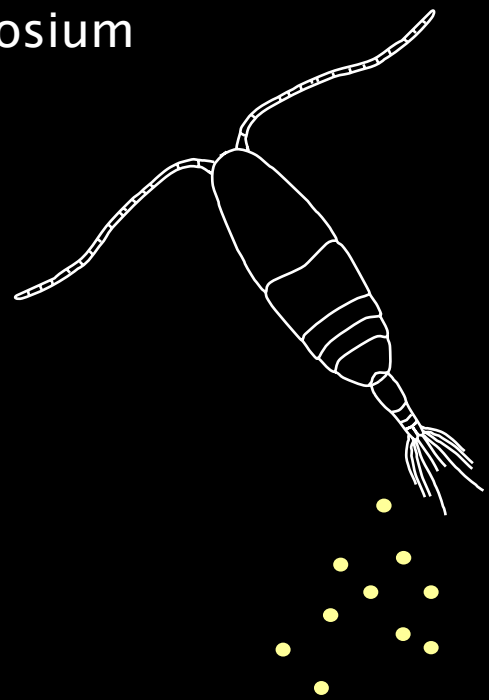
Effect of temperature on egg development time and hatching success of three congeneric Acartiid species (Copepoda: Calanoida) from the Straits of Malacca

4th International Zooplankton Production Symposium
May 28 – June 1, 2007, Hiroshima, Japan



Yoshida T, Liong CF, Toda T
& Othman BHR
Universiti Kebangsaan Malaysia

Overview

- Egg development times (EDT) of three congeneric *Acartia* species

- Importance of *Acartia* spp. in the Straits of Malacca

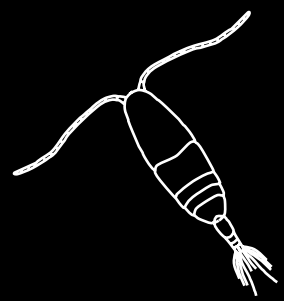
- Biological significance of temperature on egg development

Introduction

- Development rates important in predicting secondary production.

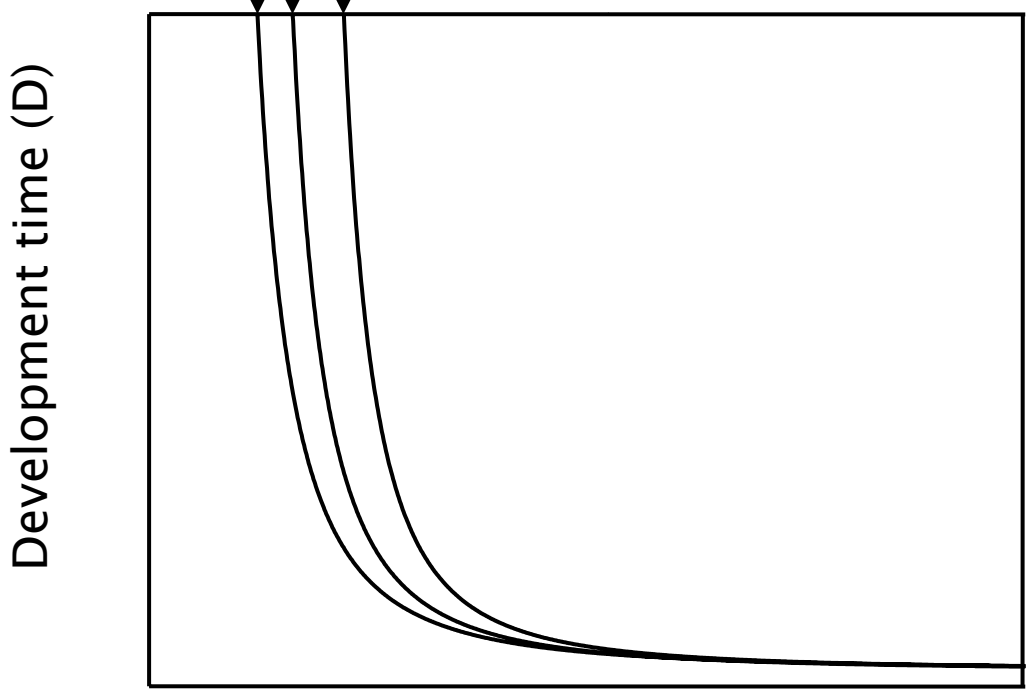
- Observations in tropical regions limited.

