

ALESSIA Guggisberg

1) Scientific significance

Does the manuscript represent a substantial contribution to scientific progress within the scope of this journal (substantial new concepts, ideas, methods, or data)?

GOOD

2) Scientific quality

Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

GOOD

3) Presentation quality

Are the scientific results and conclusions presented in a clear, concise, and well structured way (number and quality of figures/tables, appropriate use of English language)?

FAIR

For final publication, the manuscript should be

accepted subject to minor revision

General comments

This paper integrates a massive amount of granulometric, geomorphological, climatic and population genetic data from three different study sites, to understand the formation and maintenance of *Tillandsia* lomas, characteristic plant communities of the hyperarid Chilean Atacama Desert. Since grain size and index sorting differ between areas with or without *Tillandsia*, one may imply that the plants shape their own environment. Geomorphological and climatic data further indicate that banding patterns may only persist under a low wind energy system and are therefore highly sensitive to abrupt climate changes. The genetic results finally suggest an adaptive advantage of heterozygotes and emphasise the importance of clonal propagation for the establishment and long-term survival of *Tillandsia*. While previous studies have investigated the mechanistic and topographic characteristics of *Tillandsia* lomas, this is the first that specifically looks into the biotic effects on such a large scale.

[We thank the reviewer for this very positive summary.](#)

The authors provide an in-depth summary of their research results on *Tillandsia*, but fail to convey which questions remain unanswered. The paper reads a bit like a final report and it is not always clear which data were newly produced for this paper and existed already from previous studies.

[We think that we mostly stated clearly which data are new and which results/conclusions refer to past observations. However, we consider this comment carefully to avoid confusion about past and actual new data. Also all genetic data are newly generated.](#)

Overall, the paper needs to be streamlined and better structured. Since this study integrates data from very different research areas (ranging from geomorphology to genomics), it is important to clearly formulate the questions or null hypotheses at the very beginning and explain why/how the methods that have been chosen may address those, so that a broad spectrum of researchers can grasp all the details of this study.

We may elaborate further on aims and scopes/hypotheses introduced at the end of the introduction and provide additional details with the Material & Methods section.

Similarly, this paper could gain in significance, if (seemingly) incongruent/inconsistent results would be discussed more thoroughly. For example, the exposition analyses showed major differences between the study sites (*Tillandsia* at Caldera are not perfectly facing incoming winds and coppice dunes are more developed at Oyarbide), but the explanations for these differences lack clarity.

We will work on these explanations. However, “incongruent/inconsistent” results is likely not an appropriate wording. There is varying variation in datasets and with $n=3$ (study fields) we have to accept some uncertainty. But the reviewer is fully right to ask for clarity with any of those explanations. We will highlight more clearly the differences in exposure mentioned above, which we touched upon briefly in Section 2.1 – such as the greater influence of wind direction in Caldera due to the course of the valley. The same applies to the coppice dunes near Oyarbide, which are more prevalent there and which we have already described in Section 3.3.2.

Also, at lines 819-820, the authors finally state that wind and sand dynamic parameters are largely independent from landscape characteristics, but what this exactly means in light of the study questions remains open.

We make this clearer (see also comments above) - here we aimed to refer to the spatial dimensions, and we will clarify this accordingly.

Last but not least, it would be easier for the reader, if the data were presented and discussed in a similar order throughout the sections of the paper (e.g. first sand properties, then geomorphological aspects and finally genetic results).

This comment is difficult to follow. The genetic data provide clear “positive” results and provide the population biological framing. However, since the first reviewer asked to change the order in M&M and Results section (to harmonize) we can adjust this in a way to keep the order presented in discussion..

Specific comments

More specifically, the Introduction must be shortened. Lines 80-87 seem out of scope, while paragraphs of lines 88-166 are too lengthy and read more like a textbook or a general report/review. The reader only gets introduced into the core of the topic at line 186 and into the knowledge gaps (or hypotheses) at line 220. Overall, one misses the exact reason for each type of analysis. For example, lines 605-609 clearly emphasise why grain size and

sorting index got analysed, but such explanations come too late in the text and could be moved to the Methods section and be briefly mentioned in the Introduction when listing the goals of the study.

We agree and will improve these aspects.

The Methods are described in detail, but it is not clear whether the genetic data have been newly produced, or existed already and have simply been combined for this study.

Data are new, of course. We always clearly said, when we used already existing and published data.

The Results and Figures nicely summarise the data, but the former do not refer to the (two) hypotheses posited in the Introduction.

We may have phrased the introducing hypotheses in a too complex way and will simplify those.

Some of the sentences would also better fit as arguments in the Methods or as explanations in the Discussion.

Right, this commentary fits with the above response.

The Discussion would benefit from a clearer structure that mirrors the questions and goals posited in the Introduction.

We agree and refer here to comments and responses to reviewer 1.

