

# Spatial and Temporal Patterns of Fouling Serpulid *Ficopomatus* cf. *uschakovi* Pillai, 1960 at Setiu Wetlands, Terengganu

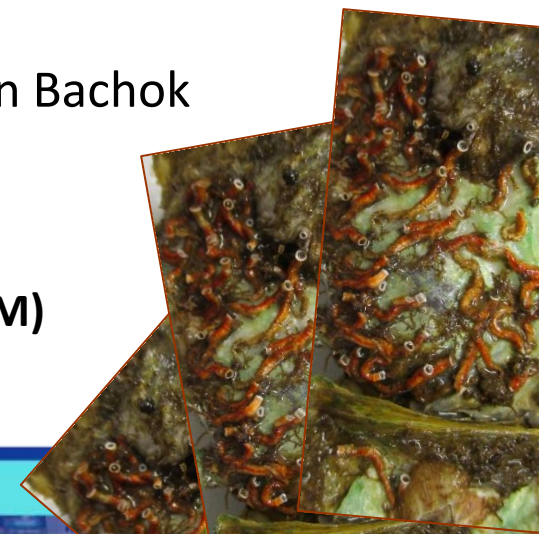
**Tema: Morfologi Pantai dan Oseanografi**

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**NO. ID: KP61**

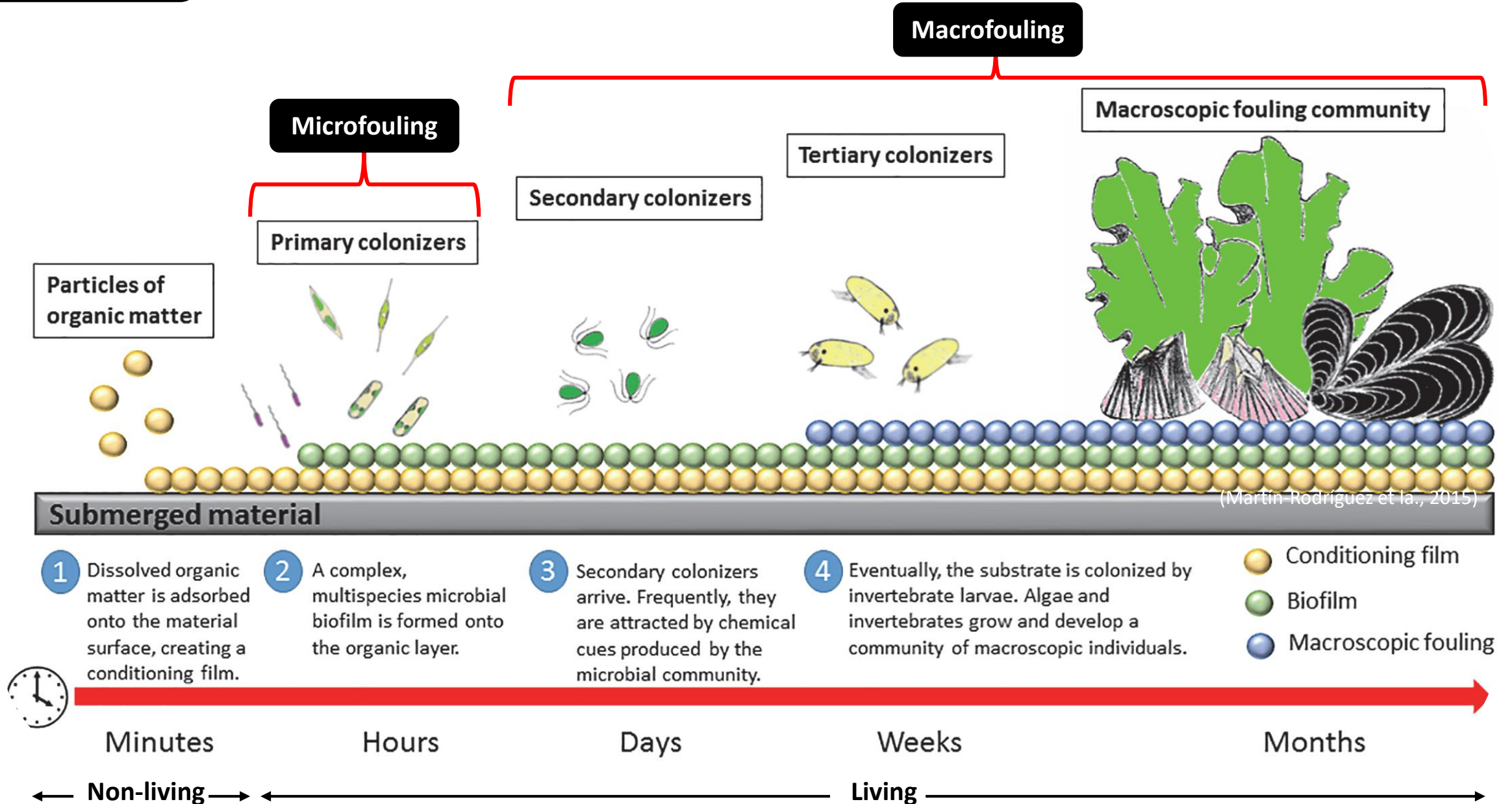
**INSTITUT PENYELIDIKAN AIR KEBANGSAAN MALAYSIA (NAHRIM)**

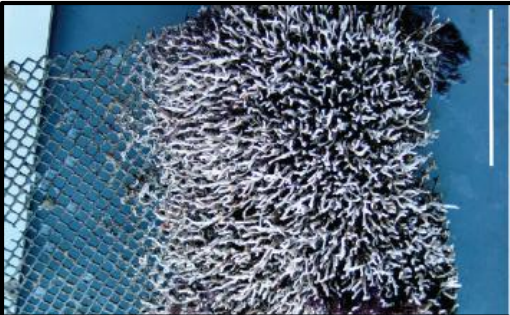
**SESI SELARI 3 / 20 JULAI 2022**



# FOULING =

Undesirable accumulation of unwanted material (microorganisms, plants & animals) on submerged structures (Dürr & Thomason, 2010; IMO, 2017)





