

# Scales and Ceanothus: An Analysis of Diaspid Distribution in San Diego County

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## Introduction

Armored scale insects (Hemiptera: Diaspididae) are plant-feeding insects with species that have a usually high host range (Beardsley and Gonzales 1975). Females are sessile for the majority of their life cycles, and juveniles are wind dispersed (Gwiazdowski et al. 2011). Scale species are largely cryptic and are best collected through large-scale host sampling over large geographic ranges (Normark et al. 2011). Their mode of dispersal and generalist diet can be a driving force for speciation events. One particular host genus (*Ceanothus*) has multiple species found throughout the chaparral of the coastal mountain ranges in central California and Baja California. Currently, 28 species of armored scale are recorded as associates of *Ceanothus*, but it is unknown what the disparity and diversity in attack rate is amongst these species (ScaleNet). These data are necessary to understand the ecological dynamics in this host-plant association. In order to address this disparity, we conducted a large-scale sampling of *Ceanothus* found throughout the San Diego County of California. Based on the nature of the dispersal of armored scales, we hypothesize that geography is a factor in Diaspid species diversification. However, based on the extremely generalist diet of scale insects, we are also investigating the possibility of host-driven diversification. We look to address the following questions: what role do geography and host-plants play in scale insect speciation? What species of scale are found on the *Ceanothus* of San Diego County?

## Methods

Over the course of a few months, we collected roughly 15 branch samples from each of 5 different species of *Ceanothus* across San Diego County (*C. palmeri*, *C. verrucosus*, *C. crassifolius*, *C. leucodermis*, *C. tomentosus*; Figure 6). Branch samples were bagged individually and brought back to the lab for analysis. Branch samples were examined for scales. Located scales were removed from the host plant and placed into a source vial unique to the type of material the scale was found on (leaf or twig). Scales were then photographed for morphological analysis, and one or two individuals (depending on vial abundance) were taken from each vial for genetic analysis. The scale bodies were punctured, and the genetic material was extracted and amplified using PCR. SANGER sequencing was used to sequence the DNA of individual specimens. A genetic analysis will be done using GENBANK to confirm the morphological identifications made. We will perform an AMOVA to analyze species differences. An ANOVA and tukey-kramer post-hoc analysis will tell us if species are geographically distributed, or if host-plants play a role in speciation.



Fig 1. Scales found on *C. tomentosus*. Preliminarily identified as *Aspidiotus neri* (left) and *Anidomytilus ceanothi* (right) by G. Morse.



Fig 2. Scales found on *C. verrucosus*. Preliminarily identified as *Hemiberlesia rapax* by G. Morse.

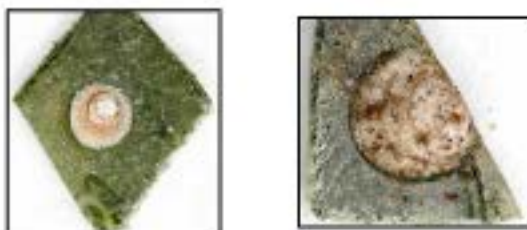


Fig 3. Scales found on *C. leucodermis*. Preliminarily identified as *Aspidiotus neri* (left) by G. Morse. The scale pictured right was unable to be morphologically identified with confidence.



Fig 4. Scales found on *C. crassifolius*. Preliminarily identified as *Aspidiotus neri* (left) by G. Morse. The scale pictured right was unable to be morphologically identified with confidence.



Fig 5. Scales found on *C. palmeri*. Preliminarily identified as *Hemiberlesia rapax* by G. Morse.



Fig 6. Distribution of 5 species of *Ceanothus* across San Diego County, proposed host plants of Diaspididae

## Results and Discussion

At this point in the project, we have finished our collection and DNA extractions for our scales. In total, 48 individuals were isolated for DNA extraction, and the amplified DNA will soon be sent off to be sequenced. A preliminary analysis of morphology based on the photography has revealed a number of different species of scales. On samples of *C. tomentosus*, we have found *Aspidiotus neri* and *Anidomytilus ceanothi* (Figure 1). Our sampling of *C. verrucosus* yielded *Hemiberlesia rapax* (Figure 2). On our samples of *C. leucodermis*, we have tentatively identified *Aspidiotus neri* (Figure 3). The second scale pictured in Figure 3 was unable to be morphologically identified with confidence. On our samples of *C. crassifolius*, we found *Aspidiotus neri* (Figure 4). The second scale pictured in Figure 4 was unable to be morphologically identified with confidence. And on samples of *C. palmeri*, we found *Hemiberlesia rapax* (Figure 5). ScaleNet is an online database containing data from over 24,000 references pertaining to over 5,400 valid species names (ScaleNet). On ScaleNet currently, only two species of armored scales have been documented as associates, neither of them being *Hemiberlesia rapax*. There are no documented associations on ScaleNet between scales and *C. tomentosus*, *C. verrucosus*, *C. leucodermis*, and *C. crassifolius*. After completion of our genetic analysis to confirm the morphological identifications, we will be able to analyze the data statistically and draw conclusions on their distributions. We will also be able to make major contributions to the current literature. Our new host associations will be important and foundational for further investigations into the scale distribution of San Diego County and California.

## References

- Beardsley, J. W., and R. H. Gonzales. 1975. The biology and ecology of armored scales. *Annual Review of Entomology* 20:17-38.
- Chikashige, R. A., L. M. Yee, J. C. Anderson, and B. B. Normark. 2011. Diversity of emphylo species among North American plant-feeding Diaspididae (Hemiptera: Diaspididae). *Biological Journal of the Linnean Society* 129:17-32.
- Normark, B. B., B. B. Morse, and G. Gwiazdowski. 2011. Armored scale insects (Hemiptera: Diaspididae) of San Jose National Park, Panama, with descriptions of two new species. *Annals of the Entomological Society of America* 104:17-32.
- Santa-Veceras, M., D. B. Miller, D. Miller, B. B. Morse, and G. Gwiazdowski. 2011. ScaleNet: A Hemispherical model of scale insect biology and systematics. *Database* 2011:1293. <http://dx.doi.org/10.1093/database/bat129>.