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Sound Production in *Cyphoderris monstrosa* (Orthoptera: Prophalangopsidae)[1]

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ABSTRACT

Cyphoderris monstrosa Uhler, one of only 2 species of Prophalangopsidae in the United States, produces intense short trills at about 13 kilohertz at 25°C. Pulse rate averages 71.4 per second and trill duration ranges from 0.5 to 2.0 second. Males switch wings regularly while calling, a phenomenon not typical in Gryllidae and Tettigoniidae.

Cyphoderris is a genus of unusual katydids represented by 2 species, *C. monstrosa* Uhler and *C. buckelli* Hebard. *C. piperi* Caudell is a junior synonym of *C. monstrosa* (Hebard 1934). Both species occur in the mountainous regions of northwestern United States and southwestern Canada. Family rank for the group is justified (Zeuner 1932) although some current authors treat the Prophalangosidae as a subfamily of Tettigoniidae. It is noteworthy that the only other extant genus in this family is *Prophalangopsis* of India.

Hebard (1934) noted that males of *C. monstrosa* begin to sing after sunset, producing a faint, elusive, high-pitched sound, "in timbre suggesting that of *Oecanthus*." He stressed the ventriloquistic nature of the song and stated that one singing male was collected on the ground. Fulton (1930) described the song as a loud, penetrating, high-pitched, shrill, metallic trill repeated at rates of 15–20/min. He noted the calling position to be a few feet up on tree trunks and in bushes. My observations concur with these descriptions. The call is ear-piercing at close range, and at a distance appears deceptively close. The call has some characteristics usually considered typically gryllid and some that are considered typically tettigoniid. Gryllids exhibit calls of almost pure frequency (pitch) between 2 and 10 khz (Walker 1962) while tettigoniids produce calls containing wide ranges of intense frequencies (2–80 khz) (Morris 1965,[2] Spooner 1968, Suga 1966). *C. monstrosa* produces intense short trills at ca. 13 khz at 25°C (Fig. 1). The possibility of ultrasonic frequencies present cannot be ruled out because of the limitations of the taping and analyzing equipment. The call appears to have gryllidlike pure frequency in a frequency range typical of tettigoniids. The high frequency is exemplified by the fact that certain persons in our laboratory with high frequency insensitivity could not hear the deafening trills or heard only faint sounds.

I made 2 tape recordings of one individual, and another recording of 2 others calling simultaneously. Each was in a separate screened cage. An Ampex 602 recorder at 7½ in./sec and an Electrovoice 655C microphone were used. All recorded calls were analyzed with a Model 6061A Sona-Graph. The general characteristics are shown in Table 1. Pulse rates listed in Table 1 were the average rates for entire trills. The variation in pulse spacing within trills was seldom greater than that in Fig. 1.

Fig. 1 is a typical trill showing variations in intensity (darkness) and variations in frequency from one pulse to another. These slight variations are detectable and were described by Fulton as "a rapid pulsation or beat." The rapid changes reflect irregular switching of tegmina from top to bottom position. R. D. Alexander (personal communication) has observed such switch-wing singing. Apparently even at rest either tegmen may be on top. Of 22 preserved males of *C. monstrosa* (20 at the National Museum of Natural History) 10 have the left tegmen on top and 12 have the right tegmen on top. Of 13 males of *C. buckelli* in the N.M.N.H., 6 have the left tegmen up and 7 the right one up (A. B. Gurney kindly examined the N.M.N.H. specimens). Tettigoniidae typically have the left tegmen above the right. In Gryllidae the right tegmen is usually on top. In Gryllidae the tegmina are usually similar in structure, but in Tettigonidae the left and right tegmina are usually distinctively different in the stridulatory

[1] Received for publication Feb. 1, 1972.
[2] G. K. Morris. 1965. Ultrasonic frequency analysis of Tettigoniidae. Unpublished M.S. thesis, Cornell University, Ithaca, N. Y. 39 p.

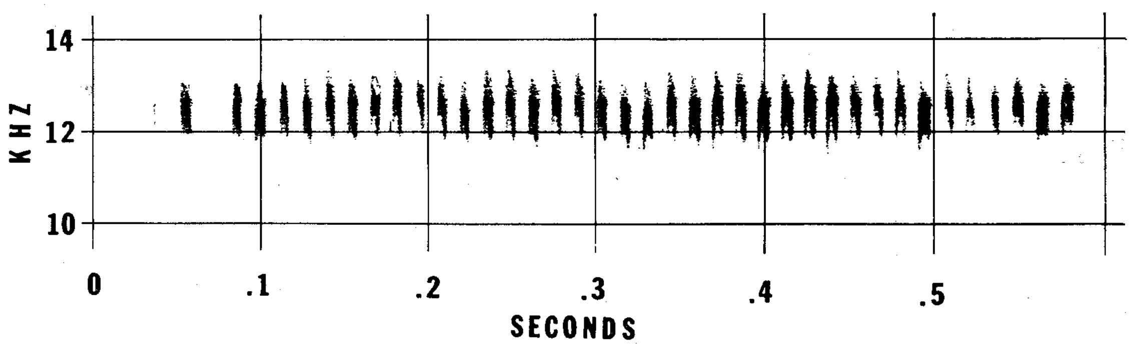

FIG. 1.—Typical trill of *C. monstrosa* at 25°C.