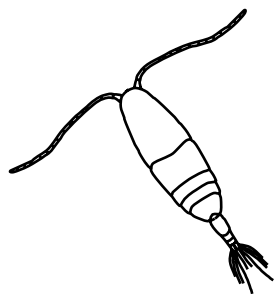
- *Acartia erythraea*, *A. pacifica* and *A. spinicauda* are one of the dominant copepods in the Straits of Malacca (Rezai et al. 2004, Yoshida et al. 2006).



Introduction

A. clausi (L. Striven, Scotland; McLaren 1978)
A. clausi (Nova Scotia; McLaren 1969)
A. hudsonica (Onagawa Bay, Japan; Uye 1980)



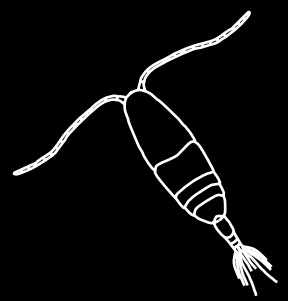


Objectives

To examine temperature effects on:

- Egg development time (EDT)
- Hatching success

of the three congeneric Acartiid copepods from the tropical waters of the Straits of Malacca

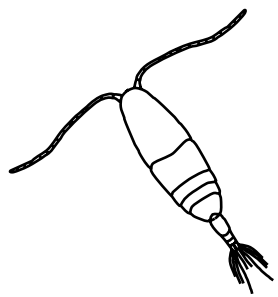


Materials and Methods

Sampling site

Straits of Malacca (nearshore)
Average depth = 6 m
Plankton net: 300 μm

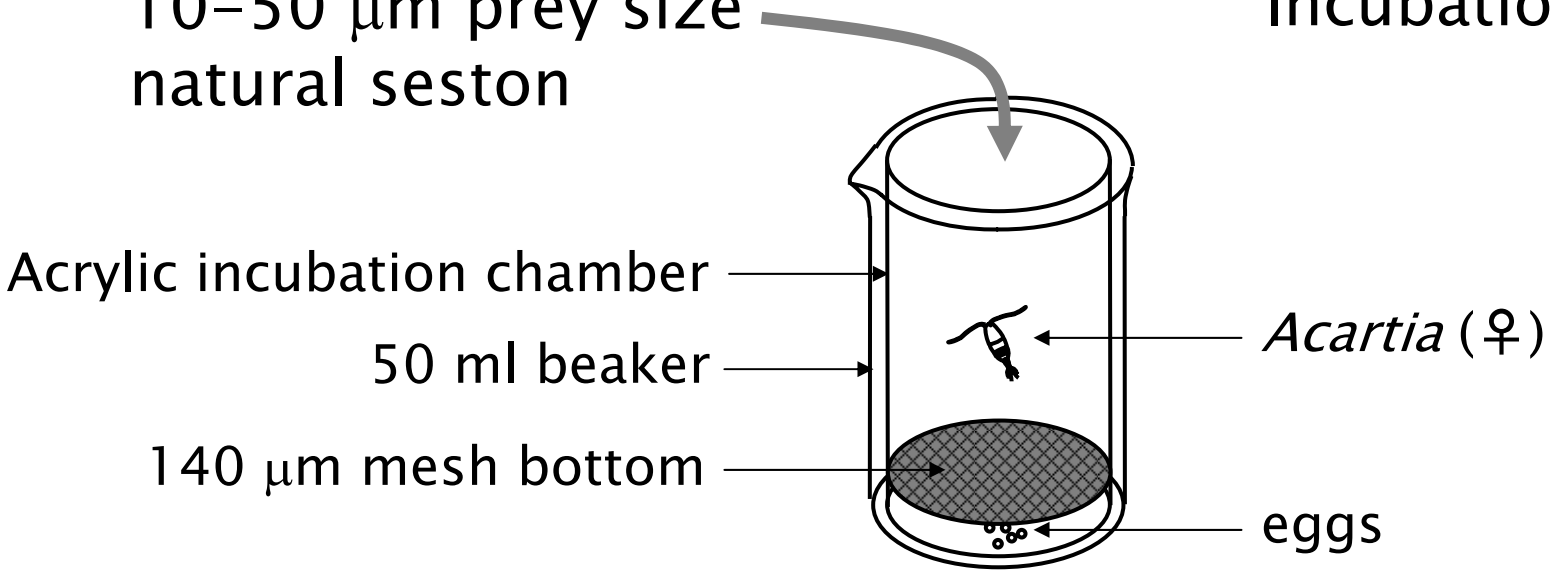
Live samples brought back to Marine Science Station University Putra Malaysia within 30 min.