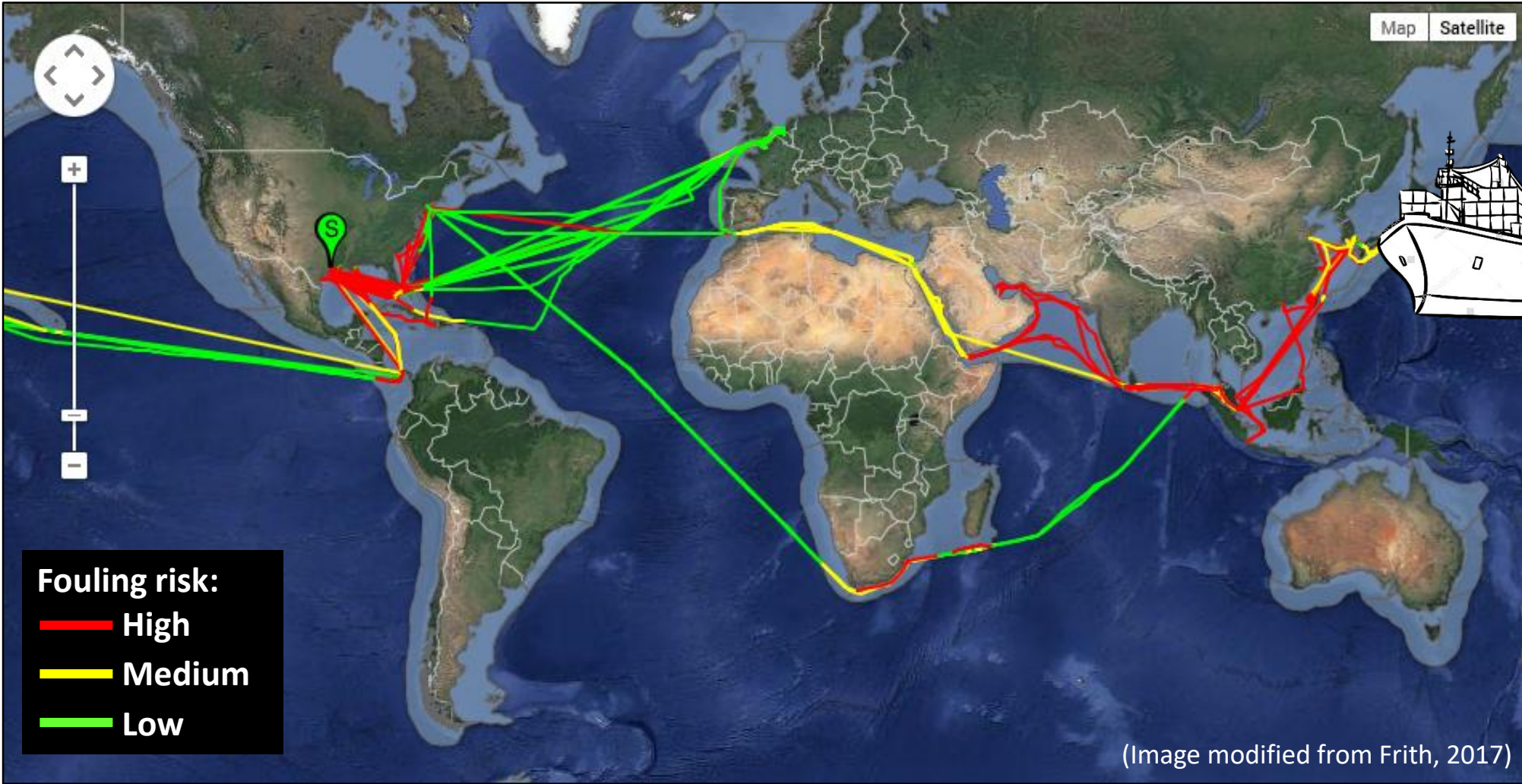
United States of America



United Kingdom



India



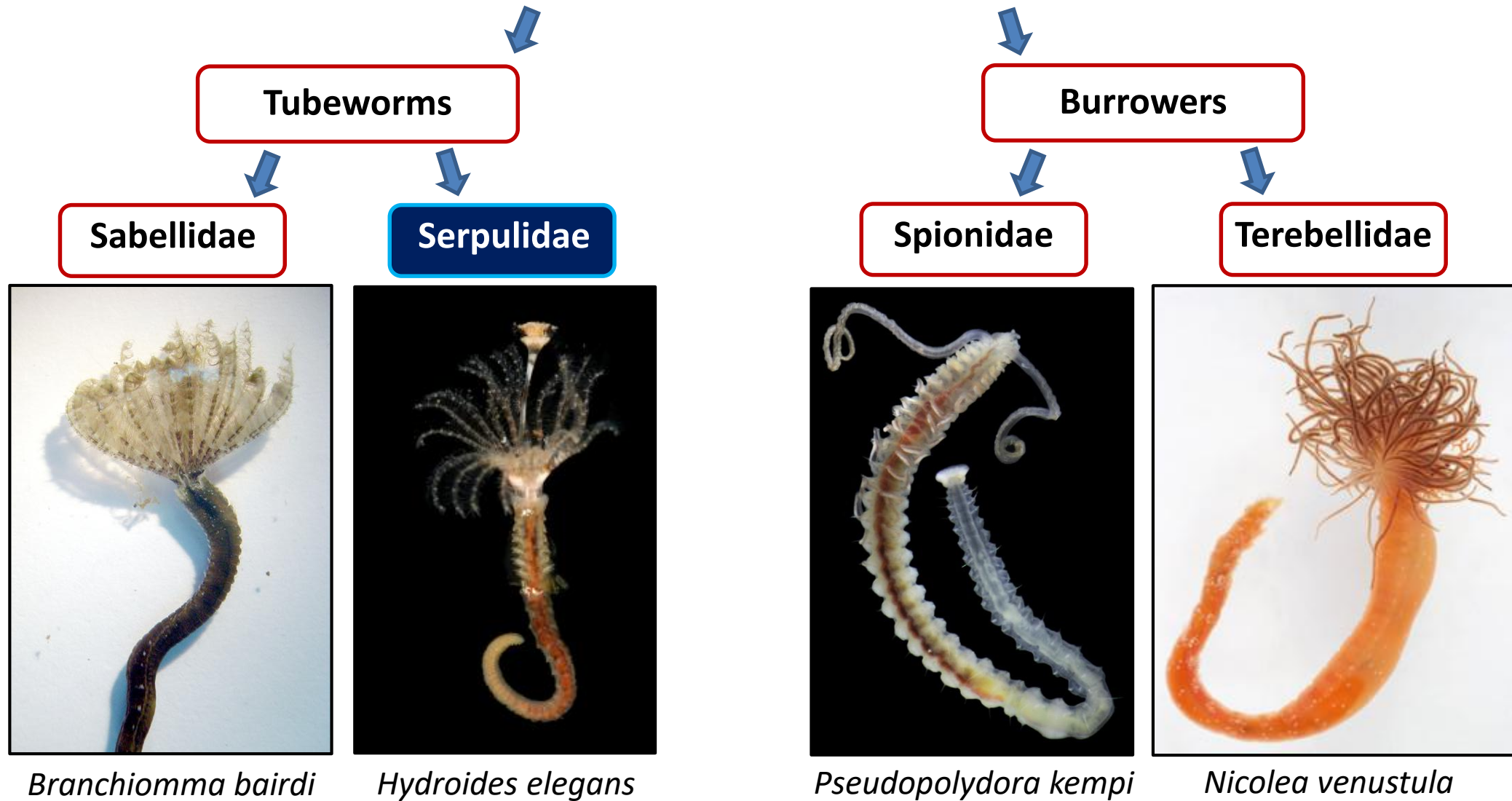
Pasir Gudang & Tanjung Pelepas Port



**Invasive!**

*Ficopomatus enigmaticus* reefs in Australia

# Fouling polychaetes

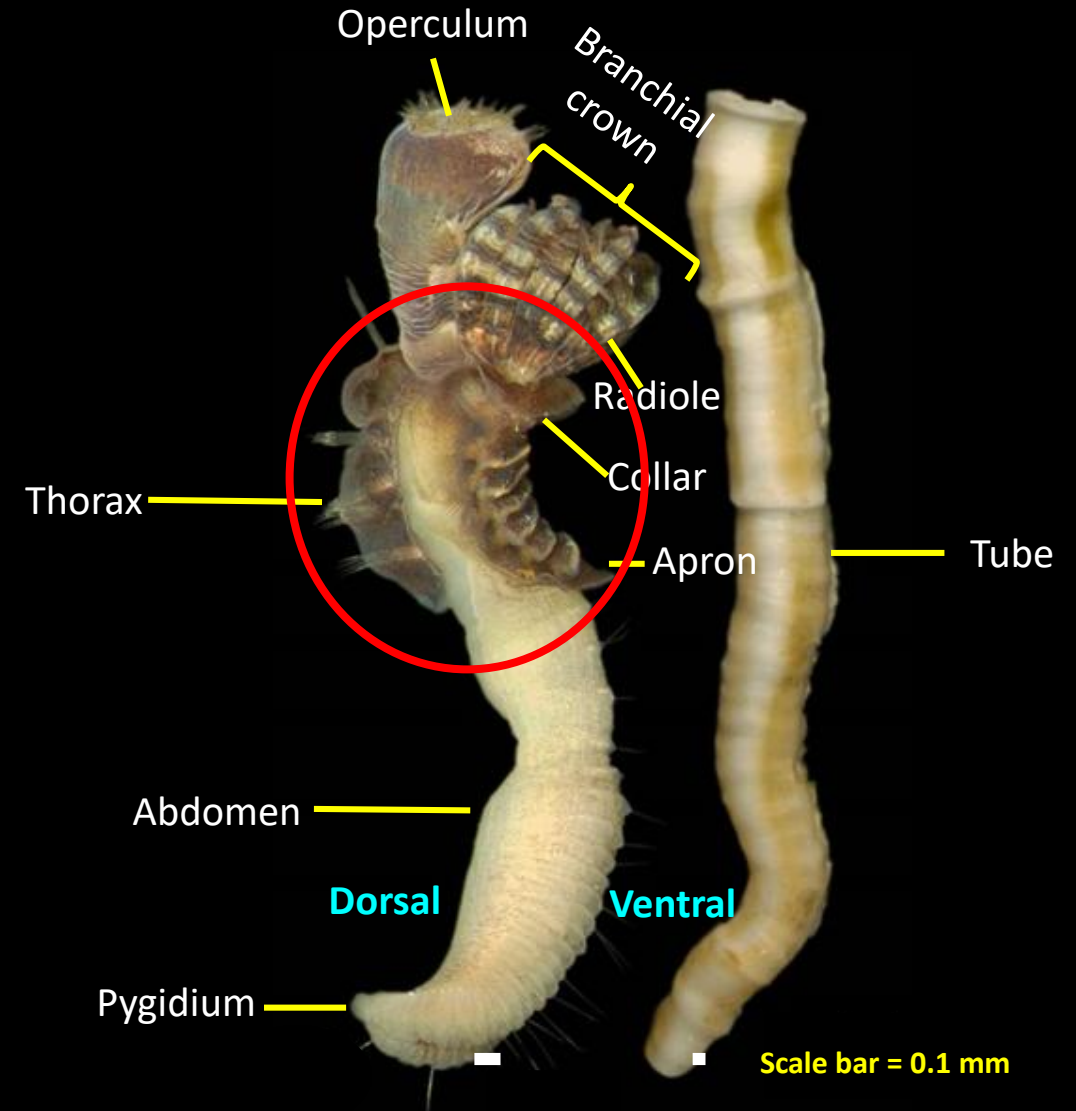


Genera = 46  
Species = 600

# Serpulidae: Genus *Ficopomatus* Southern, 1921

- Euryhaline (brackish water)
- 6 species in the world:
  - 1) *F. enigmaticus*
  - 2) *F. macrodon*
  - 3) *F. miamiensis*
  - 4) *F. shenzhensis*
  - 5) *F. talehsapensis*
  - 6) *F. uschakovi*
- Ecosystem engineer
- Factor of reproductive & settlement:
  - temperature
  - salinity
- Ideal habitat:
  - enclosed area & turbid waters
  - rich in organic matter
  - weak currents

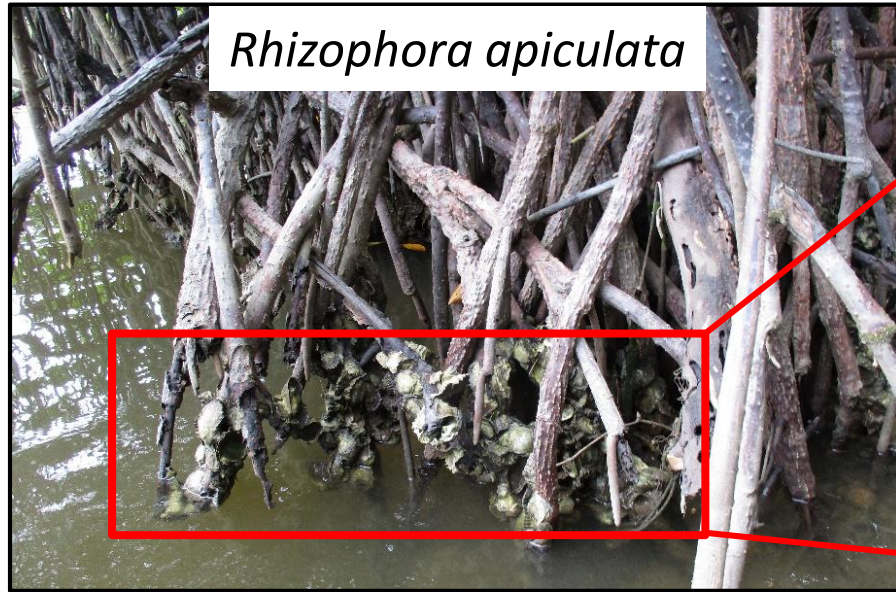
(Kupriyanova & Dittmann, 2008; Dittmann *et al.*, 2009; Bastida-Zavala *et al.*, 2017)



