measure of the total departure from HW

Example 9.2 The Wahlund effect in a lake

1

Problem Set #2
due 2/22/23

① What is the probability that a particular allele has at least 1 copy in the next gen?

Hint: Use one minus the prob. that the allele has no copies in the next gen & this eqn:

$$\lim_{\varepsilon \to \infty} (1 + \varepsilon * x)^{\frac{1}{\varepsilon}} = e^x$$

referenced p. 117 in text

one minus probability that the allele has no copies → $(1 - \frac{1}{2N})^t$

↓ w/ infinite population size prob. that allele has no copies?

e

$$\lim_{\varepsilon \to \infty} (1 + \varepsilon * x)^{\frac{1}{\varepsilon}} = e^x$$

really need some direction on this one...

$\boxed{1 - e}$ is probability that 1 copy makes it to next gen?

A_1 A_1A_1 A_1A_2 A_2A_2 $p(A_1)$ $q(A_2)$

Problem Set #2

② 1 gen / yr

estimates of pop size in table.

Estimate the avg. effective number (N_e) of moths over the 12 yr period given the estimates of pop. sizes

$$N_e = \frac{t}{\Sigma\left(\frac{1}{N_i}\right)}$$

$t = 12$ generations
N_i from table

$$N_e = \frac{12}{\left(\frac{1}{4100} + \frac{1}{2250} + \frac{1}{6000} + \frac{1}{8000} + \frac{1}{11000} + \frac{1}{2000} + \frac{1}{11000} + \frac{1}{16000} + \frac{1}{15000} + \frac{1}{7000} + \frac{1}{2500} + \frac{1}{1400}\right)}$$

$N_e = 3936.8 \Rightarrow$ **3937**

ref. p. 139 in text (eqn 7.9)

③ 200 cows ♀ 2 bulls ♂

What is the effective pop size (N_e)?

ref. equation 7.2 (p. 136)

$$N_e = \frac{4N_f N_m}{N_f + N_m}$$

$$N_e = \frac{4(200 * 2)}{200 + 2} = \frac{4(400)}{202} = \frac{1600}{202} = 7.92$$

$N_e = 7.92$

⑤

Location	N	A_1A_1	A_1A_2	A_2A_2	$p(A_1)$	$q(A_2)$
Germany	120	6	33	81	0.1875	0.8125

④ 5 populations

Q: What is "that year"?

plants
2
3
25
32
86

assume $N_e = N_c$ in "that year" & estimate N_e as well as average N_c over this period

$$N_e = \frac{t}{\Sigma\left(\frac{1}{N_i}\right)}$$

$$N_e = \frac{5}{\left(\frac{1}{2}+\frac{1}{3}+\frac{1}{25}+\frac{1}{32}+\frac{1}{86}\right)} = 5.4572..$$

$\boxed{N_e = 5}$

Do average N_c

$$\bar{N}_c = \frac{2+3+25+32+86}{5} = 29.6$$

$\boxed{\bar{N}_c = 30}$

What biological principle is being represented?

founder effect

$N_e : N_c = 1:6$

Loc
Ger
Aus
Ital

⑤

Location	N	A_1A_1	A_1A_2	A_2A_2	$p(A_1)$	$q(A_2)$
Germany	120	6	33	81	0.1875	0.8125
Austria	122	20	59	43	0.4057	0.5942
Italy	118	65	39	14	0.716	0.2839

Germany

$p = \frac{12+33}{240} = \frac{45}{240} = 0.1875$

$q = 1 - p = 0.8125$

Austria

$p = \frac{40+59}{244} = 0.4057$

Italy

$p = \frac{130+39}{236} = 0.716$

Do any pops have excess heterozygotes or deficit of heterozygotes?

Location	HWE expectations p^2N	$2pqN$	q^2N
Germany	4.2	36.5	79.2
Austria	20.1	58.8	43.1
Italy	60.5	47.8	9.5

Calculate F_{IS} | can we define terms?

$F_{IS} = \frac{H_S - H_I}{H_S}$ where H_S = expected heterozygosity averaged over the subpopulations

& H_I = observed heterozygosity per individual w/in the subpops.

Location	F_{IS}
Germany	0.309
Austria	-0.235
Italy	0.184

German population and Italian population have a deficit of heterozygotes. Austrian population have an excess of heterozygotes.