Settlement of acorn barnacles

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Acorn barnacles in the sea

http://bestbobbob.wordpress.com/ประเภทกระดอง/เพรียงหิน-rock-barnacle/

http://board.trekkingthai.com/board/show.php?forum_id=34&topic_no=100879&topic_id=101926

http://pantip.com/topic/31118816

http://www.oknation.net/blog/rosepj/2014/02/21/entry-2

http://www.oknation.net/blog/rosepj/2014/02/21/entry-2

Biology of acorn barnacle

- Classification
  - —Phylum Arthropoda
    - Class Crustacean
      - —Subclass Cirripedia
      - —~1,000 species
        - »*Balanus amphitrite*
        - »*Semibalanus balanoides*
        - »*Balanus improvisus*

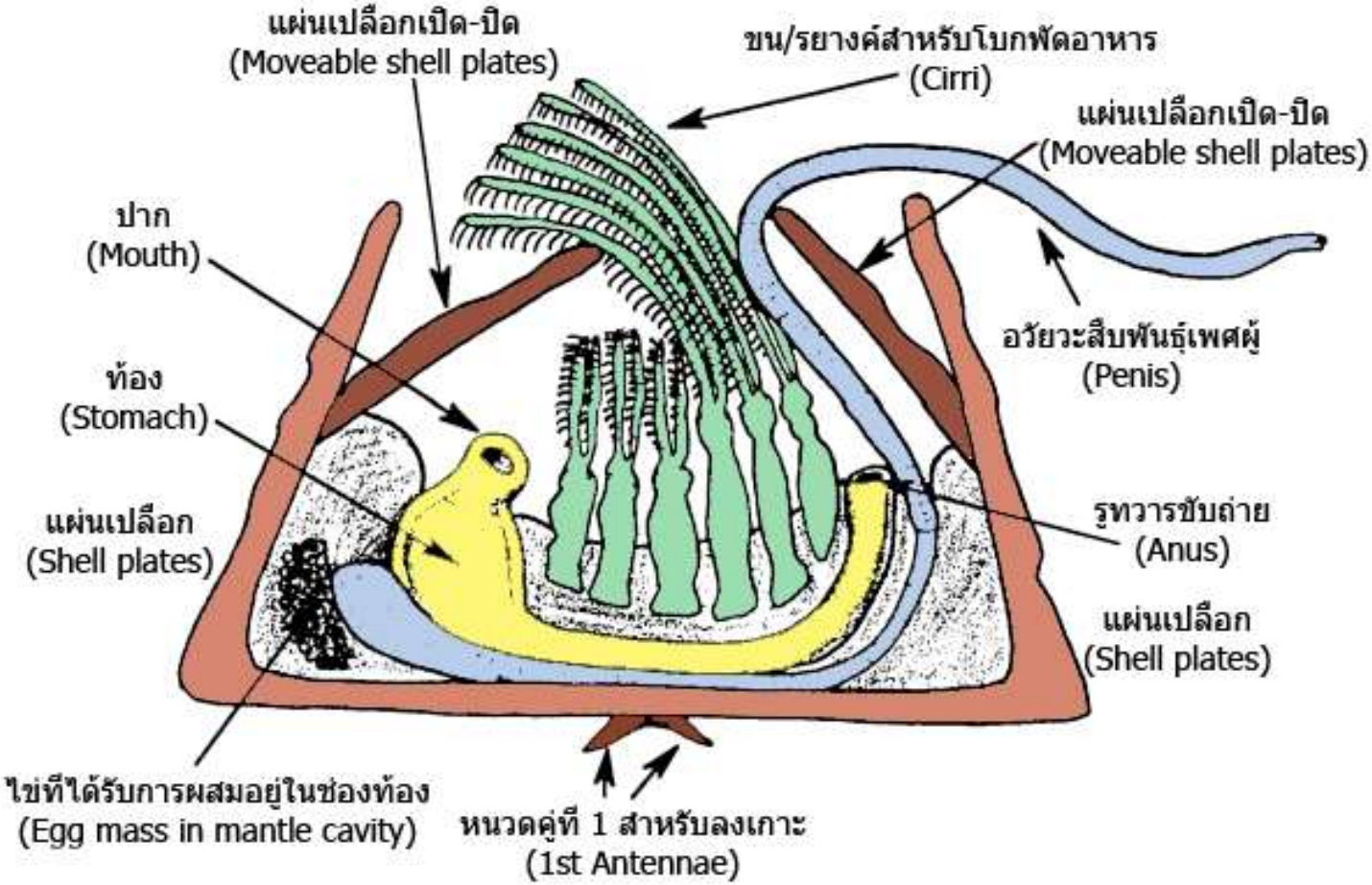
Balanus amphitrite

Semibalanus balanoides

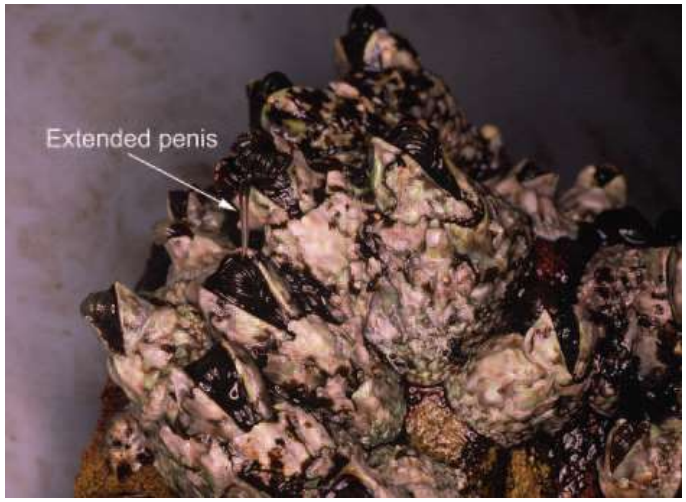
Balanus improvisus

Biology of acorn barnacle

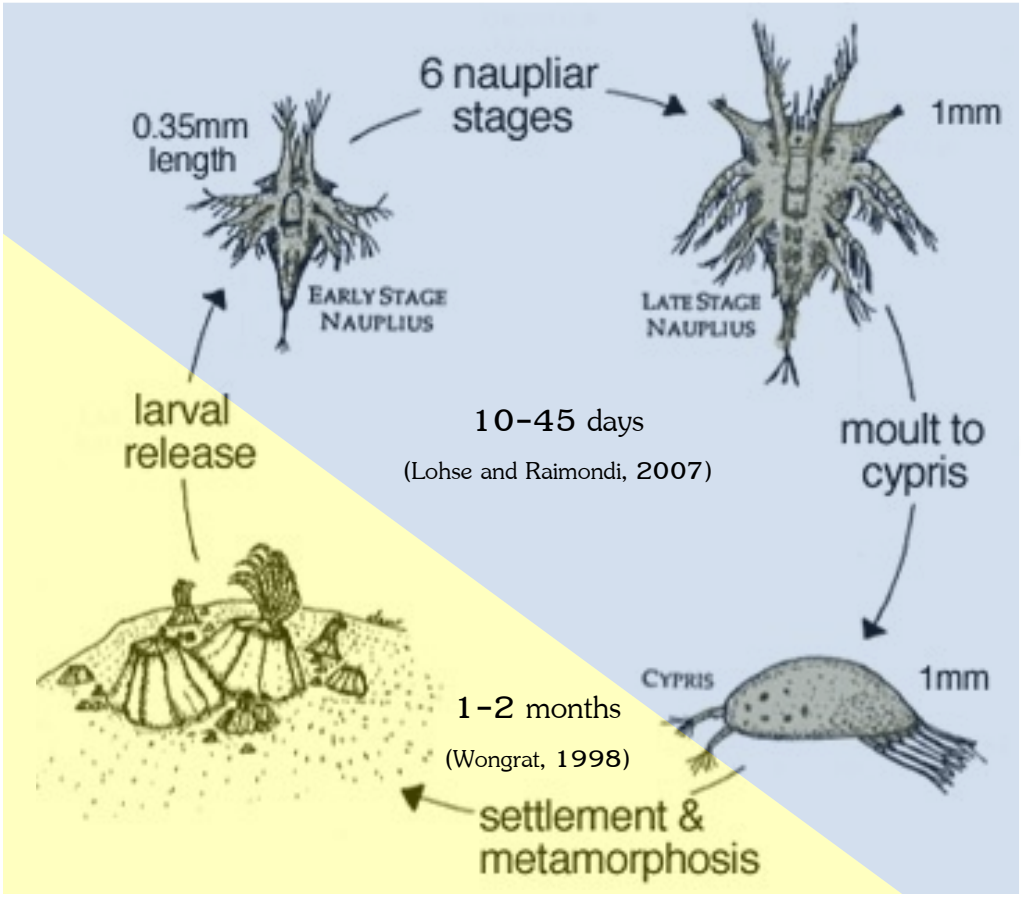
- Morphology



Life cycle of acorn barnacles



Lohse and Raimondi(2007)



http://www.asnailsodyssey.com/LEARNABOUT/BARNACLE/barnRepr.php

Settlement of barnacles

- Mechanisms

INVERTEBRATES 3e, Figure 21.33 (Part 14)
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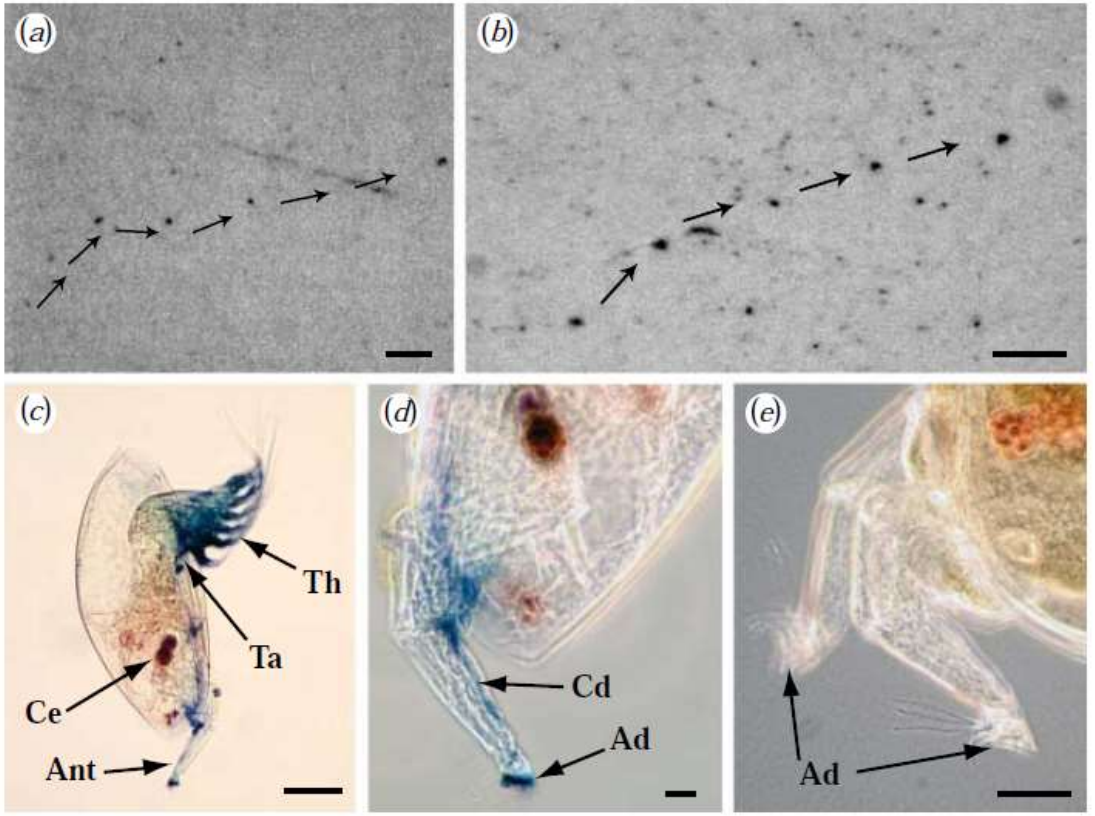
Cyprid larva