*Ficopomatus cf. uschakovi*  
(Image modified from Styan *et al.*, 2017)

# *Ficopomatus cf. uschakovi* in Setiu Wetlands (mangrove plants)

*Rhizophora apiculata*

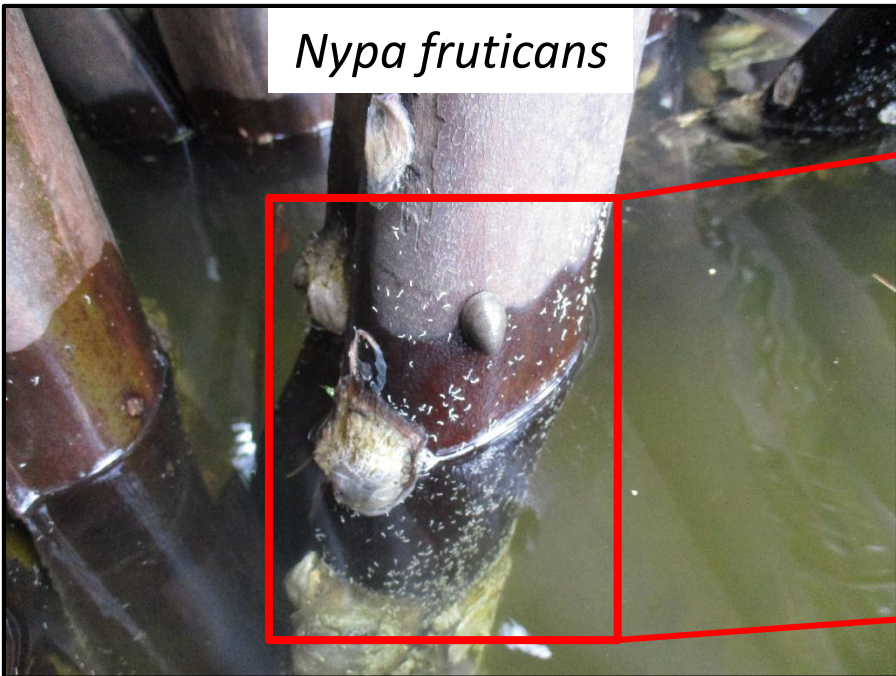


Floating rotten wood/stems



(Kupriyanova, pers. com.)

*Nypa fruticans*

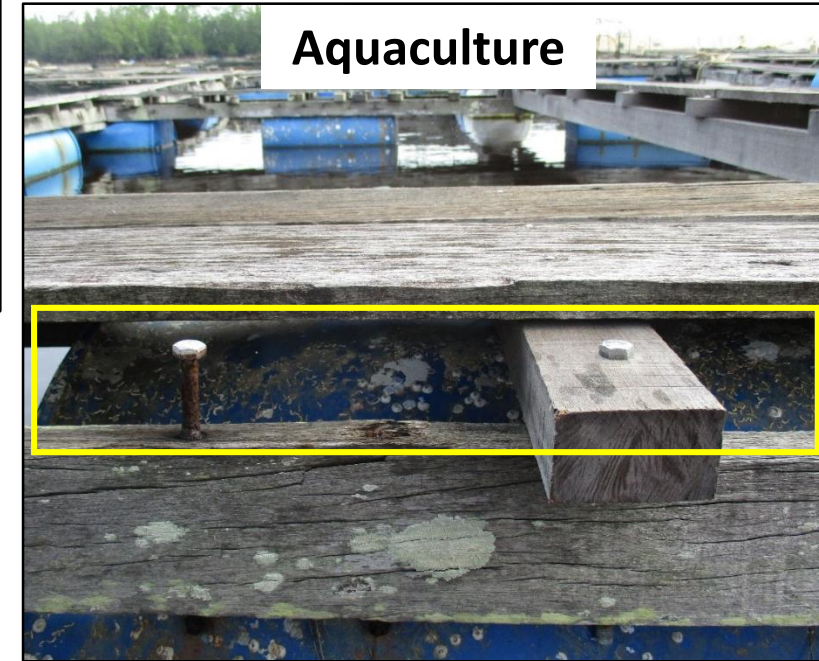
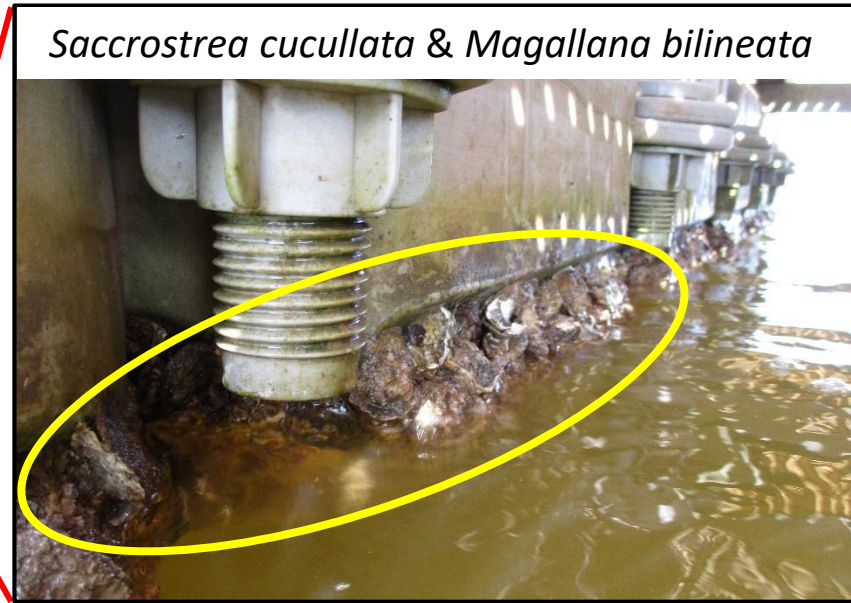


*Dostia cornucopia* &  
*Dostia violacea*

Attached on gastropod

\*Local name = **Karah/Karas**  
(Kamaruddin, pers. com.)

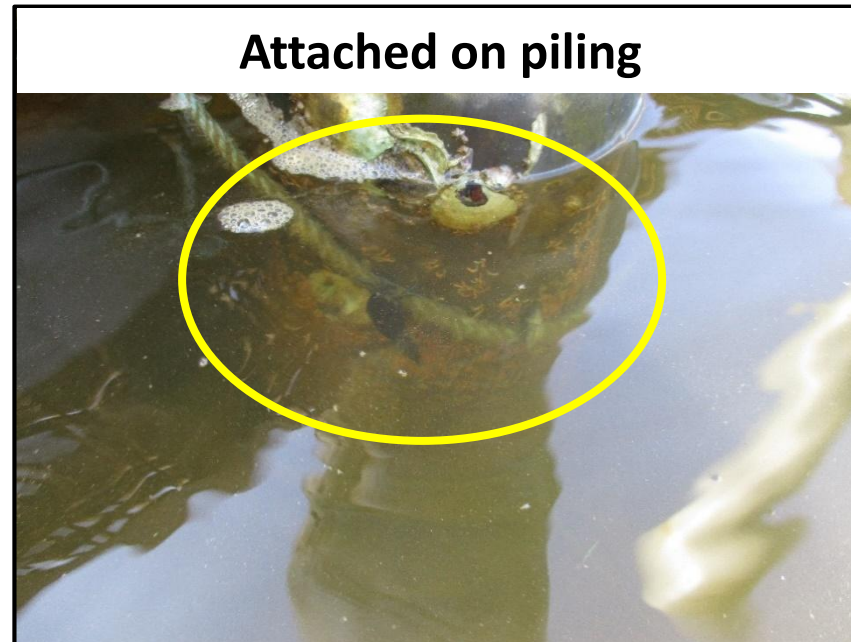
# *Ficopomatus cf. uschakovi* in Setiu Wetlands (man-made structures)



