Marine construction as a factor boosting *Aurelia aurita* s.l. blooms:

A case study of a new floating pier deployment in Hiroshima Bay, Japan

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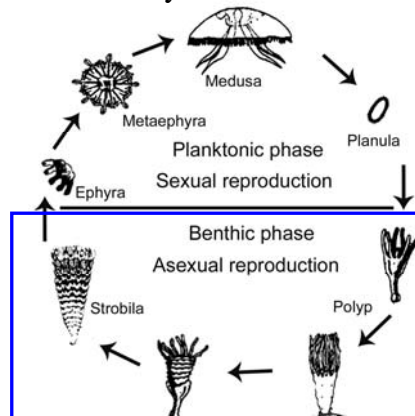Graduate School of Biosphere Science, Hiroshima University

Background

Increase of marine constructions is thought to be one of the causes of frequent jellyfish outbreaks in recent years, although no direct evidence has been reported.

The life cycle of *Aurelia aurita*

Increase of polyp habitat

Medusa

Metaephyra

Planktonic phase
Sexual reproduction

Planula

Ephyra

Benthic phase
Asexual reproduction

Strobila

Polyp

Important to determine population size of the medusae

Background

Similar scenario might occurred in the Inland Sea of Japan. During recent decades, both the bloom of *Aurelia aurita* medusae and increase of artificial coastline have co-occurred.

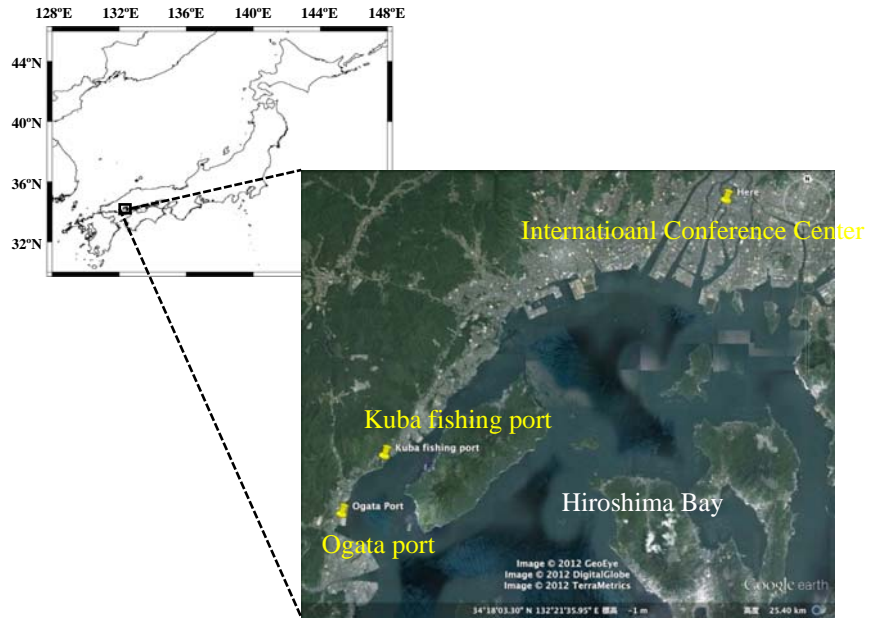In April 2010, a new floating pier was installed in the Kuba fishing port, Hiroshima Bay.

The aim of this study

To test the bellow hypothesis with monitoring of **the medusae** before and after the pier installment and of **the polyp population**

Working hypothesis

'Increase of marine constructions boosts blooms of *A. aurita* medusae'

