Sound Production in the Domino Damselfish, *Dascyllus trimaculatus* (Pomacentridae) under Laboratory Conditions

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It appears that many of the pomacentrids produce sound in courtship and defending territory (e.g. Moulton, 1958; Myrberg, 1972a, b; Myrberg and Spires, 1972; Myrberg *et al.*, 1978; Spanier, 1970, 1979). Much works on acoustic behavior of the fishes have been published on the genera *Eupomacentrus* and *Amphiprion*. That of the *Dascyllus trimaculatus*, a species commonly found in the coral reef area in southern Taiwan, was studied only by Spanier (unpublished data). The purpose of the present note is to analyze the physical parameters (e.g. frequency, energy distribution and temporal arrangement of pulses) of the *D. trimaculatus* sounds produced under laboratory conditions.

Materials and methods

Ten live specimens of *D. trimaculatus* (body length ranged from 6.8–11.2 cm; one female and 9 males) were held in aquarium (120 cm×45 cm×60 cm) containing some coral clumps and rocks. Sound recordings were made under two

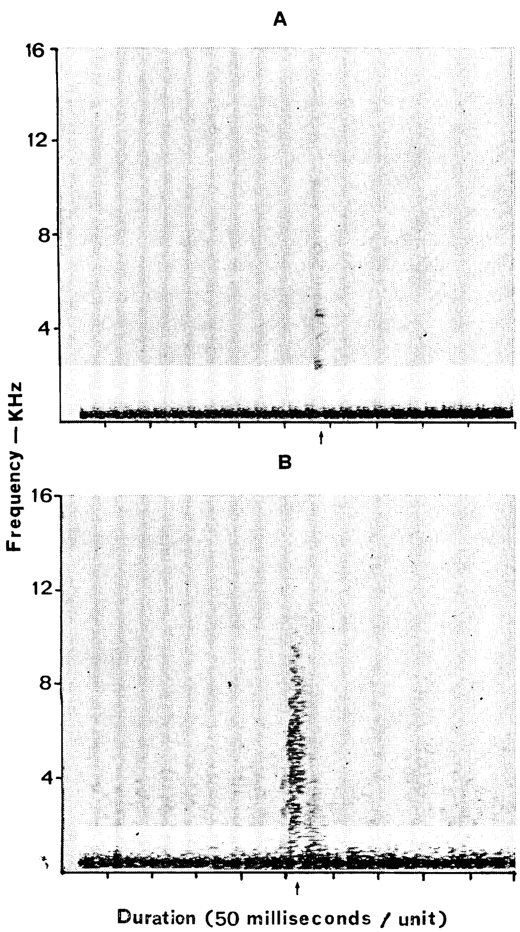

Fig. 1. Sonagrams of pop. A, recorded under the first condition (see text for explanation). B, recorded under the second condition. Arrows indicate this sound.

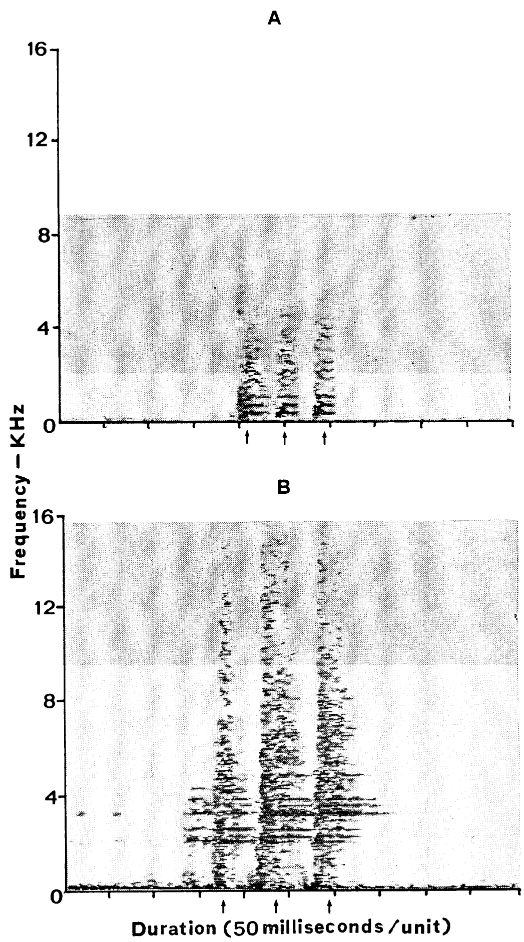

Fig. 2. Sonagrams of chirp recorded under the first condition. A, frequency range below 10 KHz. B, frequency range up to 16 KHz. Arrows indicate pulses of this sound.

