

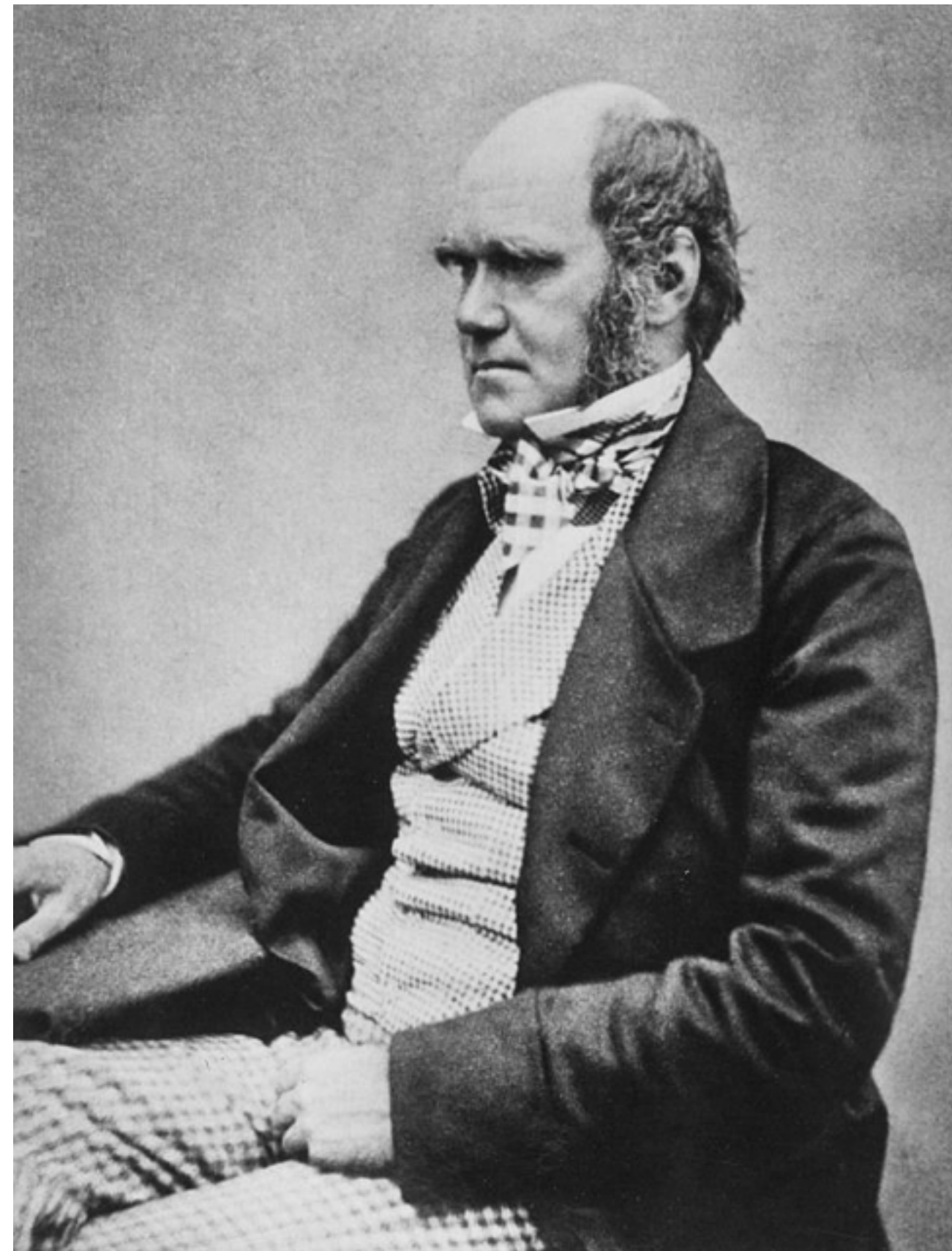


STATISTICAL THINKING IN PYTHON II

Darwin's finches: A full-blown statistical analysis

Your well-equipped toolbox

- Graphical and quantitative EDA
- Parameter estimation
- Confidence interval calculation
- Hypothesis testing



Many important observations that led Charles Darwin to develop the theory of evolution.



Galapagos archipelago

particular in the study of the small birds, called finches, that inhabit them.

the islands are ideal for studying evolution b/c they are isolated (not have complicated effects from interactions with other species including humans).

Some of them are small, so entire populations can be monitored on a given island.