Study sites

Materials and Methods

Period: January 2010-July 2011

Frequency: weekly to monthly

Installment of a new pier:

in the Kuba port on 19 April 2010
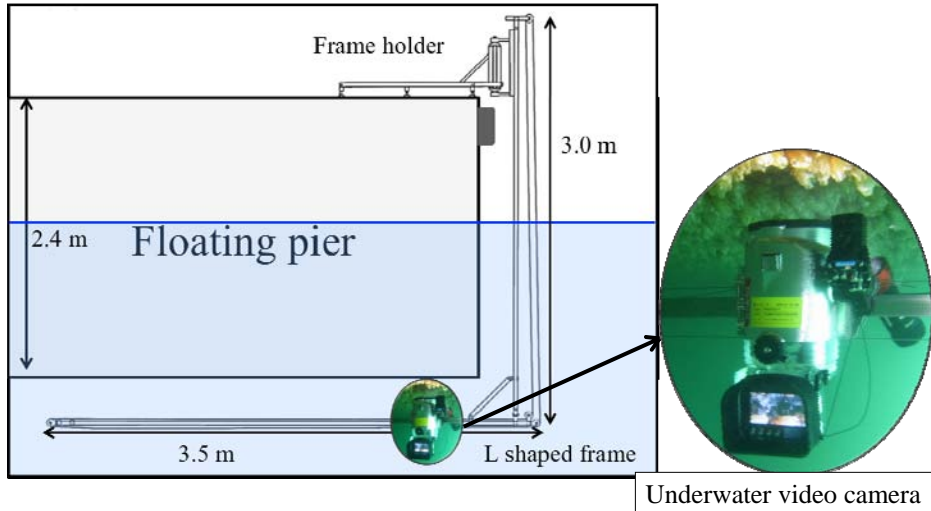
Monitoring methods

Medusa abundance and body diameter:

oblique tows of a modified NORPAC net
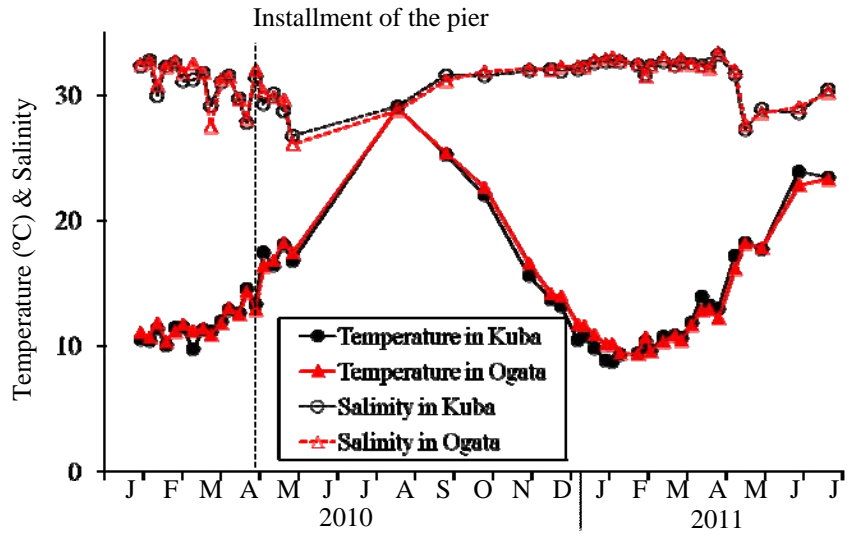(315 μm mesh)

Polyps population dynamics:

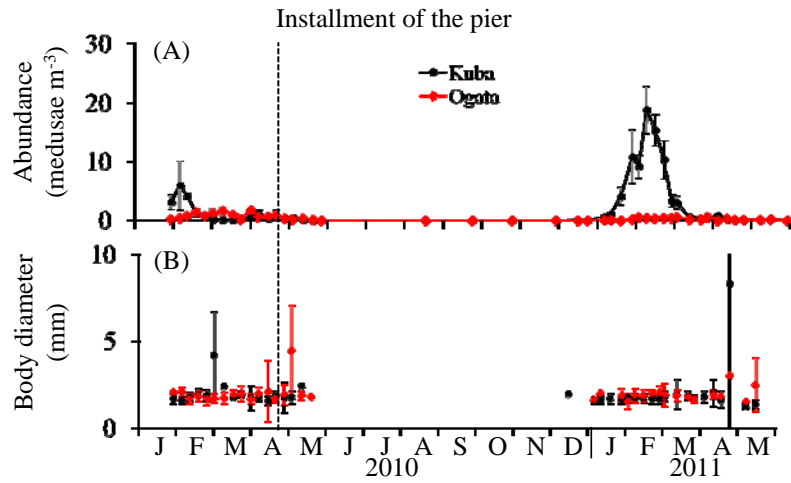SCUBA or a specially designed UPCAM

Undersurface Polyp CAMera (UPCAM)

