



Lesson 6: How Many Grandchildren?

Key Concepts:

- Survival is usually low in organisms that produce large numbers of offspring, and high in those that produce fewer offspring.
- If all monarchs survive, the world would soon be overrun by monarchs because of the large number of offspring that they produce.

Skills:

- Reasoning
- Math (multiplication of large numbers)

Materials:

- Calculator, if desired

Objective

Students will calculate the number of progeny that one female monarch butterfly could produce in one year (4 generations).

Background

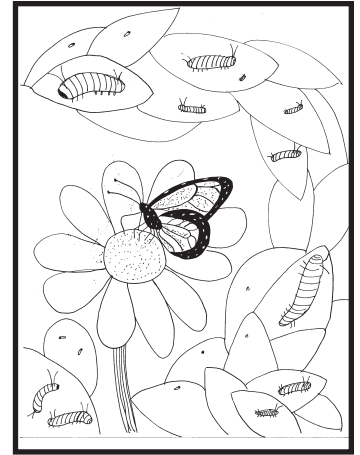
Monarchs, like most insects, produce many small offspring, few of which are likely to survive to adulthood. Monarch parental care occurs when females lay their eggs; they only choose milkweed plants, preferring plants in good condition.

However, when the larvae hatch, they are on their own. In this exercise, children will determine how many grandprogeny a single female could produce, *if all of her offspring survived*.

When biologists study how populations grow, they only count the offspring from females. If they counted offspring from both sexes, their counts would be twice as large as they should be. For example, if a human family has two children, it would not be accurate to say that because the male has two children and the female has two children, there are four children. Thus, we will only count the offspring that the female's daughters (and their daughters) have.

Procedure

1. Discuss the fact that female monarchs lay an average of 700 eggs during their lifespan, while humans and elephants have few offspring. The purpose of this is to compare the number of offspring females of different species produce. Students may say that monarchs produce so many offspring because many of them won't survive. However, they can produce so many because each offspring is very small, and receives no parental care.
2. Each egg weighs only about 0.45 mg, while a female weighs about 500 mg. Each egg is 0.09% of the female's weight. This would be like a human female who weighs 130 pounds having a baby that weighs about one tenth of a pound (or less than 2 ounces)! If a human female had 2 ounce babies and didn't provide care for them, she could produce more babies, yet many would not survive. This illustrates two different strategies: *Have many small offspring that don't receive parental care, or fewer bigger ones that receive parental care.*



3. Optional: Students that understand ratios can do the calculations themselves:

$$\frac{0.45 \text{ mg}}{500 \text{ mg}} = \frac{x \text{ lb}}{130 \text{ lb}}$$

$$x = \frac{(130 \text{ lb})(0.45 \text{ mg})}{500 \text{ mg}} = 0.117 \text{ lb}$$

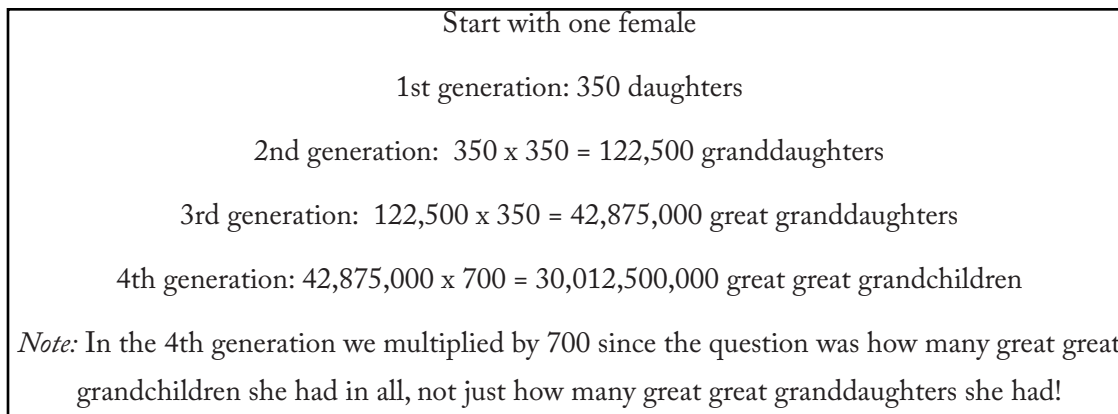


4. Have students calculate how many grandchildren (from her daughters) that one female could produce, if none of her progeny died and if half of her offspring were females. Younger students will have to be stepped through this calculation, but older students should be able to figure it out.

Answer: One female lays 700 eggs. On average, half of these eggs are females, so she has 350 daughters. If each of these daughters lays 700 eggs, the original females will have $350 \times 700 = 245,000$ grandchildren.

5. Optional: Tell students that monarchs can have up to four generations in the summer. Have them figure out how many great great grandchildren the female would have, remembering that only half of each generation will be females laying eggs.

Answer: One female has 350 daughters. Each daughter produces 350 granddaughters, who each produce 350 great granddaughters, who each have 700 total offspring; $350 \times 350 \times 350 \times 700 = 30,012,500,000$ great great grandchildren. This is more than the total number of butterflies that overwinter in Mexico each year. Clearly, all of these monarchs do not survive, and in later lessons we will address the issue of what happens to most of them. It's helpful to illustrate with a diagram:



6. This lesson illustrates exponential growth, which is very fast. Compare the number of offspring after two generations to that after four generations. You may want to make a graph using these numbers, but it is difficult to do this when the numbers are so large.
7. If desired, use these calculations to discuss human population growth (which can also be exponential). Furthermore, discuss how environmental factors like space, food, water and disease could limit such fast growth. Try the calculation using two children in each generation, and then do it with four children. Compare the number of great great grandchildren.