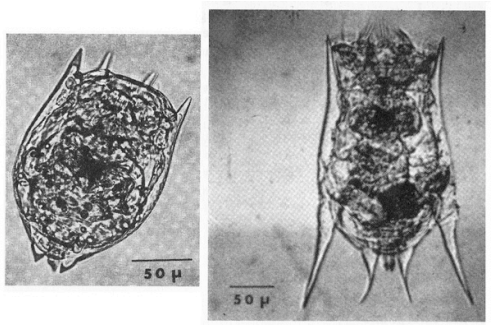
Variance

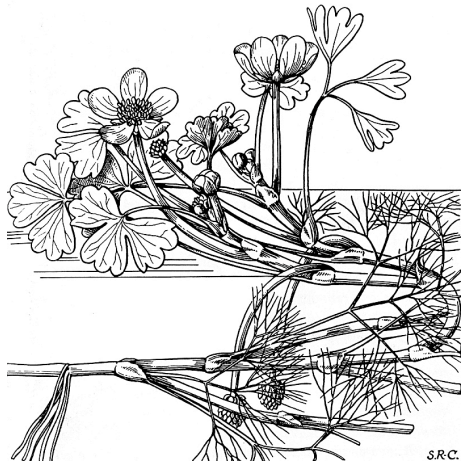
- Yet another complication in studying variance is that some variance might result from environment-gene interactions (e.g. genes "turning on" only because of some environmental cue)
- $V_P = V_G + V_E + V_{GxE}$
- One example of this is the phenomenon of *reaction norms*.

Reaction Norms

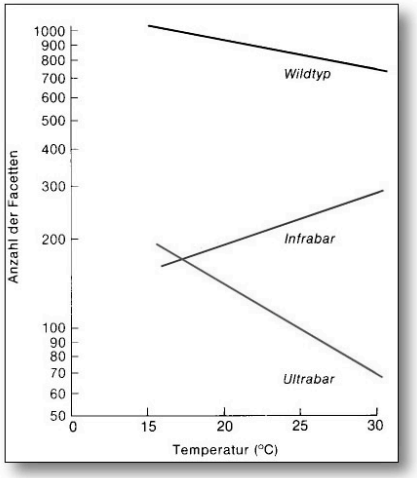
- A genotype often doesn't specify exactly what the phenotype will be.
- The genotype often determines a range of phenotypes that an organism will have under different environments.
- The fact that phenotypes vary with environment is known as *phenotypic plasticity*.
- The specific relationship between phenotype and environment, given a certain genotype, is called a *reaction norm*.

The rotifer *Brachionus calycoflorus* develops spines when predators are present in its environment (right), but not in their absence (left). This is *phenotypic plasticity*.



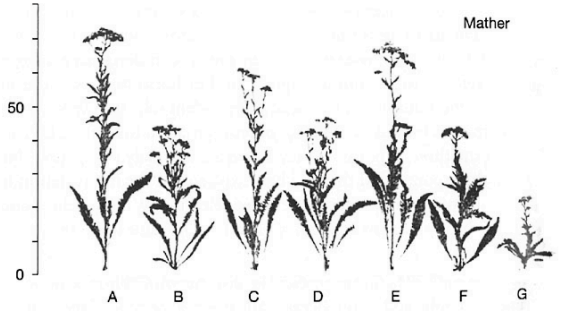


Water crowfoot, *Ranunculus aquatilis*, grows broad leaves that float on the surface of the water, and branching filamentous leaves below the surface of water—another example of phenotypic plasticity (Lamarck mentioned this).



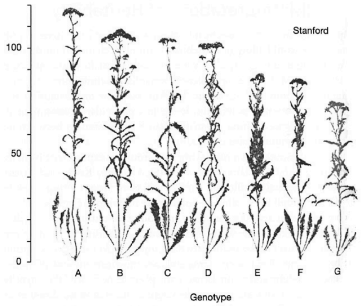
Two different fruit fly mutant alleles, called *infrabar* and *ultrabar*, both produce a phenotype with unusually small eyes (the y-axis shows "number of facets" in the eye)—but they differ in their reaction norms

Clausen et al. (1948) grew cuttings from seven wild yarrow plants (*Achillea*) in the same garden at Mather, California. Here's what they got. . .

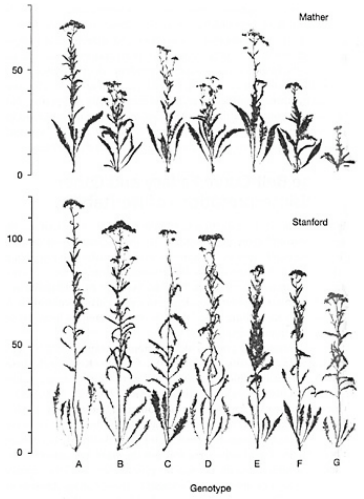


They all grew in the same environment, so differences in height must be genetic.

When they grew cuttings from the *same* seven wild plants in a different garden at Stanford, California, they got this. . .



Again, they all grew in the same environment, so the differences in height must be genetic. . .



Here's the two compared directly. Remember that the Mather and Stanford plants are genetically identical—both grew from cuttings from the seven original wild plants. What's different about them is their *norms of reaction*.

Human Behavioral Reaction Norms—Case Study

- Caspi et al. (2002) studied several hundred human males. . .
  - There's a brain enzyme called monoamine oxidase A, or MAOA, that breaks down neurotransmitters
  - Differences in the promoter sequences of MAOA mean that some men have low MAOA activity, and some have high activity—and this is genetically controlled.
- Caspi et al. also recorded whether the men had been abused in childhood. . .
- . . . and they scored them for antisocial behavior (which you can measure using psychological tests).

Caspi et al. (2002) found that men with low vs. high MAOA activity have different reaction norms. . .