Consequences of extensive aquaculture-structure removal: the relative importance of planktonic versus structure-related changes

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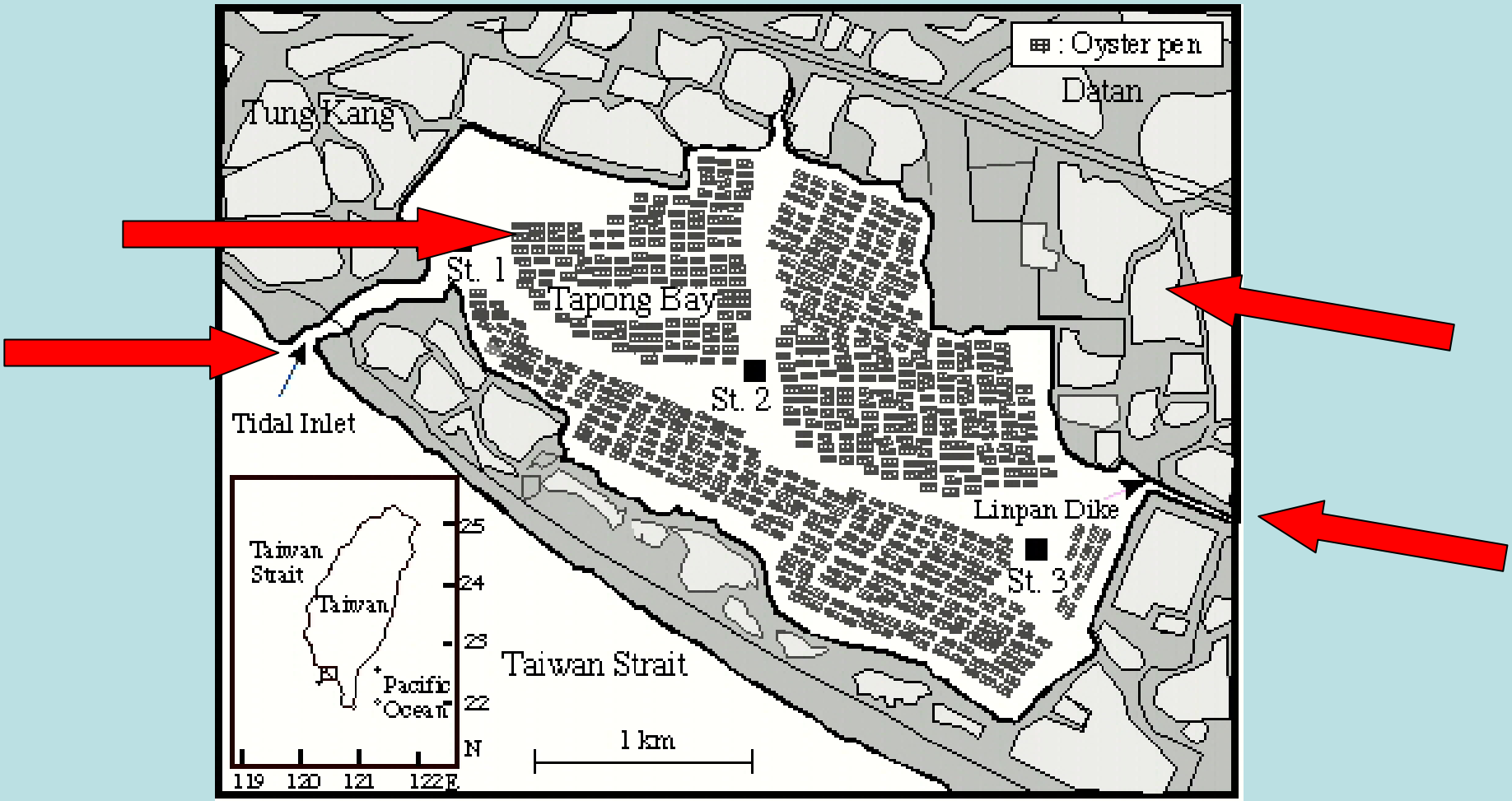