Frame holder

3.0 m

2.4 m Floating pier

3.5 m   L shaped frame

Underwater video camera

This enable us quantitative monitoring of polyps
on the undersurface of the pier without SCUBA

Results 1: Environmental conditions

Installment of the pier

Temperature (°C) & Salinity

- Temperature in Kuba
- Temperature in Ogata
- Salinity in Kuba
- Salinity in Ogata

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2010   2011

Ogata was reasonable as a control

Abundance and body diameter of medusae

Installment of the pier

(A)

Abundance (medusae m^{-3})

Kuba
Ogata

(B)

Body diameter (mm)

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2010 2011

Relative integrated medusa abundance in Ogata port during 29 Jan.-13 May:
Before (in 2010) : After (in 2011) = 1.00 : 0.32

Estimation of the numbers of exported medusae from Kuba port

The export rate of medusae was calculated with medusa abundance and water exchange rate. The water exchange rate (Q_h) was calculated from the equation (Takeoka 1989). Tidal data were from Japan Coast Guard 5th Regional Coast Guard Headquarters.

$$Q_h = \frac{\beta \pi A \eta^2}{2 t_m h L W}$$

A: area (m^2)
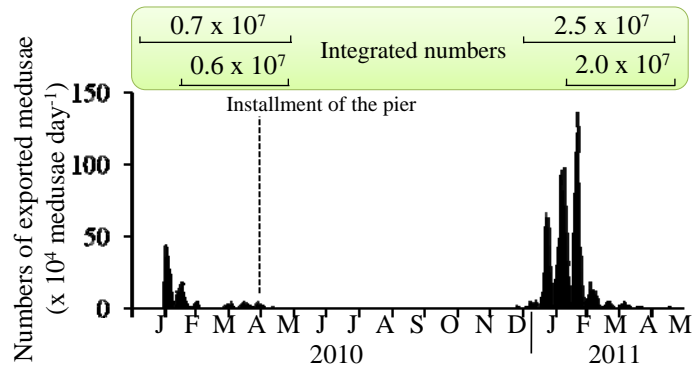H: water depth (m)
L: length (m)
W: width (m)
$\beta = 0.1$
t_m: M_2 cycle (seconds)
η: tidal range (m)

The numbers of exported medusae in Kuba port

Numbers of exported medusae (x 10^4 medusae day^{-1})

0.7×10^7
0.6×10^7

Integrated numbers

2.5×10^7
2.0×10^7

Installment of the pier

150

100

50

0

J F M A M J J A S O N D J F M A M
2010   2011

Estimated medusa number in Kuba port excluding those from the new pier:
(0.7 x 10^7 x 0.32 =) 0.2 x 10^7 medusae
→ 2.2 x 10^7 medusae derived from the pier

Effect of the pier on number of exported medusae

Duration	Estimated medusa number (x 10^7 medusae)
29 Jan.-13 May, 2010	0.6
29 Jan.-13 May, 2011	2.0
Dec. 2009-May 2010	0.7
Dec. 2010-May 2011	2.5

Estimated assuming same pattern of seasonal variation among the years

port excluding

(0.7 x 10^7 x 0.32 =) 0.2 x 10^7 medusae

Estimated medusa number derived from the new pier in Kuba port
(2.5 x 10^7 - 0.2 x 10^7 =) 2.2 x 10^7 medusae pier^{-1}

Large contribution of medusae from the new pier, increased the total number to **10.8-fold**