The island of Daphne Major



Yearly (From 1973), Peter and Rosemary Grant of Princeton Uni have been spending several months on the tiny volcanic cinder cone island in the Galapagos.

The finches of Daphne Major

2 dominant ground finch species.

The Grants have monitored them every year, tagging them, making physiological measurements, taking samples for genetic sequencing...





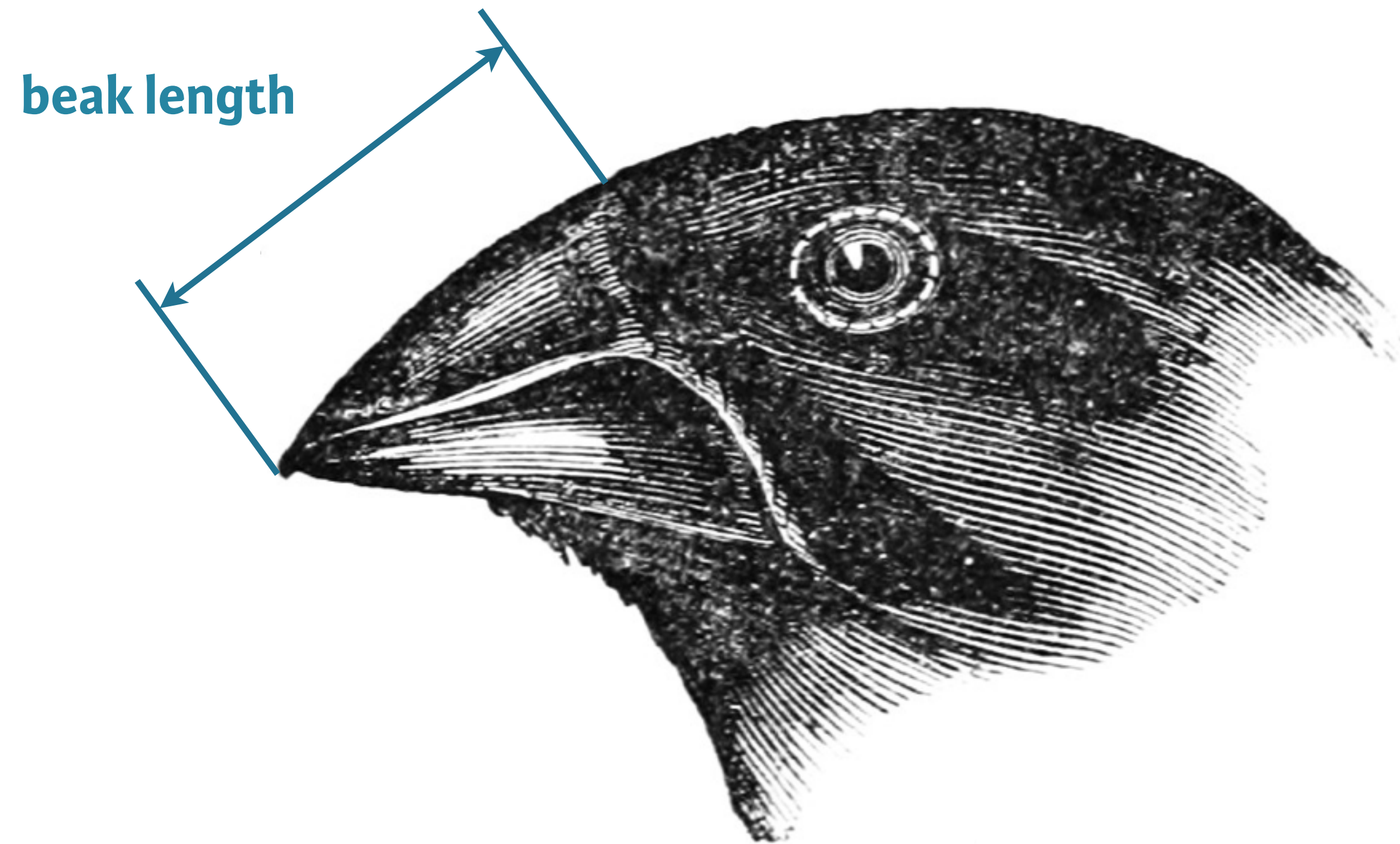
Our data source

- Peter and Rosemary Grant
40 Years of Evolution: Darwin's Finches on Daphne Major Island
Princeton University Press, 2014
- Data acquired from Dryad Digital Repository (all of their data)
<http://dx.doi.org/10.5061/dryad.g6g3h>

