ACOUSTIC COMMUNICATION BETWEEN MALES AND FEMALES OF THE COTTON LEAFHOPPER, *AMRASCA DEVASTANS* (DISTANT) ON CERTAIN PLANT AND NON-PLANT SUBSTRATES

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ABSTRACT

Acoustic communication between the males and females of the leafhopper *Amrasca devastans* (Distant) varies with the nature of the substrate on which they are present. The sounds are propagated through the leaf of the non-host castor and both the sexes showed sexual behaviour in response to each other's sounds in as high a degree as on the host cotton. Though the sounds were propagated through certain non-plant substrates, the sexual behaviour was not shown on these substrates. Glass plate was found to be unsuitable for transmitting the acoustic signals of the leafhopper.

INTRODUCTION

The sounds of males and females of the leafhopper *Amrasca devastans* (Homoptera: Cicadellidae) travel through the surface of the host-plant on which they rest allowing them to pair[1]. Whether the sounds of the sexes would travel through non-plant substrates is not known. The suitability of various non-plant substrates for transmitting the acoustic signals of the leafhopper *A. devastans* has been studied in this paper.

MATERIALS AND METHODS

The larvae of *A. devastans* collected from fields of okra (*Abelmoschus esculentus*) were reared, one each on a piece of okra fruit, in a glass vial (5 cm long; 2 cm dia) at 28 ± 1°C under a LD 13:11 cycle. As the leafhopper shows maximum sound emission and mating 5–7 days after ecdyses[2,3], the unmated males and females of this age were used to study their acoustic behaviour on different substrates.

The following substrates were tested: the host leaf cotton, the non-host leaf castor, parafilm membrane, Whatman filter paper No. 1, Nylon-net (40 meshes/cm^2), a PVC sheet and glass plate (2 mm thick). The tests were conducted in a glass petri dish as well as in a T-tunnel.

Tests in a petri dish

In this case the given substrate was kept stretched on the mouth of a petri dish (10 cm dia). An individual of the required sex was confined on the upper surface of the test substrate within a PVC ring (2 cm dia × 1 cm high) with nylon-net top (40 meshes/cm^2). An insect of the opposite sex was confined at the desired position on the same substrate under another PVC ring. The sounds emitted by the insects were picked up by a gramophone crystal cartridge and were monitored as described earlier[1]. The insects were also observed through the binocular microscope to study the relationship between the sound production and abdominal vibrations of the female.

Tests in a T-tunnel

In this test a T-tunnel made of glass, as shown in figure 1, was split into a lower and an upper half between which was stretched a T-shaped sheet of any of the above-mentioned substrates. The sheet was suspended in the air except along its margins, and divided the bottom from the upper half of the tunnel. A glass shutter (sh) is slided vertically to close off or open the upper basal compartment (bc) at the stem of the T-tunnel which formed the entry arm (ea) of the tunnel. Vertical nylon netting (40 meshes/cm^2) demarcated 2-cm terminal compartments (tc) at the ends of the transverse arm.

Five individuals of the required sex were introduced into one terminal compartment, the other being left blank. A single insect of the opposite sex was released in the basal compartment. When all the six insects had settled on the substrate, the glass shutter was raised and the behaviour of the insect released in the basal compartment was observed for 15 min. The numbers of insects, which showed sexual behaviour after their release in the basal compartment, as well as of those reaching the two terminal compartments of the transverse arm were recorded.

