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The Sounds Produced by Swarming Honey Bees*

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Zusammenfassung. 1. Schwirrläuferinnen vibrieren alle 0.5 bis 3 sec mit ihren Flügeln, wenn sie durch den Stock laufen. Die Frequenz der Flügelbewegungen liegt zwischen 180 und 250 Hz.

2. Sobald die Schwirrläuferin eine Stockgenossin anrempelt, erzeugt sie ein Dauergeräusch, in dem die Frequenz von 200 auf 500 Hz ansteigt.

3. Im Dauergeräusch erscheint eine zweite, unabhängige Frequenz von 4000 bis 5000 Hz. Die Amplitude von Schwingungen dieser Frequenz kann auf $^1/_3$ der Amplitude der Schwingungen der niedrigeren Frequenz anwachsen.

4. Bienen eines nicht schwärmenden Volkes reagieren auf Tonbandaufnahmen von Kontakt haltenden Schwirrläuferinnen mit der „Stillhaltereaktion." In schwärmenden Völkern bleibt die „Stillhaltereaktion" aus.

Summary. 1. "Schwirrläuferinnen" buzz their wings every 0.5 to 3 sec while performing straight runs. The frequency within a buzz varies between 180 and 250 cps.

2. The "Schwirrläuferin" produces a permanent noise as soon as it contacts a hivemate. In this permanent noise the frequency increases to about 500 cps.

3. In the permanent noise a second, constant and independent sound with a frequency of about 5,000 cps shows up. Its amplitude can reach $^1/_3$ of the amplitude of the lower frequency noise.

4. Bees in a non-swarming hive react to tape recording of contacting "Schwirrläuferinnen" with the "freezing" response. This response can not be elicited in swarming hives.

Introduction

Different observers have reported that bees of a colony which is ready to swarm leave the hive only after they get a "command" to do so. The "command" is the so called "Schwirrlauf" (LINDAUER, 1955; MARTIN, 1963; v. FRISCH, 1965). In a "Schwirrlauf" the bee runs with vibrating wings through the hive and seeks contact with hivemates. As soon as the "Schwirrläuferin" touches a hivemate the latter starts a "Schwirrlauf" too. In this way the message spreads through the hive very quickly.

In 1962 we checked different "Schwirrläuferinnen" on the surface of a swarm cluster hanging in the open with a highly directional microphone (cited in v. FRISCH, 1965) and found that the "Schwirrläuferinnen" produced a sound quite similar to that which can be heard in the wagging

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periods of the well known dances (Esch, 1961). Recent investigations inside an observation hive revealed, however, that also quite different acustical signals can be heard.

Results

We made our observations on bees of the *Italien* race (*Apis mellifica ligustica* Spin.) The lower quarter of the window of a usual two frame observations hive was removed and replaced by a thin screen through which sound recordings could be made. The recording technique was described in an earlier paper (Esch, 1961).

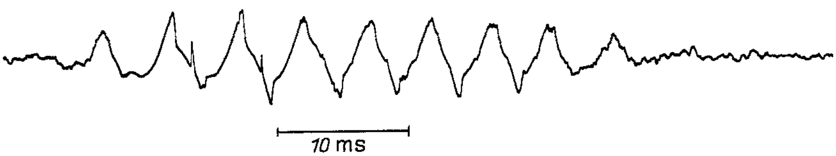

Fig. 1. Buzz from a straight run. Average frequency about 200 cps

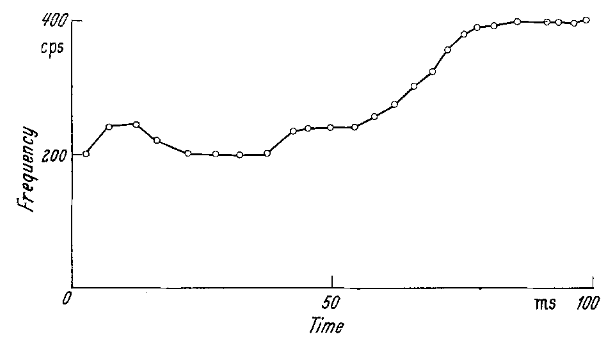

Fig. 2. Change in frequency as a "Schwirrläuferin" approaches a hivemate

The swarming of the observation hive was released by "Schwirrläuferinnen" which showed up all of a sudden in the middle of another experiment. The "Schwirrläuferinnen" made straight runs in which they did not touch other bees and during which they buzzed with their wings every 0.5 to 3 sec. As one can see from Fig. 1 the wingbeat frequency within a buzz is near to that of a normal flight. It ranges from 180 to 250 cps. The wave form is far from being sinusoidal indicating that there is a high energy content in the overtones. As soon as the "Schwirrläuferin" touches a hivemate (and she does it intentionally) the buzz becomes permanent for the time of the contact. The wingbeat frequency in the buzz increases very fast to 400 or 500 cps (Fig. 2). It stays at this level as long as the contact between the two bees is made (Fig. 3). This is sometimes up to 5 sec. As soon as the two animals separate the frequency falls to about 200 cps and the noise stops completely for some seconds.

