



# Gap-bridging strategies in arboreal chameleons

*Ellen Decaestecker* based on peer reviews by *Simon Baeckens* and 2 anonymous reviewers

Allison M. Luger, Vincent Vermeulen, Anthony Herrel, Dominique Adriaens (2020) Do substrate roughness and gap distance impact gap-bridging strategies in arboreal chameleons? bioRxiv, ver. 3, peer-reviewed and recommended by Peer Community in Zoology. <https://doi.org/10.1101/2020.08.21.260596>

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Until now, very little is known about the tail use and functional performance in tail prehensile animals. Luger et al. (2020) are the first to provide explorative observations on trait related modulation of tail use, despite the lack of a sufficiently standardized data set to allow statistical testing. They described whether gap distance, perch diameter, and perch roughness influence tail use and overall locomotor behavior of the species *\*Chamaeleo calytratus\**. Peterson (1984) described already the pattern how and when the tail is moved when bridging the distance from one perch to another. The study by Luger et al. (2020) further explores how this bridging distance, as well as other perch parameters modulate this behavior and the importance of tail use in it. Zippel et al. (1999) study the underlying musculoskeletal anatomy of the tail in chameleons, showing that chameleons have a strikingly different tail anatomy than other prehensile squamates. The difference is (partially) to be seen in the capacity of tail autotomy, that has been lost in chameleons. Luger et al. (2020) describe the role the tail has in bridging a gap, and show that challenging and acrobatic movements to bridge large gaps, or when grasping on not so rough surfaces, relies heavily on a strong tail. Full body suspension with the tail can explain why tail autotomy has been lost, thus explaining the diverging tail musculature. They speculate on the role of this behavior for sexual selection for males. Sexual selection for males with a higher gripping performance could explain why male chameleons perform better for their size. In addition, boldness could have played a role. The authors state that exploring personality and its links to morphology, performance, and behaviors like gap-bridging would be a worthwhile avenue for future research on sexual selection in reptiles.

**References:**

Luger, A.M., Vermeylen, V., Herrel, A. and Adriaens, D. (2020) Do substrate roughness and gap distance impact gap-bridging strategies in arboreal chameleons? bioRxiv, 2020.08.21.260596, ver. 3 peer-reviewed and recommended by PCI Zoology. doi: [<https://doi.org/10.1101/2020.08.21.260596>](<https://doi.org/10.1101/2020.08.21.260596>)

Peterson, J. A. (1984). The locomotion of *Chamaeleo* (Reptilia: Sauria) with particular reference to the forelimb. *Journal of Zoology*, 202(1), 1-42. doi: [<https://doi.org/10.1111/j.1469-7998.1984.tb04286.x>](<https://doi.org/10.1111/j.1469-7998.1984.tb04286.x>)

Zippel, K. C., Glor, R. E., and Bertram, J. E. (1999). On caudal prehensility and phylogenetic constraint in lizards: the influence of ancestral anatomy on function in *Corucia* and *Furcifer*. *Journal of Morphology*, 239(2), 143-155. doi: [[https://doi.org/10.1002/\(SICI\)1097-4687\(199902\)239:2%3C143::AID-JMOR3%3E3.0.CO;2-O](https://doi.org/10.1002/(SICI)1097-4687(199902)239:2%3C143::AID-JMOR3%3E3.0.CO;2-O)]([https://doi.org/10.1002/\(SICI\)1097-4687\(199902\)239:2%3C143::AID-JMOR3%3E3.0.CO;2-O](https://doi.org/10.1002/(SICI)1097-4687(199902)239:2%3C143::AID-JMOR3%3E3.0.CO;2-O))

## Reviews

### Evaluation round #1

DOI or URL of the preprint: <https://www.biorxiv.org/content/10.1101/2020.08.21.260596v1>

### Authors' reply, 19 November 2020

[Download author's reply](#)

### Decision by [Ellen Decaestecker](#), posted 03 November 2020

#### Minor revision

Dear Allison Luger and co-authors,

I received now 3 review reports of your manuscript. All 3 reviewers are enthusiastic with respect to your study. Nevertheless, they point out that your study remains descriptive. One of the reviewers suggests additional tests that may be considered upon the revision. Therefore I suggest to resubmit your manuscript and address the points the reviewers made in combination with a rebuttal letter how you addressed the comments. Based on these I will make a fast decision to recommend your study through the PCI Zoology