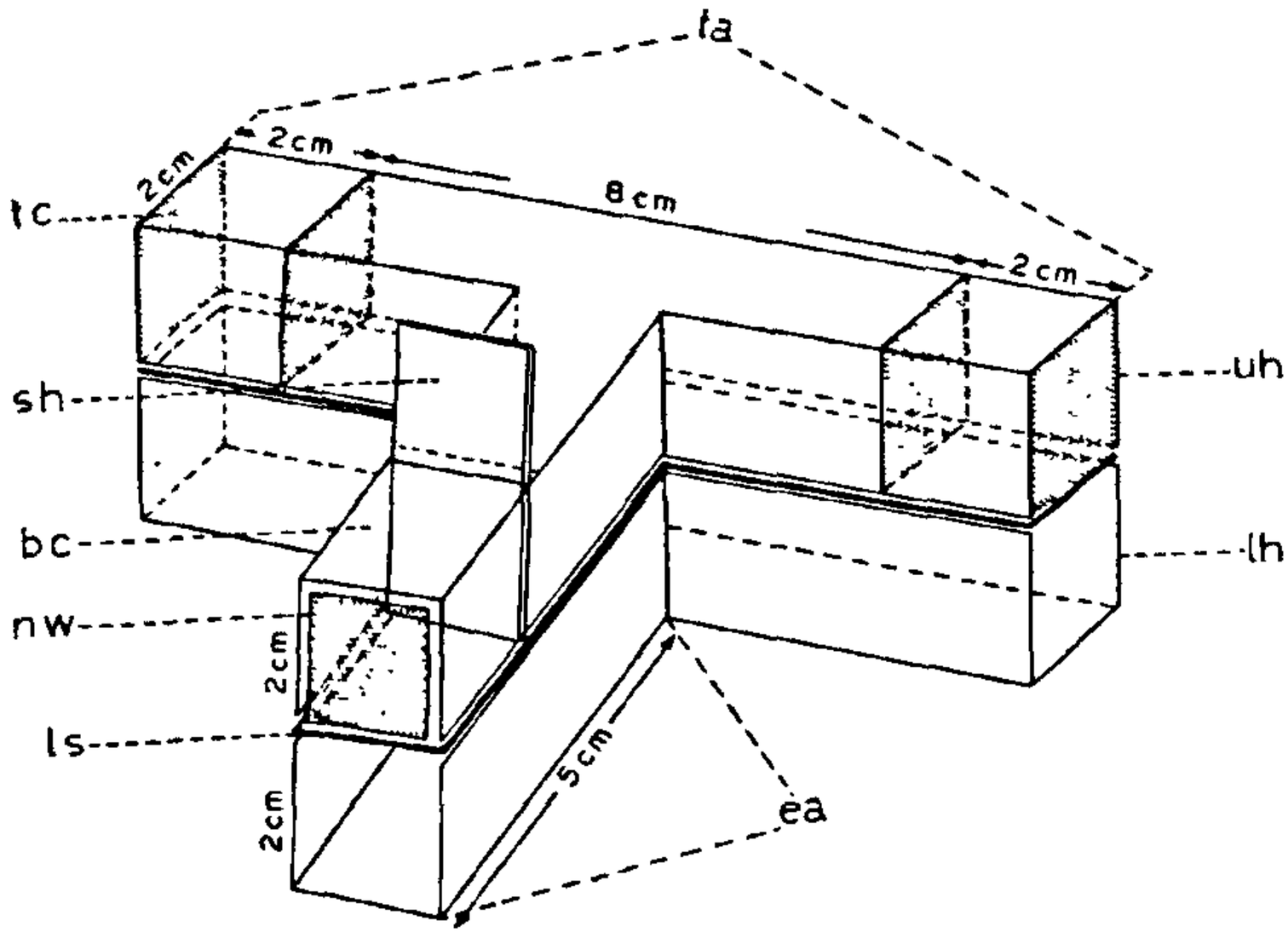

Figure 1. T-tunnel used for the study of acoustic communication of *Amrasca devastans* on different substrates: bc, basal compartment; ea, entry arm; lh; uh, lower half and upper half of the tunnel; ls, T-shaped leaf-sheet (heavy line); nw, nylon net wall (stippling); sh, glass shutter; ta, transverse arm; tc, terminal compartment.

RESULTS AND DISCUSSION

The males of *A. devastans* emit 'croaking' sounds which are transmitted through the plant on which they are feeding[1]. The females, if present on the same plant, respond to such croaks by emitting their own substrate-borne 'cooing' sounds. The 'coos' stimulate the males to emit croaks more frequently and commence 'dancing' movements during which they approach the females. On reaching the females, the two sexes copulate.

Sound emission and abdominal vibrations

There is hardly any information on the relationship between the sound emission and abdominal vibration in the leafhopper of the family Cicadellidae though females of certain planthoppers have been reported to vibrate their abdomens during sound production[4]. In the present work, it was observed that there was a direct relationship between the abdominal vibrations of the female and its sound production. One complete vibration correspond to one 'coo' of the female. In the absence of a male, the female exhibited hardly any abdominal vibration (3–4/30 min). However, when a male and a female were confined together on a leaf, there was a tremendous increase in the number of abdominal vibrations by the female (400–600/30 min). During abdominal vibrations, the abdomen remained above the leaf with no contact with the surface suggesting some internal mechanism of sound production. However, no such relationship was observed in the males.

Table 1 shows that the sounds were transmitted through different substrates except glass and were picked up by the phonograph cartridge as far as

Table 1 *Sounds of Amrasca devastans propagated through different substrates (tests based on number of 10 males and 10 females)*

Substrate[a] used	Propagation of sound[b] through the substrate
Cotton leaf	+
Castor leaf	+
Parafilm membrane (unstretched)	+
Parafilm membrane (stretched)	+
Filter paper	+
Nylon-net	+
PVC sheet	+
Glass plate	None

[a] Each substrate was used as a circular sheet of the same diameter as the mouth of the petri dish and kept stretched on the mouth of a petri dish. [b] Sounds of males and females picked up by a phonograph cartridge at 10 cm from the singing insect.

