THE SIX-LEGGED SUBJECT: INSECT INCORPORATION IN HIGH SCHOOL BIOLOGY CLASSROOMS

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ABSTRACT

Insects and their associated systems can be used in science classrooms to teach fundamental science concepts and engage in scientific inquiry. However, reviews of insect incorporation in primary and secondary classrooms have not included teacher self-reporting of entomology instructional practices. This paper will describe how and why insects are being used in biology classrooms, identify potential gaps in entomology education and barriers to incorporation, and address ways in which education or conservation organizations can support teachers in improving entomology education in the classroom.

INTRODUCTION

Studies and anecdotal evidence supports the claim that insects and other invertebrates are effective teaching tools in formal K-12 classrooms (Killermann, 1998; Matthews, Flage, & Matthews, 1997; Shepardson, 1997) Insects provide concrete examples of a variety of abstract science concepts such as growth and development, life cycles, structure and function, behavior, and ecology (Matthews et al., 1997). In addition, they spark student curiosity and provide opportunities for students to engage in hands-on learning with real-world subject matter (Matthews et al., 1997). Researchers have examined primary (grade K-6) student conceptions of insects and features of effective instructional strategies at these grade levels (Barrow, 2002; Shepardson, 2002). However, examination of secondary student (grade 9-12) experiences with insects in the classroom remains unexplored. Also, in-service teacher perspectives have not been documented to determine how insects are used with grade 9-12 students, what tools or resources would support future insect incorporation, or why these experiences are perceived as valuable to students. A better understanding of how and why insects are used in secondary classrooms is needed to support entomology education in formal classrooms. Our study employed a web-based survey of U.S. high school biology teachers to collect data on teacher perspectives on the process, barriers, and benefits of insect incorporation.

METHODS

Survey development: Our survey was constructed using the tailored design method (Dillman, 2009). The survey was developed and distributed via Qualtrics Survey Software (Provo, UT). Our instrument was limited to a maximum of 24 questions to minimize participant dropout due

to fatigue. The majority of participants (73%) required 10-20 minutes to complete the survey. To maximize content validity, four high school biology teachers with prior experience incorporating insects in the classroom piloted the survey for clarity and content prior to implementation.

Recruitment of participants: We licensed 2000 high school biology teacher email addresses from MCH Strategic Data (Silver Springs, MO), a compiler of national education data. An initial recruitment email was distributed to 1000 potential participants on April 3, 2015. The remaining 1000 teachers were contacted on April 6, 2015. Two follow-up reminder emails were sent on April 13 and April 20 to all potential participants who had not yet taken part in the survey.

Survey content: The survey included both closed-ended and open-ended questions to collect quantitative and qualitative data. It included 1 item to confirm participants were consenting to participate in a research survey. Remaining items allowed for collection of data on the following:

- Teacher demographics (8 items)
- Description of insect incorporation such as frequency or type of insect used (9 items)
- Barriers to incorporation (1 item)
- Teacher attitudes (2 items)
- Preferred resources to improve future incorporation (2 items)
- Perceived student benefit (1 item)

RESULTS

Accuracy and representativeness of sample: We collected survey data from 254 high school biology teachers. With approximately 52,000 biology teachers in the U.S., this survey has a confidence interval of 95% with a margin of error of 6.1%. Comparisons of participant demographics were made to U.S. science teacher demographics from the U.S. Department of Education's National Center for Education Statistics, Schools, and Staffing Survey to determine if our sample was representative of the U.S. natural science teacher population. Our sample tended to be slightly older (18% more than average are 40 years or older), more female (7% more than average), with more teaching experience (22% more than average with 10 or more years of teaching experience), and with a higher degree (15% more than average with a masters or doctorate degree). In addition, our sample included was slightly over-representative of suburban teachers (9% more than average) while slightly under-representing those living in cities and rural areas (-3% and -6%, respectively).

