Both of these problems have fictional specific details, though they are based on real biological phenomena. They are both quite tricky! Drawing diagrams can help.

1. A crocodile species normally has temperature-dependent sex determination. There are no sex chromosomes. If the temperature at which the eggs incubate is relatively cool, offspring will be mostly male; if it is relatively warm, they will be mostly female.

   A temperature-switch gene Tmp has two alleles. Tmp+ allows temperature to affect sex. Under current climate conditions a population which is all Tmp+ will be 80% females and 20% males. Tmp- causes all offspring to be male. Tmp- is dominant to Tmp+.

   We begin a population with 800 Tmp+/Tmp+ females, 200 Tmp+/Tmp+ males, and 200 Tmp+/Tmp- males.

   (a) We can't find any Tmp-/Tmp- males to breed from. Why?

   (b) After one generation, what will be the proportions of males and females? (Hint: draw a Punnett Square with male parents on one side and females on the other, because they do not have the same allele frequencies.)

   (c) After one generation, what are the allele frequencies of Tmp+ and Tmp- in males? In females?

   (d) After a long time, what will be the proportions of males and females, assuming the climate remains the same? (This can be answered on general principles.)

   (e) At the point where the sex ratio is 50/50, what is the frequency of Tmp-?

2. Male elephant seals compete for females. Winners accumulate harems of around 40 females. Assume that losers do not mate at all. (In fact, some sneaky mating probably goes on; this has been found in almost every harem-keeping species in which paternity testing has been done.)

   This raises an obvious evolutionary question: why is the sex ratio still close to 50/50? We know that mammals can evolve unequal sex ratios, so why don't elephant seals do that? It seems strange for a female to give birth to many sons who will mostly never reproduce, when she could instead have daughters who will definitely reproduce.

   Assuming we currently have equal proportions of males and females:

   (a) How many surviving offspring will the average male have in the next generation, assuming the population size is constant? (Note that this average must include both successful and unsuccessful males.)

   (b) How many offspring will the average female have?

   (c) Suppose that the sex ratio shifts so that 90% of births are now females. How many offspring will the average male have now? The average female?

   (d) It's been argued that a genetic variant leading to more female offspring should spread in this population, as the excess males are "wasted." Based on your answers so far, critique this argument. (In other words, if a genetic variant which could make more females did occur, why wouldn't it become common?)