Analysis of the entomological accuracy of the online news article:
“Insects hold breath for days because air could kill them”

Bio3323

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Introduction

The February 2, 2005 LiveScience popular press article entitled “Insects hold breath for days because air could kill them”, written by Robert Roy Britt, presents the results of a new study which states that the reason that insects close their spiracles and keep them closed for extended periods of time is due to the fact that an overabundance of oxygen in their tracheal system could kill them.

In order to assess the entomological accuracy of this popular press news report, I consulted the scientific article upon which the report is based. This article, entitled “Insects breathe discontinuously to avoid oxygen toxicity”, by Stefan K. Hetz of Humboldt University in Berlin and Timothy J. Bradley of the University of California at Irvine, was published in the February 3 issue of the journal *Nature* (2005). I also consulted other scientific literature to verify the entomological data presented in the popular press article.

Comparing the Popular Press Article with the Scientific Evidence

While the LiveScience news article “Insects Hold Breath for Days Because Air Could Kill Them”, is very easy to read and can be easily understood by the average person, it is almost simplified to a point where it no longer resembles science. The article is limited to a very basic view of the discontinuous gas exchange cycle (a term that the author never even uses), where the author describes the new theory proposed in the scientific article in an extremely simplistic manner by stating, “The opening and closing of spiracles is controlled in a way that exhales carbon dioxide as needed without inhaling too much oxygen” (Britt, 2005). While the author did mention that the pupae of the moth *Attacus atlas* was used as the model organism in the experiment, he never mentions the method the researchers used to come to the conclusion that *A.*
*atlas* can maintain constant oxygen levels (Britt, 2005), whereas the scientific article shows that the environmental oxygen partial pressures were varied from 5-50 kPa, and the internal partial pressure of oxygen in the pupae stayed relatively stable at 4 kPa over the whole range of partial pressures (Burmester, 2005). Another issue the author of the news article neglects to discuss is which insects use the discontinuous gas exchange system. The popular press article states that only some insects do use it (Britt, 2005), but never mentions why some use it and others don’t. The scientific article states that while some insects do use discontinuous breathing, most do not; the insects that do, use it only when they are not active or not moving (Hetz and Bradley, 2005). This bizarre respiratory pattern has been seen in many adult insects and in resting butterfly and moth pupae (Burmester, 2005), which explains why the *A. atlas* pupae were used in this experiment. One huge inaccuracy in the numeric data presented by Britt in the news article, was that he reported that the tracheal system of insects “transfers air and carbon dioxide in and out more than 100 times faster than doing it through blood,” (2005); whereas the scientific article states “the diffusion of oxygen and carbon dioxide is about $10^6$ and $10^4$ times faster, respectively, in air than in water, blood or tissue” (Hetz and Bradley, 2005). Britt also states that the two other theories that existed prior to this study, that also try to explain discontinuous breathing in insects, had no supporting evidence (2005); however, some of the articles I saw while researching the third theory seemed to provide just as much evidence to support their theories as this one did. One of these articles stated, “in an insect that employs DVC (aka DGC), overall water loss rates rise several-fold in the absence of direct spiracular control. Our findings lend strong support to the water conservation hypothesis for the role of the DVC (DGC)” (Lighton et al., 1993).

The data presented in the article is, overall, scientifically accurate, but there are some pertinent pieces of information, data and explanations missing which could mislead the reader by
making the science behind this theory seem much more simplistic than it really is.

