

POPULATION GENETICS PROBLEM #4

Salamanders in the genus *Batrachoseps* show a gradient in the number of trunk vertebrae along a gradient from coastal to inland California. Elizabeth Jockusch [1] raised families from 10 populations of four species within the genus to determine whether the difference could be accounted for by differences in developmental temperature. The data provided in the file `attenuatus.txt` at <http://darwin.eeb.uconn.edu/eeb348/supplements-2004/attenuatus.txt> is a portion of the data she used in her study.

The data is arranged in columns, and the heading of each column corresponds to the variable name.¹ Each row of the data set corresponds to information about one individual. `dam[]` is a variable identifying the mother of the individual, `trunkv[]` the number of trunk vertebrae, `temp[]` the developmental temperature, and `age[]` the age of the individual when measured.²

In analyzing these data, we're going to assume that all of the offspring are half sibs, even though we don't have any direct evidence that this assumption is true. Using these data answer the following questions:

1. What is the value of the phenotypic variance in number of trunk vertebrae, V_p , in this population?
2. What is the value of the additive genetic variance in number of trunk vertebrae, V_a , in this population?
3. What is the heritability of number of trunk vertebrae in this population?
4. Is there evidence that developmental temperature influences the number of trunk vertebrae in this population?
5. Is there evidence that the number of trunk vertebrae depends on the age at which an individual is measured?

¹The `[]` after each name is the usual WinBUGS convention for a vector.

²The last two columns are actually standardized data, i.e., the score for each individual was calculated from the raw data by subtracting the mean for that trait and dividing by the standard deviation.

6. **Warning: This one's hard.** Your analysis assumed that all offspring were half-sibs, i.e., that they all had different fathers. Would your estimates of V_a and h_N^2 be larger, smaller, or unchanged if some of the offspring were full sibs? Why?

Hints

- Since this is a half-sib analysis, you can leave out the stuff in the example involving sires. Your model will involve only a dam effect and a variance within sibships.
- Include developmental temperature and age as covariates in your analysis. To do this, express the expected number of trunk vertebrae in each individual as

```
mu[i] <- nu + beta[dam[i]] + gamma*temp[i] + delta*age[i]
```

`gamma` and `delta` are coefficients that tell you how the expected number of trunk vertebrae depend on developmental temperature and age at measurement, respectively. For example, if `gamma` > 0, then an increase in developmental temperature is associated with an increase in the expected number of trunk vertebrae.

- Use the following priors for your analysis.

```
# priors
nu ~ dnorm(0.0, 0.001)
gamma ~ dnorm(0.0, 0.001)
delta ~ dnorm(0.0, 0.001)
tau.within ~ dgamma(1, 0.25)
k <- 3*tau.within
tau.dam ~ dgamma(1, 0.25)I(k,)
```

References

- [1] E. L. Jockusch. Geographic variation and phenotypic plasticity of number of trunk vertebrae in slender salamanders, *Batrachoseps* (Caudata: Plethodontidae). *Evolution*, 51:1966–1982, 1997.