

Stridulating Organs of Female Tettigoniidae (Orthoptera).

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The literature on the Orthoptera contains a number of records in which an observer claims to have heard calls by the female of some species of Tettigoniidae. Riley, describing the song of *Scudderia furcata*, says "the call is occasionally re-

sponded to by a faint chirp from the females, produced by stretching out their wings as if for flight." He described the prolonged rattling song of *Microcentrum rhombifolium* and says that it "is invariably answered by a sharp 'chirp' or 'tschick' from one or more females who produce the sound by a sudden upward jerk of the wings." Were it not for the last statement one would strongly suspect that he had heard the other type of male song, which he apparently failed to recognize.

Caudell has reported that the female katydid (*Pterophylla*) makes a sharp scraping noise when handled, and this observation has been confirmed by Allard, who also reports that he has heard the females of other species of Tettigoniidae making a noise of their own accord out of doors, and mentions specifically *Scudderia curvicauda*, *Amblycorypha rotundifolia*, and *Microcentrum rhombifolium*. He says that "these call notes appear to be in the nature of true sex calls or invitations to the males, for a number of these in every instance at once congregated about her, some of them flying from the shrubbery around."

My own observations include instances of stridulation by females of three species of Tettigoniidae. Late one afternoon I heard five sharp but not loud sounds like "tsip," coming from a small bush in which only a female *Microcentrum rhombifolium* could be located. At another time while collecting after dark I heard close by a faint ticking sound. I turned my flash light in the direction of the sound and saw a female *Amblycorypha rotundifolia*. She did not repeat the sound but no other insect could be found at that place.

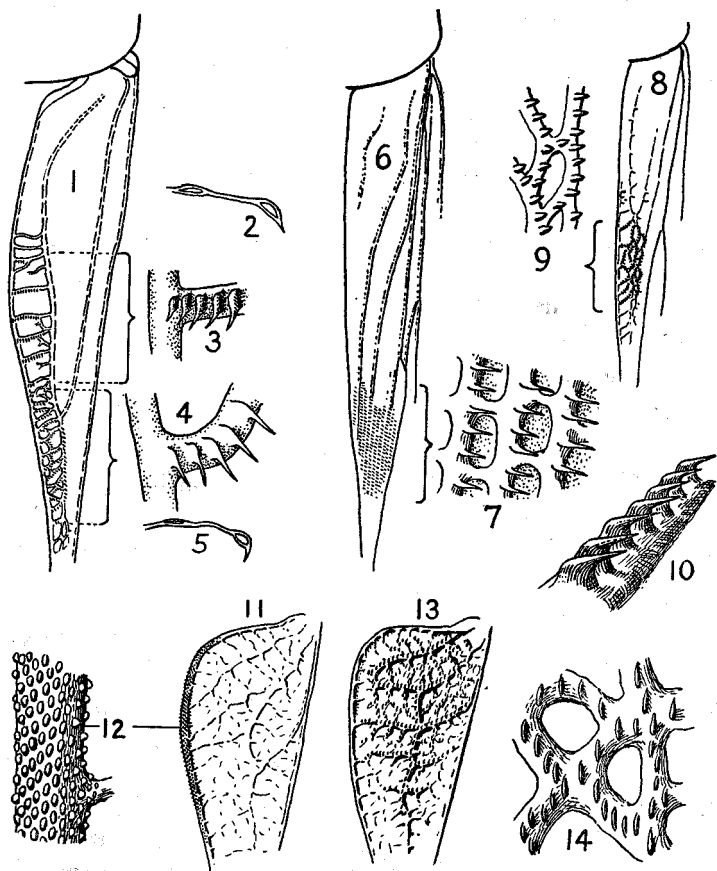
A more striking observation was made on *Scudderia texensis*. While sitting on the porch one night I heard a male of this species singing in the lot next door and noticed that immediately after it sang, a brief series of faint tapping sounds came from a cedar tree at the edge of the porch. With a flash light I located a female in the tree and saw it produce the sound by working the tegmina in a manner similar to the male. The reply always came about a half second after the conclusion of the male song. I caught the female to verify the species and turned it loose again. A little later I heard a similar reply coming from another cedar tree at the edge of the lot and found another female there. Presently the male came to this

second tree and each time its song ended both females could be heard simultaneously. The female in the further tree remained on the branch where first found and the male crawled over to her. Later a spermatophore was found attached to her.

On another night I heard at a distance of about 30 feet a faint sound like "chp," following the prolonged ticking song of *Microcentrum rhombifolium*. This was repeated nearly every time a *Microcentrum* sang within a radius of about 40 yards. I located the female in a low tree branch and watched her make the noise by spreading the dorsal edges of the tegmina a few millimeters and closing again. I went on past the tree to listen to another insect but noticed that a male *Microcentrum* sang twice in the upper branches of the tree and that the female replied each time. I heard no more of this male and after several minutes I went back to look at the female. I found her licking the abdomen of a male who was humped up so that the closed tegmina were perpendicular to the leaf it was standing on. The female had a large spermatophore attached to her.

The last two observations agree with Allard's statement that the males come to the females. The females did not move from the places where they were first discovered. If the males are guided only by the faint replies made to their songs, they must have a remarkable ability to locate sounds.