Dreanno *et al.* (2006)

Settlement of barnacles

- Cyprid larva



Factors effects to settlement of barnacles

- Presence of their parents or same species (gregariousness) (Crisp and Meadows, 1962)
- Biofilm formation from bacteria (Gregoris, 2011)
- Surface of substrates (Crisp, 1961)
- Water current (Crisp, 1955)
- Light intensity (Newman and Abbott, 1980)
- Predators (Newman and Abbott, 1980)

Factors effects to settlement of barnacles

— Presence of their parents or same species (gregariousness)

Biofouling
The Journal of Bioadhesion and Biofilm Research

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The complex barnacle perfume: identification of waterborne pheromone homologues in *Balanus improvisus* and their differential expression during settlement

Anna Abramova, Ulrika Lind, Anders Blomberg & Magnus Alm Rosenblad

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Secretory locations of SIPC in *Amphibalanus amphitrite* cyprids and a novel function of SIPC in biomineralization

Gen Zhang[1,†], Xiao-Xue Yang[1], Pok Man Leung[1], Li-Sheng He[2], Tat Yin Chan[1], Guo-Yong Yan[2], Yu Zhang[3], Jin Sun[1], Ying Xu[3] & Pei-Yuan Qian[1]

Settlement-inducing protein complex (SIPC) is a pheromone that triggers conspecific larval settlement in the barnacle *Amphibalanus amphitrite*. In the present study, immunostaining and scanning electron microscopy of SIPC revealed signals in the frontal horn pores and the secretions from carapace pores, suggesting that SIPC might be directly secreted from these organs in *A. amphitrite* cyprids. Further

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Journal of EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY

www.elsevier.com/locate/jembe

Involvement of the barnacle settlement-inducing protein complex (SIPC) in species recognition at settlement

Catherine Dreanno [a,b,*], Richard R. Kirby [c], Anthony S. Clare [a,*]

[a] School of Marine Sciences, Newcastle University, Newcastle upon Tyne NE1 7RU, UK
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[c] School of Biological Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA, UK

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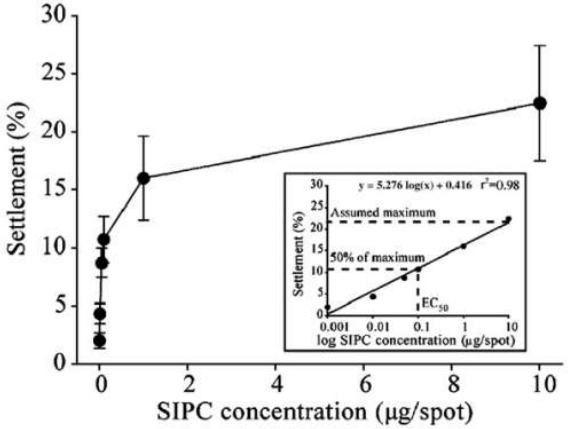
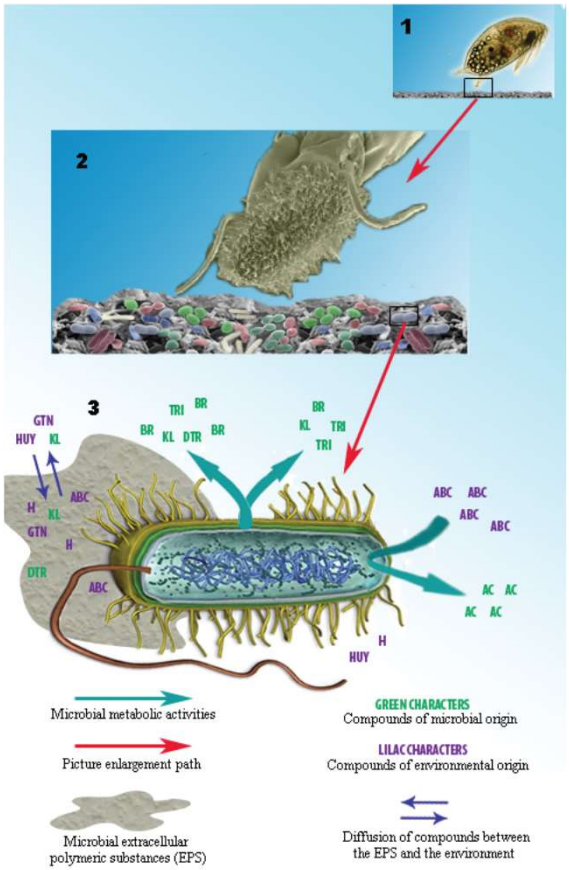


Fig. 2. Settlement response of *B. amphitrite* cyprids to different concentrations of *B. amphitrite* SIPC, (n=3). The insert indicates the effective concentration of *B. amphitrite* SIPC to achieve a 50% settlement of *B. amphitrite* cypris larvae (EC_{50}).