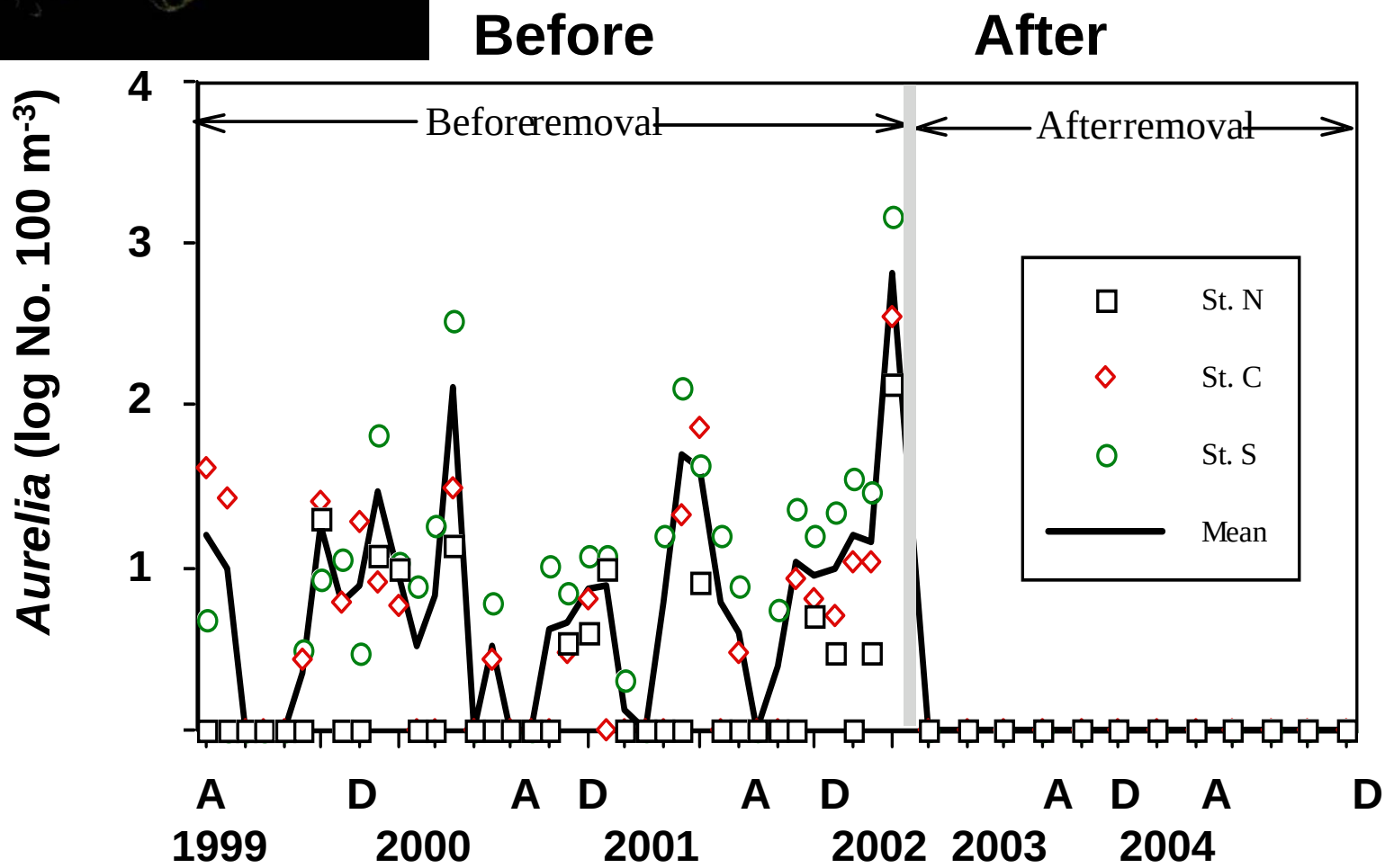
Tapong Bay is a small (4.44 km^2), semi-enclosed, shallow (2.2 m), eutrophic, tropical lagoon in southern Taiwan with nutrients from aquaculture rafts and ponds

