

The Importance of Addressing Biogeography in Secondary Biology Classrooms

Biogeography and its Connection to Biology Instruction

Despite the numerous topics and concepts taught in a typical high school biology curriculum, the term and concept of “biogeography” has not been given the full attention this field of study deserves. The very definition of biogeography, the geographical distribution of plants and animals, identifies this discipline as a vital part to any life science class (Hamel, 2012). Though biogeography seems to be taught to students indirectly in high school biology classes, the specific term, definition and meaning should be directly introduced (Erkens, 2013). Biogeography needs to come out of the shadows of biological curricula and be recognized more predominantly at the high school level. To mention that biogeography has been totally ignored in the classroom would be inaccurate because by the field’s very definition, biogeography encompasses many biological disciplines such as zoology, botany, and ecology. But because biogeography also intertwines with geography, geology, and paleontology, an educator cannot escape addressing the concept of “life” without the concept of “place” in their classroom (Kyle, 2016).

Interestingly, in the field, biogeography is a discipline that geographers practice the least. It has been noted, at least in the past, that one does not become a biogeographer because they study biogeography. Biogeographers instead study many subjects such as zoology, botany, chemistry and physics to name a few (Wilhelm, 1967). It is not the intention of this manuscript to diverge from geography or imply that biogeography is solely a discipline reserved only for biology. On the contrary, geography and biology must, and meaningfully so, co-exist when addressing biogeography. Rather, this paper focuses on the importance of addressing

biogeography in the secondary biology classroom for the purpose that this discipline helps to explain so many concepts found in the field of biology. Even though biology is defined as the study of life (Reece et al., 2018), biotic as well as abiotic factors must be addressed when teaching this subject matter. One cannot appropriately address the topic of evolution without mentioning the geological contributions to the theory; so why not literally and intentionally incorporate the concept of biogeography meaningfully with other biological topics throughout a yearly curriculum?

Connecting Biogeography to Standards-based Practices

Biogeography can offer meaning to a wide range of high school science topics. The unifying nature of biogeography as a discipline can offer genuine and objective viewpoints, discussions, and understandings to any general biology curriculum. Even if biogeography were to be introduced to students at a younger age, during their elementary or middle school years, biogeography would be more effectively and efficiently used to help explain and understand more advanced concepts once in high school. Additionally, students would develop an appreciation of biogeography and an increased awareness of its importance to science. To employ lessons that focus on a cross curriculum with, for example, a geography or geology high school teacher would solidify how biogeography can be applied in various disciplines while encompassing biology (Wilhelm, 1968).

To extend beyond secondary education, biogeography has even been proposed to revitalize education socially in the medical fields. For example, by borrowing and modifying the concept of biogeography, nursing students have been able to develop better empathy,

engagement and enquiry for their patients based on understanding what it means to walk in their patient's shoes, changing and helping the lives they encounter, and bringing abstract concepts to life. Even biogeography can evolve in order to help enhance career training (Kyle, 2016).

In order to incorporate biogeography in the high school biology classroom, a teacher needs to know that biogeography is much more than just biology and geography; and that the discipline has a history of contributors to the field. Obviously, the teacher needs to establish terminology, concepts, and practicalities with an engaging lecture. However, the teacher, along with his or her students, needs to perform like a biogeographer by developing experiments, analyzing data, discussing issues, applying the concepts and asking questions with regards to biogeography in as many appropriate areas of study in biology as possible (Hamel, 2012). Why are species distributed throughout the world as they are?, have species always been in the same place as they are now? and do species all have a common origin? These are examples of the kind of biogeographical questions that teachers and students alike should be asking in high school botany, zoology, ecology, and evolution courses (Erkens, 2013). Discussing biological concepts such as evolution typically includes an introduction to the major contributors involved in the topic. With regards to evolution, Charles Darwin (English naturalist, geologist and biologist, best known for his contributions to the science of evolution) and Alfred Wallace (British naturalist, explorer, geographer, anthropologist, and biologist) are often mentioned and accredited for their contribution to the theory; but what an opportunity to employ biogeography into these scientists understanding of nature.

