Impact Of Colour On The Predation Of Worms – Model Of Directional Selection

What is the influence of phenotype (colour) on the predation of worms by chickens?

ABSTRACT

From the beginning of the earth to the end of the universe, natural selection will remain relevant. The experiment aimed to model natural selection in order to further prove and explain this phenomenon. In particular this report explores directional selection where the phenotype of flora or fauna changes/adapts, after certain interactions, to suit their environment. The experiment focuses on the impact phenotype (colour) has on minimising predation, therefore enabling a population to survive and expand. Bucatini pasta was utilised to model worms, separated into 5 groups, each a different colour (blue, red, yellow, green and plain). The five phenotypes were placed amongst chickens in an enclosed space to track the most preyed upon colours in a two minute time frame. After four repetitions, the ‘worms’, coloured green and blue were shown to be least attractive to the chickens, becoming superior by far outnumbering the other colours in population size. In contrast, the plain (no dye), red and yellow coloured pasta were preyed on most, diminishing in numbers during the experimental period. It is speculated that these results occurred due to the phenotypical similarities or differences the coloured ‘worms’ had with a typical chicken diet. Therefore the experiment models directional and natural selection as the phenotype of the ‘worms’ significantly influenced their chance of survival. Some populations (such as the green and blue ‘worms’) were able to thrive due to their phenotypical traits and subsequent selective advantage, while others (such as the red, yellow and plain ‘worms’) declined in population due to their phenotype. This experiment fulfils its aim whilst also offering a multitude of possibilities and questions for future experimentation and research.

INTRODUCTION

The purpose of this research is to explore natural selection, and more specifically, directional selection, and its impact on both past and present flora and fauna. Natural selection can be defined as a “process that results in the adaptation of an organism to its environment by means of selectively reproducing changes in its genotype, or genetic constitution.” (The Editors of Encyclopaedia Britannica, 2018)

Through time, natural selection has occurred so species may increase their chances of survival. This idea was first introduced to be explained by naturalist and biologist, Charles Darwin, through his extensive research and findings. As the pioneer of many evolutionary theories, Charles Darwin is a focal and highly significant individual when considering modern day natural selection. He was born in 1809 in England, spending his life travelling the world as a geologist/biologist and naturalist. Following many years of exploration, Darwin’s theories of natural selection and evolution were published in his book ‘On the Origin of Species’ (1859). Within this, he documented much of the worlds diversity of flora and fauna.

An example of the fauna which Darwin discovered and documented was the peppered moth. Over time, the phenotype of this insect changed from a light colour (with dark spots) to a darker colour. This occurred in response to the pollution from industrialisation in Britain during the 19th century. With trees dusted with a blackened powder, the moths adapted, camouflaging themselves to avoid predation by birds. This adaption is within the category of directional selection, one of three types of natural selection Darwin outlines.

Directional selection, the focus of the experiment occurs as a result of changes in conditions for species. This in turn affects the phenotype of animals and plants. Directional selection is more observable in animals, however most plant adaption fits within the subcategory of ‘stabilizing selection’, due to their less extreme adjustments and adaptations. In relation to animal directional selection, a major selection pressure is food availability. This may force animals to adapt, or simply allow for the survival of the fittest, with those most able to search, find and consume, surviving and reproducing.

Examples of directional selection include peppered moths and tree frogs. Through time and by natural selection, treefrogs have adapted by changing their colour to grey or green, depending on their environment. The grey frogs have utilised their darker colour to blend into bark on trees. The green frogs, on the other hand, utilised their lighter colour to suit their green wetland surroundings. The tree frog’s ability to change their phenotype is extremely valuable in combating selection pressures, in order to survive.

The experiment of focus for this report aims to model directional selection of worms. However to effectively complete this, it is necessary to consider the diet of chickens, to ensure they prey on the worms. Regardless of the species, when exposed to all foods, there is a tendency for chickens to prey on red wriggler/earth worms. Although chickens eat the majority of foods, they are highly attracted and suited to these worms due to their high protein and nutrient density. In a contained environment, chickens may not be fed worms by humans, rather scraps or chicken food (seed mix). However, this does not remove their instinctual omnivorous nature, which is attracted to worms.

An important component of the experiment is the chosen colour of worms, as the independent variable. To ensure all bases of colour are included, the primary colours must all be covered, scientific and artistic. The four primary colours are red, green, blue and yellow and are therefore the colours chosen for the experiment.

The aim of this experiment is to model directional selection through predators differing attraction to certain colours of ‘worm’, as those ‘worms’ unattractive in colour will survive and grow in population size.

DISCUSSION

The experiment conducted models directional selection through the impact of different coloured worms in the predation of chickens. The interest of chickens in the worms was recorded after each two minute interval to determine what colour was most attractive for consumption. The experiment also illustrated the changing population sizes of each colour after each repetition, representing natural selection. There were four colours selected to be tested: yellow, red, green and blue along with a control with no dye as an additional ‘colour’. The experiment was repeated twice (on two separate days) having similar trends:

Red was the most attractive colour, always eaten and having a tendency to be eaten in the shortest time. Blue was the least attractive colour, not touched in either trial. This was closely followed by green, which was rarely eaten. Therefore there was a clear trend of an increase in the population of blue and green worms and a decrease in the population of red, yellow and non-dyed worms. Due to this, the divide in population between colours grew to a point where the blue and green worms far outweighed the worms of a red, yellow or no dye.