The Discontinuous Gas Exchange Cycle

Insects breathe using tubular respiratory organs called trachea, which open to the external environment using spiracular valves that control gas exchange (Hetz and Bradley, 2005). Many insects breathe in a discontinuous pattern called the discontinuous gas exchange cycle or DGC, where insects have rhythmic patterns of spiracular control; this cycle underlies the major theory proposed by Bradley and Hetz (2005). This cycle begins with the spiracle closed, allowing for very little gas exchange with the surrounding environment (Lighton, 1996). During this closed phase, the partial pressure of oxygen in the trachea decreases and the partial pressure of carbon dioxide increases (Hetz and Bradley, 2005). The next phase is called the fluttering-spiracle phase where carbon dioxide release occurs only during brief intervals of spiracular opening (Lighton, 1996). This phase allows a large inflow of oxygen down the pressure gradient, and a small release of carbon dioxide out of the insect (Hetz and Bradley, 2005). The carbon dioxide inside the insect continues to increase until the partial pressure reaches about 4-6 kPa, causing the third and final phase called the open phase, where the spiracles remain completely open (Lighton, 1996). During this phase, carbon dioxide escapes, and the partial pressures of both carbon dioxide and oxygen move toward the level present in the external environment as the gases diffuse down their concentration gradients (Hetz and Bradley, 2005). It seems as if the flutter phase is activated by a very low partial pressure of oxygen, and the open phase is activated by a very high partial pressure of carbon dioxide (Hetz and Bradley, 2005).
**Previous Theories of Discontinuous Breathing and the New Theory**

Prior to the new research presented in this news article, there have been two other conflicting theories proposed to explain discontinuous breathing in insects. One of the hypotheses that is used to describe this discontinuous gas-exchange cycle (DGC) is that insects close their spiracles for extended periods in order to reduce water loss (Burmester, 2005). One example mentioned by Hetz and Bradley to disprove this theory is how the grasshopper, when in very hot and dry conditions, does not show discontinuous breathing, but shows it at night when respiratory water loss has already been minimized (Hetz and Bradley, 2005). The second hypothesis that has been suggested is that the DGC developed in order to allow insects to release carbon dioxide, a product of respiration, when the insects are underground (Burmester, 2005). Even though many insects that show DGC do spend large amounts of their life cycles underground, in hypoxic (oxygen poor) environments, there are many insects such as grasshoppers that have no connection to underground living, and still use DGC (Hetz and Bradley, 2005). The new theory put forth by Hetz and Bradley suggests that insects limit their intake of oxygen by using the DGC, because when the spiracles are left open, oxygen diffuses in faster than carbon dioxide diffuse out due to the partial pressures of these gases (2005). Even though oxygen is needed for respiration, it also creates toxic compounds called reactive oxygen species (ROS), which can damage protein, DNA, and lipids (Burmester, 2005). Therefore, when the need for carbon dioxide release has been met, the spiracles are closed to avoid high levels of oxygen, thus avoiding cell damage and eventually death. (Hetz and Bradley, 2005) The different stages of the DGC are used to replenish or diminish the amounts of oxygen and carbon dioxide in the insect as needed.
Suggestions for Improving the Popular Press Article

Obviously, one of the most important improvements that can be made in the popular press article is to correct any inaccuracies between the news article and the scientific evidence presented in the article published in Nature. With the exception of a few mistakes in reporting the data from the scientific study by Hetz and Bradley, as a popular story this article serves it’s purpose fairly well, since it is easy to understand. However, it is missing a lot of information necessary to completely understand the science used to develop the theory. A more thorough and detailed account could have drastically improved this article, and with the correct wording could have been understood by the general public. Some things that could have been better explained are the conflicting theories of the function of the DGC, as well as the experimental procedure and methods used to obtain the data. Perhaps including some sort of application that people who aren’t familiar with science could appreciate, would be helpful in drawing more attention to the subject, such as pointing out the fact that further knowledge about insect respiration patterns could tell us the best time to use pesticides to control insects, which is crucial for the agricultural industry (UCI, 2005).

The popular press author, Robert Roy Britt, did however base his article on information from accredited researchers. Timothy J. Bradley is a professor of Ecology and Evolutionary Biology at the University of California. Bradley obtained his B.A. in biology at Vanderbilt University in 1971, his M.Sc. in Zoology at the University of Oklahoma in 1973, and went on to complete his Ph.D. in Zoology at the University of British Colombia in 1976. (UCI) Co-author Stefan K. Hetz is an assistant professor in the Department of Animal Physiology at Humboldt University in Berlin, Germany.
Conclusion

The next time I read any popular press/news article, especially one based on scientific research, I will be much more critical of the information presented, and instead of just assuming that the information is accurate and complete, I will do some of my own research, because now I know that “the truth is out there” if you take the time to look for it.
References


Credentials for Timothy Bradley from University of California. URL: [http://compphys.bio.uci.edu/bradley/bradley.htm]