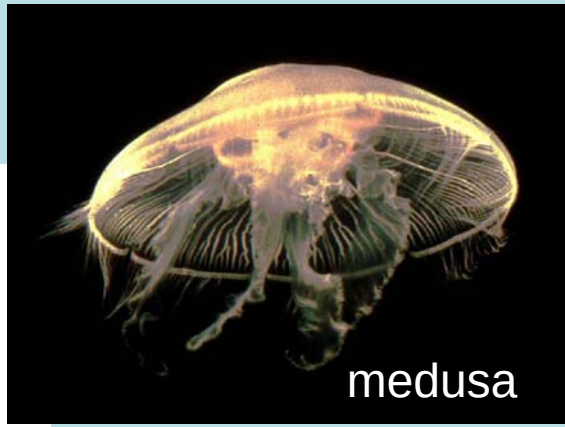


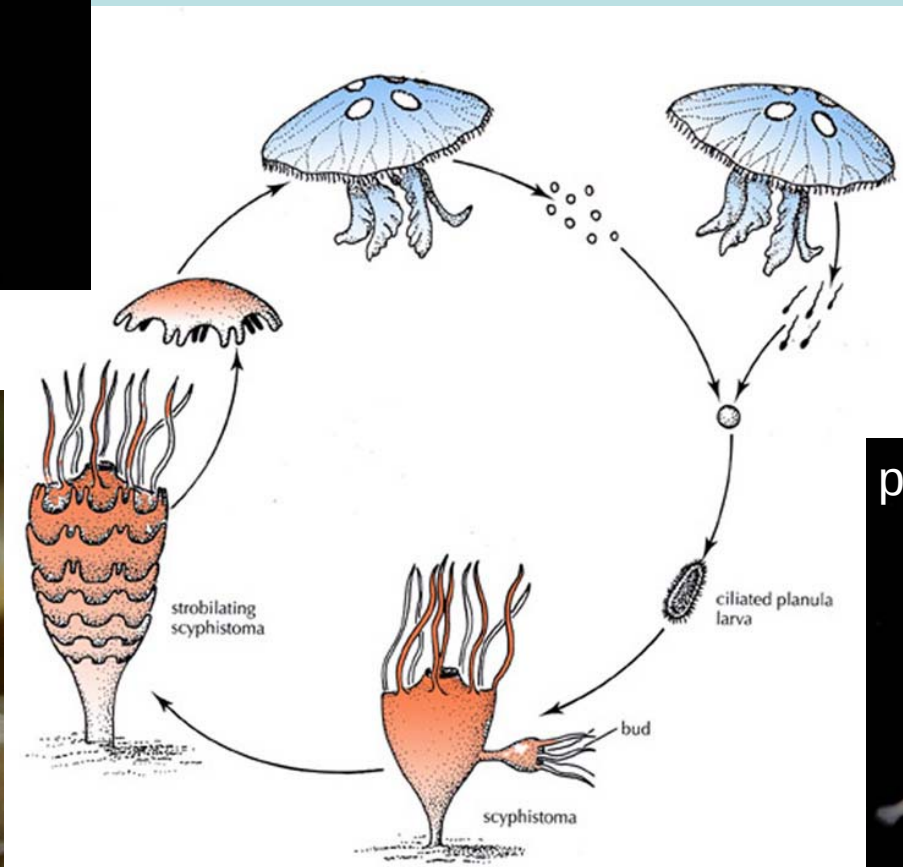
The five-year study was from Aug 1999 to Sep 2004 covering removal of oyster culture pens in Jun 2002