Dreanno et al. (2007)

Factors effects to settlement of barnacles

— Biofilm formation from bacteria



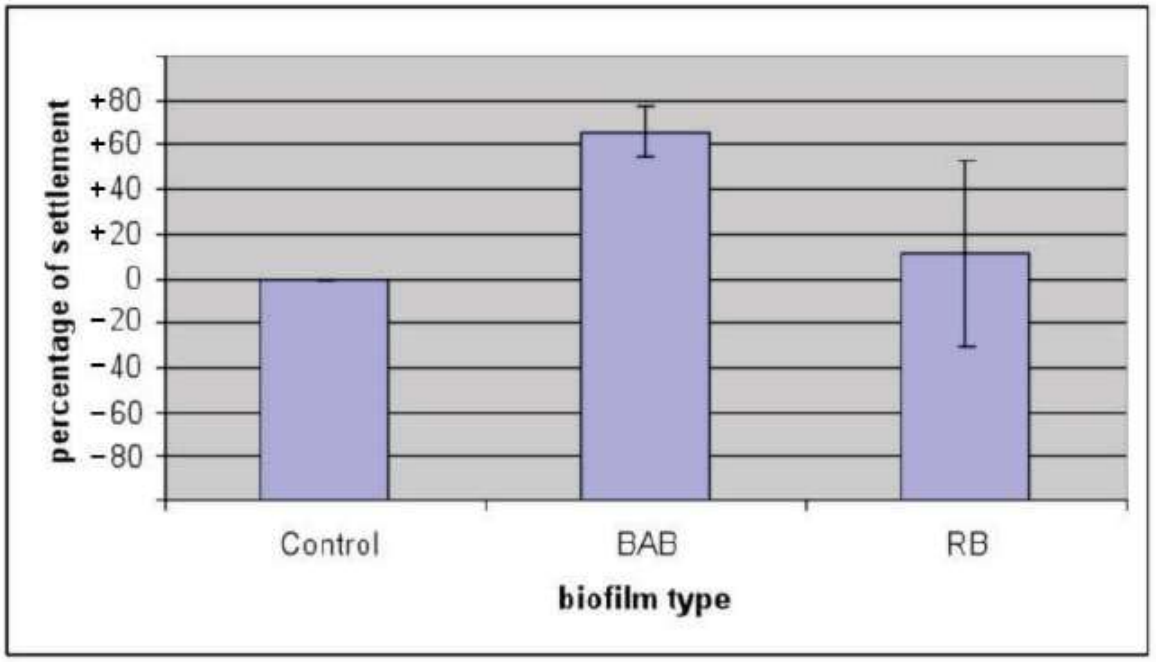


Figure 5.4 - **Effect of biofilm on larval settlement**

Comparison of *Balanus amphitrite* settlement between biofilm-free surface (Control), barnacle-originating biofilms (BAB) and rock-originating biofilms (RB). BAB and RB are expressed as +/- percentage of settlement on control surface.

Gregoris,(2011)

Factors effects to settlement of barnacles

- Surface of substrates

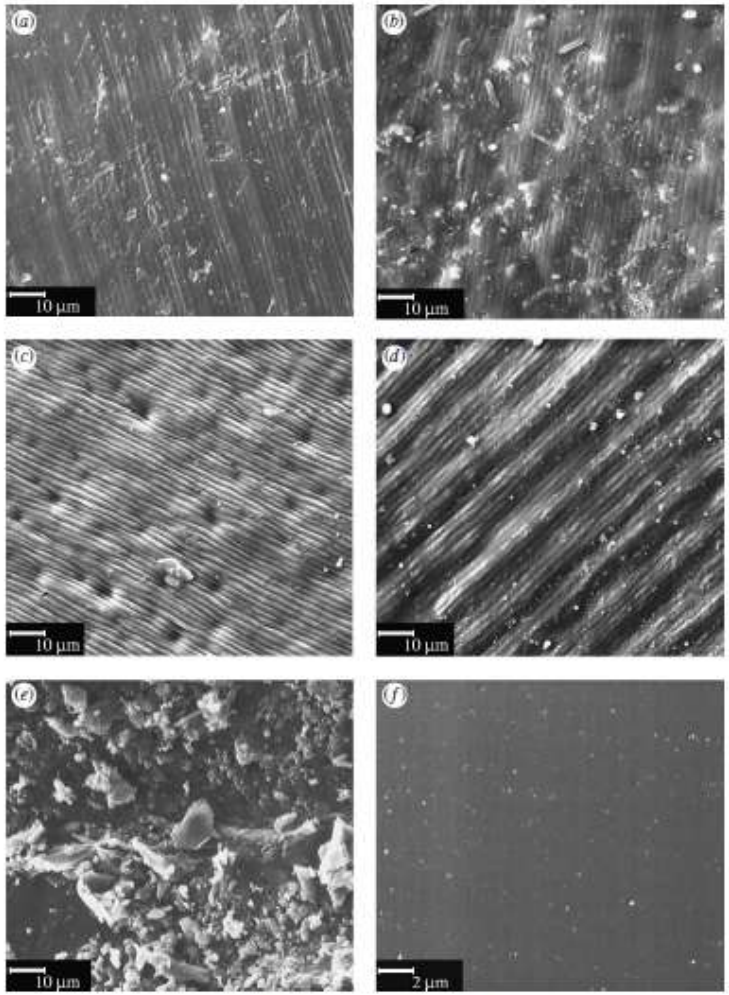


Figure 1. Scanning electron micrographs of: (*a*) *Perna perna* (Brazil); (*b*) *Mytilus adulis* (Russia); (*c*) *Mytilus adulis* (UK); (*d*) *Mytilus adulis* (Germany); (*e*) rough control; (*f*) smooth control.