The Conclusion is too short and general, and does not do justice to the significance of the results. The authors briefly mention that tillandsiales are threatened by climate change, but they do not share their opinion on how the community may evolve, if the conditions would remain stable or would further change over time, which of the study site may be more resilient, or which of the parameters (sand/wind dynamics, genetics, etc.) are most relevant for the plants to survive. Accordingly, the Abstract and Short Summary can be improved, to better emphasise the knowledge gaps, goals and methods used to address these, and increase the relevance of the study for researchers working on desert ecosystems.

We agree to elaborate on abstract, short summary and conclusion accordingly. It is only “to define knowledge gaps” which would be too arbitrary.

Technical comments

If not otherwise commented and outlined any of the following comments will be followed and improved (=tbi).

L. 29: ... *Tillandsia landbeckii* known as *Tillandsia* lomas or tillandsiales, which...

L. 32: which other plant community? This can be deleted.

L. 29-35: On the one hand, you certify that sand plays a crucial role in the persistence of the

plant community, but on the other hand this is exactly what you want to investigate. Could you better phrase what one still doesn't know, what you exactly want to test? [Good point. However, it makes no sense to say what we do not know, but we can include a half-sentence about what we wanted to test..](#)

L. 46: Could you clarify which substrate characteristics change the most? [We will do, but we should avoid providing too many details here. Otherwise the abstract will be too lengthy.](#)

L. 46-49: Based on the Abstract, the reader cannot grasp the relevance of the genetic results. [Likely too short? We can expand this very dense sentence.](#)

L. 50: The 1st sentence is weak; we know that sand plays a central role since line 31. Could you rather conclude on how the dynamics may evolve with the prevailing conditions and what would be the long-lasting consequences? [We will work on this.](#)

L. 71: What do you mean by 'predominant grain sizes'? [Dominant ... wrong wording.](#)

L. 72-75: Are the two statements saying the same, namely that heterozygous genotypes are fitter? [Yes, to be corrected](#)

L. 88: What is the difference between plant communities and vegetation units? [A plant community is different from vegetation. But we agree that we have to simplify terms here.](#)

L. 88: ...forming plant communities and vegetation units, whereby biotic and abiotic... [tbi](#)

L. 88: new paragraph after (Willi et al., 2002). [tbi](#)

L. 139: ...monospecific stands of shrubs and perennial grasses [tbi](#)

L. 142: simply altered or rather enhanced fire regimes? [tbi](#)

L. 146: ...these interactions cause noticeable spatial structures in monospecific vegetation. [tbi](#)

L. 152: ...vegetation patterns, which are finally reduced to highly isolated patches... [tbi](#)

L. 154: ...formed by (various sets) of plant species... [tbi](#)

L. 155: new paragraph after "...across continents". [tbi](#)

L. 163: ...contour lines, which occur in Africa... [tbi](#)

L. 190: ..."*Tillandsia lomas*" (or tillandisales) [tbi](#)

L. 197: new paragraph after (Rundel et al., 1997) [tbi](#)

L. 214: ...vegetative growth strategy for this long-lived perennial plant. [tbi](#)

L. 226-227: What do you mean here, that if wind/fog conditions change over time, we would observe a concerted response of the community over time? [Yes, correct.](#)

L. 232: To verify these hypotheses, we investigated three... [tbi](#)

L. 234: ...using population genomic data with... [tbi](#)

L. 245: punctuation or words missing in the sentence?! [delete "in"](#)

L. 258: ...Chilean populations herein named Arica (Fig. 1). [tbi](#)

L. 262: ...characterized by well-developed... [tbi](#)

L. 269: ...according to results from genetic assignments. [tbi](#)

L. 276: ...Humboldt Current, whereby coastal upwelling... [tbi](#)

L. 280: ...daily sea-breeze... [tbi](#)

L. 287: From a geological and a geomorphological point of view, the three populations experience different settings. [tbi](#)

L. 291: ...as possible sediment sources. [tbi](#)

L. 292-293: ...sand/silt matrix are scarce. [tbi](#)

L. 294: ...are most probably providing the source... [tbi](#)

L. 296: ...sand and silts are dominant. [tbi](#)

L. 312: ...we gathered data on... [tbi](#)

L. 326: How much 'in front', did you fix a given distance? [in cm scale.](#)

L. 353-354: ...filled two-third with dH₂O. [tbi](#)

L. 412-427: Does it mean you combined data from three different sequencers? [Yes, we had to combine different experiments. But it worked well.](#)

L. 445-446:across all GBS experiments. [tbi](#)

L. 449: A dataset without duplicates... [tbi](#)

L. 452-454: In addition, genetic assignment tests were also performed for all three study fields to ensure that historical genetic differentiation processes are not biasing the analyses. [tbi](#)

L. 482: Did the year of the measurements (March 2022 – March 2023; see line 482) fit within

the average annual fluctuations or should it rather be considered as exceptional (e.g. Niño year)? We will check this carefully. But we have no longer time series nor data from nearby sites to be compared with.