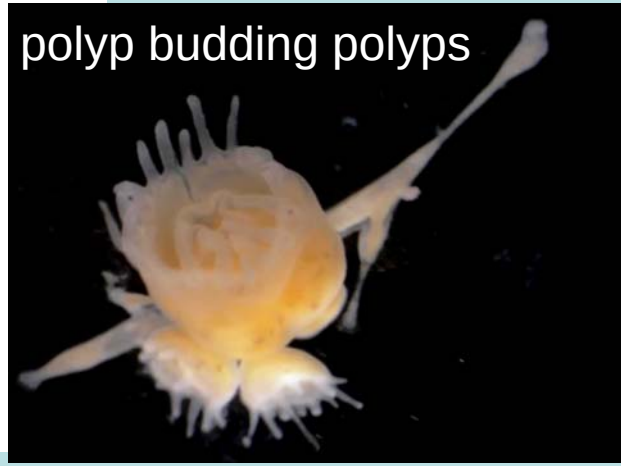
Jellyfish disappeared after removal of the aquaculture rafts



Life cycle of scyphozoan jellyfish







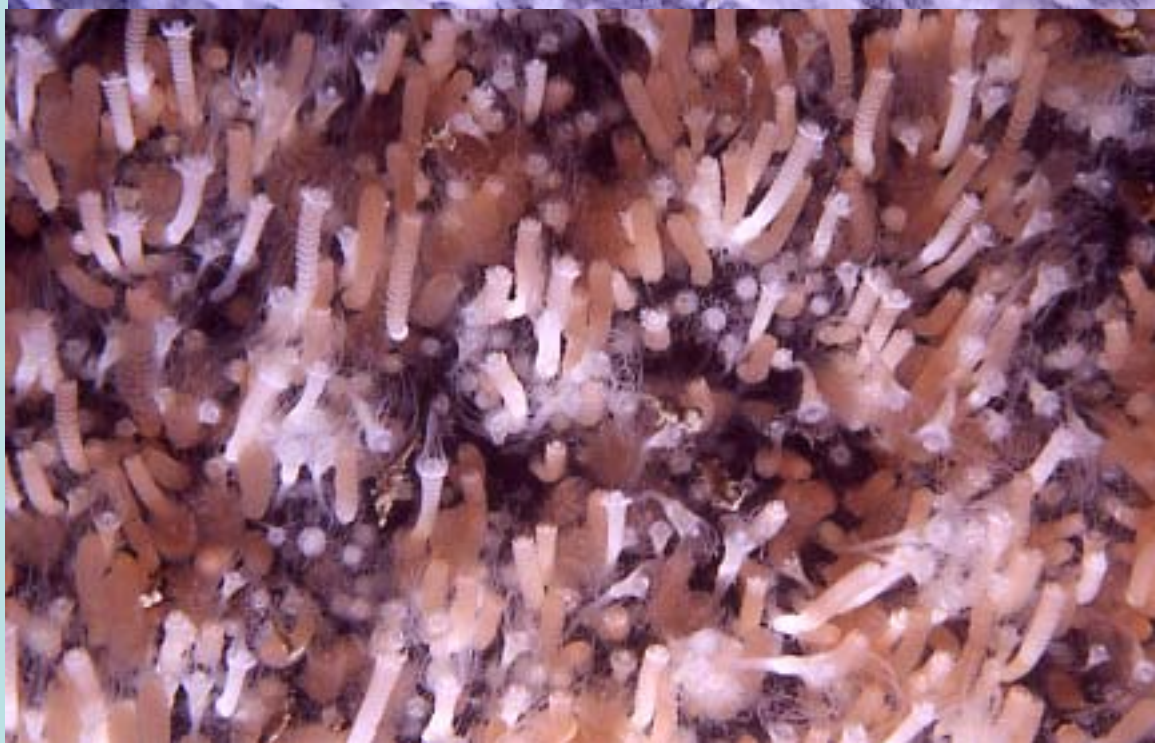
http://jellieszone.com/scyphomedusae.htm