Description of insect incorporation in high school biology classrooms: Nearly 88% of teachers incorporated insects to some degree within a typical academic year. Incorporation could include presentation of or interaction with any media depicting an insect such as a picture, video, audio, text, lecture, discussion, activity, lesson, pinned specimen, live insect, etc. Teachers used a wide diversity of insect types (Figure 1) but did so on an infrequent basis with 65% of respondents incorporating insects less than once a month. Lesson plans were used by 81% of teachers (Figure 2) with nearly half of all teachers (49%) creating their own lesson plans (Figure 3).

Figure 1: Insect Types Incorporated

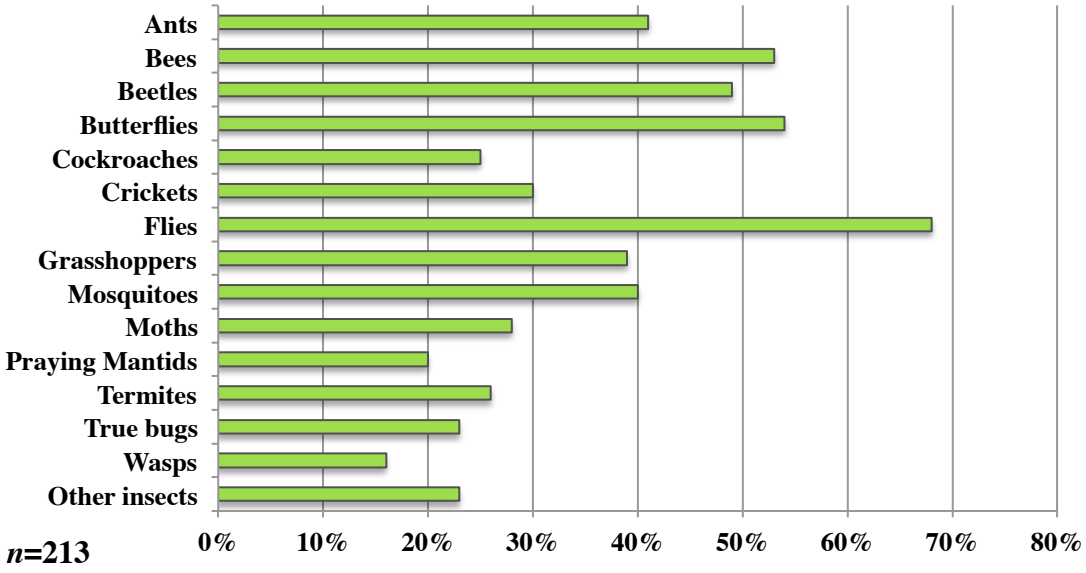


Figure 2

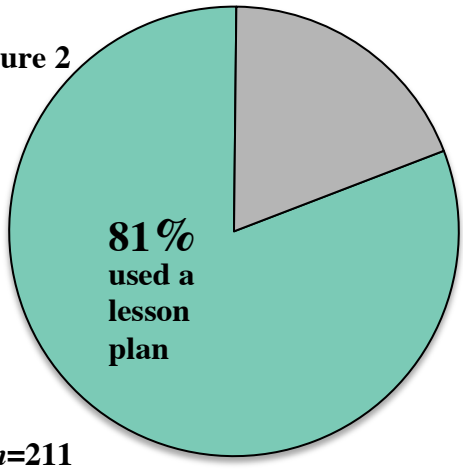
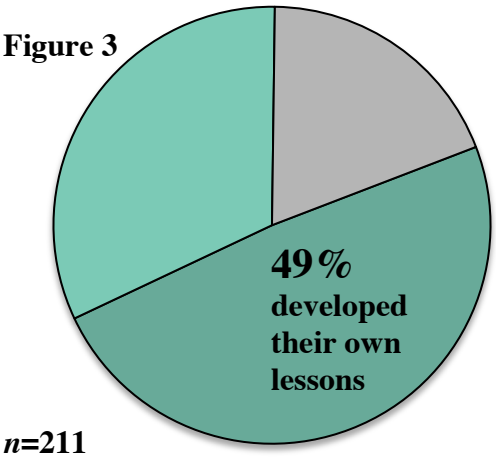
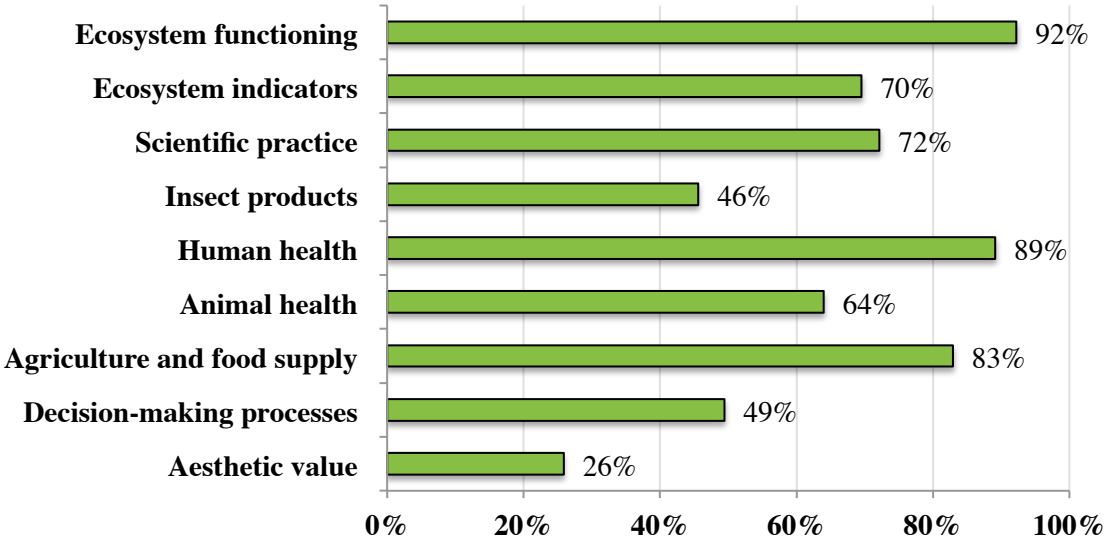


Figure 3



In order to determine if students were being exposed to fundamental entomology topics, we used Pearson, Skinner, & Hoback (2007) as a reference for what students should know and be able to do concerning entomology. Insects were used to teach a variety of these entomology topics with ecosystem functioning, impacts on human health, and insects' role in agriculture and our food supply being the most common topics covered. In contrast, aesthetic value of insects, the decision making process of considering the costs and benefits of insect control, and value of insect products were introduced least often (Figure 4).

Figure 4: Entomology Topics Supported by Insect Incorporation



Using the recently revised national science standards known as the Next Generation Science Standards (NGSS), we made a list of concepts or core ideas, which are commonly covered in life science instruction. Teachers reported which concepts or core ideas were most commonly supported by insect incorporation in their classroom (Figure 5). Similarly, the NGSS were used to identify a list of science practices which could be supported by insect incorporation. More than 75% of teachers indicated insects were used for observation, encouraging students to ask questions, analyzing or interpreting data, and evaluating and communicating information (Figure 6). Science practices such as developing and using models or engaging in argument from evidence were newly added to the NGSS. This may help to explain why insect incorporation is not yet encouraging these practices to a greater extent.