Kind regards, Ellen Decaestecker

### Reviewed by [Simon Baeckens](#), 03 November 2020

It is with great interest and enthusiasm that I have read the manuscript by Allison Luger and colleagues, entitled "Do substrate type and gap distance impact gap-bridging strategies in arboreal chameleons". Using an experimental set-up, and focussing on both males and females of the species *Chamaeleo calytratus*, the authors test whether gap distance, perch diameter, and perch roughness influence tail use and overall locomotor behaviour of chameleons when crossing a gap between two perches. Overall, I believe the manuscript is very well written. The authors succeed in describing the gap-bridging behaviour of the species clearly and eloquently; it was truly a pleasure to read. In addition, the authors do a great job in explaining and introducing the novelty of their study by pinpointing the current gaps in the literature and by thoroughly laying out the predictions of the planned experiments. Also, I really appreciated the "cautious" style of writing in the discussion: the

authors are not too bold with strong statements and conclusion, which is an honest portrayal because the study is largely based on qualitative observations rather than quantitative results. Indeed, as mentioned by the authors (L144), the manuscript is primarily descriptive, focussing on qualitative traits in tail use. While I understand why the authors were reluctant to analyse their data qualitatively (see specific comments below), I believe there might be ways to statistically test for the predictors of tail use. Of course, I have no notion of how the actual raw data looks like, but I encourage the authors to give it a try. Alternatively, I feel the authors should provide some explanation on why they did not analyse their (valuable!) data quantitatively. Regardless, in my humble opinion, I believe this paper has ample potential and (with some relatively minor changes) will be warmly welcomed by the zoological scientific community.

Below some more specific comments:

L19: Maybe change "...has not been studied to date." to "...has been largely neglected."

L20: Suggestion: maybe change "type" by "roughness"? Similar for the title?

L23: Suggestion: maybe change "material" by "surface"?

L68: Word missing here (after "their").

L69: "We also wanted to compare ..." feels odd. Maybe change to "In addition, we examined whether this behaviour differs between sexes."

L71-L88: It is good that the authors elaborate on their (many) predictions. In order to keep some sort of structure for the readers, I believe it would be convenient if the authors provide a numbering throughout this paragraph. For instance: "First of all, we predict ...", "Second, ...". Try also to be consistent with verb tenses (e.g. "predicted" vs. "predict").

L72: I think it would be helpful to mention that these tests were performed in an indoor experimental set-up (and that they are not e.g. observations in the wild), as on L19 in the abstract.

L74: I suggest changing "...substrates as this would also decrease the grasping ..." to "...substrates as this decreases grasping ...". In addition, I suggest including a reference after the statement that smoother substrates decrease grasping ability, maybe e.g. Spinner et al. 2014 (Scientific Reports). Or are the authors truly testing the effect of substrate roughness on grasping ability?

L75: A suggestion: changing "...when bridging greater gaps animals would have to suspend ..." to "...when bridging greater gaps, animals suspend their body ...".

L78: A suggestion: changing "We therefore also predicted that as gap distance increases that the animals would resort to more often use their tail as an anchor." to "We therefore predicted that animals more often use their tail as an anchor as gap distance increases."

L80: Change "...able to cross greater gap distances." to "...able to cross greater gap distances than on smoother surfaces."

L82: Provide "," after genus name.

L85-86: I suggest changing "...predict that males would be able to cross ..." to "...predict that males are able to cross ...".

L88: Maybe change to "... due to their expected higher grip strength.?"

L104-106: Personally, I would include table 1 as supplementary material. And also Table 2, actually.

L108-113: Were lizards able to reach their preferred body temperature prior to the trials?

L119-120: Is the average (preferred) perch diameter in nature known for the study species? This would have helped with the choice of perch size/diameter.

L114: Although I understand why, in a way, it is a shame that no statistical analyses were performed here. This is likely due to the many variables involved (especially the six different tests for gap size) making statistical analyses more challenging. However, what if the authors rearrange their input data so that (a) the PVC tests are excluded (because of the low success rate) and (b) so that the variable "gap distance" is reduced to e.g. two categories (i) small gap (i.e. lower or equal than shoulder-hip length, thus lumping gap distance 0.5 and 1) and (ii) large gap (i.e. lumping 1.25, 1.5, 1.75, and 2 gap distance). Consequently, the authors can perform a glmer model (binomial) testing whether gap size (small vs. large), perch thickness (thick vs. thin), and/or perch

roughness (wood vs. sandpaper) can predict tail use (binary response variable; yes = 1; no = 0). Depending on the statistical power, the authors can do this separately per sex or combined (i.e. sex as an additional factor). Of course, the authors need to account for repeated measures (as each individual was tested multiple times). The data input file could be structured with the following columns: (column 1) individual, (column 2) tail use, (column 3) gap size, (column 4) perch thickness, (column 5) perch roughness, (and maybe (column 6) sex). Wouldn't this be worth the try?