17 Jan 04

Aurelia labiata
10 polyps cm^{-2}

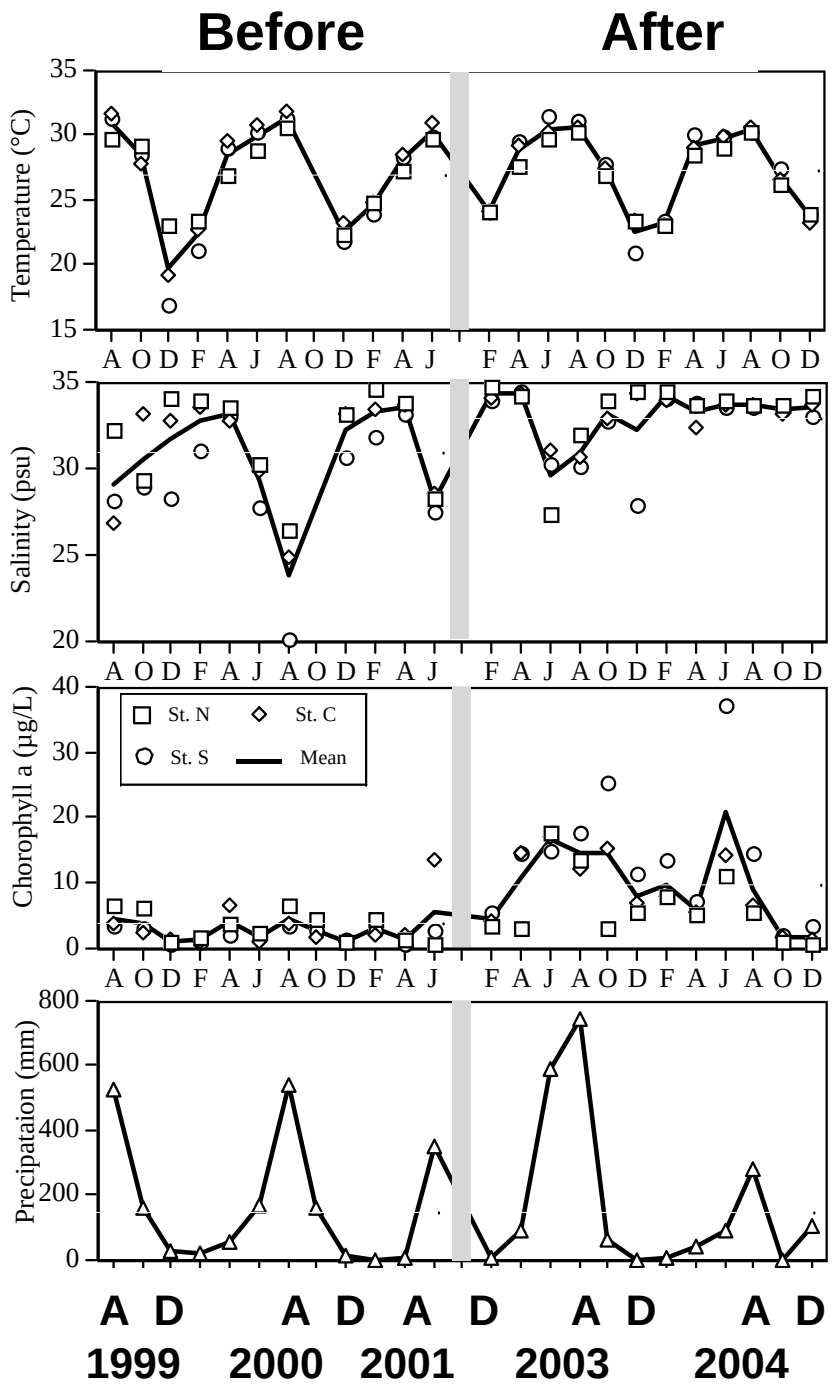
17 Feb 04

13.4 disks $polyp^{-1}$
est. 4,550 ephyrae



Data analyzed from Tapong Bay

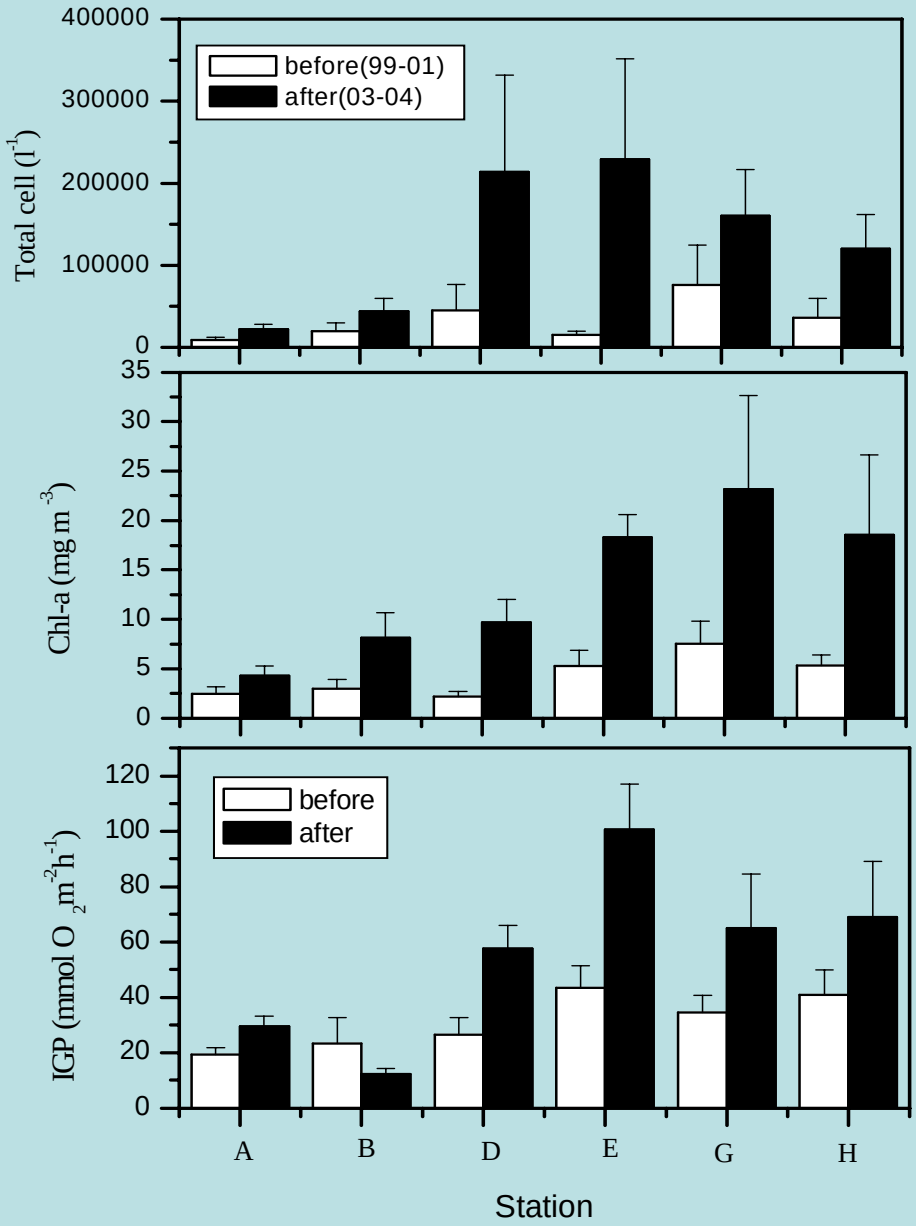
	Stas (No.)	Days before / after removal (No.)
Hydrography (T)	**3**	**11 / 12**
(S, pH, DO)	**10**	**9 / 5**
Water budget (exchange)	**1**	**9 / 5**
Nutrients (P, N, Si, C)	**10**	**9 / 5**
Phytoplankton, Chl-a, PP	**6**	**9 / 5**
Zooplankton and jellyfish	**3**	**11 / 12**



Hydrographic variables

26.9 Temperature (˚C) ≈ 27.2 NS
31.8 Salinity < 32.6 P = 0.002
6 Chl *a* (mg m-3) < 13 P = 0.01
169 mm Rain ≈ 168 NS

Phytoplankton, Chl a, primary production



3 x 10^4 Phytoplankton cells l^{-1}

≤ (diat : flag = 7:1)

13 x 10^4

P = 0.1 (diat : flag = 1:1) P = 0.02

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6 Chl a (mg m-3)

<

13

P = 0.01

PP (mmole O_2 m^{-3} h^{-1})