Attached on oyster



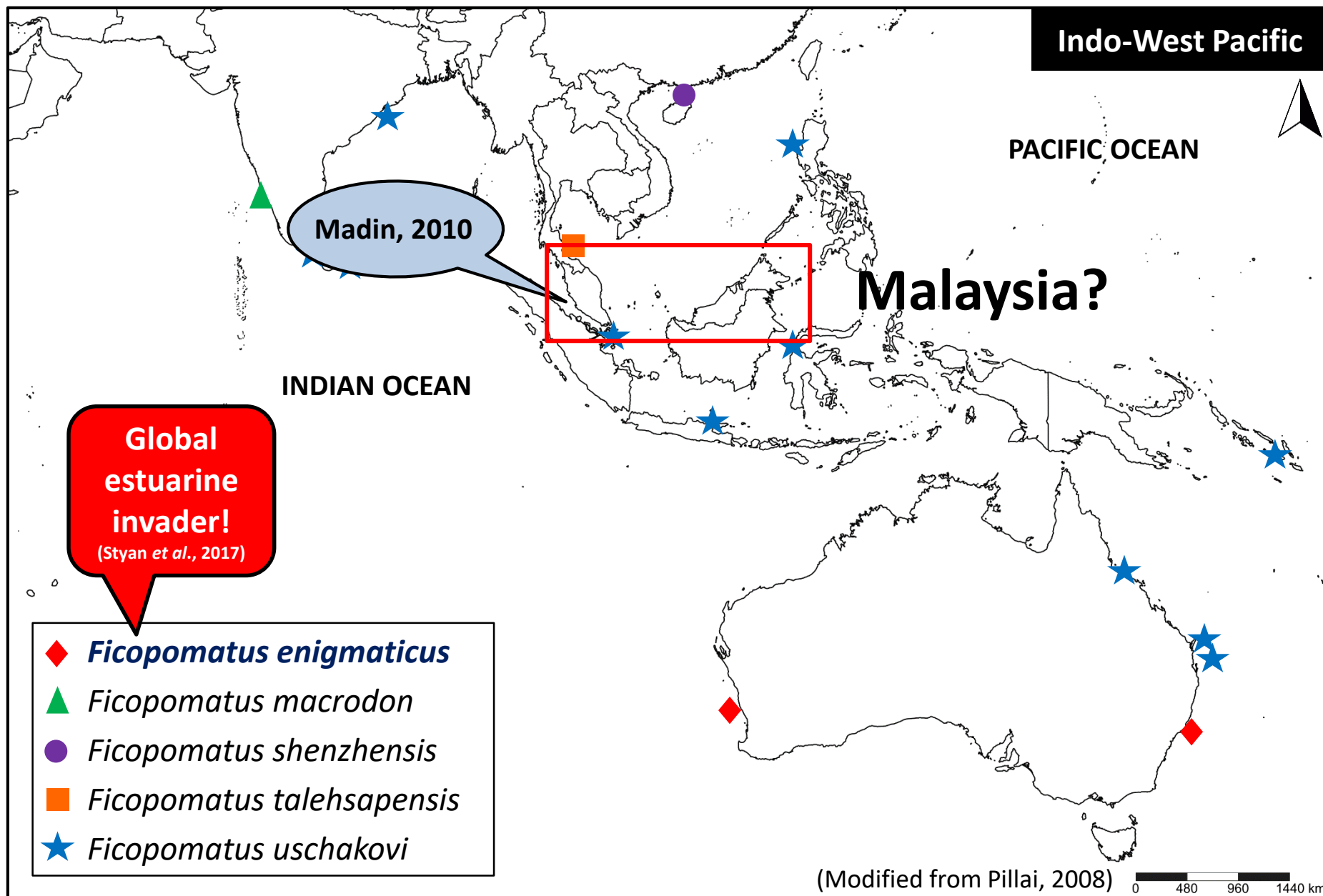
Attached on piling





# Why fouling serpulid study is important?

- Fouling pattern research - **worldwide**
- Fouling serpulid status in **Malaysia** - poorly known
- Previous fouling study - **west coast Peninsular Malaysia**

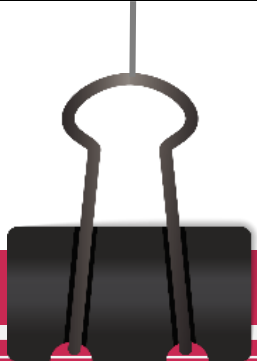


# Objectives



**1**

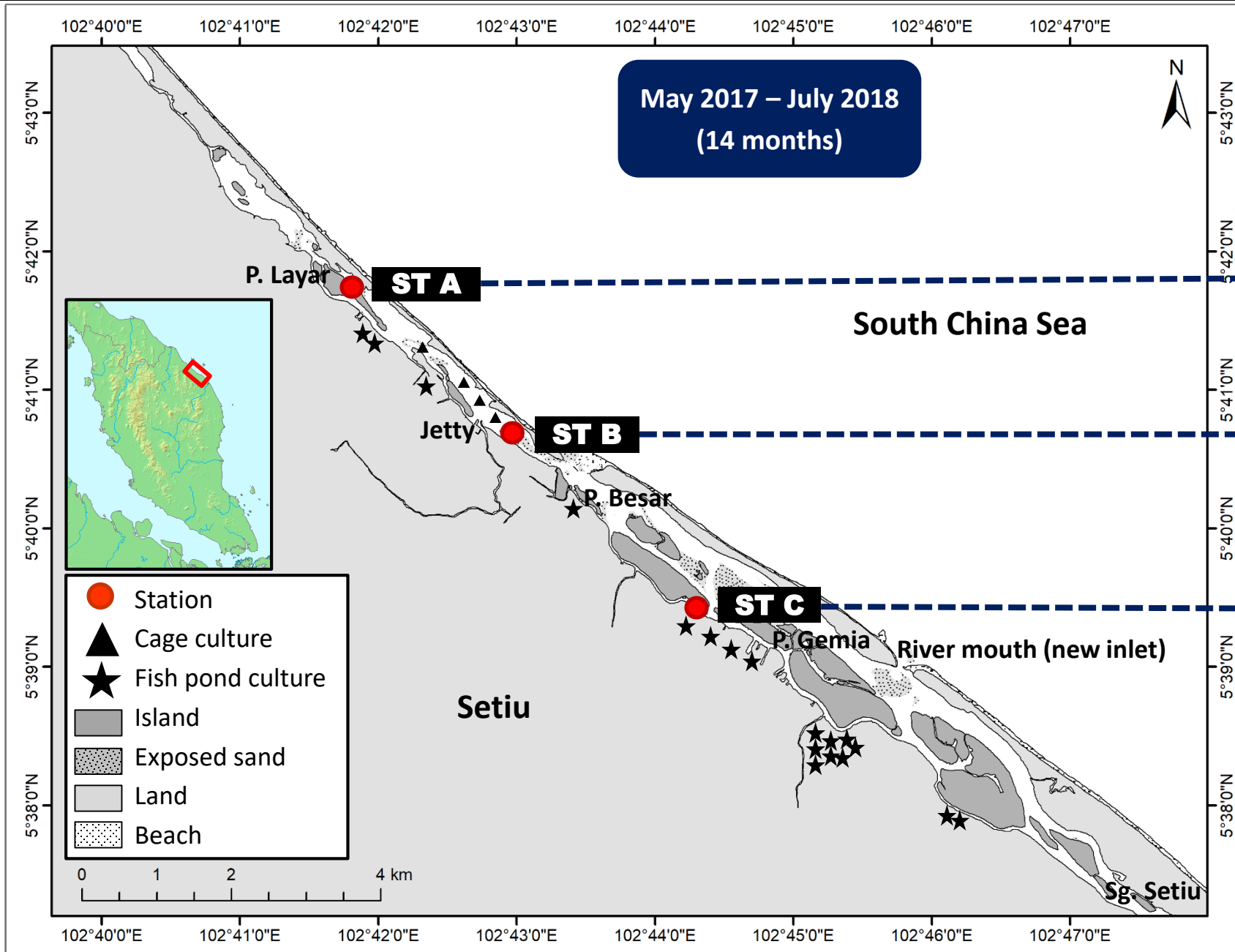
To determine spatial and temporal distribution of *Ficopomatus cf. uschakovi* in Setiu Wetlands



**2**

To determine the effect of environmental parameters on the distribution of *Ficopomatus cf. uschakovi* in Setiu Wetlands

# Study location



# Monthly assessment & statistical analyses

## In-situ parameters (surface & bottom):

1. Temperature (°C)
2. Salinity (ppt)
3. pH
4. DO (mg/L)

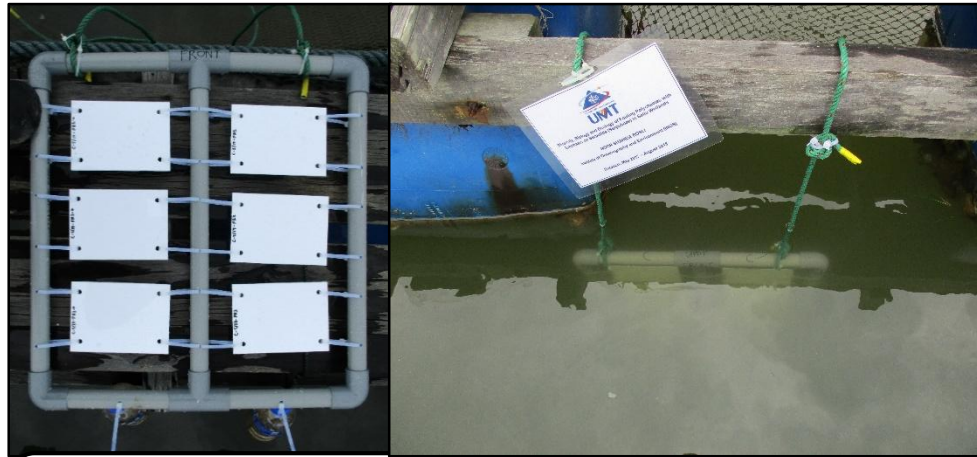
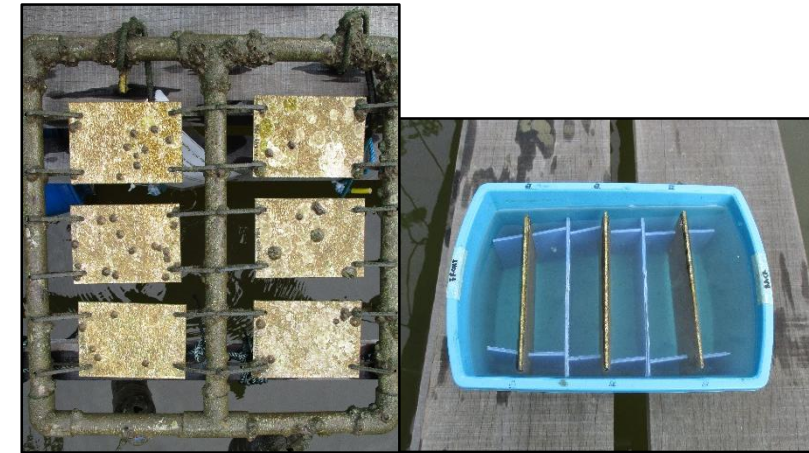


Plate deployment (14 cm x 10 cm)



Monthly assessment  
(May 2017 – July 2018)



## Statistical analyses:

1. Kruskal-Wallis /  
One-way ANOVA
2. PCA

Statistical significance,  $p < 0.05$



Mean density =  
 $\text{Individuals.dm}^{-2}$   
(1 dm = 100 cm)