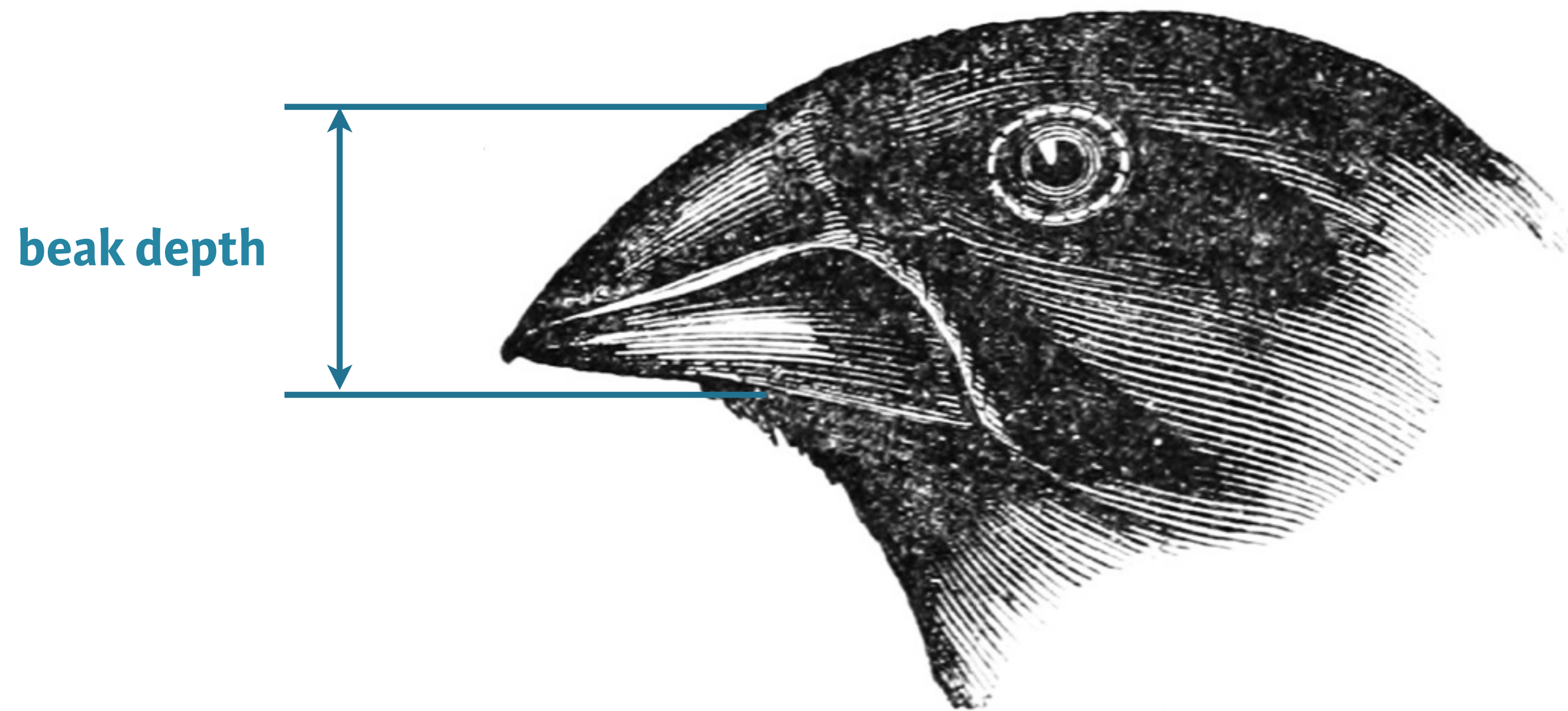


The dimensions of the finch beak

Work with the Grant's measurements of the beak length and beak depth.



The dimensions of the finch beak



consider different aspects of the beak geometry, including how it varies over time, from species to species, and from parents to offspring.



Investigation of *G. scandens* beak depth

- EDA of beak depths in 1975 and 2012
 - Parameter estimates of mean beak depth
 - Hypothesis test: did the beaks get deeper?
1. investigate how the beak depth of *G. Scandens* has changed over time.
- start with EDA
 - perform parameter estimation, with confidence interval, of mean beak depth for those respective years.
 - finally, do a hypo test investigating if the mean depth has changed from 1975 to 2012.



