BIOL 121-123 2021 – Group Midterm & Individual Midterm Prep

Group Number from Canvas________________________ Max Group Members = 6

Name	**Student Number**
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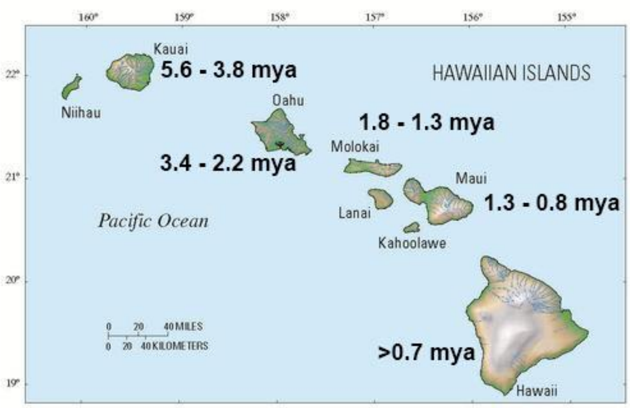
Background on Drosophila from Hawai'i

The Hawaiian archipelago is a chain of volcanic islands in the Pacific ocean. Picture-winged fruit flies are common on the islands and look similar to the fruit flies you studied in genetics. The *showy* picture-winged fly lives on the island of Hawai'i, the *drab* picture winged fly lives on the island of Maui (see map below).

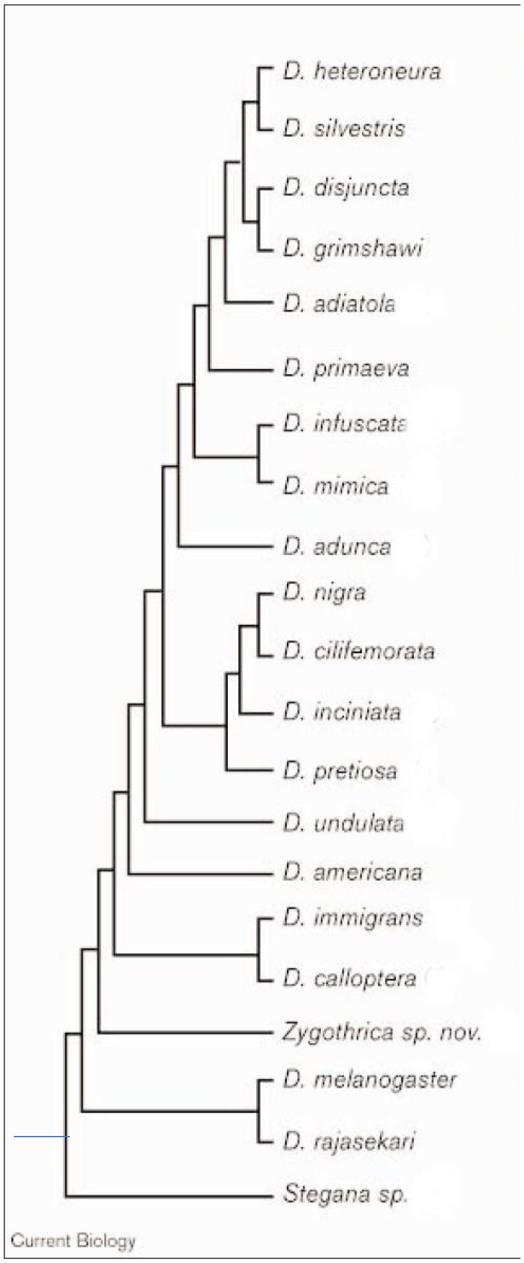
The islands of the Hawaiian archipelago are volcanic and formed at different times. The ages of the Hawaiian Islands in millions of years are as follows: Kauai, 5.6 - 3.8; Oahu, 3.4 - 2.2; Molokai, 1.8 - 1.3; Maui, 1.3 - 0.8; and Hawaii, less than 0.7 (see map below). The islands of Maui and Hawai'i are separated by 40 km of ocean. *Drosophila* generally can't fly more than a few kilometers but can occasionally be transported longer distances by storms or rafting on material floating in the water.

The *showy* fly from Hawai'i has a larger head, stalked eyes and a larger body than the *drab* fly from Maui. Hybridization can occur in the lab and hybrids have been observed in nature.



Map modified from Hawaiian Islands https://www.usgs.gov/media/images/hawaiian-islands (Public Domain)

1) The phylogeny below shows the relationship among species of Drosophila from Hawai'i.



a) What is/are the closest relative(s) of *D. pretiosa*? (**1 mark**)

There are three species equally related to *D. pretiosa: D. inciniata, D. cilifemorata and D. nigra.*
(These species are equally related to *D. pretiosa*. These species share a most recent common ancestor with *D. pretiosa*)

b) Is *Stegnata* sp. the ancestor of the *Drosophila* species that occur in Hawai'i? Briefly explain your reasoning. (**2 marks**)

No, *Stegnata* sp. is a species that is living today so can't be ancestral to the Drosophila species that occur in Hawai'i.

c) Based on the phylogeny, should the name of *Zygothrica* sp. nov. be changed to *Drosophila* sp. nov.? Briefly explain your reasoning. (**2 marks**)

Yes, *Zygothrica* sp. nov is the only species within the Drosophila clade that is not included within the genus Drosophila. For the genus Drosophila to be monophyletic, it would need to contain *Zygothrica* sp. nov. so this species would need to be renamed.. (Another way of presenting this would be that removing *Zygothrica* sp. nov. from the genus Drosophila would make the genus polyphyletic.)

d) Is *D. heteroneura* the most highly evolved species of *Drosophila* on the islands of Hawai'i? Briefly explain your reasoning. (**2 marks**)

No, all of the lineages have been evolving for the same amount of time since they shared a common ancestor. There are no "more or less-evolved" taxa.