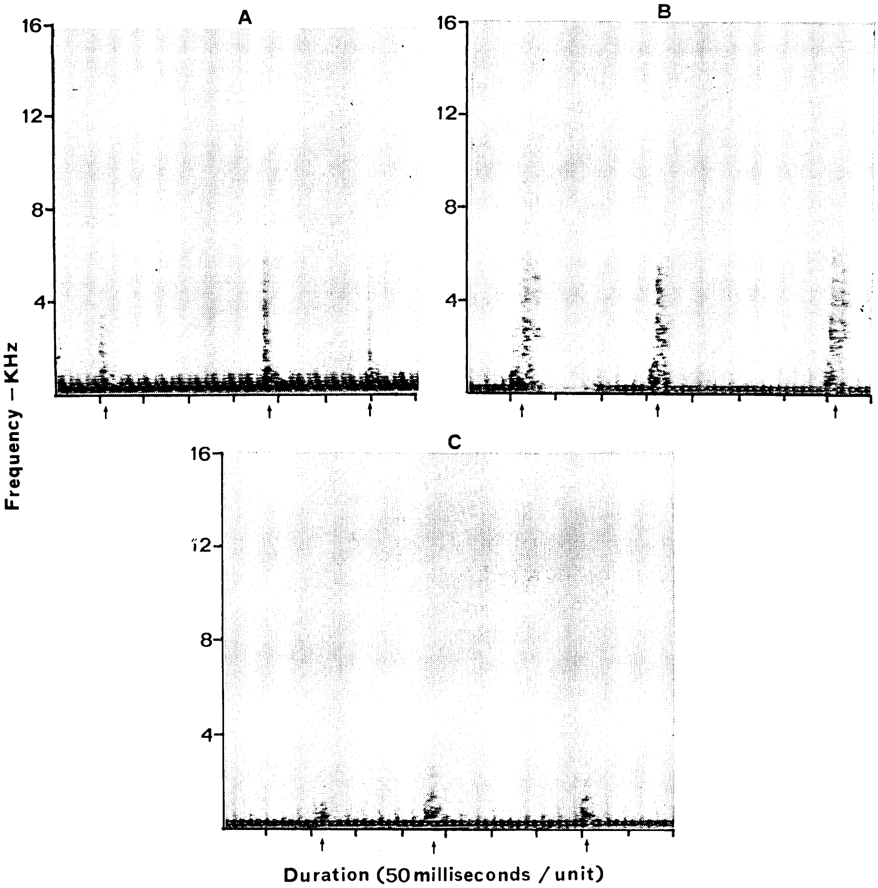

Fig. 3. Sonagrams of grunt. A, recorded under the first condition. B–C, recorded under second condition. Arrows indicate pulses of this sound.

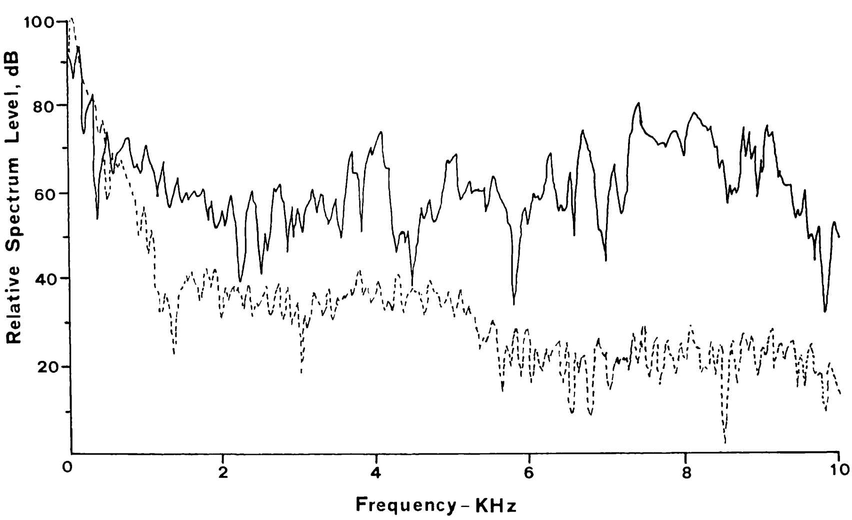

Fig. 4. Spectra of one pulse in chirp and background noise recorded under the second condition. Solid line is pulse, doted line is background noise.

