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Vibrational communication and other behavioural traits in *Scaphoideus titanus*

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Abstract

The role of substrate-borne acoustic signals in intra-specific communication and pair formation of *Scaphoideus titanus* Ball was investigated. Vibrational signals were recorded from grapevine leaves with a laser vibrometer. All recorded vibrational signals of *S. titanus* have a dominant frequency below 900 Hz. Two main types of male emission were detected: the calling signal and the courtship phrase. Pair formation begins with the spontaneous emission of the male calling signal. The calling signal can turn into a courtship phrase, formed by four consecutive sections. Section 1 consists of single pulses with a regular repetition rate and buzz in the interval between pulses, section 2 of regularly repeated double pulses and buzz in the intervals, section 3 of only the buzz. During section 4 the male searches the female.

Key words: leafhoppers, bioacoustics, vibrational signals, mating behaviour, laser vibrometer.

Introduction

Scaphoideus titanus Ball (Hemiptera Cicadellidae) is a leafhopper vector of the phytoplasma that causes "flavescence dorée", the most threatening among European grapevine yellow diseases. Despite its importance, very little is known about this species besides its general biology and disease transmission. We focused our attention on some behavioural aspects, with particular reference to the mating strategy that has been preliminarly described in a previous meeting (Lucchi *et al*., 2004). Mate recognition and localization in Auchenorrhyncha (with the exception of most cicada) are mediated via acoustic signals transmitted through the substrate (reviewed in Čokl and Virant-Doberlet, 2003; Virant-Doberlet *et al*., 2006). In this study, we provide the description of some aspects of intra-specific vibrational communication related to the mating strategy of this species. In addition we describe other daily activities like grooming and brochosomes production.

Materials and methods

All tests were conducted on unmated adults 7-15 days old in an anechoic and sound insulated chamber (Amplifon Fa., Amplaid, Italy) at temperatures of 22-25 °C and relative humidity between 70-75%. Tested specimens were placed on a cut grapevine stem with a leaf, inside a plexiglas cylinder (height 50 cm; diameter 30 cm) with a small opening at the top to let the laser beam pass through. The bottom of the stem was put into a vial filled with water to prevent withering and placed upright in a jar filled with moist artificial substrate. The behaviour of *S. titanus* was recorded with a Canon MV1 miniDV camcorder. Vibrational signals were detected on the leaf lamina by the use of a laser vibrometer (OFV 353 sensor head with OFV-2200 vibrometer controller or PDV 100, both Polytec GmbH, Waldbronn, Germany). Signals were digitized with 48 kHz sample rate and 16-bit depth and stored directly onto a hard drive of a PC computer using Sound Blaster Audigy 4 sound card (Creative Labs Inc.) and Cool Edit Pro 2.0 (Syntrillium Software). Video recordings were transferred into the computer with Adobe Premiere 5.1. Audio and video were simultaneously recorded in order to identify the specimens emitting the signals and to associate them with particular behaviours. Signal recordings were analyzed using the computer software program Raven 1.2.1 with a FFT window length of 1024 samples. Trials were conducted on single males, single females and pairs.

Results and discussion

Usually, the first activity recorded after the specimens were put on the plant was the grooming, done within the period of 5 minutes. Both genders groom their antennae, wings and abdomen moving the legs with stereotyped fast movements. This behaviour was also observed after brochosomes production. Brochosomes are emitted by the insect while standing in vertical posture with stylets inserted in the leaf tissues and all legs lifted from the substrate and kept straight along the body. Brochosomes are released from the anal opening as transparent droplets that are collected with the hind leg tarses and immediately spread all over the legs. Later, brochosomes are anointed all over the body surface while doing grooming.

All recorded sex specific vibrational signals of *S. titanus* have a dominant frequency below 900 Hz. Two emissions characterize the male repertoire: the calling signal (MCS) and the courtship phrase (MCrP).

MCS is the signal emitted by a male while looking for a female over the grapevine vegetation. It is part of the typical leafhoppers “call and fly” strategy. In *S. titanus*, the male, after emitting a series of MCS - usually 1-3 within few minutes - jumps from a leaf (or other plant surfaces) to another and repeat the sequence, possibly, until the finding of a receptive female. MCS consists of a series of pulses (MP1) that are associated with slow dorso-ventral movements of the abdomen. The amplitude of pulses increases over the signal. MCS is always preceded by the “rumble” (a series of clicks, whose mean dominant frequency is some 560 Hz) that is emitted either for several minutes or just few seconds before the first emission of pulses, growing strongly in intensity in the few instants before the CS, then, gradually disappearing during its course.

MCrP is a sequence of sound elements regularly repeated. Unlike the MCS, it is done only after the male is aware of the presence of a female nearby and, consequently, it represents a short range means of communication on which the courtship strategy is based. It is composed of four sections characterized by different specific features. During the first three sections the male keeps a stationary position on the leaf. Section 1 is composed of a train of MP1 with regular repetition rate and a “buzz” sound in the intervals between pulses, never overlapping them. The “buzz” consists of long stressed “rumble” clicks endowed with a characteristic harmonic structure and fundamental frequency of 280 Hz. Section 2 differs from the previous in lower pulse repetition rate and the presence of a second strong pulse (MP2) coupled with MP1. Section 3 consists exclusively of “buzz” elements that are progressively decreasing in duration. Finally, during section 4, the male moves searching for the female while producing clicks associated with very fast abdominal shaking. Actually, the search is made only in presence of female replies, otherwise the male performs a static S4, often characterized also by the scratching of the rear legs against the fore wings. This section always ends with a strong single pulse, similar to MP2, associated with a strong body shake and wing-flicking movement.

Females emit pulses (FP) while duetting, in response to male's pulses of MCS and MCrP, and so constituting a mating duet. No other sounds or clicks connected with mating behaviour were ever recorded in females.

Conclusion

S. titanus showed a rather stereotyped mating behaviour where the male acts like caller/courter and searcher and the female only as responder, giving rise to a mating duet whose proper development is essential for the mating achievement. On the other hand, the establishment and the maintenance of the mating duet proved to be strongly dependent on the respect of precise features.

It has been shown in the past that in leafhoppers production of male calling song has been inhibited by playback of random noise (Hunt and Morton, 2001) and that mating can be interrupted by external sounds of certain frequencies (Saxena and Kumar, 1980). In our opinion, the mating disruption in *S. titanus* by playing-back opportune vibrational signals into plant tissues is feasible. Further experiments should provide the essential knowledge for future development of effective and low environmental impact control practices.

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