

Review: Delord et al., *The challenges of independence: ontogeny of at-sea behaviour in a long-lived seabird*

This study presents wet-dry patterns recorded by geolocators on Amsterdam albatrosses at different life stages. The authors use these patterns to infer differences in foraging behavior among life stages, sexes, and individuals. The study allows for direct comparisons between juvenile, immature, and adult life stages tracked over multiple months, which is relatively unique.

Although the questions raised are interesting and the dataset is comprehensive, some aspects of this article feel more like an exploratory analysis than a finished product. From a single binary measurement (whether a sensor is wet or dry), the authors derive five very similar, interrelated metrics (% time on water, number and duration of wet bouts, number and duration of dry bouts), which are then analyzed independently to infer essentially the same behavior (foraging). Given that similar and overlapping interpretations are offered for these metrics, this gives an overall impression of unnecessary redundancy. In addition, the authors make extensive and sometimes contradictory assumptions about the meaning of the wet-dry patterns they observe. For example, they interpret differences in wet-dry patterns between juveniles and adults to represent decreased foraging success/efficiency during the juvenile period, but interpret similar differences between sexes in adults to represent different foraging strategies (foraging-in-flight vs. sit-and-wait). Thus, the results often feel repetitive, and the interpretations strained. A more effective approach might be to use multivariate analysis to evaluate whether distinct foraging behaviors can be detected across the various aspects of wet/dry dynamics, and then to evaluate how use of these strategies varies over time and among individuals.

Aside from the general approach, I also had concerns about the framing of the study, analysis and interpretation of results, sample sizes, and figures, which I will discuss in turn.

Framing:

- The introduction does not effectively contextualize most of the hypotheses presented in Table S1, instead focusing entirely on the juvenile stage. Thus, there is no context for the importance of moult (and nature of predicted seasonal changes), importance of the immature period, and predicted sex-based differences presented in the hypotheses and in the discussion. At the same time, given the wide variety of studies on foraging and movement in juvenile seabirds and other birds described in the Introduction, the novelty of the study's central findings is not especially clear.
- The authors present several unknowns in the introduction that are not tested as part of this study, including whether decreased foraging efficiency contributes to juvenile mortality and which processes (e.g., learned experience vs. physical development) are responsible for post-fledging changes in foraging behavior. Focusing on these questions gives the misleading impression that they will be addressed in the manuscript.
- The authors emphasize the longitudinality of their study and mention multi-year data, which initially led me to believe that individual results would span multiple life stages and/or years. In fact, the groups for each life stage are composed of different individuals, comparison among the three groups is only possible for the first 10 months post-departure, and individual trajectories are not directly mentioned or analyzed. If the main goal of the paper is to make comparisons among life stages/seasons, I would suggest focusing on this aspect of the work rather than on

individual longitudinality; otherwise, results related to individual changes over time should be presented.

Analysis/interpretation of results:

- A particular strength of this study would appear to be the multi-year data obtained from juveniles, but (as far as I can tell) the authors do not use these data to compare behavioral changes within individuals between subsequent years. The one exception is in Figure 6, which compares juvenile behavior 15-16 months post-departure with immature/adult behavior immediately after departure; however, it is not clear why this particular time lag is suggested or how to interpret it.
- The difference in tracking duration between juveniles (2 years) and immatures/adults (1 year) also raises the question of how the second year of data in tracked juveniles was treated, since behavior appears to be very different during Year 2 after departure compared to Year 1. Were both years combined in other analyses (e.g., month-of-year) and, if so, why? Why not present direct comparisons of Year 1 and Year 2 for juveniles?
- Individual variability is mentioned in the Methods in reference to the use of mixed models, but results are not presented or discussed. Given that the intercept terms in the models are significant, it seems as though individual variability (i.e., specialization on different foraging strategies) could be a contributor to observed variability. It would be interesting to know more about this, including whether and at what rate intra-individual variation in foraging strategies decreases or stabilizes during the juvenile period (which would suggest development of specialized individual foraging behaviors). Given the small sample sizes, the degree of individual specialization could influence results and limit extrapolation.
- Similarly, individual trajectories are not analyzed, and months since departure are treated independently rather than as a continuous process. I would expect (at least in juveniles) some evolution in foraging strategies over time, but the present analyses are not sufficient to detect such changes on the individual level.
- Month of year is a rather arbitrary way to analyze seasonal changes, especially since months are considered categorically. A more useful approach might be to use time as a continuous covariate and fit a non-linear function (e.g., quadratic) to better show changes over the annual cycle, or to select ecologically meaningful seasons within which relevant environmental covariates (wind, sea surface temperatures, presence of fronts/eddies, etc.) are relatively consistent in the study area.
- Although linear modeling results show significant differences in many of the tested covariates, the ecological relevance of these differences appears to be relatively weak (coefficient values of <0.5 for most parameters). Such differences might be expected given the large sample sizes of wet-dry bouts (numbering in the thousands) and high within-individual replication. The figures also seem to show large variance and high overlap among life stages across all response variables. Some discussion of effect size and whether observed differences are ecologically meaningful is warranted.
- In the text, adults and immatures are typically presented as a single group (in contrast to juveniles). However, the figures and some results suggest that immatures may differ from both adults and juveniles in some aspects of their behavior. It would be useful to include some discussion of these differences, and of the immature life stage in general.

- The Abstract states that juvenile foraging behaviors are similar to adults within 2-3 months post-fledging, while the Discussion asserts that they do not become similar until 10-17 months post-fledging. I am not sure where the 10-17 months figure comes from (since direct comparisons are only possible through Month 10). I assume this is related to the 15-16 month offset shown in Figure 6, but I have no idea what this offset means, why it is different for adults vs. immatures, how it interacts with seasonal patterns, etc. Arbitrarily comparing one aspect of adult/immature post-departure behavior to juvenile behavior more than a year later does not allow for any conclusions about whether juveniles are behaving similarly to adults/immatures at that time. In any case, some clarification is needed about which figure (2-3 months or 10-17 months) is correct, as well as where the 10-17 month value comes from.

Sample sizes:

- It is unclear what the sample sizes were for male-female comparisons within each life stage, since sex ratios are not given. As sample sizes were small for all life stages (10-13 individuals per stage), this suggests that sex-specific samples by stage could have consisted of only a few individuals.
- Other sources of variability (e.g., differences in departure dates and bimodal distribution of departures in adults) could also affect observed patterns, especially if they differed between sexes. Some discussion or analysis of how departure dates are distributed, as well as how time since departure interacts with annual-cycle patterns, would be warranted.

Figures:

- The figures themselves are very monotonous, and many of the results highlighted by the authors are not readily apparent from looking at the figures alone given the very large variability and relatively narrow range of variation in averages among months.
- Most of the figures focus on male-female differences, while most of the discussion focuses on comparison among life stages. Understanding how and whether life stages differed from one another requires mentally superimposing the subfigures, which is tricky to do.
- Minor comment: in Figure S4, the juvenile values appear to be the same in both subfigures.