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Dear Dr.Chris Foote,

We are writing to re-submit a Nature Note “*Floral phenology of an Andean bellflower and pollination by Buff-tailed Sicklebill hummingbird*” for consideration at *Ecology and Evolution.* Thank you, and to the anonymous reviewers, for your considerate and thoughtful feedback on the first submission (ECE-2022-02-00175) of the manuscript.

We have carefully incorporated the suggestions of the two reviewers in this revised version. Most notably, we have included new text that better frames the goals and findings of this manuscript in terms of the broader implications for how specialization influences diversification. We have also attempted to clarify the role of traplining in the evolution of specialization, emphasizing that while floral morphology may act as a stronger filter, steady state flowering is likely to have pre-dated floral curvature in *Centropogon*. Finally, there are several instances of incorrect citations of the figures in the main text that have been corrected.

We appreciate the encouraging comments and feedback, and we are confident that the resulting manuscript is substantially strengthened following these revisions. In the following text you can find all reviewer comments and our responses with line-specific references to the revised manuscript.

We look forward to your response in anticipation that our work will make a constructive contribution to *Ecology and Evolution*.

Kind regards,

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David Guevara-Apaza,

Jill Jankowski,

Quentin Cronk

This document is the ‘Response’ to the reviews sent to the authors of “Floral phenology of an Andean bellflower and pollination by Buff-tailed Sicklebill hummingbird” on March 10, 2022. We thank the EIC and the anonymous reviewers for their thoughtful and constructive comments that have substantially improved the manuscript. Our responses to each reviewer’s comments are shown in bold below. We hope that our responses will clarify any remaining discrepancies.

**Reviewer: 1**

(1) Line 44: Overall, I miss some theory in the Introduction. There is several important information that is only mentioned in Discussion section and it should be in the Introduction. For instance, the relation between specialization and diversification, hermits behavior and bill morphology that influences community organization and also patterns of diversification...

**Thank you for the suggestion. We have attempted to better tie specialization to diversification at lines 43-47. In the revised text, we briefly outline how specialization can sometimes lead to reduced interspecific pollen transfer (i.e. gene flow) thus reinforcing or initiating reproductive isolation. We then point the reader to Armbruster 2017 (*Functional Ecology*) where this concept is explained detail.**

**Lines 43-47: “For some centropogonids, pollinator shifts are concomitant with pollinator specialization, which can initiate or reinforce reproductive isolation (Lagomarsino & Muchhala 2019). That is, a pollinator shift may incidentally reduce the number of effective pollinators and in some cases lower interspecific pollen transfer (Armbruster 2017).”**

(2) Lines 51 – 54: For better text flow, this part should be at the end of Introduction. Furthermore, visitations rates are not hypothesis, but patterns. Perhaps this sentence should be reformulated to make it clear that the hypothesis is related to the presence of floral characters that facilitates the observed pattern of visitation.

**This paragraph serves to introduce the eucentropogonids, their unique floral morphology, and the expectation that they are pollinated by Sicklebills. Therefore, we believe the placement of this paragraph early in the Introduction is appropriate.**

**We do not mention visitation rates in this paragraph, only morphology. We believe it is appropriate to frame the expectation that “eucentropogonids are pollinated by Sicklebills” as a hypothesis because it is testable and can be supported by rejecting the null.**

(3) Line 87: I feel that this whole paragraph should be in Methods section and not in Introduction

section. Furthermore, I believe that Gentry framework deserves better explanation at the Introduction.

**In the revised text we have attempted to better introduce the Gentry framework before discussing how the *Centropogon-Eutoxeres* system may fit into Gentry’s phenological types (lines 83-86):**

**“Phenological patterns at this scale have been previously categorized by Gentry (**[**1974**](#ref-gentry_1974)**): for example, ‘big bang’ species produce many flowers simultaneously over several days, while ‘steady state’ species produce only a few flowers per day over a number of weeks.”**

**However, we have left this paragraph in the Introduction because it exposes the reader to concepts needed to understand the motivation for the study, but does not directly explain how we carried out the study, as would be appropriate for the Methods section. For example, in the Methods section we explain *how* we use the linearity metric, whereas in the Introduction we discuss *what* linearity is as it relates to Gentry’s phenological types.**

(4) Line 95: This is the paragraph where there should be your questions and your predictions. By reading the hole introduction, one can understand some of your expectations, but it should be clear and organized by the end of the introduction.