*F. cf. uschakovi* tubes  
(front & back) were  
counted & recorded

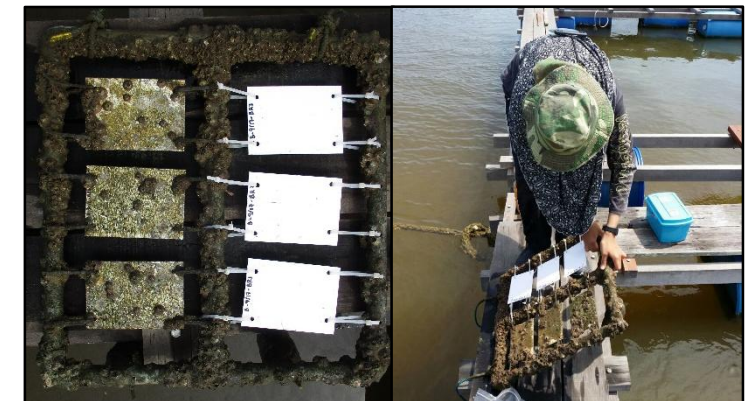
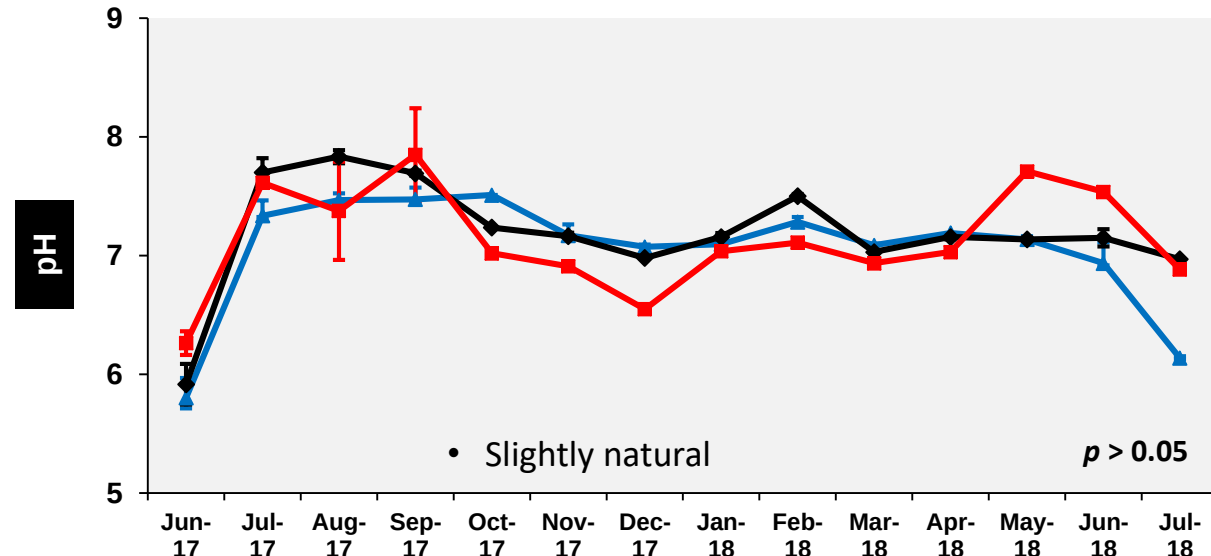
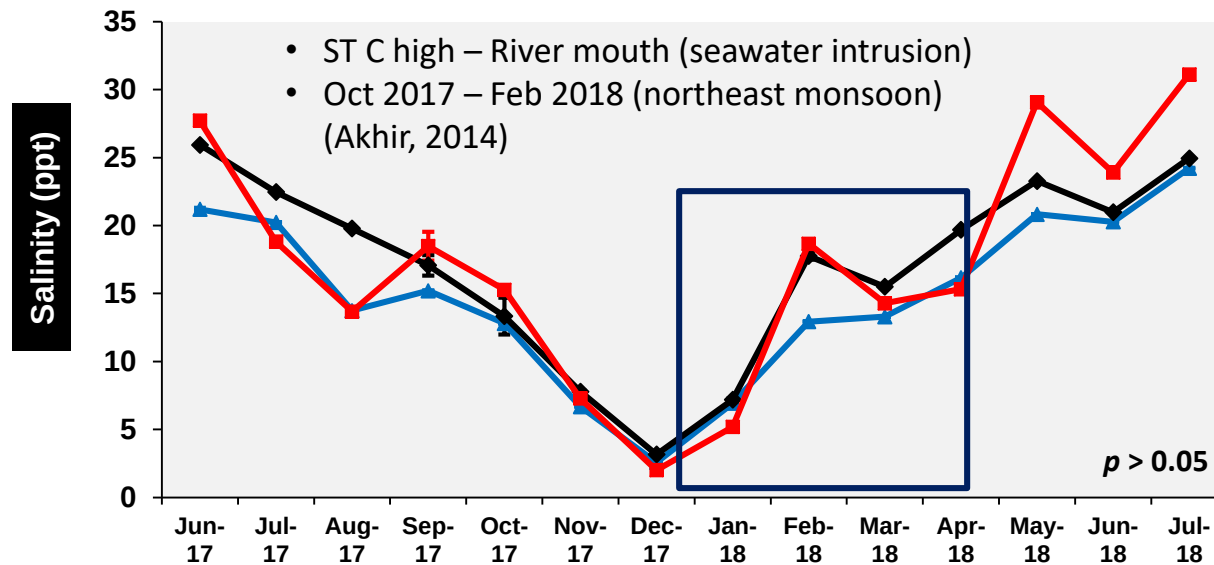
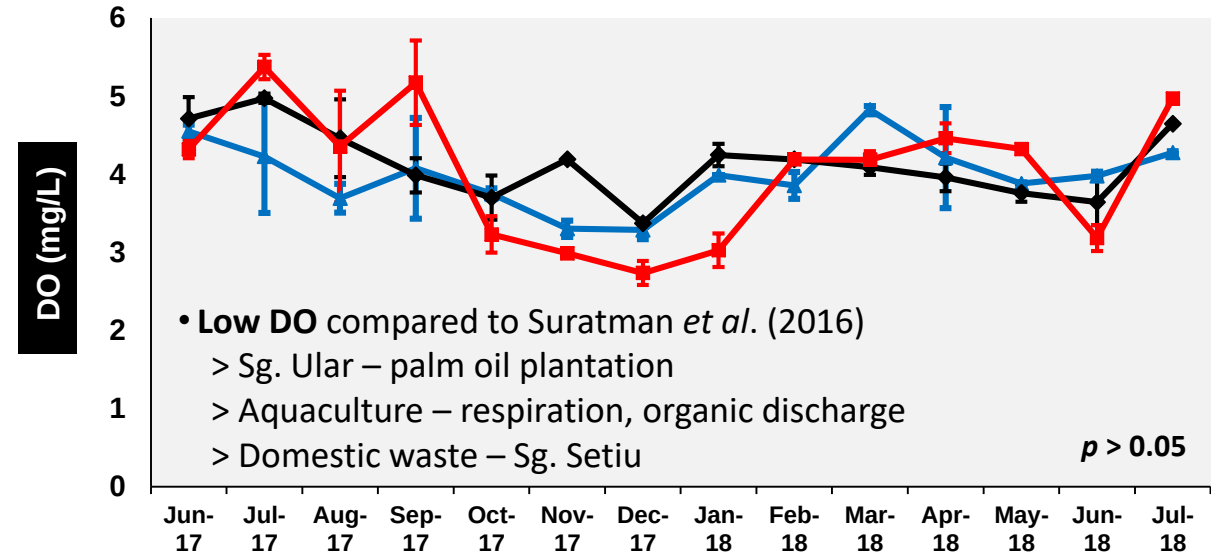
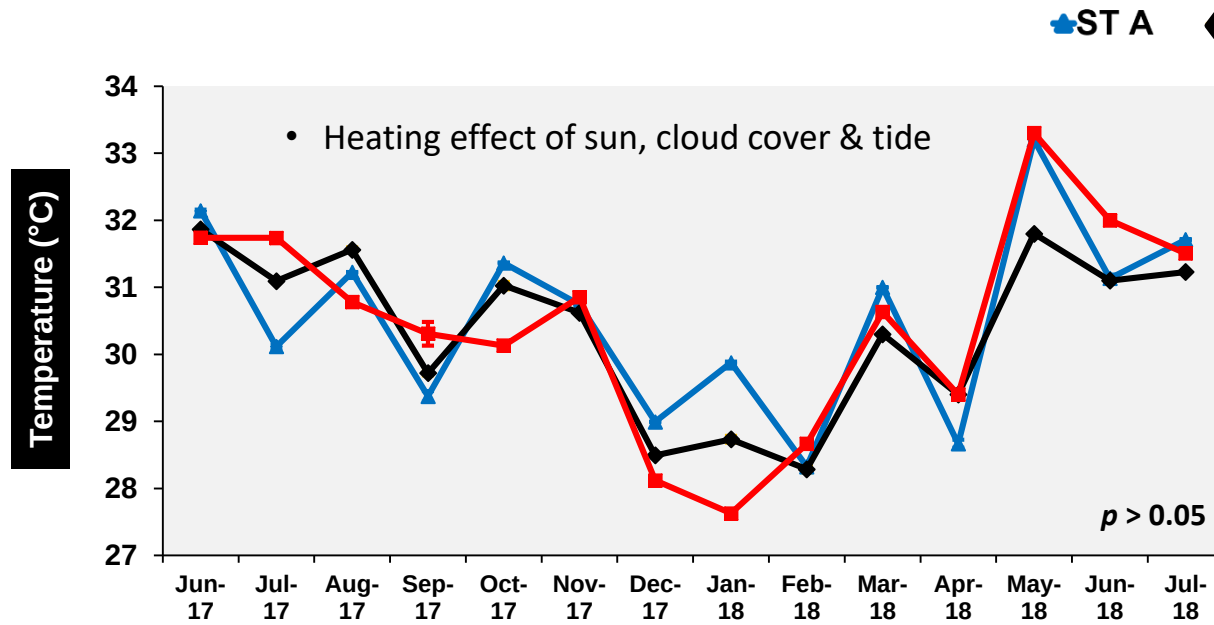