Population density of polyps and strobilae on the undersurface of the new pier
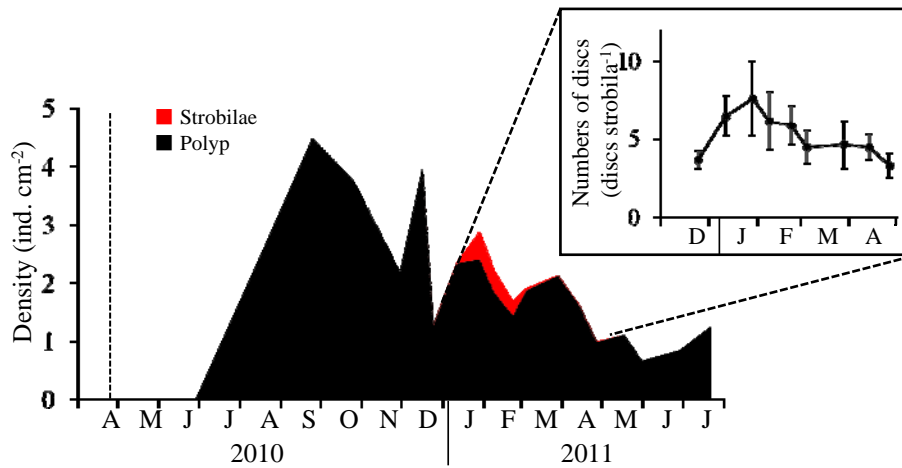
Numbers of ephyrae liberated from the new floating pier

Total number of ephyrae produced (*TP*, ephyrae cm^{-2}) was estimated by the following equations:

$$P_i = N \times D \times C^{-1}$$

$$C = 108.53 \times e^{-0.221 \times T}$$

$$TP = \sum_{i=1}^{n} P_i$$

P_i: daily production rate of ephyrae (ephyrae cm^{-2} day^{-1})
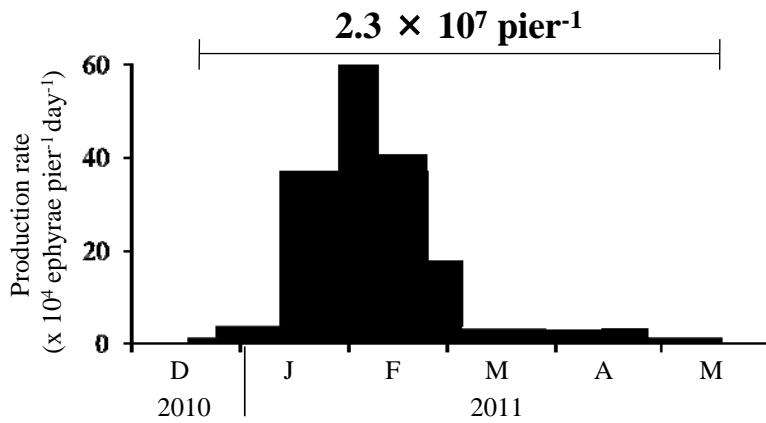N: density of strobilae (strobilae cm^{-2})
D: numbers of discs per strobilae (discs strobila^{-1})
C: duration of red-colored strobilae (days)
T: water temperature (ºC)

* The second equation (Duration of red-colored strobilae) was determined by the experiment.

Production rates of the ephyrae from the pier

2.3×10^7 pier^{-1}

Total numbers of ephyrae liberated from the pier:
2.3×10^7 ephyrae pier^{-1}

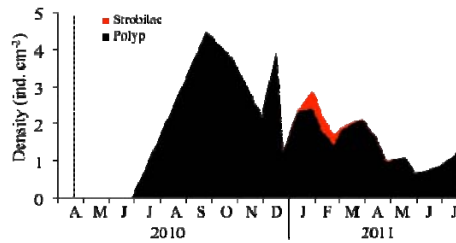Number of exported medusae derived from the pier:
2.2×10^7 medusae pier^{-1}

Summary

	Number of <u>exported</u> medusae (x 10^7 medusae)		
	From other than the pier	From the pier	Total
Before Dec. 2009 to May 2010	0.7	---	0.7
After Dec. 2010 to May 2011	0.2	2.2	2.5

10.8-fold

The new floating pier boosted the production of ephyrae

The results clearly supported the hypothesis!

1. The maximum polyp density: 4.5 polyps cm^{-2}

Low category (due to low productivity in the second year)

2. The size of the pier: 6 x 48 m

Relatively small compared to others

Several countermeasures are needed !

Thank you