



# 20 YEARS OF BIOFOULING ON BIOINC

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## ABSTRACT

In 1991 took place the first Brazilian Biofouling meeting, which included mainly the researchers of IEAPM and Marine Biology Department of the Federal University of Rio de Janeiro. In 1997 the II Biofouling, Benthic Ecology and Biocorrosion meeting (BIOINC) was officially started as a biennial event at Araraial do Cabo, Rio de Janeiro-Brazil, with several Brazilian institutions and universities, totaling 520 presentations (ca. 50 per meeting). A total of 194 studies (40%) refer to the Biofouling topic, which included four main themes: Biofilm (N = 10%), Painting + Ballast water + Imposex (11%), Natural Anti-Fouling (27%) and Ecology (52%), all performed on more than 20 national research institutions and universities (Ceará, Pernambuco, Alagoas, Rio de Janeiro, São Paulo, Paraná and Santa Catarina states) and with international collaborations (e.g. England, Oman, Sweden, Chile, USA). During the 20 years of BIOINC, the anti-fouling studies started dealing with painting with and without TBT, in situ and in lab tests, anti-fouling activity in marine organisms and other natural biocides from pepper and soy to low-emission anti-barnacle coatings, bacterial quorum sensing inhibitors preventing biofouling, chemical defense on macroalgae including molecular and cell aspects, and also the use of macroalgae on bioprospecting models and the extraction of metabolites with high economic value. The Ecology theme started on ships and experimental panels, their components as epifauna, nematofauna, incrusting algae and associated macrofauna, their interactions as competition, predation and herbivory, the ecological processes as recruitment and succession, temporal and spatial variations at different scales to multiple hypothesis tests, modeling, natural x artificial substrates, natural and induced disturbances, in situ and laboratory test with larvae, hydrodynamics, fish community associated, experimental designs, artificial reefs as reefballs, shipwrecks and oil platforms. Recent and new approaches will be discussed.



Marine biofouling is caused by the adhesion of barnacles, macroalgae and microbial slimes. It is a worldwide problem in marine systems, such as oil and gas industries, nuclear power plants and to navy industry. On ships' hulls, biofouling results in an increase in roughness, fuel consumption, hull cleaning, paint removal and repainting, and all contribute to the costs of biofouling. Because its economic implications, se-

veral experimental studies have been performed, in order to study biofouling community dynamics, antifouling products and fouling control (Figure 1). Recognizing the importance of understand biofouling dynamics and consequences, in 1991 took place the first Brazilian Biofouling meeting. It included mainly the researchers of IEAPM and Marine Biology Department of the Federal University of Rio de Janeiro.



**Figure 1. Examples of biofouling on ship hulls, experimental studies and structures.**

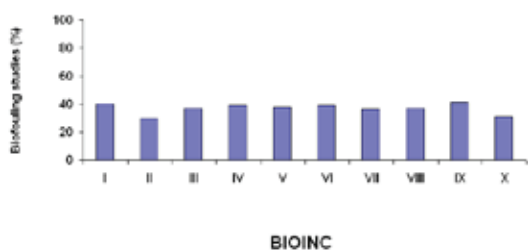
Since 1997 the II Biofouling, Benthic Ecology and Biocorrosion meeting (BIOINC) was officially started as a biennial event at Arraial do Cabo, Rio de Janeiro-Brazil, with several Brazilian institutions and universi-

ties. A total of 520 abstracts included oral and poster presentations (ca. 50 per meeting), which showed the lowest number at the last meeting (N = 30) and the highest one at the V Bioinc (N = 68) (Table 1).