**This is indeed the paragraph where our questions and predictions are explicitly defined. We briefly allude to the hypothesis that “*C. granulosus* is solely pollinated by Sicklebills..” at lines 55-56, but this is stated only to motivate the Introduction from the outset, before providing more background on the study system. The Introduction is thus organized as:**

**(1) eco-evolutionary observation/theory,**

**(2) brief mention of the main hypothesis generated by (1),**

**(3) background information explaining the study system, and**

**(4) explicit definition of the questions and hypotheses to be tested in the present study.**

(5) Line 126: If I understand correctly, sicklebill hummingbirds are the unique visitors of these flowers. I believe that the information about invertebrates here are unnecessary, unless if there are invertebrates also visiting this species. If this is the case, this should be point out in the study system and Discussion.

**There are invertebrates that visit this species, as is discussed in the Results (lines 195-201), also pasted below. We have included new text that briefly discusses our interpretation of the significance of these invertebrates for pollination at lines 234-239 (see below). See also: our response to comment #5 from Reviewer #2.**

**Lines 195-201: “Numerous invertebrates occupied or visited the flowers of *C. granulosus* in this study. As found in previous studies, we observed ants (Stein 1992), mites (Naskrecki & Colwell 1998), and dipterids (Weiss 1996) in or on the flowers of this species. We observed unidentified Aranids inside of the floral tubes, and note that *Anelosimus* spiders (Araneae) are known to build webs scaffolded by *Centropogon coccineus* (Hook.) Regel ex B.D.Jacks. (Nentwig & Christenson 1986). We also recorded a larval lepidopteran inhabiting a flower (Figure A8), and a stingless bee (Meliponini) collecting pollen from the anther scale (Figure A9).”**

**Lines 234-239: “As predicted from its extreme bill curvature, Buff-tailed Sicklebill (*E. condamini*) is a visitor to *C. granulosus*, and these visits are necessary for developing fruit. No other hummingbirds were observed legitimately probing these flowers. Covering flowers with wire cages excluded hummingbirds while allowing invertebrates to access the flowers freely — however none of these flowers produced fruits. Therefore, we conclude that Buff-tailed Sicklebill is the sole pollinator of *C. granulosus*.”**

(6) Line 129: Figure 3 do not relate to the stages of floral development. I believe that this should be removed.

**Thank you for catching this typo. The text now reads “Figure 4” instead of “Figure 3” (line 133 in the revised text).**

(7) Line 151: The biological explanation of this analysis should be here and not at line 87.

**We believe the background information that justifies this analysis is appropriate as written in the Introduction (see our response to comment #3).**

(8) Line 162: There should be Figure 3 and A4.

**Thank you -- We have revised the text at line 166 in the revised text.**

(9) Line 167: Despite being a Supplementary Material, I don’t see the need of this graph. Besides, this result is already in the main text.

**This graph visually conveys the visitation behaviour of *E. condamini* and is indicative of traplining as the most likely foraging mode of this species. This reinforces the notion that traplining and steady state flowering are a result of the evolution of specialization via phenology. Further, because very little is known of the natural history of *E. condamini*, and of traplining behaviour in general, we believe any information about this elusive species and its behaviour has the potential to be useful in studying the evolution of this unusual pollination system.**

(10) Line 191: Here we have the information about invertebrates. At line 31 and later in the discussion, you state that E. condamini is the sole pollination of C. granylosus, but these invertebrates might also be playing this role. Perhaps you should change it by the sole vertebrate pollination. Furthermore, I believe that you should mention that visitation might not always results in actual pollination, since it is a big discussion in the scientific community.

**We have been careful not to imply pollination in this paragraph (lines 195-201), and only use the word ‘visitation’. The results of the pollination exclusion experiment rule out invertebrate pollination: invertebrates were free to access hummingbird-excluded flowers, but none of these flowers produced fruit. This is discussed in the revised text at lines 234-239.**

(11) Line 207: I think that is Figure 2.

**This should read Figure 4 as written.**

(12) Line 209: This is such an important result. Thus, it can be said that, in this case, visitation by the hummingbird actually result in pollination, and invertebrate visitation is not as efficient as

vertebrate pollination.

**We agree with the reviewer’s comments.**

(13) Line 218: This should be Figure 5.

**Thank you! The revised texts reads as Figure 5.**

(14) Line 224: I think that this should be Figure 4.

**This should read as Figure 5, though we mistakenly cited Figure 3. All references to Figures and Tables in the revised manuscript have been double-checked for accuracy.**

(15) Line 228: There is no mention of some of your expectation in Discussion. For instance, you have explicitly tested whether the visit of the sicklebill hummingbird affects the reproductive success of plants and you have such an interesting result, but no discussion about it. It would beinteresting to be discussed.

