**Outline for disparity paper/chapter**

These are Natalie’s comments which she wrote on a printed copy when we were in Madagascar

Just morphological, ecological data will take longer to gather

**Broad question:** Is morphological disparity more than skin deep? This is too tenrec focussed, make it a general question which is tested on tenrecs

**Possible journal:** Biology Letters? (2,500 words including references, figure legends, acknowledgements) This is probably too long for Biology Letters; Journal of Evolutionary Biology would be a good fit; 6-10 printed pages with about 900 words per page and subtract around 160 words per page for figures or tables. Abstract is less than 250 words. References by author and year and use the abbreviated journal titles

**Current story** (if results stay the same after I check my code with simulated data)

* Tenrecs appear to be morphologically diverse so we expect them to have high disparity
* Define high disparity as more than their nearest relatives and more than expected by chance
* Compared to golden moles; tenrecs are more disparate in skull shape but not in mandible shape. Is it possible to combine the mandible and skull stuff somehow? Either stitch the two views together by common landmarks or is it possible to take the raw coordinates and do a common Procrustes analysis? I don’t see how that would work since the combined points would no longer be a biologically meaningful shape and therefore the splines wouldn’t make sense.
* Compared to chance; tenrecs (and golden moles) are less morphologically disparate than expected by chance
* Conclusion; important to test assumptions, tenrecs are diverse but they’re not exceptional in their diversity – probably because of the Microgale or due to a lack of resolution within the Microgale

**Introduction**

* Adaptive radiation; phenotypic diversity therefore expected high levels of disparity (but remember that the two may not be correlated throughout a clade’s history ([Ruta et al., 2013](#_ENREF_9))) there are also issues with extinction
* Common assumption that superficial morphological diversity corresponds to significant levels of disparity
* Tenrecs are a superficially diverse and therefore presumably disparate group but this hasn’t been tested quantitatively…
* Some degree of convergence is expected to evolve by chance ([Stayton, 2008](#_ENREF_10)) so the same could be true of disparity?)
* If tenrecs are truly an exceptional example of morphological diversity then there are two predictions;

1. 1) Tenrecs are more morphologically disparate than expected by chanceTenrecs show a significantly higher level of morphological disparity than their closest relatives, the golden moles

* Focus on morphological disparity of the skull
* Generalist insectivore diet in most of the species so don’t expect significant changes in dentition
* However, even superficial observations of the crania indicate that there are different shapes among the species
* Interested in overall shape rather than direct changes between corresponding homologous features; geometric morphometric approaches are a great improvement for studying morphological disparity compared to previous work based on discrete character traits ([Foote, 1997](#_ENREF_3)) This section possibly belongs to the methods

**Methods**

* Data collection; museums, photographs, replicates (*supplementary file with museum accession numbers/ figshare reference?)* figshare link is probably sufficient
* Sample size as a proportion of the total species in that family – mention the ~31/34 tenrec species and ~10/20 golden moles (remember that Steve’s small mammals book has a different list of tenrec species than the other references that I’m using)
* Taxonomy and phylogenies
* Landmarking; example picture for each view *(landmark* *definitions and descriptions in supplementary?)*
* Superimposition, PCA, choose axes for 95% of the variation
* Simulations of shape evolution separately on each phylogeny (tenrecs and golden moles)

**Disparity calculations –** Remember only do what answers the questions; no need to have multiple methods if they’re not relevant

* There isn’t a single best method to measure disparity, it’s important to compare methods ([Ciampaglio et al., 2001](#_ENREF_2))
* Sum and product of range and variance ([Brusatte et al., 2008](#_ENREF_1), [Foth et al., 2012](#_ENREF_4), [Ruta et al., 2013](#_ENREF_9), [Wainwright, 2007](#_ENREF_11)) What figure do they report in Wainwright 2007 and Price et al 2013 – I added the two Price papers to ReadCube – they both calculate disparity based on O’Meara’s method i.e. from the sigma squared parameter in separate BM models of each individual morphological trait ([Price et al., 2010](#_ENREF_8), [Price et al., 2013](#_ENREF_7))
* Directly from the Procrustes shape data ([Zelditch et al., 2012](#_ENREF_12))
* *Morphological disparity index (*[*Harmon et al., 2003*](#_ENREF_5)*) – probably not relevant because they calculated subclade disparity through time but I might be able to modify it* Why not do subclade disparity through time? I thought that I couldn’t do this method because it involves explicit ancestral state reconstruction but that’s what I’m doing anyway within the character simulations in Geiger so I could look at applying this method too.
* *Maybe use a different method? (*[*O'Meara et al., 2006*](#_ENREF_6)*) Disparity depends on the rate of morphological evolution, length of evolution and the relationships of the taxa. – this is just sigma squared from the BM model – it’s what they use in the two Price papers*
* Could I sub-divide some disparity comparisons into sub-genera to try and get around the problem of having large numbers of Microgale? No because it’s not asking the same question and it’s sort of fixing the data!

**Results**

1. Morphospace plots – just tenrecs and golden moles for each data set
2. Tenrecs vs. golden moles:

* Boxplots for different disparity measures ( This isn’t clear; calculate disparity for each PC axis separately? Get the overall disparity from the mean of each of the separate axis calculations and then the variance comes from the axes?
* NPMANOVAs – significantly different areas of morphospace (doesn’t test for significant difference in disparity measures directly)
* Subdivide disparity comparisons into genera? – Probably not – there aren’t really enough species in most of the genera
* *Rarefaction curves to show it’s not an artefact of sample size (supplementary? yes)*

1. Tenrecs vs. chance

* Compare observed to simulated disparity measures – just give p values, distributions in supplementary? – no need to give the distributions, they’re easy to generate

**Discussion**

* Tenrecs are more disparate than golden moles in their skull shape but not their mandible shape; *I don’t understand why there’s a difference – need to come up with some suggestions*
* Tenrecs are not more disparate than expected by chance- importance of testing assumptions
* Yes they’re a diverse family but most (19/31 in my data) are Microgale – general shrew-type morphology. *There’s probably greater disparity among tenrec genera but this comparison will be tricky because there are both tenrec and golden mole genera that are only represented by single species – could repeat just without the Microgale, would there be enough species?*

**References**

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