Table 1.—Characteristics of the call of *C. monstrosa* collected at Salt Creek Falls, Lane Co., Oreg.

Recording	°C	No. trills analyzed	Pulses/sec Range	Pulses/sec Avg±SD	Trill duration (sec) Range	Trill duration (sec) Avg
1-a	25.1	32	68.8–75.2	73.3±0.9	0.5–1.1	0.7
1-b	25.0	30	66.7–76.3	73.8±4.2	.1–1.0	.5
2-a[a]	25.0	37	62.4–71.7	67.2±3.9	.3–2.0	1.0

[a] Two individuals recorded together.

area. In 2 *C. monstrosa* at hand, the stridulatory files and scrapers are equally developed on each tegmen. The tegmina are constructed similar to those of gryllids, with a rigid dorsal portion at ca. 90° to a rigid lateral portion. Walker (1962) concluded that such a tegmen is a highly damped, simple harmonic vibrator driven by the impacts of the stridulatory file and scraper. Walker further concluded that the change in dominant frequency from beginning to end of a single pulse results from a change in toothstrike rate caused either by a change in the rate of closure of the tegmina or by changes in the spacing of the teeth. Single pulses of *C. monstrosa* trills do change frequency from beginning to end, increasing first and then decreasing (Fig. 1). Table 2 shows that the teeth are closer together on the anterior, or inner, end of the file than along the middle portion and are farther apart on the posterior, or outer, end next to the scraper.

All teeth except a few (fewer than 10) on the outer end of the file are well developed, and it is probable that most of the file is involved in producing a pulse. In Fig. 1, some pulses measure 0.0087 sec. At 13,000/sec, 113 teeth are struck in 0.087 sec. *Gryllus* has well-developed teeth not used in calling (Walker 1962). The uniform shape of the pulses in *Cyphoderris* indicates that all pulses are made in the same manner, either on the closing strokes or opening strokes of the tegmina. In crickets the teeth project toward the inner end of the file and sound is made on closing. The file teeth of *C. monstrosa*

Table 2.—Characteristics of the stridulatory files of 2 males of *C. monstrosa.*

	Specimen 1[a] Left tegmen[b]	Specimen 1[a] Right tegmen	Specimen 2[a] Left tegmen	Specimen 2[a] Right tegmen[b]
Length of file (mm)	3.57	3.51	3.51	3.35
Total teeth in file	115	111	105	107
Tooth density[c] (teeth/mm) per 20 teeth of file length	39.8	41.6	38.4	37.8
	32.6	31.6	31.6	32.1
	30.7	30.3	29.1	29.5
	30.3	31.1	29.9	31.1
	31.6	31.1	27.5	31.1
	26.9(14)	22.4(10)	15.4(4)	25.8(6)

[a] Specimen 1 from Salt Creek Falls, Lane Co., Oreg.; specimen 2 from Muir Creek Campground, Douglas Co., Oreg.
[b] This tegmen on top.
[c] Tooth densities listed start with the forward (inner) end of the stridulatory file at the top of each column. The last numeral in each column is based on less than 20 teeth, the actual number of teeth shown in parentheses.

project toward the outer end of the file, which suggests that sound may be produced on the opening strokes. The well-developed, closer spaced teeth at the inner end of the file may tend to keep the toothstrike rate up when the tegmina are speeding up at the beginning of the sound-producing stroke. Of course, it is possible that only the uniformly spaced teeth in the central portion of the file are involved in the sound-producing stroke, in which case the slightly lower frequency at the beginning and end of the pulse results from changes in speed of tegminal motion during acceleration from zero to full speed and back to zero. The tegmina must move at ca. 43 cm/sec (slower at inner end) to produce a toothstrike rate of 13,000/sec.

The variations in parameters described here are only slightly greater than variations described for species of crickets (Walker 1962). Save for an occasional decticine, there is presently little opportunity for contact between *C. monstrosa* and other stridulating ensiferan species, hence selection pressure in the past may account for the uniformity of call in this species.

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