It was observed as a pattern that in each repetition (replenishment of worms) the same colours were taken (red, no dye and yellow) with green and blue remaining untouched. This pattern of data showing the impact of phenotype on determining predation was supported by secondary evidence, making results in future trials predictable.

The worms colour had a direct relationship with the predation from the chickens, as the interest on one colour (eg. red) , prevented interest in other colours (eg. Blue). This relationship between worms colour and chance of being taken was clear due to the consistent data, demonstrating the correlation between the fall of one phenotype's population and rise of another.

Supporting and modelling the theory of natural selection, the experiment is accurate, due to the repetition which achieved very similar results. The experiment is accurate as these results are supported by secondary research, which consistently suggests that phenotype is influential on the ability to survive throughout time. In this experiment, it was noted that the blue and green 'worms' and their population were exceedingly benefited by their phenotype, which deterred predators, in all tests.

The validity of the experiment is achieved through the results which clearly support and model the theory of focus, that of natural selection. The experiment utilises materials relevant to the area of study, live chickens, in order to fairly test the hypothesis. In order to ensure the experiment is controlled, the variables such as the number/type of chickens, type of pasta/dye, time provided for feeding and mode of recording results were maintained throughout.

The experiment is moderately reliable due to the one repetition of the experiment. With two sets of similar results derived from two trials, the overall argument and ideas are solidified. As results are consistent in both tests, and averaged to derive the most accurate overall result for discussion. However, there are a multitude of factors which may act upon the experiment, which repeating once cannot solve including the conditions, temperature, season, interest from chickens etc. which may not reflect normality. These have not been considered in the testing process, as the experiment was repeated on two consecutive days, with the same conditions, not reflecting the possibility for any other elemental changes. The lack of repetition allows no margin for error, including that in the form of outliers etc. Although the experiment provides foundational knowledge on the topic, the results may not be completely trusted or relied upon due to the minimal repetition.

No error was noticed within the data collected, as all matched what was predicted and hypothesised. There were few anomalies in the experiment, including the 2 green worms taken, and the red worms taken last in one trial. These however, did not repeat, and had little impact on the overall results, remaining anomalies.

After the experiment was repeated twice, with similar results each time, an element of uncertainty arose. Although the experiment aims to model natural selection, an additional questions may also be asked, including: why was red the most consumed colour and why was blue least attractive to chickens. It can be speculated that the red ‘worms’ held the most similar colour characteristics with live worms which chickens would normally feed on. However, it is unknown why the green coloured worms in particular were not preyed upon by the chickens, due to their similarities with other chicken foods like grass. This is the main unknown of the experiment, only justified by the fact that worms are not normally green.

Possibilities for future experimentation:

- In the process of designing the experiment, colours were decided for the worms, with all primary colours covered (yellow, blue and red). In future experimentation, to broaden the research, a greater breadth of colours (all secondary colours) could be included, to solidify that red was the most attractive colour.

- The experiment could be expanded through a greater range of red/yellow shades, to find at what point the chickens best perceive the spaghetti as worms.

- In relation to the aim of the experiment, to act as a model, the experiment could be extended over a greater time period, with 2 worm replenishments completed over many repetitions to further show the divide due to a difference in predation, allowing some phenotypes to survive and thrive.

There are some limitations in this experiment around time, as the chickens were given only 2 minutes to prey on the spaghetti. It is unknown whether a different outcome would have been achieved if the plate were left for longer. Would all the ‘worms’ be eaten if left longer? Would this therefore prove different?

There were challenges associated with using live chickens, as they must be accustomed to the area for feeding process prior to the experiment, and must be relied upon heavily to derive results for discussion. This is a difficult component to control, as chickens differ in type/preferences depending on area, season, temperature and many other variables. This factor reduces the reliability of the experiment as repeating the experiment across the world would most likely show different results.

RELEVANCE

This experiment is relevant, modelling and supporting evidence on natural selection, and in particular, directional selection. Although both topics have been modelled and proven innumerable times through time since the time of Charles Darwin, experiments such as this aid the understanding of concepts such as the rise and fall of species and phenotypes and genotypes.

CONCLUSION

In conclusion, the experiment supported the initial hypothesis, modelling natural selection, as the colours not preyed upon grew in population.’, through obvious directional selection. The red, yellow and non-dyed worms saw a decrease in population over time due to the greater interest from chickens. In contrast, the blue and green ‘worms’ had little interest from predators and therefore experienced a greater population growth (400% for blue worms in each trial). Therefore the phenotype of the ‘worms’ within the experiment was proven to impact predation, and further, the chance for survival and population growth, modelling natural selection.