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Let's do it!

determined that the beak depth of *G. scandens* changed over the course of 37 years.
there are a few hypothesis as to why this is the case.

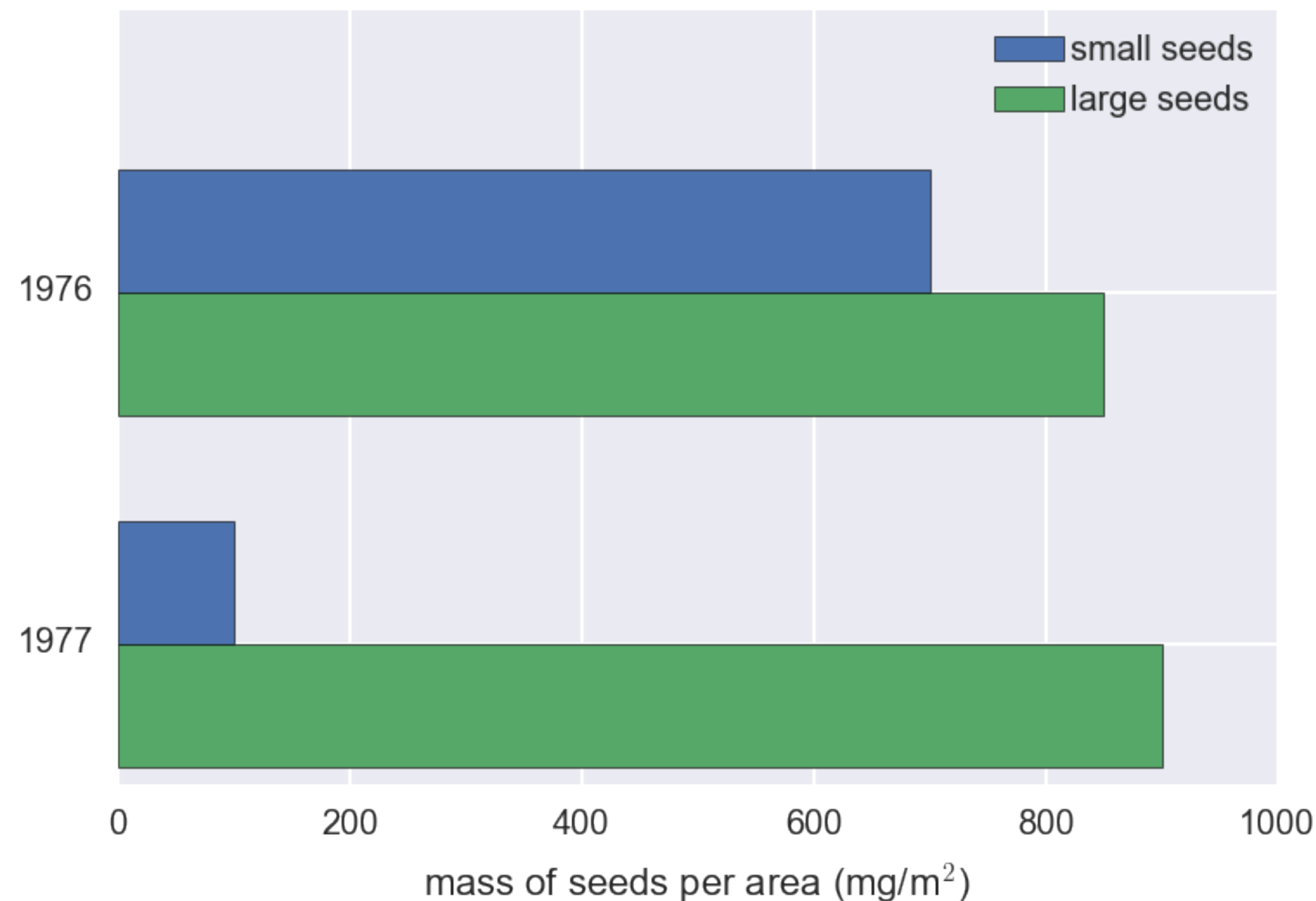


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Variation in beak shapes



The drought of winter 1976/1977