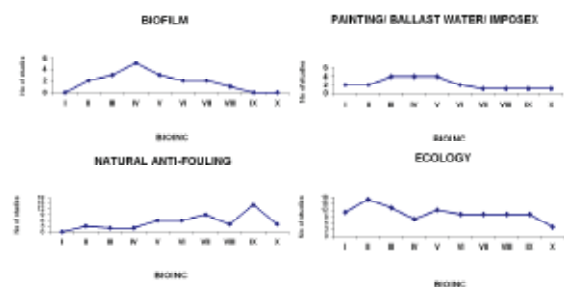
**Table 1. Total number of presentations on each Biofouling, Benthic Ecology and Biocorrosion meeting at Arraial do Cabo, southeaster Rio de Janeiro.**

- 1991: I BIOINC (N = 33)
- 1997: II BIOINC (N = 57)
- 1999: III BIOINC (N = 46)
- 2001: IV BIOINC (N = 51)
- 2003: V BIOINC (N = 68)
- 2005: VI BIOINC (N = 54)
- 2007: VII BIOINC (N = 66)
- 2009: VIII BIOINC (N = 52)
- 2011: IX BIOINC (N = 61)
- 2013: X BIOINC (N = 30)

A total of 194 studies (~ 40%) refer to the Biofouling theme on almost all the 10 meetings (Figure 2). This big topic includes four main issues: Biofilm (N = 18), Painting + Ballast water + Imposex (N = 21), Natural Anti-Fouling (N = 50) and Ecology (N = 105) (Figure 3).



**Figure 2. Percentage of biofouling studies presented at the Biofouling, Benthic Ecology and Biocorrosion meeting from 1991 (I) to 2013 (X).**



**Figure 3. Number of studies of the four main themes on Biofouling topic presented at the Biofouling, Benthic Ecology and Biocorrosion meeting from 1991 (I) to 2013 (X).**





The biofouling researches are performed on more than 20 national institutions and universities from northeast (UFCE, UFPE, UPEP, UFAL), southeast (UFF, UFRJ, UERJ, UENF, IEAPM, IOC, JBRJ, PETROBRAS, COPPE, USP, UNICAMP) and southern Brazil (UFPR, UNIVALI, FURG), and with international collaborations (e.g. University of Portsmouth-UK, Sultan Qaboos University-Oman, SP Technical Research Institute-Sweden, Duke University-USA).

During the 20 years of BIOINC, the anti-fouling studies started dealing with painting with and without TBT, in situ and in lab tests, anti-fouling activity in marine organisms and other natural biocides from pepper and soy to low-emission anti-barnacle coatings, bacterial quorum sensing inhibitors preventing biofouling, chemical defense on macroalgae including molecular and cell aspects, and also the use of macroalgae on bioprospecting models and the extraction of metabolites with high economic value (Table 2).

**Table 3. Evolutive approaches of the main research topics on ecology theme at Bioinc meeting (1991-2013).**

1991-1997	2005	2011-2013
painting efficacy TBT impact anti-fouling activity in orgs chemical ecology anti-fouling tests	pepper biocide soy biocide chemical defense (algae) painting efficacy (TIN-free)	low-emission anti-barnacle coating bacterial quorum sensing inhibitors chemical defense (algae) molecular aspects (algae) modeling for bioprospecting (algae) capsaicin and curcumin

The Ecology theme started on ships and experimental panels, their components as epifauna, nematofauna, incrusting algae and associated macrofauna, their interactions as competition, predation and herbivory, the ecological processes as recruitment and succession, temporal and spatial variations at different scales to multiple hypothesis tests, modeling, natural x artificial substrates, natural and induced disturbances, in situ and laboratory test with larvae, hydrodynamics, fish community associated, experimental designs, artificial reefs as reef-balls, shipwrecks and oil platforms.

**Table 2. Evolutive approaches of the main research topics on anti-fouling theme at Bioinc meeting (1991-2013).**

1991-1997	2005	2011-2013
biofouling program -IEAPM ships and panels components methodological approaches interactions temporal / spatial variations physiology: barnacles ecological processes artificial reefs	modeling natural and induced disturbances multiple hypothesis tests natural x artificial substrates larvae: in situ and lab tests oil platforms and shipwrecks	heterogeneity, spatial variation fish community associated biofouling on aquaculture experimental designs hydrodynamics AR: epi/infauna/fish

According to the main researchers recent and new approaches on biofouling topic include larvae tests on lab and in situ, natural x artificial substrates, artificial reefs (benthic-pelagic trophic connectivity through stable isotopes and environmental and socio-economic impacts: stakeholder perceptions) and biotechnology (modeling, bioprospecting, biomolecular issues and chemical defense).