BEETLE TALK

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As the shadows lengthen in the evening, the familiar strident chirping of crickets and katydids resound through city yards and country forest and field. We have, at times, been deafened by the tymbal chorus of cicadas high in the old cottonwood tree on a hot summer day, or startled by a crepitating grasshopper as we passed through a quiet field. But have you ever eavesdropped on a rotten log to listen to the intimate communications of beetles?

Many species of beetles are known to make sounds by the usual method of scraping some form of washboard apparatus (stridulation). The most familiar beetle sounds are the "disturbance" signals made when they are picked up or squeezed. Various longhorn beetles (Cerambycidae), weevils (Curculionidae), and scarabs (Scarabaeidae) respond this way.

But what do beetles say to each other? This is little known except for the water scavenger beetles (Hydrophilidae), bark beetles (Scolytidae), and those which are the subject of this article, the patent leather or betsy beetles (Passalidae). These will be familiar to those of you who have ever broken open old oak logs or stumps in the deciduous woodlands of the eastern United States. Often, one or more shiney, black beetles approximately an inch long will come tumbling out as the log falls apart. The common U.S. species, Odontotaenius disjunctus*, is easily recognized by the hook-like horn on its "forehead." In the spring or summer, you might also find with the adults a nest of red (young) to green (old) eggs or a number of white grubs. These larvae are easily recognized as Passalidae, for they appear to have only two pairs of legs, quite a rare occurrence for an insect! This, however, is really no exception to the "six-leg rule" because the third pair is actually present, but very small. This last pair has lost the walking function and, instead, is used in sound production! These reduced legs possess five or six small teeth which produce a faint rasping sound when rubbed against a striated area on the base of the second pair of legs, as if tickling themselves under their own armpits. In this family, the children have a voice as well! The adults make sounds by an entirely different mechanism. They rub two rough, oval areas on the upper surface of the abdomen against the hind wings, thus producing their louder sounds.

In the past 22 years, we have kept over 70 species of betsy beetles in our home, usually in some prominant place where they could easily be seen and heard, such as the kitchen table. They keep quite well in large glass Petri dishes with plenty of moist, rotten wood. They are easier pets for children to care for than are most feathered and furred vocalists. Though not as loud as the cats on the back fence, they, too, have awakened us with their persistent courtship sounds.

Most species of Passalidae we've studied produce the same sorts of sounds, with minor variations. We have recorded the greatest vocabulary of sound from O. disjunctus. In fact, if we consider an acoustical signal as a particular type (structure) of sound produced in a particular behavioral context, then O. disjunctus has the largest acoustical repertoire known for any species of arthropod, including crickets and katydids, larger, in fact, than that of many vertebrates! O. disjunctus produces at least 14 different acoustical signals, not including those produced during interactions involving larvae.

The object of this article is not a beetle dictionary, but we would like to describe those sounds you are most likely to hear if

* Formerly known as *Passalus cornutus* or *Popilius disjunctus*.

you keep some betsy beetles around the house. One means of describing sound is to pass the signal into an audiospectrograph. This machine produces an audiospectrogram, a "picture" of the sound with time on the horizontall axis and frequency (pitch) on the vertical axis. The louder the sound is, the darker the mark.

