Songs and Systematics of Some Tettigoniidae from Colombia and Ecuador I. Pseudophyllinae (Orthoptera)

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Abstract

This paper provides taxonomic description for 16 species of pseudophylline katydid. Analysis of the calling songs is given for all but one. Among 14 genera *Mystron* and *Stetharasa* are new. Eleven new species are described from four Provinces in Ecuador: Morona Santiago, Pichincha, Los Rios and Napo, and two southern Departamentos of Colombia: Valle del Cauca and Risaralda.

The diverse species-specific calling songs of Pseudophyllinae are comprised of either transient or sinusoidal pulses. The carrier frequency song spectrum occurs in conjunction with these two pulse types, as either a band (transient pulse, low Q) or a single dominant narrow-peak carrier (sinusoidal, high Q). And stridulatory file morphology differs accordingly. Principal carriers in the songs of the species described here range from the audio to the low ultrasonic (20-30 kHz); overall among pseudophylline species whose songs are known (n = 65), a majority (75%) incorporate high Q pulses. [**Key words:** Tettigoniidae, systematics, acoustic signaling, taxonomy].

Introduction

False-leaf katydids, Pseudophyllinae, are a common nocturnal presence on the understory vegetation of South American primary rainforests (Belwood 1990). Taxonomic information about Ecuadorean and Colombian Pseudophyllinae is found largely in Hebard (1924, 1927, 1933) and Beier (1960, 1962). The latter lists >140 pseudophylline species from these two countries. Still the taxonomy of this very diverse group is quite incomplete and each newly examined tropical locality inevitably yields new species.

The present paper treats 16 pseudophylline species. Eight were studied by GKM on trips to Ecuador (1983-1989) and are from the Provincias Napo, Pichincha and Morona Santiago. Another 8 species were taken jointly by FM and GKM during May 1996 and March 1997 in southwestern and southcentral Colombia, in the Departamentos del Valle del Cauca, and Risaralda. A few additional Colombian specimens were obtained in 1998 and 1999. One species of *Eubliastes* is found in both countries. In addition to illustrated taxonomic description and redescription, for all but one of these species we give details of the physical features of the calling song.

Species List

Pleminiini
- *Championica walkeri* sp. nov.

Platyphyllini
- *Triencentrus atrosignatus* (Brunner v. Watt., 1895)

Cocconotini
- *Trichotettix pilosula* Stål, 1873
- *Eubliastes chlorodictyon* sp. nov.
- *Mystron flavospinus* sp. nov.
- *Mystron beieri* sp. nov.
- *Docidocercus gausodontus* sp. nov.

Teleutiini
- *Teleutias fasciatus* Brunner v. Watt., 1895
- *Teleutias akratonos* sp. nov.
- *Chibchella nigrospecula* sp. nov.
- *Stetharasa exarmata* sp. nov.

Eucocconotini
- *Gnathoclita sodalis* Brunner v. Watt., 1895

Leptotettigiini
- *Macrochiton macromelos* sp. nov.

Pterophyllini
- *Parascopioricus cordillericus* Beier, 1960
- *Scopioricus spatulatus* sp. nov.

Pterochrozini
- *Typophyllum zingara* sp. nov.

Methods

We examined material from the United States National Museum (USNM), University of Michigan Museum of Zoology (UMMZ), Royal Ontario Museum (ROM) and Philadelphia Academy of Natural Sciences (ANSP). Unless otherwise indicated, cerci of males are drawn in dorsal aspect. Dimensions are mostly given in the text rather than as figure scales.

All size measurements are in mm, made either with digital calipers (Fowler Ultra-cal mark III) or an ocular micrometer. Other than for single specimens, values are stated as a mean and range. Body length is the distance from the most anterior part of the head, usually the fastigium verticis, to the most posterior extremity of the abdomen proper, i.e. excluding all terminalia. Pronotal length is measured in the dorsal midline. The length of a subgenital plate excludes any terminal emargination. For tibiae and femora we determined the greatest dimension when the leg is viewed anteriorly or posteriorly, excluding trochanters. The ovipositor was measured as a straight line between its tip and the posterior extremity of the subgenital plate. Ovipositor width is taken at this appendage's widest point excluding its base. Spination counts are reported as the most frequent value with a range in parens. Stridulatory files were studied after removal, using scanning electron microscopy (SEM); teeth were counted with file length taken as the straight line distance between the first and last tooth.

Color descriptions are based upon photographs (slides) of living animals; where color refers to pinned material this is expressly noted. With minor indicated exceptions, material is deposited at 1) Museo de Entomologia, Instituto de Ciencias Naturales (ICN), Universidad Nacional de Colombia, Santa Fe de Bogota. 2) Museo Entomología, Universidad del Valle, Cali, Colombia (MEUV), 3) Quito, Católica Zoologia (QCAZ) 4) in the Academy of Natural Sciences, Philadelphia (ANSP) and 5) Univ. of Toronto, Erindale College (ERN). Material collected by both authors is labelled as F. Montealegre and G.K. Morris.

Given at the outset of each sound signal description is the number of specimens successfully recorded. Measures of physical parameters which follow are averaged for all available individuals unless otherwise stated. Several to many repetitions of an individual's songs comprise a single tape recording; so several (usually ten) calls were averaged to obtain mean values of call parameters. For certain physical parameters variation in song measures between individuals can be very substantial and ideally a number of different singers should be sampled. Unfortunately this was rarely possible and should be borne in mind as a limitation on the song descriptions.

In describing songs we have also employed the real-time unaided human ear terminology suggested by Morris et al. (1989. p. 217). These names usually coincide with spectral types: zip or tick denote a noisy band spectrum, note or chirp a high-Q, musical spectrum. But many of the very short (< 1 s) calls here give no sense of musicality in real time. So if not heard to be musical with the unaided human ear they were considered noisy and termed either a 'zip' (infrastructure perceived) or 'tick' (no infrastructure). Often in fact they were composed of short sustained pulses in which a single frequency predominated. A signal (e.g. *Teleutias fasciatus*) which in real time must be called a tick because it sounds as a single 'pop' of static, becomes both particulate and musical if slowed by only a factor of 2, i.e. it would be considered a 'chirp'. On this basis we have sometimes specified a call as a chirp or note when slowed by a factor of 2, 4, 8 etc.

Phonatome is a useful term (Leroy 1966): it designates that repeated unit of the song corresponding to each cycle of the generating apparatus. The speed of stridulation usually prevents the association of generator movement and signal elements by observation. So in the absence of special techniques one can only guess at the phonatome of a particular species. Nevertheless many species alternate two types of pulses or pulse trains, one presumably corresponding to a forward the other to a backward scraper movement. And where the directions have been determined, more intense, more sustained components are typically made on closure (Pierce 1948, Morris and Pipher 1972, Walker 1975). So on this basis the term phonatome is used here as a 'probable' repeated motor unit, even when the actual correspondence of sound elements to the direction of generator movement remains unknown.

We hunted for insects at night along forest footpaths with the aid of headlamps. Some specimens were recorded in the field, with equipment limited to the audio range; others were transported to Canada alive and their songs recorded there in a laboratory in Mississauga, Ontario. In the lab the equipment permitted a full assessment of the audio and ultrasonic range, from 1 -100 kHz.

Field recording was with a Sony Walkman WM D6C Professional cassette tape recorder and ECM 909 microphone. Several times the zero-crossing meter of an Ultrasound Advice S-25 Bat Detector was used to record a song. This device discards carrier frequency information but stores temporal patterning. Temperatures were taken with an Omega HH23 digital thermometer.

Laboratory analysis employed Bruel and Kjaer equipment. A 1/4" (4135) or 1/8" (4138) condenser microphone was connected to a 2606 measuring amplifier or to a 2204 B and K sound level meter. Output from either of these amplifiers was recorded on a Racal instrumentation tape recorder running at 30"/s. Subsequently the signals were digitized using either a Keithley DAS50 digitizing board or Tucker Davis system II and then analysed with DADISP software.

Energy in spectra was only considered significant if it was no more than 20 dB below the most intense peak frequency. Descriptions of the distribution of spectral energy given here presume this '20 dB cutoff'. Spectra were almost always calculated on a single (putative) phonatome element and if otherwise are so indicated. Where the entire song is excessively short, e.g. < a few hundred ms, then the complete call is used as the basis of a FFT calculation.

Sound levels were measured (Table 13) with a 1/4" condenser microphone connected to the 2204 sound level meter. Readings were taken on Fast or Impulse/Hold, usually with a distance of 10 cm from the microphone tip to the dorsum of the singer. The long axis of the microphone was normal to the longitudinal axis of the insect and the microphone cover was always on.

Scanning electron micrographs were obtained using an Hitachi S-2500 microsope belonging to the Dept. of Zoology, University of Toronto. File lengths and tooth counts were taken from SEM records of a single specimen of each species; the specified length is the straight-line distance between the two most distant complete teeth (partially formed 'teeth' at the extremities being ignored). Most of the drawings were prepared by FM. Sound analyses and song descriptions were by GKM. In Colombia both authors participated in fieldwork.

Localities: Colombia

All listed Colombian localities excepting Ucumari are in the Departamento del Valle del Cauca. Bajo Calima, Anchicaya, Vereda Veneral del Carmen, La Plata and Papayal are all in the municipality of Buenaventura.

El Ensueño, Bitaco, Zingara: these premontane forest sites are close together in the western cordillera, reached by Via al Mar, the main road running northwest from Cali over the cordillera to Buenaventura on the Pacific Ocean. El Ensueño, in the municipality of Dagua, is undisturbed rainforest above a housing tract (3° 36' N, 76° 4' E; elevation 1800 m) near km 26 on Via al Mar; Bitaco is just to the east, elevation 1600 m; Zingara (3° 35' N, 76° 40' E; elevation

2000-2200 m) is closer to Cali, reached by a side road from Kilometro 18, the top of the pass. Annual rainfall at all these sites is about 200 cm.

San Antonio is cloud forest of the central cordillera, on Via al Mar before 'Kilometro 18' and the site of a communication tower (3° 32' N, 76° 70' E; elevation 2300 m)

La Sirena is premontane forest of the central cordillera in the municipality of Palmira. This is a natural forest reserve of the River Nima, the main water source for Palmira; 6250 hectares in extent, it has an annual rainfall of 160-280 cm (3° 32' N, 76° 7' E; elevation 2600-4100 m).

Bajo Calima: this site is disturbed lowland tropical rainforest (4° 10' N and 77° 15' W; elevation 50-70 m) in the Dpto del Valle del Cauca, situated on the extensive coastal plain (Choco Biografico) between the eastern slope of the eastern cordillera and the Pacific ocean. (Choco is a Dpto of Colombia, but Choco Biografico refers to Colombia's Pacific coastal rainforest, extending from Ecuador to Panama; and so these three countries may share species, e.g. *Eubliastes chlorodictyon*, see below.) About 13 km before Buenaventura a road leads north from the Via al Mar 13.2 km to Bajo Calima and the Centro Agroforestal, Universidad del Tolima. Our collections were on the grounds of the Centro Agroforestal. Annual rainfall here is almost 600 cm.

Anchicaya: this locality (3° 30' N and 76° 50' W; 300-350 m elevation) is undisturbed tropical rainforest on the western slope of the western cordillera; it is in the Dpto del Valle del Cauca within the municipality of Buenaventura and is reached via the old route from Cali to Buenaventura (Simon Bolivar Road). Rainfall is >340 cm per year with peaks of precipitation between March-May and October-November.

Veneral del Carmen, La Plata, Papayal: These localities are all low elevation (0-40 m) coastal forest of the Pacific Ocean. In additon to a high annual rainfall (up to 600 cm) this forest floods with brackish water as a result of the interaction of tide with river levels raised to overflowing near their mouth. Access is by boat, up small rivers ('quebradas') from the sea. Veneral del Carmen (3° 20' N, 77° 20'E) is the most southerly of the three and on the Rio Yurumangui. From Buenaventura, La Plata is to the southwest on Quebrada El Morro (4° 1' N, 77° 18' E) and Papayal to the northwest on Quebrada Guaipare (3° 34' N, 77° 55' E).

Yotoco: this forest preserve of subtropical wetforest (3° 52'N, 76°23' W; elevation 1400-1600 m) is in the Departamento Valle ~50 km north of Cali near Buga between the municipalities of Yotoco and Restrepo. It is also on the eastern slope of the western cordillera. The village Yotoco is the nearest settlement. Annual rainfall is 100-200 cm.

Ucumari: Parque Regional Natural Ucumari (PRN; 5° N 76° W) is on the eastern slope of the central cordillera, above the tiny hamlet of El Cedral, 22 km east of Pereira in the Departamento Risaralda. A narrow glaciated valley rises into montane rainforest over elevations of 1850-2600 m and high waterfalls enter along the sides. Yearly rainfall is 200-400 cm and the trails often become rock-strewn streams. Our collections were within a few kms (above and below) the Refugio Turistico La Pastora, 6 km up the valley from El Cedral.

Localities: Ecuador

Baeza, Prov. Napo: lower montane forest (0° 27' S, 77° 53' W; elevation 1500-1800 m) on the eastern Andean slope. This is a forest remnant bordering the right fork of the sendero above the old town.

Tinalandia, Prov. Pichincha: a small forest preserve southwest of Quito, at km 112 of Via Santo Domingo de los Colorados, 16 km SE of Santo Domingo (0° 19' S, 79° 3' W; elevation ~600 m). This is lowland rainforest typical of the western slopes of the Andes with faunal affinities reaching into Colombia (e.g. Bajo Calima, see above).

Rio Palenque, Prov. Los Rios: this is a remnant of lowland rainforest of the central coastal region of Ecuador, 47 km south of Santo Domingo de los Colorados (0° 27' S, 79° 25' W; elevation 150-220 m).

Mishaualli, Prov. Napo: lowland rainforest 17 km east of Tena at the junction of the Rios Misahualli and Napo (1° 2' S, 77° 40' W; elevation 400 m).

Jaguar, Prov. Napo: the focal point of this locality is a hotel in mostly undisturbed lowland rainforest; it is on the north bank of the Rio Napo 2 hours down river from Misahualli by canoe (0° 59' S, 77° 30' W, 300 m).

Primavera, Prov. Napo: this locality is lowland rainforest at a tiny settlement on the north bank of Rio Napo, 26.5 km east of Coca (Puerto Francisco de Orellana) (0° 25' S, 76° 45' W; elevation ~90 m). Reached by downstream canoe from Coca in 1 hour.

Limoncocha, Prov. Napo: lowland rainforest surrounds a settlement 40 km east of Coca and 8 km N of Pompeya on the Rio Napo (0° 24' S, 76° 37' W; elevation 250 m). Annual rainfall here is 250-280 cm.

Plan de Milagro, Prov. Morona Santiago: a site of montane rainforest about 1 km west of the junction (Indanza) of the road from General Leonidas Plaza Gutierrez (Limón) to Gualaceo with the road south to Gualaquiza (3° 1' S, 78° 28' W; elevation 2000 m).

Taxonomy

Tribe Pleminini

Championica walkeri sp. nov.
Figs 1, 18, 30; Table 1

Distribution.— Ecuador: western lowland rainforest.

Holotype.—Male, Ecuador, Prov. Pichincha, Tinalandia (type locality), 18 xii 1986, G.K. Morris, ANSP.

Etymology.—This species is named for Dr. Thomas J. Walker of the University of Florida.

Remarks.—The pronotal metazona of *C. walkeri* is not strongly broadened: it is just slightly wider than the prozona. In Beier's key this feature directs the species to the subgenus *Championica*. But (same couplet) the presence of a tiny beaded tubercle at the medial margin of the eye, the absence of a distinct hyaline wing border and possession of a (slightly) upcurved ovipositor, place it in the subgenus Auchenacophora. Other characters, e.g. two large thick triangular teeth just below the tympanal chambers (Fig. 1D) and a reduction in number and prominence of pronotal spines, also make Auchenacophora more appropriate.

Diagnosis.—Within Auchenacophora *C. walkeri* keys to *Championica unispinosa* (B. v. Wattenwyl). (We have not viewed the female type of *C. unispinosa* and rely on Beier's (1962, p. 254) description.) The metazona of the pronotum of *C. unispinosa* is described as strongly broadened, flanged, and spined along the margin. Brunner von Wattenwyl in his original description characterizes the metazona margin of *C. unispinosa* as "toto spinoso." *C. walkeri* may thus be readily distinguished from *C. unispinosa* by the modest breadth and weak armature of its pronotal metazona (Fig. 1E): it has no marginal spines posteriorly and only two laterally (Fig. 1 E,F). These spines are low, wide-based, conical, and tilt strongly laterad, their apices blunt-tubercular; the anterior pair, just behind the posterior transverse sulcus, are slightly larger than the posterior. The weakly arcuate posterior rim of the metazona bears only a tiny median tubercle; between

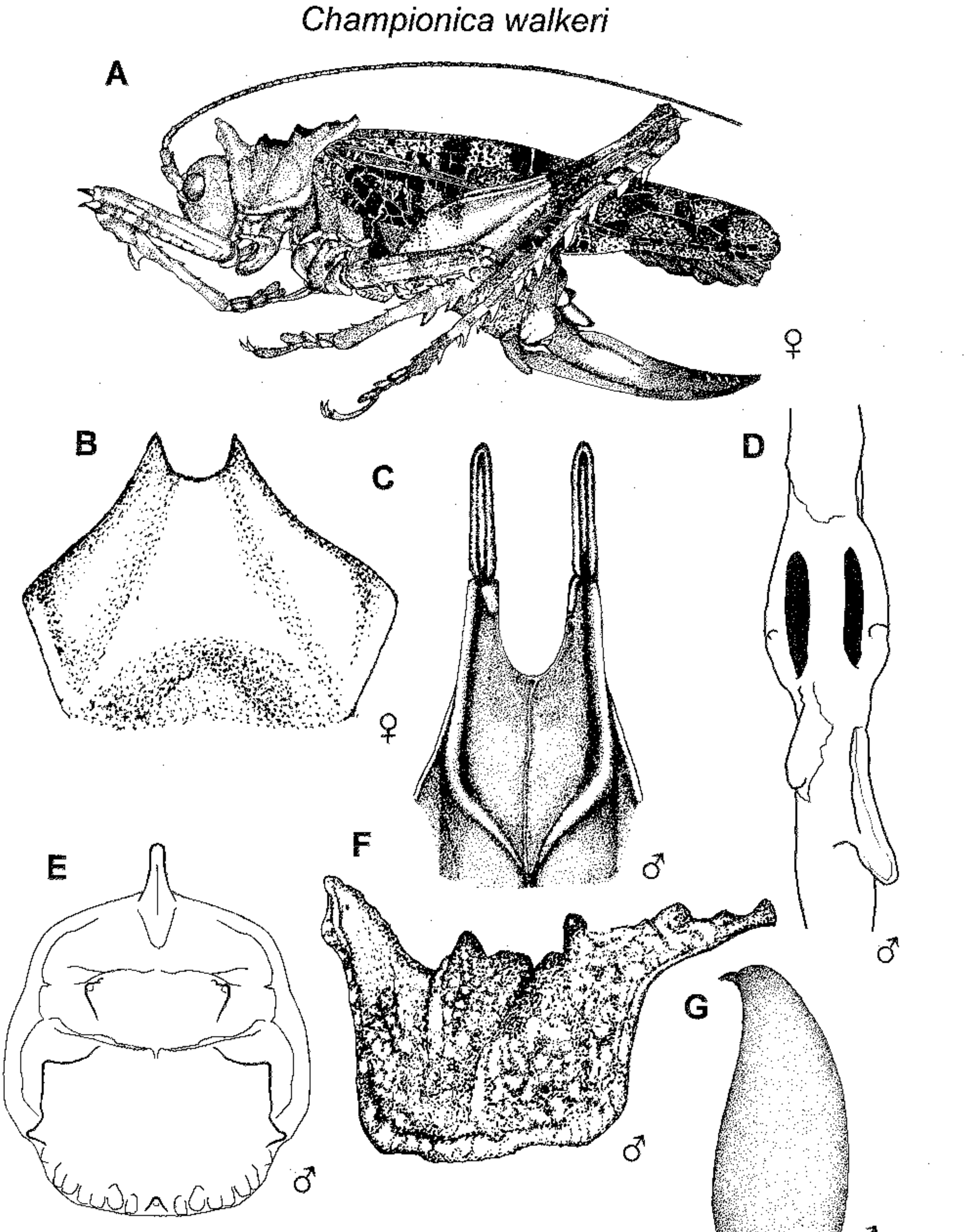


Fig. 1. *Championica walkeri*: female, habitus (A), subgenital plate (B); male, subgenital plate (C), foretibia (D), pronotum dorsal (E), and lateral (F), cercus dorsal (G).

this and the most caudal lateral spine, 5-6 poorly defined tubercles range along the margin. *C. walkeri* is also distinguishable from *C. unispinosa* on the basis of its much smaller size e.g. female body length 28.9 mm compared to *C. unispinosa* 45 mm.

Description.—Medium-sized Pleminini, robust; moss-lichen mimic. In death, overall mottled brown, olivaceous, grey-white; living, olivaceous, gray and brown with widespread oeruginous spotting and plaga; tegminal cells black, glassy, interspersed with patches of cream-white reticular (archedictyon) venation. *Head.* Frons smooth with short dispersed hairs, broader than long, mottled oeruginous spots on dark brown; above the frontoclypeal suture a narrow indistinctly margined band of watery grey. Vivid oeruginous triangular marks dorsolaterally on frons beneath scrobal sclerites; frontal fastigium separated, conical, above white median ocellus; terminal segment of labial and maxillary palpi orange, black proximad. Antennal scape and first antennal segment mottled as frons, scape with a short, blunt terminal spine; antennal filament marked with variable breadth dark and light bands; bead-like tubercle on vertex at eye inner margin. Fastigium verticis not surpassing antennal scrobes, foveate, with basal tubercles, apex bifid, these apices bluntly rounded, bright green. *Pronotum* with prominent rims, shoulders deflexed (Fig. 1 E,F) surface extremely finely granular, candied, olivaceous green and brown; anterior median spine uniform light green, this color continuing in bilateral bands across the pro and mesozona of the disk between the mesozonal spines; pale green tubercles on anterior and posterior pronotal rims; lateral lobe margins anteriorly and ventrally with yellow tubercles, ventral margin straight. *Prosternum:* armed with stout triangular spines. Meso and metafurcal pits transverse, deep; lateral lobes broad, yellow-orange, not strongly angled. *Tegmina:* just surpassing abdomen; green veins delimit fuscous hyaline cells; patches of cream-white reticulate venation cluster laterad of the M near the sound field. Sc and R over basal half at first rapidly divergent then convergent, becoming closely parallel past middle and widely divergent again to edge; Rs arising in distal third. *Wings:* mostly fuliginous; behind the radius scattered feeble pale yellowish transverse veins, centered in irregular breadth hyaline bands; Rs main stem absent. *Femora:* fore and mid femora, compressed, rectangular in section, not edged dorsally; armed ventrally only on anterior margin with mostly large compressed triangular spines; all genicular lobes with stout, weakly curved, divergent conical spines. *Tibiae:* on dorsal margins of fore tibia beside each tympanal slit a mid-chamber tubercle (Fig. 1D), distad of each slit a triangular flange-like blunt oeruginous tooth, the posterior arising immediately, the anterior more

Table 1. Measurements of *Championica walkeri* and *Triencentrus atrosignatus*. Where no range is given the stated value is not a mean but a single measure.

Lengths (widths) mm	*C. walkeri*				*T. atrosignatus*			
	Males (5)		Females (2)		Males (5)		Females (4)	
	means	range	means	range	means	range	means	range
body	28.6	25.7-33.9	28.9		30.8	28.2-33.7	32.1	28.9-38.0
pronotum	9.4	9.2-9.6	10.0		7.4	6.1-8.2	7.2	6.8-7.6
fore femur	8.7	8.3-9.2	10.8	10.6-10.9	9.7	8.1-10.9	10.0	9.7-10.2
mid femur	9.6	9.1-11.3	11.5	11.4-11.6	9.6	8.1-10.5	9.8	9.4-10.2
hind femur	19.0	18.8-19.4	24.0	23.6-24.4	20.1	15.8-22.4	19.8	18.6-20.3
fore tibia	10.2	9.7-10.6	12.5	12.3-12.6	10.7	9.4-11.8	10.7	10.3-11.2
mid tibia	11.4	11.0-11.9	14.6	14.6-14.6	11.0	8.7-11.9	11.0	10.0-11.5
hind tibia	21.1	20.1-21.5	26.4	25.7-27.0	21.5	16.7-25.1	20.4	18.7-21.3
tegmen	23.7	23.1-24.4	34.3	33.2-35.3	29.6	20.8-30.3	29.0	23.8-32.2
cercus	2.9	2.7-3.0	4.3	4.0-4.6	3.0	2.2-3.4	2.8	2.5-3.3
subgenital plate	4.6	4.2-4.8	3.4	3.4-3.4	6.4	4.6-7.0	3.7	3.4-4.1
stylus	1.9	1.7-2.0			1.8	1.4-2.1		
ovipositor			17.3	17.3-17.4			14.3	13.6-14.9
(ovipositor)			(3.7)	(3.6-3.8)			(3.4)	(3.2-3.7)
femoral spines, ant.: post. ventral margins								
fore	4 : 0		4 : 0		4 (3-4) : 0		4 : 0	
mid	4 : 0		4 (4-5) : 0		3 (3-4) : 0		(3-4) : 0	
hind	8 (8-9) : 0		7 (7-8) : 0		6 (6-8) : 0		6 (5-8) : 0	
tibial spines, ant.: post. ventral margins								
fore	7 (6-7) : 7		7 : 7		7 (6-8) : 7 (6-7)		7 (6-7) : 7 (6-8)	
mid	7 (4-7) : 6		7 : 6 (6-7)		7 (6-8) : 7 (6-7)		7 (6-7) : (6-8	
hind	12 (10-12) : 9		12 : 10		12 (8-12) : (8-10)		(10-12) : (10-12)	

Triencentrus atrosignatus

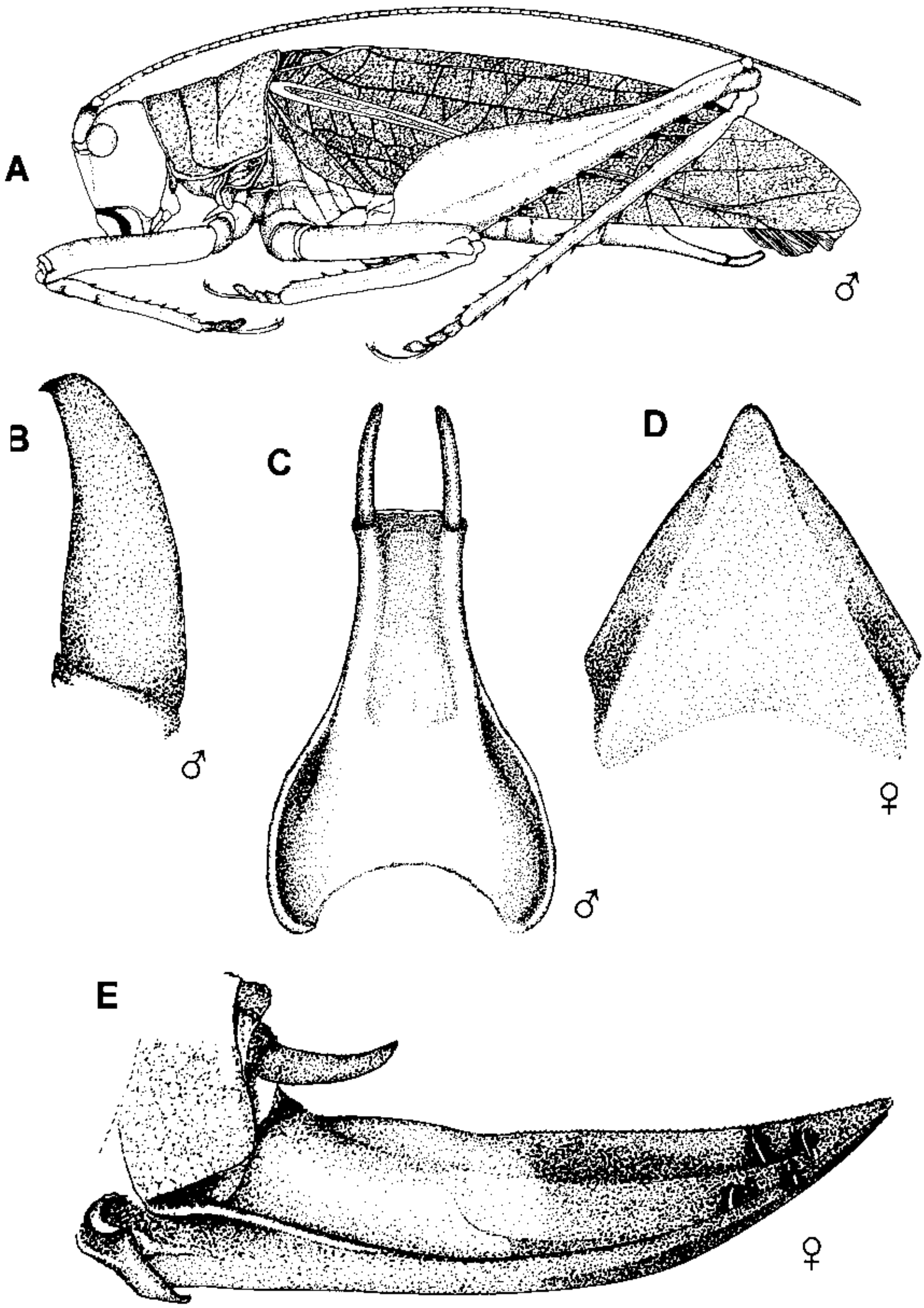


Fig. 2. *Triencentrus atrosignatus*: male, habitus (A), cercus (B) and subgenital plate (C); female, subgenital plate (D) and ovipositor (E).

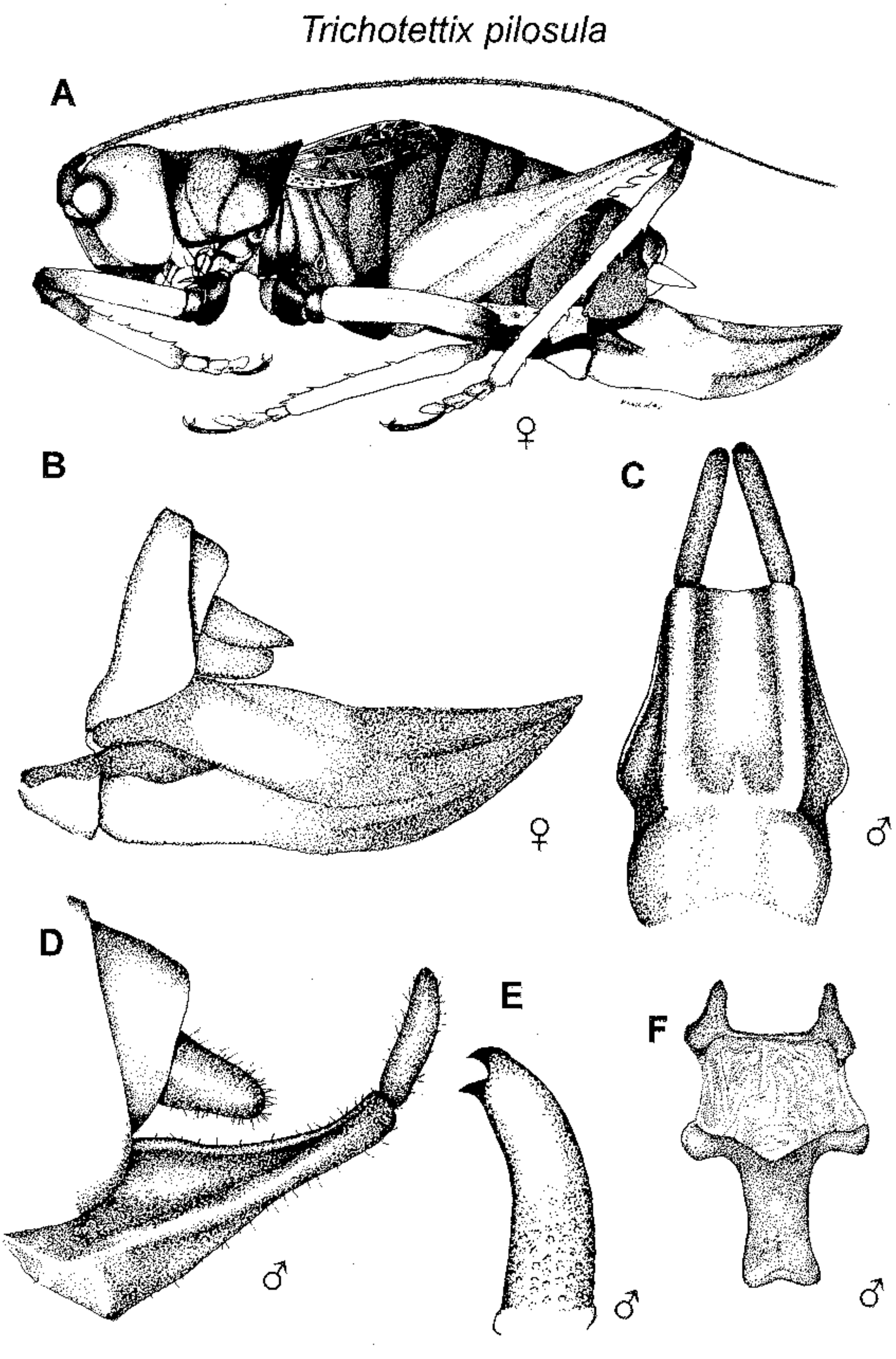


Fig. 3. *Trichotettix pilosula*: female, habitus (A), ovipositor (B); male, subgenital plate (C,D), cercus (E) and titillators (F).

distad, bent (Fig. 1D); oeruginous plaga with hint of lobular spines on dorsal distal third of foretibia.

Terminalia: Male: cercus setose, uniform pale green with small terminal inward directed sclerotized tooth (Fig. 1G); supraanal plate produced arcuate; subgenital plate (Fig. 1C) smooth, mottled black and green as on abdomen. Female: subgenital plate (Fig. 1B) green ventromedially; ovipositor green ventromedially at its base and laterally in middle third, then becoming rich brown over weakly upcurved distal third (Fig. 1A).

Specimens.—Paratypes: 4 males, 2 females. 1 male, 1 females, Ecuador, Prov. Pichincha, Tinalandia, 18 xii 1986, G.K. Morris, ANSP; 1 female (head and part of pronotum absent), 2 males, 20 ii 1988, G.K Morris, ANSP; 2 males, 27 xii 1986, G.K. Morris, QCAZ.

Measurements.—See Table 1.

Tribe Platyphyllini

Triencentrus atrosignatus (Brunner von Wattenwyl).
Figs 2, 19, 31; Table 1

Distribution.—Ecuador: western lowland rainforest.

Remarks.—In Beier's key (1960, p. 33) our specimens reach the couplet separating *Triencentrus atrosignatus* (B. v. Watt.) (Ecuador) from *Triencentrus difficilis* (Hebard) of Colombia. This is on the basis of: black femoral spines with light preapical rings (Fig. 2A); face partially black; males, extremity of subgenital plate not emarginate and so without end lobes (Fig. 2C), cerci unmodified, relatively stocky, tapering distally (Fig. 2B); females, ovipositor upturned (Fig. 2E) and shorter than the hind femora.

Diagnosis.—The truncate termination of the male subgenital plate of *T. atrosignatus* (Fig. 2C) will distinguish it from *T. difficilis*; in *T. difficilis* this interstylus region is weakly arcuate (compare Fig. 7, plate XXI, Hebard 1927). The styli of *T. atrosignatus* are longer and more slender than those of *T. difficilis*, just slightly longer than the interstylus distance. The male cercus in *T. atrosignatus* is more tapered (Fig. 2B).

Beier (1960) describes the female subgenital plate of *T. difficilis* as acuminate triangular and that of *T. atrosignatus* as pointed (Fig. 2D). The ovipositor of *T. atrosignatus* (Fig. 2E) is mostly straight, curving only slightly over its distal fifth; that of *T. difficilis* curves more strongly and over the distal half (compare Fig. 8, plate XXI, Hebard 1927).

Specimens.—5 males, 4 females. 2 males, Ecuador, Prov. Pichincha, Tinalandia, 27 xii 1986, G.K. Morris, rec., QCAZ; male, same locality, 18 xii 1986, G.K. Morris, rec., ANSP; female, same locality, 24 xii 1986, G.K. Morris, alcohol, ANSP; female, same locality, 18 xii 1986, G.K. Morris, ANSP; female, Ecuador, Prov. Los Rios, Rio Palenque, 3 vi 1983, D. Klimas and G.K. Morris, QCAZ; male, Ecuador, Prov. Pichincha, Rio Toachi, 2000 m elev., 10 km e Santo Domingo de los Colorados, 21 v 1985, J. Cook, UMMZ; male, U.S.A., Louisiana, New Orleans, on bananas ex Ecuador, unusually small, 10 ix 1953, USNM; 1 male, 1 female, U.S.A., Texas, Port Arthur, on banana debris ex Ecuador 14 x 1952, USNM.

Measurements.—See Table 1.

Tribe Cocconotini

Trichotettix pilosula Stål
Figs 3, 20, 32; Table 2

Distribution.—Colombia: eastern slope of central cordillera.

Remarks.—The identity of this species was confirmed by comparing a male specimen from Ucumari with Stål's male holotype in the Naturhistoriska Riksmuseet, Stockholm.

Hebard (1933) and Beier (1960) identify as *T. pilosula* an apterous female from Santa Elena, Antioquia, Colombia. We have not seen this specimen, but upon Hebard's account our Ucumari females differ: 1) rather than aptery, they show brachypterous tegmina and wings, both reaching the third abdominal tergum (Fig. 3A); 2) they lack a minute tooth found on the anterior pronotal margin of Hebard's specimen; 3) all genicular lobes of the Santa Elena female have a "large straight spine" except the anterior of the middle femora; whereas in our females (and males) the genicular lobes of the forelimbs are unarmed, while those of both mid and hind limbs are armed only posteriorly and the spine is small and bent; 4) the anteroventral margins of the femora of Hebard's female are armed with stout spines: fore 3, mid 3, hind 5; but in our specimens we observe 2, 2, and 5 (Table 2); 5) on the prothoracic femora of our *T. pilosula* of both sexes there is one distal anteroventral femoral spine, positioned opposite the top of the tympanal organ of the flexed tibia. A second spine, alligning when flexed, opposite the bottom of the tympanal organ, is distinctly smaller, sometimes almost tubercular though never absent.

These differences indicate that Hebard's Antioquia female is not *T. pilosula* but a different and undescribed Colombian species. This being so, descriptive detail of females of *T. pilosula* has not been given previously and we do so here.

Diagnosis.—*Trichotettix pilosula* Stål is distinguished from *T. nuda* Beier by: denser pubescence, pronotum flatly granulate, genicular lobes armed with minute spines, excepting inner lobes of fore and mid femora which are unarmed; midfemora with 1-3 ventral spines; tegmina present in both sexes, micropterous, exposing about 2/3 of abdomen.

Trichotettix nuda: pubescence sparser than *T. pilosula*; smooth non-granular pronotum; all legs with rounded unarmed genicular lobes; unarmed mid femora; tegmina and wings of female reduced to small, oval, laterally situated flaps, the wings overlying the distal costal margin of the tegmina (Fig. 46, Beier 1960).

Description.—**Female**: Small for Cocconotini, larger than male (Table 2), robust, compact. Colorful insects, cranberry red, dark or pale brown (tan) or red brown with contrasting dark brown pronotal margins. *Head:* Frons smooth to lightly wrinkled, broader than long, red-brown, hispid; prominence dorsad of anterior mandibular articulation declining rapidly above. Postclypeus black; labrum and clypeus contrasting pale white against dark brown mandibles; labial palp white. Antennae, fastigia, scrobes all smoky brown, as also small midregion between the scrobes and below the frontal fastigium; antennae pilose, ringed alternately in dark and light brown; brown continued posterad of the eye. Frontal fastigium separated widely from vertex, oval, with large white ocellus ventrally; occiput between the eyes red-brown as frons; fastigium verticis deeply foveate, apex upswept, with lateral ocellar tubercles. *Pronotum:* hispid, margin dark brown banded, fading onto light tan; disc anterior and posterior margins moderately broadly excurved, submarginally diffusely rugose then irregularly low pebbly on pro and metazona; mesozona irregularly pebbled and with levigate patches; posterior pronotal margin thinly but distinctly rimmed; meso and metazona scabrose onto lateral lobe; transverse sulci distinct, moderately deep; pro and mesozona subequal, metazona larger; lateral lobes strongly rimmed, ventral margin straight, rising posteriorad, anterior angle about 90°, posterior angle obtuse. *Sternites*: uniform dark brown, prosternum armed with two low triangular spines; mesosternum rectangular with indistinct transverse sulcus, metafurcal indentation short, bent, pit-like. *Tegmina:* tip smoothly curvilinear ovate; vivid canary yellow veinlets contrast with dark brown areae in costal region and distal third of wing; veins of subcostal and anal area brown; veins increasingly yellow distad in discoidal field. *Wings:* membranous, colorless, just covered by tegmina. *Abdomen:* hispid, smoky brown, smooth, shining. *Legs:* femora pale brown basally, gradually darker distad becoming darkest red-brown across femorotibial joint. Tibiae becoming uniform cranberry red. Tarsi charcoal-grey black, fringed white, ear slits black. *Terminalia:* ovipositor (Fig. 3B) short, stout, broad, bone white over proximal half; cerci and subgenital plate white except the plate dark brown on lateral extremities, this brown continuing in a band onto dorsobasal corner of first valvula and onto third valvula just beyond its swollen base (2'nd valvifer); ovipositor distal half amber red, with 3-4 preapical flaws near tip of 3rd valvula; weakly serrate dorsally over distal third.

Specimens.—5 males, 3 females. 1 male, Colombia, Dpto Risaralda, PRN, Ucumari, 25 v 1996, F.Z. Montealegre and G.K. Morris, ICN; 2 males, same locality, 26 v 1996, same collectors, ANSP; 2 females, same locality, 26 v 1996, same collectors, ICN; 2 males, same locality, 15 v 1997, same collectors, ANSP; 1 female, same locality, 15 v 1997, same collectors, ANSP.

Measurements.—See Table 2.

Table 2. Measurements of *Trichotettix pilosula* and *Eubliastes chlorodictyon*.