For a long time the writer supposed that the sounds made by female Tettigoniidae were produced by merely striking the overlapping anal areas of the tegmina together. This theory was rejected when it was found that a faint rasping noise could be produced by manipulating the tegmina of a recently killed female *Scudderia*. The specimen was examined under a binocular microscope and there it was noticed that a portion of the edge of the left or upper tegmen near the caudal part of the anal area was bent downward to form a scraper (Fig. 5) and that when it was dragged over the anal area of the right tegmen a rasping sound was produced. The right tegmen at this point bears a patch of minute stout spines (Fig. 4) projecting from the veins and directed diagonally backward and to the right so as to catch in the recurved margin of the left tegmen when the two are moved apart. Anterior to this area there are trans-



Stridulating organs of female Tettigoniidae. Fig. 1. Anal area of right tegmen of *Scudderia curvicauda* showing spined veins. Figs. 2 and 5. Cross sections of margins of left tegmen showing scrapers for anterior and posterior sets of spines, respectively. Fig. 3. Anterior spines, enlarged. Fig. 4. Posterior spines. Fig. 6. Anal area, right tegmen of *Neoconocephalus triops*, showing patch of spines. Fig. 7. Enlarged portion. Fig. 8. Anal area, right tegmen of *Orchelimum concinnum*. Fig. 9. Enlarged portion. Fig. 10. *Microcentrum rhombifolium*, perspective of spines on one of anterior transverse veins. Fig. 11. Anal area, right tegmen of *Pterophylla camellifolia*. Fig. 12. Vein on inner margin. Fig. 13. Ventral surface, anal area, left tegmen of *Pterophylla*. Fig. 14. Enlarged portion.

verse veins near the margin which bear rows of minute knobs (Fig. 3) each with a stiff spine directed posteriorly and nearly parallel to the tegmen surface. At this level the margin of the left tegmen projects downward with a sharp edge (Fig. 2) but is not recurved or hooked. This edge catches on the spined knobs when moving either direction but more so when the tegmina are coming together.

Although the structures described are minute, they appear to be specialized stridulating organs. The anal edge of the right tegmen does not project to the same extent and is nowhere recurved. The left tegmen does not bear any spines and does not have any well developed transverse veins. The right tegmen of the male has some spines along the veins in the posterior part of the anal area, but they are much more delicate in structure than those of the female.

After making this discovery the writer went through his collection, which contains nearly all the common eastern Tetti-goniidae and many western species, and examined the females. Every species in which the female has overlapping tegmina was found to have some form of female stridulating organ. All species examined in the genera, *Scudderia* (8 spp.), *Ambly-corypha* (5 spp.), *Microcentrum* (2 spp.), *Inscudderia*, and *Symetropleura* have an apparatus very similar to the one described above. In *Microcentrum* the spines (Fig. 10) are unusually well developed.

The species of *Neoconocephalus* (Figs. 6, 7) and *Pyrogocorypa uncinata* have an area of spines only at the caudal part of the anal area. All species of *Orchelimum* (Figs. 8, 9) examined (13 spp.) have well developed areas of very short blunt spines mostly in the caudal part of the anal area, but in some species extending farther forward somewhat as in *Scudderia*. *Conocephalus* (12 spp. examined) has less well developed patches of blunt spines. They were found even in *C. saltans* which has very abbreviated tegmina.

Among the Decticinae only three species having overlapping tegmina in the female were found in the collection. *Capnobotes fuliginosa* and *C. occidentalis*, have long tegmina with a patch of scattered but well developed spines on the caudal portion of the anal area of both tegmina. *Apote notabilis* has small ovoid

tegmina with a well developed scraper on the left and an extensive area of conical erect spines on the right.

Pterophylla camellifolia, the true katydid, has an apparatus similar to those described, but the spines are relatively few and scattered. This species however has another structure which is apparently designed for sound production. The vein bounding the anal area of the right tegmen only (Fig. 11) is large and well rounded above and for a considerable part of its length is thickly studded above with very minute but prominent knobs (Fig. 12) arranged in regular diagonal rows. The under surfaces of the anal areas of both tegmina have a network of prominent veins (Fig. 13) bearing many short ridges or keels (Fig. 14) all directed parallel to the length of the tegmen regardless of the direction of the vein. They are most numerous in the central portion of the anal area where those on the left tegmen would scrape over the file-like vein bordering the right if the tegmina were slightly spread apart.

No stridulating organ could be found on females of any of the Gryllidae. Baumgartner claims that the female *Gryllotalpa* has a loud distinct chirp and that in both this genus and *Scapteriscus* the females have stridulating organs. The writer has not been able to locate any file or spines on any of the veins on either surface of the tegmina in any of the female mole crickets in his collection.

A distinctly audible sound can be produced by manipulating the tegmina of a freshly killed female of any species of Tettigoniidae as large as an *Orchelimum*. A very faint sound can be produced with species as small as *Conocephalus fasciatus*. Such sounds have been heard in nature only from those species in which the males sing at irregular intervals. With many species the males keep up such a constant noise that the female reply, if made, could not be heard, at least by human ears. It is probable that only females in a certain "mood" or physiological state reply to the calls of the male.

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