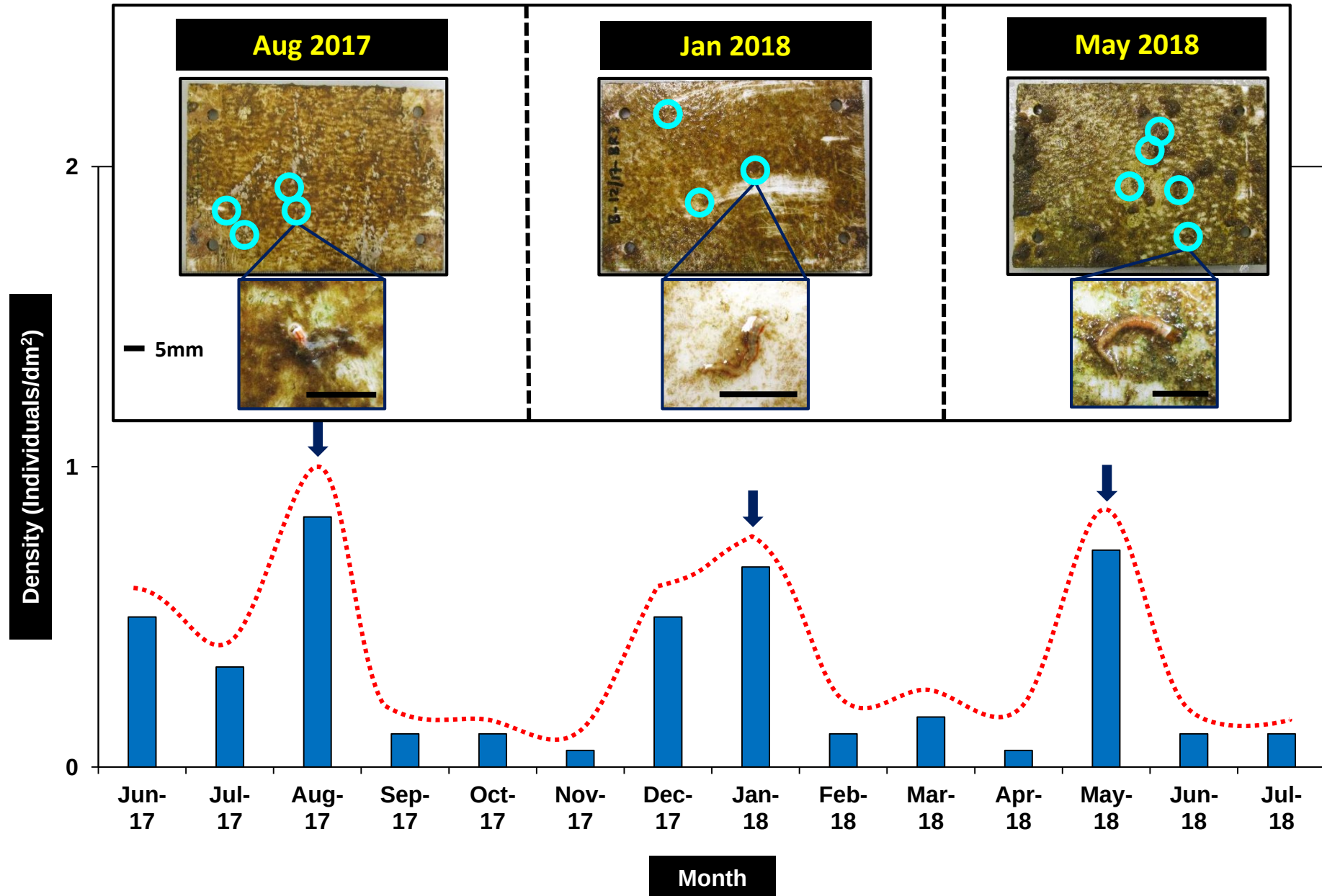
Plate replacement

# Physico-chemical parameters

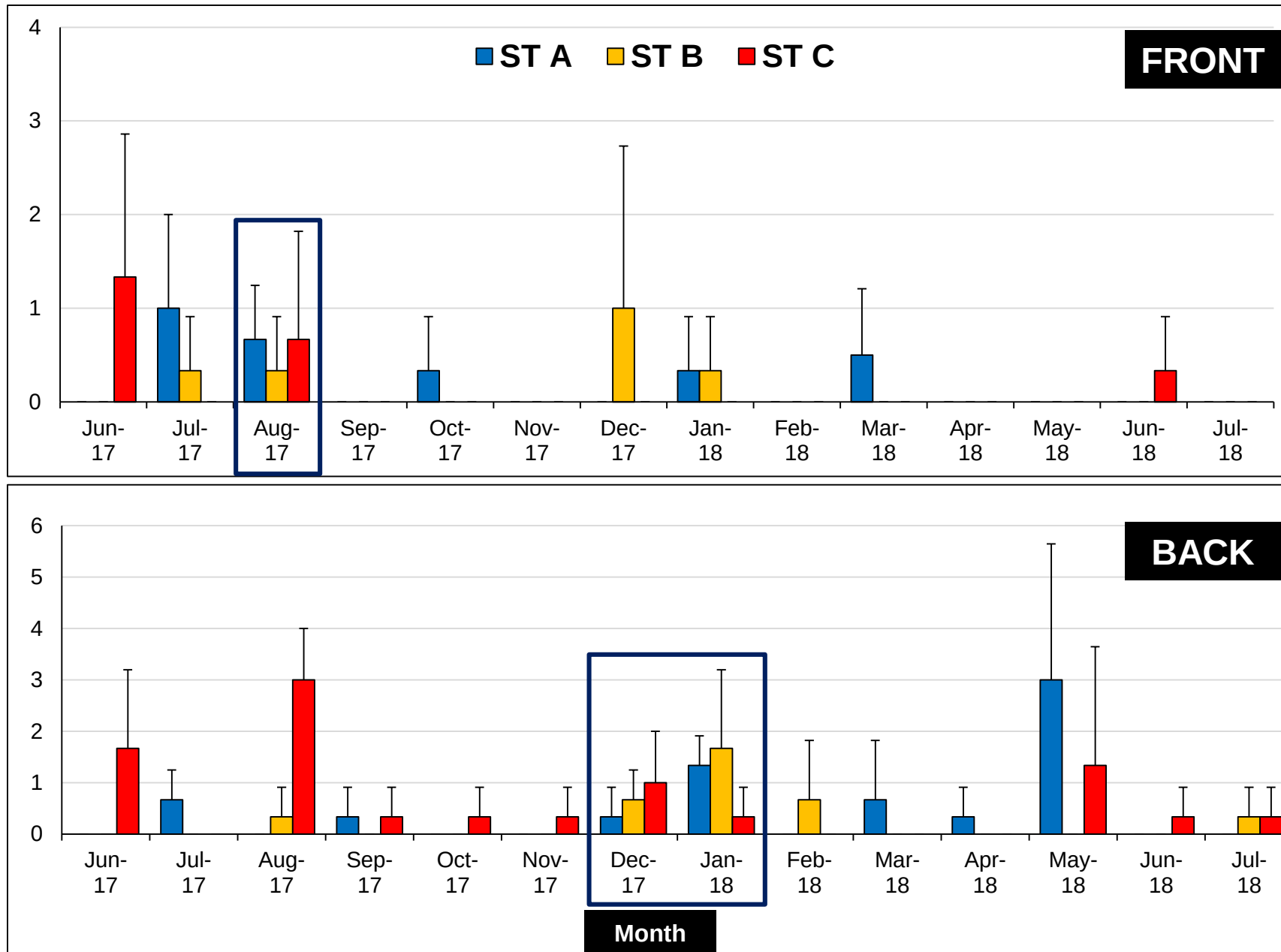


Month

# Mean density of *Ficopomatus cf. uschakovi* tube

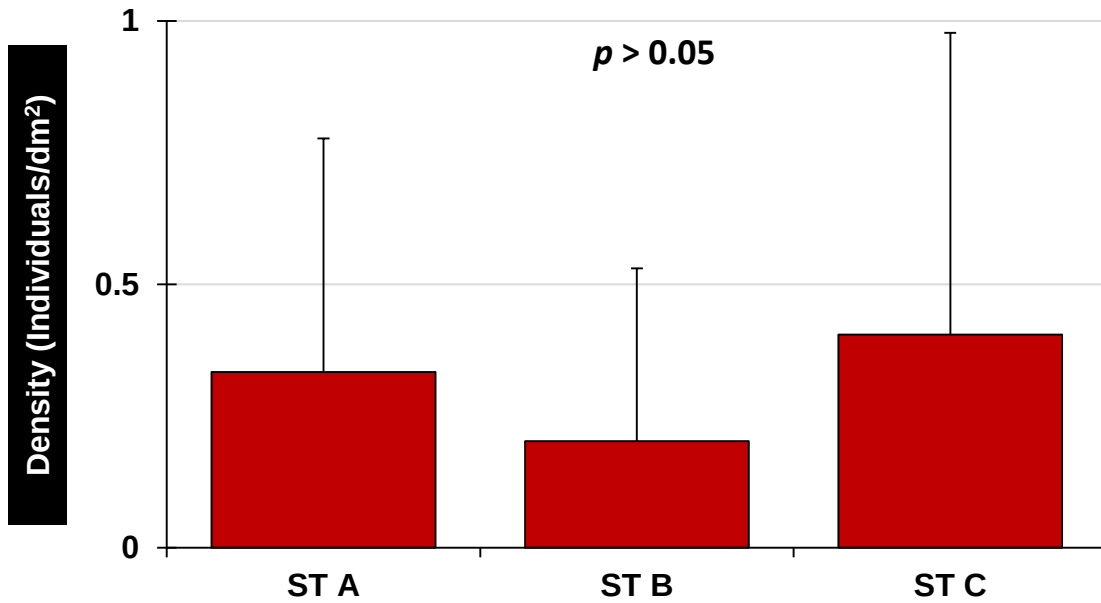


# Mean density of *Ficopomatus cf. uschakovi* tube



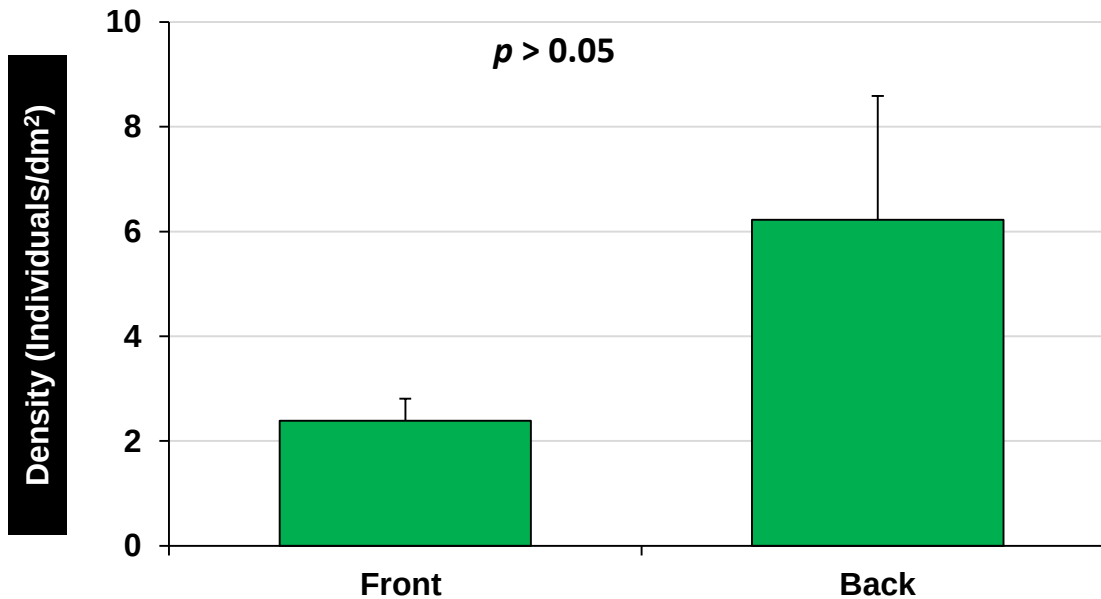
- Kruskal Wallis test:

- **Wide variation**
- Mean density (front & back) **did not differ significantly** ( $p > 0.05$ ) between sampling stations
- **High density** – back side (protected orientation & weak current)



## Mean density VS station

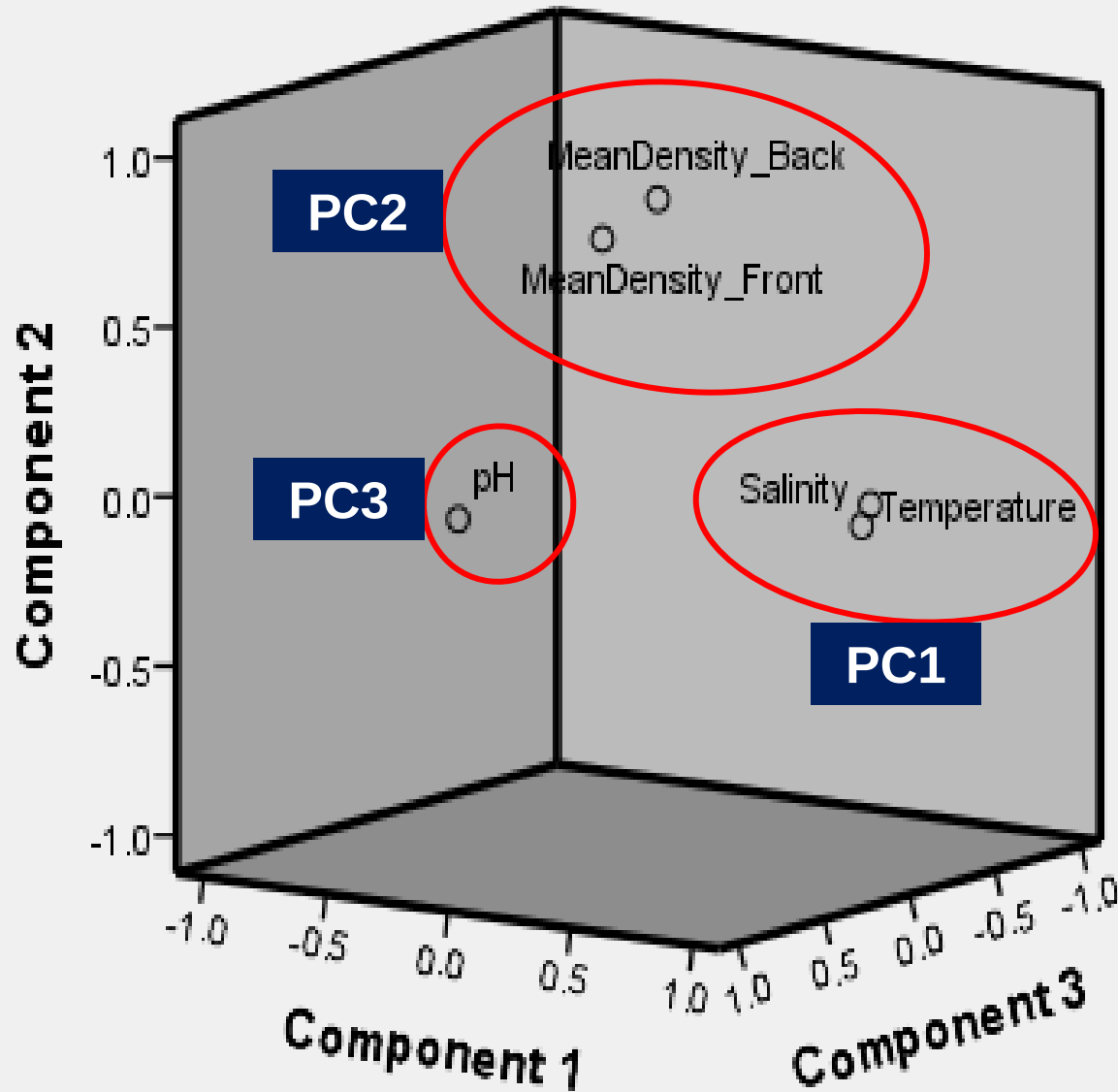
- High occurrence – **ST C** (high salinity & sheltered)
- Salinity – affected larval settlement (Dittmann *et al.*, 2009)



## Mean density VS plate

- High density – **back side** (protected orientation & weak current)
- Larval preference – **enclosed area & weak water currents** (Dittmann *et al.*, 2009)

# Principal Component Analysis (PCA)



- Distribution and occurrence affected by:
  - **temperature**
  - **salinity**
  - **pH**
- The occurrence and breeding periods of marine organisms largely depend on environmental fluctuations – particularly **temperature and salinity** (Sahu, 2011)

## Conclusion

### *Ficopomatus cf. uschakovi* in Setiu Wetlands:

-  Larval attachment – **spatially & temporally variable**
-  Higher density – station with **high salinity** & in **protected orientation**
-  Distribution & occurrence affected by **temperature, salinity & pH**

## Recommendations

- ✓ **Yearly monitoring** is needed
- ✓ **Settlement cue** for antifouling measures

# Acknowledgements



INOS staffs



Mr. Kamaruddin & Mr. Azmi



Postgraduate friends



Family members



**Research Grant**

## HICoE

Higher Institution Centre of Excellence  
(Vot. 66928)

**Scholarship**



**KEMENTERIAN PENDIDIKAN TINGGI**  
**MINISTRY OF HIGHER EDUCATION**

**Facilities & sponsor**



*Envision Marine Future*  
(Vot. 66904)



***Thank you for your attention!***

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## *Ficopomatus cf. uschakovi* settlement rate

| Station    | Plate position | Settlement rate<br>(individuals.dm <sup>-2</sup> /sampling month) |
|------------|----------------|-------------------------------------------------------------------|
| A          | Front          | 0.027                                                             |
|            | Back           | 0.067                                                             |
| B          | Front          | 0.020                                                             |
|            | Back           | 0.037                                                             |
| C          | Front          | 0.023                                                             |
|            | Back           | 0.090                                                             |
| Mean total |                | 0.044                                                             |