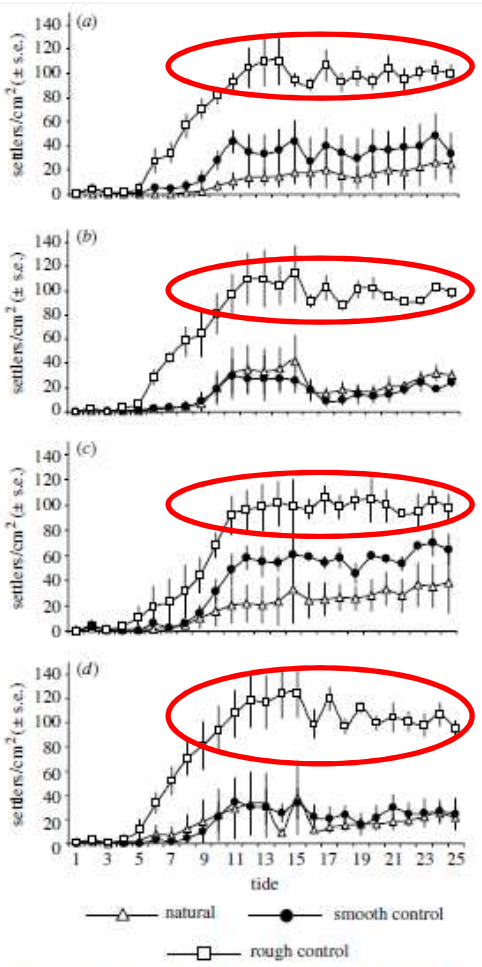
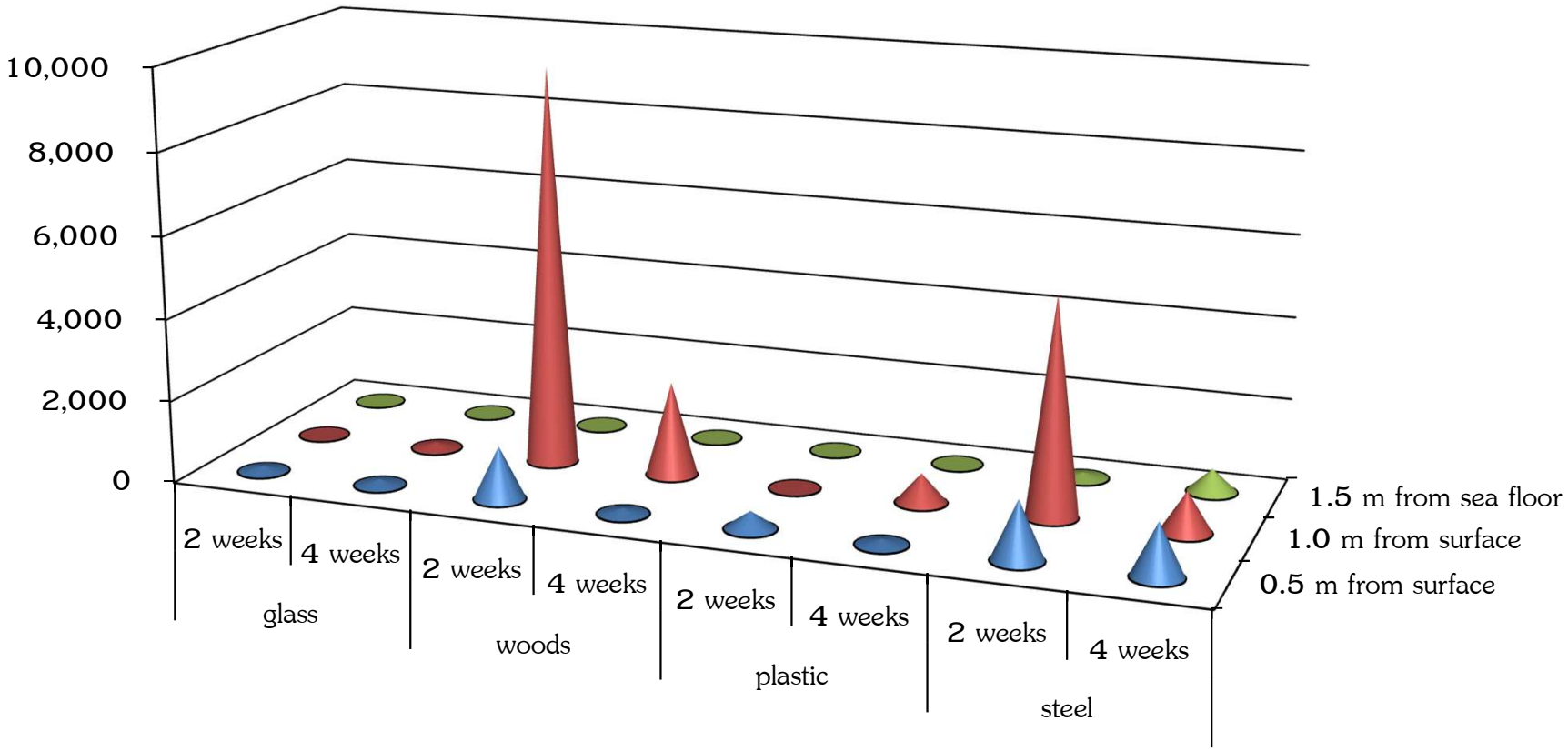


Figure 2. Barnacle settlement on natural, smooth and rough replicas of (*a*) *Perna perna* (Brazil), (*b*) *Mytilus edulis* (Russia), (*c*) *Mytilus edulis* (UK), (*d*) *Mytilus edulis* (Germany). Error bars indicate s.e.

Bers et al.(2006)