Materials and Methods

10–50 μm prey size
natural seston

Incubation: 26 °C



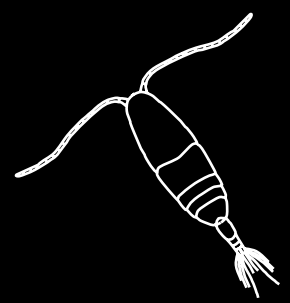
Materials and Methods

Eggs:

- Transferred to multi-well dish
- 5 ml filtered seawater (0.22 μm Millipore)
- Fresh eggs used (spawned within 2 hr)

EDT experiments:

- Incubation temperatures 10, 14, 18, 22, 27, 31 ^{o}C
- Hatching of eggs checked periodically
- EDT defined by Belehrádek's function
- Hatching success calculated



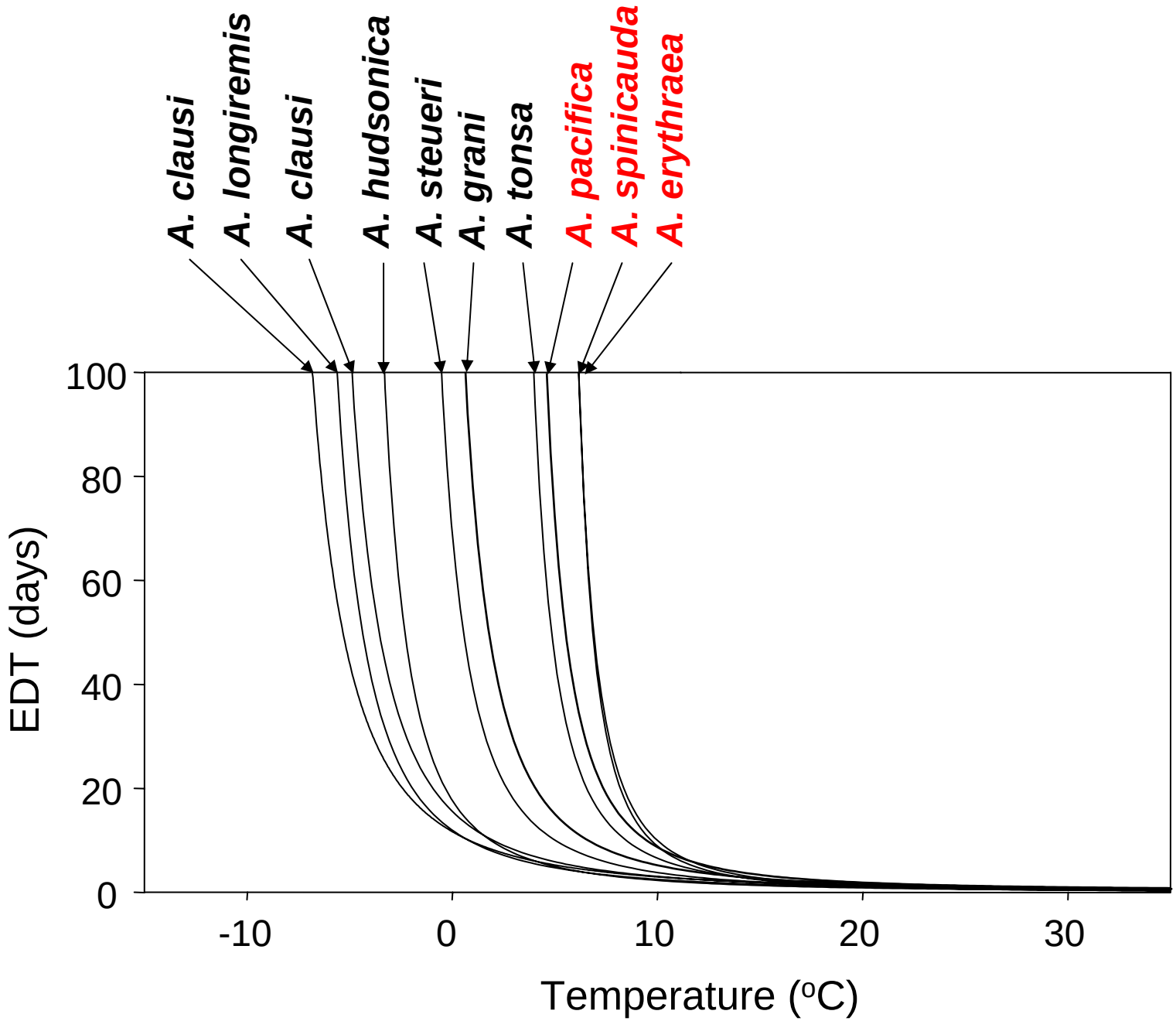
Egg development time

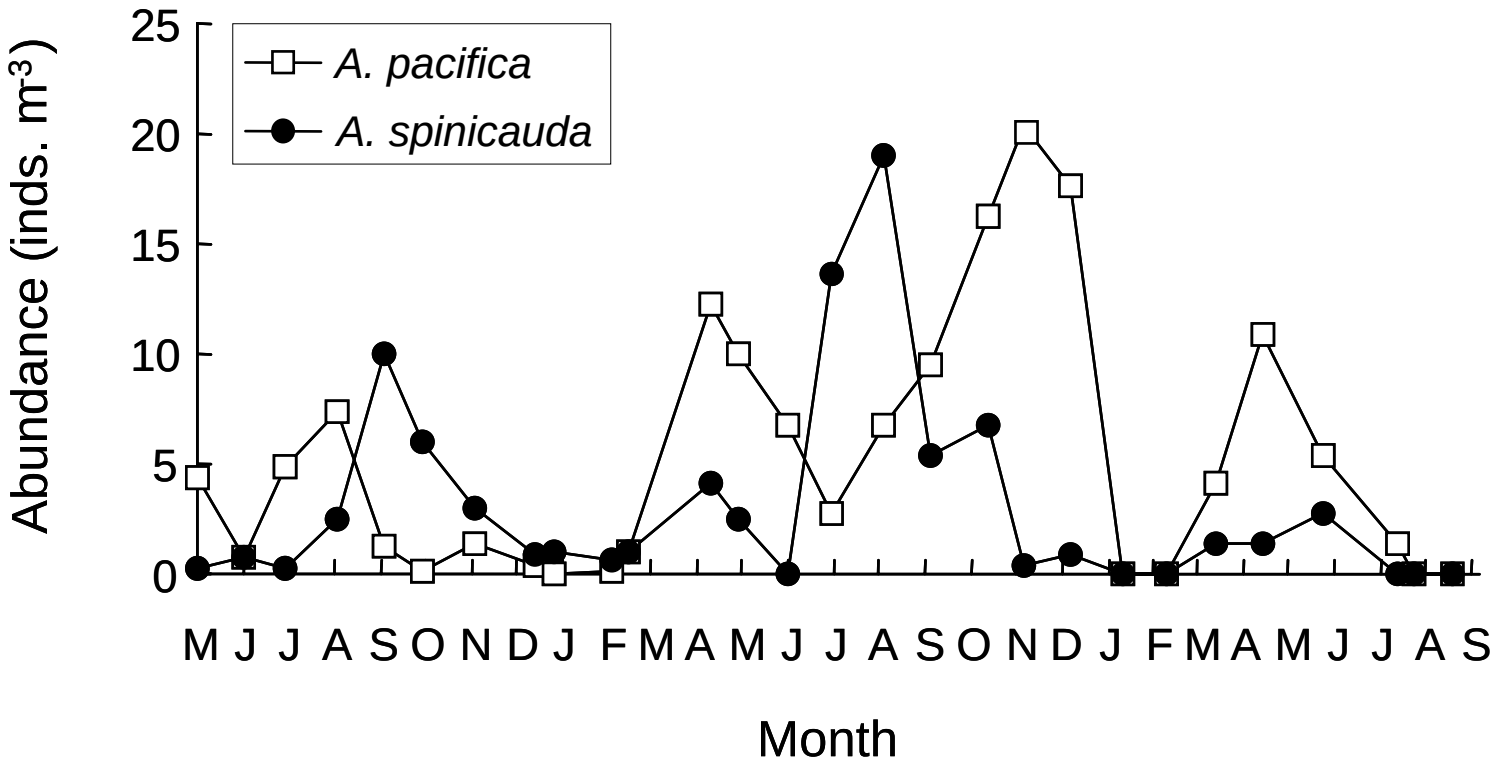
Species	Equation	Correlation coefficient
A. erythraea	$D = 294(T-4.47)^{-2.05}$	r = 0.980
A. pacifica	$D = 545(T-2.16)^{-2.05}$	r = 0.983
A. spinicauda	$D = 352(T-4.30)^{-2.05}$	r = 0.996