conditions: 1) hydrophone placed in glass aquarium, 2) hydrophone placed in aquarium in which wooden boards were put against the inner walls to reduce sound reflection from the glass. A hydrophone (Inter Ocean System, Inc., Model 902) and a cassette recorder (Pioneer, Model SK-404F) were used to record the sounds which were analyzed by using a digital Sona-Graph (Kay Elemetrics Corp., Model 7029A) and a high resolution signal analyzer (Brüel & Kjaer, Type 2033).

Results

Three types of *D. trimaculatus* sounds were recorded: 1) the pop, composed of a single pulse (Fig. 1); 2) the chirp, composed of a series of pulses and time interval between pulses was 8–16 msec (Figs. 2, 6); 3) the grunt, composed of a series of pulses and time interval between pulses was 100–200 msec (Fig. 3). Duration of the pulse in these sounds ranged from 13 to 55 msec (sample size 17; Figs. 2, 3, 6). The sounds received in the two recording conditions were rather similar in frequency. The frequency range of the pop, chirp and grunt was mostly up to 10 KHz with dominant energy around 4–8 KHz, but in very rare occasion frequency of chirp and grunt could range below 5 KHz or up to 16 KHz (Figs. 1–5). To understand the temporal change of energy distribution in frequency, three spectra were obtained by scanning a single pulse of a grunt recorded under the second condition (Fig. 5B–D). At the on set of the pulse, more energy appeared around 7 to 9 KHz (Fig. 5B). Subsequently, dominant frequency dropped from that range to one covering almost continuously from 4 to 8 KHz (Fig. 5C, D). Number of pulses in a chirp and grunt ranged from 3–6 (sample size of chirp was 3 and grunt was 4). Sound intensity of the pulse descended rapidly with time (Fig. 6).

Discussion

The bicolor damselfish (*Eupomacentrus partitus*) produce three types of courtship sounds, i.e. chirp, long-chirp, and grunt with a series of pulses and the pop composed of a single pulse in agonistic encounter, both in the laboratory and the field (Myrberg, 1972a). The differences in these courtship sounds of *E. partitus* were number of pulses and time interval between adjacent pulses. Number of pulses in chirp, long chirp and grunt

