisture were generally harmful to the isopods in question; increased temperature resulted in nearly a 2x increase in mortality, and decreased moisture led to a 2.5x increase in mortality. Reproductive success was negatively affected by increased temperature and decreased moisture, as was immune function. The study is putatively aimed at understanding the reponses of arthropods to future climate regimes.

This paper is well written, interesting, and timely. As heat and moisture are the most important regulators of insect persistence and distribution, this work is helpful in gauging invertebrate reponses to future climate scenarios. I support the publication of this article, and I have only minor comments:

line 47-48: "survival decreases with increasing temperature" makes it sound like a linear function, when surely, it is a quadratic function where there is an optimal temperature where survival is at it's peak, with a drop it survival on either side of the curve where temperature is higher and lower than the optimum. I would clarify this phrase.

line 60: "woodlice" (plural) should be "woodlouse" (singular). Change throughout.

line 128: I would state here that the immune function tests are destructive

line 234: Is "time" age in days? Days in treatment? Please clarify.

line 252: I would put at the beginning that all analyses were done in R

line 257: "Survival was" instead of "The survival was."

Figure 1. On my black and white printer, all the colors look the same. Specifically, in C and D, I cannot tell the colors apart for the treatments.

Very intersting research. Good luck!

Reviewed by Michael Morris, 02 November 2022

I recommend rejecting for the following reasons.

Firstly the paper is not providing anything new. It has been known for at least 40 years since I was at secondary school that woodlice are sensitive to moisture and temperature conditions. Woodlice are used as a paradigm in science classes to demonstrate how animals use taxes and kineses to find suitable habitat. I published a lesson plan for demonstrating taxes in woodlice in the 'journal of Biological education' 20 years ago.

Secondly, the researchers used a laboratory grown line of woodlice that had been reared under constant conditions of daylength, temperature and humidity 40 years. This strain would have very different characteristics from a wild strain and would be less likely to be adaptable to any temperatures or humidity deviating from the range they are used to.

Thirdly, I question the ethics. Animal experimentation is becoming less acceptble. As we learn more about animal sentience, more animal taxa are being included in the circle of moral concern. The New Zealand Animal Welfare Act includes crabs and shrimps as animals showing 'sentience'. Experiments on these animals need ethics committee approval, and can be rejected if the costs to the animals outweigh any benefits.

Woodlice are not decapods, but they are crustaceans, with the same advanced nervous system as decapods. It is therefore likely that they feel pain, which makes lethal experiments on them ethically questionable, especially with no ethical oversight.