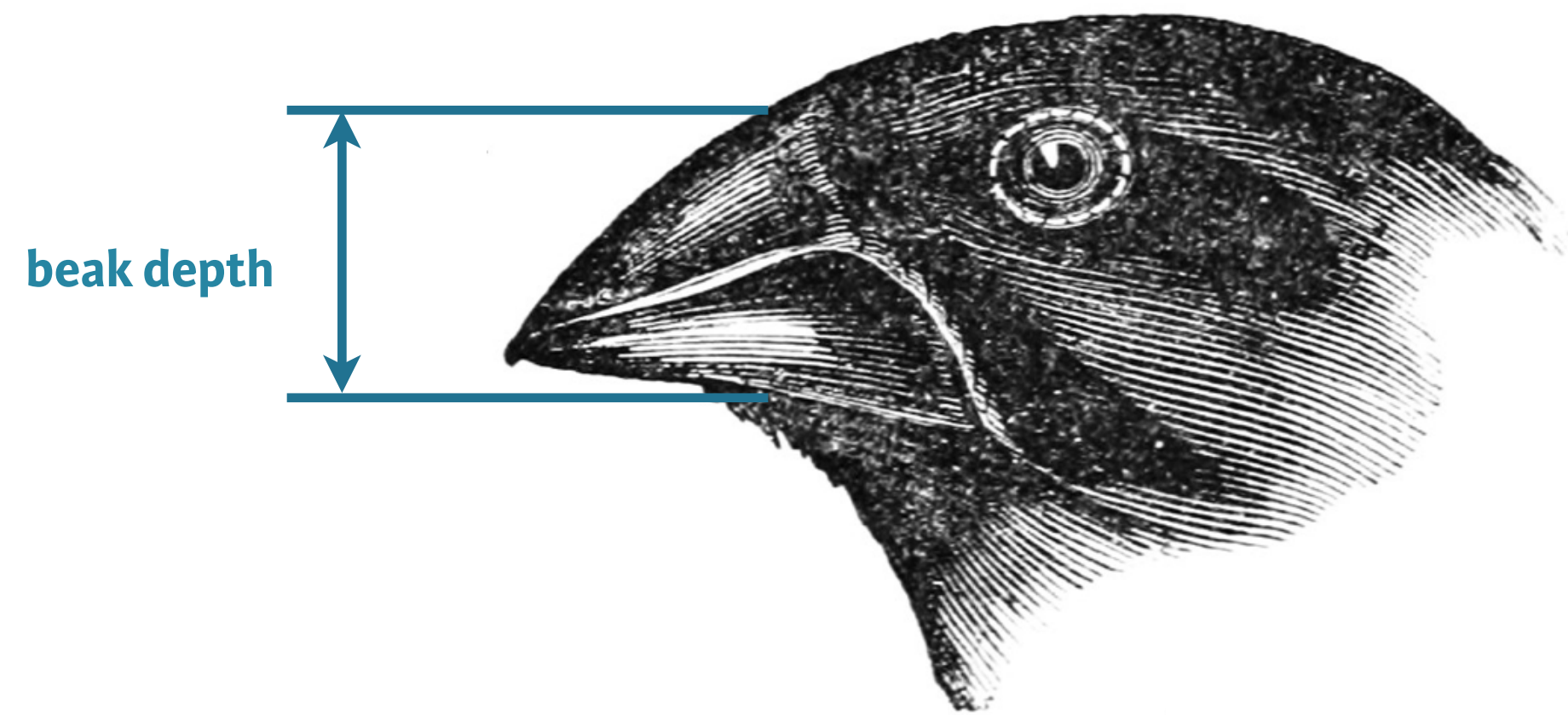
one reason may be a drought in 1976/77 that resulted in the death of the plants that produce small seeds on the island.

The larger seeds required deeper beaks to crack them, so larger-beaked birds survived and then reproduced.

if this is the case, it stands to reason that the length of the beak might also change over time.