Belehrádek's temperature function

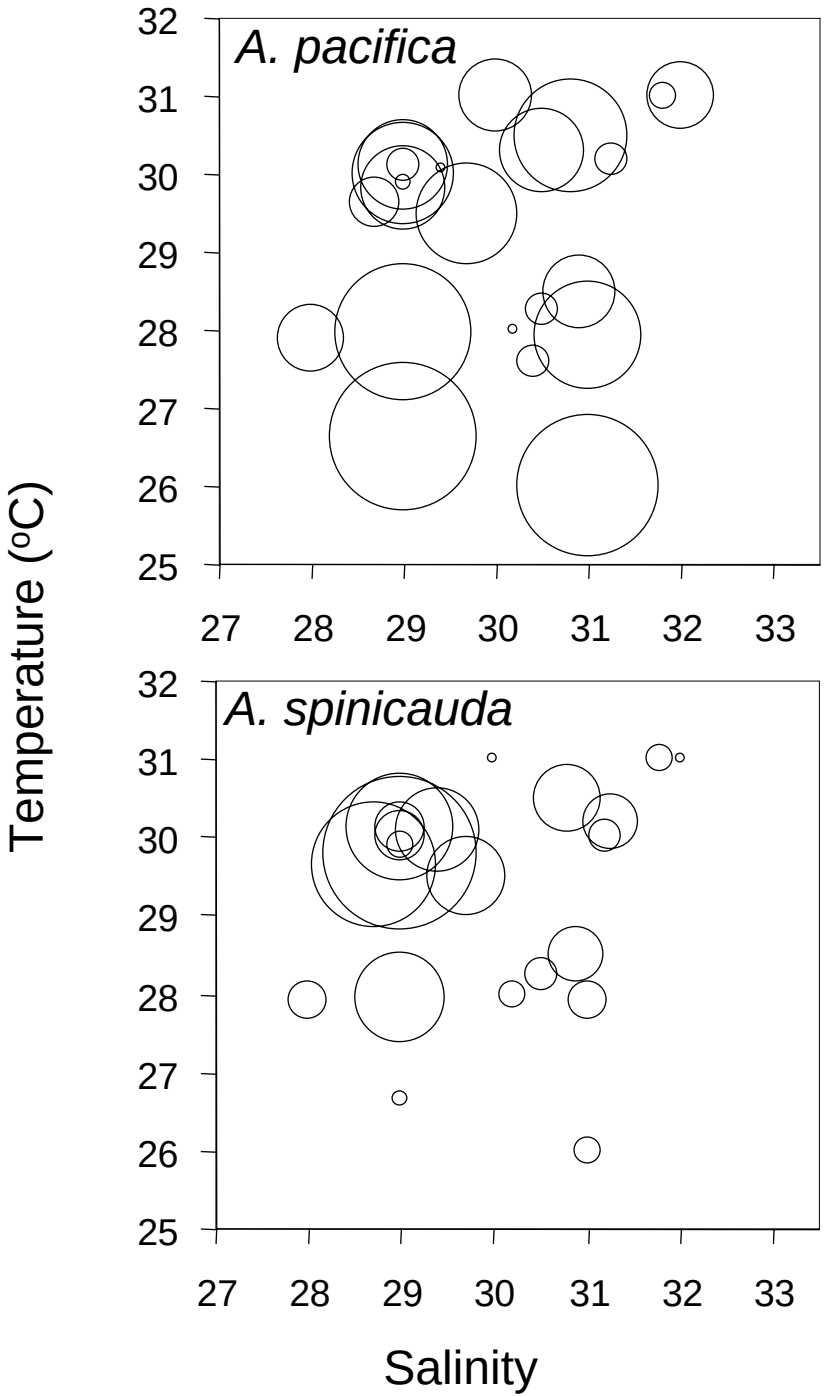
$$D = a(T-\alpha)^b$$

D : development time (days)
T : temperature (^{o}C)
α : 'biological zero'