Lengths (widths) mm	*Trichotettix pilosula*				*Eubliastes chlorodictyon*		
	Males (4)		Females (3)		Male	Females (4)	
	means	range	means	range		means	range
body	19.5	18.6-20.9	23.8	19.7-26.0	38.1	36.5	32.8-40.0
pronotum	6.2	6.0-6.5	5.9	5.7-6.0	7.8	7.5	7.3-8.0
fore femur	6.2	6.0-6.4	7.3	7.0-7.7	12.5	13.9	13.0-15.1
mid femur	6.3	6.0-6.4	7.9	7.8-8.1	13.0	14.0	13.3-14.5
hind femur	10.9	10.4-11.3	10.5	9.0-13.1	27.1	28.8	27.3-32.0
fore tibia	6.7	6.5-6.9	8.1	7.9-8.3	13.0	14.4	13.1-15.5
mid tibia	6.9	6.5-7.3	8.9	8.8-9.0	14.0	14.9	13.6-16.0
hind tibia	10.6	10.0-10.9	13.5	12.9-14.2	27.3	30.1	29.4-31.9
tegmen	6.9	6.4-7.5	7.1	6.8-7.5	45.1	48.5	46.4-53.1
cercus	1.9	1.7-2.1			3.1	3.1	3.0-3.4
subgenital plate	3.9	3.7-4.1	2.0	1.9-2.0	6.7	2.8	2.4-2.9
stylus	1.5	1.4-1.7			0.6		
ovipositor			10.0	10.0-10.0		22.7	22.0-23.8
(ovipositor)			(3.4)	(3.4-3.4)		(4.1)	(4.0-4.2)
femoral spines, ant. : post. ventral margins							
fore	2 (1-2) : 0		(1-2) : 0		3 : 0	3 (2-3) : 0	
mid	2 : 0		2 : 0		3 (3-4) : 0	3 (2-3) : 0	
hind	5 (4-6) : 0		(5-6) : 0		5 : 0	5 (4-6):0	
tibial spines, ant.: post. ventral margins							
fore	6 (4-7) : 5		6 : (4-5)		7 : 7	7 (6-7) : 6 (6-7)	
mid	6 (5-6) : 5 (4-5)		(6-7) : (4-5)		7 : 7	7 (6-8) : 7 (6-7)	
hind	9 (9-10) : (4-5)		10 : 5		10 : 6	11 (10-11) : 6 (6-9)	

Eubliastes chlorodictyon sp. nov.
Figs 4, 33; Tables 2, 4

Distribution.—Colombia, Ecuador: coastal plain of southern Colombia, between the eastern cordillera and the Pacific Ocean and south to the western coastal forest of northern Ecuador.

Holotype.—Male, Colombia, Dpto del Valle del Cauca, Bajo Calima (type locality), 13 v 1996, W. Novoa, G.K. Morris, F. Montealegre, ICN.

Etymology.—Named for the vivid light green color of within-cell tegminal venation (Gk., chloros = green; arche-primitive; dicty = net.)

Remarks.—In Beier's key to *Eubliastes* species, two features 'middle tibiae dorsally unarmed' and 'anal margin of tegmina not darkened', take our specimens to a further choice between 'disk of the pronotum and lateral lobes black' and 'disk of the pronotum and sides reddish-brown'. *E. chlorodictyon* fits neither: the light amber of the lateral pronotal lobes extends onto the margins of the disc and contrasts with a dark brown longitudinal band medially. In our Colombian specimens the anterior and posterior margins of the lateral pronotal lobes are edged in dark brown; but in the Ecuadorean species, lobes and the genae are concolorous.

A specimen of *E. chlorodictyon* from Rio Palenque, Ecuador was described in error as the male of *Eubliastes ferrugineus* (B. v. Watt.) (Morris et al. 1989; see there Fig. 3E for a habitus drawing of the male of *E. chlorodictyon*).

Diagnosis.—Diagnostic of *E. chlorodictyon*: dark brown bands upon frontoclypeal and clypeolabral sutures frame pallid grey postclypeus; the anteclypeus beneath and the labrum of same grey. Pronotal lobes very light glazed amber, almost orange, concolorous with genae.

Several features of *E. chlorodictyon* (Fig. 4, A, B,C) distinguish it from *E. ferrugineus* (Beier 1960 Fig. 74, p.120): 1) female subgenital plate proportionately smaller, without a bowl-shaped depression laterally; 2) ovipositor broader, dorsal margin smooth, straight rather than sinuous, its distal half not serrate, ventral margin upcurving over distal third; 3) hind femoral spines light brown, not black.

Eubliastes chlorodictyon may be separated from *E. aethiops* on the basis of: vertex of *E. chlorodictyon* matt (unglazed) brown; pro and mesozona of the pronotal disc with narrow brown medial band, fading laterad before reaching the lateral lobes; in *E. aethiops* vertex and full width of anterior pronotal disk glazed black. The frons in *E. aethiops* is marked with black maculae and immaculate light brown in *E. chlorodictyon*. Spines of the hind femora are basally black in *E. aethiops*, but uniform light brown in *E. chlorodictyon*.

Eubliastes willemsei is a Venezuelan species, known only from the holotype male, smaller (30 mm body length) than our males of *E. chlorodictyon* (38.1mm). Separable on the following features: *E. willemsei* all inner genicular lobes, and outer of hind femora, armed; *E. chlorodictyon* armed only on the inner genicular lobes of the mid and hind femora. Dorsal half of clypeus (postclypeus) glazed black; in *E. chlorodictyon* postclypeus watery grey (as above).

Eubliastes chlorodictyon differs from *E. pollonerae* in having green throughout its anal tegminal field, rather than black upon the basal part. And the frons in *E. chlorodictyon* is without any spots, whereas in *E. pollonerae* it is "indistinctly spotted with vaguely defined brown flecks" .

Description.—Large, elongate-winged, moderately robust insects with dark brown markings on the head and pronotum. *Head:* eyes ovoid dark brown prominent; frons and genae smooth, glazed, light brown (amber); postclypeus watery grey framed in dark brown, anteclypeus watery grey onto labrum; fastigium frontalis and frons coplanar, with prominent oval white ocellar spot; internal margin antennal scrobes, antennae, fastigia, vertex medially, all matt dark brown. Antennal scape with a short conical tubercle on inner distal face; fastigium verticis ending well short of antennal scrobes, narrowly foveate with prominent ocellar tubercles, apex weakly upturned. *Pronotum:* anterior margin arcuate, posterior margin almost straight; metazona produced posteriorly beyond high humeral sinus; disc moderately rugose, with a medial dark brown band, narrower because fading laterad over pro and mesozona, then full width on metazona; posterior transverse vein occurring just beyond middle; lateral lobes longer than high, with broader margin posteriorly and ventrally; anterior corner widely rounded, posterior corner sharply right angled, smooth. *Sternites:* prosternum with 2 short conical spines, metasternal sulci meeting at a point, with triangular tilted lateral lobes; metasternum strongly narrowed posteriorly, metafurcal indentation a pit. *Tegmina:* in life reticulate veinlets of oeruginous green, contrasting with black areae (Fig. 4A), uniformly over costal, anal and discoidal fields, but with black patches bare of veinlets at interstices of transverse and major veins; anterior costal margin proximally edged yellow, costa narrowed distad of tegmen middle; radial sector arising well beyond the middle; M-Cu petiolate. *Wings:* transparent, veins brown, membrane infuscate. *Abdomen:* very light brown. *Legs:* femora light smoky brown darkening distad, tibiae and tarsi uniform dark smoky brown; armed on the inner genicular lobes of mid and hind femora. *Terminalia:* Male: 10th tergite truncate; cerci white, short, robust, gradually incurved apically, terminating in a short, sharp, recurved apical tooth (Fig. 4D); subgenital plate elongate with medial v-shaped emargination and two short white styli (Fig. 4E). *Terminalia:* Female: subgenital plate (Fig. 4B) obtuse triangular, with small subbasal lobes; minutely terminally emarginate, with two broadly rounded keels beneath, lateral aspect smooth, without depressions. Cerci white. The ovipositor (Fig. 4C) long, broad, dorsal margin almost straight, with minute dorsal distal serrations; reddish-brown in its distal half, basally very light brown.

Specimens.—Paratypes: 4 females, 1 male, 1 female, Colombia, Dpto Valle, Bajo Calima, 13 iii 1996, W.W. Novoa, ICN; 1 female, Ecuador, Prov. Los Rios, Rio Palenque, 3 vi 1983, G.K. Morris and D.E. Klimas, ANSP; 1 female, same locality, 22 vi 1983, same collectors, ANSP; 1 female, same locality, 24 vi 1983, same collectors, ANSP; 1 male, same locality, 22 vi 1983, same collectors, USNM.

Measurements.—See Table 2.

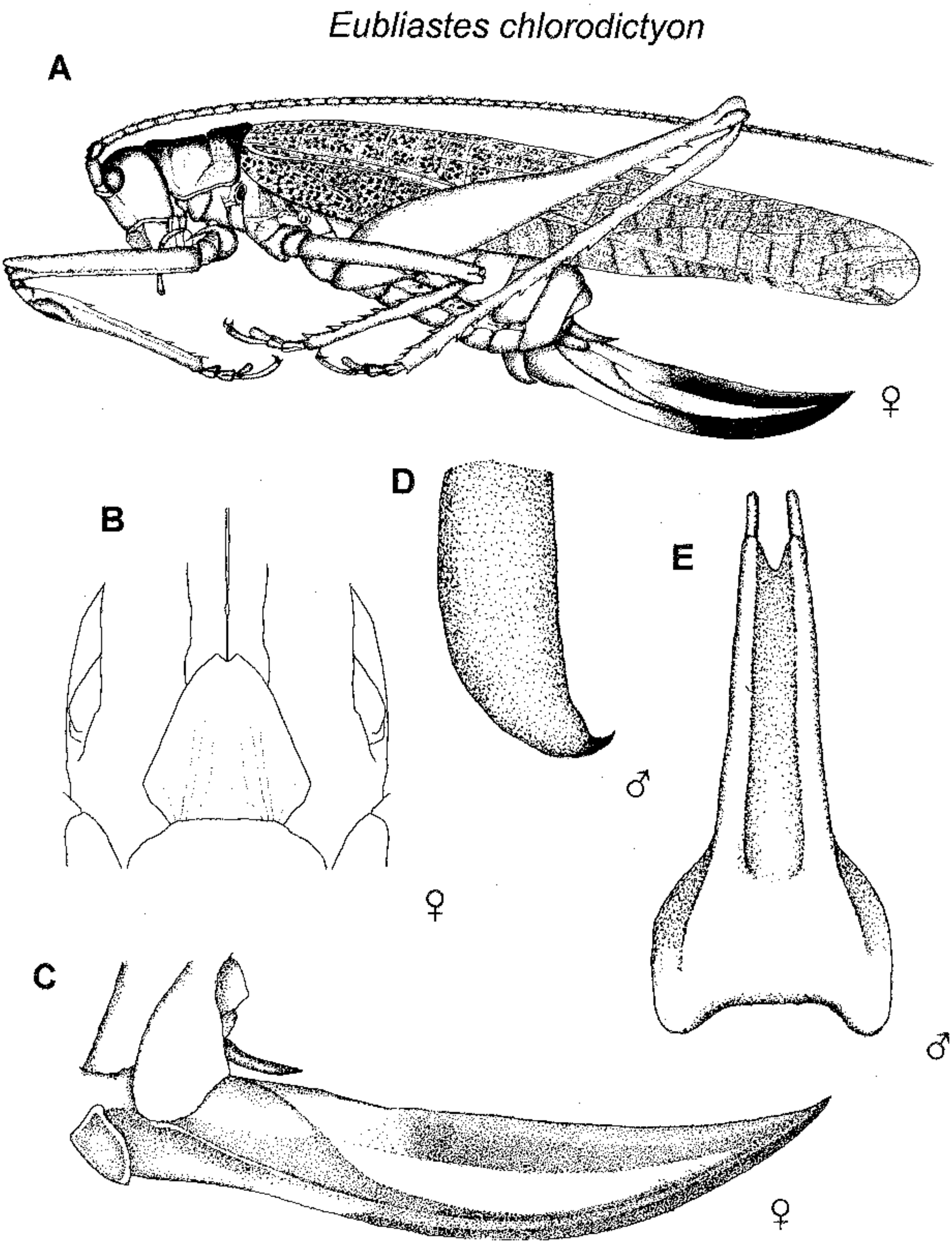


Fig. 4. *Eubliastes chlorodictyon*: female, habitus (A), subgenital plate (B) and ovipositor (C); male, cercus (D) and subgenital plate (E).

MYSTRON gen. nov.

Type species.—*Mystron flavospinus* here designated.

Distribution.—Ecuador: lower montane rainforest of the eastern Andean slope.

Etymology.—Named in reference to the foveate fastigium verticis and its likeness to a spoon (Gk., *Mystron* = spoon).

Remarks.—Enlarged femoral spines are a feature of *Mystron*. For *M. flavospinus* females the most distal is always the largest spine, and the two most distal spines of both sexes are comparably developed (Fig. 5A; 6 B,C). More proximal spines are sexually dimorphic: in males the antepenultimate spine is far larger than any others of either sex, and projects beyond the flexed tibia; the most proximal spine is also much larger than its female counterpart. Similarity in spination of females of *M. beieri* and *M. flavospinus* suggests that sexual dimorphism of femoral spination may prove a generic character.

Elaborate defensive spines occur in other tribes of pseudophyllinae, e.g. *Arrhenotettix* spp. (Glaphyraspidini) and *Myopophylum speciosum* Beier (Eucocconotini) (Morris et al. 1995). *M. speciosum* is co-active with *M. flavospinus* and shares habitat at Baeza. In all these species the largest spine is located about 2/3 of the distance from the femur base.

The statement 'M-Cu petiolate' re tegmen venation follows the terminology of Beier 1960 and is equivalent to M + Cu1a forking just beyond the wing base into MA vs MP+Cu1a (Ragge 1955).

Diagnosis

Beier's key to genera of Cocconotini, puts *Mystron* near *Eubliastes* and *Melanonotus*. Diagnostic features separating these three genera are given in Table 4. The most important for *Mystron* are 1) foveate fastigium verticis rectate, apically rounded (Fig. 6 A,F), 2) hind femoral spines modified (Figs 5 A; 6 B, C,G).

Description.—Moderate sized Cocconotini; yellowish-brown and honey-amber with contrasting yellow and dark brown markings; variably sparse to scant yellow pilosity. *Head:* eye brown, obovate; frons mostly, frontal fastigium and postclypeus entirely, dark brown; frons broader than high, smooth, hispid, scattered punctate; frontal ocellus white, almost flat; gena light brown or yellow, crossed vertically by sinuous shift in plane running eye to pleurostoma and marked with dark brown. Antenna light brown with darker brown rings every several articles; scape with tiny mediodistal tubercle, light brown anteriorly, lighter brown or yellow behind. Fastigium verticis, dark brown, straight sided, with low white lateral ocelli; foveate, rectate, apex rounded blunt; vertex brown with postocular brown longitudinal bands continued onto shoulders of pronotum. *Pronotum:* rugose, disc deeply eroded laterad; dorsal anterior margin of disc weakly produced arcuate, posterior margin medially truncate; posterior sulcus situated just behind middle, deeper than anterior, curving anterolaterad onto

Table 3. Measurements of *Mystron flavospinus* and *Mystron beieri*.

Lengths (widths) mm	*Mystron flavospinus*				*Mystron beieri*	
	Males (7)		Females (8)		Females (3)	
	means	range	means	range	means	range
body	27.4	24.3-31.9	30.7	27.2-38.0	32.5	29.2-37.4
pronotum	6.9	6.5-7.3	7.3	6.7-7.6	7.0	6.7-7.1
fore femur	11.1	10.7-11.6	11.7	11.0-12.2	10.7	10.2-11.1
mid femur	11.2	10.7-11.8	11.8	11.2-13.0	11.1	10.6-11.5
hind femur	23.6	22.7-25.4	24.6	23.5-26.0	22.8	21.4-24.3
fore tibia	12.1	11.6-12.6	12.7	12.1-13.7	11.1	10.9-11.2
mid tibia	12.8	12.3-13.2	13.6	12.6-14.6	11.4	11.2-11.5
hind tibia	23.1	21.9-24.7	24.9	23.2-26.4	21.4	21.1-21.6
tegmen	29.4	27.1-31.3	35.0	33.4-37.0	34.9	34.0-36.0
cercus	3.4	3.2-3.6	3.0	2.6-3.4	2.8	2.6-3.1
subgenital plate	4.2	4.0-4.5	3.1	3.0-3.2	3.2	3.0-3.3
stylus	3.6	3.2-4.1				
ovipositor			17.3	16.4-17.8	19.0	18.2-19.6
(ovipositor)			(3.4)	(3.2-3.7)	(3.3)	(3.2-3.4)
femoral spines, ant. : post. ventral margins						
fore	(3-5) : 0		3 : 0		2 : 0	
mid	3 (3-4) : 0		3 (2-3) : 0		2 : 0	
hind	4 (4-5) : 0		4 (4-5) : 0		3 : 0	
tibial spines, ant. : post. ventral margins						
fore	8 : 8		8 (7-8) : 8		8 : 8 (7-9)	
mid	9 (9-10) : 8 (8-9)		9 (8-9) : 8 (7-9)		8 : 8	
hind	14 (13-15) : 14 (12-15)		14 (13-14) : 12 (11-12)		13 (13-14): 9 (9-11)	

Table 4. Principal distinguishing features of *Mystron*, *Eubliastes* and *Melanonotus*.

Genera	*Mystron*	*Eubliastes*	*Melanonotus*
fastigium verticis	rectate, apex broadly rounded; white lateral ocelli, not raised (Fig. 6 A, F)	acclivous, apex acute ocelli protuberant	acclivous, apex acute, ocelli protuberant
tegmina	well beyond abdomen; many cells adjoining transverse veins have dark smoky brown patches bare of veinlets; Sc & R parallel but well separated (Fig. 5 A)	usually well beyond abdomen; many cells adjoining transverse veins have dark smoky brown patches bare of veinlets; Sc & R parallel, narrowly separated	usually not exceeding abdomen, or slightly; cells without dark bare patches; Sc & R parallel, well separated
antero-ventral spines of hind femora	enlarged, disparate in size, spacing, taper; longest interspinal space penultimate; cream white (yellow in life) with dark brown tips (Fig. 5 A; 6 B, C, G)	not enlarged or disparate in size, spacing, taper; mostly black, reddish preapical ring	not enlarged or disparate in size, spacing, mostly black
male supraanal plate	broadly transverse rectangular, posteriorly straight truncate or depressed eccentrically near midline	broadly transverse, semicircular	posteriorly nearly always straight truncate
male cerci	disproportionately robust distally compressed & weakly dilated blunt, terminal spinule, subterminal tooth (Fig. 5B)	moderately thin to sturdy, weakly bent with single inwardly directed terminal spine	short and sturdy with one inwardly directed terminal spine
male subgenital plate	breadth reduced modestly stepwise from middle; not grooved; terminally shallow v-shaped emarginate; rod-like styli very robust, length subequal to plate (Fig. 5 C)	moderately strongly diminished, grooved; terminally short angular truncation; styli moderately long, small rod-like	terminally often weakly attenuate truncate; styli small rod-like
female subgenital plate	incurvate terminal median sinus with extremities (terminal lobes) produced pointed; basal sclerite prominent (Fig. 6E, J)	variously formed rounded or pointed; basal sclerite oval, excavated, occasionally moderately small	obtusely triangular, terminally rounded truncate; basal sclerite mostly small, occasionally indistinc

lateral lobes, crossed in middle by a short, shallower, longitudinal sulcus. Dark brown depressed eroded regions, from humeral angles convergent anteriorad framing metazona, along shoulders of prozona divergent anteriorly framing prozona. Lateral lobes longer than deep, narrowly marginate anteriorly, midventral margin abruptly widened posterorly to humeral angle. *Thoracic sternites:* prosternum armed with 2 slightly retorse conical spines; mesosternum transverse, lateral lobes produced triangular, tilted posterolaterally, conical; metasternum constricted behind, metafurcal indentation a squarish pit; metasternal lobes less elevated, margin semicircular, ending in tubercle. *Tegmina:* narrow; principal veins dark brown; veinlet patches of conspicuous yellow within cells in precostal, costal, subcostal, radial and medial areas; bare brown patches adjoining crossveins; cubital area posterior _ continuous yellow archedictyon, so on flexed tegmina mediodorsal yellow blaze; tegmina surpassing abdomen, apically rounded. Sc and R parallel, well separated; Rs arising in apical third; M-Cu petiolate. *Wings:* principal veins brown; cross-veins light brown; membranes semi-transparent, lightly fumate. *Legs:* predominantly honey-colored, hispid; fore femora tapering basad, bent, about 1.5 times as long as pronotum; posterior genicular lobes of mid and hind femora armed with either spine or spinule; all femora armed with some spines distad on the anteroventral margin; hind femoral spines greatly enlarged, bright yellow with dark brown tips; light preapical yellow ring on hind femur adjoins 2 most distal enlarged spines; in females most distad of hind femur spines largest. *Abdomen:* tergites, light yellow-brown mottled, pilose except 1st and 2nd; sternites smooth, varnished reddish-brown. *Terminalia:* Female: Supraanal plate uniformly transverse,

Table 5. Principal distinguishing features of *Mystron flavospinus* and *Mystron beieri.*

Species	*M. flavospinus*	*M. beieri*
fastigium verticis	smaller, shorter, narrowly linear (Fig. 6 A); apex less than even with anterior margins of scrobal sclerites	much larger, broadly fusiform foveate (Fig. 6 F); apex beyond extent of anterior margins of scrobal sclerites
frons	uniform dark shining brown; vertically elongated yellow spot each medial end interrupted epistomal suture; frontal ocellus large	only consistently dark brown adjoining subgenal suture above pleurostoma and epistomal suture onto postclypeus, without yellow spots; frontal ocellus small
gena	gena vertically sinuous color banded anteriorad of plane-shift, first dark brown then yellow	gena above mandible mostly light yellow-brown, only at plane-shift itself narrowly dark brown
pronotal disk	disc coarsely rugose, anteriorly and posteriorly distinctly marginate	disc rugosity not as coarse, anterior posterior margination less evident
genicular lobes	armed with stout spine posterior mid and hind femora, others unarmed	armed with spinule posterior mid and hind femora, others unarmed
forefemora	rectangular in section, robust	subcylindrical, less robust
midtibia dorsoposterior spines	2-5, commonly 2/3/4	dorsal spination reduced, one small spine at distal quarte
anteroventral femoral spines females	4-5 (usually 4) spines (Fig. 6 C, Table 3); spines larger	3 spines (Fig. 6 G, Table 3); spines smaller
dorsal spines hind tibia	spined almost to base on both anterior and posterior	spines absent on anterior except for 1 or 2 distad , occurring only on distal third posteriorly
supraanal plate female	medial unsclerotized region of Xth tergum lesser, so not appearing cleft in dried specimens	medial unsclerotized region more extensive, so in dried specimens bisected by deep medial cleft (Fig. 6 H)
ovipositor	very slightly shorter; distal half upcurved on dorsal margin (Fig. 6 D)	slightly longer; distal half more upcurved on dorsal margin (Fig 6 I)
basal sclerite of ovipositor	smaller, strongly excavated anteriorly (Fig. 6 D, E)	larger, smoothly convex (Fig. 6 I, J)
subgenital plate female	narrowing only slightly posteriorly, medioapically conspicuously U-incised (Fig. 6 E)	strongly constricted posteriorly, smaller U-shaped emarginate (Fig. 6 I)

truncate posteriorly, weakly sclerotized medially, more so posteriorad, so subject to shrinkage in drying (Fig. 6 H); cerci smoothly tapered uniform very light yellow; subgenital plate broad basally, narrowing distad, apically emarginate, the terminal lobes pointed acuminate (Fig. 6 E, J). Ovipositor moderately broad, acuminate over distal half; valvulae widely margined in dark brown against central light color; 3-5 transverse elevated subapical creases (Fig. 6 D, I); posterior half dorsally serrate, ventrally with finer serrations and only at apex; basal sclerite excavated or smooth convex.

Mystron flavospinus sp. nov.
Figs 5, 6 A-E, 22, 34; Tables 3, 4, 5

Distribution.—Ecuador: lower montane rainforest of eastern Andean slope.

Holotype.—Male, Ecuador, Prov. Napo, Baeza (type locality), 5 i 1992, A.C. Mason, ANSP.

Etymology.—The specific epithet refers to the color of the enlarged defensive spines on the hind femora (L., flavus = yellow; spina = spine).

Diagnosis.—The most important features distinguishing *M. flavospinus* from *M. beieri* are the fastigium verticis, hind femur spination and basal sclerite of the ovipositor (Table 5).

The female supraanal plate is also usefully diagnostic. In alcoholic specimens of both species this plate, the Xth tergum, is uniformly planate rearward to where it deflects to become continuous with the epiproct. But its medial region is relatively unsclerotized and in the course of drying, shrink-

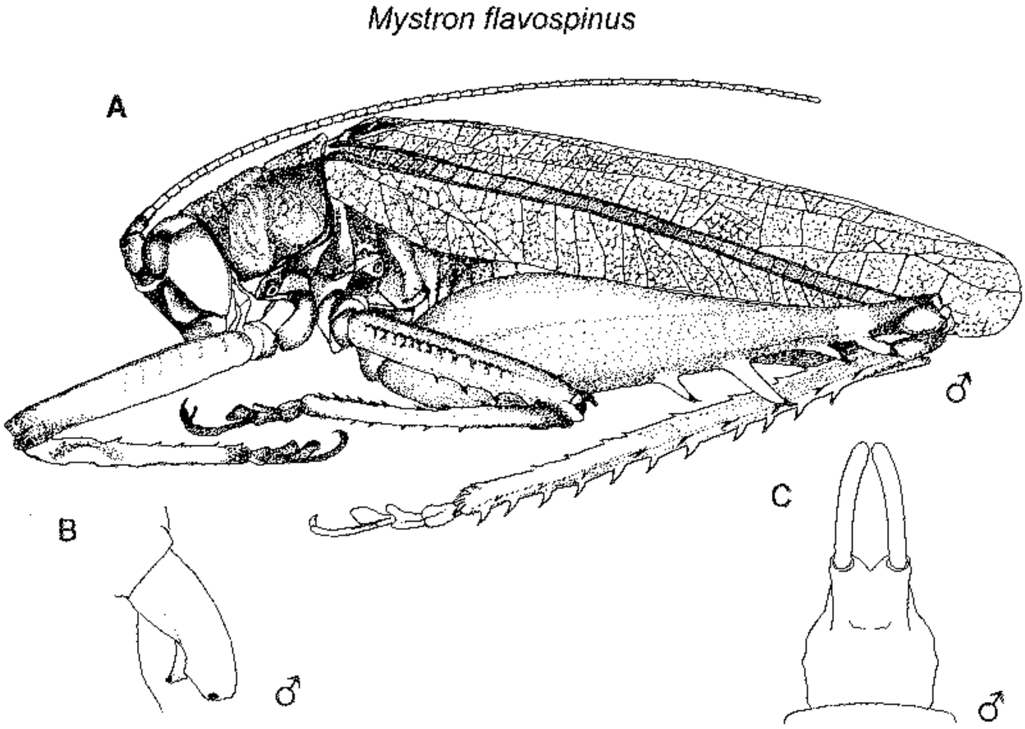


Fig. 5. *Mystron flavospinus*: male, habitus (A), dorsal and slightly medial aspect of right cercus (B) and subgenital plate (C).

age and collapse can create a distomedial depression. This membranous area of the Xth tergum is apparently less extensive in *M. flavospinus* than in *M. beieri* and so the shrinkage of the latter during drying is greater: the entire plate appears, identically in our 2 pinned specimens of *M. beieri*, to be bisected by a deep medial cleft (Fig. 6 H). By contrast, for all our pinned *M. flavospinus* females, supraanal plate shrinkage is more limited, producing a somewhat asymmetrical medial deflection distad without ever being completely cleft.

Description.—Variably brown, honey-colored insects with vivid yellow markings; sparsely yellow pilose, in places moderately dense. *Head:* fastigia, scrobes, frons, anterior face of mandible, postclypeus, labrum, mostly shining dark brown; anteclypeus very light brown. Sinuous vertical plane-shift crossing gena, marked dark brown anteriorad; between this dark band and the frons a yellow band runs above anterior mandibular articulation onto scrobal sclerite; gena posteriorad of plane-shift mostly uniform very light brown. Vertex light brown, excepting dark brown longitudinal postocular bands. *Pronotum:* dark brown longitudinal banding on pronotal shoulders, darkest and widest on pro- and metazona. *Tegmina:* yellow veinlet patches lacking in median and anal areas basad. *Wings:* yellow pilosity very short, dense, concentrated near anal margin on upper surface. *Legs:* femora and tibiae mostly honey-colored with dark brown markings at femorotibial joints; enlarged anteroventral spines of hind femora sexually dimorphic in males, the two most proximal larger than in females (Fig. 6B,C), smoothly curving tapered except most distal spine which is uniform cylindrical becoming abruptly acuminate subapically. *Terminalia:* male: 10th tergum rectangular, broadly truncate or partly depressed medioposteriorly, densely covered dorsally with long yellow hairs; cerci and subgenital plate uniform bright yellow, unusually robust; cercus cylindrical, compressed apically, strongly incurved, ending broadly obtuse in its dilated plane; short apical spine and larger ventromedial tooth (Fig. 5B); subgenital plate with long thick cylindrical styli, tiny v-shaped median emargination (Fig. 5C).

Specimens.—Paratypes: 6 males, 8 females. Female, Ecuador, Prov. Napo, Baeza, 11 vii 1985, G.K. Morris, alcohol, ANSP; female, same locality, date, collector, QCAZ; female, same locality, collector, 10 ii 1988, ANSP; 2 females, same locality, collector, 6 iv 1989, QCAZ; female, same locality, collector, 8 iv 1989, ANSP; female, same locality, collector, 23 iv 1989, ANSP; female, Ecuador, Prov. Napo, Rio Huagra Yacu, 22 iv 1990, G.K. Morris, alcohol, ANSP; male, Ecuador, Prov. Napo, Baeza, 11 vii 1985, G.K. Morris, alcohol, ANSP; male, same locality, collector, 10 vii 1985, QCAZ; male, same locality, collector, 8 iv 1989, ANSP; male, same locality, collector, 14 iv 1990, QCAZ; male, Ecuador, Prov. Napo, Rio Huagra Yacu, 22 iv 1990, same collector, ANSP; male, Ecuador, Prov. Napo, Baeza, i 1992, A.C. Mason, ANSP.

Measurements.—See Table 3.

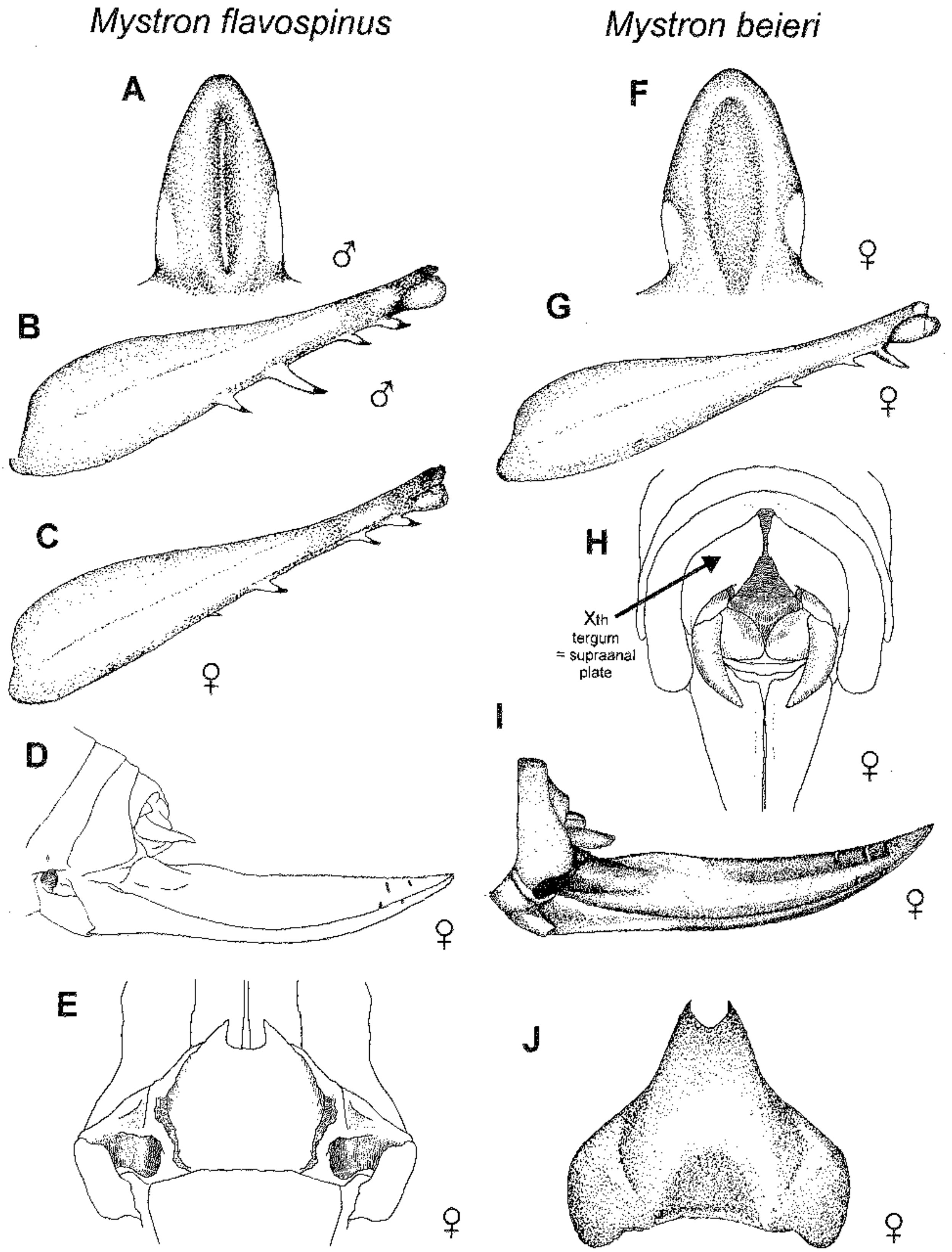


Fig. 6. *Mystron flavospinus*: male, fastigium verticis (A), hind femur (B); female, hind femur (C), ovipositor (D) and subgenital plate (E). *Mystron beieri*: female, fastigium verticis (F), hind femur (G), supraanal plate (H), ovipositor (I) and subgenital plate (J).

Mystron beieri sp. nov.
Fig. 6 F-J; Tables 3, 5

Distribution.—Ecuador: lower montane rainforest of eastern Andean slope.

Holotype.—Female, Ecuador, Prov. Morona Santiago, Plan de Milagro (type locality), 23 xii 1986, G.K. Morris. ANSP.

Etymology.—Named for Dr. Max Beier of the Wien Museum.

Remarks.—Colors given apply to pinned specimens.

Diagnosis.—See Table 5 for features that distinguish *M. beieri* from *M. flavospinus*.

Description.—Dark and light brown, amber and yellow insects with scant, variably present, short yellow pilosity (much less than *M. flavospinus*). *Head:* frons color variable, centrally either uniform dark brown or uniform light yellow-brown; antennal scape, scrobal sclerites, light yellow-brown; fastigium verticis almost contiguous laterally with scrobal sclerites. *Pronotum:* anterior margin of disc only thinly marginate, posterior margin vanishingly so. *Tegmina:* patches of reticulate veinlets likely yellow in life. *Legs:* most distal of enlarged hind femur spines uniform cylindrical becoming abruptly acuminate subapically.

Specimens.—Paratypes: 2 females. 1 female, Ecuador, Prov. Morona Santiago, Plan de Milagro, 23 xii 1986, G.K. Morris, QCAZ; 1 female, same data, alcohol, ANSP.

Measurements.—See Table 3.

Docidocercus gausodontus sp. nov.
Figs 7 A-D, 8 A, B, 21 A, 35; Tables 6, 7

Distribution.—Colombia: coastal plain of southern Colombia, between the eastern cordillera and the Pacific Ocean.

Holotype.—Male, Colombia, Dpto Valle del Cauca, Bajo Calima (type locality), 13 v 1996, Coll. F. Montealegre and G.K. Morris, ANSP.

Etymology.—The specific name refers to the strongly bent cercal tooth (Gr., gausos = bent; odontos = tooth).

Remarks.—The face of *D. gausodontus* is blue-green in life. And this is also the case for *D. chlorops* (Morris et al. 1989) and *D. gigliotosi* (Belwood 1990, Plate 14). Facial color in these and other tropical tettigoniid species may serve a cryptic function by blending with the colors of the leaf bases of daytime refuge vegetation.

Diagnosis.—*D. gausodontus* is closely related to *D. chlorops* and *D. gigliotosi*. Males of *D. gausodontus* are distinguished (Table 7) primarily by the armature of the cercal apex, but also by a triangular subgenital plate bearing longer cerci, and by the robust processes of the paraprocts; the subgenital plate and ovipositor distinguish between females.

Description.—Elongate, long-legged fulvid insects, often with colored frons and contrasting dorsal midline cream markings; hispid-pubescent. *Head:* eyes dark brown banded, prominent, subglobose; frons in part, scrobal sclerite and mandible base, blue-green; frons broader than high, levigate, scattered punctate, hispid; gena and vertex light yellow-brown; area of frontal fastigium largely a prominent cream white median ocellus, this oviform with narrow end dorsal, vertical axis ~1 mm, length subequal to antennal scape width; fastigium verticis short, foveate, blunt, upturned with prominent lateral oval cream-colored tubercular ocelli; antennal scape with short blunt terminal spine. *Pronotum:* anterior edge weakly produced arcuate, thinly margined, posterior edge truncate, margin wider; transverse sulci distinct not deep; pro and mesozona length subequal, metazona length about twice mesozona; posterior transverse sulcus at disc longitudinal midpoint; disc and lobes coarsely granular, some granules contrasting cream-colored; light yellow macula narrowly medial on prozona, becoming more scattered laterad and posteriorad on meso and metazona with yellow confined to granule tops, absent in females (see *D. chlorops* below re isosceles triangular pronotal macula); ventral edge of lateral lobes straight, margined with spaced tuberculate cream dots at intervals; lateral lobe 1.5 X wider than deep. *Thoracic sternites:* prosternal spines low conical feeble; meso and metasternal coxae with distomedial tubercle; meso and metasternal lobes only slightly elevated. *Tegmina:* brown, narrow, about 6X longer than wide, exceeding body >15 mm; posterior half of narrow anal field characteristic of *Docidocercus* a uniform cream from sound generator distad; oval bulla posteriorad of scraper and mesad of mirror. *Wings:* yellow-brown veins, membrane smoky infuscate, finely pubescent. *Abdomen:* abdominal tergites dark brown dorsally. *Legs: Femora:* anterior tympanal chamber cream with black mark below; all femoral spines dotted basally with cream on black, apically red-brown; posterior genicular lobes armed. *Terminalia male:* supraanal plate declivent, lateral margins parallel basally then converging to a triangular thick blunt apex; sclerotized paraproct processes thickly conical, divergent (Fig. 7D). *Terminalia female:* supraanal plate triangular, terminally V-emarginate (Fig. 8A); apical half of ovipositor dark brown-reddish, dorsal serration begining in apical third ending subapically, 3rd valvula with two transverse flaws subapically on its dorsal edge, inclined anteriorad, ventrally just proximad one flaw inclined posteriorad; inferior valve with small tooth-shaped ridge on its dorsal margin, midway between the dorsal ridges of the superior valve (Fig. 8B).

Specimens.—Paratypes: 6 males, 2 females. E, Colombia, Dpto del Valle del Cauca, Bajo Calima, 13 v 1996, Coll. F. Montealegre and G.K. Morris, ICN; female, Colombia, Dpto del Valle del Cauca, Buenaventura, Papayal, 0-40 m, 26 ii 1998, Coll. F. Montealegre, alcohol, ANSP; male, Colombia, Dpto del Valle del Cauca, Anchicaya, Rio Danubio, 300 m, 16 x 1995, Coll. F. Montealegre, MEUV; male, Colombia, Dpto del Valle del Cauca, Bajo Calima, 15 v 1996, 70 m, Coll. F. Montealegre and G.K. Morris, ICN; 2 males, Colombia, Dpto del Valle del Cauca, Buenaventura, Vereda Veneral del Carmen, Rio Yurumangui, 15 ii 1998, 60 m, Coll. F. Riascos, alcohol, ERN; male, Colombia, Dpto del Valle del Cauca, Buenaventura, La Plata, Quebrada el Morro, 40 m, 25 iii 1998, Coll. F. Montealegre, alcohol,ERN; male, Colombia, Dpto del Valle del Cauca, Vereda Guaimia, Bajo Anchicaya zone, Road Simon Bolivar (old road Cali-Buenaventura), 100 m, 15 iii 1999, Coll. F. Vargas, alcohol, ERN.

Measurements.—See Table 6.

Table 6. Measurements of *Docidocercus gausodontus* and *Docidocercus chlorops.*

Lengths (widths) mm	*Docidocercus gausodontus*				*Docidocercus chlorops*	
	Males (7)		Females (2)		Male	Female
	means	range	means	range		
body	37.1	32.0-42.1	46.0	45.0-47.0	31.2	42.7
pronotum	7.1	7.0-7.4	6.9	6.4-7.3	8.3	8.7
fore femur	12.6	11.8-13.5	12.4	11.8-13.1	14.3	15.4
mid femur	12.0	11.3-12.7	12.4	12.0-12.8	13.6	14.4
hind femur	26.3	24.0-27.0	26.5	25.0-28.0	28.7	31.1
fore tibia	13.7	12.2-14.5	13.5	13.0-14.0	15.6	16.3
mid tibia	13.3	12.2-14.5	13.0	12.8-13.2	15.8	15.9
hind tibia	28.7	26.9-30.0	29.2	28.6-29.8	30.3	34.0
tegmen	40.0	39.0-41.0	42.0	38.4-45.5	46.9	53.9
cercus	7.2	6.5-7.8			6.0	3.8
subgenital plate	4.9	4.5-5.3	2.8	2.6-3.0	4.9	3.2
stylus	2.4	2.1-2.6			3.1	
ovipositor			15.6	15.1-16.2		19.7
(ovipositor)			(3.3)	(3.0-3.6)		(3.9)
femoral spines, ant. : post. ventral margins						
fore	5 (3-4) : 0		4 (3-5) : 0		(3-4) : 0	3 : 0
mid	3 (3-4) : 0		4 (3-4) : 0		3 : 0	(3-4) : 0
hind	8 (7-8) : 0		(7-8) : 0		6 : 0	(7-8) : 0
tibial spines, ant. : post. ventral margins						
fore	7 : 7 (6-7)		(6-8) : (6-7)		7 : 7	7 : 7
mid	7:7		7 : 7		7 : 7	7 : 7
hind	10 (9-13) : 9 (8-14)		10 : 9		12 : 9	12 : (9-10)

Docidocercus chlorops Nickle
Figs 7 I-L, 8 E, F; Tables 6, 7

Distribution.—Ecuador: western coastal forest.

Remarks.—This species was established (Morris et al. 1989) on a single Ecuadorean male; the female, previously unknown, is described here for the first time.

A cream-colored pronotal mark on the holotype male was originally indicated as diagnostic of *D. chlorops:* a macula on the pronotal disk, shaped like a tall isosceles triangle with its base at the posterior margin and its apex at a small median "tooth on the anterior margin". A similar mark is present on an additional male specimen of *D. chlorops* from Rio Palenque, but is absent from the female. Similar triangular pronotal marks also occur in males of other *Docidocercus* spp., though somewhat variably. It is found in all our males (n = 7) of *D. gausodontus* but is absent from the females (n = 2). In *D. gigliotosi* it is seen in a male from Darien (Panama) and a female from Costa Rica, but is absent from 3 males and 4 females collected at Barro Colorado Island, Panama. This marking should not be taken as exclusively diagnostic of male *D. chlorops* (it may be symplesiomorphic for the genus).

Diagnosis.—Males are most readily distinguished by the dorsal scerotized tooth of the cercal apex which is rectangular-blunt (Fig. 7 J, K). See Table 7.

