

Original Article

## Biological control of incrusting organisms and sediments in Chilean oyster cultures

Controle biológico dos organismos incrustáveis e sedimentos em culturas de ostras Chilenas

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### Abstract

The oyster culture has the incrusting organism as problem for production, in this context, it evaluated as biological control against incrusting organism and sediments the introduction of gastropod *Tegula atra* (Lesson, 1830) in Chilean oysters (*Triostrea chilensis* Phillippi, 1844) cultures in conditions of starvation presence and absence located in floating cages and bottom cultures. The predation and mechanic effect on *T. atra* grazing generated a decreasing in seven days of 19.8% and 13.7% of incrusting organisms in cage culture and bottom sediments by effects of gastropods without starvation respectively. Whereas it had a decrease of 12.6% and 11.4% of incrusting organisms in cage culture and bottom sediments by effects of gastropods with starvation respectively. The incrusting organism removed were mainly algae, colonial ascidia, polychaeta, bryozoan and small crustaceans.

**Keywords:** oyster culture, *Triostrea chilensis*, *Tegula atra*, biological control.

### Resumo

A cultura da ostra tem como problema de produção o organismo incrustante, neste contexto, avaliou como controle biológico contra organismos incrustantes e sedimentos a introdução do gastrópode *Tegula atra* (Lesson, 1830) em culturas de ostras chilenas (*Triostrea chilensis* Phillippi, 1844) em condições de presença e ausência de fome, localizadas em gaiolas flutuantes e culturas de fundo. A predação e o efeito mecânico no pastejo de *T. atra* geraram uma diminuição em sete dias de 19,8% e 13,7% dos organismos incrustantes na cultura em gaiola e nos sedimentos de fundo, por efeito de gastrópodes sem fome, respectivamente. Considerando que houve decréscimo de 12,6% e 11,4% dos organismos incrustantes na cultura em gaiola e nos sedimentos de fundo pelos efeitos dos gastrópodes com fome respectivamente. Os organismos incrustantes removidos eram principalmente algas, ascídias coloniais, poliquetas, briozoários e pequenos crustáceos.

**Palavras-chave:** cultura de ostras, *Triostrea chilensis*, *Tegula atra*, controle biológico.

### 1. Introduction

One of the main limitant factors in oyster culture is the presence of incrusting organism (fouling) and sediments in cultured species and their respective culture systems (Arakawa, 1990; Guenther et al., 2006; Kishore and Southgate, 2016; Sievers et al., 2017).

The oyster culture has problems due the incrusting organism and sediments depletion and physic-chemical and biological prevention procedures (Sievers et al., 2017), such as natural control in example predators (Lodeiros and García, 2004) that would have interesting

projection in shellfish farmings, because these procedures would not generate environmental pollution, that is a disadvantage if it is used physic-chemical methods, and it is a cheap method in comparison to hand extraction (Lodeiros et al., 2018).

It is necessary the control procedures against incrusting organism and sediments that affect the oyster culture in Chile, in this context, the aim of the present study is analyse the capacity of gastropod *Tegula atra* (Lesson, 1830) as potential biological control considering their herbivore diet (Viviani, 1975), that also it does not has predator or competitor for cultured oysters, and it has

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the advantage of wide geographical distribution among rocky shores in Chile and it is easy to collect (Castilla & Paine, 1987; Osorio & Reid, 2002; Moreno and Jaramillo, 1983; Moreno et al., 1984; Castilla and Duran, 1985; Castilla et al., 2014).

## 2. Material and Methods

It used adults specimens of *T. atra*, that were utilized in two experiments, in the first it distributed 4 kg of individuals in 10 suspended hangings from a raft, and similar *T. atra* quantity in 10 hangings over the substrate. In the second experiment, the *T. atra* specimens were starved previously during five days. As control, 10 hangings were used in both experiments. The experiment was done in Apiao island close to Chiloe Island (42° 36' S; 73° 12' W).