2) Consider a situation where *showy* flies from Hawai'i have been transported to Maui due to human activities (e.g. movement of produce and people by boat from Hawai'i to Maui) resulting in the establishment of a small population of showy flies in Hawai'i.

a) You are investigating the differences between the populations of *showy* flies on Hawai'i and Maui and are looking at genetic markers that are known to be variable within the population but don't influence fitness. Fill in the table below with the missing allele frequencies and genotype frequencies. Show your calculations below the table. (**5 marks**)

	Hawai'i Population (Number of Individuals Observed)	Hawai'i Population (Observed Frequency)	Hawai'i Population (Expected Frequency)		Maui Population (Number of Individuals Observed)	Maui Population (Observed Frequency)	Maui Population (Expected Frequency)
A_1A_1	473	.335	0.335		838	0.631	0.632
A_1A_2	689	.488	0.488		433	0.326	0.326
A_2A_2	251	.177	.177		56	0.042	0.042
A1 Frequency	0.579				0.795		
A2 Frequency	0.421				0.205		

Frequency of A1 = (473 + ½ * 689)/(473+689+251) = 0.579
Frequency of A2 = (251 + ½ * 689)/(473+689+251) = 0.421

Expected Frequency A1A1 = 0.579^2 = 0.335
Expected Frequency of A1A2 = 2*0.579*0.421
Expected Frequency of A2A2 = 0.421^2 = 0.177

b) Is the population from Hawai'i in Hardy Weinberg equilibrium? Briefly explain your reasoning. (**2 marks**)

Yes, the observed and expected genotype frequencies are the same.

c) The expectation for the A1 and A2 alleles is that they are **not** under selection. Does it appear that these alleles are under selection in either the population from Hawai'i or Maui? Briefly explain your reasoning (1-2 sentences). (**2 marks**)

No, they are not under selection. The observed and expected genotype frequencies are the same so the population does not appear to be evolving so selection is not acting on this locus.

d) What evolutionary mechanism would likely be responsible for the differences in allele frequencies between the Hawai'i and Maui populations? Briefly explain your reasoning (1-2 sentences) (**2 marks**)

Genetic drift caused by a founder effect. The allele frequencies in the individuals that founded the population on Maui were not representative of the population on Hawai'i. Differences in allele frequencies are due to sampling.

e) For another genetic marker locus "B", there are three alleles (B_1,B_2,B_3)in the population from Maui there are only two alleles (B_1, B_3) in the population from Hawai'i.
    a. What is the most likely explanation for the presence of the B2 allele in the population from Maui? Briefly explain your reasoning (one sentence). (**2 marks**)

The B2 allele arose by mutation which occurred in the population from Maui and generated a new allele of the B locus.

    b. After several years you identify the B2 allele in the population from Hawai'i. What is the most likely explanation for the presence of the B2 allele in the population from ~~Maui~~ Hawai'i? Briefly explain your reasoning (one sentence). (**2 marks**)

Gene flow between populations is a likely explanation for the presence of the B2 allele in the population from Hawai'i. Mutation giving rise to identical alleles in both populations is less likely given that mutations are rare and migration between populations is known to occur.

f) Hybridization between *showy* and *drab* flies has been observed in the lab and hybrids are occasionally found in nature. Hybrids produced in the lab do not produce viable offspring when mated with other hybrids, *showy* flies or *drab* flies. Would the showy and drab flies be considered separate biological species? Briefly explain your reasoning. (**2 marks**)

Yes, although mating can occur the offspring are sterile (unable to reproduce) so gene flow does not occur between the populations so they can be considered separate biological species.

g) In nature, mating between a *showy* and *drab* individuals occurs on Maui in areas where the ranges overlap. How would mating between showy and *drab* individuals affect the fitness of these individuals? Briefly explain your reasoning. (**2 marks)**

This would lower the fitness of both individuals since the offspring of the mating are sterile, they are producing offspring that can't go on to reproduce.

h) There is heritable variation in *showy* males for the size of wing spots. Spots range from large to small. *Drab* males only have small spots. In mating tests in the lab, you determine that there is heritable variation in *showy* females for mate preference. Some females preferentially mate with males that have large wing spots; other females prefer males with small spots. In regions of Hawai'i where both *showy* and *drab* flies occur, would you expect the frequency of large spot males to change? Explain your reasoning. (**5 marks**)

If a *Showy* female mates with a *Drab* her fitness is reduced because offspring of that mating would be sterile. Showy females that choose males with small spots have the potential to mate with *Drab* males in areas where the ranges overlap. It would be expected that any trait that resulted in an increase in the frequency of a showy female mating with a showy male would increase fitness and experience selection Since both the variation in spots and the preference for larger spots is heritable, selection can act on both traits to increase their frequency. The trait of preference for large spots in Showy females would be expected to increase in frequency.