Factors effects to settlement of barnacles

— Surface of substrates



Factors effects to settlement of barnacles

— Water current

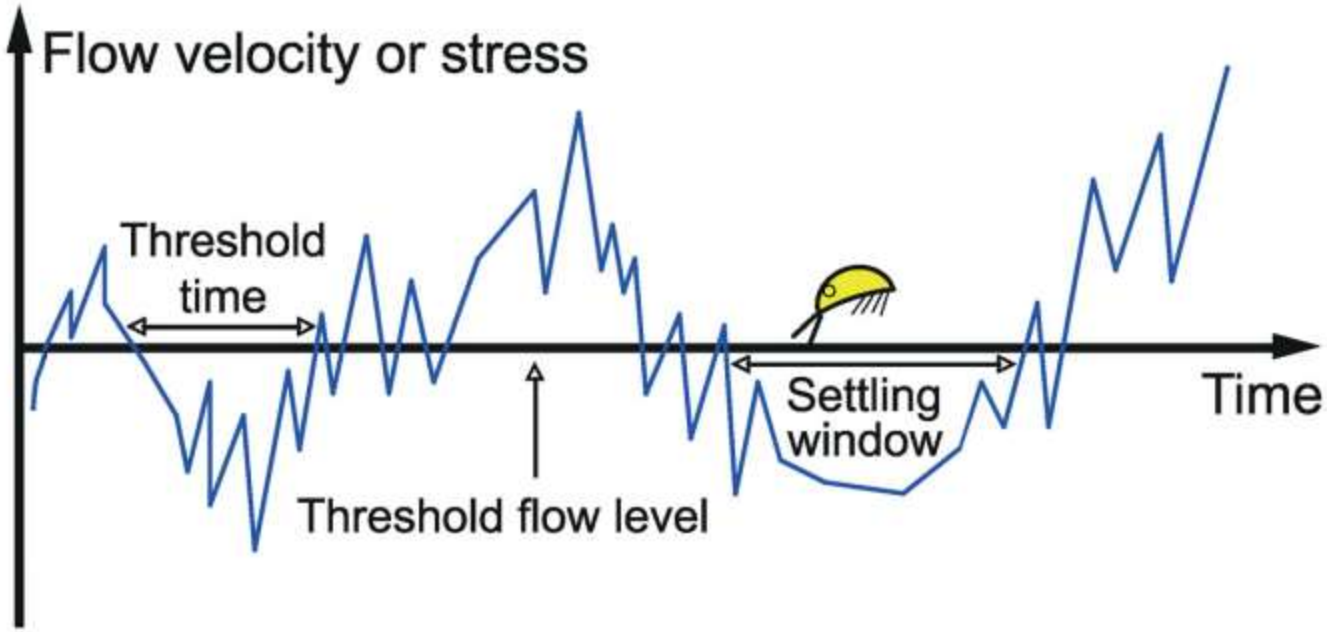


Fig 2. Schematic drawing of the interaction between flow velocity fluctuations and the opportunities for larval attachment. A "stress lull" or "settling window" is defined as the minimum time interval below some critical flow velocity required for successful attachment. According to this hypothesis the cyprid can only use the proportion of time in settling windows for attachment.

doi:10.1371/journal.pone.0158957.g002

Lasson et al. (2016)

Factors effects to settlement of barnacles

— Water current

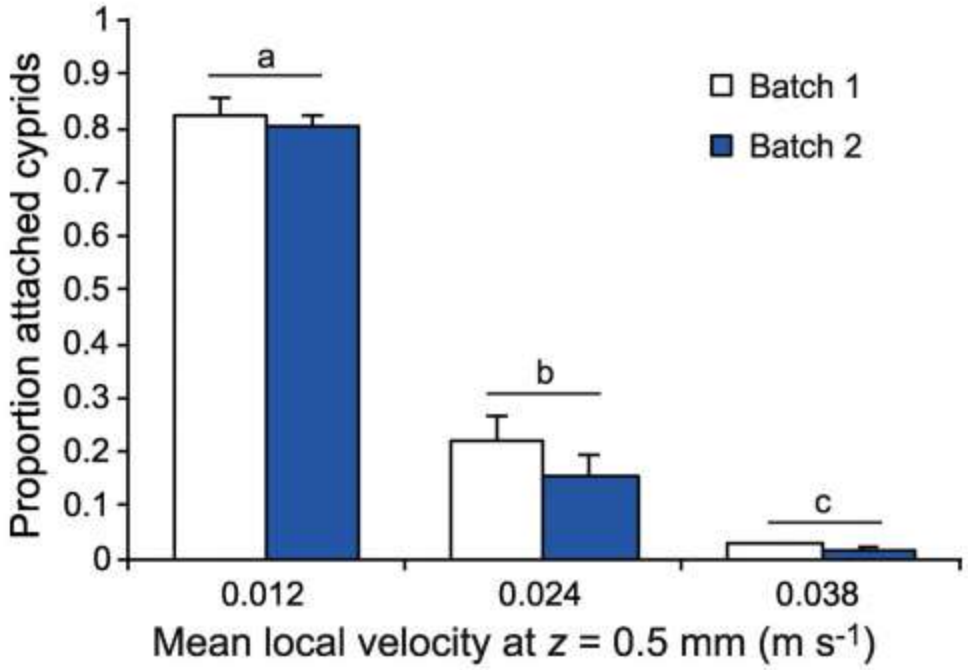


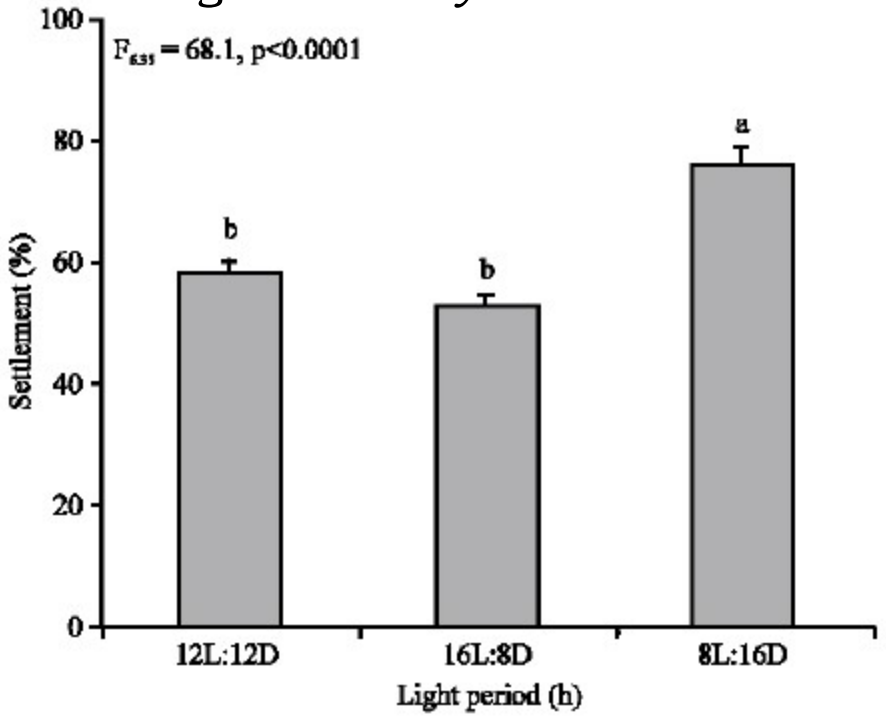
Fig 5. Flow-dependent proportion of temporary attachment in cyprids. Bars represent the proportion (mean ± SE, $n = 4$) of attachment for 20–40 cyprids released in a flume flow at free-stream velocities of 0.1, 0.15 and 0.2 m s^{-1}. Lowercase letters denote significant differences among factor levels ($P < 0.05$, SNK post-hoc). The labels show the mean local velocity at the height where cyprids interact with the bed ($z = 0.5$ mm). Data shown are original attachment proportions not normalized to flow speed (see Materials and Methods) and include two larval batches.