L. 504: new paragraph after 'on site'. Has the recording at Oyarbide been done during the same period (March 2022-March 2023) as at Caldera and Arica? information will be added, thx for spotting this

L. 536: The total vector units were accumulated... tbi

L. 558: ...is about 14 cm and the data are freely available. tbi

L. 584-587: rephrase (incomprehensible) tbi

L. 652: ...size from Caldera (Fig. 2c, d). tbi

L. 653: ...the coarsest grain size and Oyarbide the fines... tbi

L. 658-659: Since the three sites show different results regarding grain size and sorting index, can we actually conclude with a general trend as in header of §3.1? And are the observed differences between sites necessarily the result of different aeolian sand origins? Yes, as already noted in the comments regarding reviewer 1, all three study areas exhibit a low-energy wind system, meaning that the differences observed are primarily due to petrographic variations, which are described at the end of Chapter 2.1. And yes, we agree that the first comment is fair and the header could be reframed, as it suggests a more "positive" result than we can state.

L. 660: How do you know the sands came from distant areas? see also statement at line 43 in the Abstract and line 904 in the Discussion

Thank you very much for pointing this out. We have expressed ourselves ambiguously here. In fact, as already mentioned in Chapter 1, line 227, our data indicate that the sand originated regionally. Aeolian transport took place from the areas adjoining the study area to the west, primarily from alluvial fans.

L. 667-668: What biases could therefore be introduced, how could this error rate affect the results and how trustful are the conclusions drawn from these analyses? We consider this effect as minor. As mentioned in the manuscript, we provided here the error rate across all runs and all sample fields. There is no/little effect on genetic assignment analyses and admixture plots, which has been supported by scaled Manhattan-distance analyses between Q-vectors of duplicate samples. It could be, of course, that we overestimated the number of MLGs (Multi-Locus-Genotypes) while considering "artificial variation". This would mean that eventually clonality is even higher. In Jabbusch & Koch (2025) we found 19 MLG at Oyarbide (with 100 individuals studied –different genetic dataset), and herein it is 48 MLG (per 100) with a more randomized sampling. We agree that we should comment on potential bias of genetic data.

- L. 672-673: ...comparisons across all sites with past analyses... tbi
- L. 677: ...not attributed to increased outbreeding but rather preferential clonal propagation... tbi
- L. 724: Could you formulate a summary sentence for each header, as for §3.1 and §3.2? tbi
- L. 728: Study fields at Arica and Caldera... tbi
- L. 743: ...channelled through the valley, from which no wind data records exist. tbi
- L. 766: Is there an error in the sentence, like a word missing? ... direction ...
- L. 768: ...direction (Caldera). tbi
- L. 775: ...and Caldera (MSC3 and 1). tbi
- L. 786: Do you mean 'aspects' by 'exposition'? Yes ... to be reformulated.
- L. 791-793: Do you mean the dunes at Oyarbide are so high that on the lee side, no *Tillandsia* can grow? Please, reformulate more clearly. Yes ... to be reformulated.
- L. 815: ...the inclined plane is slightly rotated. tbi
- L. 813-816: I do not get this point!
- L. 818: 'Between the two groups', do you mean sand/wind vs. terrain parameters? Please, specify.
- Both comments ask for clarification and better explanation, which we will follow. We assume that it is basically because we here intended to describe the putative meaning of missing correlations and "incongruencies".
- L. 827: Why shall the tillandsiales be confusing and illogical? We agree, it might be a misleading wording.
- L. 833: Specify the word 'that' at the beginning of the sentence. tbi
- L. 835-839: redundant sentences tbi
- L. 859-862: Any explanation for the differences between the lower and upper part of the study site? as outlined with line 857, tbi
- L. 885: '...they transport' shouldn't refer to both wind and sand, I think, but only wind. tbi
- L. 891: What are these 'correlating patterns'? to be mentioned
- L. 909 & 917: '*Tillandsia*' should be italicised. tbi

L. 935-937: ...in the phyllosphere of *Tillandsia* have been proposed as potential source of nitrogen, which may have a direct effect on growth and need to be fine-tuned... tbi

L. 988: missing reference for the dieback tbi

Graphical abstract: I could not fully grasp every graphic. To me, the 1st lane represents the banded pattern of *Tillandsia* lomas at the three study sites and highlights the analyses on grain size and index sorting. The 2nd lane emphasises the different sand and wind dynamics in grids occupied by dead/living plants or devoid of vegetation. Logically, the 3rd lane should present the genetic results, but I do not get the message.

Yes, indeed. And the cartoon in the third line shows some linear arrangement and green *Tillandsia*, while another single plant (as a symbol) is dead.

Fig. 7: Add site information in the legend or graph. tbi

Fig. 8: Could you make the graphs readable for red-green colour-blind readers? tbi