Figure 5: Science Concepts Supported by Insect Incorporation

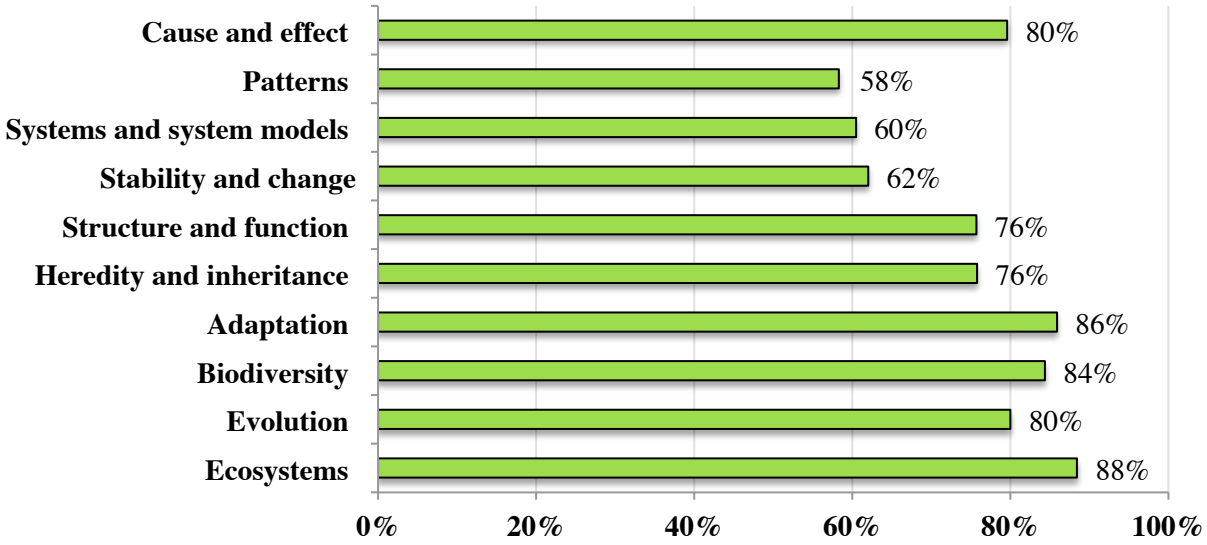
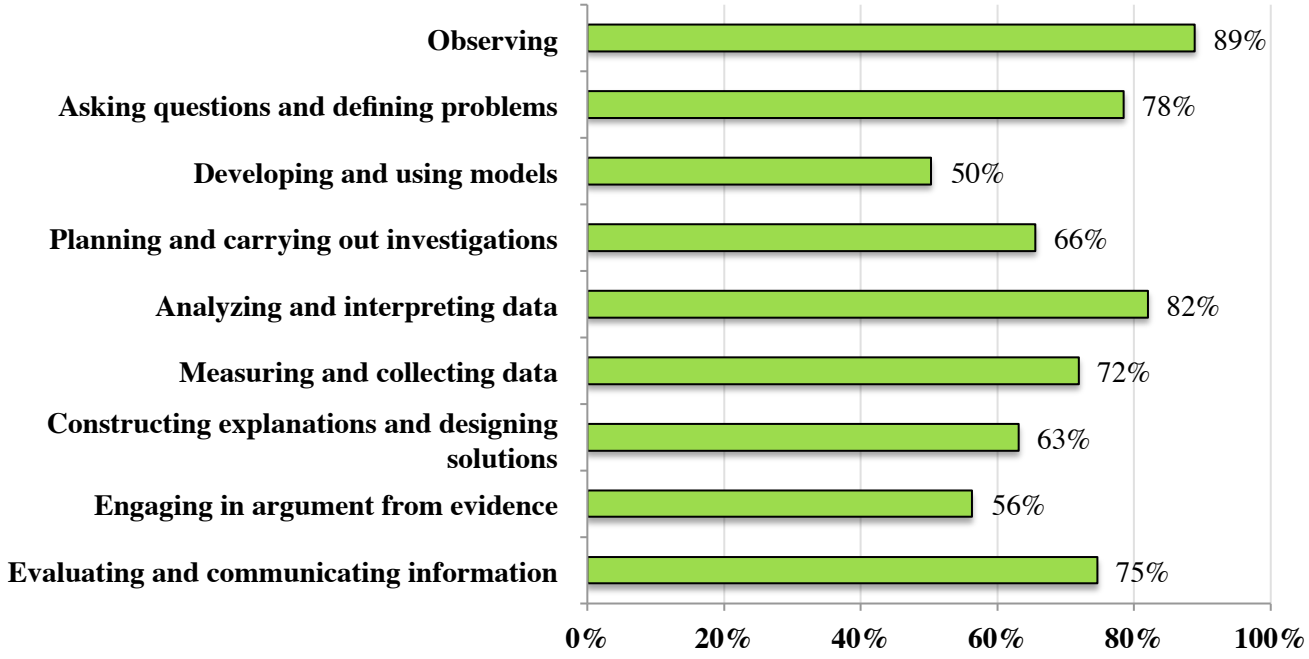
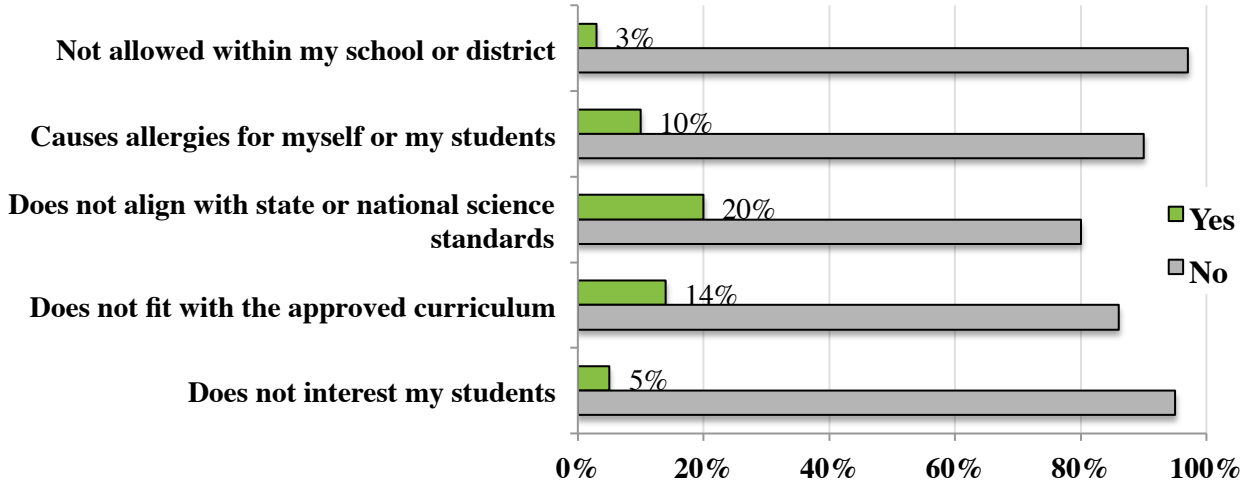