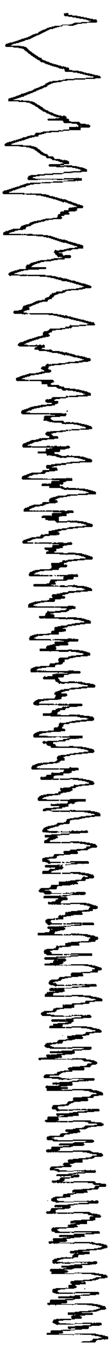

Fig. 3. "Schwirrläuferin" losing contact to a hivemate. The wingbeat frequency changes between 445 cps (left) and 250 cps (right). The second frequency stays at about 4,500 cps

With the increasing wingbeat frequency during the contacts always a second frequency shows up which remains constant at about 4,000—5,000 cps (Fig. 3) while the wingbeat frequency can change between 200 and 500 cps. We observed a similar phenomenon in the sounds made by flies and bees at different occasions and described it in an earlier publication (Esch and Wilson, 1967). The amplitude of the second vibration increases with increasing wingbeat frequency and can reach about $^1/_3$ of the amplitude of the latter. There are still higher frequencies showing up which we could not analyse with sufficient accuracy using our present equipment. New equipment purchased under the current grant will enable us to do further analysis.

The higher frequencies can be effectively emitted from the small surface of a bee and one can hear the noise with an unaided ear at a distance of about 1 m from the hive. There is no doubt that a hivemate can perceive the sounds made by the "Schwirrläuferin," too, especially if they are so close together.

The spectrum of the noise made by a "Schwirrläuferin" is similar to that of the noise which produces the long known "freezing" effect (Hansson, 1945). If one plays a tape recording of a "Schwirrläuferin" into a normal hive the movements of all bees freeze as soon as the "contact noise" can be heard. In a swarming hive, however, neither a tape recording nor the direct noise emitted from a "Schwirrläuferin" has a freezing effect.

Discussion

During the contact of a "Schwirrläuferin" and a hivemate the command to swarm is transmitted (v. Frisch, 1965). The noise emitted by a "Schwirrläuferin" while it has contact to a hivemate is so different from sounds occurring at other occasions that is it conceivable that it might be the signal to leave. The "Schwirrläuferin" can offer some important sensory inputs of a "Schwirrlauf" to the hivemate and the latter, as we can see, promptly starts a "Schwirrlauf" after the contact.

The lack of a "freezing" effect in a swarming colony shows that the response of the bees to the particular stimulus which normally releases the "freezing" response has changed. If the noise of a "Schwirrläuferin" is the command to swarm, this noise is completely out of context in a normal, non-swarming colony. The "freezing" response thus can be explained as a "displacement activity" (TINBERGEN, 1951). Further studies on this subject seem necessary.

The behavioral situation of the "Schwirrläuferin" is of particular interest. At one hand, the flight command was given to its indirect flight muscles. They oscillate with maximum energy. At the other hand, the direct muscles which bring the wings into the "flight position" did not perceive a flight command. The indirect muscles, therefore, oscillate without damping and the frequency of the oscillation increases to about the double of the normal value.

References

ESCH, H.: Über die Schallerzeugung beim Werbetanz der Honigbiene. Z. vergl. Physiol. **45**, 1—11 (1961).

—, and D. WILSON: The sounds produced by flies and bees. Z. vergl. Physiol. **54**, 256—267 (1967).

FRISCH, K. v.: Tanzsprache und Orientierung der Bienen, S. 1—578. Berlin-Heidelberg-New York: Springer 1965.

HANSSON, A.: Lauterzeugung und Lautauffassungsvermögen der Bienen. Opusc. entomol. (Lund), Suppl. **6**, 1—124, (1945).

LINDAUER, M.: Schwarmbienen auf Wohnungssuche. Z. vergl. Physiol. **37**, 203—324 (1955).

MARTIN, P.: Die Steuerung der Volksteilung beim Schwärmen der Bienen. Zugleich ein Beitrag zum Problem der Wanderschwärme. Insectes sociaux (Paris) **10**, 13—42 (1963).

TINBERGEN, N.: The study of instinct, p. 1—288. Oxford: University Press 1951.

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