doi:10.1371/journal.pone.0158957.g005

Lasson et al. (2016)

Factors effects to settlement of barnacles

— Light intensity



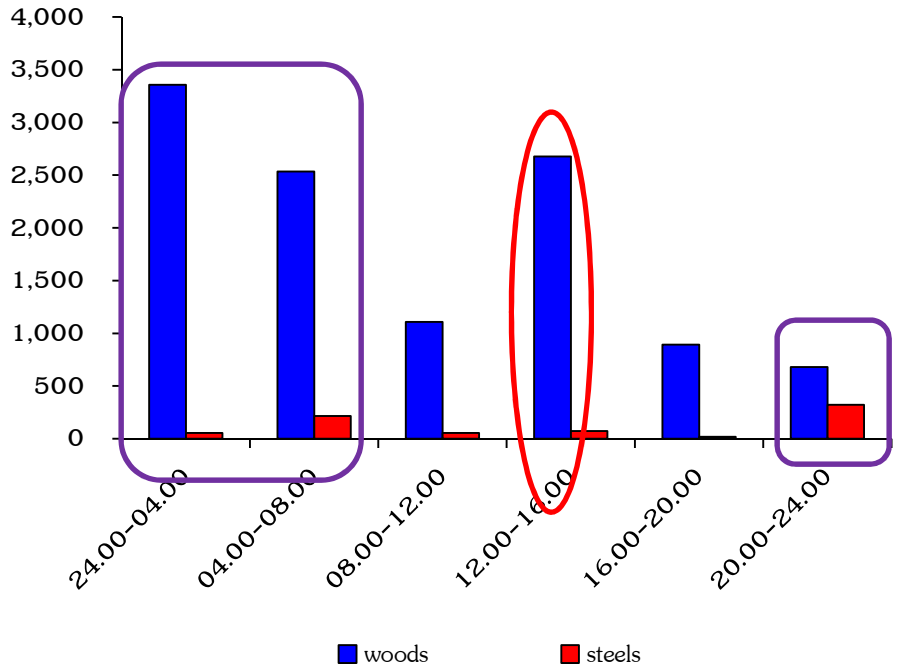


Fig. 2: Effect of light periods on the settlement of the cyprids. Each data point represents the mean (±SD) of six replicates. Data that are significantly different at $\alpha = 0.05$ in Tukey's test are indicated by different letter above the bar

Nasrolahi (2007)

Factors effects to settlement of barnacles

— Foods and predators

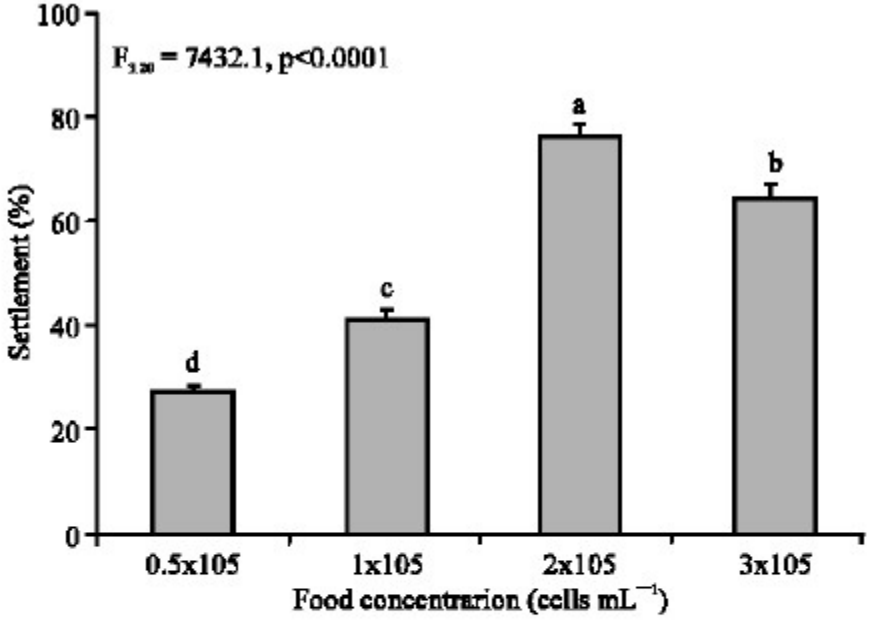


Fig. 1: Effect of food (*Chaetoceros calcitrans*) concentration used during naupliar development on the settlement of the cyprids. Each data point represents the mean (±SD) of six replicates. Data that are significantly different at $\alpha = 0.05$ in Tukey's test are indicated by different letter above the bar

Nasrolahi (2007)