Description.—Light fulvid; body elongated. *Head:* eyes subglobose prominent, faded yellow brown, with dark brown bands in life; frons, postclypeus, mandible base, in part scrobal sclerite, bluish green; frons width to height 4:3, smooth, sparsely punctate, shining, hispid; most of frontal fastigium occupied by large oviform ocellus, (vertical axis ~0.8 mm) white, its narrow end just beneath fastigium apex; gena and vertex light yellow-brown; fastigium verticis short, shallowly foveate, blunt upturned with prominent, light-colored oval tubercular lateral ocelli; antennal scape medially with short white terminal spine ending just beyond base of pedicel. *Pronotum:* light yellow-brown golden, granular rugose; margined except disc anterior; shoulder of lateral lobe and disc rounded; disc anteriorly slightly produced arcuate with a weakly expressed median tubercular projection. Anterior transverse sulcus very shallow, more so than posterior, the latter situated just behind mid-disc, interrupted medially by very short longitudinal sulcus; posterior disc edge weakly biarcuate; midline maculae lacking (no "narrow light cream isosceles triangle" as per male). Lateral lobes rectangulate, posterior lobe margin vertical to humeral angle, anteroventral angle more broadly rounded, 1.3 X wider than deep, ventral margin broadened with light-

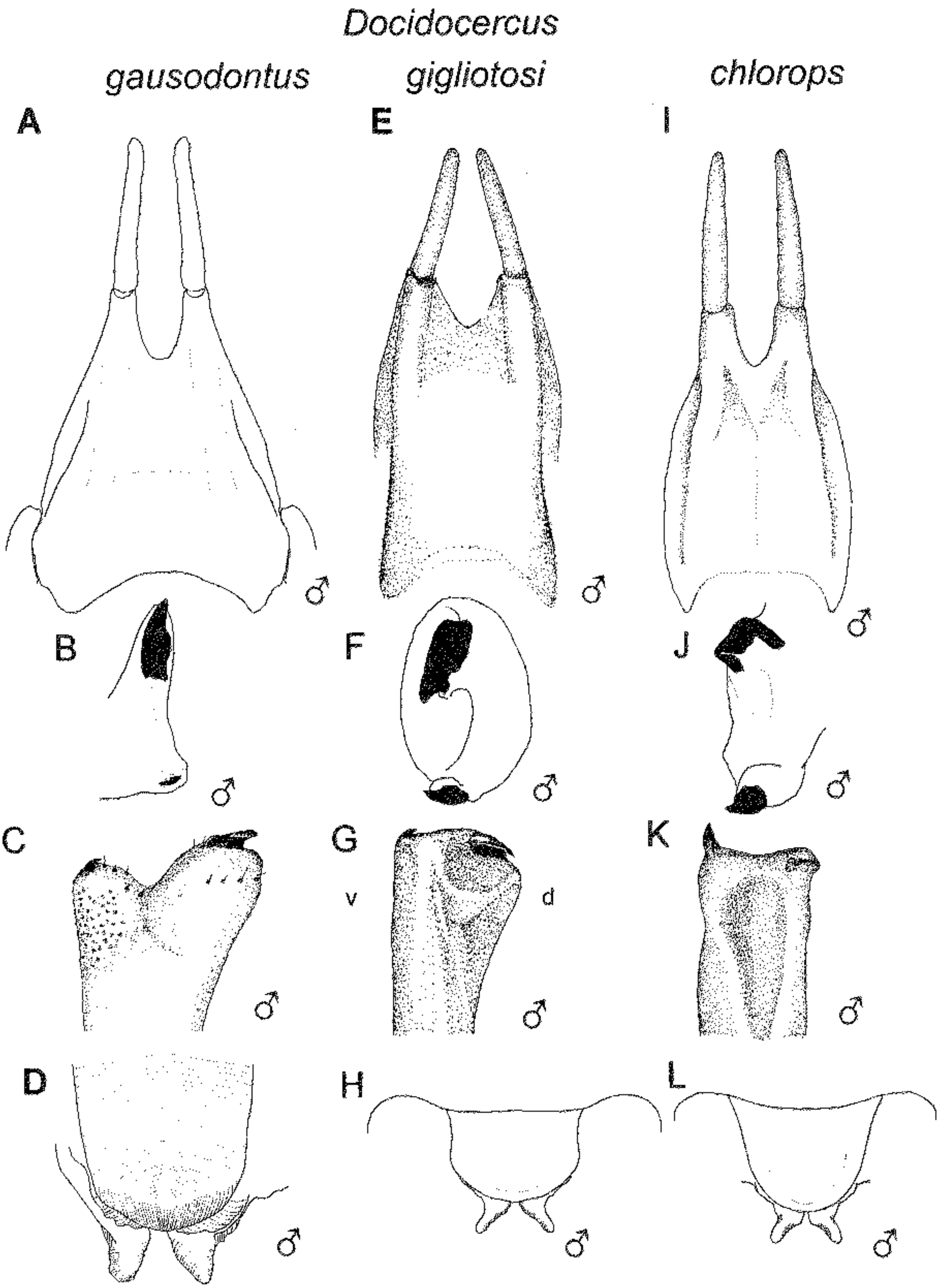


Fig. 7. *Docidocercus gausodontus*: male, subgenital plate (A), cercus tip posterior view (B) and mesal (C), paraproct processes (D). *Docidocercus gigliotosi*: male, subgenital plate (E), cercus tip posterior view (F) and mesal (G), paraproct processes (H). *Docidocercus chlorops*: male, subgenital plate (I), cercus tip posterior view (J) and mesal (K), paraproct processes (L). C,G,K are left parameres viewed mesally, dorsal tooth to the right.

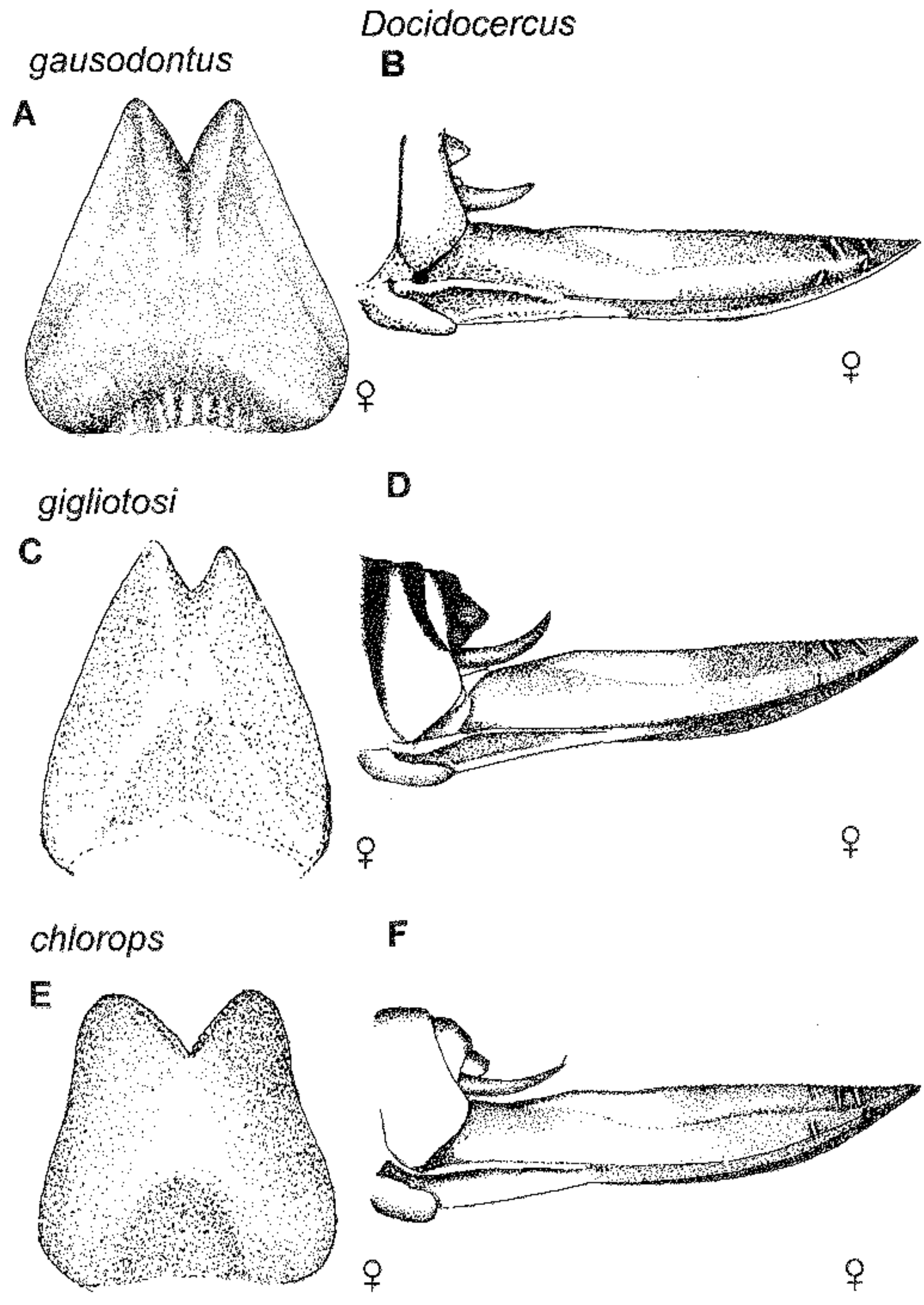


Fig. 8. *Docidocercus gausodontus*: female, subgenital plate (A), ovipositor (B); *Docidocercus gigliotosi*: female, subgenital plate (C), ovipositor (D); *Docidocercus chlorops*: female, subgenital plate (E), ovipositor (F).

Table 7. Principal distinguishing features of some *Docidocercus* species.

Species	*D. gausodontus*	*D. gigliotosi*	*D. chlorops*
male subgenital plate	broader overall, breadth reduced steadily posteriorad so more triangular (Fig. 7 A)	narrower overall, breadth not diminishing until the posterior third (Fig. 7 E)	narrower overall, breadth not diminishing until the posterior third (Fig. 7 I)
male cercus	Longer than subgenital plate, tapering slightly to and from mid-shaft, gently curving, not twisted, apex compressed clavate, bilobate; dorsal lobe with flange-like, somewhat hastate, sclerotized sharp-edged inflected tooth; ventral lobe with a small curved tooth (Fig 7. B, C)	Longer than subgenital plate, apex clavate, dilated, not bilobate, sclerotized dorsal tooth inflected flange-like sharp-edged, vertically oblique; small curved tooth ventrad (Fig. 7 F, G)	Proportionately as slender but shorter than other species; much shorter than subgenital plate; apex not dilated, shaft twisted on long axis, sclerotized dorsal tooth scalpriform, obtuse-edged, incurvate (Fig. 7 J, K; Fig. 3 C of Morris et al. 1989)
proportional length male subgenital plate styles: cercus	0.3 or less	0.3 or less	0.5-0.6
paraproct processes	robust conical apically, weakly divergent (Fig. 7 D)	narrowly papilliform apically, more divergent than *gausodontus* (Fig. 7 H)	thickly papilliform apically, smaller and more divergent than *gausodontus* (Fig. 7 L)
female subgenital plate	median emargination, deeper than gigliotosi, defines two acute lobes (Fig. 8 A)	median emargination, shallower than *gausodontus*, defines two smaller acute lobes (Fig. 8 C)	v-shaped median emargination defines broadly apically rounded lobes (Fig. 8 E)
ovipositor	longer; dorso-apical third minutely serrate ending subapically; 2 transverse flaws on apical third reach 3rd valvula margin, 1 flaw on 1st valvula more proximad (Fig. 8 B)	shorter; dorso-apical half minutely serrate to tip, lateral surface with flaws on apical third, 2 dorsal, 2 ventral (Fig. 8 D)	proximal half more sinuous dorsally, then straight with prominent serrations, subapical flaws 3 above, 2 below (Fig. 8 F)

colored tubercles. *Thorax:* prosternal spines small, blunt; equal in size to scapal spine; meso and metasternal lobes rounded and only weakly elevated; metafurcal pit deep, oval. *Tegmina:* length-width ratio ~6X; surpassing ovipositor tip; anal field narrowly linear reduced, in width < _ of distance M-Cu; anal edge lined in dark brown. *Wings:* membrane grey translucent, veins yellow-brown. Abdomen: 6-10th tergites with dark brown bands on posterior edges. *Legs:* uniform light yellow-brown; *Femora:* notably hispid throughout; spines on all femora mostly dark red-brown at base and tips, with cream-white between; genicular lobes, excepting anterior of meso and metafemora, armed with tiny, often incurved, spinules; tibiae: square in section with edges elevated ridge-like; spines dark brown throughout. *Terminalia:* Supraanal plate (Fig. 7 L) declivent basally, straight-sided, then acclivent to terminally triangular thick apex; paraprocts with short papilliform processes (Fig. 7 L); ovipositor (Fig. 8F) straight, mostly light yellow-brown basal half, red-brown over distal third; valvulae with several transverse subapical flaws, 3rd valvula dorsal edge serrate over distal half; dark brown in 2nd valvifer region (swollen base of 3rd valvula) and on dorsobasal margin of 1st valvula adjacent to 1st valvifer.

Specimens.—1 male, 1 female. Female, Ecuador, Prov. Pichincha, Tinalandia, 27 xii 1986, G.K. Morris, ANSP; male, Ecuador, Prov. Los Rios, Rio Palenque, 24 vi 1983, G. K. Morris, QCAZ.

Measurements.—See Table 6.

Tribe Teleutiini

Teleutias fasciatus Brunner von Wattenwyl
Figs 9, 23, 36; Tables 8, 9

Distribution.—Ecuador: lowland rainforest east of the Andes, drainage of Rio Napo.

Remarks.—This mottled grey-brown katydid gives a defensive display when disturbed. Transverse veins of the wings are centered on subquadrate smoky black patches, with intervening hyaline areas, forming a chequered wing

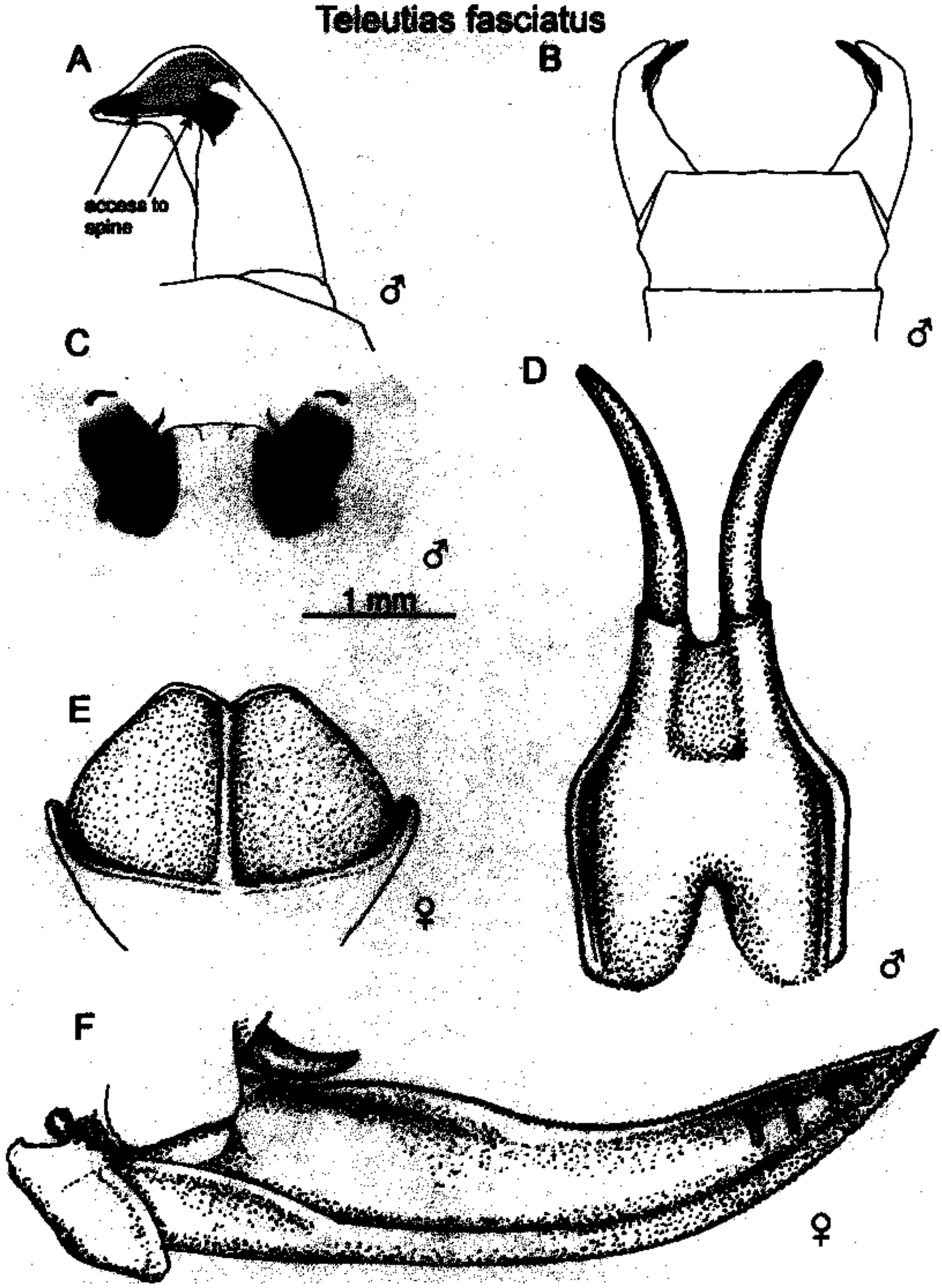


Fig. 9. *Teleutias fasciatus*: male, left cercus showing spine recessed within cap (A), cerci and supraanal plate (B), titillator in posterior view (C), subgenital plate (D); female, subgenital plate (E) and ovipositor (F).

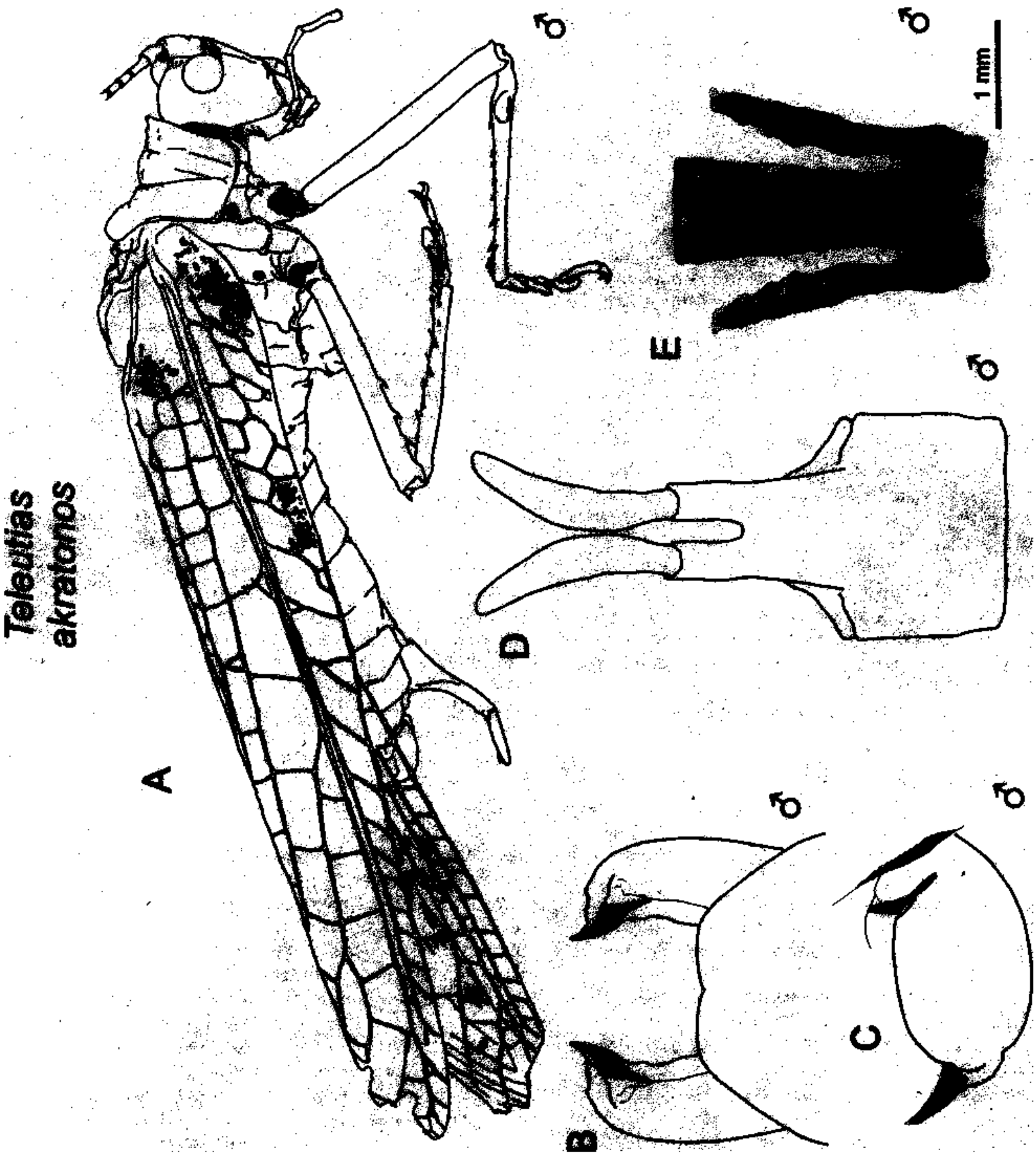


Fig. 10. *Teleutias akratonos*: male, habitus (A), dorsal aspect of cerci (B), lateral aspect right cercus (C), subgenital plate, (D) titillator in posterior view.

pattern. In display the wings are extended also exposing shining black abdominal terga.

Diagnosis.—Our specimens fit well the diagnosis of Beier (1960, p.202): W-shaped blackish mark upon the frons, femora with intermittent blackish longitudinal lines, etc. His key to species of *Teleutias* takes us via 1) 'black-brown mottling (of pronotum, tegmina, femora)' and 'chequered wing pattern', to a couplet discriminating *T. fasciatus* from *T. varius*. *T. fasciatus* has the 'dorsoposterior margin middle tibia unarmed, pronotal disc granulate, male subgenital plate styli not acuminate'; *T. varius* has 'middle tibia with 3 spines dorsoposteriorly, pronotal disc smooth, styli acuminate'. The latter two criteria, but not the armature, are diagnostic of these species.

In our *T. fasciatus* (12 males and 12 females) middle tibia armature is variable: most commonly one spine but sometimes two or none; never 3 or more. The key should be altered, reaching *T. fasciatus* via "middle tibia with 0-2 dorsoposterior spines" vs *T. varius* by "middle tibial dorsoposterior spines 3".

In both these *Teleutias* species (alive or liquid preserved) the cercal spine is recessed within a pointed hood of weakly sclerotized pale tissue. A ventral portion of the cercal apex is produced to form this chamber, tapering distally, clasping the tooth and enclosing it, except at its mesal base; only a narrow slit gives access (see arrow Fig. 9A); within the chamber apically is an adipose pad. In pinned specimens this cap may dry and shrink, largely exposing the spine.

For further diagnosis see Table 9.

Description.—Elongate insects, charcoal black, light brown and grey, with contrasting cream yellow streak along tegmen posterior margin. Males much smaller than females. Dark linear streaking on legs; generally mottled and spotted in light cream. Eyes globular red-brown; antennae pale brown, ringed darker every several segments; broad grey band on ventral half of pronotal lobe continues from gena, spotted with yellow. Terga of abdomen uniform shining black.

Female subgenital plate (Fig. 9E) semicircular, very shallowly medially emarginate, bisected by a median keel; supraanal plate triangular, apically rounded. Ovipositor upturned, dorsal margin sinuous (Fig. 9F), serrate on both margins over distal half, 3rd valvula distally with three strongly elevated transverse flaws.

Specimens.—19 males, 13 females. Female, Ecuador, Prov. Napo, Misahualli, 28 v 1983, G.K. Morris, ANSP; female, same locality and collector, 14 vii 1985, QCAZ; female, same locality and collector, 15 ii 1988, ANSP; 5 males,18 ii 1988, same locality and collector, ANSP; 2 males, 15 ii 1988, same locality and collector, QCAZ; male, 13 VII 1985, same locality and collector, ANSP; male, 11 i 1992, A.C. Mason, ANSP; female, Ecuador, Prov. Napo, Jaguar, 13 xii 1986, G.K. Morris, ANSP; female, same locality and collector, 12 ii 1988, ANSP; 2 females, same locality and collector, 13 ii 1988, QCAZ; female, same locality and collector, 16 iv 1989, QCAZ; 2 females, same locality and collector, 14 iv 1989, ANSP; male, same locality and collector, 13 ix 1989, ANSP; male, same locality and collector, 13 iv 1989, QCAZ; male, same locality and collector, 19 iv 1990, QCAZ; female, Ecuador, Prov. Napo, Primavera, 21 vii 1985, G.K Morris, QCAZ; female, same locality and collector, 19 vii 1985, ANSP; 3 *males*, same locality and collector, 20 vii 1985, ANSP; female, Ecuador, Prov. Napo, Tena, 800 m, 7 v 1963, T.H. Hubbell and L.E. Peña G., UMMZ; male, same locality, collectors, repository, 7 v 1963; male, same locality, collectors, repository, 8 v 1963; male, Ecuador, Prov. Napo, Dos Rios (2 km NE Tena) 800 m, 13 v 1963, T.H. Hubbell and L.E. Peña G., UMMZ; male, same locality, collectors, repository, 9 v 1963.

Measurements.—See Table 8.

Teleutias akratonos sp. nov.
Figs 10, 37; Tables 8, 9

Distribution.—Ecuador: lowland rainforest east of the Andes, drainage of Rio Napo.

Holotype.—Male, Ecuador, Prov. Napo, Primavera (type locality), 20 vii 1985, G.K. Morris, ANSP.

Etymology.—Named for the pure tone structure of its call (Gr., akratos = unmixed; tonos = pitch).

Remarks.—The description here is based upon two male specimens, one preserved in alcohol; color comments refer to the pinned specimen. Shining black tergites and a chequered wing pattern indicate that this species, like *T. fasciatus*, produces a defensive display.

Diagnosis

Features distinguishing *T. akratonos* and *T. fasciatus* are given in Table 9.

Description.—Yellow-brown cream-mottled, smallish, delicate, narrow animals, hispid overall. *Head:* frons levigate, yellow, this denser centrally and on frontal fastigium; frons rather flat, behind plane of clypeus and labrum; grey-mottled vertical band between scrobal sclerite and lateral clypeus; genae forward below eyes pale yellow depressed, otherwise color grey-yellow mottled as vertex; scape brown with yellow spots frontally, median spine narrowly conical, pointed; fastigium verticis foveate with prominent tubercular ocelli, yellow spotting on margins, apex yellow nodular, weakly upturned, ending well behind anterior extent of scrobal sclerites. *Pronotum:* anterior margin weakly arcuate with midline tubercle, posterior more strongly convex rearward; disc brown, granular, with scattered yellow-topped tubercles, its lateral margins strongly rounded; each side an irregular yellow line laterad, strongly divergent anteriorad on prozona, converging posteriorad on metazona. Posterior transverse sulcus much deeper than anterior. Lateral lobes broader than deep, thin-margined fore and aft, ventral margin thick flattened; humeral sinus shallow. *Thoracic sternites:* prosternum bispinose, spines conical, pointed. Lateral lobes of mesosternum bent, elevated, with posteriorly directed tubercle; metafurcal pit deep, oval, longer than broad, *Tegmina:* elongate, parallel-sided; costal exceeding anal margin so ending diagonally truncate. Sc and R narrowly separate almost to apex; Rs arising at about posterior third; Media adjacent to mirror, cream; cream streak continuing length of posterior margin. *Wings:* chequered pattern, as for *T. fasciatus*, with diffusely delimited black marks centered on the transverse veins within hyaline wing membrane. *Legs:* all genicular lobes armed with small, slightly curved spines. *Terminalia male*: cerci disproportionately robust, cylindrical; sclerotized terminal tooth directed mesad, recessed in non-sclerotized cap (Fig. 10 B,C); subgenital plate abruptly narrowing (Fig. 10D) with a deep narrow u-shaped median emargin-

Table 8. Measurements of *Teleutias fasciatus* and *Teleutias akratonos*.

Lengths (widths) mm	Teleutias fasciatus				Teleutias akratonos	
	Males (19)		Females (13)		Males (2)	
	means	range	means	range	means	range
body	27.9	23.8-32.1	41.6	36.0-46.6	28.4	26.9-30.0
pronotum	4.8	4.0-5.6	5.7	5.3-6.2	4.7	4.4-5.0
fore femur	11.6	10.6-13.2	13.3	12.3-14.4	9.9	9.3-10.5
mid femur	11.2	10.0-11.9	12.8	11.8-13.8	10.1	9.9-10.3
hind femur	24.3	21.8-25.9	28.1	24.6-30.3	21.7	20.3-23.1
fore tibia	12.4	11.0-13.4	14.4	13.3-15.1	10.5	9.4-11.6
mid tibia	12.6	11.2-13.7	14.3	13.1-15.3	11.2	10.8-11.5
hind tibia	26.9	23.0-29.5	31.0	27.8-33.0	22.8	22.0-23.6
tegmen	41.0	36.9-42.7	48.7	44.9-51.5	36.9	33.3-40.5
cercus	1.9	1.7-2.3			3.0	2.9-3.1
subgenital plate	3.4	2.4-4.1	2.1	1.7-2.5	4.2	4.1-4.3
stylus	2.5	1.9-3.0			2.2	2.1-2.3
ovipositor			12.0	11.0-13.4		
(ovipositor)			(2.6)	(2.4-2.9)		
femoral spines, ant. : post. ventral margins						
fore	4 (2-5) : 0		4 (3-5) : 0		3 (3-4) : 0	
mid	4 (3-5) : 0		4 (3-5) : 0		4 : 0	
hind	8 (7-10) : 0		9 (8-10) : 0		7 (6-7) : 0	
tibial spines, ant. : post. ventral margins						
fore	8 (7-9) : 8 (6-10)		8 (7-9) : 8 (7-9)		(6-7) : (6-7)	
mid	8 (6-9) : 8 (6-9)		8 (7-9) : 8 (7-8)		7 : 7	
hind	13 (11-15) : 11 (10-13)		13 (11-14) : 11 (11-13)		11 (10-12) : 11 (10-11)	

ation; styli large, divergent, dilatate at midlength; titillators (Fig. 10E) bilateral u-shaped sclerites, their mesal arms forming an elongate chisel-shaped projection; tiny twisted sclerites cradled basally.

Specimens.—Paratype: Male, Ecuador, Prov. Napo, 6 km W Lago Agrio, 30 viii 1975, Langley and Cohen, USNM.

Measurements.—See Table 8.

Chibchella nigrospecula sp. nov.[8]
Figs 11, 24, 38; Tables 10, 11

Distribution.—Colombia, eastern slope of central cordillera.

Holotype.—Male, Colombia, Dpto Risaralda, PRN, Ucumari (type locality), 2400 m, 26 v 1996, F. Montealegre and G.K. Morris, ANSP.

Etymology.—The specific epithet refers to the conspicuous black color of the mirror of the left tegmen; (L., nigr- = black; speculum = mirror).

Remarks.—The genus *Chibchella* is known only from Colombia. It was established by Hebard (1927) on *C. personata*. Later (1933) he described a second species, *C. femorata*. Both species are from the Region Andina. Beier (1960) added a third, *C. annulipes*, probably from this same region. The type locality for *C. annulipes* is given as "Hacienda Pehlke, Colombia"; we are unable to determine the Dpto of this locality with certainty, but it is probably Dpto del Tolima, in the Region Andina. Species of this genus are found principally in cloud forest, and it is likely that many others yet undescribed occur in Colombia (Montealegre, 1997).

In Beier's key *C. nigrospecula* runs to near *C. femorata*, but also presents some characters of *C. personata*. To separate species of *Chibchella* Beier (1960) used characters which we have found to vary within species: the number of dorsal spines on the mid tibia and the coloration of the posterior coxa. Our separation is on the basis of genitalia.

The number of spines on the posterior dorsal margin ranged between 3-5 among holotype, allotype and paratypes.

The characteristics that distinguish this genus are: pronotum finely roughened, without lateral carina; transverse sulcus of pronotal disc narrow but conspicuous, the posterior one deeper; lateral lobes longer than deep. Tegmina short: never, or only slightly, exceeding the tip of the hind femur. Prosternum bispinose; metasternal pit almost transverse, the middle portion curved ahead of the hind margin. Legs slender, all the femora with preapical ring markings. Mid tibia armed on the dorsal posterior margin.

Diagnosis.—See Table 11.

Description.—Rather short, stout, brown insects with markings of contrasting yellowish-white. *Head:* eyes globose, protruding, pale grey-brown; frons smooth, broader than high; fastigium frontalis separated blunt conical; fastigium verticis foveate, distally narrow, vertical, its edges

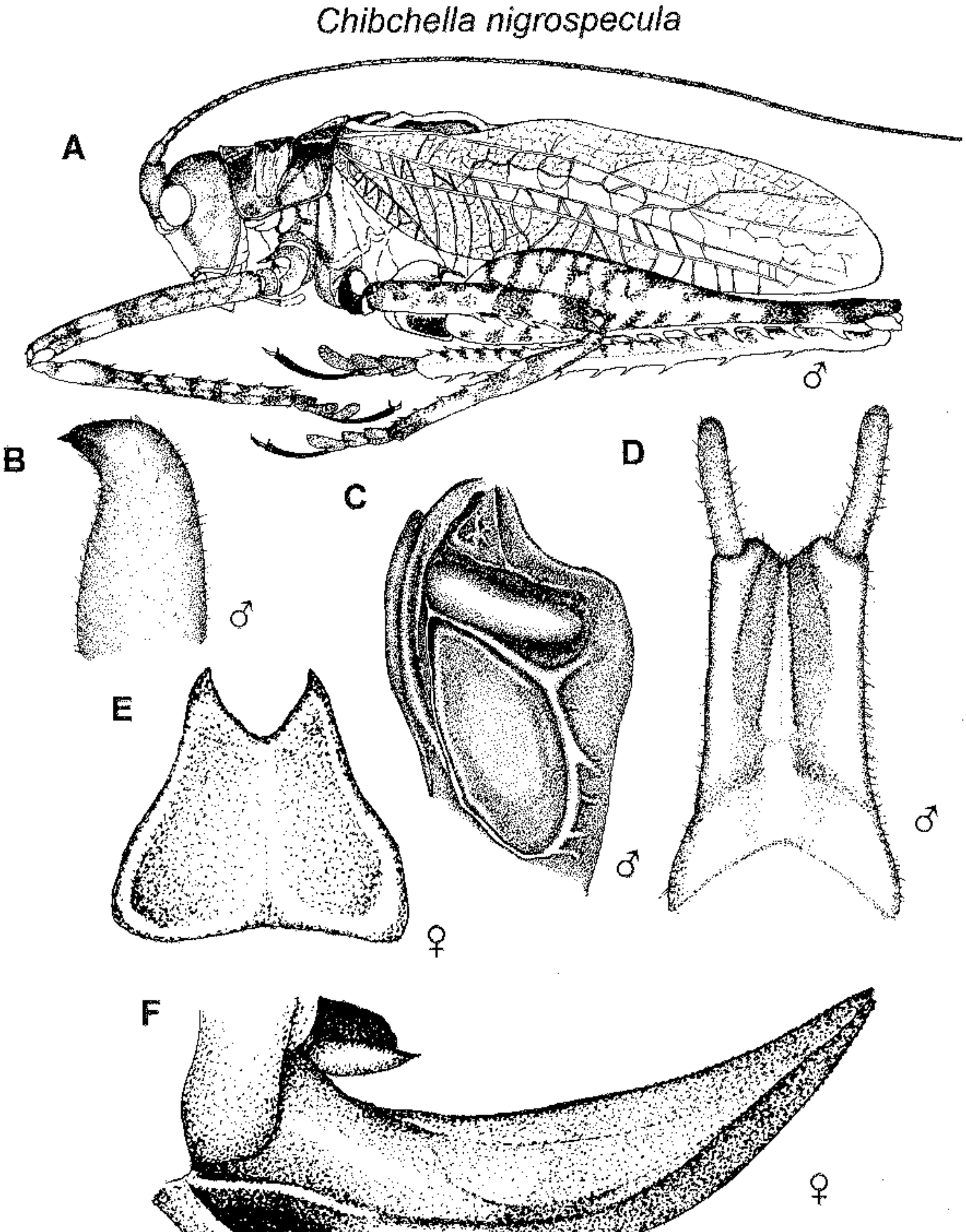


Fig. 11. *Chibchella nigrospecula*: male, habitus (A), dorsal aspect of stridulatory field (B), subgenital plate (C), cercus (D); female, subgenital plate and terminal sternite (E), ovipositor (F).

Table 9. Distinguishing characteristics of *Teleutias fasciatus* and *Teleutias akratonos*

Species	*Teleutias fasciatus*	*Teleutias akratonos*
male 10th tergite	posteriorly truncate, broadly transverse between cercal bases (Fig. 9 B)	rear margin narrowly transverse between cercal bases (Fig. 10 B)
male subgenital plate	posterior half rapidly narrowing distad, medial emargination shallow (Fig. 9 D)	moderately elongate produced, narrower than in *T. fasciatus*, medial emargination markedly deeper (Fig. 10 D)
male styli of subgenital plate	thread-like, bent, tapering distad to a blunt tip (Fig. 9 D)	Styli stout, broadest at middle, apex blunt (Fig. 10 D)
male cercus	cylindrical, slightly tapered distad; stout inward-directed terminal spine, recessed in unsclerotized cap (Fig. 9 A, B)	robust cylindrical; median tooth recessed within unsclerotized cap, twisted dorsad apically, acuminate (Fig. 10 B, C)
titillators	separate U-shaped sclerites (Fig. 9 C) with weakly convergent medial arms linked by membranous tissue; small twisted sclerite lying within the U at its bottom larger than in *T. akratonos*.	joined U-shaped sclerites (Fig. 10 E) with medial arms produced and linked distally into a ligulate median bar with angular extremities; twisted sclerite cradled in the bottom of U, smaller than in *T. faciatus*.
frons	prominent W-shaped black mark set against a lighter background.	grey mottled vertical bars below scrobal sclerites, ending short of mandible base centrally uniform pale yellow

dorsally bright green; vertex dark brown; anteriorly genae cream-yellowish. Scape of antenna with medial process tubercular (not a spine). *Pronotum:* anterior and posterior margins arcuate, edged, thinly lined yellowish-white; dorsally yellow-brown, the superior margin of the lateral lobes black; posterior transverse sulcus deeper than anterior and bisected medially by a short longitudinal black sulcus. *Thoracic sternites:* Pro- meso- and metasternum, brown with dispersed cream-yellowish spots. All coxae have dark brown with some cream spots on lateral surface. *Tegmina:* mostly brown, venation cream on the costal field, short, apex not exceeding posterior reach of hind femur, strongly convex, mirror of left tegmen conspicuous black, ovoid (Fig. 11C); crest of stridulatory file vein yellowish. Sc and R parallel; Sc ends in fork at distal quarter, Rs indeterminate or arising at the middle. *Wings:* transluscent with light brown veins. *Abdomen male*: 10th tergite deeply, widely incised, u-shaped. *Legs: Femora:* mottled brown on pale yellowish white; with cream colored ring, somewhat diffuse, on the apical third (Fig. 11A). *Terminalia:* Male and female supraanal plate triangular, apex broadly rounded, shallowly concave, mesobasally uniform dark brown. Titillators of male not sclerotized; cercus short cylindrical apically curved mesad into a small tooth (Fig. 11B); female subgenital plate deeply u-shaped emarginate (Fig. 11E); ovipositor robust, broad-based, margins without dentition until apical third then very fine small teeth (Fig. 11F).

Specimens.—Paratypes: 6 males, 3 females. Female, Colombia, Dept. Risaralda, PNN, Ucumari, 2400 m, 25/26 v 1996, F.Z. Montealegre and G.K. Morris, ANSP; male, Colombia, Dept. Risaralda, PNN, Ucumari, 2400 m, 25 vi 1996, F.Z. Montealegre and G.K. Morris, MEUV; male, same locality and collectors, 25/26 v 1996, ICN; male, same locality and collectors, 15 v 1997, ANSP; 3 males, Colombia, Dpto del Valle del Cauca, Palmira, La Sirena, 2600 m, 21 iii 1999, L. Rocha and F. Montealegre, ERN; 2 females, Colombia, Dpto del Valle del Cauca, Palmira, La Sirena, 2600 m, 21 iii 1999, L. Rocha and F. Montealegre, ERN.

Measurements.—See Table 10.

STETHARASA gen. nov.

Type species.—*Stetharasa exarmata* here designated.

Etymology.—Named in reference to the unarmed prothoracic sternum (Sp., rasa = flat; Gr., stethos = breast).

Distribution.—Colombia: eastern slope of central cordillera.

Remarks.—*Stetharasa* has affinity to *Leptoteleutias* and the monotypic genus *Apteroteleutias* and we have examined the types of these. Insects in all three genera are small elongate brownish brachypterous teleutiini. The females have either very abbreviated wings or none; the males retain only the most basal tegminal regions for sound generation.

The male of *Apteroteleutias* has lost its wings entirely; but its tegmina are present and functional. These sound organs are so abbreviated that they would seem to have compromised the capacity of their modified cells to radiate sound. In comparison to songs of other species of similar body size the song of this insect, still unknown, is likely to be unusually low in volume.

In Teleutiini the prosternum is usually armed (Beier 1960) but in these 3 genera prosternal spines are reduced to varying degrees: to a smoothly curvilinear surface without any elevation (*Stetharasa*), to low bumps (*Apteroteleutias*) or

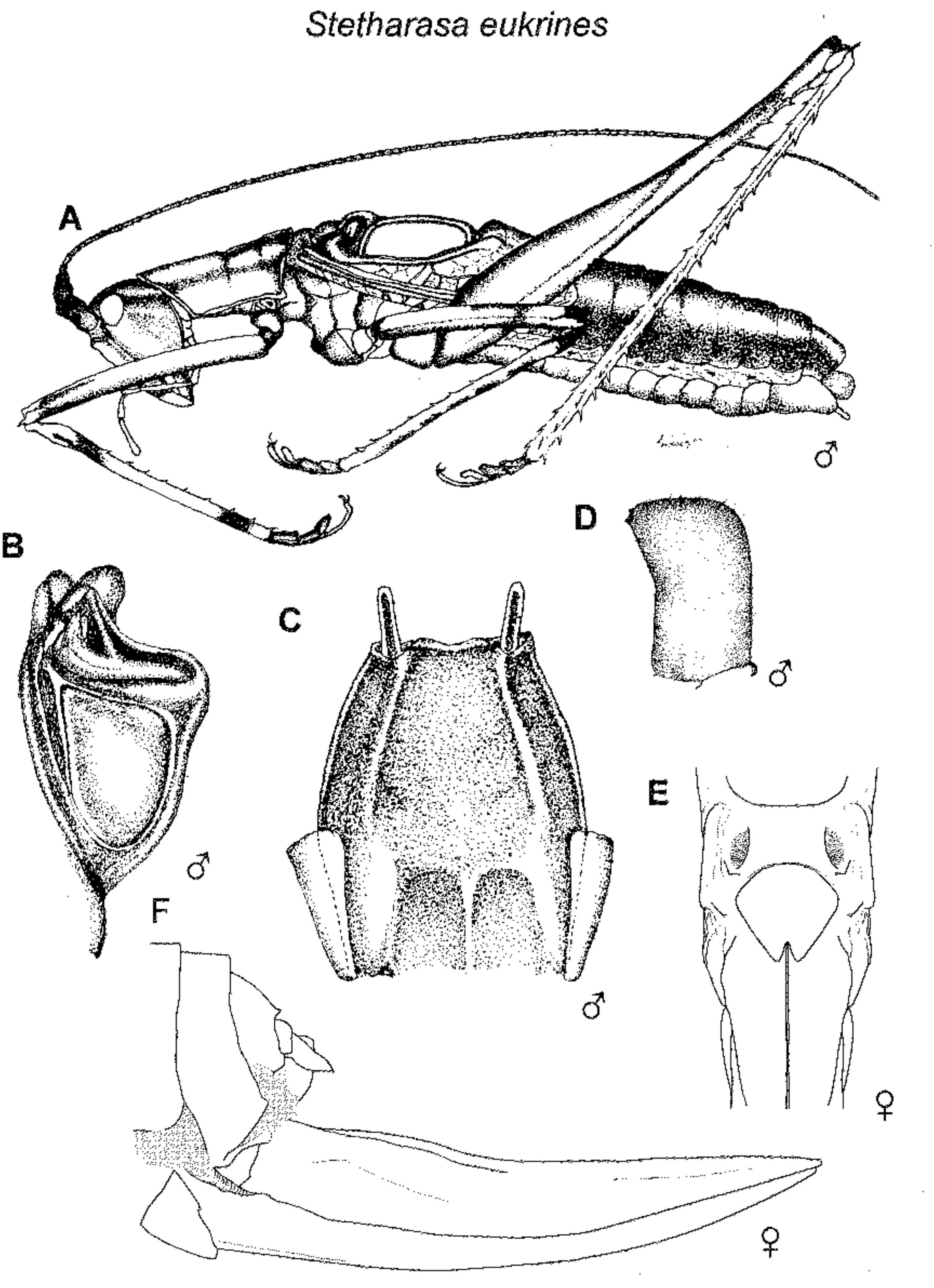


Fig. 12. *Stetharasa exarmata*: male, habitus (A), dorsal aspect stridulatory field (B), subgenital plate (C) and cercus (D); female, ovipositor (E).

