ACOUSTIC DIVERSITY AND MATING SIGNALS IN THE PSYLLOIDEA (HEMIPTERA)

Diana M. Percy
Dept. of Botany and Beaty Biodiversity Museum, University of British Columbia
3529-6270 University Boulevard, BC, Canada, V6T 1Z4 diana.percy@ubc.ca

1. INTRODUCTION

Acoustic communication is important in many insect groups (Hill 2008, Čokl & Virant-Doberlet 2003). The mechanisms and diversity of acoustic behavior in psyllids (Psylloidea, Hemiptera) has only been more extensively studied recently (Percy et al. 2006, Tishechkin 2005). Psyllids are small (2-8 mm) plant feeding insects related to aphids, scales, and whiteflies. Their sound making apparatus consists of a "simple" stridulatory system, but there appears to be a much greater diversity of sounds than might be expected from a stridulatory mechanism.

The small size of these insects makes the recording of acoustic behavior particularly challenging. Nevertheless, it has been possible to record the substrate transmitted vibrational signals, and to use playback to elicit species specific acoustic responses.

Whiteflies and aphids, which are both related to psyllids, are known to produce limited acoustic signals, but psyllids are the only members of the Sternorrhyncha clade known to produce and use acoustic signals extensively for mate location and selection.

There are a number of important agricultural pest species in the Psylloidea, the best known being the tomato/potato psyllid, the Asian citrus psyllid, and the carrot psyllid. A number of species also damage horticultural and ornamental plants. With the development of more sophisticated sound processing computer systems and electronic equipment, the possibility of detection and deterrence using acoustic signals is increasingly being investigated. I have recorded examples of male psyllids producing apparent signal jamming noises to deter mate location of rival males, and it therefore seems likely that certain background noises may compromise successful mating. However, it is not clear whether the high densities of individuals often found with pest species would be adversely affected by this approach because acoustic mate location appears to be a strategy to locate mates under conditions of low density.

1.1 Allopatric versus sympatric acoustic signals

Acoustic signals are important in both species recognition and mate selection in psyllids (Percy et al. 2006). Male and female psyllids produce reciprocal acoustic mate signalling, often as highly synchronised duetting. The role of acoustics in psyllid mating and speciation is illustrated with data from allopatric versus sympatric groups and morphologically cryptic species. Two psyllid groups that differ in the amounts of geographical and ecological sympatry were also found to have different correlations between genetic and acoustic diversity depending on whether the species were sympatric or allopatric.

The majority of this acoustic research was undertaken in one of the centers of species diversity for the Psylloidea: Australia.

2. RESULTS

I recorded a high diversity of acoustic signals from 26 species in 12 genera of Australian psyllids. The greatest diversity of Australian psyllids is found in the almost exclusively Myrtaceae-feeding subfamily Spondyliaspidinae (family Psyllidae). I selected a complex of morphologically similar taxa that occur on closely related host plants and used playback experiments to test female receptivity to conspecific and heterospecific male calls from different hosts. Using these methods I have been able to address questions relating to species concepts: specific mate recognition systems (SMRS) and reproductive barriers.

I investigated the divergence in acoustic signals between three closely related, morphologically cryptic species. I found that associations with different host plants coincided with differences in acoustic mating signals, and that the acoustic signals were more divergent in sympatric taxa. There is more phylogenetic information in groups that are relatively recently derived, and groups in which the species are not sympatric.

Among three cryptic taxa in the genus *Cardiaspina*, the results suggest a possibility of unidirectional but not bi-directional gene flow between species occurring on sympatric hosts. As these psyllids cause conspicuous leaf necrosis during feeding, and in outbreak years heavily infested trees may die completely, the reproductive biology and population dynamics of this psyllid group is of broad ecological interest.

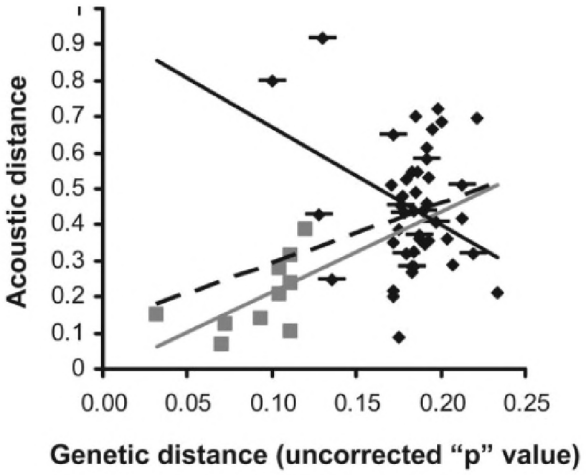

Figure. 1. Comparison of acoustic and genetic distance for 11 triozid psyllid species. There is a significant correlation between genetic and acoustic distance using pairwise comparisons of all 11 taxa (dashed line, $P = 0.005$, $R^2 = 0.1393$). An analysis of trends within the two groups showed that within the *Schedotrioza*-group (grey squares), which are recently derived species that are typically allopatric, the trend also indicates a positive correlation, though non-significant (grey line, $P = 0.07$, $R^2 = 0.3459$), but within the Casuarinaceae-feeding group (black diamonds with horizontal bar), a group of more divergent species that are typically sympatric, the trend is reversed, suggesting a negative correlation (black line, $P = 0.07$, $R^2 = 0.2302$) (from Percy et al. 2006).

3. DISCUSSION

Acoustic data from psyllids in some cases has significant phylogenetic content. However, the divergence in acoustic signals may occur rapidly under certain conditions (e.g., when taxa are sympatric), potentially confounding phylogenetic interpretations. If acoustic characters evolve rapidly through competition or sexual selection in sympatry, and are also prone to convergence due to limited repertoire, then more phylogenetic information may generally be found in acoustic data from recently speciating, allopatric taxa.

Acoustic signals in psyllids are species and gender specific, and therefore the possibility exists to use acoustic identification/detection systems. Vibrational acoustic signals for mate location are likely to be used by insects at low densities such as on colonization of a new host individual, and thus vibrational detection systems could provide an early warning of psyllid colonization on plants. The potential use of disturbance noise to deter psyllid establishment on host plants has some support in the apparent use of these tactics by psyllid males.

REFERENCES

Čokl, A., & Virant-Doberlet, M. (2003). Communication with substrate-borne signals in small plant-dwelling insects. *Annual Review of Entomology* **48**, 29–50.

Hill, P.S.M. (2008) Vibrational Communication in Animals. Harvard Univ. Press.

Percy, D.M., Taylor, G.S. & Kennedy, M. (2006) Psyllid communication: acoustic diversity, mate recognition and phylogenetic signal. *Inververtebrate Systematics* **20:** 431-445.

Tishechkin, D. Yu. (2005). Vibratory communication in Psylloidea (Hemiptera). In *Insect Sounds and Communication* (eds S. Drosopoulos & M. M. Claridge) pp. 357–363. CRC Taylor and Francis: London, UK.

ACKNOWLEDGEMENTS

Funding was provided by the Leverhulme Trust, UK.