12

≤

19 P = 0.1

Nutrients generally were lower after removal but were not limiting

Nutrients (μM)	Before : After removal
DSi	20 >10, $p<0.05$
DIN	16 > 11, $p=0.1$
DIP	4.0 >1.5, $p=0.01$
DON	24 < 40, $p=0.1$
DOP	2.4 > 1.2, $p=0.1$
DOC	162 < 232, $p=0.1$

Nutrient ratios	Before : After removal
Si : N	1.2 > 0.9
Si : P	5.1 < 6.7
N : P	4.0 > 7.6
Changes occurred towards conditions that may favor jellyfish (eutrophic, but low Si : N and low diatoms : flagellates)	

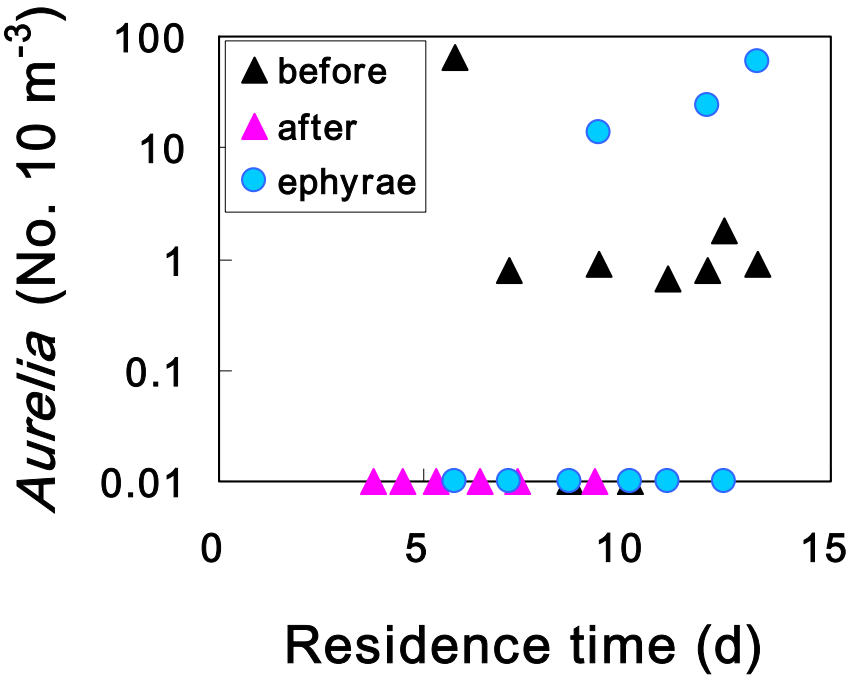
Copepod abundance was 5.6 times greater after removal 4,969 : 27,858 m^{-3}

Copepod species	Before : After removal
Oithona oculata	160.7
Paracalanus crassirostris	6.1
Acartia sinjiensis	35.5
Acartia sp.	2.5
Copepod nauplii	2.1
Bestolina amoyensis	125.1

- **Fewer competitors (oysters)**
- **Fewer predators (*Aurelia*)**

Food was plentiful for jellyfish

Possible effect of water exchange on *Aurelia*



Water exchange (d)		
	Inner	Outer
Before	7-24	4-12
After	5-13	3-7
Aurelia	0.088	0.035

Possible effect of light on *Aurelia*

Removal of culture rafts eliminated shaded surfaces for larval settlement. Increased light in Tapong Bay may have inhibited settlement on other surfaces.