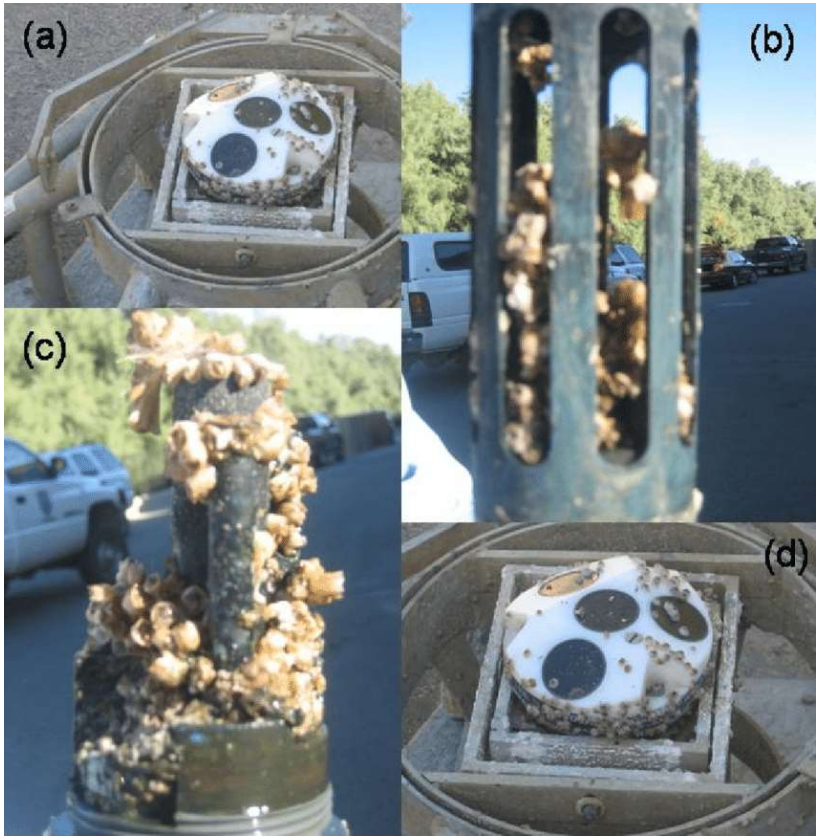
Factors effects to settlement of barnacles

- Foods and predators

Needs of antifouling in marine researches

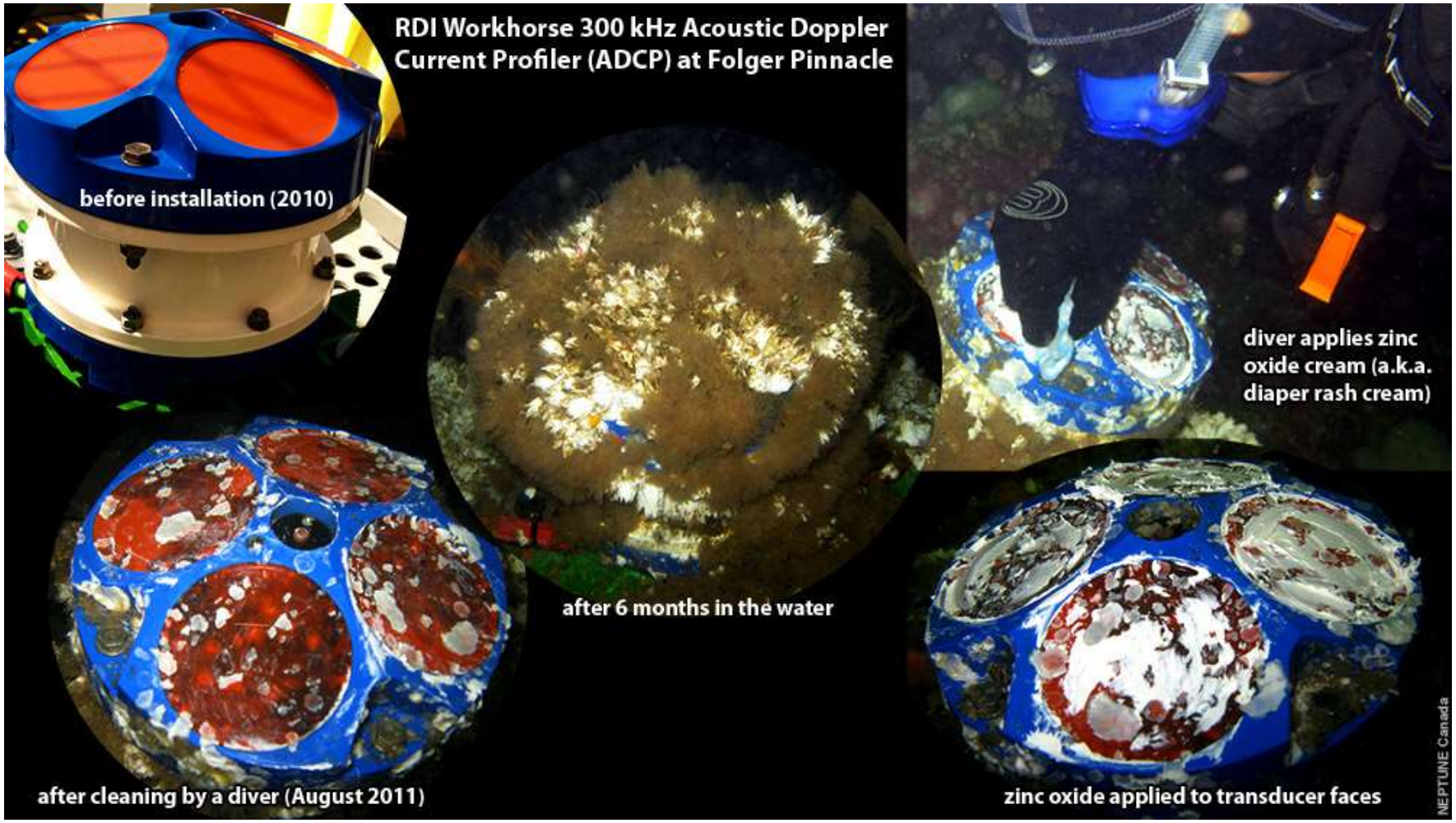
Many instruments setup in the sea

- ADCP (Acoustic Doppler Current Profiler)
- YSI



Needs of antifouling in marine researches

ADCP (Acoustic Doppler Current Profiler)



Needs of antifouling in marine researches

Ecological Buoy (at Sichang Research Station, Sichang Island)

Needs of antifouling in marine researches

Research vessels