For *T. atra* addition in to hangings by raft, was utilized two plastics trays by experiment, that were put at 1, 3 and 5 m depth to generate a *T. atra* homogeneous distribution in the hangings and around the trays. They were located in the ten hangings. In each tray were deposited 2 kg of *T. atra* (191 ind/kg average).

For hangings in the bottom, these were put in parallel, and perpendicular to the coast, and it put 2 kg of *T. atra* at similar height of the hangings, and 2 kg in the posterior extreme. Each hanging was individualized and weighted at begin and end of the experiment, without *T. atra* it was used the same procedure for control hangings.

For estimate the differences between, initial and end weight in each hanging, it utilized the pair block test (Sokal and Rohlf, 1995), and for estimate the effects between treatments (*T. atra* starved and non-starved), considering the initial total weight the percentage average in incrusting organism and sediments. For this purpose, data were angular transformed for obtain normality and homocedasticity as previous condition for apply one-way ANOVA (Zar, 1999), all statistical analysis were applied with Software SPSS 12.0.

## 3. Results

The hanging weight previous to *T. atra* introduction was constituted by 59.4% oysters, 36.4% of incrusting organisms and 4.2% of hanging materials (valves, PVC). The main incrusting macroscopic organism were mainly sponges, bryozoan, mytilids, polychaeta, colonial ascidia, tunicates, small crustaceans and algae (Table 1). Between three and four days after experiment beginning the *T. atra* totality deposited in hangings were displaced to the hangings in a number between 60-80 individuals by hanging, and they consumed many of the incrusting organism and sediments. At fifth day, *T. atra* individuals began to detach the hangings, that agree with the incrusting organism and sediments decreasing caused due *T. atra* scrapper. At seventh day, the *T. atra* detachment was 82% as average, and the unique macroscopic incrusting organism were mytilids and the tunicate *Pyura chilensis*.

It was not observed incrusting organism and sediments removal in control hangings, but, in hangings with *T. atra*

addition, the incrusting organism and sediments removal was significant notorious (Figure 1). The pair block test applied for compare weight loss experimented due *T. atra* grazing shown that is significant ( $p < 0.01$ ) in each hanging with *T. atra* starved and non-starved in rafting and bottom culture (Table 2).

The weight loss recorded in first experiment (with *T. atra* starved) considering the incrusting organism weight and sediments present in hanging was 46%, whereas in second experiment (with *T. atra* non-starved) was 33%. The results of ANOVA revealed significant differences ( $p < 0.01$ ).

## 4. Discussion

*T. atra* introduction in oyster hangings also or remove existent flora, it remove significantly important sediment and macroscopic incrusting fauna, the mechanism is difficult to determine, nevertheless, the grazing action would remove small fauna, that would generate removal of potential predators of these small fauna (Margalef, 1998).

Incrusting organism detachment from hangings such as crustacea and polychaeta, was probably by *T. atra* consumed the algal community and sediments that sustain these organisms, similar to the descriptions of Paine (1969), who described the grazing activity of *T. funebris* on epiphyte diatoms and brown algae (kelps) that are located in intertidal zones. Whereas, probably the sessile fauna removal such as bryozoan, sponges and colonial ascidia would be explained due *T. atra* grazing or mechanic grazing action. These results would be similar to observations for Chilean intertidal rocky shores (Jara & Moreno, 1984; Aguilera & Navarrete, 2011; Castilla et al., 2014).

The minor effectivity observed by *T. atra* located in hangings probably due sediments present in hanging has a disposal of dragged algae due stream action that are entangled to the hangings such as was observed for algae of *Ulva* genus, that was adhered during the present experiment into hangings, that were grazing by *T. atra*, decreasing proportionally the *T. atra* effectivity incrusting organism and sediment removal from the hangings.

The observed differences obtained in both experiments would suggest that *T. atra* voracity affect the effectivity of them for organism incrusting and sediment removal during a determined time interval, probably starvation generate minor effectivity, and it would generate predation on organism that in optimal physiological conditions are not preferred.