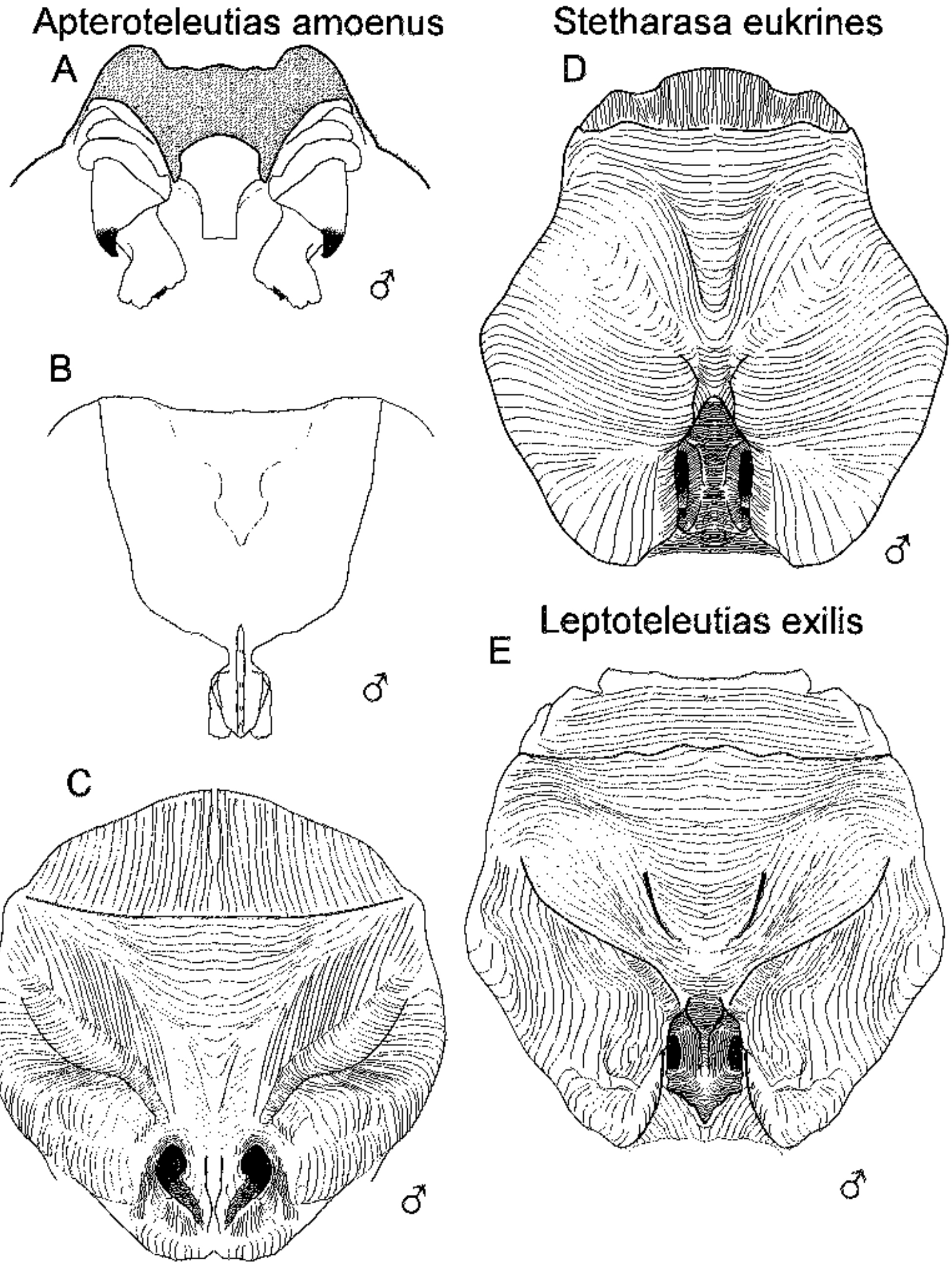


Fig. 13. *Apteroteleutias amoenus*: male, posterior view of reduced cerci below supraanal plate, hypophallic lobes beneath (A), subgenital plate ventral view (B), metasternum (C). *Stetharasa exarmata*: male, metasternum (D). *Leptoteleutias exilis*: male, metasternum (E).

Table 10. Measurements of *Chibchella nigrospecula* and *Stetharasa exarmata*.

Lengths (widths) mm	*Chibchella nigrospecula*				*Stetharasa exarmata*			
	Males (7)		Females (3)		Males (10)		Females (2)	
	means	range	means	range	means	range	means	range
body	28.6	24.8-33.0	28.8	26.5-30.0	26.1	24.8-27.5	30.2	29.1-31.2
pronotum	5.7	5.5-5.9	5.4	5.0-5.7	5.2	4.8-5.8	5.5	5.3-5.7
fore femur	9.8	9.6-10.0	10.4	10.0-11.0	8.9	8.7-9.3	9.7	9.3-10.1
mid femur	9.8	9.3-10.2	10.2	10.0-10.7	9.0	8.7-9.5	10.0	9.7-10.2
hind femur	18.7	17.2-20.0	19.9	19.5-20.2	17.0	16.2-17.7	18.5	18.3-18.7
fore tibia	11.4	11.0-11.7	11.3	11.3-11.4	9.4	8.8-10.0	10.2	10.0-10.4
mid tibia	11.7	11.3-12.1	12.2	11.9-12.3	10.4	10.0-11.0	11.7	11.6-11.8
hind tibia	21.0	19.6-22.0	21.9	21.8-22.0	19.2	18.1-20.0	21.7	21.2-22.3
tegmen	22.1	21.0-23.0	23.8	22.3-26.0	8.3	7.0-9.1	6.2	5.7-6.6
cercus	1.9	1.6-2.1	2.0	1.9-2.1	1.5	1.2-1.8		
subgenital plate	3.7	2.8-4.4	2.2	2.0-2.4	2.5	2.4-2.7	2.2	2.0-2.3
stylus	1.3	1.0-1.7			0.5	0.4-0.6		
ovipositor			13.5	13.0-14.0			14.1	13.6-14.5
(ovipositor)			(2.9)	(2.8-3.0)			(2.2)	(2.1-2.2)
femoral spines, ant. : post. ventral margins								
fore	4 (3-7) : 0		4 (4-5) : 0		3 (0-5) : 0		2 (1-2) : 0	
mid	4 (2-4) : 0		4 (3-4) : 0		0 (0-1) : 0		0 (0-1) : 0	
hind	7 (5-9) : 0		6 (6-8) : 0		6 (3-7) : 0		(3-6) : 0	
tibial spines, ant. : post. ventral margins								
fore	8 (7-8) : 8 (7-8)		8 (7-8) : 8 (7-8)		8 (7-9) : 7 (7-8)		(6-8) : 7 (7-8)	
mid	8 (7-8) : (4-8)		9 (8-9) : 8		8 (7-9) : 7 (6-9)		(8-9) : 7 (7-8)	
hind	11 (11-14) : (9-13)		11 (10-11) : 10		15 (14-18) : 15 (13-16)		(13-18) : 15 (14-16)	

to tubercules (*Leptoteleutias*). All three genera also share shallow pronota and the absence of a procoxal spine.

Diagnosis.—*Stetharasa* is more closely related to *Leptoteleutias* Beier than to *Apteroteleutias* Beier. With this genus it shares an excavated supraanal plate. It is distinguished from *Leptoteleutias* by the morphology of the metasternum: in *Stetharasa* the lobes of this are laterally produced angulate and relatively flat. The anterior portion of its basisternite is narrowly transverse and strongly deflected entad. A medial elevation of the basisternite anterior to the furcal pits, forms a narrow prominence posteriorad (Fig. 13D). The furcal pit is longitudinally rectangular (reflecting the lengthening and narrowness of the animal) and divided by a robust partition, recessed at a planar depth. It is also distinguished by its prosternum which lacks armature, exhibiting a smooth gently curving surface. Further diagnostic features separating *Stetharasa* from both *Leptoteleutias* and *Apteroteleutias* are in Table 12.

Description.—Small slender elongate brachypterous yellowish brown Teleutiini. *Head:* eye prominent, obovate; frons without lateral margins, broader than high, smooth, shining. Mediodistal spine of scape very short, blunt. Fastigium verticis foveate with low ocelli, ending behind anterior extent of scrobal sclerites. *Pronotum:* disc sparsely hispid, smoothly, shallowly rugose, lateral disc margins broadly rounded onto lateral lobes; anterior disc margin strongly produced arcuate, posterior margin almost truncate; transverse sulci shallow; lateral lobes (Fig. 12A) much longer than deep, their ventral margin curving above coxa, posterior angle drawn into tooth, narrowly marginate, humeral angle scarcely evident. *Thoracic sternites:* prosternum unarmed narrow, slightly convexly curvilinear; mesosternum lateral lobes scarcely produced; metasternum (Fig. 13D) with furcal pit rectangular elongate, partitioned by recessed septum. *Tegmina:* brachypterous in both sexes, male: reaching second abdominal tergite, rounded apically; Media robust, left almost straight, right slightly curved, tapering beyond Cu1a of mirror as tegmina become elevated into fold-like flexure (Fig. 12B). Female: reaching to first abdominal tergite. *Wings:* both sexes: brachypterous, pale membranous, just shorter than tegmina, dilate distad. *Legs:* all genicular lobes armed with slightly convergent moderately long thin spines. *Terminalia:* both sexes: supraanal plate fused with epiproct, subtriangular; male: cerci short robust (Fig. 12D). Female: subgenital plate small medially emarginate (Fig. 12E).

Table 11. Principal distinguishing features of *Chibchella personata*, *Chibchella annulipes*, *Chibchella femorata* and *Chibchella nigrospecula*.

Species	*Chibchella personata* (female only)	*Chibchella annulipes* (male only)	*Chibchella femorata*	*Chibchella nigrospecula*
tegmina apex	slightly exceeding hind femorotibial joint	scarcely surpassing hind femorotibial joint	slightly exceeding hind femorotibial joint	not attaining femorotibial joint (Fig. 11A)
middle tibia dorsal armature	2 small spines posteriorly	anterior 2, posterior 6-7 spines	anterior 1-2, posterior 4-6 spines	anterior 0, posterior 3-5 spines
coxae	uniformly light color	uniformly light color	middle & hind coxae with dark brown markings	middle & hind coxae with dark brown markings
hind femora markings	distad dark brown with sharply defined light preapical ring	brownish distad gradually gradually blackish brown, with sharply defined yellowish preapical ring	distad dark brown, well defined light preapical ring; lateroventrally dark brown band	tesselate brown on base yellow, no sharply defined preapical ring
supraanal plate	very slightly broader than long, lateral margins strongly convergent, broadly convex to small, bluntly acute-angulate produced at apex.	not known	supraanal plate rounded triangular	supraanal plate long, basally wide, narrowing distally and apically rounded.
male subgenital plate	not known	short, distally scarcely narrowed, apically truncate, with small median lobe, styli thin rod-like, straight	distally not reduced, finely carinate, apically truncate, styli thickened, club-shaped	relatively long, rectilinear, distally not reduced, apically weakly v-emarginate, styli rod-like (Fig. 11 D)
male cercus	not known	not given	conical, narrowed with small terminal spinules	cylindrical, tapered with single terminal spine (Fig. 11 B)
female subgenital plate	broad and convex, lateral margins straight, convergent to small produced apex, with small blunt acuminate median lobes	not known	almost twice as broad as long, posterior margin straight with one mesal projection pointed, prominent	basally transverse, distad gradually narrowed, apically broadly v-shaped emarginate, terminal lobes acute (Fig. 11 E)
ovipositor	slender, gradually acuminate only slightly upcurved, red-brown distad, 5 preapical flaws, margins smooth (Plate XXI, Fig. 4 Hebard 1927)	not known	more slender than personata with 3 fine preapical flaws	broad, moderately upcurved, 4.4X longer than wide, apically acutely pointed, inconspicuously serrate on margins, lacking oblique or transverse preapical flaws (Fig. 11 F)

Stetharasa exarmata sp. nov.
Figs 12, 13D, 25, 39; Table 10,12

Distribution.—Colombia, eastern slope of central cordillera.

Holotype.—Male, Colombia, Dpto Risaralda, PRN Ucumari, 2400 m, 15 v 1997, F. Montealegre and G.K. Morris, ANSP.

Etymology.—The specific name indicates the lack of sternal armature (L., ex- = beyond; armatus = armed).

Remarks.—In addition to many specimens taken at night on understory plants, one male was collected during the daytime from deep within the leaves of a very low growing (but not terrestrial) bromeliad.

Description.—Pale-whitish brown, with dark brown and yellow markings. *Head:* eye brown, obovate; frons, clypeus, labrum, frontal fastigium, scrobal sclerites, lowest 0.25 of anterior scape, extremely pale brownish white, becoming

Table 12. Principal distinguishing features of *Stetharasa*, *Leptoteleutias* and *Apteroteleutias*.

Genera	*Stetharasa*	*Leptoteleutias*	*Apteroteleutias*
prosternum	unarmed, curvilinear, no prominences	unarmed, with 2 obtuse coniform tubercles	unarmed, 2 smoothly rising broad low prominences
terminal tergite	typical	rectangular, posterior margin truncate between modest right and left lobule laterad	unusual, combined seamlessly with supraanal plate, strongly deflected, produced, terminally emarginate between two produced toothlike lobes (Fig. 13 A, Abb. 6 Beier 1962)
supraanal plate (10th tergite)	posterior half with deep crescentic excavation, both sexes	rounded triangular, not longer than broad, in females excavated	combined with epiproct and produced in two ventrally directed spines (Fig. 13 A)
cercus	compact, cylindrical, proportion normal, spinules, no terminal spine (Fig. 12 D)	short, thickset, proportion normal, uniformly flattened beyond basal swelling, terminal knob helmet-shaped with straight, sharply acuminate inward-directed terminal spine	disproportionately shortened, concealed by supraanal plate, directed ventrad, coniform, curved smoothly into mesad-directed terminal spine (Fig. 13 A; Abb. 6 Beier 1962)
male subgenital plate	apically truncate, entire; almost as broad as long, gently narrowing rearward; styli short thread-like (Fig. 12 C)	deeply terminally emarginate, styli very reduced, button-like	compressed, complex, terminal process, styli absent (Fig. 13 B; Abb. 6, Beier 1962
male tegmen length	1.6X longer than pronotum	as long as or just slightly longer than pronotum	<1/3 pronotum length
female flight organs	present, slightly longer than pronotum	absent	absent
metafurcal pit	rectangular, longitudinally elongate, septum recessed at uniform depth (Fig. 13D)	ovoid, septum anteriorly at plane of basisternite, progressively recessed posteriorad (Fig. 13E)	transversely cardioid, divergent entally, septum entirely at sternal surface (Fig. 13C)
metasternal lobes	produced laterally, angulate, topographic changes shallow (Fig. 13D)	basisternite anteriomedial of furcal pit almost flat (Fig. 13E)	medial region of basisternite anteromedial of pit inflated arching (Fig. 13C)
metasternum basisternite anteriorad of furcal pit	narrow median elevation pointing posteriorad (Fig. 13 D)	median elevation lower broader than *Stetharasa* (Fig. 13 E)	broadest median elevation, gutter-like depressions, smooth, wide, divergent anterolaterad from pits (Fig. 13 C)

white when pinned and dry; exposed face of mandibles with a diffuse brown spot basad, pale yellow distad; frons without lateral edges, broader than high, smooth, shining; gena extremely light brown. Scape medioanteriorly and upper edge of scrobal sclerite, dark brown, mediodistal spine of scape very short, blunt white-tipped; flagellum pale brown with darker brown ringing at intervals of many articles. Fastigium verticis, dark brown, foveate with light low ocelli, ending behind anterior extent of scrobal sclerites. Vertex with two dark brown diffusely edged bands behind eye, the more laterad proceeding directly posterior, the other arching toward the midline before straightening posteriorad; between these bands contrasting light yellow (white in death). *Pronotum:* disc sparsely hispid, smoothly, shallowly rugose, lateral disc margins broadly rounded onto lateral lobes; anterior disc margin strongly produced arcuate, posterior margin almost truncate; transverse sulci shallow; middle longitudinal third of disc a narrow median line of yellow flanked by broader dark brown stripes, laterad longitudinal thirds yellow brown becoming broadly yellow over metazona; lateral lobes (Fig. 12A), brown, much longer than deep, ventral margin curving above coxa, posterior angle drawn into rear-directed tooth, narrowly marginate, humeral angle scarcely evident. *Tegmina:* male: reaching second abdominal tergite; rounded apically; both Sc and R extend to near apex, parallel, brown, smoothly arcing; file vein dorsally dark brown massive, protruding; principal veins light brown; darker brown within cells; female: tegmina reaching to first abdominal tergite; *Wings:* male and female: brachypterous, pale membranous, just shorter than tegmina, dilate distad. *Legs:* fore femora 1.6 X pronotal length; spination (Table 10); femora brown with brownish white dorsoanterior patches diffusely delimited on preapical third; tibiae distad variably white and grey becoming more mottled brownish proximally, spines reddish brown. *Terminalia:* male: 10th tergite short, subtriangular, apically rounded continuous with epiproct; parameres short, bulky, cylindrical with minute terminal inward-directed tooth (Fig. 12D), titillators membranous; subgenital plate longer than broad with short rod-like styli (Fig. 12C). Female: supraanal plate broadly transverse crescentic weakly excavated distad, continuing seamlessly posteriorly as rounded triangular epiproct; cerci moderately long conical, light brown; subgenital plate small, apically narrowly emarginate, the terminal lobes pointed acuminate, inturned (Fig. 12E). Ovipositor slender, slowly tapering, slightly browning distad; margins smooth, dorsally very weakly sinuous, ventrally weakly upcurved, basal sclerite not excavated (Fig. 12F).

Specimens.—Paratypes: 7 males, 2 females. Female, Dpto Risaralda, PRN Ucumari, 2400 m, 26 v 1996, F. Montealegre and G.K. Morris, ANSP; male, same locality and collectors, 26 v 1996, ANSP; 2 males, same locality and collectors, 25 v 1996, ANSP; male, same locality and collectors, 25 v 1996, ICN; 2 males, same locality and collectors, 15 v 1997, MEUV; male, same locality and collectors, 16 v 1997, ANSP; female, same locality and collectors, 16 v 1997, MEUV.

Measurements.—See Table 10.

Tribe Eucocconotini

Gnathoclita sodalis Brunner v. W.
Figs 14, 26, 40; Table 13

Distribution.—Colombia: eastern slope of western cordillera.

Remarks.—The unusual cephalic development of *G. sodalis* males may be an adaptation for aggressive behaviour. The enlargement and ventral production of the head parallels that of Australian tree wetas *Hemideina* (Brown and Gwynne 1997) in which such features are known to be important in male fighting with conspecifics.

Description.—Scapus, antennal scrobes, fastigium verticis, vertex, frons, genae, clypeus and mandibles dark brown-reddish; eyes (in life) gray-greenish. Anterior and ventral margins and metazona of the pronotum black; pro- and mesozona yellowish. All of the femora and in part the tibiae are green; the femoral apex and base of the tibiae are brownish. The epimeron of the pro- and meso-pleuron is dark brown-reddish. The venation of the tegmina is green, but in some areas yellow-whitish. The rest of the body is yellow-brown.

Titillators blackly sclerotized, curled conical, bearing tiny teeth; extruded phallus ventromedially with small linguiform sclerotized projection (Fig. 14D).

Specimens.—4 males, 1 females. Male, female, Colombia, Dpto del Valle del Cauca, Dagua, Borrero Ayerbe, El Ensueño, in copula, 18 v 1996, M. Satizabal, MEUV. Male, same locality, 18 v 1996, F. Montealegre and G.K. Morris, ANSP ; same locality, 19 v 1996, F. Montealegre and G.K. Morris, ICN G, same locality, x 1996. A. Osorio, ICN; Male, Colombia, Dpto Valle de Cauca, Cali, San Antonio,TV tower Cerro la Horqueta, ii 1995, N. Carrejo, MEUV.

Measurements.—See Table 13.

Tribe Leptotettigini

Macrochiton macromelos sp. nov.
Figs 15, 27, 41; Tables 13, 14

Distribution.—Eastern Ecuador: Amazon lowland rainforest.

Holotype.—Male, Ecuador, Prov. Napo, Jaguar (type locality), 13 ii 1988, G.K. Morris. ANSP.

Etymology.—Named with reference to the extreme length of the forelimbs (Gr., macros = long; melos = leg).

Remarks.—We have not viewed the relevant material and rely here upon the descriptions of Beier (1960). Brunner (1895) erected the genus *Macrochiton* with 3 species: *M. adjutor* (Peru, Bolivia), *M. heros* (Colombia) and *M. pallidespinosus* (Venezuela). He separated these species on the basis of femoral spine coloration, the shape of the tegminal apex and the presence or absence of apical rings on the hind femora; these characters are used by Beier in his key (p. 265, 1960). *M. macromelos* appears most closely related to *M. adjutor*.

Diagnosis.—All femora lack apical rings. Elongate subtriangular supraanal plate of male is strongly pubescent, ending in a small emargination. Cerci elongate, tapering, ending gradually as ventromesad curving tooth. See Table 14.

Description.—Narrow-bodied, extremely long-legged, reddish-brown insects, with long broad tegmina; pubescence in most regions of the body. *Head:* eyes prominent, gray. Frons smooth, pubescent; frontal ocellus conspicuous, ovoid, cream. *Pronotum:* anterior margin pronotal disk convex. Ratio posterior-anterior disk margins 1.20 E,1.25 G. Pronotal lobes slightly longer than deep, their anterior and posterior margins slightly curving, ventral margin somewhat concave. Lateral margins of disk not carinate. Pronotum smooth, matt. *Tegmina:* Sc and R diverging on distal half, Rs arising well before the middle, branching distally 2-3 times, M and Cu parallel throughout their length. Stridulatory field elongate, bracketed by massive Median veins of opposing tegmina; speculum of right tegmen ovate with narrow end posterior. *Legs:* all of unusual length (Fig. 15A), caramel-colored in death, in life reddish brown; preapical rings absent, distal portion of femur pale; fore femora tapering near base, 3 times as long as pronotum; all genicular lobes armed with short blackish spinule. *Abdomen:* Abdominal sternites reddish. *Terminalia:* Male: supraanal plate (Fig. 15C) subtriangular, surface granular, distally rugose, invested densely with long curving yellow hairs, with a shallow longitudinal excavation, apically a tiny emargination defining small rounded lobes. Cercus setose, rather elongate

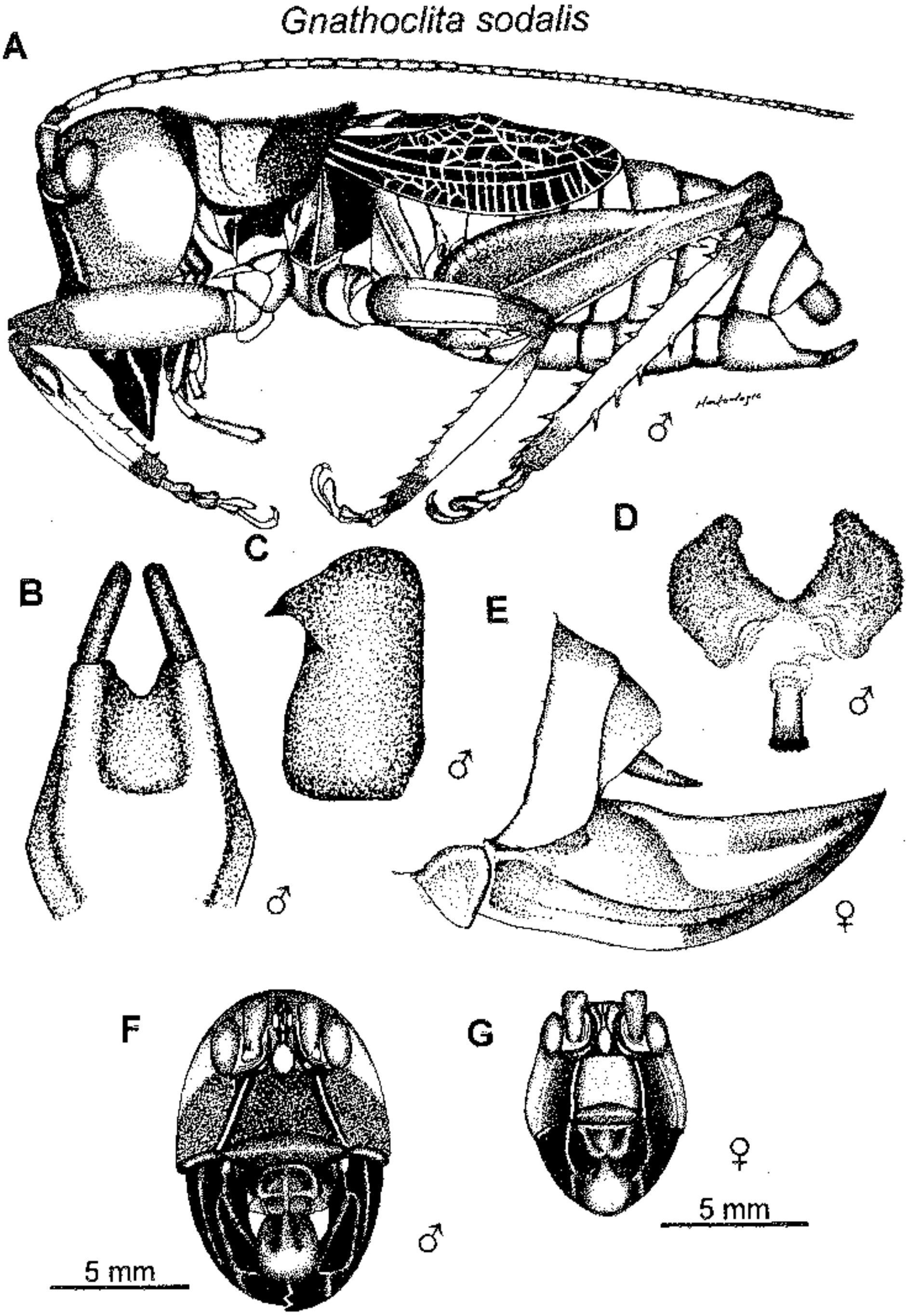


Fig. 14. *Gnathoclita sodalis*: male, habitus (A), subgenital plate (B), cercus (C), titillator (D); female, ovipositor (E). Frontal aspect, head of male (F) and female (G).

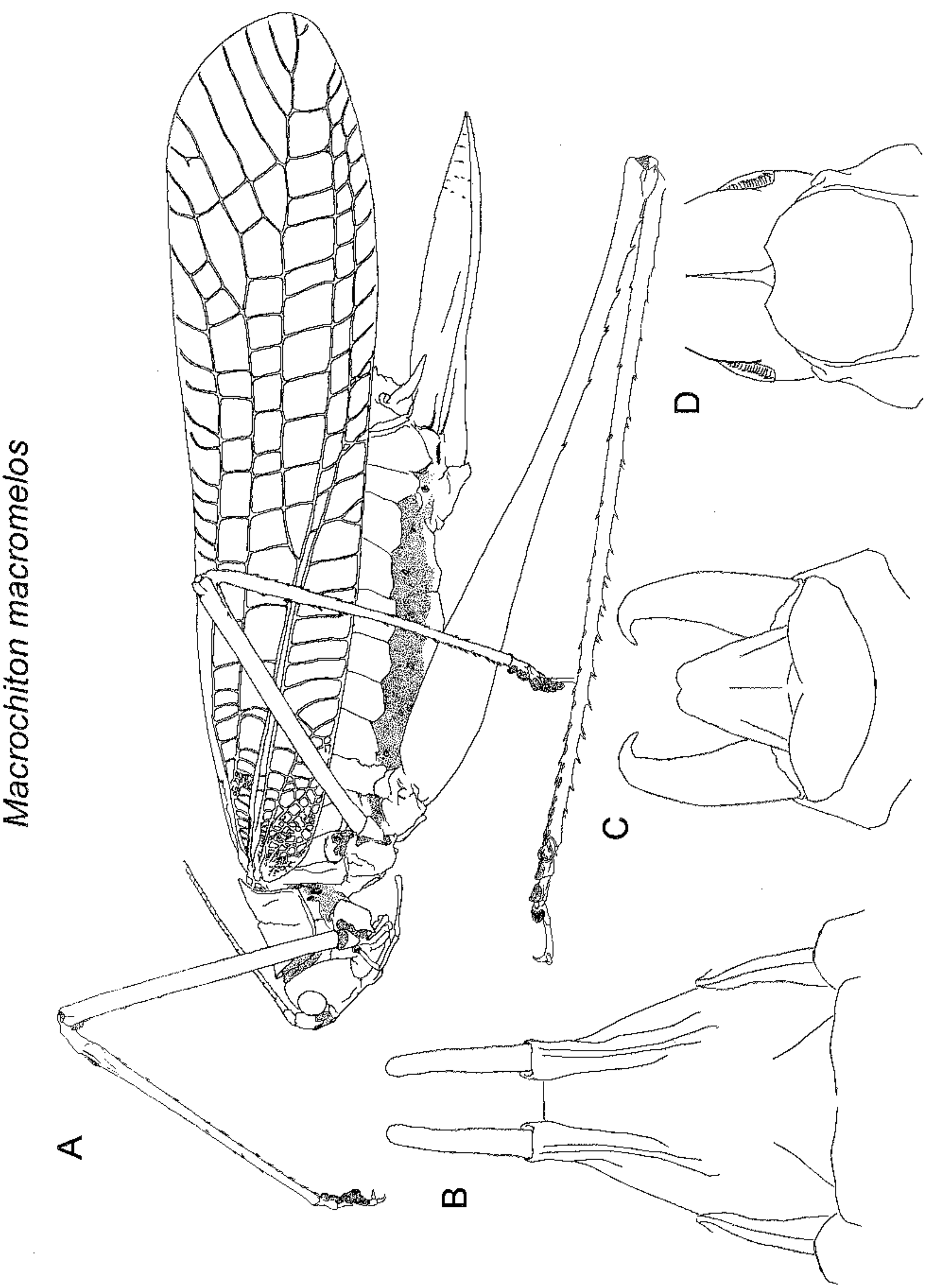


Fig. 15. *Macrochiton macromelos*: male, habitus (A), subgenital plate (B), cercus and supraanal plate (C); female, subgenital plate and ovipositor base (D).

Table 13. Measurements of *Gnathoclita sodalis*and *Macrochiton macromelos.*

Lengths (widths) mm	*Gnathoclita sodalis*			*Macrochiton macromelos*			
	Males (6)		Female	Males (7)		Females (4)	
	means	range		means	range	means	range
body	27.4	24.3-33.0	30.0	36.8	31.2-45.9	51.5	49.5-55.2
pronotum	6.0	5.5-6.2	5.4	7.9	7.4-8.3	8.5	8.1-8.7
fore femur	7.7	7.1-8.0	7.0	24.5	23.1-26.8	24.6	24.0-25.5
mid femur	7.5	7.0-8.1	7.6	22.5	20.8-24.1	24.3	22.0-26.0
hind femur	12.2	11.9-12.8	14.0	47.5	45.3-48.3	52.5	49.5-55.5
fore tibia	8.2	7.9-8.8	7.0	25.7	22.7-28.0	26.1	24.0-28.0
mid tibia	8.3	8.0-9.0	9.0	25.2	23.6-26.6	25.6	23.5-27.0
hind tibia	12.9	12.0-14.5	14.0	52.6	51.0-54.4	56.9	54.5-60.0
tegmen	11.0	10.0-12.3	13.5	56.6	55.2-58.2	65.5	61.0-68.5
cercus	1.8	1.6-1.9		4.4	4.2-4.6	5.6	4.7-6.5
subgenital plate	3.9	3.8-4.0	1.8	6.0	5.1-7.1	5.7	5.0-6.6
stylus	1.5	1.3-1.7		3.4	2.6-4.2		
ovipositor			9.8			25.7	24.5-26.5
(ovipositor)			(3.2)			(4.0)	
femoral spines ant. : post. ventral margins							
fore	1 : 0		0-1 : 0	2 (0-4) : 0		2 (0-3) : 0	
mid	2 (1-3) : 0		2 : 0	1 (0-1) : 0		1 (0-2) : 0	
hind	5 (3-6) : 0		4 : 0	(5-7) : 7 (2-10)		(5-7) : 6 (5-7)	
tibial spines, ant. : post. ventral margins							
fore	(6-7) : 4 (4-6)		7 : 4	(11-14) : (11-13)		14 (13-14) : 13 (11-13)	
mid	7 : 5 (4-6)		7 : 5	13 (12-15) : 13 (9-13)		13 : 13 (11-13)	
hind	10 (9-12) : 4 (4-7)		10 : 4	20 (17-22): 16 (15-22)		20 (18-20) : 15 (15-16)	

gradually tapering and curving inward and downward into a moderately sharp tooth (Fig. 15C). Subgenital plate (Fig. 15B) elongate, surface shiny, hispid, very dark brown, with projecting swollen styli bases, between these apically truncate; styles long. Female: supraanal plate shape similar to male, smooth, less pubescent. Subgenital plate (Fig. 15D) short, broadened basally, apically with 2 very shallow acute-tipped lobes and a shallow median rounded emargination. Ovipositor (Fig. 15A) long, robust, almost straight, acute apically; dorsal edge toothed on the distal half, ventral margin smooth. Superior valve with at least 5 transverse elevated subapical flaws (creases), 2 more on ventral portion of this valve; ventral valve with only one flaw dorsodistally. Additional smaller creases sometimes occurring on distal ovipositor.

Specimens.—Paratypes: 6 males, 4 females. All from Ecuador, Prov. Napo, Coll. G.K. Morris. Male, Jaguar, 20 vii 1985; male, Misahualli, 10 xii 1986, rec. 86-2; 2, Jaguar, 11 xii 1986; male, Jaguar, 12 xii 1986, rec. 86-1; male, Jaguar, 13 ii 1988; male, Jaguar, 13 iv 1989. Female, Misahualli, 18 ii 1988. In alcohol: 1 female, Primavera, 20 vii 1985; 1 female, Jaguar, 12 ii 1988; 1 female, Jaguar, 13 ii 1988.

Measurements.—See Table 13.

Tribe Pterophyllini

Parascopioricus cordillericus Beier
Figs 28, 42; Table 15

Distribution.—Colombia: premontane rainforest of eastern slope of the western cordillera.

Remarks.—A single male was taken, discovered as it molted in the night to adult, on the underside of a hand-sized herbaceous leaf; it was about 3 m above the ground in the forest understory.

Diagnosis.—Our specimen conforms to the diagnostic features given by Beier (1960: 295, Fig. 191b) for this species. In particular its lanceolate acuminate tegmina, the anal margin much less bent than in *Scopioricus*, two radial sector-like veins given off from the closely adjoined Sc and R in the distal half of the postradial field, the absence of any large polygonal wing cells in the radial field (as in *Scopioricus*); inner genicular lobes of mid femora with terminal spine; male supra-anal plate quadrate, ending broadly truncate; male cerci short, conical and acuminate with a terminal inflected spine. Male subgenital plate keeled basally with a proximad truncate, distally lanceolate, elevation; the ventrally grooved plate then tapering distally, ending in a terminal cleft which forms subequal lobes; lobes medially acuminate projecting (more so in our specimen than in Beier's

Table 14. Comparison of *Macrochiton heros*, *Macrochiton pallidespinosus*, *Macrochiton adjutor* and *Macrochiton macromelos*.

Species	*Macrochiton heros*	*Macrochiton pallidespinosus*	*Macrochiton adjutor*	*Macrochiton macromelos*
Preapical rings hind femur	present	present	absent	absent
Tegmina	broadened distally	not broadened distally	broadened distally	broadened distally
Male subgenital plate	pitchy brown, glazed, terminal lobes and styli longer than M. adjutor	light brownish yellow, terminally weakly sinuous, end lobes short	dark pitchy brown, glazed, distally reduced, almost straight truncate between two short terminal lobes, styli rod-like	elongate, apically truncate, with small corner lobes; long styles, almost half plate length; ventral surface glassy, pubescent, brown-blackish (Fig. 15 B)
male supraanal plate	about 2 X as long as broad, tongue-shaped, apically rounded	distinctly longer than broad, gradually reduced distad, apically weakly rounded	longer than broad, tongue-shaped with rounded apex	tongue-shaped, as wide at base as long, covered in long curving golden hairs, longitudinally concave, narrowing steadily distally, apically a tiny emargination (Fig. 15C).
female subgenital plate	more deeply rounded emarginate than M. adjutor	unknown	broad, distally strongly reduced, with roundish terminal notch, bluntly acuminate terminal lobes	(Fig. 15 D) short, basally transverse, apically a shallow broad emargination creates 2 acute-tipped lobes
cercus	apically weakly bent with distinctly disposed terminal spines	straight, apically bent inwards with moderately long thin obtuse terminal spine	moderately slender, straight, apically strongly bent inward; terminal spine proportionately short, not sharply disposed	cercus setose, elongate, tapering, ending gradually as ventromesad curving sclerotized tooth (Fig. 15 C)
female supraanal plate	distally reduced; sinuously truncate apically	unknown	longer than broad, sinuously truncate apically	smoothly hairless, glazed, gently offset downward midway to apex, apically broadly emarginate

figure) and surmounted by short rod-like styli.

Specimens.—Male, Colombia, Dpto del Valle del Cauca, Dagua, El Ensueño, 19 v 1996, Montealegre, F. and G.K. Morris, ANSP.

Measurements.—See Table 15.

Scopioricus spatulatus sp. nov.
Figs 16, 29, 43; Table 15

Distribution.—Colombia, eastern slope of central cordillera.

Holotype.—Male, Colombia, Dpto Risaralda, PRN Ucumari (type locality), 25 v 1996, F. Montealegre and G.K. Morris, ANSP.

Etymology.—This insect is named in reference to the spatulate procoxal spine (L., spatula = broad stirring tool).

Remarks.—The most closely related genus is *Parascopioricus*. Within *Scopioricus* there are currently 3 species with *S. spatulatus* keying closest to *Scopioricus sutorius* (Stål) also of Colombia.

Tegmina are broader in males than in females, with the anal margin abruptly bent upward just posterior to the sound field, apparently an acoustic-related modification.

Diagnosis.—*Scopioricus* rather than *Parascopioricus* on the basis of: pronotal disc with median sulcus defined by slightly swollen edges; with anal tegminal margin very strongly bent, arcuate (Fig. 16A); postradial field in both sexes with large polygonal wing cells; no indication of Rs-like veins in the distal half of the postradial field; costal field with several slanted parallel veins; mirror of left tegmen more developed for sound radiation than is usual, hyaline, more closely approaching the area and thinness of the right (Fig. 16D); cerci long, thin, apically bent inward (Fig. 16 E,F); genicular lobes obtusely acuminate, without terminal spines (though spinules present).

S. spatulatus distinguished from *S. sutorius* by: dorsal procoxal spine pedunculate, compressed spatulate distally (Fig. 16B); deep midline sulcus of pronotal disc extending almost throughout, fading only on the posterior half of the metazona; cerci tapering but not acuminate; supra-anal plate, rapidly reduced posteriorad, triangular, rounded apically (Fig. 16E).

Description.—Pale green except for light brown veins bordering male sound fields. *Pronotum*: very flat, anterior margin straight, posterior strongly arcuate; transverse sulci linear, intersecting the deep median longitudinal sulcus at right angles. *Tegmina*: broad, more so in males, costal margin straight in females, very weakly bent in males, the anal margin strongly arched in both sexes and obtusely acumi-

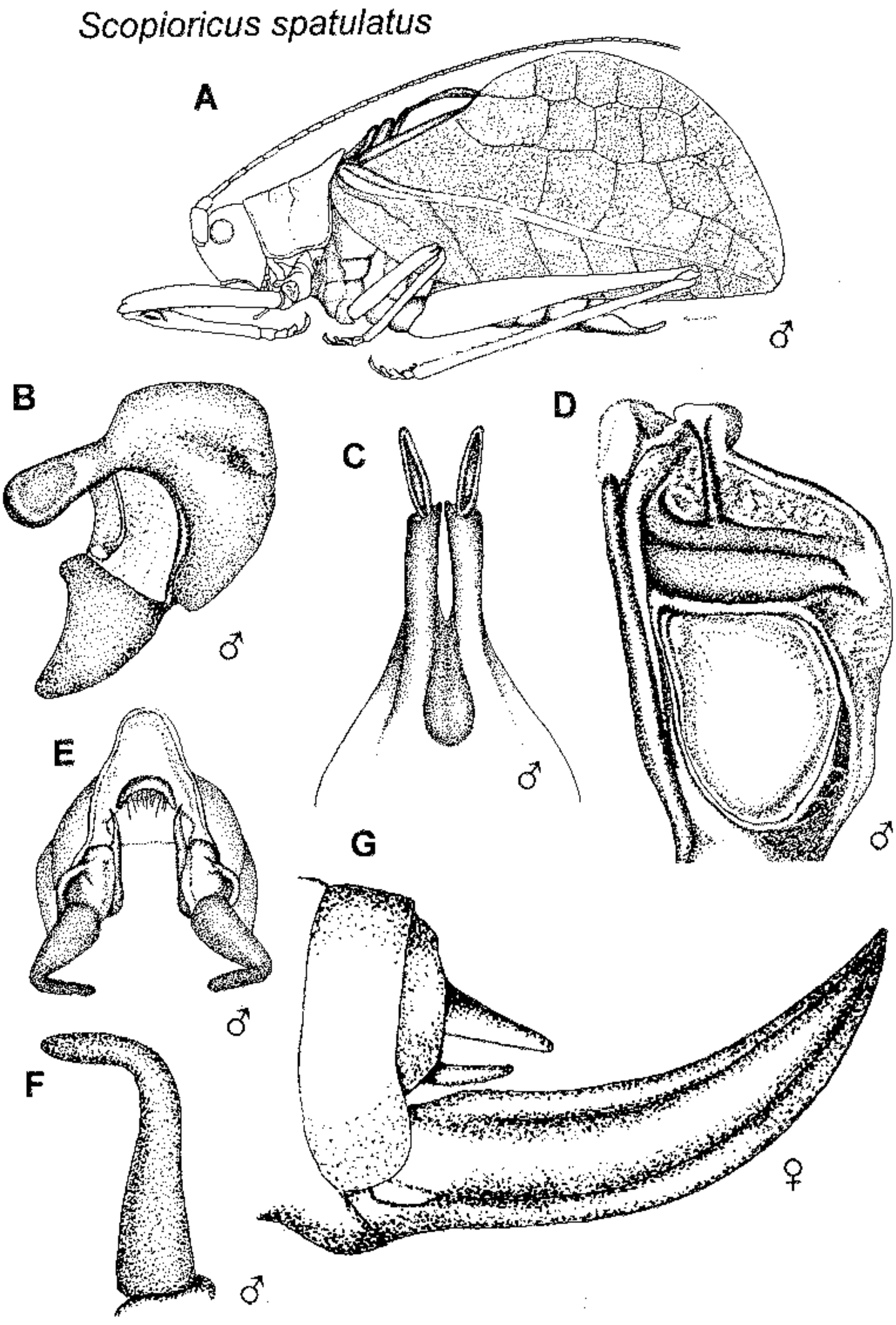


Fig. 16. *Scopioricus spatulatus*: male, habitus (A), forecoxa (B), subgenital plate (C) and dorsal aspect of left tegmen stridulatory field (D), posterior view of deflected supra-anal plate and paraproct spines (E) and cercus (F); female, ovipositor (G).

