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Much Ado About Moths

Tommy Mitchell, Ph.D., Answers in Genesis

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Stop me if you have heard this tale before. It's about one of the sacred cows of evolution: the peppered moth. The story of this moth has been set forth for decades as *the* prime example of evolution in action. It is a fascinating story about how, due to a combination of environmental changes and selective predation, a moth turned into, well, a moth.

The peppered moth, scientifically known as *Biston betularia*, exists in two primary forms, one light colored with spots and one almost black. As the tale goes, in the mid 1800s, the lighter variety of the moth (*typica*) predominated. During the Industrial Revolution, the lichen on tree trunks died, soot got deposited on trees, and as a result trees got darker. As this change occurred, the population of darker moths (*carbonaria*) increased, presumably due to the camouflage offered by the darker trees. Bird predators could not see the dark moths against the dark bark. As the darker moth population increased, the lighter moth population decreased.[1]

This story has been touted for years as a great example of Darwinian evolution in action. Countless textbooks are lavishly illustrated with photographs of light and dark moths resting on light and dark tree trunks to teach the wonders of evolution. "It is the slam dunk of natural selection, the paradigmatic story that converts high school and college students to Darwin, the thundering left hook to the jaw of creationism."[2]

Much of the "proof" for this evolutionary change came from the work of a man named Dr. Bernard Kettlewell, a medical doctor-turned-entomologist, at Oxford University. Dr. Kettlewell had been intrigued by changes in the relative populations of the moths. In his experiments he set out to show that the changes were a result of natural selection in response to environmental change and selective predation.

The Work of Kettlewell

First of all, Kettlewell had to show that birds were indeed predators of these moths. Up to that time, many biologists did not consider birds the primary predators of Biston. Kettlewell released moths into an aviary and observed the moths being eaten as they rested. This observation settled the issue of bird predation, at least to Kettlewell's satisfaction.[3]

For the next phase of his study, Kettlewell went to a polluted woodland area near Birmingham, England. There the trees had become darkened due to pollution. In the woods, Kettlewell undertook the first of his release-recapture experiments. He released moths, 447 of the *carbonaria* variety and 137 of the *typica* variety. Traps were set to recapture the moths that night, and the numbers of each variety were assessed the next morning. A much higher percentage of darker moths than lighter moths were recovered. Kettlewell recaptured 27.5% of the *carbonaria*, but only 13.0% of the *typica*. From this data, Kettlewell concluded that "birds act as selective agents"[4] and subsequently felt that this represented evolution by natural selection.

To further examine this, Kettlewell then undertook another release-recapture experiment. This was done in a wooded area near Dorset, England. Here the trees had not been darkened by pollution. As before, both light and dark moths were released and then recaptured and counted. Here 12.5% of the *typica* were recaptured but only 6.3% of the *carbonaria*. Kettlewell anticipated this result because he hypothesized that birds would more easily prey upon the darker moths than the lighter moths due to the lighter color of the trees.

Adding credence to Kettlewell's theory, others noted that, as pollution decreased, the population of lighter moths increased in some areas. In the late 1950s, pollution control laws were enacted and air quality improved. In some places, as the lichen returned to the trees, the expected increase in the population of the *typica* variety of moth occurred.[5] Scientists believed this increase further confirmed this living example of evolution.

From this point on, there was no stopping the peppered moth bandwagon. High school and college biology textbooks heralded the peppered moth as the classic example of evolution in action. The peppered moth story has been presented to students for years as a classic case of evolution, the process by which molecules eventually turned into man.

Trouble in Paradise

Scientific claims must be confirmed through repetition, but over the years many attempts to repeat Kettlewell's studies have failed to confirm his results. These contradictory reports showed high populations of *typica* in polluted areas[6] or inordinately high numbers of *carbonaria* in lightly polluted areas.[7] Some studies failed to confirm the observation that the lighter moths increased as the lichen cover of the trees recovered. Nonetheless, the challenges failed to remove the vaunted moth from its lofty perch.

