



STUDY ABOUT THE PHYSICAL METHOD TO CONTROL OF THE DEVELOPMENT OF CIRRIPIEDIA (CRUSTACEA: MAXILLOPODA) IN ARTIFICIAL SUBSTRATES: A BIBLIOMETRIC ANALYSIS

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ABSTRACT Biological encrustation can be considered as harmful growth of the marine community on submerged surfaces. The competition of the barnacles for a place to settle is accentuated, being able to cause problems, since they are opportunistic species and their colonization in solid surfaces damages the structures. Biocides are effective at controlling them, but their applications are restricted due to environmental concerns. This article uses the bibliometric study on physical methods for barn control using the Scopus database, and the articles are surveyed by controlled indicators. The results show that the researches published between 2005 and 2014 reported that the use of ultrasound and ultraviolet radiation are the most studied methods for the control of the Balanomorpha fauna in artificial substrates submerged in marine environments. During this period, 10 papers on this topic were published. Ultrasound and UV can affect nesting, viability and behavior of barnacles, if promising in the prevention of fouling.

KEYWORDS : ultrasound; barnacle; Ultraviolet; Bio fouling

INTRODUCTION

Biological fouling in certain artificial structures can be considered as detrimental growth of the marine community on these submerged surfaces. Tommasi et al. (1972) report that biological encrustation is the growth of animals and plants on surfaces introduced into the sea, which causes damages. (Carpio et al., 2011). In this study, the use of barnacles (Cirripedia) is a notorious problem, since barnacles are opportunistic species and their gregarious colonization occupies solid man-built surfaces (Guo et al., 2011). Fouling marine organisms and their adverse effects are widely known and new processes to combat them have been widely studied (Andrade, 2010).

Biocides are effective, but their applications are restricted or banned because of environmental concerns because they kill organisms. An alternative to this problem is the use of ultrasound to prevent cipi settlement. In fluid or biological tissue, the energy transmitted by the propagation of ultrasonic pressure fluctuations can induce biological changes as a result of thermal and non-thermal effects induced by ultrasound (Brondum et al., 1998; Guo, Lee and Chaw, 2011). These authors verified that the use of irradiation with ultrasound waves was considered an effective approach to solve the problem of barnacle-induced marine fouling. For Guo et al. (2011), the effect of ultrasound on the inhibition of cipi settlement, alters exploratory behavior and reduces the size of newly metamorphized barnacles.

Another option to this combat is the ultraviolet irradiation that has microbicidal effect if it is used with sufficient intensity and time of exposure (Alexandre et al., 2008). In systems such as power plants and water treatment facilities, UV light exposure, provided by lamp banks in a main system "chamber" for sufficient time, can kill or disable the suspension of organisms that would colonize system surfaces (Piola et al., 2016). The efficacy of this UV irradiation method, even in suspended cells, is highly dependent not only on the UV intensity (energy density) but also on the exposure duration and water clarity (influenced by turbidity, suspended solids, organic) at the time of

treatment (Rajagopal et al., 2012).

This work has built a bibliographic research for the Research and Development (R & D) project entitled Development of Eco-efficient Solutions for Control of the Biofouling Process in the Termopernambuco Cooling System in Pernambuco, Brazil, developed by the researchers of the Advanced Institute of Technology and Innovation - IATI, with resources from the National Electric Energy Agency - ANEEL. Therefore, this article has as objective the collection of data on the physical methods of control of the development of Cirripedia based on the use of Ultrasound and Ultra Violet, contributing to guide the works in the area.

METHODOLOGY

The research has a qualitative and quantitative approach, having been carried out through literature review, using the bibliometric studies technique, which is an indirect data collection.

The bibliometric research method allows to intensify the knowledge in the study area related to fouling control, ascertaining which subjects related to this topic are being researched (Schmitt, Haide; Dreher, 2013). The research method employed is bibliometric, which refers to a quantitative analysis of written communication, that is, it consists of numerical analyzes of the patterns that appear in the publications and use of documents (Diodato, 1994; Muniz et al., 2011). There is a relationship between the most important works and those cited more frequently. Techniques such as Bibliometric are used to identify the most important works and authors regarding the subject researched (Muniz et al., 2011).

