Preliminary Study of Behaviour and Sound Emitted by European Spiny Lobster *Palinurus Elephas* During the Interaction with Predators

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ABSTRACT

In this work it was analyzed the antipredatory behaviour of the European spiny lobsters (*Palinurus elephas*) in presence of two natural predators: the European conger eel and the common octopus. Behaviour of lobsters and predators was audio-video monitored using water-proof cameras and a pre-amplified hydrophone. Analysis of the data allowed the study of the antipredatory behavioural events (including the sound emissions) of lobsters exposed individually or in groups to a single specimen of predator. No antipredatory behavioral events were observed during the control phase, neither acoustic signals audible by the operator were emitted. Predators used to attack mainly the groups of lobsters. During the test phase, indeed, the most frequent behavioral events were the Alert (a kind of behavior, never described) the Point and the Whip while the Tail Flip and the Lunge were mainly associated to the sound emissions. Although uncertainties still remain about the function of acoustic emissions, is possible to hypnotize that these sounds represent an integral part of defense mechanisms against the predators.

Author Keywords

Lobster, behaviour, acoustics emission, predator.

INTRODUCTION

The Mediterranean lobster (*Palinurus elephas*) shows a antipredatory behaviour in response to an imminent threat [5,1,2,8]. This behaviour could also comprise acoustic emissions, associated to other defence-related behavioural events or not, even if the motivational mechanisms determining this antipredatory attitude are not entirely known [4,7,6,9]. The aim of this work was to analyze European spiny lobster antipredatory behavioural events (*Palinurus elephas*) in relation to acoustic emissions, in presence of natural predators. The octopus, in fact, is an active predator of spiny lobsters [2] and the conger eel is known as a voracious predator of fish, cephalopods and crustaceans [3]. Consequently, this study employed the European spiny lobster (*Palinurus elephas*), the European conger eel (*Conger conger*) and the common octopus (*Octopus vulgaris*).

METHODS

The study was carried out using 50 European spiny lobsters, 5 European conger eels and 5 common octopuses. 20 experimental trials in total were carried out in a circular tank (3.0 m diameter), 10 of which with single lobsters (five with an octopus and five with a conger eel) and 10 (five by each predator) with groups of four lobsters. After an hour of acclimation, lobsters were monitored by an audio-video system for one hour without predators (**control phase**); then, a solitary predator was introduced into the tank and the monitoring was carried out for one hour (**test phase**). Visual monitoring was carried out using two water-proof cameras, the first one located on the bottom of the tank and the second one upon the tank. Signals coming from the video cameras and from a pre-amplified (VP1000, Reson, Slangerup, Denmark) hydrophone (8104, Bruel & Kjer, Nærum, Denmark) were synchronized and digitalized by DV-RT4 Real Time (D-Vision) card, managed by the DSE D-Vision (Torin, Italy) software. Audio-video files were analyzed in continuous and each behavioral event observed was noted. Eventual acoustic emission, associated to the other behavioral events, was also recorded. Behavioral events were identified and recorded on the basis of the general scheme proposed by Lavalli & Herrnkind [8] modified by the authors (Table 1). Moreover, a kind of

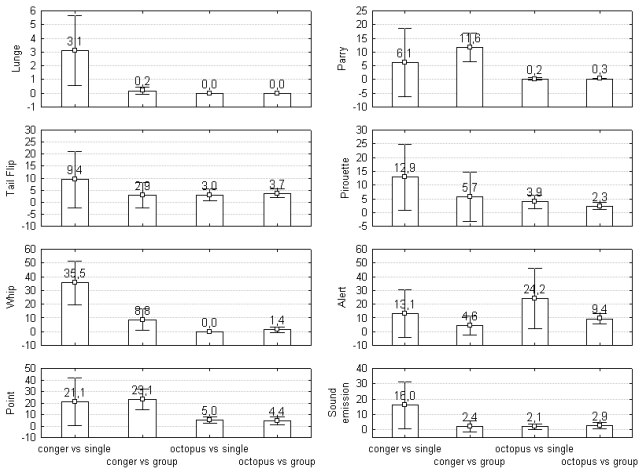

Figure 1. Mean number of antipredator behavioural events (n/h-1 ± standard deviation) of lobsters per test typology with predators.

behavioral event, never described before and named *Alert*, was recorded during the experiment. The entire work presented here complied with current regulations regarding animal experimentation in Italy.