Figure 6: Science Practices Supported by Insect Incorporation



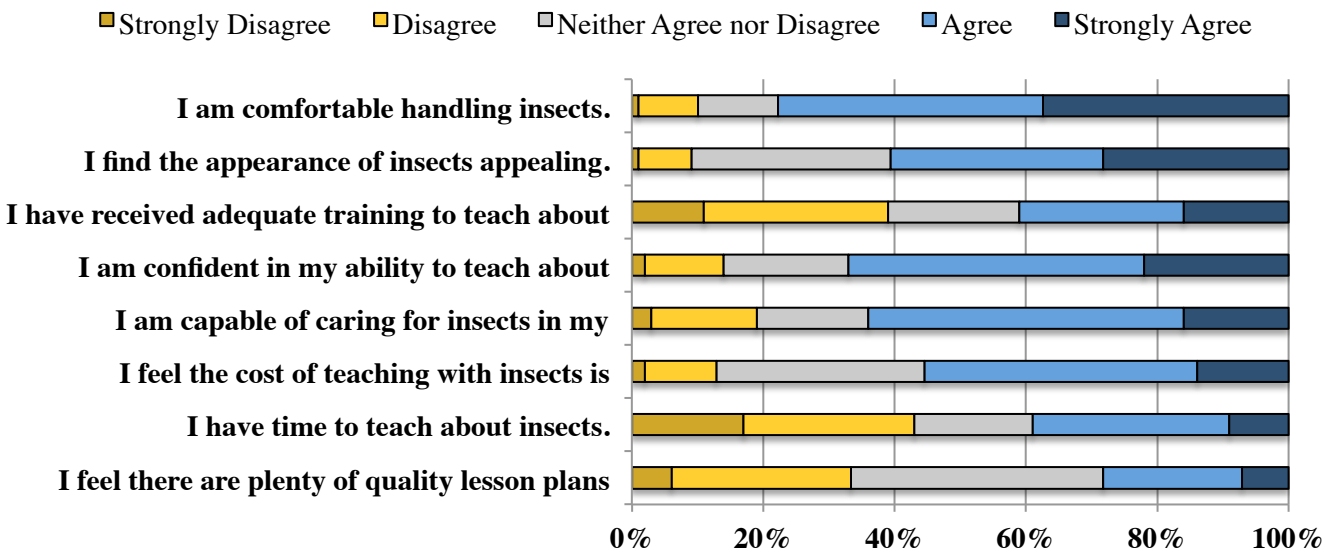
Barriers to incorporation: Teachers were asked to identify if any barriers existed in their incorporation of insects. The perceived lack of alignment with state or national science standards and lack of fit with a prescribed curriculum were the most common barriers reported (Figure 7). In addition, 30% of teachers listed other barriers including lack of time, facilities, budget, or other resources, and lack of ability or unwillingness to care for insects during academic breaks.

