HANDOUT I.2: Sex linkage and Hardy-Weinberg

Let's consider a diploid population with *X*-*Y* sex determination (females are *XX* ; males are *XY*). We want to study evolution of a locus with two alleles on the *X*-chromosome (with no counterpart on the *Y*-chromosome).

Some notation:

$p_f(t)$ = frequency of the *A* allele among *X* gametes in females in generation *t*;

$p_m(t)$ = frequency of the *A* allele among *X* gametes in males in generation *t*.

Under the H-W assumptions, the following offspring genotype frequencies are found:

Daughters

AA: $P_{AA}(t+1) = p_f(t)\, p_m(t)$

Aa: $P_{Aa}(t+1) = p_f(t)[1 - p_m(t)] + p_m(t)[1 - p_f(t)]$

aa: $P_{AA}(t+1) = [1 - p_f(t)][1 - p_m(t)]$

Sons

AY: $P_{AY}(t+1) = p_f(t)$

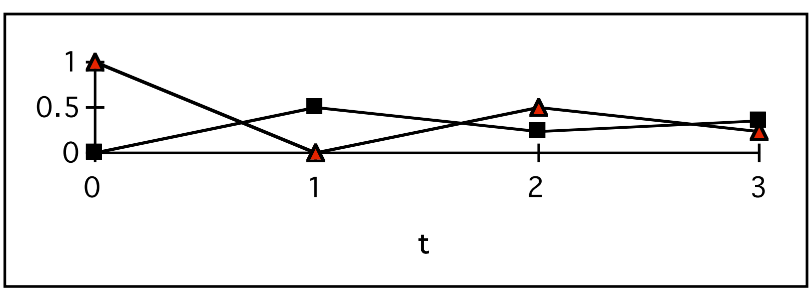
aY: $P_{aY}(t+1) = 1 - p_f(t)$

Allele frequencies among the offspring (computed from these genotype frequencies) are:

- $p_f(t+1) = \frac{1}{2}\,[p_f(t) + p_m(t)]$ (*average* of allele frequencies in both parent sexes)
- $p_m(t+1) = p_f(t)$ (the allele frequency among just the *female* parents)

Evolutionary Dynamics: Suppose we have the extreme case $p_m(0) = 1,\ p_f(0) = 0$:

t	0	1	2	3
$p_m(t)$	1	0	0.5	0.25
$p_f(t)$	0	0.5	0.25	0.375



Unlike cases we've seen up until now, the evolutionary paths oscillate towards an equilibrium. What equilibrium is eventually reached? It turns out that the frequency of the *A* allele becomes $p_{\text{eq}} = \tfrac{1}{3} p_m(0) + \tfrac{2}{3} p_f(0)$ in both sexes. In the above case, $p_{\text{eq}} = \tfrac{1}{3}(1) + \tfrac{2}{3}(0) = \tfrac{1}{3}$.