Researchers can use bibliometric methods to evaluate the influence of an author, for example, or to describe the relationship between two or more authors or works, which is done through the citation analysis, based on the idea that the authors cite articles that (eg, Muniz et al., 2011). In the present study, we found that the most important articles

cited in this study are the ones that are important for the development of their research.

To search the results, the Scopus database was used, and the articles were surveyed by exploring the keywords. The codes used were: control; ultrasound; barnacle; Ultraviolet, for the saturation of the articles. We chose to use the English terms to obtain more results, since the database has predominantly articles in this language. The search was made so that all publications that had the selected descriptors of the title, abstract and/ or keywords were considered.

RESULTS AND DISCUSSION

A total of 14 articles were found in the areas of ultrasound and ultraviolet, in surveys published between 1998 and 2016 (Figure 1). The authors with more publications were Guo et al. (2011 to 2014), followed by Chiang et al. (2003 and 2007); and Dobretsov et al., (2005); Gosselin; Jones (2010) and Hung et al. (2005). The largest number of papers published on the ultrasound technique was held at the National University of Singapore, while publications on UV at the University of Hong Kong.



Figure 1. Quantitative publications in the Scopus database with the descriptors: control, ultrasound, barnacle and ultraviolet

Guo et al. (2011) indicate that the reduction is the largest and the strongest cavitation in filtered water and 23 kHz frequency. This induced force can lead to physical damage leading to a higher mortality; indicating the reduction of establishment of larvae at this frequency. Guo, Lee and Chaw (2011), exposed cypr larvae at a frequency of 23 kHz, at a pressure of 22k for 30 seconds, and this exposure to ultrasound effectively reduced nesting. Guo et al. (2012) in their studies concluded that low-frequency ultrasound increases inhibition of cypr larvae, but with increasing frequency the settlement decreases. Guo et al. (2013) studied cavitation bubbles, which can be used to remove fixed barnacles. It would be more efficient if it were applied during the first stages of scale, before the formation of calcareous structures. Guo et al. (2014) found that ultrasound treatment reduced the adhesion of newly metamorphosed barnacles up to 2 days old. They suggest that treatment with ultrasound reduces the secretion of cypr footprints (adhesives), which can affect recruitment.

Chiang et al. (2003) concluded that UV-B radiation can induce ocular damage in barnacles larvae, damaging the photo tactic behavior of nauplii larvae, reducing the success of cypr larvae colonization. Chiang et al. (2007) provides evidence in the field, and although nauplii can avoid UVB irradiation by downward migration, UV energy is sufficient to cause eye damage to nauplii and impair their phototactic responses. Gosselin & Jones (2010) concluded that ultraviolet radiation (UVR) does not directly influence the selection of cypr larvae. E Hung et al. (2005) analyzed the indirect effects of UV-A and UV-B on cypr fixation, and increased UV radiation may not significantly affect recruitment of barnacles by affecting inductive larval attachment of microbial films. Dobretsov et al. (2005) concluded that RUV affects the composition of early communities of biofouling in shallow and successional waters in tropical waters, as well as colonization and mortality of single species.

CONCLUSIONS

The application of the bibliometric technique showed that the researches published between 2008 and 2016 report the use of ultrasound and ultraviolet radiation as the most studied physical methods for the control of the Balanomorpha fauna in submerged artificial substrates in marine environments. In this period, 14 studies were published that indicate ultrasound and UV to prevent and control nesting of larvae as a promising action in the prevention and control of scale.

The bibliometric analysis carried out through the Scopus database identified the articles and authors that work the most on this subject of physical methods using UV and ultrasound in the control of Cirripedia. The authors who stand out are Guo et al., Dobretsov et al., Hung et al.,

Chiang et al., And Gosselin and Jones.

Ultrasonic and UV radiation techniques can provide a non-toxic alternative to scale prevention and control. These physical methods showed a positive result in their influence on the reduction of fouling by barn biofouling.

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