RESULTS

During the control phase, no antipredatory behavioral events reported in the Table 1 were observed for all the lobsters, neither acoustic signals audible by the operator were emitted by the lobsters.

During the test phase, in relation to predator attacks, many behavioral events were observed and the most frequent of which were the Alert, the Point, and the Whip, respectively (Figure 1). Predators used to attack mainly the groups of lobsters and the conger eels carried out more predation attempts than the octopuses. In total, 2433 behavioural events were recorded of which 239 (10%) were Sound Emissions. (Table 2). Moreover, a positive relation was found between the total number of predator attacks and the total number of the acoustic emissions of lobsters, both individually and in group (Figure 2).

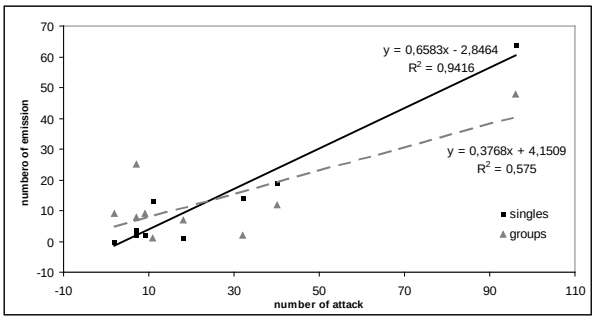

Figure 2. Linear correlation between the total number of predator attacks (both octopuses and conger eels without distinction) and the total number of acoustic emissions of the lobsters, both in the test in single and in group.

Lobster Event			
Alert	**Point**	**Parry**	**Whip**
The lobster points towards the direction of predator with the antennae, rising the legs and the telson.	One or both antennae of the lobster move towards in the direction of the predator.	The tip or side of an antenna of the lobster makes contact with some part of the predator.	The lobster strikes the predator with either one or both antennae.
Pirouette	**Tail Flip**	**Lunge**	**Sounds**
The lobster turns on the spot with the antennae in the direction of the predator.	The lobster makes a rapid flexion of the extended abdomen, one or more times.	The lobster's antennae are swept together rapidly in front of the predator.	The lobster emits a single or multiple audible acoustic signal.
Predator Action			
Attack	The predator moves directly towards the lobster to within one antenna's length.		

Table 1. General scheme proposed by Lavalli and Herrnkind (2009) modified by the authors: description of the behavioural events of the European spiny lobster and predators.

CONCLUSION

The present study pointed out an important relation between the lobster anti-predatory behavioral events and the sound emissions. This relation is more evident in the Tail flip and in the Lunge, that represent the behavioral events displayed by lobsters when in extreme danger of predation (the Tail flip is a quick removal from the predator, while the lunge is the quick move toward the predator). Although uncertainties still remain about the function of acoustic emissions and the identity of the targets of these emissions (as the majority of marine predators is not able to perceive lobsters' emission frequencies, Buscaino et al. unpublished data), it is possible to hypnotize that the sounds represent, in association with other behaviors, an integral part of the defense mechanisms against the predators. Moreover, we described a behavioural event for which there is no evidence in the literature, which was called *Alert* and observed that the effectiveness of the "controlling" behavioural events (using with an higher frequency Alert, Point and Whip) reduce the frequency of the "last attempt" events (Tail Flip, Lunge).

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	Tail Flip	Lunge	Parry	Whip	Point
Total number of events	185	15	386	352	595
Event with sound emission (% of total)	140 (76)	8 (53)	52 (13)	37 (11)	2 (0.3)
Event without sound emission (% of total)	45 (24)	7 (47)	334 (87)	315 (89)	593 (99,7)

Table 2. Audible sounds emitted by the lobsters in association behavioral events recorded during the test phase.

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