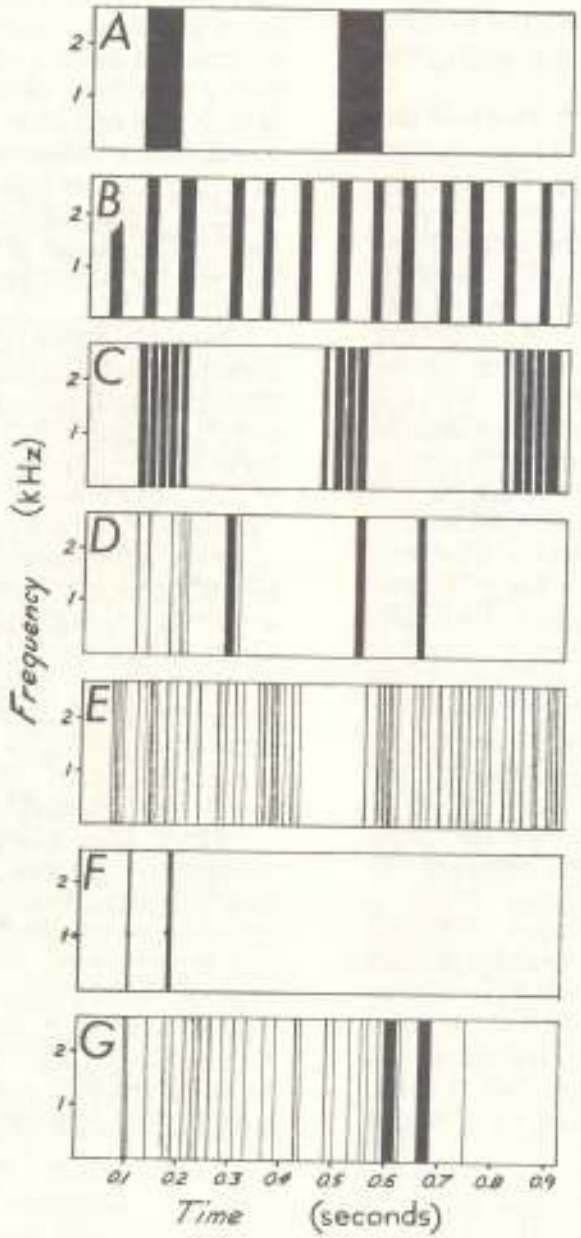
If you introduce a passalid beetle into the container of another of the same species, you may provoke a spectacular fight. The aggressor places its head (mandibles spread, antennae vibrating wildly) under the side of the other beetle. By jerking upward with the head, one beetle can overturn the other. Sometimes the aggressor's mandibles may close on the other's leg and lift its whole body clear off the ground! In this situation, two sound types are commonly produced. Female aggressors produce "stuttering" sounds: short "dz dz dz dz dz dz dz." Male aggressors produce "whirring" sounds: "trrr trrr trrr trrr" (see audiospectrograms). Sometimes the beetle receiving the aggression produces a long "buzz" sound similar to that produced when disturbed: "zzzzzzz zzzzzzz zzzzzz zzzzzzzz."

Though an introduction may instead initiate a "love affair," beetles which have been living together for some time may engage in courtship. Initially, courtship resembles a fight (not an uncommon occurrence in other animals...including humans). The male places his head to the female's side, vibrates his antennae rapidly, and produces whirring sounds. He is less violent, however, and does not toss his partner with his widely spread mandibles. Next, he turns his body parallel to hers and faces the same direction. In this position they begin to circle, the female on the inside with bodies remaining parallel. In some species, including O. disjunctus, he changes his tune at this point and producess a series of short buzzes: "zzzz zzzz zzzz zzzz zzzz." She often produces a similar sound during this courtship "circle dance." In the laboratory this may become a dance marathon. We have watched a pair of beetles dance in this manner for as long as 12 hours! If you are very lucky you may observe copulation, during which conversation usually ceases. Afterward, you may hear some soft, strange sounds of which little is known. Incidentally, certain species of passalids copulate venter to venter facing the same direction, a position not known for other beetles and rare for other insects.

Many interesting questions remain concerning passalid beetle sounds. Do species from different parts of the world have different "languages"? So far, we have studied New World species from Peru to the United States. Many seem to possess a similar vocabulary. The greatest inter-specific difference we have encountered is in the whirring sound produced by Odontotaenius zodiacus, a species known only from the Sierra Madre Oriental Mountains of Mexico. Its whirring is of much longer duration and the component elements are much shorter than whirring sounds we've heard from other species. But what about Old World passalids? Do they speak an "oriental" dialect?

How does sound communciation function in the social behavior of Passalidae? Social and subsocial insects often have large communicative vocabularies. It is significant that the largest insect acoustical vocabulary known is possessed by what may be socially the most highly advanced beetles, the Passalidae. Further study of their communication in relation to their level of sociality may provide new insights into the evolution of social behavior.

Semi-diagramatic drawings of audiospectrograms.



Sound types produced by Passalidae. Semi-diagramatic drawings of audiospectrograms: Type A—(female courtship signal, 30°C), Type B—(female aggressive signal, 29°C), Type C—(male courtship initiation signal, 29°C) all *Passalus punctatostriatus;* Type D—(mild aggressive signal, 30°C), Type E—(male aggressive signal, 30°C) both *P. punctiger;* Type F—(post-aggression signal during "push-ups", 25¼°C) *P. convexus;* Type G—(signal produced while feeding alone, 28°C) *P. punctiger.*