Connecting Life and Place to a Biologist Work

Evolution is an area of biology that is riddled with the concepts of biogeography. In addition to Darwin and Wallace, contributing biologists like Edward O. Wilson (American biologist, researcher, theorist, and naturalist) and Jared Diamond (American ecologist, geographer, biologist, anthropologist) make use of the concept and the importance of “life and place”. Studying geographic distributions of organisms helped develop the evolutionary theory.

Charles Darwin

For example, mentioning during a lecture on evolution that Darwin’s trip to the Galapagos was crucial for his understanding of natural selection is expected; but, it would also be worth mentioning that biogeography played a critical role in the evolution of the plants and animals on those islands. Natural selection is directed or guided by environmental changes (Flannery, 2011). To go one step further, educators should deem it important to address to their life science classes that even in Darwin’s day, biogeographers recognized the differences between ecological biogeography and historical biogeography (Crisci, 2009). Having students understand the difference between these “present” and “past” biogeographical processes could help students understand why even today there can be controversy with regards to evolution.

Alfred Russel Wallace

The Indo-Australian Archipelago that Wallace lived on for nearly 8 years, his visit to the Amazonian rainforest and contribution to the concept of natural selection should be worth mentioning when discussing evolution in a life science class. The reason being is that his experience in these environments and various biomes helped him not only begin thinking about the concept that life is and always has been a struggle for survival; but, also helped to establish modern biogeography (Rosenau, 2012). In those days and the days to come, biogeography was

not considered a developing and independent scientific field. However today biogeography is prospering with an increase in publications and notoriety (Erkens, 2013). This is another reason why this discipline needs to be more fully incorporated into today's science curriculum. Take for example, Wallace's Law of Biogeography which stated that species that lived geographically closer to one other were more likely to share a common ancestor than those species that lived geographically further away. When students are exposed to this law, biogeography is being used to explain speciation. Just as biogeography helped developed the theory of evolution, biogeography can help explain other such biological concepts for students today.

It is important that students perform experiments and recognize clarification about ecological discrepancies or uncertainties; perhaps utilizing GIS (Geographic Information System).

Educators need to present to their students how biogeography is studied and why this scientific discipline matters (Hamel, 2012). Exploring life's diversity and geography by helping students live through past and present researchers, explorers, and naturalists will allow them to gain an appreciation of the importance of biogeography (Rosenau, 2012). It is vital that biology classrooms bridge disciplines such as genetics, ecology, and geology in order to help explain why and how an organism lives where it does by utilizing biogeography (Hamel, 2012).

Helping Students in the Classroom

Instructional approaches that embed biogeography can help students understand how the development, conservation, and demise of all life involves biological, geological, social, and historical processes (Eldredge, 2009; Wilhelm, 1967).

Through principles and applications of biogeography, students would have the opportunity to understand and even witness, for examples, by attending museum fieldtrips,

inviting guest speakers, or participating with interactive biogeographic blogs how and why species are distributed throughout the world (Lei, 2010).

Biogeography requires an immense amount of understanding and knowledge about biology, as well as geology or geography and other areas of science. So, the best way to address this field in a high school biology class efficiently and effectively is to incorporate and integrate biogeography into biological topics such as zoology, botany, and ecology just to name a few.

Why is it important to include biogeography in a high school biology class? Even before a term like “biodiversity” was created and utilized in science, biogeography has made a lasting impact as an academic discipline (Liu, 2009). However, despite its longevity the very term and concept of biogeography has seemingly become removed from public education either intentionally or unintentionally. The Next Generation Science Standards, National Science Education Standards, and the 2016 Indiana Biology Standards do not use the term biogeography. Studying biology through the lens of biogeography, students can better understand and appreciate how species are distributed by geographical means (Hamel, 2012). In addition, because of the numerous biological and geological components that help to define the discipline, biogeography is a necessity to provide meaning and explanations to other the areas of study that encompass all the fields of biology.

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Figure. General biology students searching for marine fossils of the Paleozoic Era and applying their understanding of how paleontology supports evolution and biogeography can be used to explain the distribution of organisms along the Ohio River Basin that once lived millions of years ago. Fossil Hunting Field Trip [Personal photograph taken in Richmond, Indiana]. (2017, October 11). Life science class searching for 450-500 million old specimens.