Table 15. Measurements of *Parascopioricus cordillericus*, *Scopioricus spatulatus* and *Typophyllum zingara*

Lengths (widths) mm	*Parascopioricus cordillericus*	*Scopioricus spatulatus*				*Typophyllum zingara*		
	Male	Males (6)		Females (4)		Male	Females (2)	
		means	range	means	range		means	range
body	16.7	19.6	18.8-21.0	20.5	17.0-23.0	22.8	26.2	22.0-26.2
pronotum	3.9	5.9	5.5-6.2	4.7	4.5-5.0	3.9	5.0	4.9-5.0
fore femur	7.3	7.8	7.5-8.0	8.4	8.2-8.5	5.4	8.3	8.1-8.5
mid femur	6.7	6.7	6.3-6.9	7.7	7.1-8.0	5.6	7.0	7.0-7.0
hind femur		13.7	13.3-14.0	15.2	14.7-15.8	13.1	17.3	17.0-17.5
fore tibia	7.6	8.1	7.8-8.8	9.0	8.9-9.3	6.5	8.8	8.8-8.8
mid tibia	7.0	6.9	6.5-7.2	7.8	7.5-8.1	6.5	8.1	8.0-8.1
hind tibia		13.8	13.4-14.3	15.5	14.9-16.0	13.5	18.2	17.8-18.5
tegmen	17.2	22.6	21.5-23.5	26.7	25.9-27.5	18.9	28.6	28.0-29.1
cercus		2.0	1.6-2.2			1.0		
subgenital plate	4.0	2.9	2.7-3.0	1.4	1.3-1.6	1.4	1.8	1.6-1.9
stylus	0.8	0.3	0.2-0.6					
ovipositor				10.5	10.0-10.9		10.5	10.2-10.7
(ovipositor)				(2.2)	(1.9-2.4)		(1.1)	
femoral spines, ant. : post. ventral margins								
fore	3 : 0	4 (2-6) : (3-6)		1 (0-7) : 7 (0-8)				
mid	0 : 0	1 (0-3) : 0		(0-4) : 0 (0-2)				
hind	missing	2 (0-5) : 0		(0-6) : 0				
tibial spines, ant. : post. ventral margins								
fore	6 : 6	9 (6-10) : 8 (7-9)		10 (9-11) : 8 (8-9)				
mid	6 : 6	(6-9) : 7 (5-7)		9 (8-9) : (5-8)				
hind	missing	13 (10-13) : 11 (11-12)		(10-14) : 12 (10-12)				

nate apically. *Wings*: folded non-functional greenish white, exceeding the tip of the hind femur. *Legs*: femoral spines tiny, scarcely evident; fore femora usually armed, mid and hind femora ventrally unarmed; mid tibiae dorsally unarmed. *Terminalia*: cercus long, tapering, past its mid-length bent abruptly inward, ending obtusely (Fig. 16 E, F); paraprocts bearing a medial conical, attenuate, curved spine directed dorsally (Fig. 16E); subgenital plate of male strongly uniformly reduced from base distad 2/3 of its length, then produced at fixed width, ventral surface concave apicomedially, deeply apically cleft with short slightly tapering styli (Fig. 16C). Female subgenital plate with a small mediodistal emargination; ovipositor (Fig. 16G) strongly upcurved, weakly serrate over ventro-apical third.

Specimens.—Paratypes: 4 males, 5 females. Male, Dpto Risaralda, PRN Ucumari, 2400 m, 25 v 1996, F. Montealegre and G.K. Morris, MEUV; male, same locality and collectors, 26 v 1996, ANSP; 2 females, same locality and collectors, 25 v 1996, MEUV; 2 males, same locality and collectors, 15 v 1997, ICN; male, same locality and collectors, 15 v 1997, MEUV; 2 females, same locality and collectors, 15 v 1997, ICN; female, same locality and collectors, 15 v 1997, MEUV.

Measurements.—See Table 15.

Tribe Pterochrozini

Typophyllum zingara sp. nov.
Figs 17, 44; Table 15

Distribution.—Colombia: cloud forest of the western cordillera.

Holotype.—Male, Colombia, Dpto Valle del Cauca, Zingara, NW of Cali nr Kilometro 18, ~2100m, 22 v 1996, F. Montealegre and G.K. Morris, MEUV.

Etymology.—Named in reference to the type locality.

Remarks.—Our specimens are closest to *Typophyllum histrio* (Brunner v. Watt.), a species originally described in the monotypical genus *Catasparata* on a single male (Wien). Vignon (1931, p.113, Fig. 37) illustrated the wings of a second male (British Museum). Beier (1960) moved *C. histrio* into *Typophyllum*, with which it has good affinity.

A postmedial costal field sinus, is indicated for all *Typophyllum* males, absent in all females: this criterion in the pterochroziine generic keys of both Beier and Vignon, distinguishes *Typophyllum* from *Rhodopteryx*. Our female has such a sinus (Fig. 17C) so *zingara* keys (per Beier) not to *Typophyllum*, but *Rhodopteryx*. Yet our specimens cannot be reconciled with other features of *Rhodopteryx*: broad reddish wings with black transverse banding, necrotic spot t2

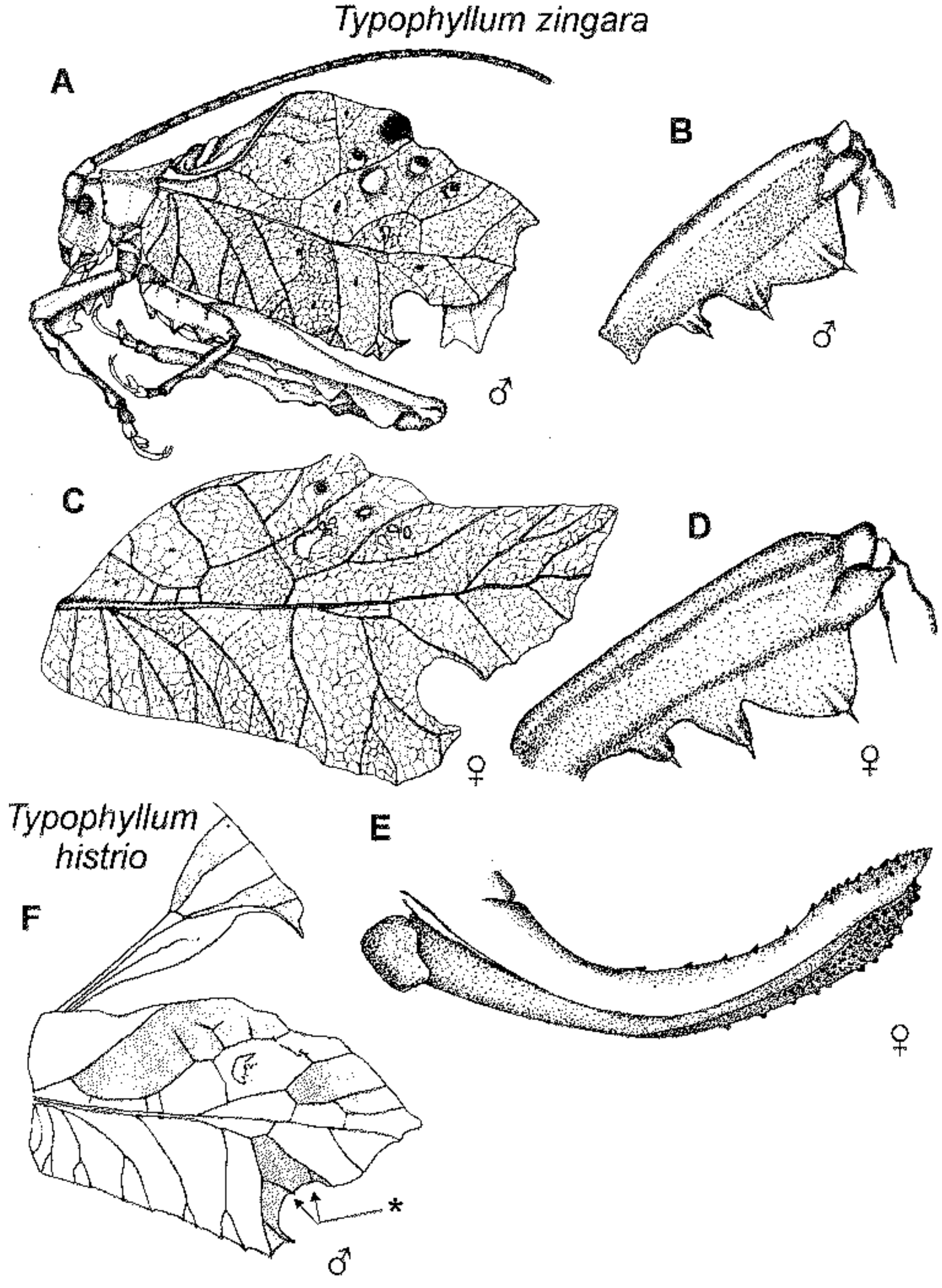


Fig. 17. *Typophyllum zingara*: male, habitus (A), anterior aspect fore femora (B); female, tegmen (C), anterior aspect fore femora (D), ovipositor (E); B and D drawn to the same scale. *Typophyllum histrio*: male, tegmina and wing lobes from Vignon, Fig. 36, p. 113 (F).

miniscule. So we place *zingara* in *Typophyllum*.

The male and female were collected together from the upper surface of low (~1 m) understory vegetation, in close contact but not in copula. The male stood entirely upon the female's folded tegmina, on her left side, facing in the opposite direction, his tegmina (also folded) and his mediosagittal plane normal to hers. She had the metathoracic leg of that side forward and extended down and out of his way. Each insect deployed its antennae contiguously, the female's following a linear leaf edge straight ahead, the male's curving smoothly down along the line of another leaf. Forelimbs of both insects were supinated by 30° or so, thus increasing the extent in dorsal view of the extreme, distad-broadened, triangular, forefemora. This precopulatory 'riding behaviour' is typical of a number of pterochrozine spp. (Castner and Nickle 1995a).

Diagnosis.—Posterior margin of pronotal disc medially notched; deep semi-circular postmedial sinus in the costal field just proximad of Sc marginal terminus, deeper than that of *T. histrio*. Necrotic spot t1 greatly exceeding t2 in size. The marginal cell subtended by branches of the radial sector with additional necrotic spots not occurring in T. histrio. In male *T. histrio* two distal branchlets of the Sc (* of Fig. 17F) join the costal margin within the sinus; in *T. zingara* (male, female) no Sc branches reach the margin within the sinus (Fig. 17 A,C).

A proximally arched Rs in the male creates a cross-vein delimited medial cell against the radius, broader and proportionately shorter than in *T. histrio*, with a poorly defined central hyaline spot; no cross vein delimits this cell in the female and the hyaline spot of this region is scarcely apparent.

Both sexes with hind wing apices fuscescent, lobular acuminate, curving anteriorly, projecting beyond the closed tegmina (Fig. 17A). This feature shared with *T. histrio*.

Description.—Sexually dimorphic, male smaller, more delicate than female. General coloration: Female in life predominantly brunneus but with vivid green markings on anterior and posterior margins of pronotal disk, proximal regions fore-femora, thence continuous onto the coxae, on the terminal segment and claws of the tarsi and narrowly edging the anal margin of the tegmen. Male grading from dark reddish brown to mocha; pronotal disc light brown with shoulders dark brown. Female antennae cream-white, weakly blackened at article joins; male antennae blue-black, lighter at articulations. In preserved specimens indications of reddish pigmentation on body; wing membrane pinkish-white with red-brown veins, excepting visible portion (Fig. 17A), the latter matching dark brown color and texture of tegmina. *Head:* eyes inconspicuous grey-brown. In male, mouthparts, face, scapes with many fine red spots; maxillary palpi red tipped, frons smooth, flat; in female labrum white, clypeus red, frons flat with scattered brown tubercles; scrobes deepened broadened, red pigmented; scrobal sclerites flattened, converging mediodorsad above frontal fastigium; scape transversely broadened (greatest width in male 0.7 mm, in female 0.8 mm). On its anterior aspect basally, female scape bears two levigate smooth oval regions. Fastigium verticis ovoid, narrowly sulcate, its dorsal eges inflated. *Pronotum:* disc anterior corners slightly produced acute; anterior and posterior disc margins each with 5 tubercles: median, right and left corner, right and left intermediate. Tubercles of female robust black wart-like. Lateral margins of pro and mesozona carinate; metazona broadened posteriorad, more strongly in male, the humeral angle thus accomodating tegminal base. Width ratio of posterior:anterior disk margins 1.4 (E) ,1.6 (G). Transverse sulci of disc faint; in male pro and mesozona of disc rectangular, broader than long, in female pro and mesozona together quadrate. Posterior disk margin, thin, not edged, made roundly biarcuate by medial v-emargination. Pronotal disc of female uniformly brown, finely granulose with scattered low tubercles; posterior transverse sulcus reduced to tiny diamond-shaped midline depression. *Tegmina:* Costal margin of tegmina (Fig. 17 A,B) flatly sinuous before the deep costal field sinus. Anal margin marked with a vivid green line, tuberculate proximally. R moderately straight, terminating below the lobular apex of the tegmen; Rs in female arising before the middle, 2-branched; in the male arising just beyond the middle, 2-branched but joining back to the radius by a transverse vein giving a central cell (I of Vignon) with a central necrotic spot (Fig. 17A). *Abdomen:* fleshy dorsal crests on abdominal terga: on segment 2, largest on segment 3, then gradually diminishing and disappearing posteriorad. *Legs:* fore femora both sexes ventroanteriorly (Fig. 17 B,D) with 3 tooth-shaped lobules centered by spines, incrementing in size distad, smaller in males; ventroposterior margin bears one small spine. *Terminalia:* ovipositor (Fig. 17E) moderately upcurved, tapering slightly over proximal third then widened distad in apical fourth; dorsal valve ending acute. Upper margin of dorsal valve with ~6 well separated regularly spaced retrorse teeth, becoming denser, triangular and also situated laterally over distal quarter; ventral valves with papilliform teeth marginally and laterally in the distal third.

Specimens.—Female, Colombia, Dpto Valle del Cauca, Zingara, NW of Cali near Kilometro 18, ~2100m, 22 v 1996, F. Montealegre and G.K. Morris, MEUV; female, Colombia, Dpto Valle del Cauca, Bitaco, nr km 26, 8 xii 1998, F. Montealegre and F. Vargas, ANSP.

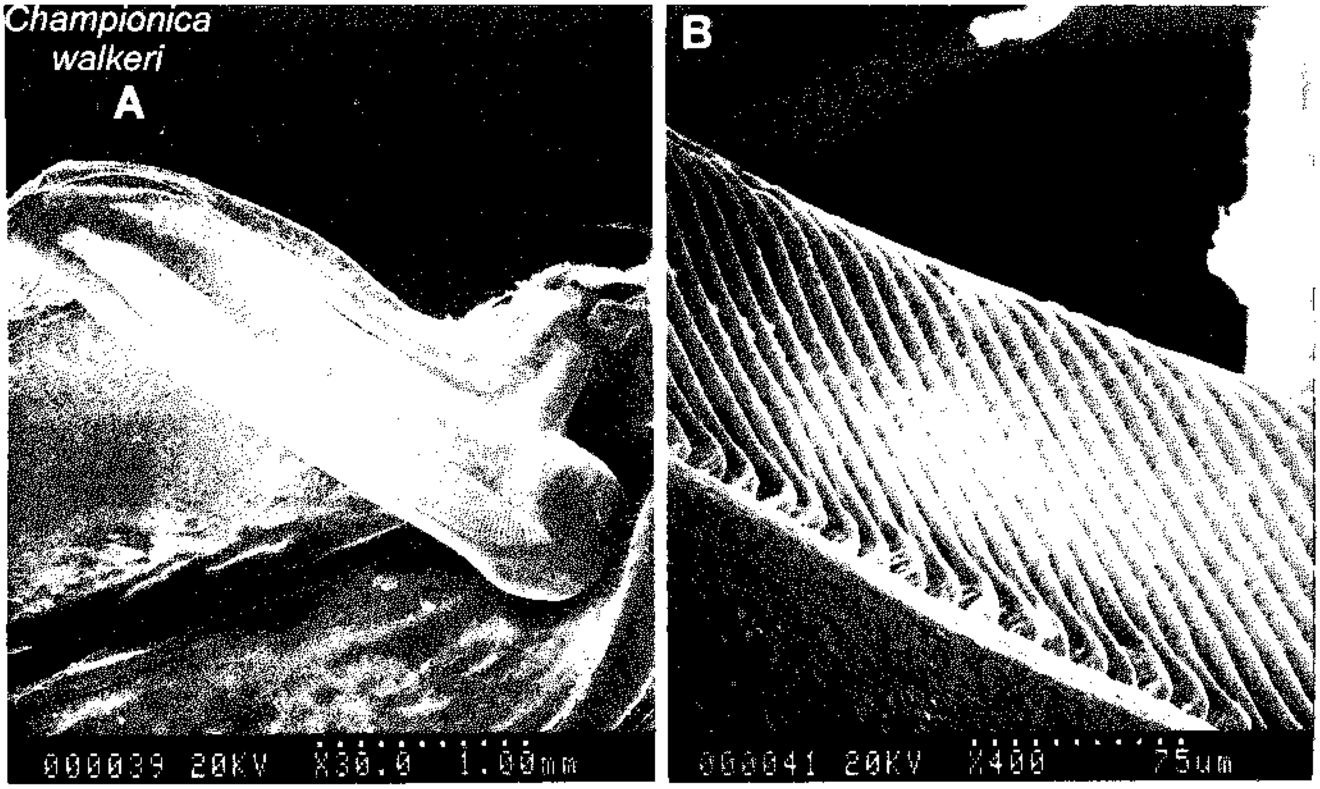
Measurements.—See Table 15.

Bioacoustics

Mechanism and pulses

Most tettigoniid males stridulate using a scraper and file located on their forewings. Part of the anal margin of the right tegmen bears a dorsally projecting ridge, the scraper. This engages teeth (file), that project in a row ventrally from the Cu2 vein (Ragge 1955) of the left tegmen. As the scraper is drawn to and fro along the file by thoracic wing muscles, a succession of tooth contacts excites the oscillation of sound fields, proximal wing regions of modified veins and cells that serve as sound radiators.

The tegmina of tettigoniids are usually bilaterally dimorphic. The cell membranes of the right sound field are thinner than those of the left, and a right file, when present, is tiny and non-functional. However there are some genera in which the forewings are mirror images (e.g. *Neduba*, Morris et al. 1975; Agraeciini, Morris and Mason 1995): in these species, cells, file and scraper are developed equally on both tegmina and individuals are encountered in the field that use either



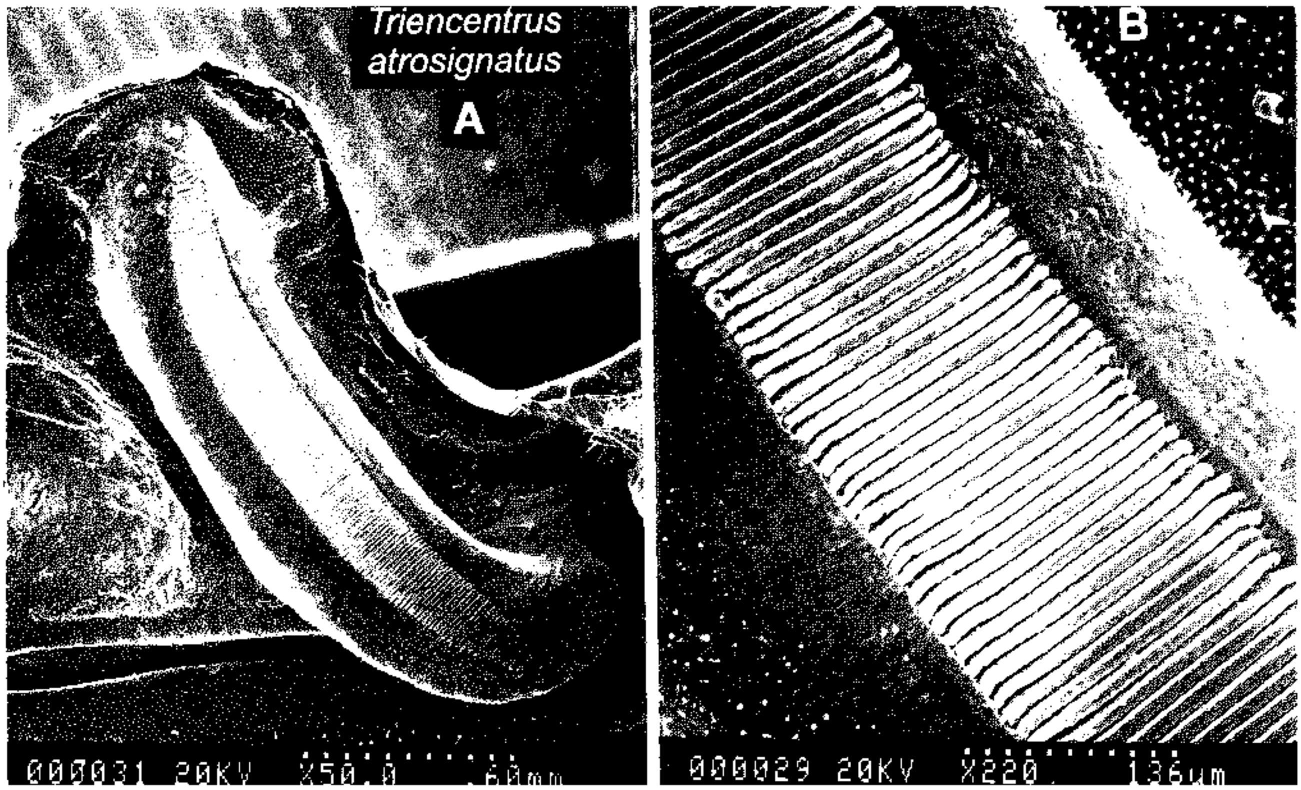
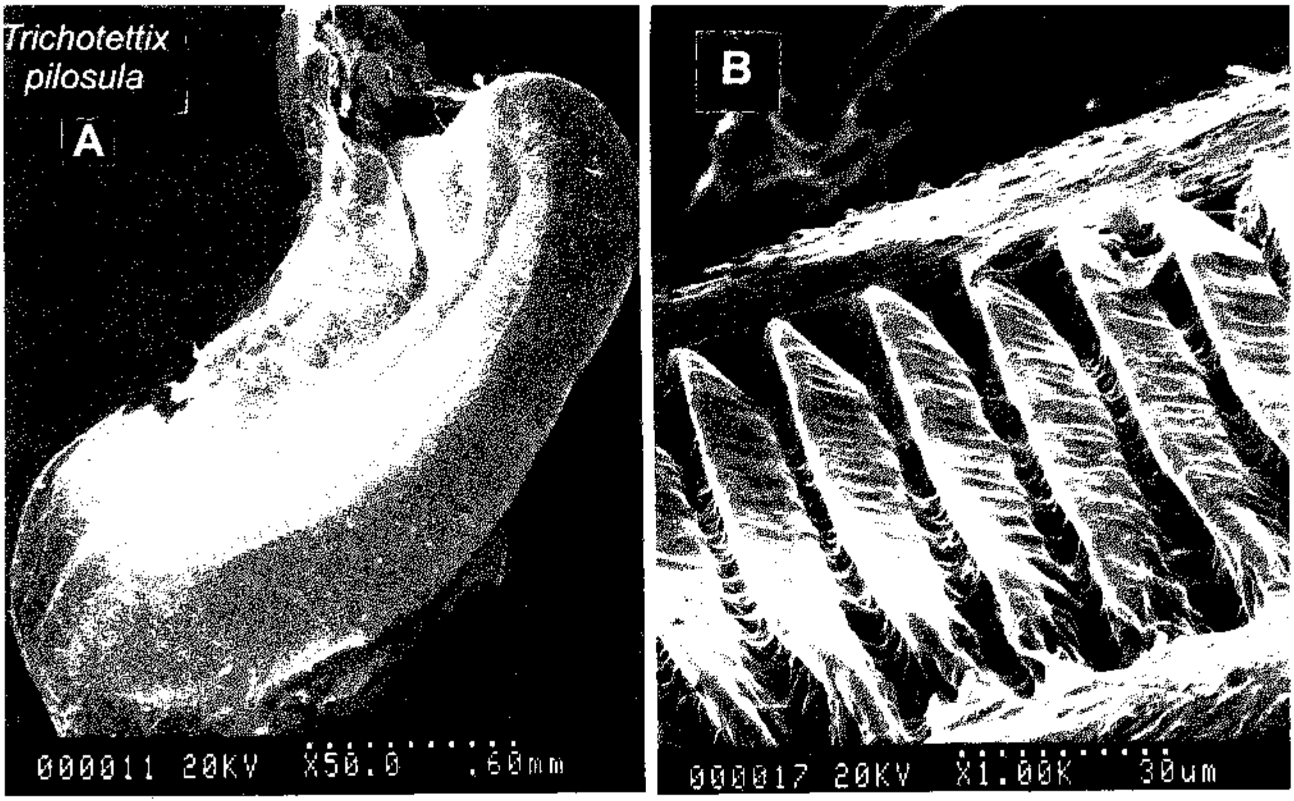


Fig. 18. TOP. *Championica walkeri*: file (A) and tooth close-up (B) showing lateral recess.

Fig. 19. BOTTOM. *Triencentrus atrosignatus*: file (A) and tooth close-up (B).



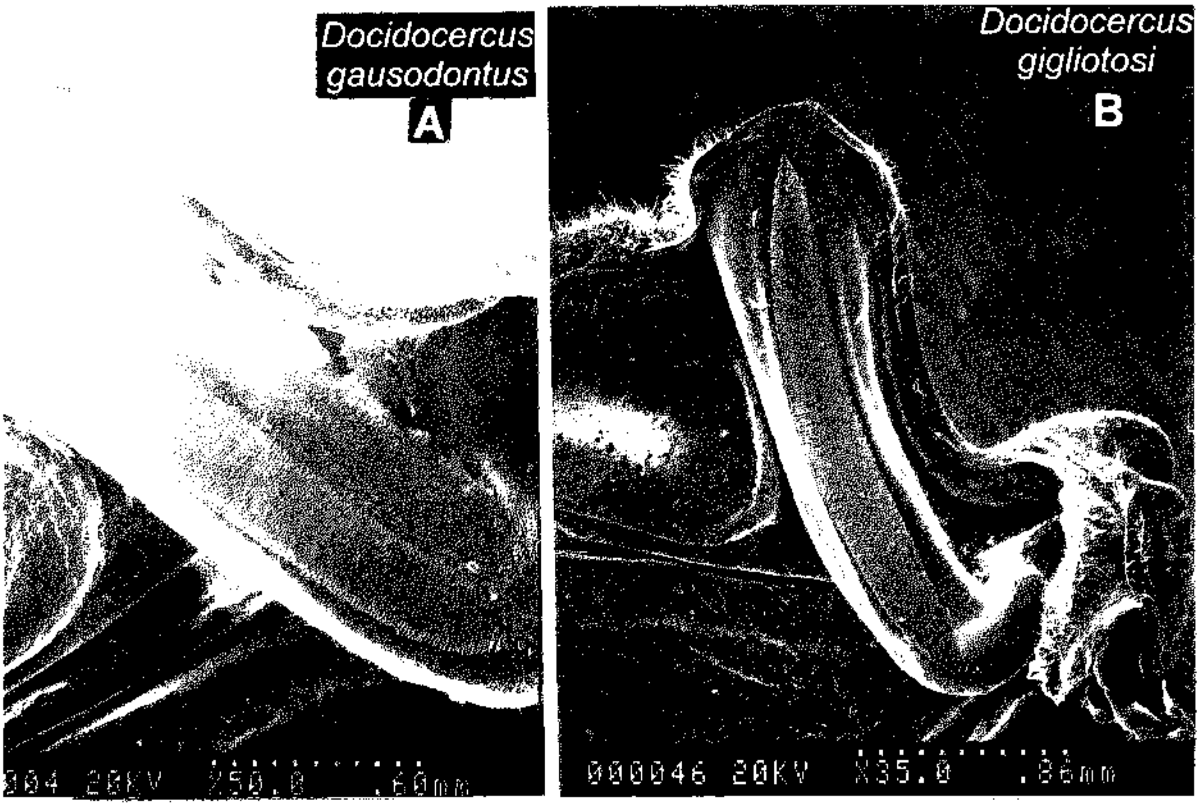
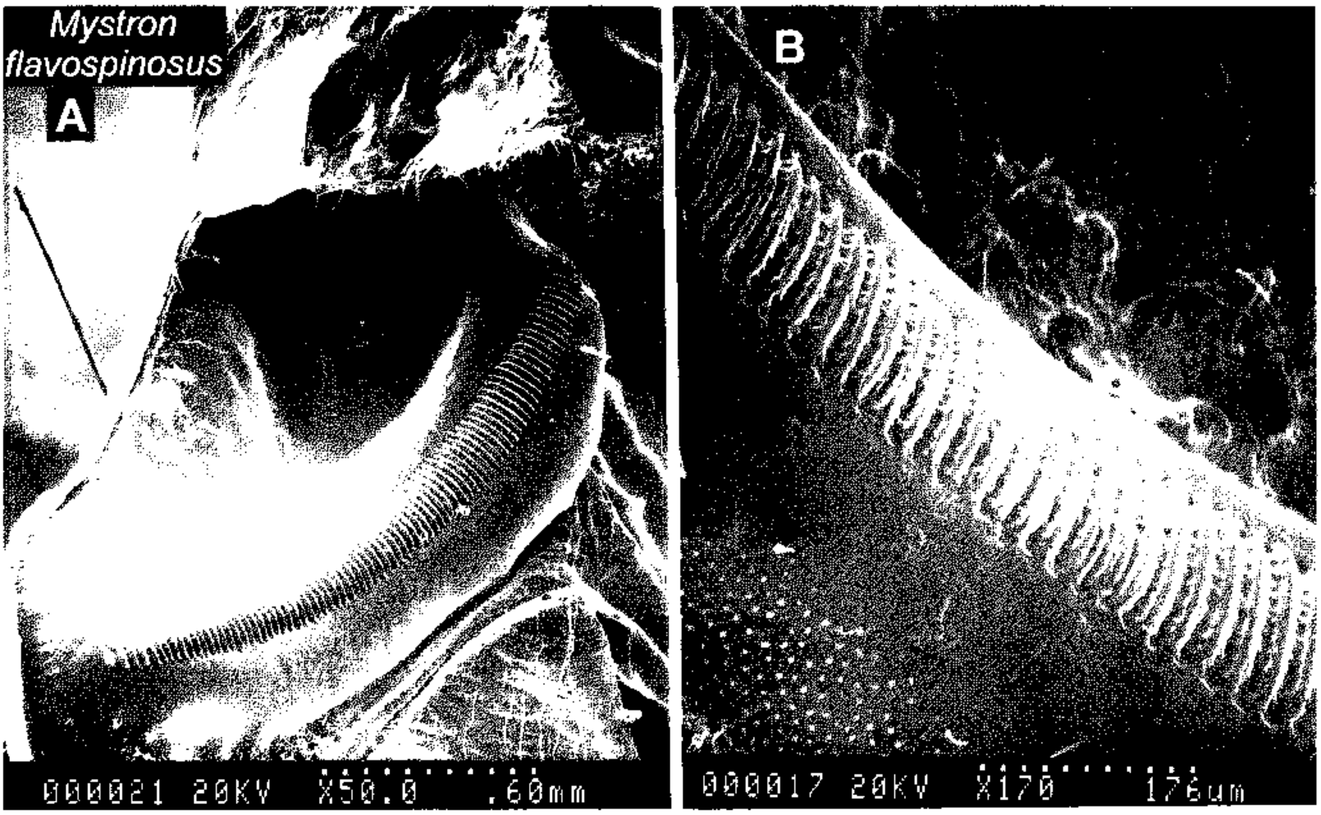


Fig. 20. (TOP) *Trichotettix pilosula*: file (A) and tooth close-up (B).

Fig. 21. (BOTTOM) Files of *Docidocercus gausodontus* (A) and *D. gigliotosi* (B).



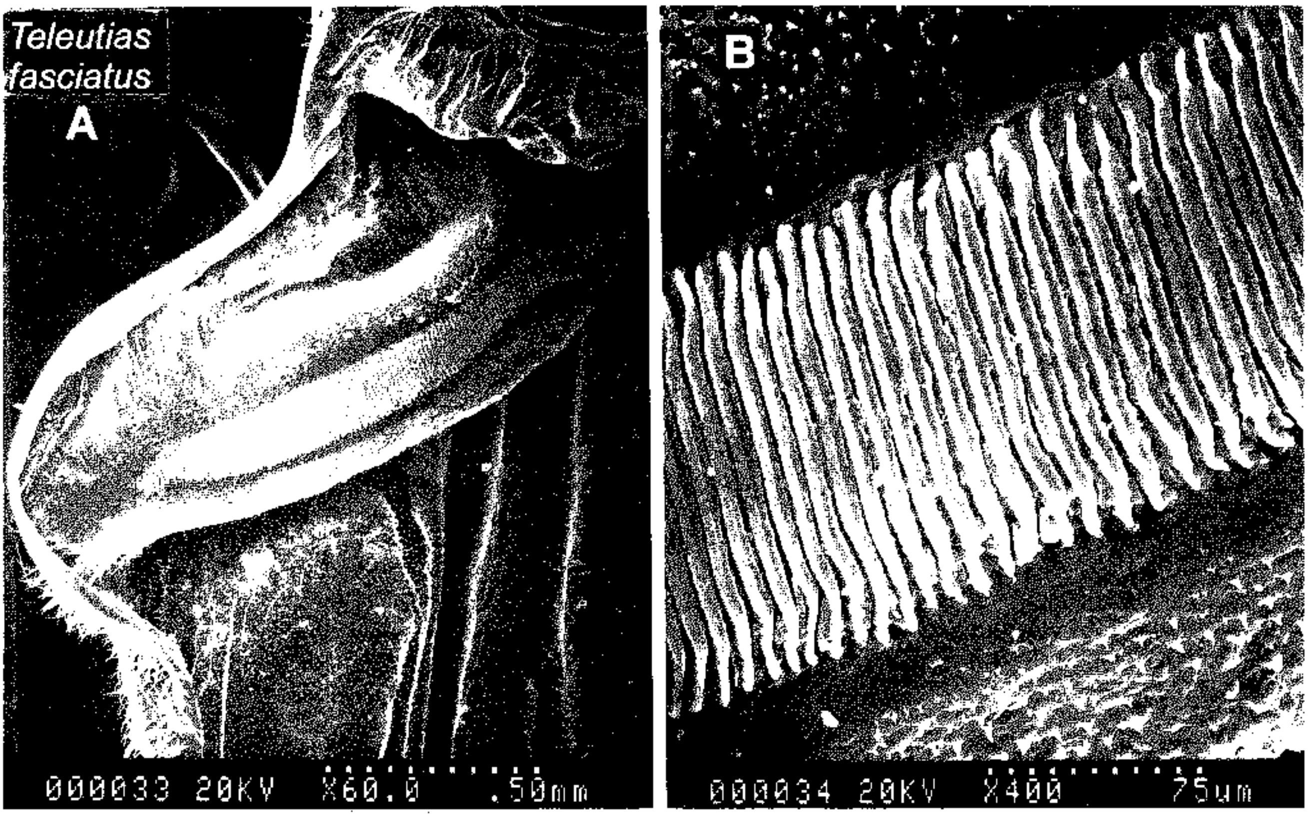
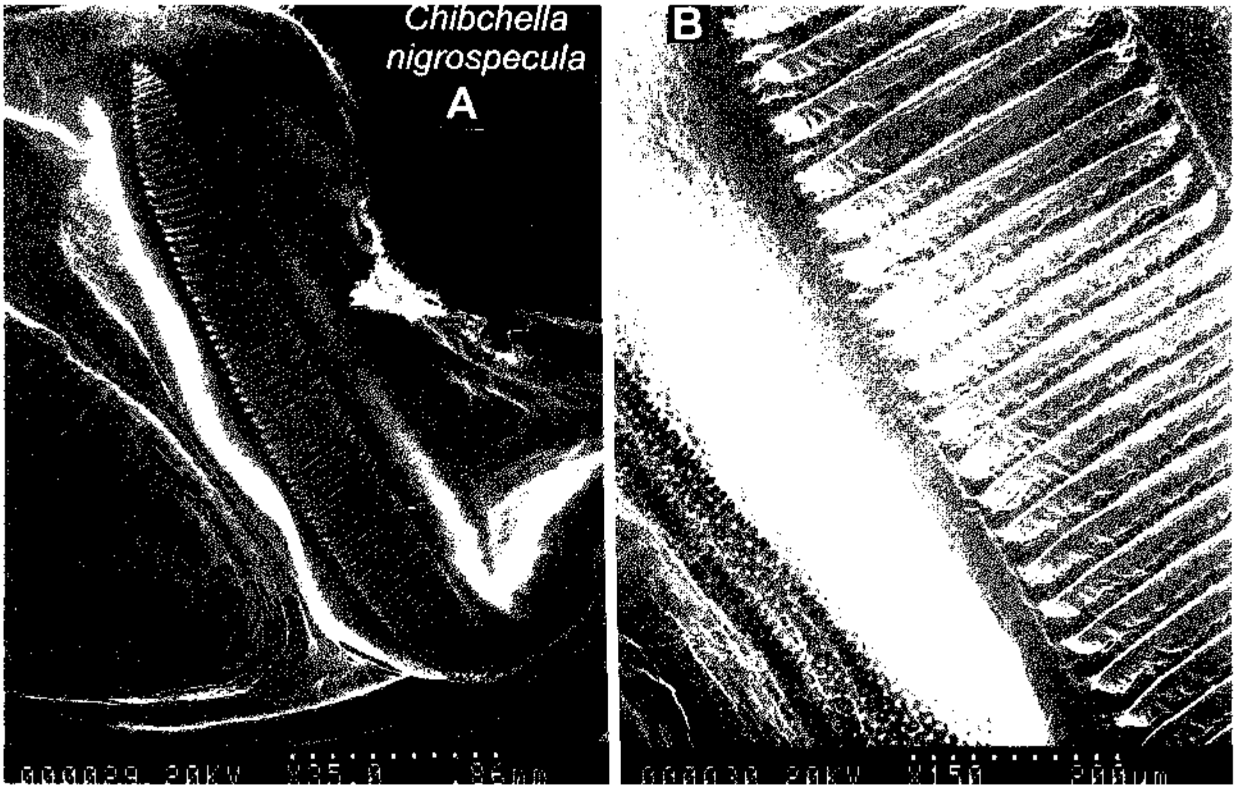


Fig. 22. (TOP) *Mystron flavospinus*: file (A) and close view of relatively undeveloped teeth (B).

Fig. 23. (BOTTOM) *Teleutias fasciatus*: file (A) and tooth close-up (B).



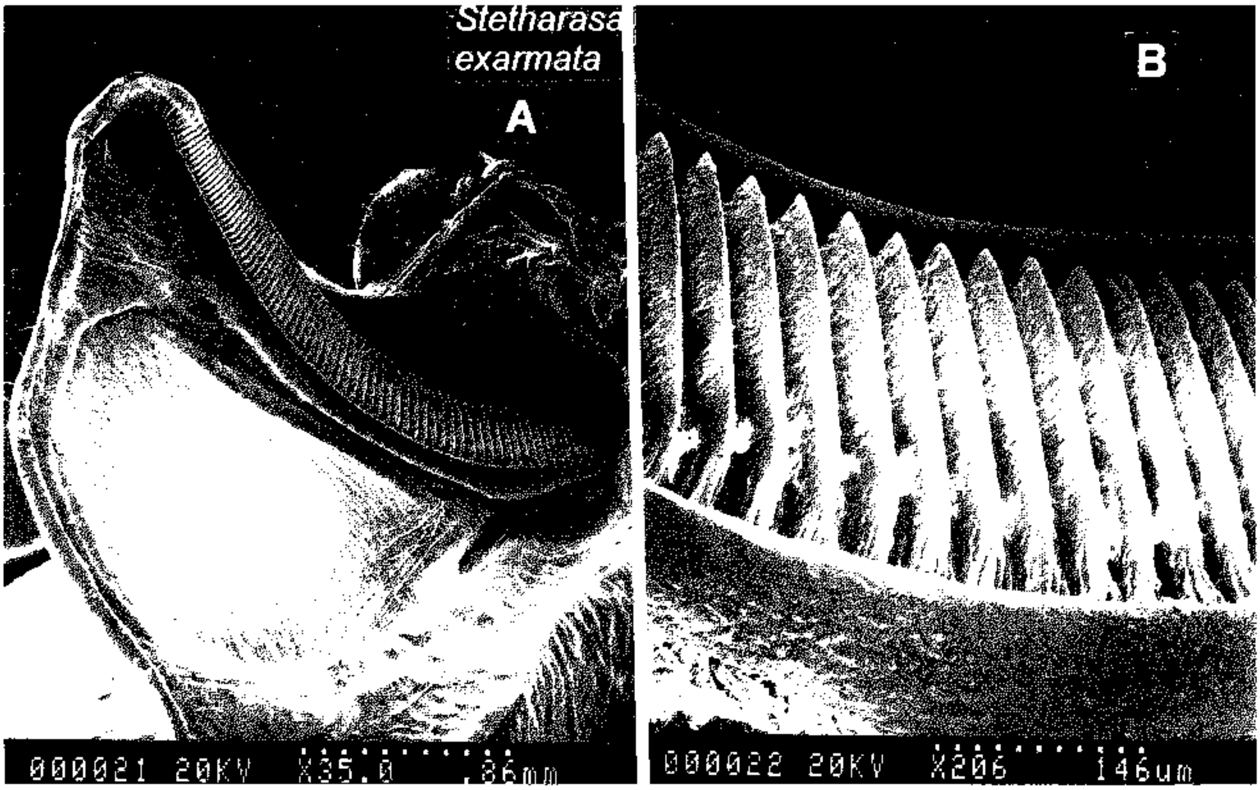


Fig. 24. (TOP) *Chibchella nigrospecula*: file (A) and tooth close-up (B).

Fig. 25. (BOTTOM) *Stetharasa exarmata*: file (A) and close-up of strongly recessed teeth (B).