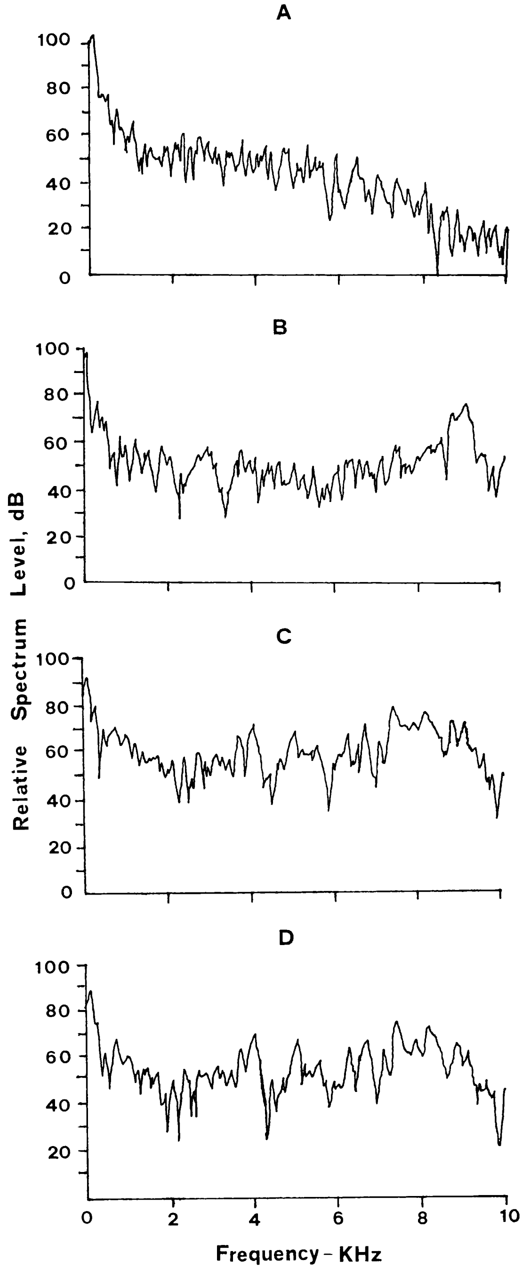

Fig. 5. Sequential spectra of one pulse in chirp recorded under the second condition. A, background noise. B–D, sequence of one pulse.

were 3, 5 and 4, respectively. Time interval between adjacent pulses in chirp and long-chirp was shorter than that in grunt. Sea anemone fishes (e.g. *Amphiprion xanthurus* and *A. polymnus*) produce threatening, fighting and submissive

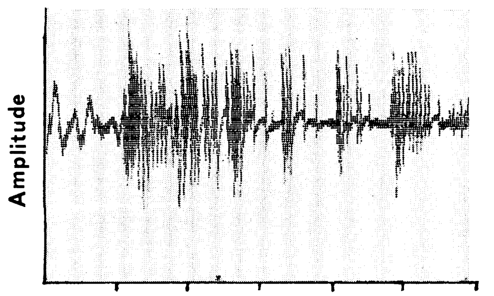

Fig. 6. Waveform of one chirp recorded under the first condition.

sounds (Schneider, 1964). These sounds are distinguishable on the basis of duration, being 25 to 30 msec, 45 to 60 msec, and 250 to 400 msec, respectively for *A. xanthurus* and 12.5 to 20 msec, 22 to 30 msec, and 90 to 120 msec for *A. polymnus*. It is clear that submissive sound is the longest one and the threatening sound is the shortest one. According to our observations, the sound types of *D. trimaculatus* could occur when one fish chased the others. No indication of courtship was noted throughout the study and therefore these sounds of *D. trimaculatus* could be considered agonistic sound. Since there was no observable indication showing which fish produced a particular sound, we were unable to comment if both male and female emitted sound. However, we believe that both sexes are possible producers of agonistic sound. If all the *D. trimaculatus* sounds described above were considered agonistic, grunt may be a submissive sound and chirp, which was the most common type recorded in the present study, may be a threatening one. The actual functions of these sound types remain to be studied by close observation during agonistic interaction. The frequency and energy distribution of the sound of *D. trimaculatus* and *E. partitus* were different. For *E. partitus* energy spread mostly below 2.4 KHz with the dominant energy range located around 600 Hz (e.g. Myrberg, 1972a, b; Spanier, 1979), while that of the *D. trimaculatus* were much higher (see above). The reason for these spectral differences may be due to the dissimilarity in sound producing mechanism or a result of artifact due to difference in recording conditions. The sound producing mechanism in *D. trimaculatus* was discussed by Spanier (1970) who believed that grating of the epipharyngeal against the hypopharyngeal plates produces sound, which is resonated through the adjacent air bladder. The stridulatory sound usually spread over a wider frequency range tilting toward a higher frequency than other ways of sound production (Fine *et al.*, 1977). No comments on the sound producing mechanism in *E. partitus* are noted in literature. Due to the *E. partitus* sounds were recorded in laboratory and natural conditions (see above), it becomes more plausible that the producing mechanism may account for the above difference.

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ミツボシクロスズメダイの発音

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スズメダイ科魚類の多くが求愛やテリトリー保持のため音を発することが明らかにされている．クロソラスズメダイ属やクマノミ属の音響生態についての研究が報告されている．台湾ではサンゴ礁域で普通に見られるミツボシクロスズメダイのそれは Spanier（未発表）によって研究されただけである．この報告では実験室での飼育状況下で発生したミツボシクロスズメダイの音の物理的性質（周波数・強度分布・パルスの発生状況）を明らかにすることを目的とする．