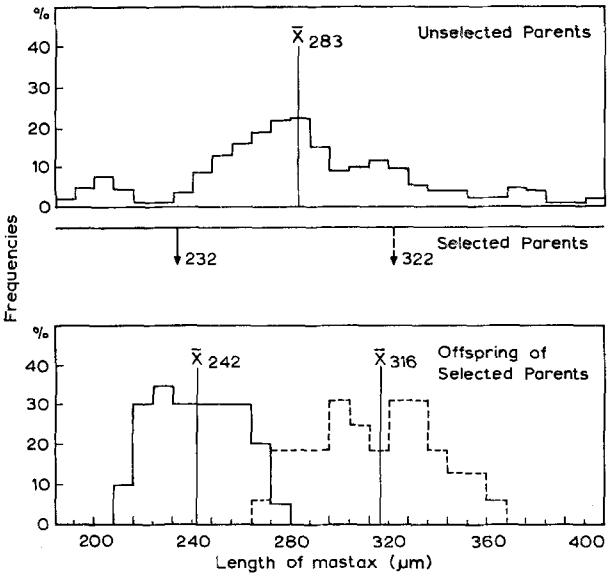

Fig. 2. Results of selection experiments in Line 3.

For this study a metric character was chosen, the length of mastax (m) (Figure 1), which a preliminary investigation showed to be in linear and positive correlation ($r = 0.29$; $t_{93} = 2.92$; $p \ll 0.01$) with the length of the adult animal. Actually, its growth can be considered practically negligeable from birth on.

The results of selection experiments, which were controlled with normal statistical methods, are summarized in the Table and are illustrated by Figure 2. They definitely demonstrate a genetic origin of the phenotypic variability which is observed in parthenogenetic lines of *Asplanchna*. Therefore the results support the working hypothesis, and the parthenogenetic lines cannot be regarded as clones.

It is thus possible to explain in terms of population genetics the classic phenomena of cyclomorphosis and appearance of mictic females. In fact, assuming that in Rotifers there is some mechanism of recombination, whether endomeiosis, as reported by COGNETTI[13] for Aphids, or somatic crossing-over, both cyclomorphosis and the alternance of amphigonic and parthenogenetic generations can be interpreted as different expressions of balanced polymorphism. Research along such lines is in progress.

Riassunto. Lo studio dell'ereditabilità di un carattere metrico (la lunghezza del mastax) e le relative esperienze di selezione dimostrano l'origine genetica della variabilità fenotipica riscontrabile in ceppi partenogenetici di *Asplanchna sieboldi* (Rotatoria). I risultati ottenuti suggeriscono un'interpretazione analoga per il ciclo sessuale e la ciclomorfosi.

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Non-Intentional Sound Production in a Cichlid Fish (*Haplochromis burtoni*, Günther)

Social communication in the Cichlid fish has been of interest to ethologists for many years. The brightly colored markings of these fish are an obvious means of visual communication and have been studied in several species[1-3]. Much less well studied, however, are the chemical and auditory signalling systems. We are particularly interested in the importance of these other systems in determining the behavioral activities of the African mouthbrooding Cichlid, *Haplochromis burtoni*. The behavioral activity elicited by the species-specific colour patterns has been studied in detail[4,5]. Studies of chemical communication are in progress (personal communication, CRAPON DE CAPRONA).

In this report, we describe experiments designed to test whether sound is also used by *Haplochromis burtoni* as a means of intraspecific communication.

Materials and methods. A 150 l aquarium with a gravel floor, some rocks and plants was placed in a quiet, isolated room. Water temperature was kept at 26° ± 1 °C. A hydrophone (Type 2, Krupp Altas Electronic, Bremen) was set up in the middle of the tank and the excess cable buried under the gravel. The hydrophone was connected through a pre-amplifier to an Uher Royal De Luxe tape recorder and monitored through earphones during observations. An incandescent overhead light was installed to minimize electrical noise. The lighting was set on a 12:12 light-dark schedule (08.00–20.00 h). Observations were made both during light and dark hours from a blind 1.2 m from the tank. Since the fish were monitored with filter, air bubbler and heater turned off, observations were kept within 90 min and usually lasted between 20 and 50 min. Selected recordings were later analyzed for frequency content with a Kay Elemetrics Co. (Pinebrook, N.J.) sound spectrograph.

In order to test the viability of the aquarium environment for sound production and recording and the sensitivity of the hydrophone, a Cichlid fish (*Tilapia mossambica*, Peters) reported to produce intentional sound[6,7], was used. 3 males and 3 females were tested. 'Drumming' sounds, as described by RODMAN and MARSHALL, were heard from the adult males during courting or threatening behaviour. These sounds were recorded and analyzed with the sound spectrograph and the spectral content found to be comparable to that published by RODMAN.