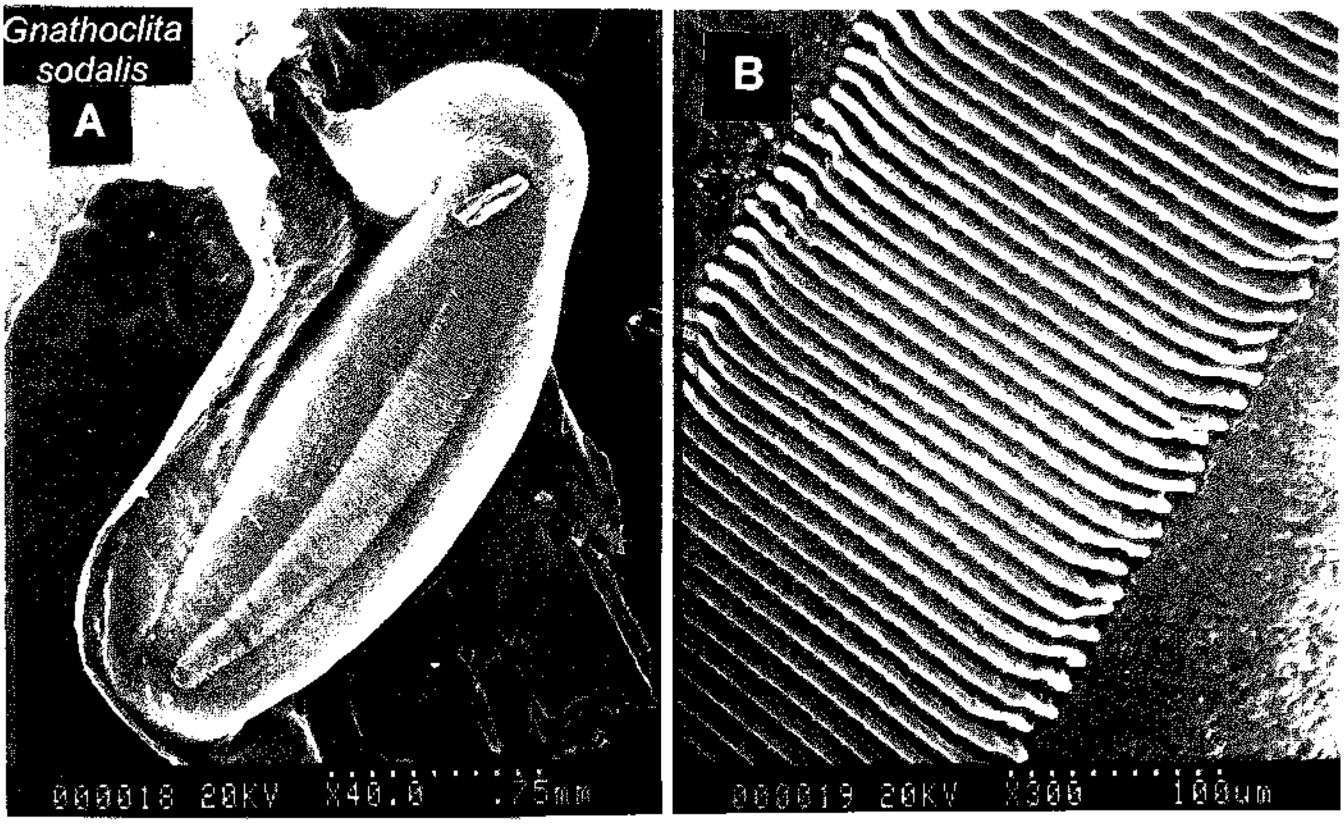


Fig. 26. *Gnathoclita sodalis*: file (A) and tooth close-up (B).

overlap. In their mirror-image tegmina such tettigoniids ressemble Haglidae, the sister group of tettigoniids (Gwynne 1995), although in haglids the same individual can reverse his overlap (Morris and Gwynne 1978).

Katydid songs can be visualized in the time domain as waves. The most elemental song component is a single wave train, a sound **pulse**: a continuous succession of waves whose start and finish are in practice determined by their emergence above background sound. Pulses, varying in duration and amplitude, are the basic amplitude modulation (AM) units of all katydid songs. Typically pulses of relatively low amplitude accompany each low energy recovery (opening) stroke of the file-scraper generator. More intense pulses are associated with higher energy (closing) strokes (Pierce 1948, Suga 1966, Morris and Pipher 1972, Walker 1975) and these largely determine the nature of the generated sound.

Two basic forms of high intensity sound pulse occur, **transient** and **prolonged**, corresponding to two generating mechanisms characterized by Elsner and Popov (1978) as non-resonant and resonant (see also Morris 1998). The distinction between resonant and non-resonant mechanisms is the rate of tooth contact by the scraper relative to the broadcast carrier frequency. In like manner to timing the pushing of a child on a swing, the generator's oscillation is most efficiently sustained when each input of additional energy, is in appropriate phase with the ongoing oscillation of the sound field. When the rate of tooth contact (or some multiple thereof) matches the rate of wing cell radiator vibration, the moving structures can be kept from decay. Thus a radiator can be made to continue oscillating for several milliseconds at a steady amplitude and a single dominant carrier frequency. A sound pulse made in this way by one scraper passage along the file is 'prolonged' (by tens of milliseconds) and its spectrum tends toward one relatively narrow peak at a particular (nearly) pure tone frequency, the spectrum of a single-frequency sine wave (see e.g. Figs 30, 35, 37 or 44). The spectrum of such a sound may be termed **high-Q** as reflecting a high 'quality' resonance system. Regions of the tegminal sound field, radiators and their surrounding (loading) cavities, may be tuned to operate best at that same particular resonance frequency, increasing the efficiency of sound generation.

A second mechanism occurs when the rate of tooth contact is below the frequency of radiator oscillation. This lower rate permits the radiator to decay appreciably or completely between successive tooth-scraper energy inputs. What is generated then is a succession of transient pulses, a **pulse train**, one or a few waves per tooth, each pulse decaying almost immediately from its peak amplitude. During one traverse of the file by the scraper (see e.g. Figs 34, 39, 43 or 45) a train of transient pulses is produced, each pulse

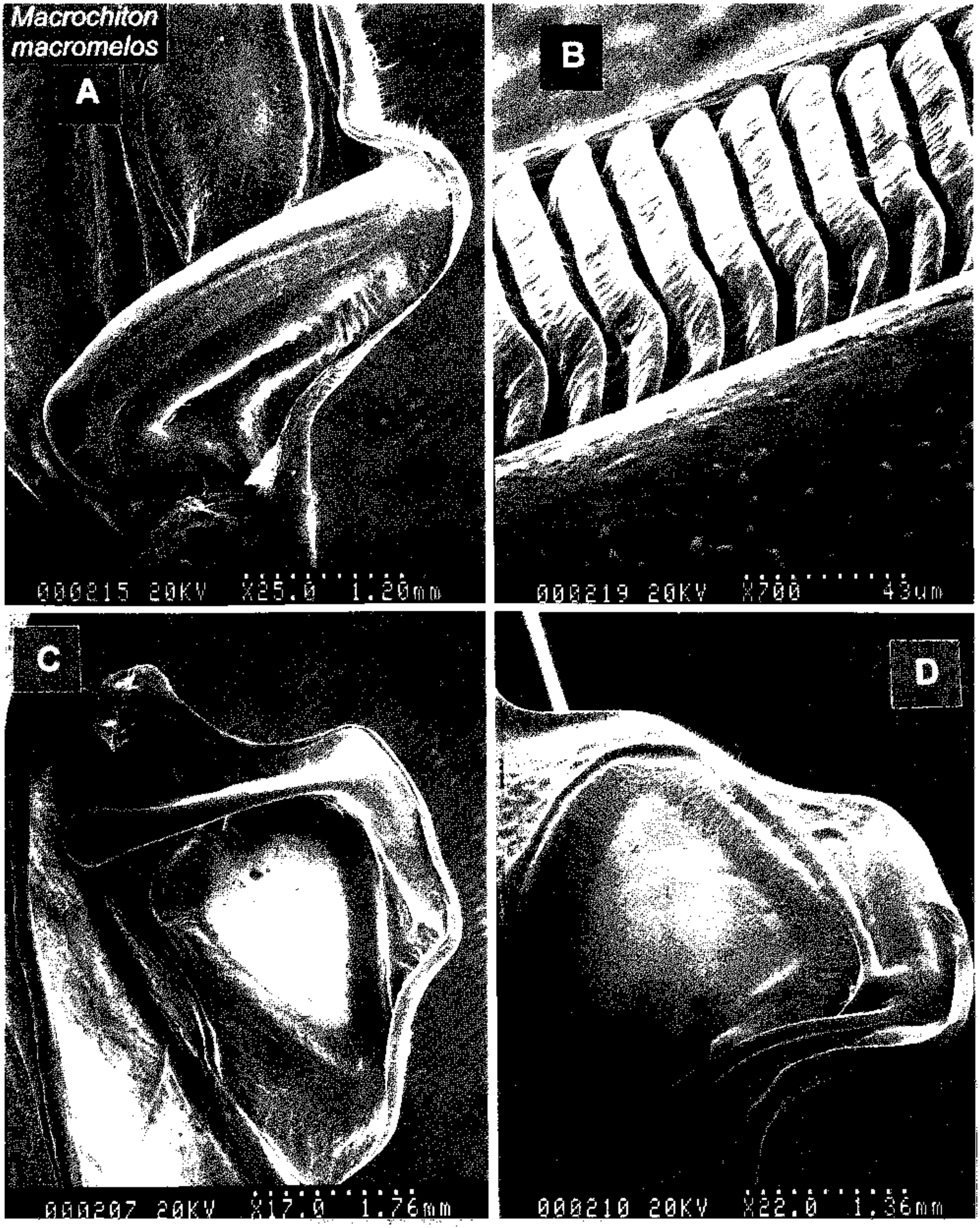


Fig. 27. *Macrochiton macromelos*: file (A); tooth close-up (B); right tegmen, ventral aspect, scraper strut and mirror (C); right tegmen, dorsal aspect, showing mirror and scraper (D).

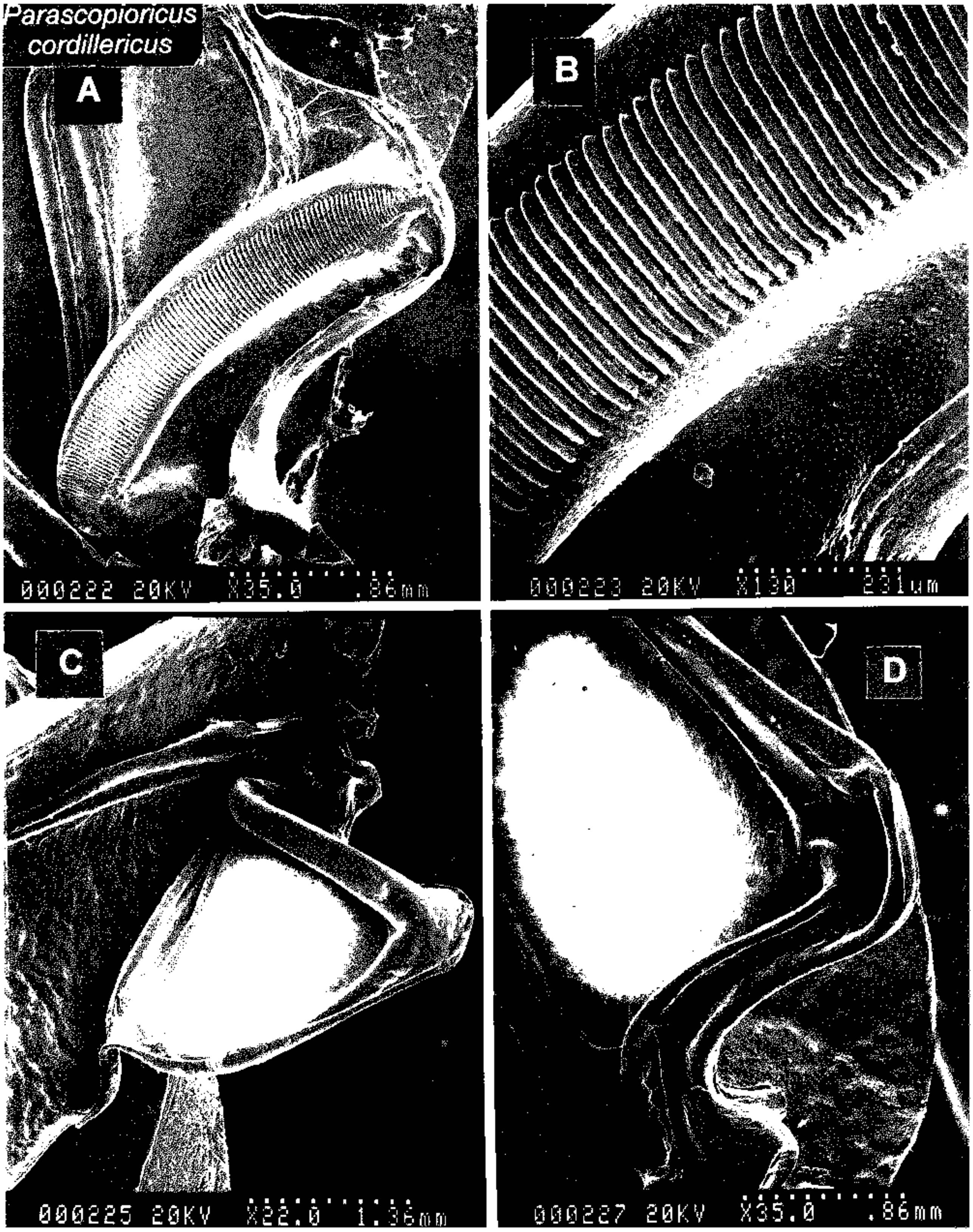


Fig. 28. *Parascopioricus cordillericus*: file (A); tooth close-up (B); right tegmen, ventral aspect, scraper strut and mirror (C); right tegmen, dorsal aspect, mirror and scraper (D).

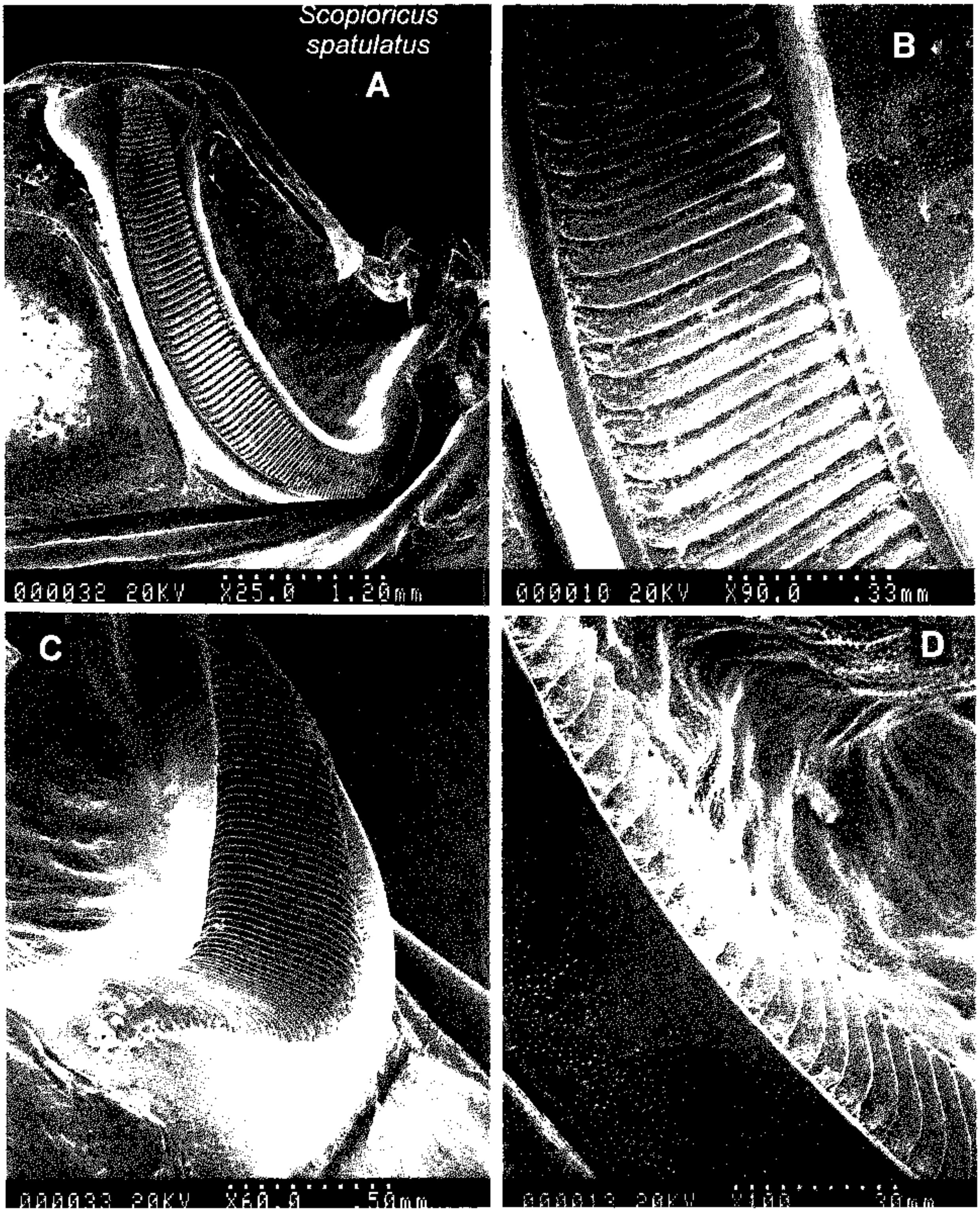


Fig. 29. *Scopioricus spatulatus*: file (A) and tooth close-up (B); low aspect view of file, looking proximad (C); buttress seen obliquely, showing lateral recess (D).

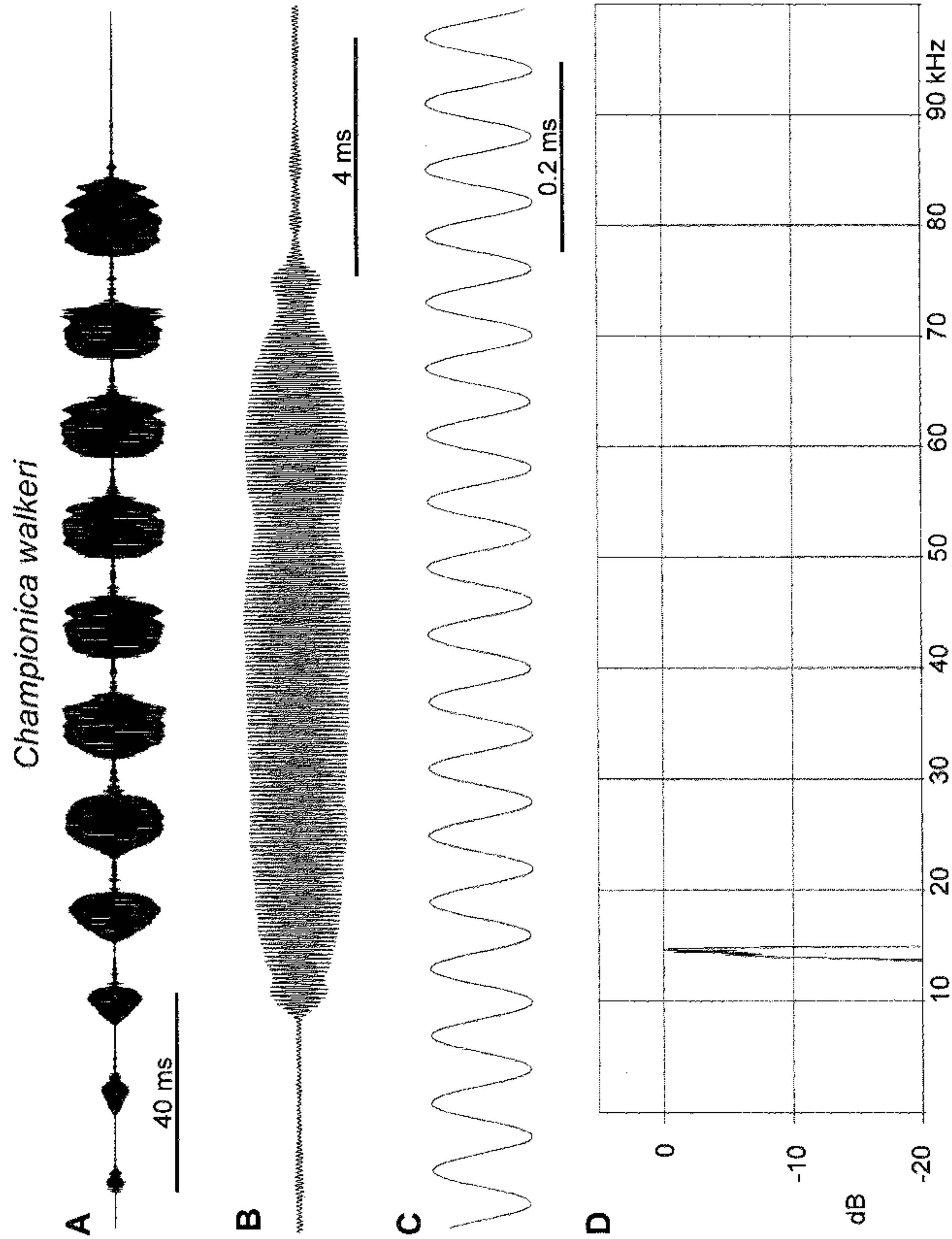


Fig. 30. Song of *Championica walkeri*. A. One complete note (call). B. One phonatome from the call at higher resolution. C. Part of the 14.5 kHz pure tone waveform. D. Power spectrum of the phonatome in B.

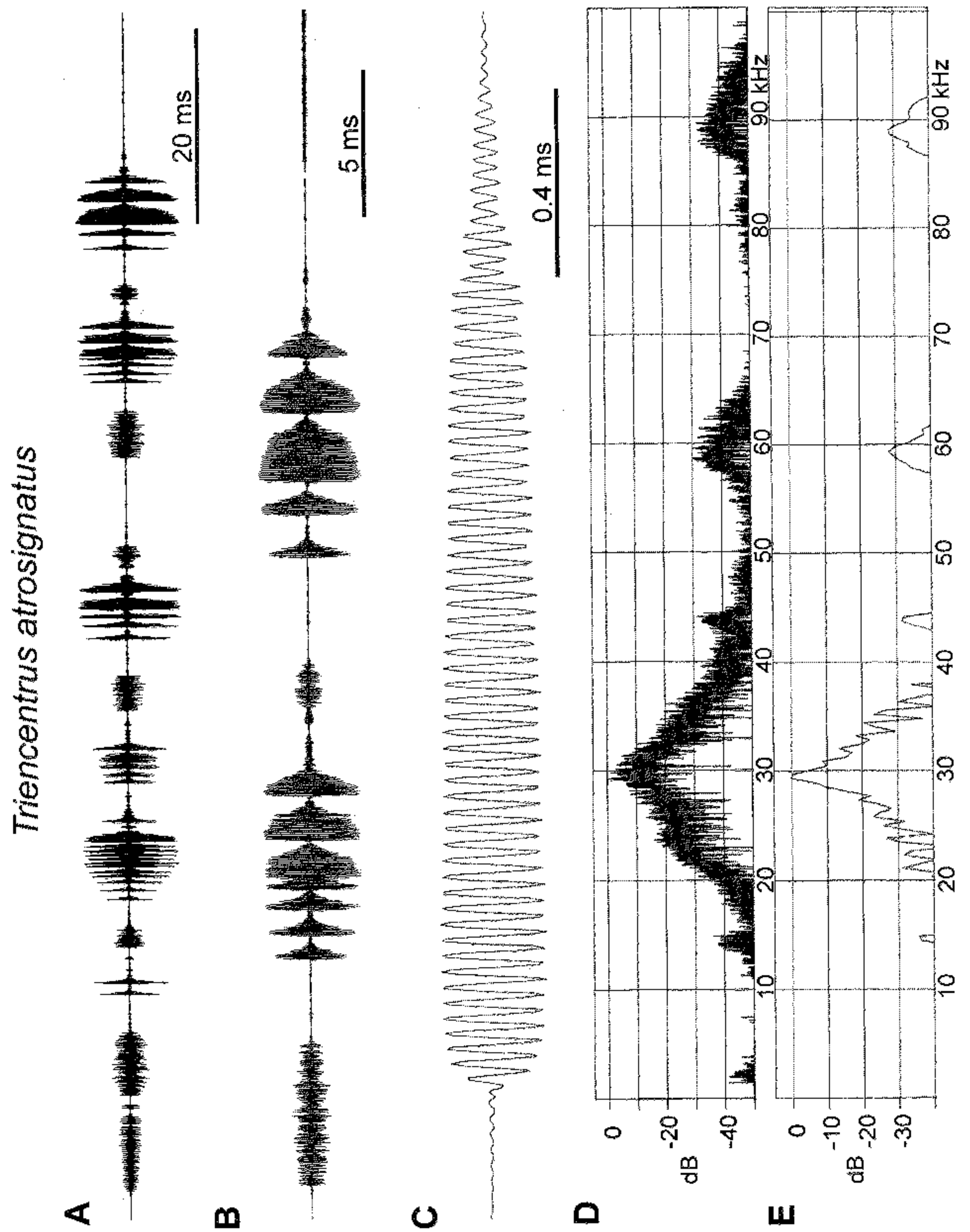


Fig. 31. Song of *Triencentrus atrosignatus*. A. One complete call . B. Final 2-phonatome portion of call at higher resolution. C. Waveform of a late more sustained pulse. D. Power spectrum of B time sample. E. Power spectrum of single pulse of C.

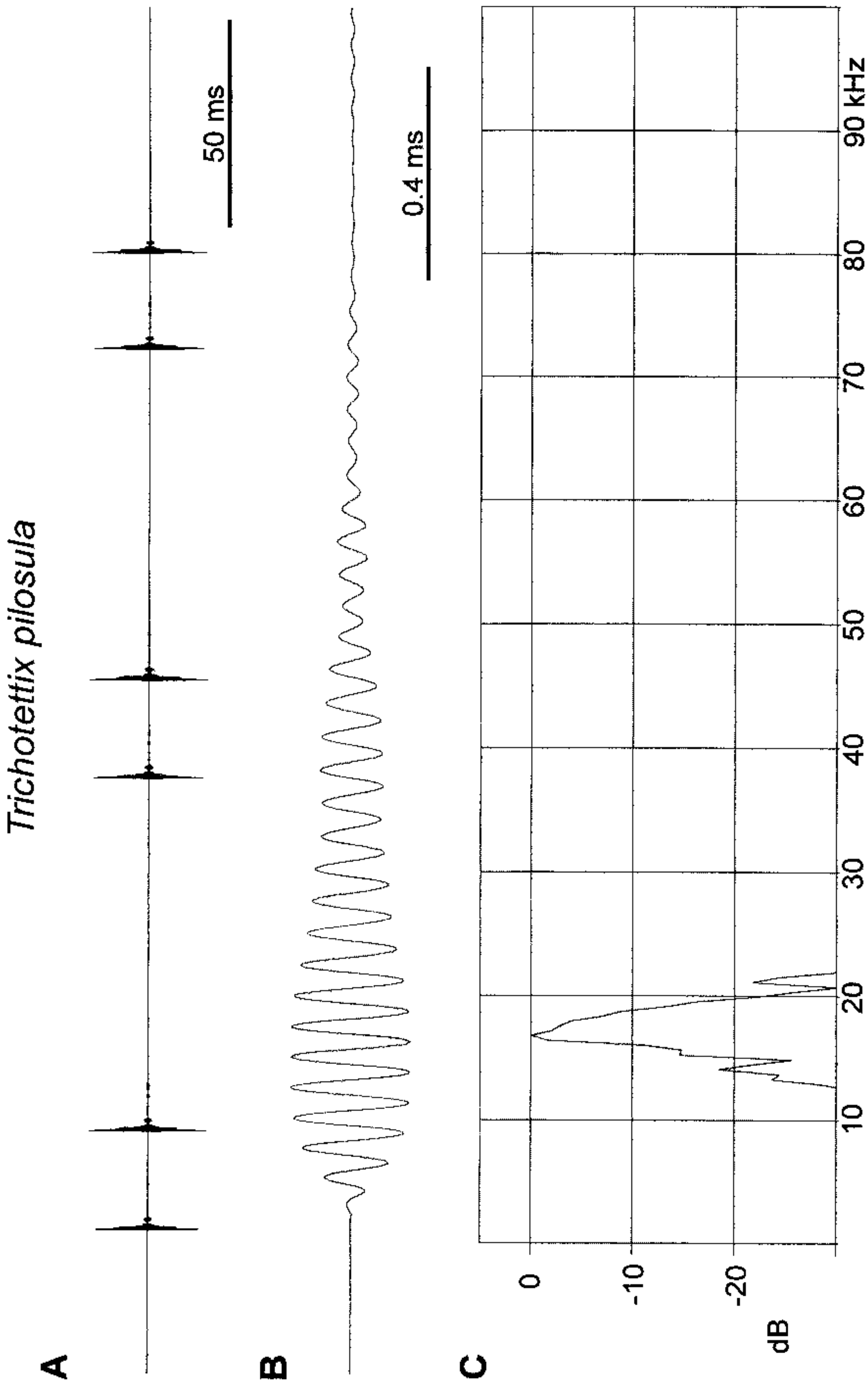


Fig. 32. Song of *Trichotettix pilosula*. A. Three calls. B. A single pulse at high resolution. C. Power spectrum of the pulse seen in B.

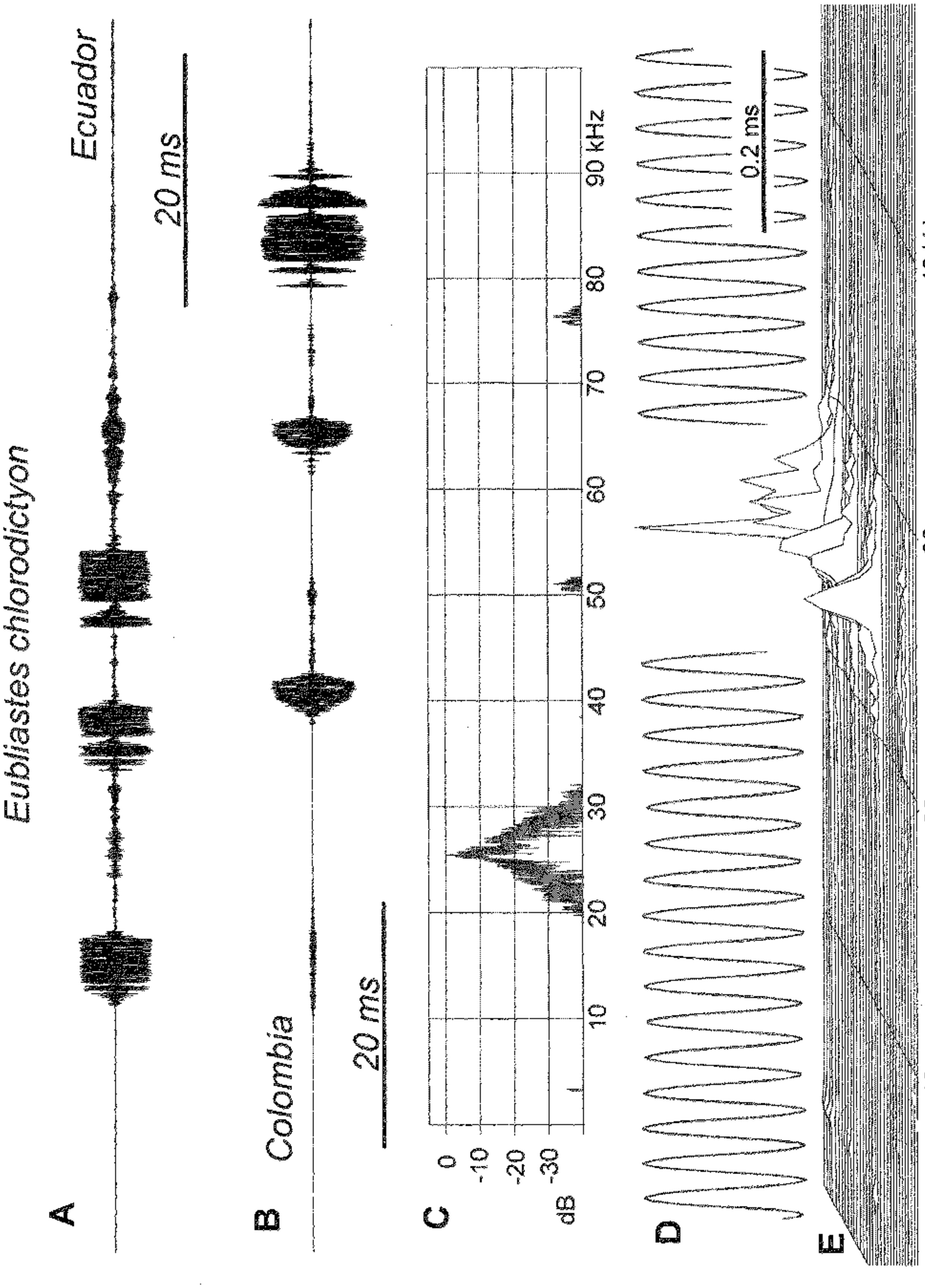


Fig. 33. Song of *Eubliastes chlorodictyon*. Ecuador specimen: A. Single call. Colombian specimen: B. Single call. C. Power spectrum. D. Portion of a pulse at high resolution showing sinusoid waveform. E. Waterfall spectral display of one call.

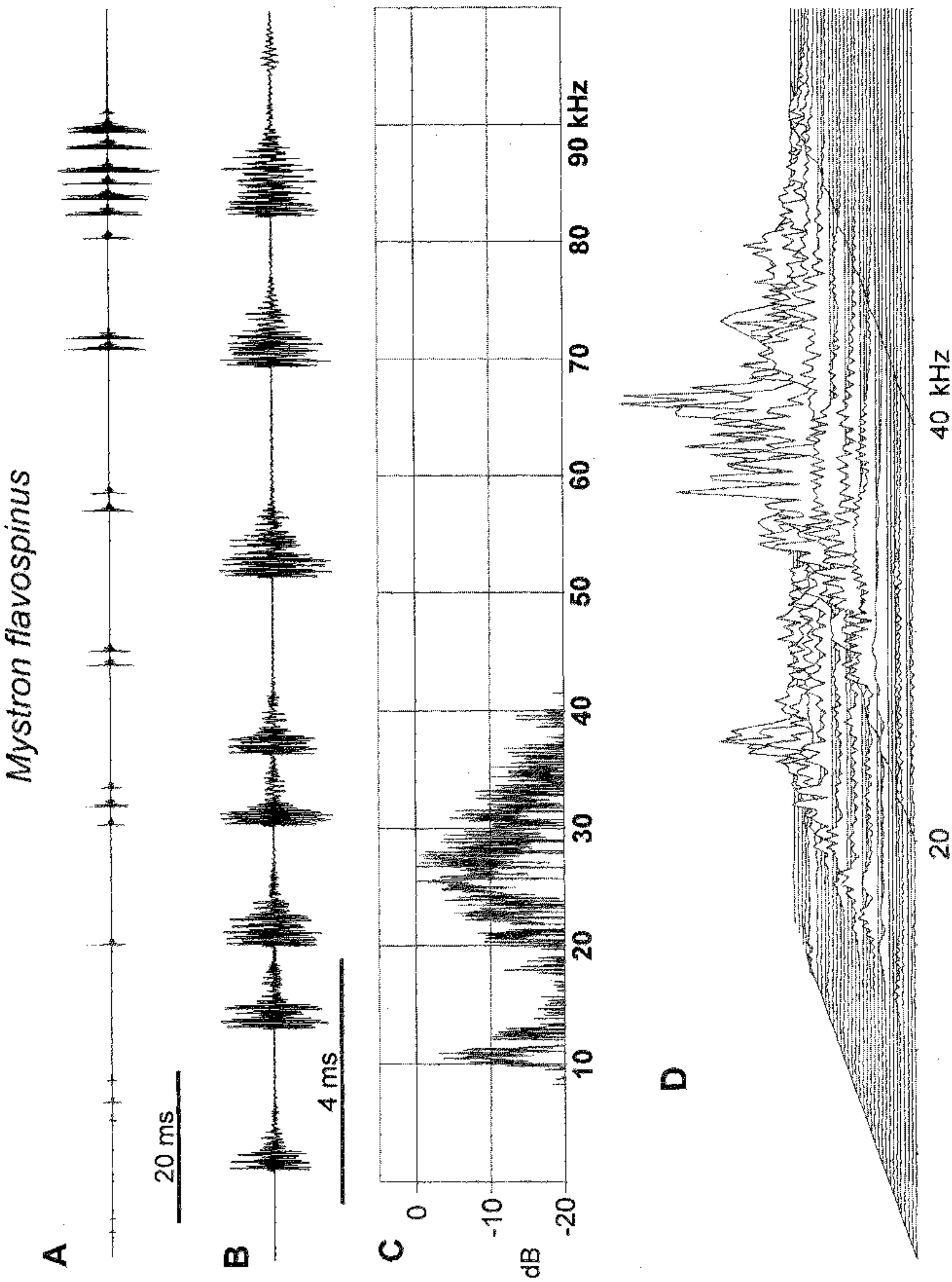


Fig. 34. Song of *Mystron flavospinus*. A. Single call. B. Final pulse train at higher resolution. C. Power spectrum of final train in B. D. Waterfall display of one call.

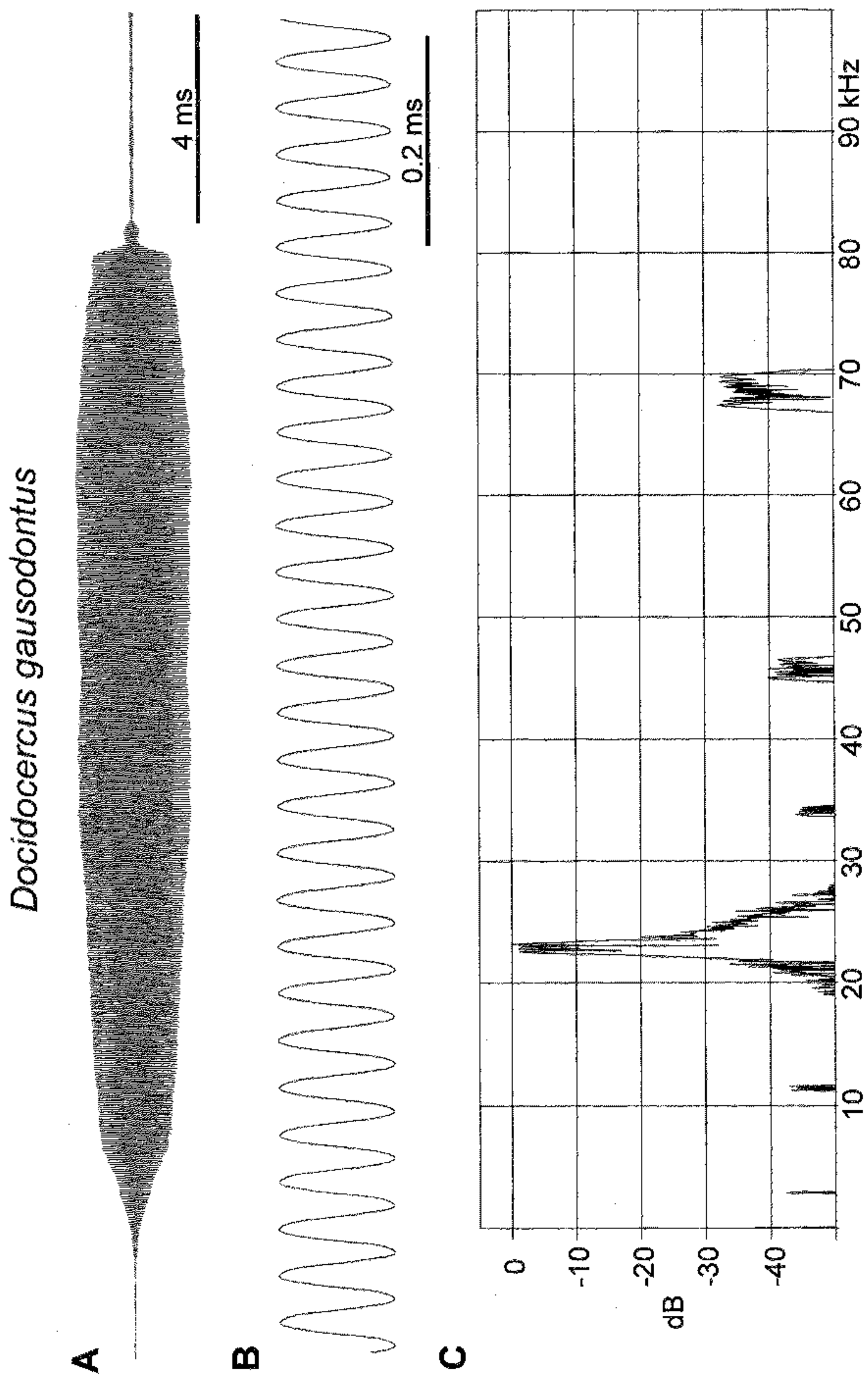


Fig. 35. Song of *Docidocercus gausodontus*. A. Single prolonged pulse. B. Small time sample of pulse showing sinusoidal waveform. C. High-Q power spectrum with harmonics.

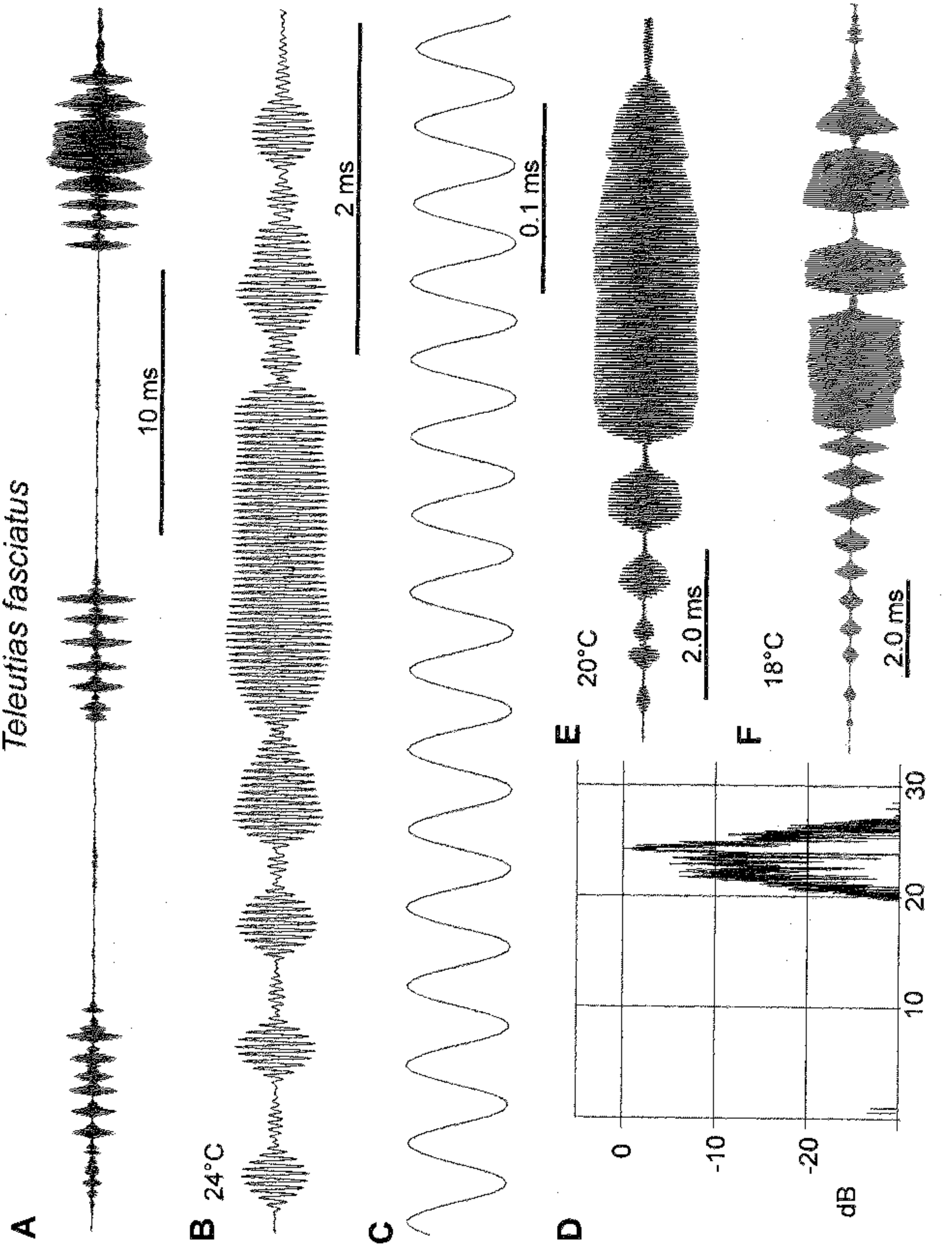


Fig. 36. Song of *Teleutias fasciatus*. A. Three-train tick. B. Final pulse train from A at higher resolution. C. Single-frequency waveform. D. Power spectrum of tick displayed in A; no sound energy occurred between 30 and 100 kHz. E. and F. Last trains from the calls of two other males to illustrate AM variation.