The major challenge to Kettlewell's work came in 1998 when Michael Majerus, a geneticist from Cambridge published a book entitled, *Melanism: Evolution in Action*.[8] Although many of the criticisms of Kettlewell's work had been around for years, Majerus's critique of Kettlewell's methods caused quite a stir in evolutionary circles. In a review of this book in the journal *Nature*, Dr. Jerry Coyne said this; "My own reaction resembles the dismay attending my discovery, at the age of six, that it was my father and not Santa who brought the presents on Christmas Eve."[9] He further commented; "It is also worth pondering why there has been general and unquestioned acceptance of Kettlewell's work."[10] Things were starting to look bad for our friend, *Biston betularia*. Then things got worse.

In 2002, a journalist named Judith Hooper published the book *Of Moths and Men: An Evolutionary Tale*. This book detailed the story of the research involving the peppered moth, including an exploration of the lives of the principal people involved. She described the lives and backgrounds of not only Kettlewell but also of E.B. Ford, Kettlewell's mentor at Oxford. The somewhat unflattering portraits of these men were disturbing and, in one sense, made for good reading—if by good reading one likes reveling in the shortcomings of other human beings.

However, it was Hooper's detailed examination of Kettlewell's experimental techniques, which fueled the most controversy. She thoroughly described the method used by Kettlewell in each of his field studies, along with an analysis of the data he collected. Her conclusions were shocking in that she suggests that Kettlewell, after obtaining disappointing data in the early phase of his study, manipulated his collection of data later in the study in order to obtain the desired result. The possibility of outright fraud was even mentioned. The scientific community was aghast. The first and foremost evidence for evolution in action, "the prize horse in our stable,"[11] was apparently in jeopardy.

What's the Problem?

Although there have been many concerns raised about Kettlewell's experimental techniques, the biggest issue seems to revolve around where moths rest during the day. In his study, Kettlewell released moths during the daytime and watched them take resting places on the trunks of trees. He then observed birds preying on the moths. During the night, he collected and counted the moths. He concluded that birds preyed more readily on the more visible moths than on the ones better hidden by their surroundings. The problem with this conclusion is that, over many years of study, it had been determined that these moths don't rest on tree trunks during the day! They fly only at night, and they take resting places high in the trees on the underside of branches. In these places they are much better concealed from birds than were the moths in Kettlewell's experiments. According to Howlett and Majerus; "exposed areas of tree trunks are not an important resting site for any form of *B. betularia*."[12]

This is more than an insignificant criticism. Abnormal placement of the moths into a location rendering them much more visible would bring into question the validity of Kettlewell's results. First of all, the distinction between light and dark moths would be much less on the shadowy underside of a branch. Secondly, the unnaturally high concentration of moths in an unusual area might have changed the normal feeding pattern of the birds. In fact, some researchers are not convinced that birds are the primary peppered moth predators in nature—James Carey of the University of California, for example.[13] Also, some researchers (although not Kettlewell himself) have conducted experiments by using dead moths glued to tree trunks,[14] a practice that has been criticized by some observers. Furthermore, many researchers considered the method by which Kettlewell assessed the degree of moth camouflage to be overly subjective. This bias would call into question the entire body of data.

These criticisms bring into question the entire issue of selective bird predation being the driving force behind this so-called splendid example of natural selection. Without an observable, defined environmental factor to push the peppered moth to "evolve," the famous moth could not even be a candidate to be used as evidence to support Darwin's theory.

Was Kettlewell wrong?

So was Kettlewell wrong? One major figure in this discussion has come to Kettlewell's defense, and that person is none other than Majerus, the man whose book fueled much of the recent controversy.

Over the last few year Majerus has reexamined this question. He has conducted a study that apparently

does not suffer from some of the supposed deficiencies of Kettlewell's experimental techniques. He was very careful to ensure that the moth's resting places mimicked those seen in nature, and the moths were released at night.[15] Also, using binoculars, he observed birds eating the moths. He claims that the results of his study validate Kettlewell's work. De Roode concludes, "the peppered moth should be reinstated as a textbook example of evolution in action."[16]

Good scientists must examine and reexamine the methods and techniques used to study our world. The experimental method itself relies on others conducting the same or similar types of investigations to see if previous conclusions are indeed valid. As part of this quest for knowledge, flaws in the methods used by prior investigators are sometimes uncovered. After all, no one makes a perfect plan. Shortcomings in methodology can be corrected and further data collected to ensure proper conclusions are reached. To that end, all those who have questioned Kettlewell's methods should be commended. If there were problems with his methods, and apparently there were, those problems have apparently been corrected in subsequent evaluations.