Table 2 *Percentage of 5-day-old male Amrasca devastans showing various responses in the presence of 5-day-old females on different substrates in a T-tunnel; n = 30 in each row*

Types of substrate[a]	Dancing (%)	Movements in tunnel (%)			Reaching female-bearing terminal compartment (%)	Reaching blank compartment (%)
		To female-bearing arm (A)	To blank arm (B)	Reversing from B to A		
Cotton leaf	100 ± 0b	77 ± 9b	13 ± 3b	13 ± 3b	90 ± 6b	0
Castor leaf	90 ± 6b	47 ± 7c	40 ± 11c	40 ± 11c	87 ± 7b	0
Parafilm membrane (unstretched)	0c	0d	0d	0b	0c	0
Parafilm membrane (stretched)	60 ± 6d	50 ± 0c	7 ± 3b	7 ± 3b	57 ± 3d	0
Filter paper	10 ± 6c	10 ± 6d	0b	0b	10 ± 6c	0
Nylon	20 ± 10ce	10 ± 6d	10 ± 6b	10 ± 6b	20 ± 10ce	0
PVC-sheet	0c	0d	0b	0b	0c	0
Glassplate	0c	0d	0b	0b	0c	0

[a] Each substrate was used as T-shaped sheet of the same size as the tunnel and was stretched across the arms between its lower and upper halves; The means within a column followed by the same letters are not significantly different from each other ($P > 0.05$); (ANOVA test).

10 cm from the source of production (i.e. male or female).

Communication between sexes

When a single male was released in the basal compartment of the T-tunnel with one terminal compartment containing five females, the sexual responses of the insects varied according to the nature of the substrate presented to them (table 2). On the leaf of the host cotton plant, all the males started 'dancing' and on lifting the shutter (figure 1, sh), the dancing male advanced along the stem of the T to its transverse arm, where most males advanced towards and reached the female-bearing terminal compartment. A few males, however, first advanced towards the blank terminal compartment without reaching it, and reversed to reach the female-bearing compartment. On the leaf of a non-host castor however the direction finding by males was not as precise as on cotton leaf. The percentage of males first turning towards the blank terminal compartment was significantly greater than that on cotton leaf. However, the total percentage of the males reaching the female-bearing compartment remained as high as on the cotton leaf (table 2).

On a parafilm membrane (unstretched), none of the males showed 'dancing' and never reached any of the two terminal compartments. However, on the stretched (four times its length) sheet of the parafilm membrane, the percentage of males showing dancing increased to 60 though it was significantly lower than that on cotton leaf-sheet. On entering the transverse arm, almost 50% turned and reached the female-bearing compartment. The remaining males, however, reached neither of the two terminal compartments. On the sheets of the filter paper and nylon net, the percentages of the males exhibiting dancing movements declined significantly to about 1/10 to 1/5 of that on the cotton leaf. All these males reached the female-bearing terminal compartment. On a PVC sheet, the males neither showed dancing nor did they reach any of the terminal compartments (table 2).

Thus, despite the fact that the parafilm membrane, filter paper, nylon-net, PVC sheet were capable of transmitting the acoustic signals of the leafhopper (table 1), the sexual orientation of the males towards the females on these substrates (except the stretched parafilm membrane) was almost insignificant. Such differences were due to the fact that the artificial substrates did not provide any stimulus (Olfactory, hygro) to the insects to enable them to settle on these substrates. Consequently, the males and females arrived on an artificial substrate randomly so that the chances of the two sexes arriving on the same substrate simultaneously were reduced, thus affecting the sexual communication between the two sexes. Since the glass plate did not transmit the acoustic signals, it is inferred that it is unsuitable for studying the sexual orientation of the males towards females.

So it is tentatively concluded that (i) the abdominal vibration in the female *A. devastans* is related with its sound production; and (ii) the host cotton leaf would be the most ideal substrate for eliciting the sexual orientation of the male to female in response to their mutual substrate-borne acoustic communication.

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ANNOUNCEMENT

WORKSHOP ON ANTARCTIC STUDIES

Antarctic, the coldest, windiest and the least accessible has become an object of immense scientific interest and has attracted scientists of numerous disciplines from different corners of the world. The beginning of the Indian program of Antarctic research was made when the first Indian expedition led by Dr. S. Z. Qasim landed in Antarctica on 9th January, 1982. Since then the Government of India has launched seven successful expeditions to Antarctica, the last one sailing off from Goa on 25th November, 1987. At present there is a permanent Indian research station, manned round the year, at Dakshin Gangotri, Antarctica.

The need has now been felt to have a common platform where the participants of all previous expeditions and all those who have been associated with Indian Antarctic research, directly or indirectly, could come together to share their experiences and discuss the results in detail. This will enable us to have an overall perspective view-to appreciate the achievements of the research efforts so far, to note its shortcomings and finally to decide a definite direction for future planning.

With this objective in mind a "Workshop on Antarctic Studies" will be organised under the sponsorship of the Department of Ocean Development (DOD) from 3rd to 5th May, 1988 at the National Physical Laboratory (NPL), New Delhi. The topics to be covered in the Workshop are wide open. Some of these are: Meteorology; Earth Sciences; Oceanography; Atmospheric Sciences; Ecology and Evolution; Physiological, Psychological studies and Researches in Polar Medicines and Human Adaptabilities; Antarctic Resources; Biological and Biomedical studies; Habitat and System Support and Future Programmes of Antarctic Research.

The details of Workshop are available with Dr B. S. Mathur, Deputy Director, National Physical Laboratory, Dr K. S. Krishnan Road, New Delhi 110 012.