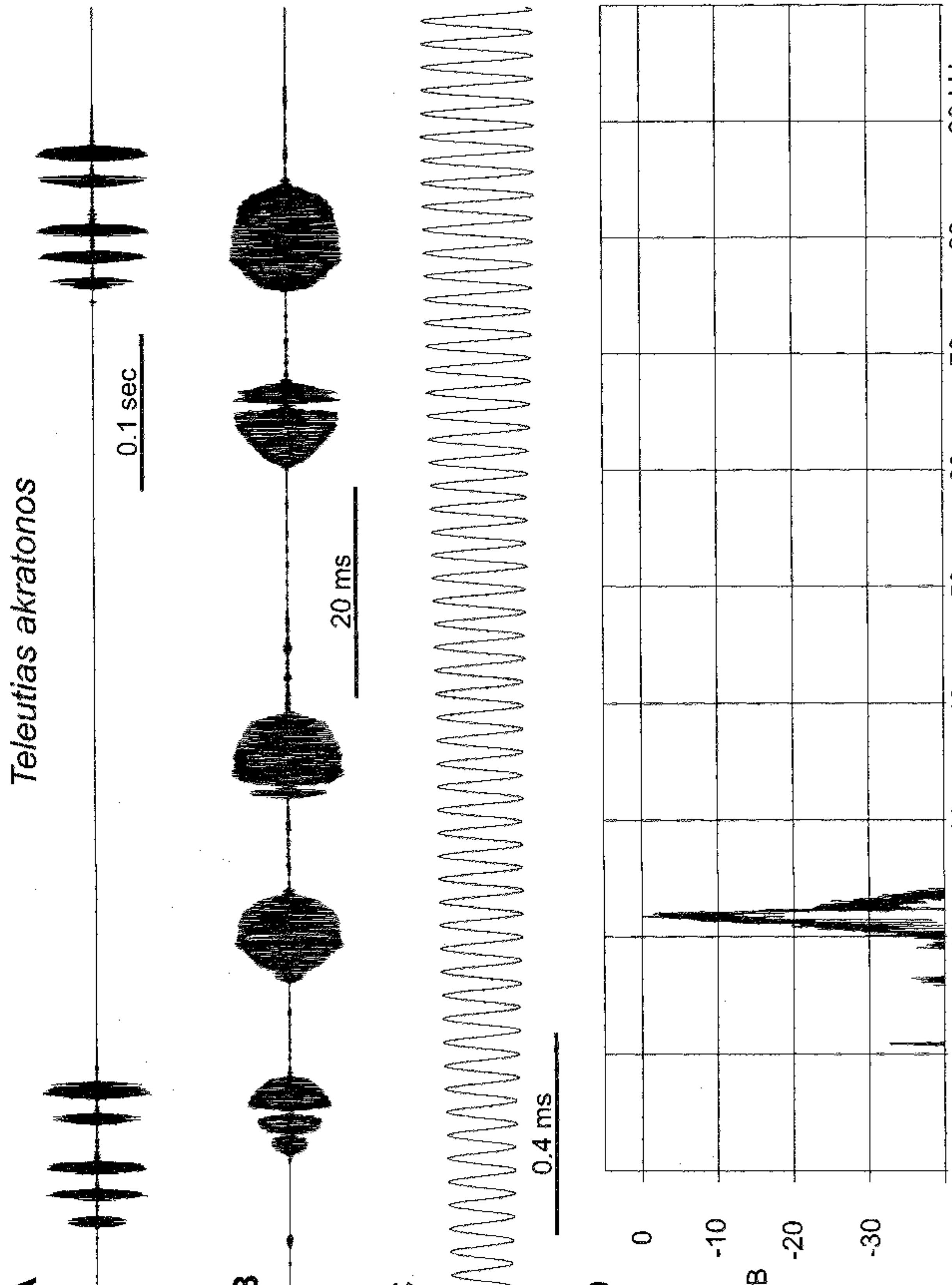


Fig. 37. Song of *Teleutias akratonos*. A. Two calls at typical inter-call interval. B. One call at higher resolution. C. Portion of rising amplitude of final pulse to show pure tone waveform. D. Power spectrum of B with very high-Q single peak.

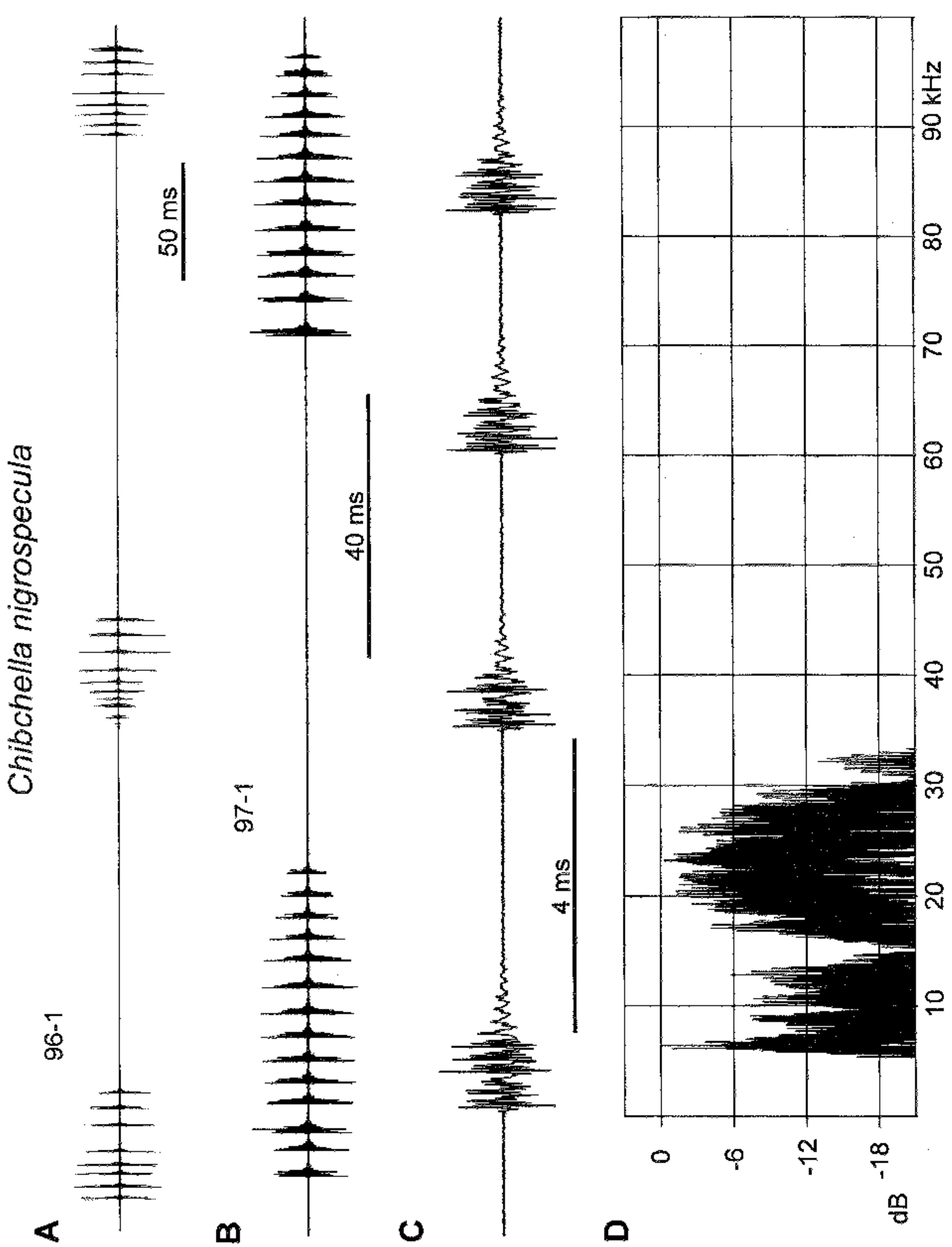


Fig. 38. Song of *Chibchella nigrospecula*. A. A three-zip call of a specimen collected 1996. B. Typical double-zip; specimen collected 1997. C. The first four pulses of the second train in B at higher time resolution. D. Power spectrum of B.

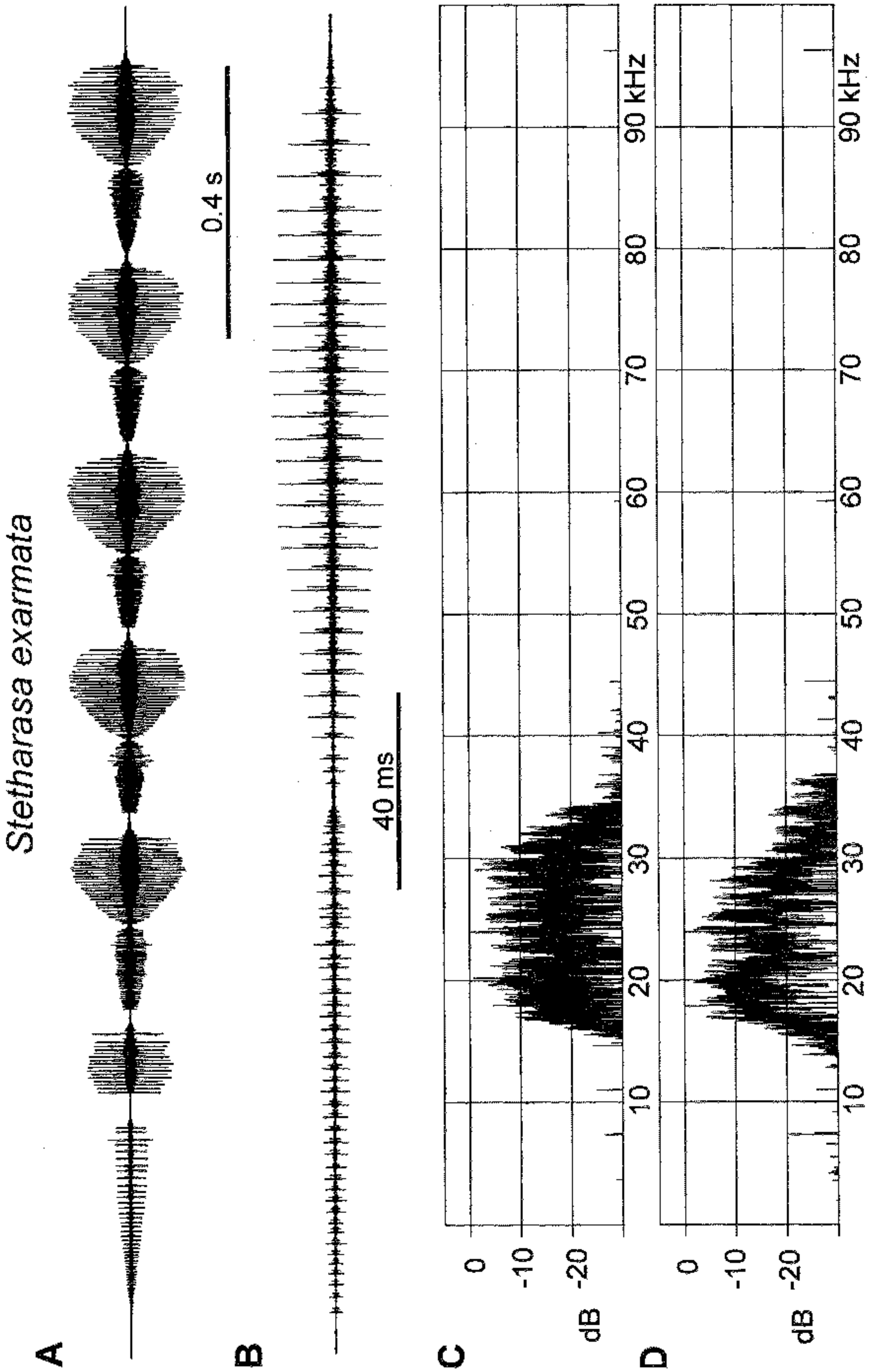


Fig. 39. Song of *Stetharasa exarmata*. A. Complete call. B. One phonatome. C. Power spectrum of A. D. Power spectrum of B.

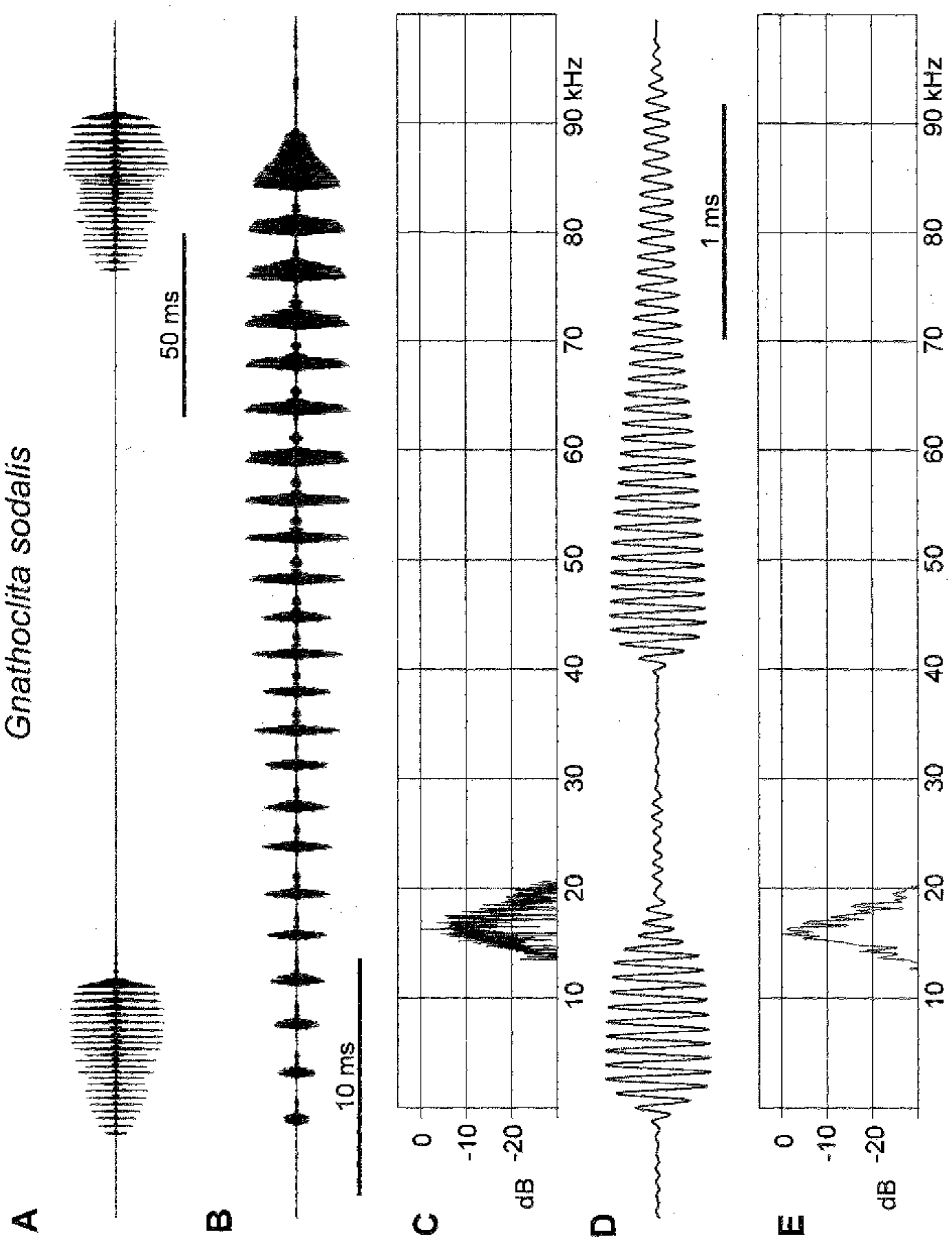


Fig. 40. Song of *Gnathoclita sodalis*. A. Two calls. B. One call (pulse train) at higher time resolution. C. Power spectrum of pulse train. D. Final two pulses of train showing sinusoid wave form. E. Power spectrum of pulses from D.

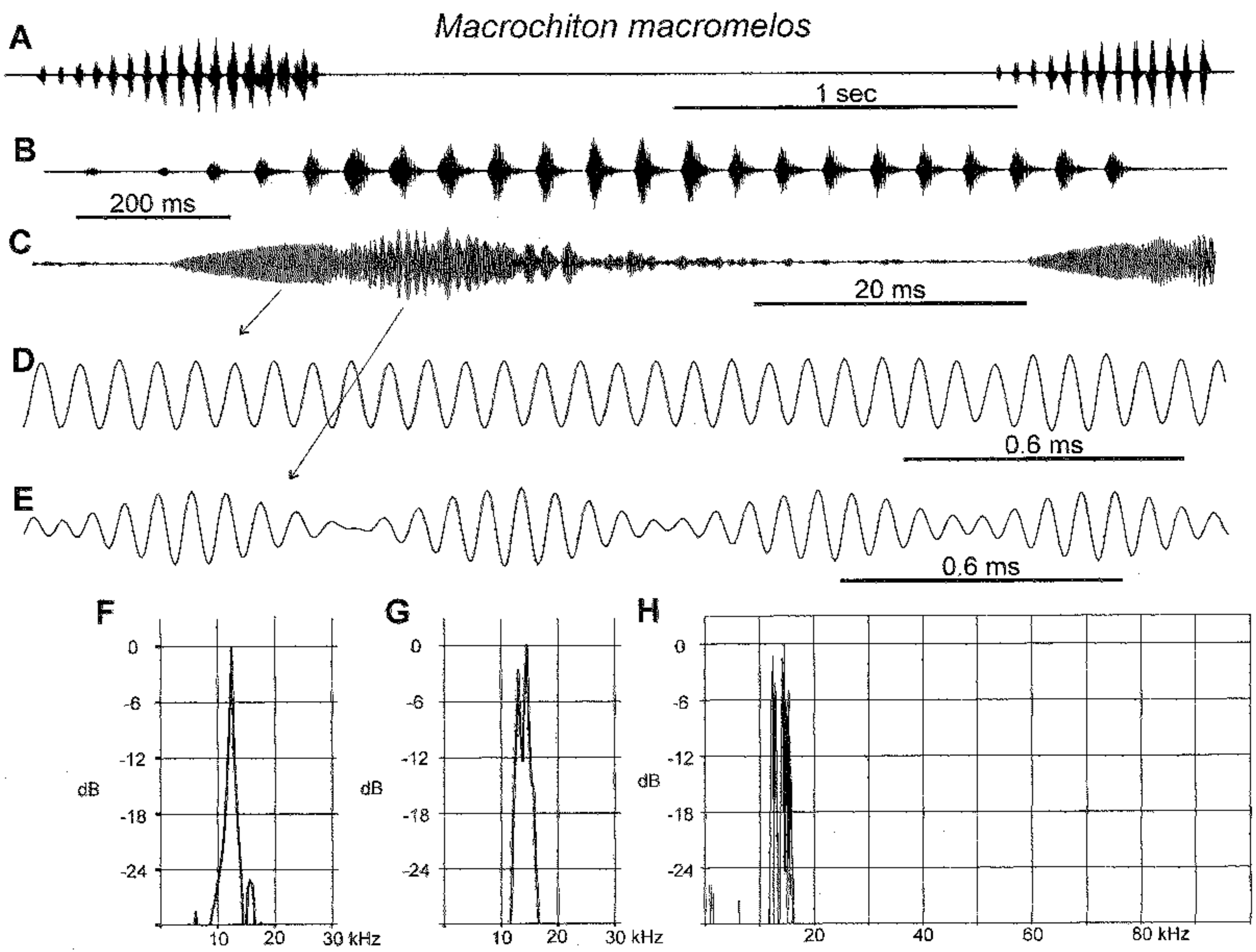


Fig. 41. Song of *Macrochiton macromelos*. A. Two calls; a second individual calls in the background ending the first song. B. One call of 22 pulses. C. One early pulse (= phonatome) and start of a second from call in B. D. High resolution waveform from sustained high amplitude region of pulse in C. E. High resolution waveform from region of beat modulation. F. Unitary peak power spectrum of waveform in D. G. Dual-peak power spectrum of waveform in E. H. Power spectrum of the complete pulse of C.

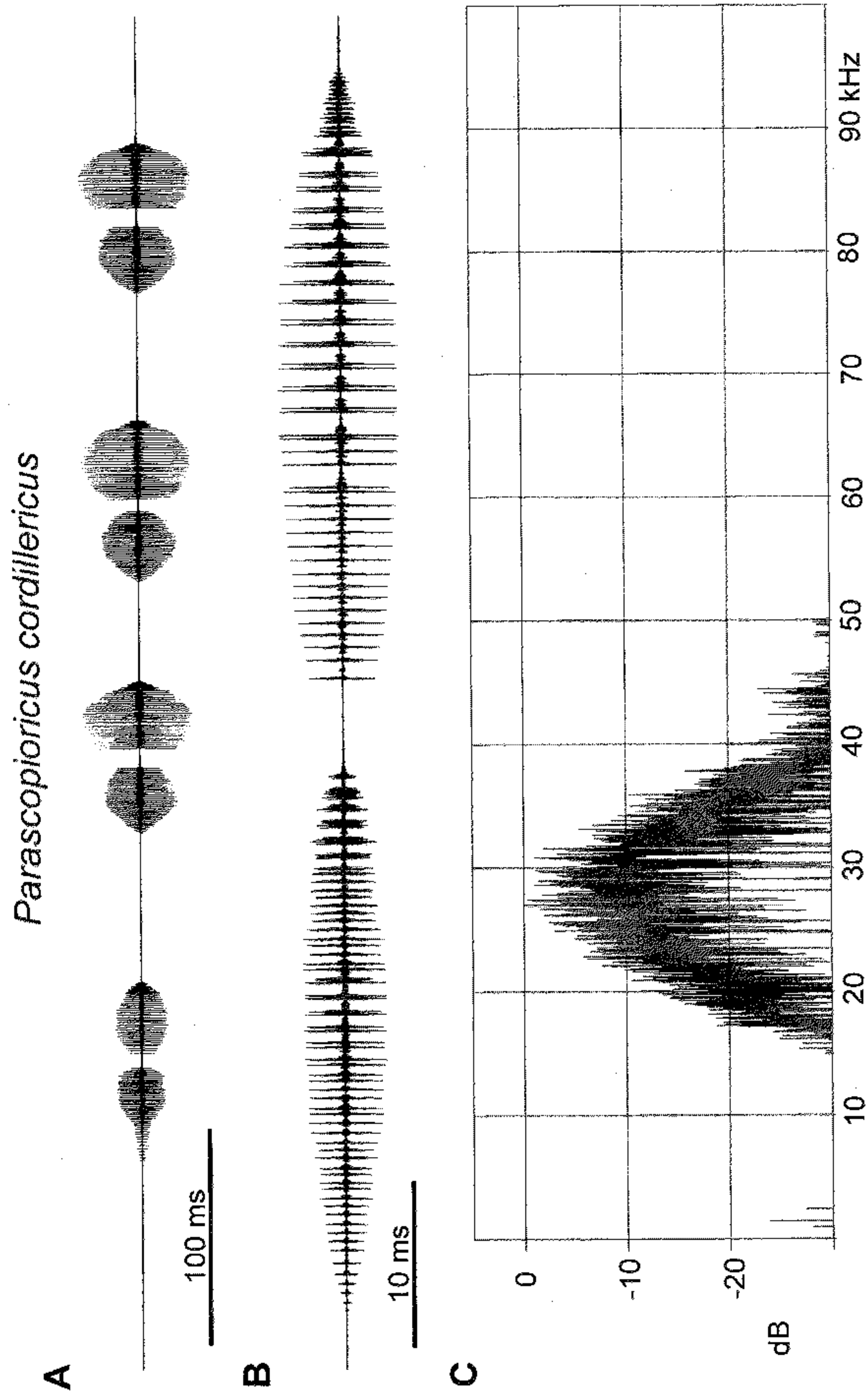


Fig. 42. Song of *Parascopioricus cordillericus*. A. One complete four-phonatome zip. B. One phonatome at higher resolution. C. Power spectrum of phonatome in B.

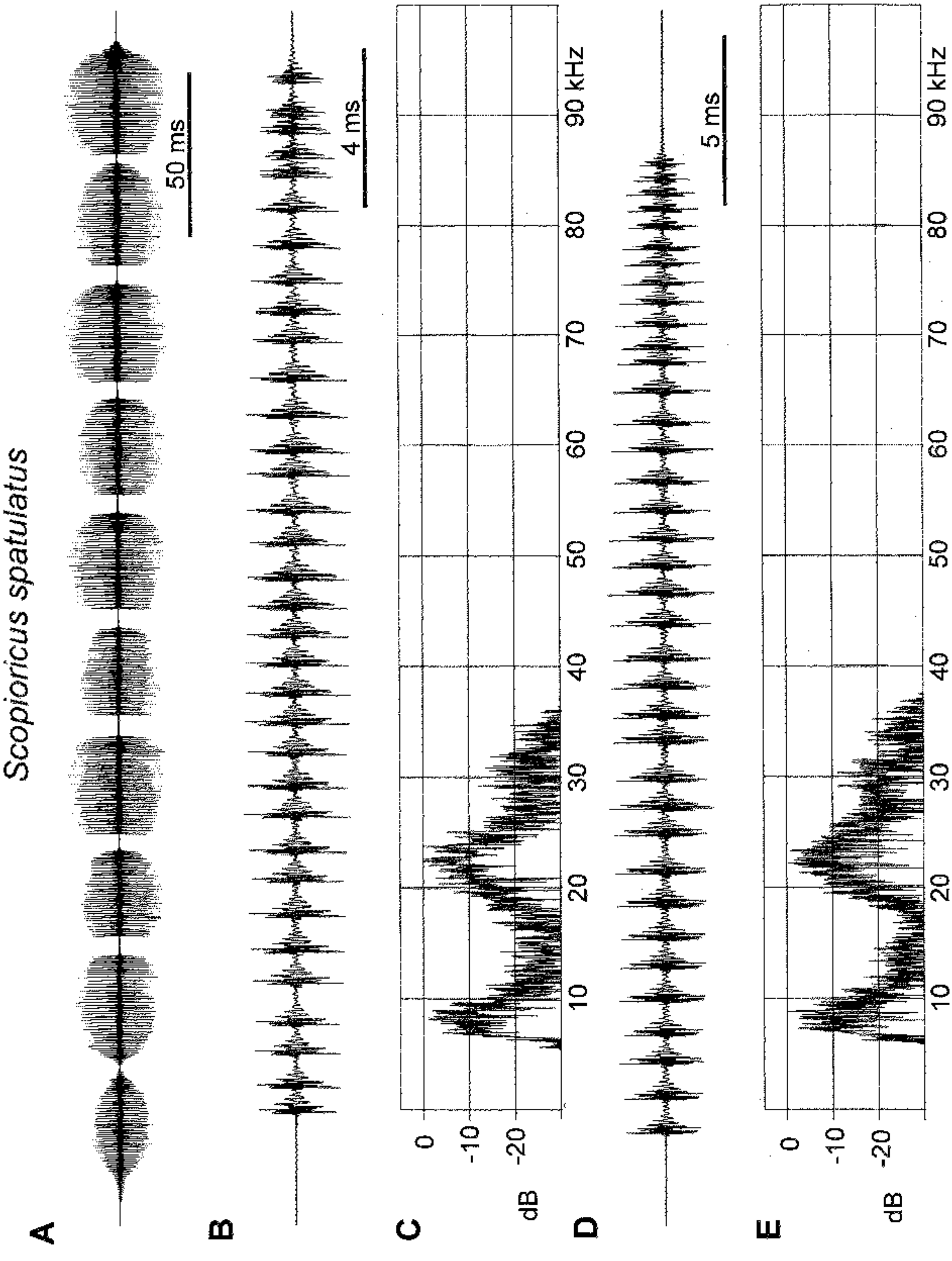


Fig. 43. Song of *Scopioricus spatulatus*. A. One call. B. One 'to' pulse train. C. Power spectrum of train in B. D. One 'fro' pulse train. E. Power spectrum of train in E.

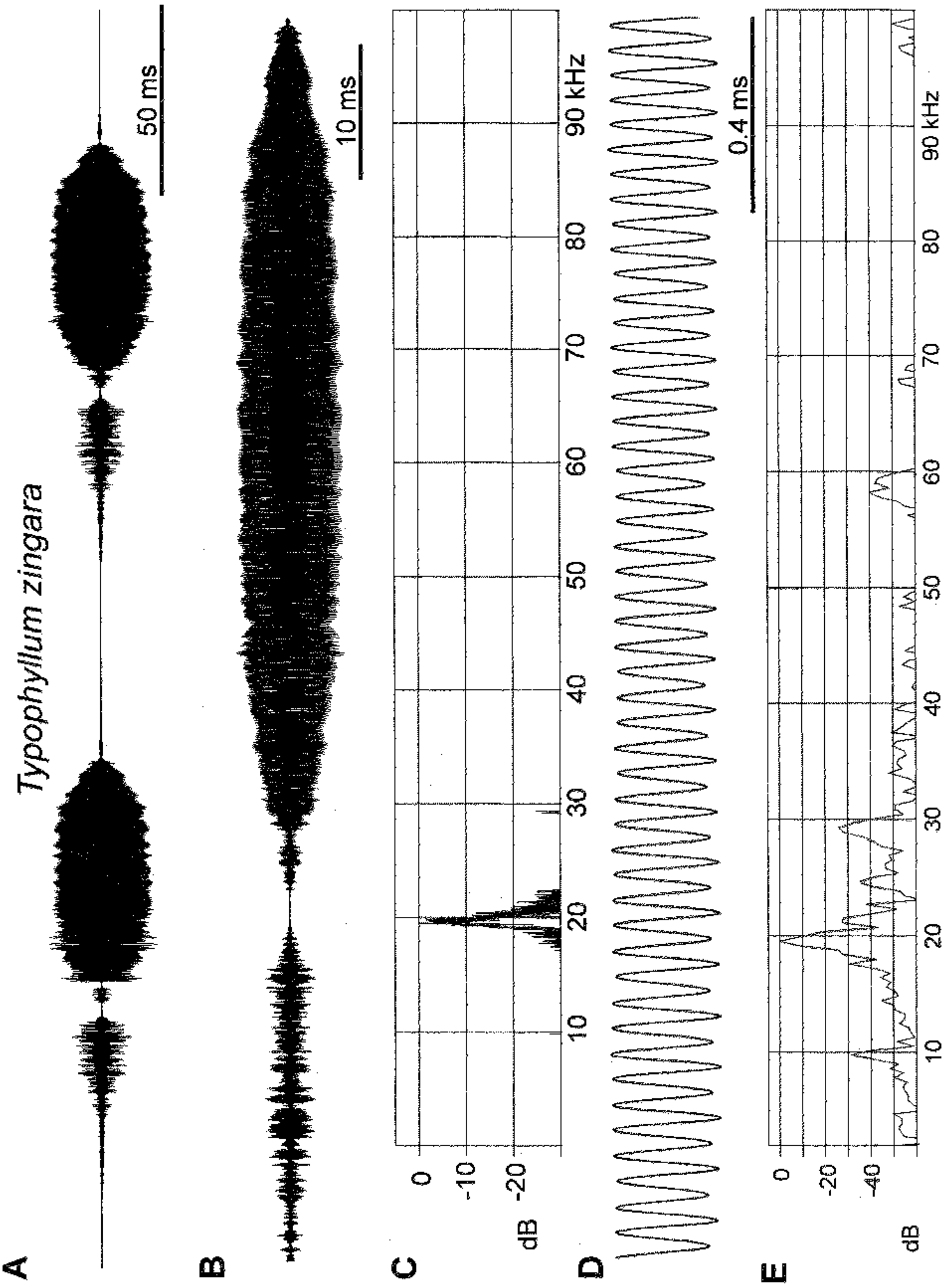


Fig. 44. Song of *Typophyllum zingara*. A. One call. B. One phonatome at higher resolution. C. Power spectrum of phonatome showing high-Q nature of call. D. Portion of major pulse showing sinusoid wave form. E. Power spectrum of wave sample in D.

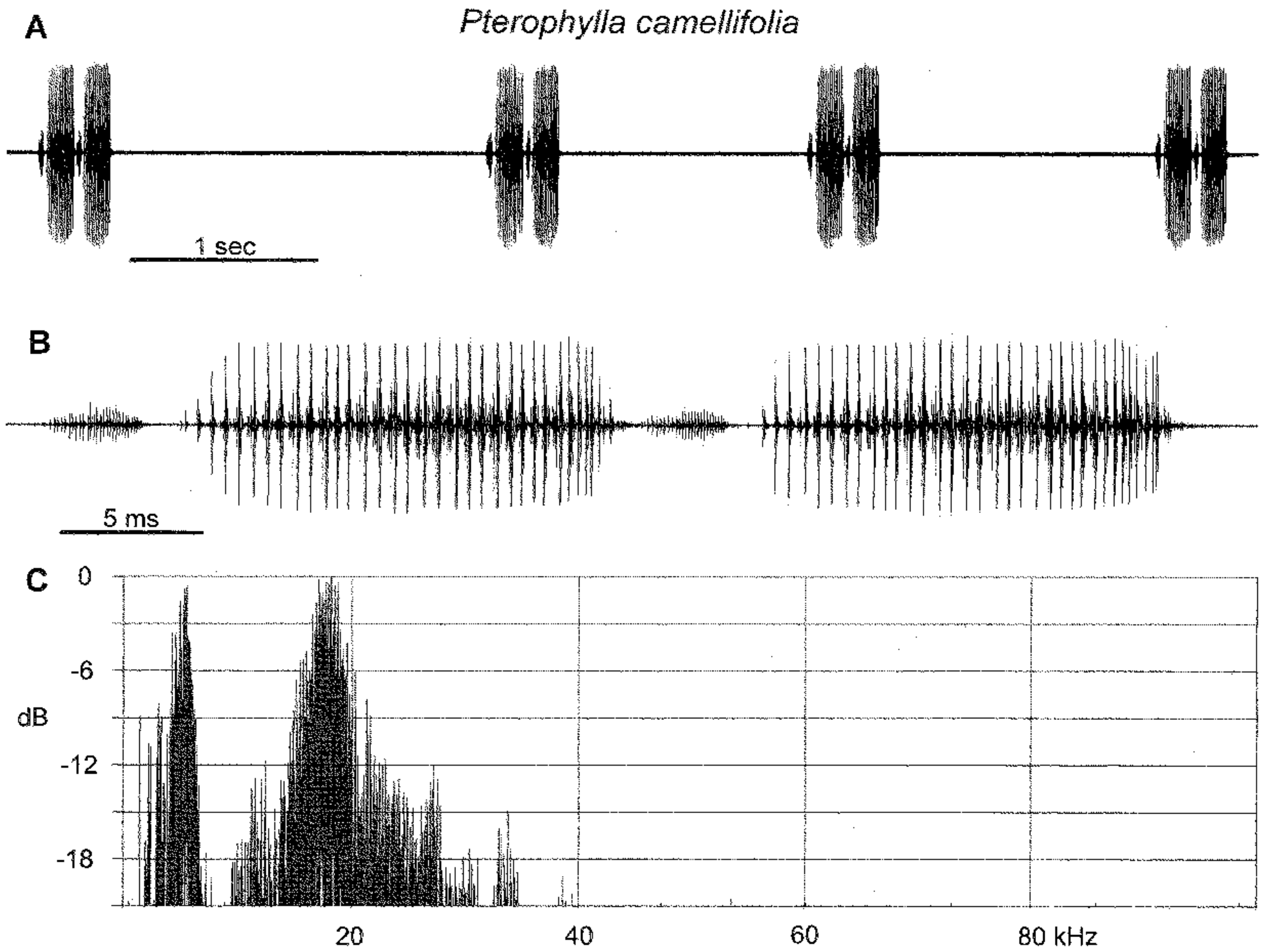


Fig. 45. Song of *Pterophylla camellifolia*. A specimen collected in 1973 by G.E. Kerr from Williams, Norfolk Co., Ont. and recorded at 23°C with equipment flat to 40 kHz. A. Four calls, each a double-phonatome ('katy-did'). B. A double-phonatome at higher resolution. C. Power spectrum of one call.

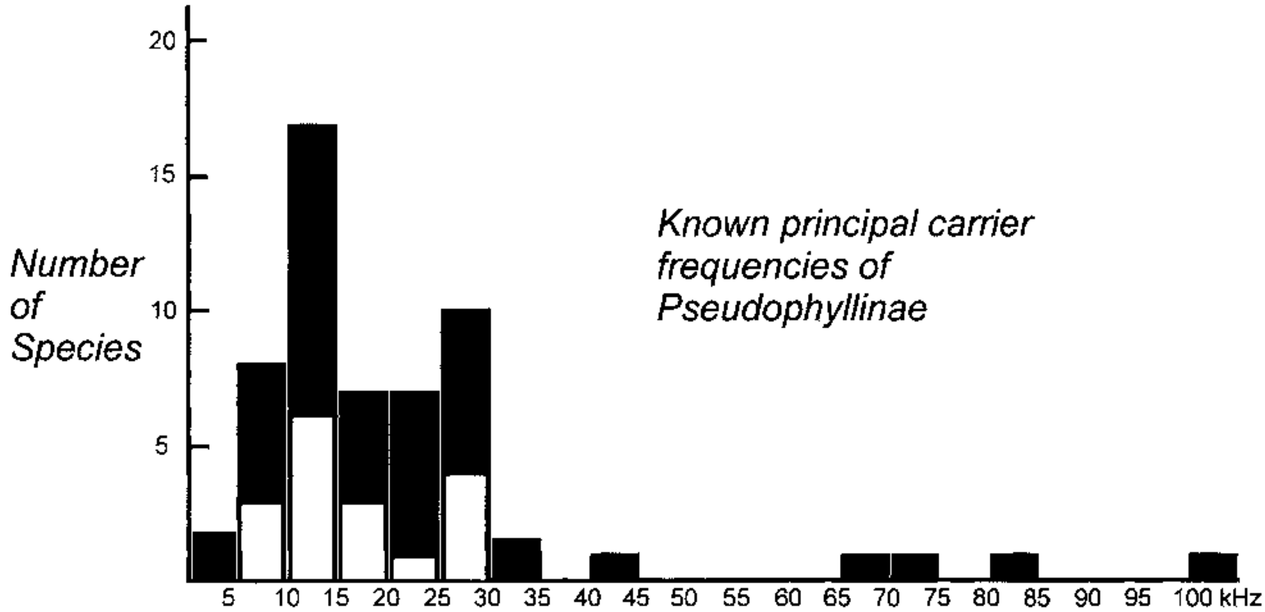


Fig. 46. Frequency distribution of principal carrier frequencies for the 66 Pseudophyllinae for which song information exists. Species whose highest amplitude pulses are sustained and so exhibit moderate to very high-Q resonant output are represented by black bars (49 spp.); those with trains of transient pulses, generating band spectra, by white bars (17 spp). Species with mixed pulse types are incorporated as high-Q.

separated substantially from the next by a rapid return to baseline amplitude. Because of their transience, these pulses have associated with them a wide spectrum of sound frequencies extending over tens of kHz. The generated sound may best be termed a **band** of frequencies, though still showing, for a given species, spectral subpeaks characteristically positioned, filtered by natural vibrational tendencies of sound field regions and their surrounding cavities.

Sustained vs transient pulse generation, high-Q vs band spectra, are the basic extreme alternatives of all orthopteran stridulatory sound signals. And the songs of most species can be classified as involving predominantly one or the other mechanism. But species that exhibit prolonged pulses as major amplitude song components may also have low amplitude (return stroke) pulses that are non-resonant. And a few species, e.g. *Ancistrocercus circumdatus* (Morris and Beier 1982) or *Metrioptera sphagnorum* (Morris 1970) have both pulse types as major amplitude components. Species also vary widely in their prolongation of pulses and it is common to find species songs in which prolonged pulses originate as shorter elements early in a call, becoming progressively fused into more sustained pulses by call's end (e.g *T. atrosignatus* Fig. 31 A, *T. fasciatus* Fig. 36A).

Song description

Championica walkeri

(3 males recorded) Specimens were found an hour after midnight (22°C) in a pasture, calling from the lichen and moss-covered lower limbs of an old lime tree. The song is readily audible. A few callers were just within reach overhead, others up to several meters above. One male was later recorded extensively in Canada with ultrasonic capable equipment at two different temperatures, 19°C and 27°C.

The following mean measures are of the lab-recorded male at 27°C. He produced a succession of notes (calls) with a period of 4.6 s (range 3.5-5.5 s). Slowed by a factor of 8, each note is a musical warble, and consists of a train of prolonged pulses (Fig. 30A). The first few pulses are lower in amplitude and shorter in duration, then increment to become each about 10 ms in duration. The final pulse (Fig. 30B) is somewhat longer (average: 13.5 ms). Each note lasted 166 ms. Pulse period was 15.2 ms.

Some call component durations of this insect increased at the lower temperature (19 °C): note to 216 ms; final pulse to 17.7 ms; penultimate pulse to 13.1 ms (from 10.2 ms); pulse period to 20.2 ms.

This insect produces no ultrasonic sound. The very uniform single audio frequency waveform is shown in Fig. 30C. The spectrum is one exceptionally high-Q, narrow peak at 14.6 kHz (Fig. 30D). At the lower temperature this frequency and the number of pulses per call, changed very little: carrier became 14.4 kHz; mean pulses per note went from 10.7 to 11.3.

Two field recorded animals exhibited the following averages: call note period ~10 s; note duration 290 ms, 12 pulses/note, final pulse in the train 22 ms, penultimate pulse 17.6 ms, pulse period 25 ms. The average carrier for the two field males was 13.5 kHz.

Triencentrus atrosignatus

(1 male recorded) We successfully recorded the singing of one specimen at 28°C. This male's duty cycle was extremely low: in making a succession of seven calls he sang

for about 1/3 of 1% of the time available. Each call was a zip lasting 106.7 ms (c.v. = 1.6%). One complete zip is shown in Fig. 31 A. Average down time between calls was 35.8 s (n=9).