Figure 7: Barriers to Insect Incorporation



Teacher attitudes: On the whole, secondary biology teachers did not appear to have an aversion to the physical appearance of insects or handling insects as may be the case for primary teachers. The most common concerns were lack of time to teach about insects, lack of adequate training, and availability of quality lesson plans (Figure 8). Interestingly, despite lacking adequate training, most teachers were confident in their ability to care for and teach about insects.

Figure 8: Teacher Attitudes



Preferred resources

When asked to rank six potential resources in terms of their usefulness to future insect incorporation, teachers ranked lesson plans aligned to state or national standards and professional development workshops teaching how to use insects to support inquiry as the top two most useful resources (Figure 9).

Figure 9: Preferred Resources

Rank	Resource	Mean rank ± SE
1	Lesson plans aligned with standards	2.61 ± 0.122
2	Professional development on using insects in inquiry	2.64 ± 0.111
3	Professional entomologists visiting the classroom	3.75 ± 0.123
4	Live insects available for check-out	3.78 ± 0.106
5	Insect collecting supplies available for check-out	4.00 ± 0.099
6	Guide on insect care	4.22 ± 0.104

CONCLUSIONS AND RECOMMENDATIONS

Findings from this study indicate that secondary biology teachers are incorporating insects to support standards-based educational objectives. Incorporation involves a diversity of insect types but is infrequent throughout the year. Teacher responses indicated that limited time and a push for all classroom content to be tied to state or national science standards make it increasingly difficult to teach *about* insects. Rather, insects are being used in the classroom to illustrate hard-to-grasp concepts in concrete ways.

An interesting finding from this survey was that nearly half of all teachers using a lesson plan reported creating their own. Matthews et al. (1997) provided teachers and entomologists with sources of ideas and materials for insect incorporation in formal classrooms; however, in the nearly two decades since its publication, many of the resources are either difficult to find, no longer available, or out-of-date. Additionally, despite claims that a wide variety of entomology

resources are available for K-12 teachers to use in the classroom, it seems that a vast majority of these materials are written for grades K-6. Relatively few resources are directed at the 9-12 grade levels. Unless teachers are particularly committed to teaching with insects and developing their own lessons, this gap represents another significant barrier to increased insect incorporation in high school biology instruction.

To address the issues of lack of time, limited availability of lesson plans, and perceived lack of fit with science standards, we recommend that invertebrate education and conservation organizations should consider developing lesson plans aligned to the Next Generation Science Standards (NGSS). This valuable contribution would save teachers time in the planning process. With 20% of teachers reporting that they do not see how teaching with insects is aligned to science standards, it is also important to make relationships between insects and the standards explicit in any materials developed for use in formal classroom settings.

To address the 39% of teachers who feel they have not received adequate training to teach about insects, organizations could partner with local school districts to provide teachers with opportunities to expand their entomology experience. This could include developing a formal professional development program or providing informal experiences focused on increasing teacher appreciation and attitude toward insects and other invertebrates.

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