Twenty-five *Haplochromis burtoni* were observed and monitored for a total of 19 h in situations including: females alone; females with adult males; adult males

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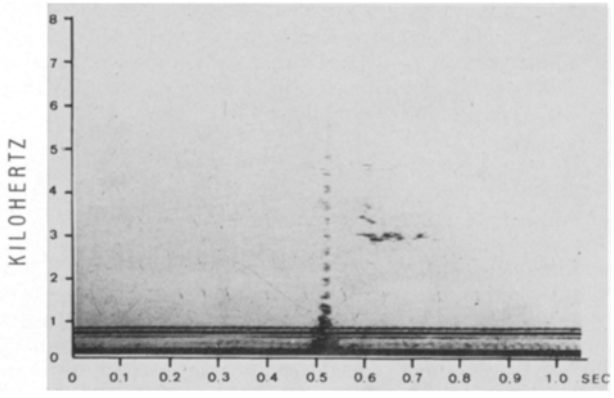

Fig. 1. A hydrodynamic 'whipping' noise made by a male *Haplochromis burtoni* during a rapid, acute turn.

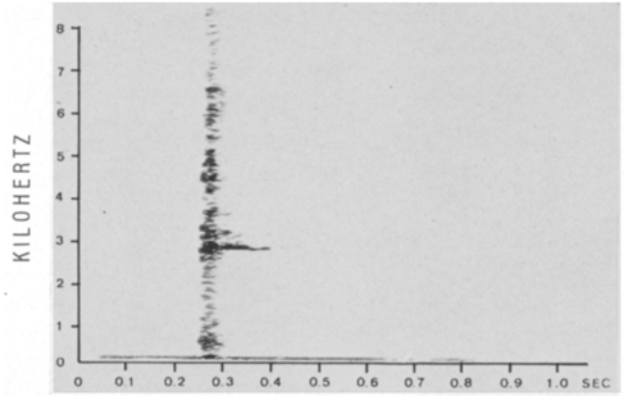

Fig. 2. Sound of a male *Haplochromis burtoni* biting another male during territorial fighting.

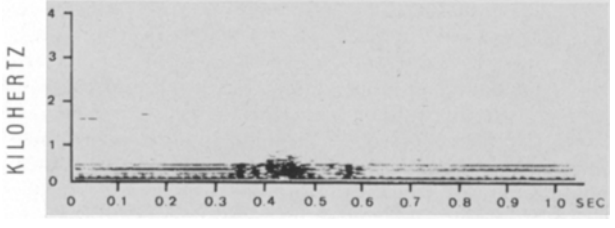

Fig. 3. Sound made by a male *Haplochromis* during courting when the anal fin is rapidly vibrated in front of a female.

visually isolated from females; adult males separated from females with a glass partition; females with juveniles; females, adult males and juveniles (a normal colony situation during which spawning was also observed and monitored); and females with newly hatched young. Some of these situations were chosen on the basis of other observations[6–12] which reported intentional sound production most prevalent during reproductive and aggressive activities. Other situations were chosen to see whether auditory communication was used when visual and tactile communication was not possible.

Results. The entire known repertoire of behaviour patterns for *Haplochromis burtoni* was observed during the experimental period and the sounds recorded. Several different types of sounds were heard, all of which, without exception, were correlated with some physical activity of the fish. Figure 1 shows a spectrogram of a hydrodynamic sound associated with a 'whipping' noise generated by a fast acute turn[13]. This is most likely generated by the fins. In Figure 2 the spectrogram of sounds is produced by biting during male to male fighting. The rapid vibration of the anal fin during courting was correlated with the sound shown in the spectrogram in Figure 3. These sounds appear to be incidental to other behaviour and do not always occur during conspecifically directed activity (e.g. feeding, gravel sifting, digging and chafing).

Conclusions. It seems unlikely that these sounds are used for purposeful communication. As defined by MOULTON[8], intentional or purposeful sounds are '... those produced by organs especially adapted for sound production, or actions of muscles and skeletal parts which create vibrations of the gas of the air bladder'. *Haplochromis burtoni* have physoclistous (closed) type air bladders[14], but it has not been demonstrated that they have musculature to vibrate this bladder. Furthermore, the sounds produced by Haplochromis burtoni are quite different from those heard in the *Tilapia mossambica*. In the latter, the intentional sounds produced are in a narrow frequency range (2 kHz) and of long duration (up to 3 sec). In contrast, the *Haplochromis burtoni* sounds strongly suggest a mechanical source of short duration. Further, it is interesting to note that the spectral content of the mechanical sounds of the *Haplochromis burtoni* are quite similar to those recorded from the *Tilapia mossambica*. Therefore, although the sounds produced by *Haplochromis burtoni* may communicate its presence, it is unlikely that they serve the purpose of intentional communication[15].

Zusammenfassung. Wir haben die akustischen Signale bei sozialem Verhalten der afrikanischen Cichliden-Fische, *Haplochromis burtoni* untersucht. Wir fanden keine Beweise dafür, dass diese Signale eine Kommunikationsfunktion haben.

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