*T. atra* has a rapidoglose radule that allow macroalgae and microalgae grazing (Reyes et al., 2001), it is mainly a macroalgae herbivore, and epiphyte such as diatoms and invertebrate scappers. The *Tegula* feeding alimentation described it as grazer, that consumpt by action or omission invertebrates, similar to the results obtained in the present study, and on this basis, *T. atra* would be omnivorous. *Tegula* predate on many items, such as macroalgae fragments, foraminifera, dinoflagellates, invertebrate appendices, sponge spiculae, invertebrate larvae, and parasite swarms (Hidalgo et al., 2013). From

**Table 1.** Flora and fauna associated to oyster culture.

FAUNA		FLORA	
Porifera:	Porifera non-identified	Chlorophyta:	<i>Enteromorpha Ulva</i>
Briozoos	<i>Bugula neritina</i>	Phaeophyta:	<i>Macrocystis</i>
Brachiopoda	Brachiopoda non-identified	Rhodophyta:	<i>Pulysiphonia</i>
	Nudibranch		
	<i>Plaxiphora carmichaelis</i>		
	<i>Crucibulum quiriquinae</i>		
	<i>Crepidatela dilatata</i>		
Mollusca:	<i>Aulacomya ater</i>		
	<i>Semimytilus alghosus</i>		
	<i>Choromytilus alghosus</i>		
	<i>Chlamys patagonica</i>		
	<i>Entodesma sp</i>		
	Nereidae		
Annelida	Terebellidae		
	Polychaeta non identified		
	Cirripedia		
	Amphipoda		
	<i>Botaeus truncatus</i>		
Arthropoda:	<i>Nauticaris magallanica</i>		
	<i>Halicarcinus planatus</i>		
	<i>Pilomoides perlatus</i>		
Echinodermata:	<i>Loxechinus albus</i>		
	<i>Piura chilensis</i>		
Chordata:	Colonial ascidia non identified		

**Table 2.** Incrusting organism and sediments removal from oyster hanging by *T. atra* grazing effect.

Sytems	n (hangings)	Starved				Standard error
		Initial weight (kg)	Final weight (kg)	Weight difference (kg)	Weight difference (%)	
Raft	10	89.8	72.0	17.8	19.8	0.10
Bottom	10	102.3	88.3	14.0	13.7	0.11
		<b>Non-starved</b>				
Raft	10	93.0	81.3	11.8	12.6	0.10
Bottom	10	107.8	95.5	12.3	11.4	0.13

n = number of observations for each treatment.

macroalgae, the presence of Chlorophyte (two genus and two non identified), Rhodophyte (one genus) were identified, about Diatoms were identified four genus and 52 species (Perez, 2010). *T. atra* graze mainly on brown algae such as *Macrocystis pirifera* and other algae such as *Ulva* sp. (Chlorophyta), and *Mazzaella laminaroides* (Rhodophyta) (Pinochet et al., 2018).

In Chile, there are not records of work related with gastropod use as biological controls on incrusting organisms and sediments in oyster hangings and the information related to other countries is scarce. In this context, Arakawa (1990) mentioned that potentially possibilities of biological controls that include selective grazing of some nudibranch on turbellaria, and snail feedings of the Cypraeidae and Lamellaridae families on *Botrylloides violaceus* Oka, 1927 and *B. schlosseri* (Pallas, 1766) and other colonial ascidia. Hidu et al. (1981) mentioned the crustacean *Cancer irroratus* Say, 1817 as efficient biological control in oyster cultures, nevertheless

**Figure 1.** Oyster hangings with *T. atra* presence and absence for incrusting organisms and sediments removal.

in comparison to *T. atra*, this crustacean species in an active predator on juvenile oysters.

The obtained results, and the difficult of found an animal that remove incrusting organisms without damage cultured organism (Maurin and Le Dantec, 1979), would allow that *T. atra* would be an interesting species with potentiality as biological control on incrusting fauna and sediments in oyster cultures and their respective culture systems.

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