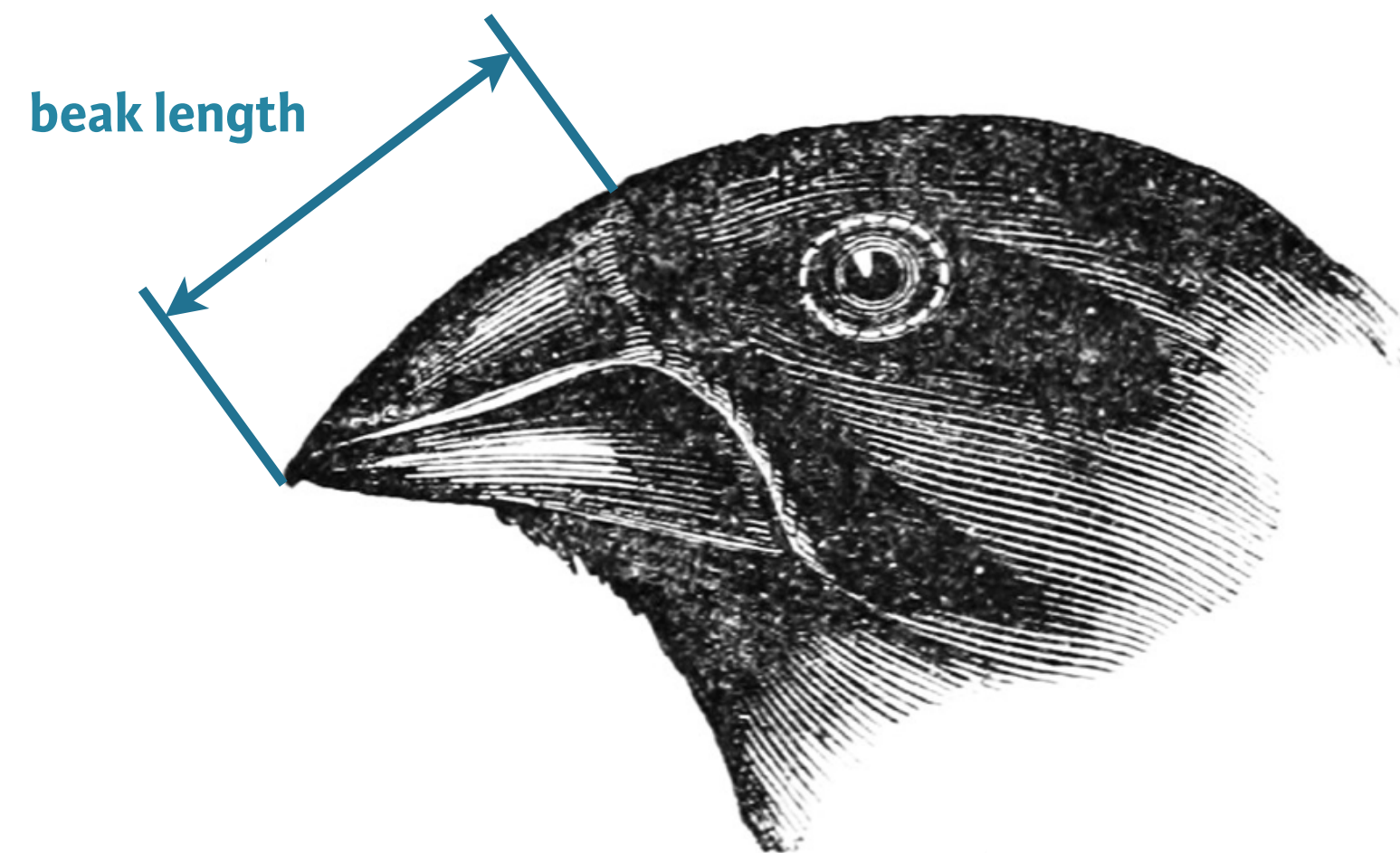
importantly, if the length and depth change at the same rate, the beak has the same shape; it just gets bigger.

Beak geometry



but if the beak length and beak depth change differently, the shape of the beak changes.

--> investigate how beak length and depth change together. (linear regression)



Hint

- `draw_bs_pairs_linreg()` will come in handy
in computing confidence intervals this of linear regression parameters



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Calculation of heredity

what is causing the beaks of *G. Scandens* to get bigger over time?

- the selective pressure brought on by the drought

But why do some birds have such large beaks to begin with?

a prevailing explanation is that *scandens* birds are mating the other major finch species on Daphne Major, *G. fortis*.

The finches of Daphne Major

these hybrid birds then mate with pure scandens, (introgressive hybridization, which can bring fortis characteristics into the scandens species.

In order assess the viability of this explanation:

--> know how strongly parental traits are passed on to offspring



Heredity

- The tendency for parental traits to be inherited by offspring

---> investigate the extent to which parental beak depth is inherited by offspring in both *scandens* and *fortis*.



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Final thoughts

Your statistical thinking skills

- Perform EDA
 - Generate effective plots like ECDFs
 - Compute summary statistics
- Estimate parameters
 - By optimization, including linear regression
 - Determine confidence intervals
- Formulate and test hypotheses



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Bon voyage!