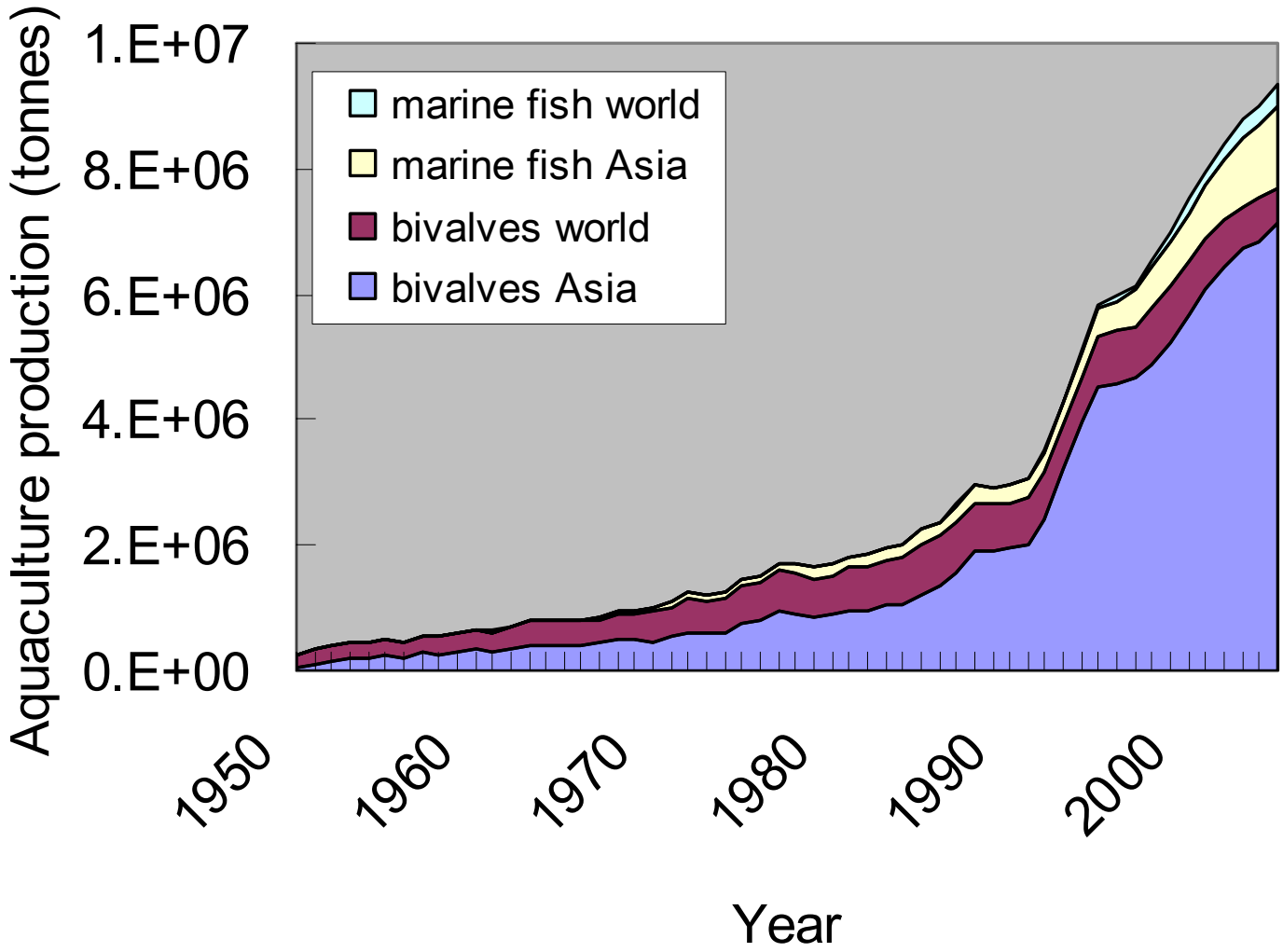
Light at bottom (μ E m^{-2} s^{-1})	
Before	197
After	225

What caused the jellyfish to disappear?

- Temp.,DO, pH?
- Salinity?
- Nutrients?
- Food?
- Light?
- Water exchange?
- Substrate?

- No change
- Combination Hi T/ Hi S?
- Decreased, but still high
- More production, more copepods. Better
- Increased. Too much light?
- Increased. Washed out?
- Mostly removed

World and Asian aquaculture trends 1950-2005 (FAO)



Conclusions

- Extensive aquaculture increased jellyfish population by providing surfaces and shading for jellyfish polyps, and increased retention in Tapong Bay
- Asian marine aquaculture is expanding rapidly, and may provide opportunities for jellyfish populations to increase, especially in semi-enclosed water bodies