**Agreed. We have included a new paragraph at lines 234-239 in the Discussion that addresses the pollination exclusion experiment.**

**Reviewer: 2**

(1) Lines 43 – 44: The sentence is confusing, a better explanation of what this means is needed "pollinator shifts are concomitant with pollinator specialization"

**Thank you for the suggestion. Here, we are attempting to convey that pollinator shifts can result in increased specialization which can sometimes lead to or reinforce reproductive isolation. We have attempted to clarify this point at lines 43-47.**

**Lines 43-47: “For some centropogonids, pollinator shifts are concomitant with pollinator specialization, which can initiate or reinforce reproductive isolation ([Lagomarsino & Muchhala 2019](#ref-lagomarsino_2019)). That is, a pollinator shift may incidentally reduce the number of effective pollinators and in some cases lower interspecific pollen transfer (**[**Armbruster 2017**](#ref-armbruster_2017)**).”**

(2) Lines 84 – 86:  Does "we expect steady state flowering to provide insufficient daily nectar" refer to the amount of flowers from a single species or the entire site community not providing enough nectar for territorial hummingbirds? If it is only from the focal species, then you have evidence of hummingbirds visiting plants outside the ornithophilic spectrum in search of resources to maintain themselves in a territory (Maruyama 2013, Rodrigues & Rodrigues, 2014, Waser et al. 2018). In the case of the focal plant it seems to be more a morphological limitation of access to nectar than with respect to quantity.

**Correct, this sentence is referring to the focal species. We agree that floral morphology (specifically curvature) is likely the most important trait in promoting specialization with *Eutoxeres* in present day. However, because traplining likely pre-dates the extreme bill morphology of *Eutoxeres*, we see specialization evolving iteratively: first with steady-state flowering excluding some territorial species (except in the cases highlighted in the references you have provided), and second, with curvature further filtering the traplining species. Therefore, steady-state flowering is not necessarily indicative of specialization to *Eutoxeres*, but is at least indicative of specialization to trapliners, of which *Eutoxeres* is most likely to be. We’ve attempted to clarify this last point in the discussion (lines 300-305).**

**Lines 300-305: “Finally, while steady state flowering is not solely indicative of specialization to *Eutoxeres*, we speculate that it is a component of the iterative process by which specialization evolves. That is, steady state flowering may have first co-evolved with traplining hummingbirds (Rombaut *et al.* 2022) which excluded visitation by species under stabilizing selection for territoriality. Among the steady state species, floral morphology continued to evolve, further partitioning the steady state species between grades of curvature (Figure 1).”**

(3) Line 161: I suggest putting the scientific name of the hummingbird in parentheses. In fact, I suggest always putting the scientific name of the hummingbird instead of the popular name, or always putting the scientific name in parentheses.

**We have been careful to tie common names to species names in the introduction, and in the first mention in each subsequent section (methods, results, etc.). We believe the reader can easily refer to the numerous mentions of the scientific name in the manuscript if necessary.**

(4) Lines 179 – 181: Very interesting and curious observation!

**Agreed!**

(5) Line 160: Floral Visitors - Of the visitors, only the Buff-tailed Sicklebill acts as pollinator or the meliponini could also act as pollinators? As the manuscript discourses on all the visitors, quite an interesting point, I think it would fit at the beginning of the results a short and direct sentence/paragraph informing who is a potential pollinator and who is not.

**Stingless bees were not excluded from interacting with flowers covered with wire cages. However, none of these flowers produced fruit. We then assert that the presence of invertebrate visitors in the flowers is insufficient for pollination. To emphasize this point we have added a brief explanation at lines 234-239.**

**Lines 234-239: “As predicted from its extreme bill curvature, Buff-tailed Sicklebill (*E. condamini*) is a visitor to *C. granulosus*, and these visits are necessary for developing fruit. No other hummingbirds were observed legitimately probing these flowers. Covering flowers with wire cages excluded hummingbirds while allowing invertebrates to access the flowers freely — however none of these flowers produced fruits. Therefore, we conclude that Buff-tailed Sicklebill is the sole pollinator of *C. granulosus*.”**

(6) Line 229: "Buff-tailed Sicklebill is a pollinator of *C. granulosus*." Here would fit a paragraph explaining that statement. Why is it a pollinator? Missing some mention of specialization of the system, since apparently only this hummingbird acted as pollinator.

**Thank you for the suggestion. We have added a summary of the evidence behind this statement at lines 234-239. We designate *E. condamini* as the “sole pollinator” which we believe conveys specialization.**   
  
(7) Line 343: There is a missing citation to Figure 4 in the manuscript.

**Thank you for catching this -- We have amended the citation at line 211 in the revised manuscript.**