The amplitude modulation of the call is complex and a little variable; it incorporates trains of rapid-decay pulses of low amplitude as well as trains of higher amplitude prolonged pulses (Fig. 31B); within the trains these latter tend to increment in duration. The maximum prolonged pulse duration achieved was in the final train (Fig. 31B,C): 2.1 ms.

The call always begins with a pair of low-amplitude rapid-decay pulse pulse trains. Then there are a few short sinusoidal pulses at higher amplitude and finally a short succession of the rather variable (presumed) phonatomes, each comprised of a minor low amplitude train preceding a major train of several maximally sustained pure tone pulses (Fig. 31 A,B).

Though this insect's song includes so many low amplitude rapid-decay pulse trains, its spectrum is is nevertheless dominated by a single relatively high-Q peak of unusual symmetry (Fig. 31 D,E). At any signficant distance from a singer a female would only perceive this dominant carrier. The peak is the product of the higher intensity pulses which involve one dominant frequency: 29.3 kHz (c.v 1.3%). Though not obvious in all spectra there are also very low harmonic peaks. There is a fundamental at 14.5 kHz >37 dB down. The principal carrier is thus the first harmonic of this suppressed fundamental. Other low harmonic peaks occur, 2'nd, 3'rd, 5th, all >30 dB below the dominant peak. One prolonged pulse is shown (Fig. 31C) at a resolution that reveals the pure-tone sinusoid; the power spectrum of this particular time sample is shown in Fig. 31 E.

Trichotettix pilosula

(2 males recorded) Songs of two males were recorded in the lab at 21°C. For one of these we had also obtained an earlier field recording at 11°C. The call is a rattle comprised of short sinusoidal pulses, paired in time, the pairs repeated over minutes without interruption (Fig. 32A). It evokes the sound of a minature one-stroke engine. Each pulse is only a few ms in duration (Fig. 32B) and never reaches an amplitude plateau.

In the lab a male (96-2) gave a pair rate of 8.5/s; his pair period was 117 ms with a pulse period of 27 ms. The other male (96-3) repeated pairs at 7.8/s; his pair period was 128.5 ms, pulse period 26 ms. In the field as a cold singer this same male (96-3) had a pair rate of only 3.3/s, the second pulse following the first (pulse period) by 55 ms.

At 21°C the pairs, but not the pulses, are resolved by human hearing. But at low temperatures each pulse becomes discriminable to the human ear and their paired nature very apparent.

The amplitude of a pulse rises quickly to form 7-14 intense waves with little or no plateau (Fig. 32B) and then there is some amplitude variation in a long decay. Possibly each pair constitutes a phonatome, i.e. the two correspond to one cycle of wing movement. But this notion is difficult to reconcile with the large number of teeth on the file (110, n = 1) (Fig. 20A). Alternatively several pulse pairs may be produced during one file run.

The spectrum is dominated by a single moderately narrow peak near 17 kHz (Fig. 32C). Weak harmonics are present, a 2'nd and 3'rd but are more than 20 dB below the top energy of the fundamental and hence not shown in Fig. 32 C. One of the males (96-2) produced its peak carrier at 17.5 kHz (range 17.0-17.7). The other (96-3) was slightly lower at 16.3 kHz (range 16.3-16.4). The mean principal carrier measured for 96-3 in the field was 16.3 kHz, exactly the same at both 11 and 21°C.

Eubliastes chlorodictyon

(1 male recorded) The song of this species has been given in detail previously for a specimen from Ecuador (erroneously as *Eubliastes ferrugineus*, see above (Morris et al 1989: p. 225, Fig. 3 E, F, G). A song of this male is reproduced here (Fig. 33A). We recorded 4 songs of a male from Bajo Calima, Colombia (Fig. 33B), and since its call parameters departed somewhat from that of the Ecuadorean specimen an analysis is given below.

The songs of the two insects agree reasonably well in carrier. The energy in the call is almost entirely ultrasonic with the quite symmetrical peak of the principal carrier at 25.4 kHz (29.1 kHz in the Ecuadorean specimen) (Fig. 33 C,E). Diminishing harmonics of this 25 kHz fundamental, from a 2nd to a 5th, were evident in spectra, but the most intense of these, the 2nd, was 29 dB below the fundamental.

The call incidence of the Colombian specimen at 23°C was determined with a stopwatch: songs were separated on average by 1.8 min (n = 13 successive calls) with the shortest call intervals 40-45 s. The temperature was about the same as for the Ecuador male, 22°C, but that male called at intervals of ~20 s, a much higher duty cycle.

For both specimens there was a soft audible zip comprised of three prolonged (major) high-amplitude pulse trains (Fig. 33 A,B); along with these intense pulses are low intensity, lengthy complex wave trains, 'pulses' with ill-defined starts and stops. In songs of both males major pulse 'trains' may sometimes consist of but one prolonged pulse. But more often they show variably timed amplitude modulations, quite inconsistent in occurrence between calls of the same male, though there is a tendency to produce more lengthy prolonged pulses later in any given train.

For the Colombian specimen pulse duration of the first two major trains was 4-7 ms with the final always longer at 9.7 ms. Measuring between major pulse train endings, the males differ in pulse train period. In the Ecuadorean male 18 ms separate the first and second trains and 12 ms the second and third. So there is a noticable temporal grouping of the last two trains. In the Colombian male 21 ms and 20 ms are the equivalent periods: the three trains are almost equally spaced.

Call (zip) durations of the two males were comparable: 62 ms (Ecuador) vs 75 ms (Colombia) and the Ecuadorean insect also initiated its call with a major pulse/pulse train (Fig. 33A) instead of the low intensity (opening?) sound seen in the Colombian.

Mystron flavospinus

(1 male recorded) Only one male was successfully recorded (at 21.5°C, in Canada) though this species is abun-

dant at Baeza and many were captured. Other casually monitored specimens did not sing in captivity. The singer produced a succession of calls readily audible to the unaided ear. The calls are zips, sounds shorter than 1 s that create the impression of infrastructure. The average for zip intervals measured at 21.5°C was 28s, giving this species a very low duty cycle.

Pulses are rapid-decay and transient, <2 ms in duration. Each zip (Fig. 34A) is a ragged series of 4-5 pulse trains comprised of only 2 or 3 pulses/train until the call ends in a last and much longer train of 7-8 pulses (Fig. 34B). The pulses of the final train are slightly more sustained than those earlier, though still quite short (~2 ms). The record of Fig. 34 B is from a different call of this male than that shown in Fig. 34 A.

The power spectrum is a band of energy 8-40 kHz wide with a strong peak near 12 kHz and another, marginally more intense, at about 25-27 kHz (Fig. 34 C,D). An appreciable amount of this insect's sound lies within the range of human hearing but its ultrasonic energy predominates.

Docidocercus gausodontus

(2 males recorded) Two specimens were recorded, both at 23°C, both showing remarkable constancy in note interval. For one male (96-1), based on a sample of 24 successive calls from a longer sequence, the average call interval was 2.95 s with a coefficient of variation (cv) of only 2.4%. Each call of this male averaged 22 ms in duration. For the second male (96-2) mean call interval (n=19 successive calls) was 3.0 s (cv 2.7%). Each call (n=10) of 96-2 averaged 18.8 ms in duration.

Each call is one note: a single sustained pulse of about 20 ms duration (Fig. 35A), its waveform indicating one pure-tone frequency (Fig. 35B), its musicality readily apparent to the human ear if slowed on a tape recorder. In real time one hears an instantaneous 'pop'. But with tape speed reduced by a factor of 8, this signal ressembles the call of a common north american frog, the spring peeper.

The number of teeth on the file (96-1), 253 in a length of 2 mm, falls well short of the number of waves, about 400, observed in the uniform amplitude portion of the pulse. So it is impossible for the pulse to be generated on a single tooth per wave basis. Successive tooth-scraper mechanical interactions must maintain an exact phase to the ongoing resonant system to give rise to such a flat amplitude envelope.

The principal peak was the same for both recorded males: high-Q at 22.5 kHz (Fig. 35C). Second and third harmonics of this occur but both are >20 dB below the fundamental. There is a slight 600 Hz frequency modulation (FM) during the pulse. The principal peak begins at 23.1, drops to 22.5 by mid-pulse and then returns to above 23 again.

Teleutias fasciatus

(5 males recorded) Five males of *T. fasciatus* were recorded. Four specimens were from Misahualli and one from Primavera. The species has a very low duty cycle. A male caged at 21°C in the lab (88-2) was timed with a stopwatch over 50 consecutive calls and showed an average between-call down time of 34.5 s. The average song interval of another caged male (20°C, 88-1) was similar: 37.4 s (n = 15 consecutive calls). Eight recorded calls of this second male (88-1) had a mean duration of 54.2 ms, on the basis of which we calculate a call duty cycle of only 0.15 %. Pooling available records of all five males gave an average song duration of 58 ms.

In real time little is detected by the human ear, just a faint tick, without any apparent infrastructure (Fig. 36A). Slowed by a factor of 2, the tick sounds musical and is heard as a chirp. Within each tick are three ragged pulse trains each pulse having a very sinsusoidal waveform (Fig. 36 B,C).

Averaging for the 5 males, despite the rather wide range of recording temperatures (18-24°C), the successive trains have incrementing mean durations of 6.3, 6.8 and 9.6 ms. The final train was always clearly longer than the others for all males. In four of five singers there was an increment in peak amplitude of successive trains. For the male incorporating the most lengthy (prolonged) pulse (Fig. 36E) there was a uniform maximum amplitude for all 3 pulse trains of his tick. Coincident with the highest temperature (24°C) the trains had their longest durations: 7, 10, 13 ms.

Variable pulse duration is a feature of this species. Shorter initial pulses grow longer and eventually become more sustained. These pulses are not consistent in number per train, or in duration between individuals, but there is some similarity within the same individuals. Comparison of Fig. 36 B, E, F illustrates this AM variation using the final pulse from a call of each of three different males. The male of Fig. 36 E achieved the most sustained output, consistently producing a final pulse lasting >6 ms at a stable high amplitude.

Little variation occurred between the five males in the high-Q, carrier frequency. A narrow peak is at 24 kHz (mean 24.1 kHz, range 23.2-25.0 kHz) (Fig. 36D). No energy within 30 dB of the principal peak occurs beyond 30 kHz. We detected a very slight upward frequency modulation (FM): the peak moves slightly upward over the three pulses: from 23 to 24 kHz.

Teleutias akratonos

(1 male recorded) The song of the holotype male was recorded at 24 °C. With the unaided ear his call was audible as a quick zip, less than 1 second in duration, too high pitched to suggest musicality, but not noisy: one can detect a pulse infrastructure. The pure tone nature of the pulse becomes apparent during slowing on a tape recorder and is of course evident in the waveform (Fig. 37C).

This male made 51 chirps (calls) in about 2 min 20 s: a chirp period of about 2.8 s. Chirps were given in groups of 2-4, most commonly 3. Chirp period within bouts was 0.65 s.

There are always five major pulses in a chirp, (ignoring the odd short break). Sometimes a very brief low amplitude short (sixth) pulse precedes. There is a characteristic lengthened silent interval with a mean duration of 22.6 ms between the first 3 and the last two pulses (Fig. 37 A,B). Pulses are about 8-9 ms long with a period near 17 ms.

The sound spectrum is a narrow peak centered at 21.9 kHz; it is extremely high-Q (Fig. 37D). There is no significant sound energy from 25 kHz to 100 kHz. The nearest sound energy is more than 30 dB down from the carrier peak. But among other low harmonics there is a peak consistently at 11 kHz, (Fig. 37D), suggesting that the carrier of this insect is the first harmonic of an 11 kHz fundamental.

Chibchella nigrospecula

(2 males recorded) Two males were recorded with high frequency capable equipment. Since they were at different temperatures (96-1, 19.8°C; 97-1, 25.5°C) most song measures are given separately.

Songs were mostly a double zip (Fig. 38B), but sometimes a single or rarely 3 zips (Fig. 38A). For 14 consecutive calls of 96-1 (9 double-zip, 5 single-zip) mean call period was 8.3 s (range: 2.6-18.6 s). Top song rate observed in this male was about 8/min. Single zips often began his calling bout, changing to doubles later on. For double zips one can determine a mean zip period: this was longer for the colder singer than for the warmer: (96-1), 180 ms, range 128-246 (n = 9 calls); (97-1) 126 ms, range 115-146 (n = 8 calls).

Each zip is a train of 7-14 temporally discrete transient pulses, the train lasting about 50 ms (Fig. 38B). The average number of pulses per train was 7.9 (96-1); 13.4 (97-1). Mean pulse train duration was (first zip of 2-zip calls): 50.5 ms (96-1); 49.5 ms (97-1). The mean pulse rate, measured per 2 consecutive pulses early in the train, was: 212/s, (range 173-230), 96-1; 286/s, (range 271-314), 97-1; but pulse periods are quite variable within individuals.

The song is easily audible and in keeping with this, much spectral energy is in the audio range (Fig. 38D). The pulse waveform (Fig. 38C) is complex, creating a band spectrum that extends from 5-30 kHz. Mean band width per 20 dB down was 4.3-29.0 kHz (96-1) and 5.6-31.9 kHz (97-1). One male had its most intense peak in the audio at 9.8 kHz (96-1) while the other was most intense at 20 kHz. But these maximum peak differences, though consistent, were only marginally greater than other spectral components over the same individual's band.

This species was also observed producing bouts of calling tremulation while caged in the laboratory, bouts that alternated with intervals of acoustic calling.

Stetharasa exarmata

(1 male recorded) This species was abundant at night in Ucumari on low understory vegetation beside the trails in undisturbed forest. But only one male's calls were recorded, this back in Canada and inadvertently, in the background of a recording of *Typophyllum* (see below). For this reason microphone allignment and distance are not known. This male produced several songs, each lasting a bit less than 2 s. Mean duration of songs (n = 4) was 1.8 s. In each call he produced 6 phonatomes in succession (Fig. 39A). The first minor train of this sequence was distinctive, comprised of >40 pulses, peak pulse amplitudes incrementing linearly throughout the train to a maximum typical of later minor trains (Fig. 39A). The male was apparently inhibited from singing until the completion of calling bouts of the *Typophyllum*. On another occasion he produced only 3 phonatomes, taking 0.9 s, perhaps due to interference from the *Typophyllum*. The song can be described as a short rattle, faint to all but young ears.

In the call proper all pulses are rapid-decay, each phonatome (Fig. 39B) a minor (lower amplitude) train combining with a more intense major train. The resulting low-Q spectrum contains a coherent band of carrier frequencies between 16 and 34 kHz (Fig. 39 C,D). The energy is distributed rather uniformly over this band so there is no identifiable peak frequency. And there is no appreciable difference between the spectra of the two train types (putative opening and closing movements) (compare Fig. 39 C,D).

The phonatome period of *S. exarmata* is 272 ms. The phonatome rate at about 20 °C was 3.2/s. There are 42 pulses in the minor train delivered at a rate of 420/s, while there are 32 pulses in the major train occurring at a rate of 220/s. Notable in this species is the unusual coherence and temporal separation of the pulses of the minor pulse train and its rather long duration, about 100 ms. The teeth of the file, upon a low buttress, are remarkably uniform in width and spacing (Fig. 25 A,B). Perhaps this file morphology relates to the clearer separation of pulses in time. The train duration is very long in comparison to other non-resonance singers (e.g. *Conocephalus* spp.).

Gnathoclita sodalis

(2 males recorded) We recorded two males from El Ensueno. To a human ear the song is a succession of zips delivered with engine-like regularity (Fig. 40A), each with a particulate, beady quality at any temperature. Singing is interrupted irregularly after several seconds. For one male recorded in the lab with high frequency equipment (96-2, 18°C) zip (train) period was 244 ms (c.v. 4.1%); each zip had 22-24 short sinusoidal pulses (Fig. 40 A,B). The number of pulses for the other male (96-1, 24°C) was only 13-16. It is these short pulses that give the zip its particulate quality. The insect's spectrum contains but one peak (Fig. 40 C,E) at 15-16 kHz (96-1, 15.3 kHz, c.v. 1.0%; 96-2, 16.2 kHz, c.v 1.7%). In spite of the brevity of the pulses this is still a rather narrow peak and this insect produces a moderately musical song (Fig. 40 C,E).

Male 96-1 was recorded at two temperatures: with audio-limited equipment in the field at 12°C and later in a hotel room in Cali at 24°C using the S25 bat detector. In the field this male sang head down on an understory shrub about waist height at the spot where a pair of this species had been observed mating the night previous. The pulse train period in the field was 484 ms at 12°C, but at 24°C it shortened to 178 ms. Trains in the field had a duration of 53.8 ms with about 16 pulses per train. At the higher temperature trains were much shorter, 30.5 ms, but with about the same number of pulses (15). Wide changes in pulse and train rates occur with temperature.

Pulse durations are typically less than 1 ms, becoming slightly longer toward the end of the train. The mean duration of the penultimate pulse (96-2) was 1.2 ms (c.v 9.3%). This male's last pulse (2.9 ms, c.v. 4.8%) ended consistently with a uniformly slow-falling amplitude envelope (Fig. 40D).

Macrochiton macromelos

(2 males recorded) Full-range recordings were made of a caged singer (86-1) at 15 cm distance, at dorsal and ventral aspects (18-19°C). From this male we obtained 5 calls. One

song of a second male (86-2), caged separately, was recorded in the background. The two insects influenced the incidence of each other's calling. For both males acoustic output was interspersed several times with bouts of calling tremulations (see below).

Pooled average song period (n=3) for 86-1 was 3.4s. Average duration of the songs of 86-1 was 1079 ms; the single recorded song of 86-2 lasted 1110 ms. Fig. 41 A shows two successive songs of 86-1.

In real time a human listener hears a short trill, musical with detectable infrastructure. The latter is due to a train of sinusoidal pulses which comprises each song (Fig. 41B). Each phonatome in this species apparently corresponds to a single sinusoidal pulse (Fig. 41C). On average a train contained 19.5 prolonged pulses (range 13-25), given at a quite uniform pulse rate. Mean number of pulses per call was 18.8 for 86-1; male 86-2 in his single song had 23 pulses. Pulse peak amplitude increased during the call to a maximum about 2/3 of the way through, then declined somewhat.

Pulse amplitude envelopes were very variable (Fig. 41C), rising very gradually from onset to become a plateau (Fig. 41D) and then sometimes taking on the appearance of beats (Fig. 41E). Mean pulse duration was 26.9 ms and mean pulse period was 53.9 ms, calculated on the basis of all pulses in all available calls for both males. The waveform is highly sinusoidal (Fig. 41D).

The power spectrum is high-Q, dominated by a single narrow peak in the middle audio range (Fig. 41 H). For 86-1 the average carrier was 13.6 kHz (c.v. 5.1%) and the width of the peak 18 dB down was <3 kHz (12.5-15.4 kHz). The other male had a carrier of 14.0 kHz. The occurrence of beats (compare Fig. 41 D and E, taken from the pulse regions indicated by the arrows) suggests the existence on the generator of two non-harmonically related frequency sources (~12.5 and 14.5 kHz). These are not always active at the same time, so that as in Fig. 41. D, E, a level-amplitude wave corresponds to a single very high-Q peak at 12.5 kHz. When the waveform is amplitude modulated as a series of beats (Fig. 41E) one sees two peaks 12.9 and 14.5 kHz (Fig. 41G).

Both recorded males of this species were also observed engaging in calling tremulation. They oscillated their body vertically at a uniform rate for about 3 s, paused about 7 seconds, then repeated. After several vibration bouts they reverted to calling with airborne sound.

The pressure difference ear of tettigoniids conducts sound from a permanently open acoustic stigma adjacent to the first thoracic spiracle, along the acoustic trachea, traversing the foreleg to the rear of the tympana. The unusual length of the limbs of *M. macromelos* has implications for the function of its auditory system: the extreme lengthening of the foreleg must affect the phase of externally and internally arriving sound waves. And the tympana, being farther apart bilaterally, will subtend a larger than typical angle to the sound source.

Parascopioricus cordillericus

(1 male recorded) We collected only one specimen, a male. The call of this insect is a quiet sibilant zip given at intervals of about 30s (mean for 5 call intervals at 23°C). The infrastructure perceived by the human ear arises from the four constituent phonatomes (Fig. 42A). Like *Scopioricus spatulatus* (see below) this species produces two successive trains of transient pulses that are not drastically different in duration and amplitude. One of these putative phonatomes is shown (Fig. 42B) at high resolution. Excepting the first train of each call, the duration is always about 70 ms for each phonatome. The phonatome period for the final three is about 100 ms. Both trains of a phonatome have about the same number of pulses, between 50 and 60, with the second train, slightly longer and higher in amplitude, presenting them at a slower rate (1600/s for first; 1700/s for second).

A band spectrum (Fig. 42C) extends from 17 to 37 kHz and is unusually symmetrical. Its peak centers at about 28 kHz.

Scopioricus spatulatus

(4 males recorded) *S. spatulatus* is a conspicuous acoustic presence in disturbed forest near the Refugio Turistico La Pastora, Ucumari. Its calls are loud, easily audible and the males soon sing readily in captivity. (This is especially true in transit.)

Callers engage in bouts of singing activity separated by substantial silent periods. For one male (96-2) at 19°C we measured a mean interval between calling bouts of 70 s. Each bout is comprised of a number of zips; the aforementioned male had an average of zips per bout of 11 (range 9-16). Each zip is either 4 or 5 phonatomes and each phonatome a pair of rapid-decay pulse trains. Fig. 43 A shows a single zip of 5 phonatomes or 10 pulse trains. The pulses are transient and discrete, each with an nearly complete-to-background exponential decay before the next pulse occurs.

The following AM parameters are pooled averages for two males both recorded at 19°C: zip duration 401 ms, 1.4 s intervening between zips; 5 phonatomes/zip; phonatome period 76 ms; first train of the phonatome 33 ms, second train 35 ms; first train with 40 pulses, second with 41; pulse rate 1225/s first train, 1175 second train.

One of the above males and another were recorded at 12°C, a typical field temperature for this species; their pooled averages for most of the same measures are: zip duration 619 ms, 3.6 s intervening between zips; 4 or 5 phonatomes/zip; phonatome period 129 ms; first train of the phonatome 58 ms, second train 65 ms.

This species has a bimodal band spectrum (n = 2 males) with a very marginally more intense ultrasonic peak at 22.9 kHz and an audio peak at 8.3 kHz (Fig. 43C). The two peaks are consistent features of a broad band of frequencies extending from 6 to 34 kHz if one considers only energy within 20 dB of the maximum peak. The direction of stroke makes no difference in the spectrum: the spectra of Figs 43 C, E are identical.

The approximate equality in amplitude and duration of successively distinctive pulse trains is an uncommon AM feature for a katydid song. It is common for non-resonant generating species e.g. *Conocephalus* to exhibit a markedly shorter and lower intensity train preceding a longer and much more intense train. But here the two alternating types are virtually equal in both duration and amplitude. A listener receives the impression that the singer changes direction with each successive train as in the sounds of to and fro strokes made when sawing wood. Displacements of the tegmina during the zip were readily followed with the human eye and so direct observation could confirm the occurrence of approximately equal sound-effective strokes in opposite directions. There is some similarity in the file structure of this species (Fig. 29) and that of *S. exarmata* (Fig. 25).

Typophyllum zingara

(1 male recorded) The single male was recorded at 19-20°C. At his most active and undisturbed, calling bouts came separated by about 5 s of silence (5.7s, n = 4). Each bout incorporated 4-11 calls. Call period was relatively variable: on average for 9 recorded bouts it was 1.8 s. But periods ranged between 0.9-2.8s.

A call always consisted of two phonatomes (Fig. 44A). For 10 successive calls at 19°C average call duration was 295 ms (c.v. 1.0%). Each phonatome had a minor pulse (44 ms) followed after ~5 ms by a higher amplitude major pulse (63 ms) (Fig. 44B). These measured means are identical for both phonatomes of a pair. The period of the phonatome was 176 ms (c.v. 1.0%). Downtime between phonatomes was almost identical to the duration of a major pulse: 64 ms.

Call energy is confined to a single high-Q peak at 19.7 kHz (c.v. 0.5%) (Fig. 44C). This value was obtained by averaging maximum peak values for the FFTs of ten successive calls, each spectrum calculated upon one complete call. The highly sinusoidal waveform of part of a high amplitude pulse is shown in Fig. 44D and its power spectrum in Fig. 44E. The principal carrier appears to be the first harmonic of a suppressed fundamental (Fig. 44E). The spectral peak here is very close to that of a species of *Typophyllum* from Ecuador, *T. nr trapeziforme* (23.2 kHz, Morris et al. 1989). But the number of phonatome repetitions in *T. nr trapeziforme* are three per call, whereas here they were always two. Also the major pulse in *T. zingara* at 62 ms lasts more than twice as long: compare with 26 ms in *T. nr trapeziforme*.

Discussion

Songs

The first pseudophylline song analysed with modern 'electric' equipment was that of the northern true katydid. G.W. Pierce (1948), using 'supersonic'-capable instruments he fabricated himself, recorded calls of *Pterophylla camellifolia* (Fabr.). This species choruses from the canopy of mature deciduous forests in eastern North America; its raucous emphatic call easily engages the curiosity of human listeners. The song's two-part (two-phonatome) structure is the probable basis of the common name 'katy-did' (Bartram 1751).

Each *P. camellifolia* phonatome consists of two pulse trains of transient pulses, a low train followed by one at high amplitude (Fig. 45 A,B). Pierce used a "motion picture" to determine that the high intensity trains coincide with tegminal closure. And he found a broad 'noisy' spectrum, combining low audio frequencies with a mostly ultrasonic band of 18-63 kHz. (Recently, in a specimen from Southern Ontario we located the most intense spectral peak at 18 kHz with a substantial audio peak at 6 kHz (Fig. 45C).)

The second species of Pseudophyllinae analysed was *Leurophyllum modestum* (Bruner) from Trinidad. Suga (1966) examined the calls of '*Drepanoxiphus modestus*' (= *L. modestum*). The spectrum is a narrow high-Q peak at 24 kHz. And each pulse is sustained and sinusoidal, lasting 6-10 ms. By removing teeth toward one end of the file and observing the effect of this in the generated sound, Suga also showed that this species' pulses are produced on wing closure.

The calls of these first two pseudophyllines to be examined exemplify the two basic generating mechanisms indicated above: non-resonant and resonant. The sustained pulse and high-Q spectrum of *Leurophyllum* contrasts with the short (<1 ms) duration of a *P. camellifolia* pulse and its band spectrum.

Incorporating the species treated in the present paper, the physical structure of calling songs is now known for 65 pseudophyllines (Fig. 46). Sources of these analyses are: Pierce 1948, Suga 1966, Sales and Pye 1974, Morris and Beier 1982, Belwood and Morris 1987, Morris et al. 1989, Belwood 1990, Morris et al. 1994, Heller 1995, 1996 and Morris and Willemse (in preparation). These 'known songs' still constitute only 6% of the 930 pseudophylline species listed by Beier (1960,1962).

Approximately one quarter (17 of 66) of known pseudophylline songs exhibit trains of transient pulses giving a band spectrum. For the remaining three quarters, one carrier frequency predominates, and the spectrum has one relatively narrow, high-Q, peak.

Of the 15 pseudophylline songs described in the present paper, 5 are the product of a non-resonant generation mechanism: trains of transient pulses result in a band spectrum >20 kHz wide in *Mystron*, *Chibchella*, *Stetharasa*, *Parascopioricus* and *Scopioricus*. The remaining 10 spp. are 'resonant generators' that produce, to varying degrees, sustained sinusoidal pulses and more narrowly peaked high-Q spectra.

The 'transient generators' here all include frequencies in the vicinity of 23-27 kHz among their most intense. That is, for all of them, some part of their spectral band takes in this region of the low ultrasonic range. Three species have a two-peak spectrum combining a broad audio peak with a broad ultrasonic: *M. flavospinosus*, *C. nigrospecula*, and *S. spatulatus*. For the remaining two species: *S. exarmata* makes a flat-topped 20 kHz wide band, and *P. cordillericus* a symmetrical, very broad, single peak. The shapes/subpeaks/energy aggregates of these spectral bands are a consistent species-characteristic physical feature (Morris and Pipher 1967; Meyer and Elsner 1996).

A feature we have not noted previously in transient generating species of Pseudophyllinae is the occurrence of (putative) phonatomes comprised of to and fro trains of comparable duration and intensity. This is most evident in *S. spatulatus* (Fig. 43A) where only a slight difference in duration and amplitude envelope distinguishes successive pulse trains. But it is also a tendency of *P. cordillericus*: here the difference in both train duration and peak amplitude is less marked, but still exceeds that of most other species.

Among the resonant-generated songs analysed here *T. atrosignatus* produces the highest high-Q carrier: 29.3 kHz. But it achieves this with a very short pulse: the uniform high amplitude portion of its pulse never exceeds 2 ms. Likewise the longest sustained maximum amplitude wave achieved by *T. pilosula* and *G. sodalis* is < 3 ms, by *E. chlorodictyon* 3.5 - 4.0 ms and by *T. fasciatus* 6 ms. *T. akratonos* does somewhat better at 10.6 ms. Thus many of these species keep their resonators in sustained oscillation for no longer than a few milliseconds at a time. *M. macromelos* is a special case in this regard since it seems to make a virtue of never achieving a stable peak amplitude envelope within its relatively long pulse (27 ms).

The most accomplished sustained pulse, pure tone singers, are *C. walkeri*, *D. gausodontus* and *T. zingara*. They produce relatively lengthy, smoothly modulated pulses: respectively about 13, 20 and 60 ms, and they do so for relatively high principal carriers: 14.4, 22.5 and 19.7 kHz respectively. Of the three *T. zingara* is the most remarkable, for it keeps a tegminal surface in uniform maximum amplitude movement for >60 ms while producing a carrier that is just at the border of ultrasonic.

Crypsis and Q

The body form of most pseudophyllines makes some contribution to crypsis. But in three tribes, the Phyllomimini and Pseudophyllini of the old world and the Pterochrozini of the neotropics, many species show a more extreme leaf mimicry. The paleotropical species specialize in a green membranous 'foliaceousness' [Blattähnlich, Beier 1962]: most have broad, dorsally convex multi-celled tegmina ressembling green leaves. Phyllomimini are smaller and not so pronouncedly 'foliaceous', but their tegmina are characterized by produced costal lobes that project over the pronotum laterally (Beier 1962). Beneath their wings, these insects pass the day, crouching motionless, exposed on the surface of broad green leaves; their tegmina cover all their legs, perhaps removing the joint angles as a search image cue (Robinson 1973, Heller 1995). Pterochrozine (neotropical) leaf-mimic crypsis by contrast involves bilateral not dorsoventral compression of the body (Heller 1995) and an abundance of necrotic spots and excavated leaf edges; the plant model in the new world is as likely to be a brown dead leaf as a green living one. Between these leaf mimics of the old and new world there is thus some convergence in leaf mimicry but also an intriguing convergence in the Q of their acoustic signals.

Heller (1995) studied acoustic behaviour in 9 species of Pseudophyllinae (6 Phyllomimini and 3 Pseudophyllini) from Malaysia. The principal carrier of all of these species is in the audio range. And a high proportion, 2 of 3 Pseudophyllini and 4 of 6 Phyllomimini spp. have high-Q songs. The carriers of the high-Q singers all fall in the low-middle audio: 0.6-11.6 kHz. Morris and Willemse (in prep.) have analysed the songs of 3 Phyllomimini from Papua New Guinea: *Acauloplacella immunis* (B. v. Watt.) and two species of *Paraphyllomimus*. Their carriers all lie in the mid audio (8.6-12.4 kHz) with two of the three being high-Q.

The spectra of four Pterochrozini have now been determined: *T. zingara* of the present paper, *Mimetica incisa* Stål (Morris and Beier 1982), and two other *Typophyllum* spp. (Morris et al. 1989). All four have very high-Q spectra produced in conjunction with sustained pulses of relatively great length. Major pulse durations range from 26-63 ms and carriers from 9.4-23 kHz. Among these, near 60 ms, *T. zingara* has a significantly longer duration pulse than the others. There appears to be tendency for extreme leaf mimicry and high-efficiency resonance generation to occur together. But the adaptive basis of this remains obscure.

Of further relevance to the acoustic convergence of old and new world leaf mimics is a two-part tooth structure: the teeth appear "to be fused in the middle, giving the appearance of being composed of two halves" (Plate IIIa Heller 1995). In an earlier paper (Morris et al. 1989) we failed to note this feature in presenting SEM photos of files of three species of *Typophyllum*; but it is readily apparent in these figures (see Fig. 10 G-L of that paper). To our knowledge this tooth structure has not been seen in other tettigoniids, only in the three leaf mimic tribes. In all species where it is found the insects are producing unusually high-Q signals. Perhaps the mid-tooth elevation is a 'catch' that centers and 'grips' the scraper on each successive tooth contact, preventing transverse (to the tooth) movement; it might then contribute to more precise timing of new energy inputs to the active resonator, consistent with the very high Q of the output sound pulse.

Files

Associated with the production of ultrasonic, sustained pulses, both short and long, by neotropical pseudophyllines there is a consistent file morphology. The supporting vein (Cu2) becomes immensely dilated, elevating the teeth on a broad curving buttress. The teeth themselves are relatively low, several times broader than high and occur at increased density. At the end nearest the wing base the file is undercut to form a projecting bar separated from the overlying tegmen which may serve to give the scraper a straighter file passage than would occur otherwise. *C. walkeri* (Fig. 18), *T. pilosula* (Fig. 20), and the two *Docidocercus* spp. (Fig. 21) are good examples of this file form. It is a morphology that correlates here with the generation of high-Q sustained pulses, as also for a number of other Pseudophyllinae (e.g. *Scopiorinus*, Morris and Beier 1982).

Mystron flavospinosus (Fig. 22) and *Chibchella* (Fig. 24) provide examples of a less specialized tettigoniid file, one associated with a lower coherence of song structure, as seen notably in *Mystron* (Fig. 34A). Noisy, erratically timed, transient pulses produce band spectra in both species. Files have relatively narrow teeth on a modest file buttress without any basal protrusion.

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Table 16. Song time-amplitude parameters, sound levels, file length and tooth number summarized for 15 species treated here. Sound levels measured with a 1/4" B&K condener microphone via a 2204 meter. Microphone tip (cover on) clamped at 10 cm dorsal aspect; exceptions: *T. fasciatus* 88-1 at 10.5 cm; *C. walkeri* (db impulse) at dorsal 14.5 cm. (dB Hold) dorsal 12.5 cm; one specimen of *S. spatulatus* left lateral the other with measuring amplifier (B&K) 2606. File lengths are straight-line distances between the two most distant coherent teeth, measured from SEM photos. Tooth width is taken ca. mid-file as the widest possible measure.

	Principal Carrier kHz	Spectrum type	SL dB Fast	SL dB Impulse	SL dB Hold	File length mm	Tooth width mm	# file teeth	Tooth density (teeth/mm)
C. walkeri	14.6	high-Q		103	102	2.58	0.29	144	55.81
T. atrosignatus	29.3	high-Q		101	101	1.64	0.20	142	86.59
T. pilosula	17	high-Q	85	89		1.63	0.18	107	65.64
E. chlorodictyon	25.4, 29.1	high-Q							
M. flavospinus	8-40 (peak 26)	band				1.69	0.16	86	50.89
D. gausodontus 96-1	22.5	high-Q	95.2	103	99	2.06	0.25	230	111.65
D. gausodontus 96-2			91		99.3				
T. fasciatus 88-1	24.1	high-Q			91.7	1.1	0.15	114	103.64
T. fasciatus 88-2					90				
T. akratonos	21.9	high-Q							
C. nigrospecula	5-30	band			99.8	2.88	0.37	81	28.13
S. exarmata	16-34	band				2.24	0.24	83	37.05
G. sodalis	15.3, 16.2	high-Q	89-91	98.2		2.18	0.24	217	99.54
M. macromelos	13.6, 14.0	high-Q				2.8	0.33	170	60.71
P. cordillericus	17-37 (peak 28)	band	96.3	100	99	2.36	0.33	99	41.95
S. spatulatus 97-1	6-34	band			103	3.32	0.50	83	25.00
S. spatulatus 97-2					103				
T. zingara	19.7	high-Q	95	99					

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Literature Cited

Bartram J. 1751. Observations Pensilvania to Ontario, p.70. katydid: as cited in The Oxford English Dictionary.

Beier M. 1960. Tettigoniidae. Pseudophyllinae II. v 74, pp. 396. Das Tierreich. W. de Gruyter, Berlin.

Beier M. 1962a. Tettigoniidae. Pseudophyllinae I. v. 73, pp. 468. Das Tierreich. W. de Gruyter, Berlin.

Beier M. 1962b. Neue neotropische Pseudophyllinen (Orthopt.-Tettigon.). Ann. Naturhistor. Mus. Wien. 65: 81-116.

Belwood JJ, Morris GK. 1987. Bat predation and its influence on calling behavior in neotropical katydids. Science 238: 64-67.

Belwood JJ. 1990. Anti-predator defenses and ecology of neotropical forest katydids, especially the Pseudophyllinae, pp. 8-26. In: Bailey WJ and Rentz DCF. (Eds) The Tettigoniidae, Biology, Systematics and Evolution. Crawford, Bathhurst, Australia.

Brown WD, Gwynne DT. 1997. Evolution of mating in crickets, katydids and wetas (Ensifera), pp 281-314. In: Gangwere SK, Muralirangan MC and Muralirangan M. (Eds) The Bionomics of Grasshoppers, Katydids and their Kin. CAB International.

Brunner v. Wattenwyl C. 1895. Monographie der Pseudophylliden. Wien.

Castner JL, Nickle DA. 1995a. Observations on the behavior and biology of leaf-mimicking katydids (Orthoptera: Tettigoniidae: Pseudophyllinae: Pterochrozini). J. Orthoptera Res. 4: 93-97.

Castner JL, Nickle DA. 1995b. Notes on the biology and ecology of the leaf-mimicking katydid *Typophyllum* bolivari Vignon (Orthoptera: Tettigoniidae: Pseudophyllinae: Pterochrozini). J. Orthoptera Res. 4: 105-109.

Elsner N, Popov AV. 1978. Neuroethology of acoustic communication. Adv. Ins. Physiol. 13: 229-355.

Griffini A. 1898. Descrizione d'una nuova Pseudofillide del Peru e osservazioni sopra una anomalia del tipo di questa specie. Boll. Mus. Zool. Torino 13: 328: 1-5.

Gwynne DT. 1995. Phylogeny of the Ensifera (Orthoptera): a hypothesis supporting multiple origins of acoustical signalling, complex spermatophores and maternal care in crickets, katydids and weta. J. Orthoptera Res. 4: 203-218.

Hebard M. 1924. Studies in the Dermaptera and Orthoptera of Ecuador. Proc. Acad. Nat. Sci. Philadelphia 76: 109-248, pl 5-10.

Hebard M. 1927. Studies in the Dermaptera and Orthoptera of Colombia, fourth paper. Trans. Amer. Ent. Soc. 52: 275-354, pl 18-22.

Hebard M. 1933. Studies in the Dermaptera and Orthoptera of Colombia. Supplement to papers one to five. Trans. Amer. ent. Soc. 59: 13-67, pl 2,3.

Heller K-G. 1995. Acoustic signalling in paleotropical bushcrickets (Orthoptera: Tettigonioidea: Pseudophyllidae): does predation pressure by eavesdropping enemies differ in the Palaeo-and Neotropics? J. Zool. Lond. 237: 469-485.

Heller K-G. 1996. Unusual abdomino-alary, defensive stridulatory mechanism in the bush-cricket *Pantecphylus cerambycinus* (Orthoptera, Tettigonioidea, Pseudophyllidae). J. Morph. 227: 81-86.

Leroy Y. 1966. Signaux acoustiques, comportement et systematique de quelques especes de Grillidae (Orthopteres, Ensiferes). Bull. Biol. Fr. Belg. 100: 3-134.

Meyer J, Elsner, N. 1996. How well are frequency sensitivities of grasshopper ears tuned to species-specific song spectra? J. exp. Biol. 199: 1631-1642.

Montealegre F. 1997. Estudio de la fauna de Tettigoniidae (Orthoptera: Ensifera) del Valle del Cauca. Thesis, Universidad del Valle, Cali, Colombia.

Mason AC, Morris GK, Wall P. 1991. High ultrasonic hearing and tympanal slit function in rainforest katydids. Naturwiss. 78: 365-367.

Morris GK, Pipher RE. 1967. Tegminal amplifiers and spectrum consistencies in *Conocephalus nigropleurum* (Bruner), Tettigoniidae. J. Ins. Physiol. 13: 1075-1085.

Morris GK. 1970. Sound analyses of *Metrioptera sphagnorum* (Orthoptera: Tettigoniidae).

Morris GK, Pipher RE. 1972. The relation of song structure to tegminal movement in *Metrioptera sphagnorum* (Orthoptera: Tettigoniidae). Canad. Entomol. 104: 977-985.

Morris GK, Aiken RB, Kerr GE. 1975. Calling songs of *Neduba macneilli* and N. sierranus (Orthoptera: Tettigoniidae: Decticinae). J N.Y. ent. Soc. 83: 229-234.

Morris GK, Gwynne DT. 1978. Geographical distriubution and biological observations of *Cyphoderris* (Orthoptera: Haglidae) with a description of a new species. Psyche 85: 147-167.

Morris GK, Beier M. 1982. Song structure and description of some Costa Rican katydids (Orthoptera: Tettigoniidae). Trans. Amer. ent. Soc. 108: 287-314.

Morris GK, Klimas DE, Nickle DA. 1989. Acoustic signals and systematics of false-leaf katydids from Ecuador (Orthoptera, Tettigoniidae, Pseudophyllinae). Trans. Am. Ent. Soc. 114: 215-264.

Morris GK, Mason AC, Wall P, Belwood JJ. 1994. High ultrasonic and tremulation signals in neotropical katydids (Orthoptera: Tettigoniidae). J. Zool. Lond. 233: 129-163.

Morris GK, Mason AC. 1995. Covert stridulation: novel sound generation by a South American katydid. Naturwiss. 82: 96-98.

Morris GK. 1998. Song in Arthropods. In: Knobil, E. and Neill, J.D. (Eds) Encyclopedia of Reproduction. Academic Press, San Diego.

Morris GK, Willemse F. (in prep.) Songs and systematics of some Tettigoniidae (Orthoptera, Ensifera) from Papua New Guinea.

Nickle DA. 1983. A new species of pseudophylline katydid from Cocos Island, Costa Rica (Orthoptera: Tettigoniidae). Ent. News 94: 1-6.

Otte D. 1992. Evolution of cricket songs. J. Orthoptera Res. 1: 25-49.

Pierce GW. 1948. The Songs of Insects. Harvard Univ. Press, Cambridge, Mass.

Ragge D.R. 1955. The wing-venation of the Orthoptera Saltatoria with notes on dictyopteran wing-venation. Br. Mus. Nat. Hist., London.

Rentz DCF. 1979. Comments on the classification of the orthopteran family Tettigoniidae, with a key to subfamilies and description of two new subfamilies. Aust. J. Zool. 27: 991-1013.

Robinson MH. 1973. The evolution of cryptic postures in insects, with special reference to some New Guinea Tettigoniids (Orthoptera). Psyche 80: 159-165.

Sales G, Pye D. 1974. Ultrasonic communication by animals. Chapman and Hall, London.

Suga N. 1966. Ultrasonic production and its reception in some neotropical Tettigoniidae. J. Ins. Physiol. 12: 1039-1050.

Vignon MP. 1931. Recherches sur les Sauterelles-feuilles de l'amerique tropicale. Arch. Mus. Hist. Natur. 5: 57-214, 12 plates.

Walker TJ. 1975. Stridulatory movements in eight species of *Neoconocephalus* (Tettigoniidae). J. Ins. Physiol. 21: 595-603.