Further, those who would be too critical of Kettlewell should proceed with some caution. There has been much written in both the pro-evolution and the pro-creation camps that has been very critical of Kettlewell. Some of this seems justified, but much of it does not, particularly the accusation that he falsified his data. There can be no more serious accusation made against a scientist, so it would seem that more proof is needed before that charge be made. After all, others involved in this area have collected data which validates Kettlewell's original conclusions. No one can know another's heart, so some measure of charity needs be given here. Perhaps Kettlewell's shortcomings can best be measured by this quote from a colleague who characterized him as "the best naturalist I have ever met, and almost the worst professional scientist I have ever known."[17]

So Where Are We?

So does all this debate about the validity of Kettlewell's peppered moth data really pose a problem for creationists? The evolutionist claims that the peppered moth story is such a shining example of evolution in action that to question it is to demonstrate unwillingness to accept proven science. Majerus has said, "The peppered moth story is easy to understand because it involves things that we are familiar with: vision and predation and birds and moths and pollution and camouflage and lunch and death. That is why the anti-evolution lobby attacks the peppered moth story. They are frightened that too many will be able to understand."[18]

Exactly what is it that we should be able to understand? To the creationist, it is very, very simple. Over the last 150 years, moths have changed into moths! The creationist has no difficulty with this process. The issue of Kettlewell's shortcomings notwithstanding, the creationist has no problem with the results of his (and other subsequent researchers') work. The concept that a less visible organism would survive better than a more visible one seems obvious in the extreme. What is not to understand here? According to de Roode, "the peppered moth was and is a well understood example of evolution by natural selection."[19] The creationist would agree that this population change represents natural selection. However, this change is most certainly not molecules-to-man evolution. Natural selection and molecules-to-man evolution are not the same thing, and many are led astray by the misuse of these terms.

Natural selection can easily be seen in nature. Natural selection produces the variations within a kind of organism. Thanks to natural selection, we have the marvelous variety of creatures that we see in our world. However, in this process, fish change into (amazingly) fish, birds change into birds, dogs change into dogs, and moths change into moths. If, during the process of the study of peppered moths, the moths had changed into some other type of creature, a bird perhaps, then we might have something to talk about.

No amount of posturing by the evolutionist can change the fact that these moths are still moths and will continue to be moths. The variation seen is simply the result of sorting and resorting of the genetic material present in the original moths. At no time has there been any new information introduced into the genome of the moth (which is what molecules-to-man evolution would require). There is no evidence of the beginnings of an intermediate form between the present moth and the creature it is destined to evolve into. Moths stay moths, fish stay fish, and people stay people, regardless of the great variety seen within each.

Ultimately, the peppered moth story is more of the same. Although much of the clamor surrounding Kettlewell's work has made for good reading and, in some ways, has made for good science, the results are clear. There is nothing here, in even the smallest way, to provide evidence for the process of molecules-to-man evolution. That is what the creationist is "able to understand."

Footnotes

1. This darkening of the wings is due to the increased amount of the pigment melanin in the wings of the *carbonaria* variety and is known as "melanism".

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4. Kettlewell, Ref. 3, p. 342.
5. Wells, J., 1999. Second thoughts about peppered moths. *The True.Origin* archive. Retrieved from, http://trueorigin.org/pepmoth1.asp.
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9. Coyne, J. A., 1998. Not black and white. *Nature* **396**:35.
10. Coyne, Ref. 9, p. 36.
11. Coyne, Ref. 9, p. 35.
12. Howlett, R. J. and M. E. N. Majerus, 1987. The understanding of industrial melanism in the peppered moth (*Biston betularia*) (Lepidoptera: Geometridea). *Biological Journal of the Linnean Society* **30**:40.
13. de Roode, J., 2007. The moths of war. *New Scientist* **196**(2633):49.
14. Wells, Ref. 5, p. 7.
15. de Roode, Ref. 13, p. 48.
16. de Roode, Ref. 13, p. 49.
17. Coyne, J. A., 2002. Evolution under pressure. *Nature* **418**:19.
18. Coyne, Ref. 17, p. 49.
19. de Roode, Ref. 13, p. 49.