High value – back side

LOW settlement rate

# *Ficopomatus cf. uschakovi* settlement rate

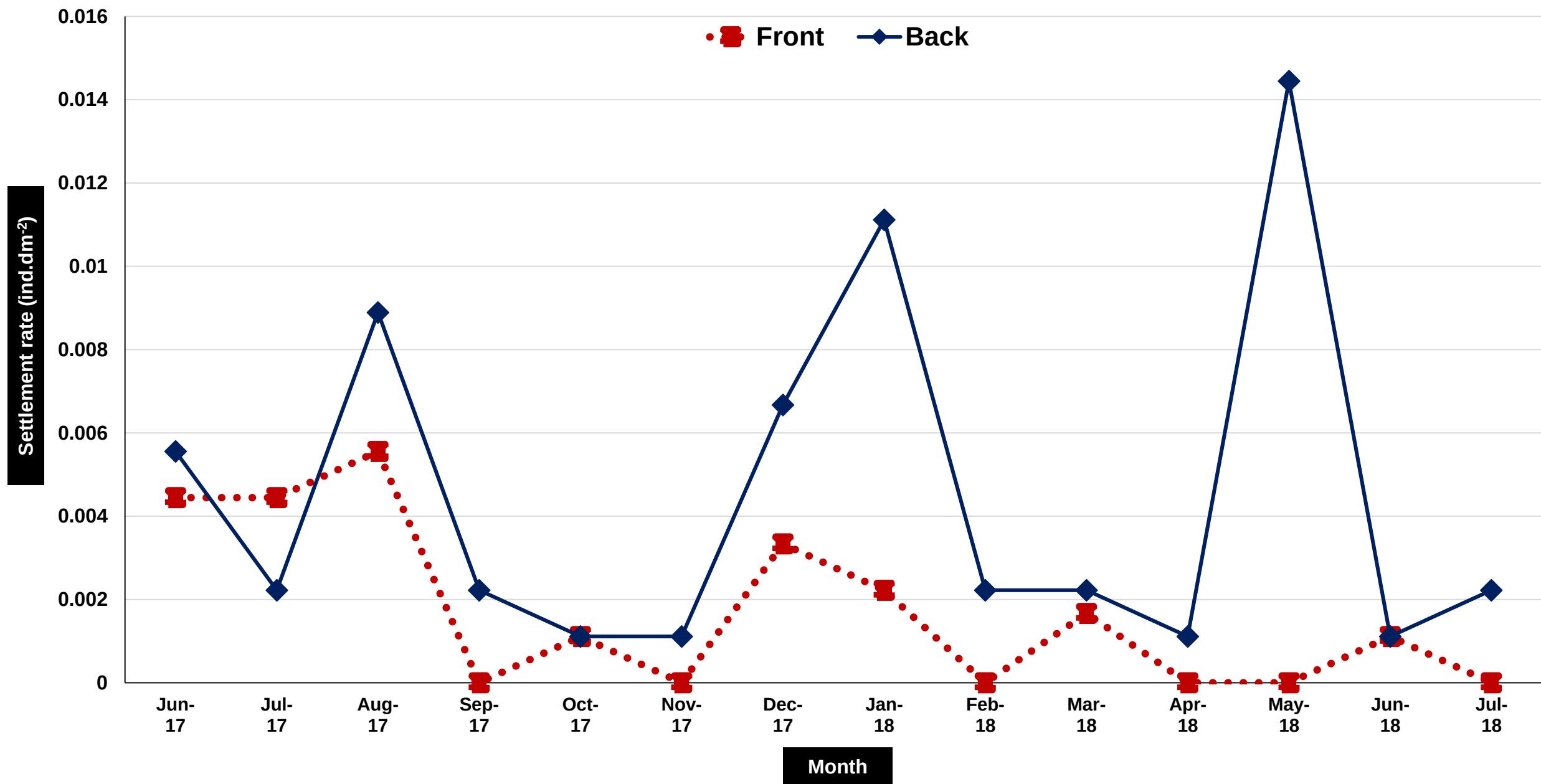


**Table 1:** Current geographic distribution of *Ficopomatus enigmaticus*.

| Continent                 | Country or region    | Source                                                                                                                                                                                                                                                                                              |
|---------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Europe                    | Baltic Sea           | Rasmussen 1958, Leppakoski & Olenin 2000                                                                                                                                                                                                                                                            |
|                           | Denmark              | Wesenberg-Lund 1941, Rasmussen 1958, Hartmann-Schröder 1971, Jensen & Knudsen 2005                                                                                                                                                                                                                  |
|                           | Germany              | Hartmann-Schröder 1967, 1971, Kühl 1977                                                                                                                                                                                                                                                             |
|                           | Netherlands          | Wolff 1968, 1969, ten Hove 1974, Vaas 1975, Velde <i>et al.</i> 1993                                                                                                                                                                                                                                |
|                           | Belgium              | Leloup and Lefevere 1952                                                                                                                                                                                                                                                                            |
|                           | France               | Fauvel 1923, 1933, Fischer 1925, Maury 1937, Bordet 1939, Remy 1948, Petit & Rullier 1952, 1956, Aleem 1952, Euzet & Poujol 1963, Rullier 1943, 1948, 1955b                                                                                                                                         |
|                           | England              | Monro 1924, Tebble 1953, 1956, Naylor 1959, Markowski 1962, Gee 1963, Nelson-Smith 1967, Harris 1970, Dixon 1977, 1980, 1981, Thorp 1987, 1994, Thomas & Thorp 1994, Joyce <i>et al.</i> 2005; see Zibrowius & Thorp 1989 and Eno <i>et al.</i> 1997 for review                                     |
|                           | Ireland              | Kilty & Guiry 1973                                                                                                                                                                                                                                                                                  |
|                           | Spain                | Rioja 1923, 1924, 1931, Fischer-Piette 1951, Martinez-Taberner <i>et al.</i> 1993, Fornos <i>et al.</i> 1997                                                                                                                                                                                        |
|                           | Portugal             | Freitas <i>et al.</i> 1994                                                                                                                                                                                                                                                                          |
|                           | Italy                | Lindegg 1934, Cognetti 1954, Rullier 1955a, Sichel 1965, Granda & Sabelli 1973, Bianchi 1981, 1983a, b, Bianchi <i>et al.</i> 1984, 1995, Aliani <i>et al.</i> 1995, Bianchi & Morri 1996, 2001, Ambrogi 2000, Bertozzi <i>et al.</i> 2002                                                          |
|                           | Greece               | Bogdanos & Satsmadjis 1992                                                                                                                                                                                                                                                                          |
|                           | Turkey               | Ergen 1976                                                                                                                                                                                                                                                                                          |
|                           | Bulgaria (Black Sea) | Marinov 1960                                                                                                                                                                                                                                                                                        |
|                           | Russia (Black Sea)   | Soldatova & Turpaeva 1960, Turpaeva 1961, Turpaeva <i>et al.</i> 1963, Shurova & Losovskaya 2003                                                                                                                                                                                                    |
|                           | Caspian Sea          | Bogoroditskiy 1963, Kasymov 1982                                                                                                                                                                                                                                                                    |
| Australia and New Zealand | Australia            | Monro 1938b, Allen 1953, Dew 1959, Straughan 1966, 1971, 1972a, Geddes & Butler 1984, Pollard & Hutchings 1990, Johnston & Keough 2003, Hewitt 2002, Hewitt <i>et al.</i> 2004                                                                                                                      |
|                           | New Zealand          | Read & Gordon 1991, Probert 1993, Forrest <i>et al.</i> 1997                                                                                                                                                                                                                                        |
| Asia                      | Japan                | Kajihara <i>et al.</i> 1976, Okamoto <i>et al.</i> 1995, Okamoto & Watanabe 1997, Nishi 2003, Iwasaki <i>et al.</i> 2004                                                                                                                                                                            |
| Oceania                   | Hawaii               | Hartman 1966, Straughan 1969, Bailey-Brock 1976                                                                                                                                                                                                                                                     |
| North America             | USA (East Coast)     | California: Smith & Carlton, 1975, Morris <i>et al.</i> 1980, Cohen & Carlton 1995, Heiman 2006, Heiman <i>et al.</i> 2008                                                                                                                                                                          |
|                           | USA (West Coast)     | New Jersey: Hoagland & Turner, 1980                                                                                                                                                                                                                                                                 |
|                           |                      | Maryland: Ruiz <i>et al.</i> 2000, Jewett <i>et al.</i> 2005                                                                                                                                                                                                                                        |
| South America             | Argentina            | Texas: Hartman 1952                                                                                                                                                                                                                                                                                 |
|                           |                      | Rioja 1943, Orensanz & Estivariz 1971, Schwindt 1997, Obenat 2001, Obenat & Pezzani 1989, 1994, Spivak <i>et al.</i> 1994, Schwindt <i>et al.</i> 2001, Schwindt & Iribarne 1998, 2000, Schwindt <i>et al.</i> 2004a, b, Luppi & Bas 2002, Obenat <i>et al.</i> 2006, Bruschetti <i>et al.</i> 2008 |
|                           | Uruguay              | Monro 1938a, Muniz <i>et al.</i> 2005a, Borthagaray <i>et al.</i> 2006                                                                                                                                                                                                                              |
| Africa                    | West Africa          | Kirkegaard 1959, Zibrowius 1973                                                                                                                                                                                                                                                                     |
|                           | Tunis                | Seurat 1927, Heldt 1944, Vuillemin 1952, 1954, 1958, 1964, Zaouali & Baeten 1983, Zibrowius 1978, Keene 1980, Ben Charrada, 1995, Diawara <i>et al.</i> 2008                                                                                                                                        |
|                           | Egypt                | Samaan & Aleem 1972, Ghobashy & Ghobashy 2005                                                                                                                                                                                                                                                       |
|                           | Côte d'Ivoire        | Rullier 1955c                                                                                                                                                                                                                                                                                       |
|                           | South Africa         | Day 1951, Stewart & Davies 1986, Davies <i>et al.</i> 1989                                                                                                                                                                                                                                          |

## Control method (Australia):

- Deoxygenation of ballast water using nitrogen gas (killed 80% of larvae)
- Physical – freshwater
- Mechanical – scrapping
- Chemical – anti-fouling paint

(Dittmann et al, 2009)

### Total Variance Explained

| Component | Initial Eigenvalues |               |              | Extraction Sums of Squared Loadings |               |              | Rotation Sums of Squared Loadings |               |              |
|-----------|---------------------|---------------|--------------|-------------------------------------|---------------|--------------|-----------------------------------|---------------|--------------|
|           | Total               | % of Variance | Cumulative % | Total                               | % of Variance | Cumulative % | Total                             | % of Variance | Cumulative % |
| 1         | 1.673               | 33.454        | 33.454       | 1.673                               | 33.454        | 33.454       | 1.641                             | 32.829        | 32.829       |
| 2         | 1.190               | 23.802        | 57.256       | 1.190                               | 23.802        | 57.256       | 1.196                             | 23.923        | 56.752       |
| 3         | 1.002               | 20.033        | 77.289       | 1.002                               | 20.033        | 77.289       | 1.027                             | 20.537        | 77.289       |
| 4         | .777                | 15.535        | 92.824       |                                     |               |              |                                   |               |              |
| 5         | .359                | 7.176         | 100.000      |                                     |               |              |                                   |               |              |

Extraction Method: Principal Component Analysis.

### Rotated Component Matrix<sup>a</sup>

|                   | Component |      |       |
|-------------------|-----------|------|-------|
|                   | 1         | 2    | 3     |
| MeanDensity_Front |           | .755 | .270  |
| MeanDensity_Back  |           | .790 | -.224 |
| Temperature       | .900      |      |       |
| pH                |           |      | .948  |
| Salinity          | .905      |      |       |

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.