L205: Wonderful name for the observed tail strategy.

L206: Suggestion: "... to safely cross ..."?

L196-217: The locomotor behaviour of the chameleons is clearly and eloquently described here.

L247: True — the success rate on the PVC substrate was low compared to wood or sandpaper. Do you think the coloration of the perches would have had an effect on the willingness or success of the lizards to cross? The grey-ish colour of PVC tubes is likely less attractive (or less inviting) perches for animals than the more naturally brown-ish coloured wood and sandpaper wrapped around wood.

L239-257: The authors studied the locomotor behaviour of one species of chameleon. Can these results be extrapolated to other species? Or do other species have more specialized skeletal or skin adaptations that allow them to cross gaps more easily/efficiently? I think it is worthwhile to elaborate a bit on this.

L272: Do the authors have a reference for this statement?

L279-291: Can the authors provide an example from other animal groups in which substrate roughness is known to affect grasping ability? Also, do you think claw size and shape has an effect on grasping ability? Is there something known about this in chameleons?

L321: Yes — I think so, too. Is there any literature on sex difference in risk taking behaviour or exploratory behaviour in lizards, which can be used as an example?

## **Reviewed by anonymous reviewer 1, 03 November 2020**

The authors conducted a qualitative study examining how the veiled chameleon uses the tail during various trials varying the substrate texture (for increased or reduced friction), width (wider vs narrower substrate) and also the length of the gap they must cross relative to the shoulder-hip distance of the chameleons (with all trials being able to be broken into male vs female datasets). In short, this was a rather straightforward, simple and yet fun series of trials examining how chameleons navigate in a 3dimensional environment (though this was in a lab setting, but theoretically approached the scenario chameleons must encounter time and time again when climbing through branches or bushes or even going from the ground to gripping the first of the low branches of their target plant). I for one found this a nice project that fills in some gaps on how tails are used by these derived chameleons and have only minor comments below.

- Running Title vs Title do not correlate completely, running title needs to be more broadly written about gap strategies in chameleons or something similar since it is not all due to tail use.

- Abstract: lines 26, 27 duplicated text (redundant).

- Page 3, line 50-51 (recently coined as Chameleodactyly – though that paper is weak and is essentially self published despite being based on a conversation on Twitter by a few chameleon biologists whom he never cited yet stole their term! ) See:

- Necas. 2020. Chameleodactyly: New term to describe the unique arrangement of digits in chameleons (Reptilia: Chamaeleonidae) *Archaius* 1(1): 4-5.

- Also, see the work of Diaz and Trainor 2015 for extensive work on the autopodium.

- Page 4, line 68: should read "...their tail when confronted...".

- Page 5, line 95: which vegetables were the veiled chameleons fed?

- While the only trials presented were those where successful crossings were made, I find it would still be of interest to present how many total attempts were conducted since that number may affect animal behavior and is also of interest (though you can still present the successful crossings as you did in figures).

- I liked the use of shoulder-hip length as a measure.

- Page 12, line 206: I feel that the page would flow better if you split into two paragraphs, with the second paragraph beginning with "With gap distances above 1.25 times shoulder-hip length...."

### **Reviewed by anonymous reviewer 2, 03 November 2020**

Dear Editor,

First, I want to apologize for the delay in my reply.

I have read the manuscript by Luger et al. entitled "Do substrate type and gap distance impact gap-bridging strategies in arboreal chameleons?". This is a straightforward and well written, but entirely descriptive manuscript on gap-crossing behavior. Hypotheses are clearly formulated (yet not really 'stunning') and the performed video-analyses seem to support the hypotheses. Apparently, no real testing is (or could be) carried out (probably because of a too fragmentary data set?). The discussion is adequate for the descriptive data available. As such, little or no comments can be formulated. This is a useful, yet not overwhelming contribution.

Line 68: 'tail' missing

Line 148: Is the number of windings of the coiling tail not relevant?

Line 166-167 (and 172-173): Syntax is a bit strange [suggestion: "Percentages giving of the number of times tails were used or not used on the three different materials (PVC, sandpaper and wood) and for the two different perch diameters (narrow and broad)."].

Line 169 (and 175): I suggest to add the absolute numbers, too (or at least to refer to table 2 for these numbers). A graphical representation of '100%' for a single count is otherwise somewhat misleading.

Line 189 (table 2): Is it not relevant to refer to the individuals? Are some of the individuals more 'participative' than the others?

Line 307: How do we know this is 'significant'?