A. clausi
A. longiremis
A. clausi
A. hudsonica
A. steueri
A. grani
A. tonsa
A. pacifica
A. spinicauda
A. erythraea
100
80
60
40
20
0
EDT (days)
-10
0
10
20
30
Temperature (°C)



Seasonal variation of *Acartia pacifica* and *A. spinicauda* abundance at a fixed station in the Straits of Malacca (Yoshida et al. 2006)



Low temperature
High salinity

Scale (inds. m^{-3})

10.0

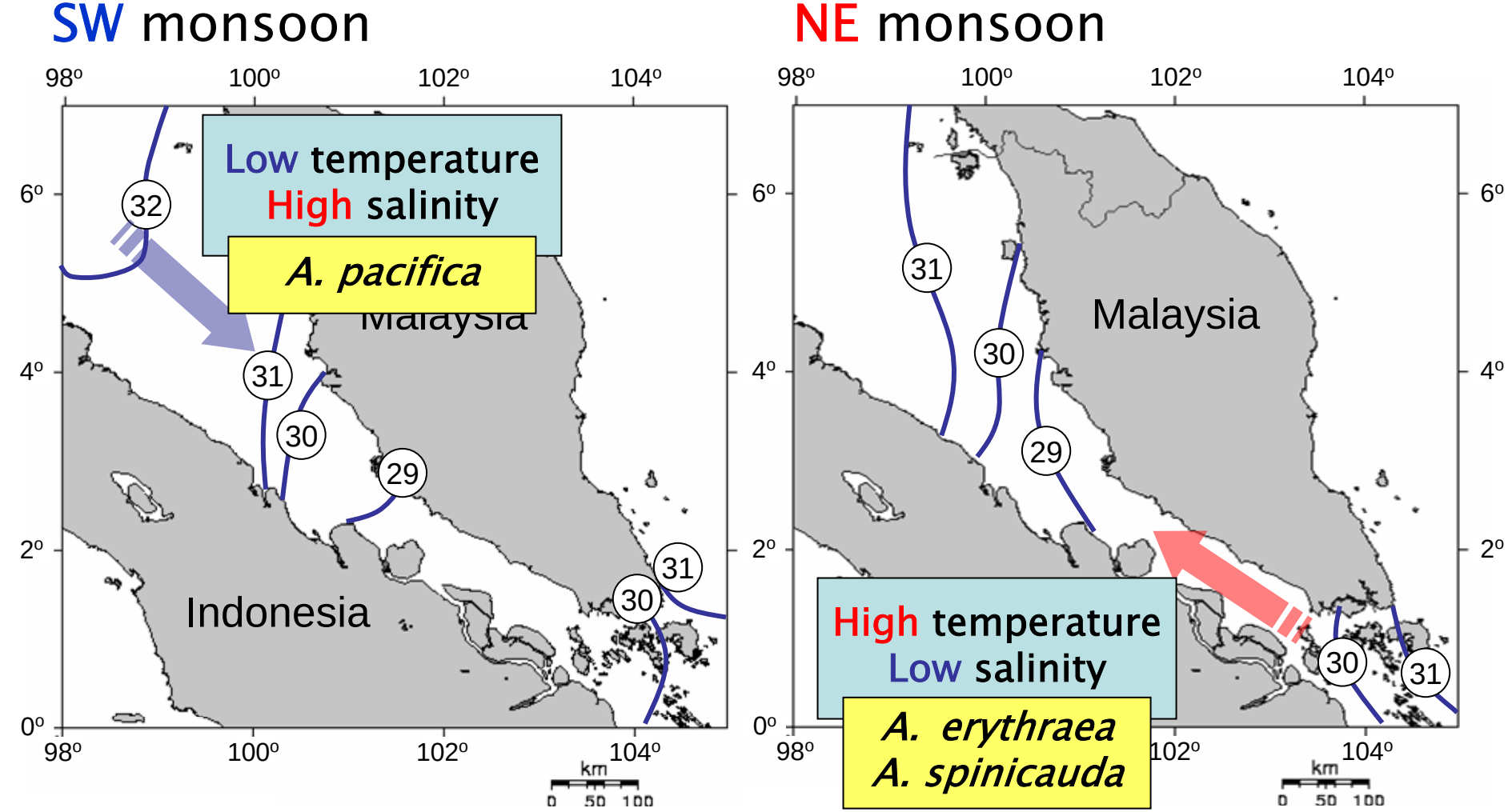
2.5

0.5

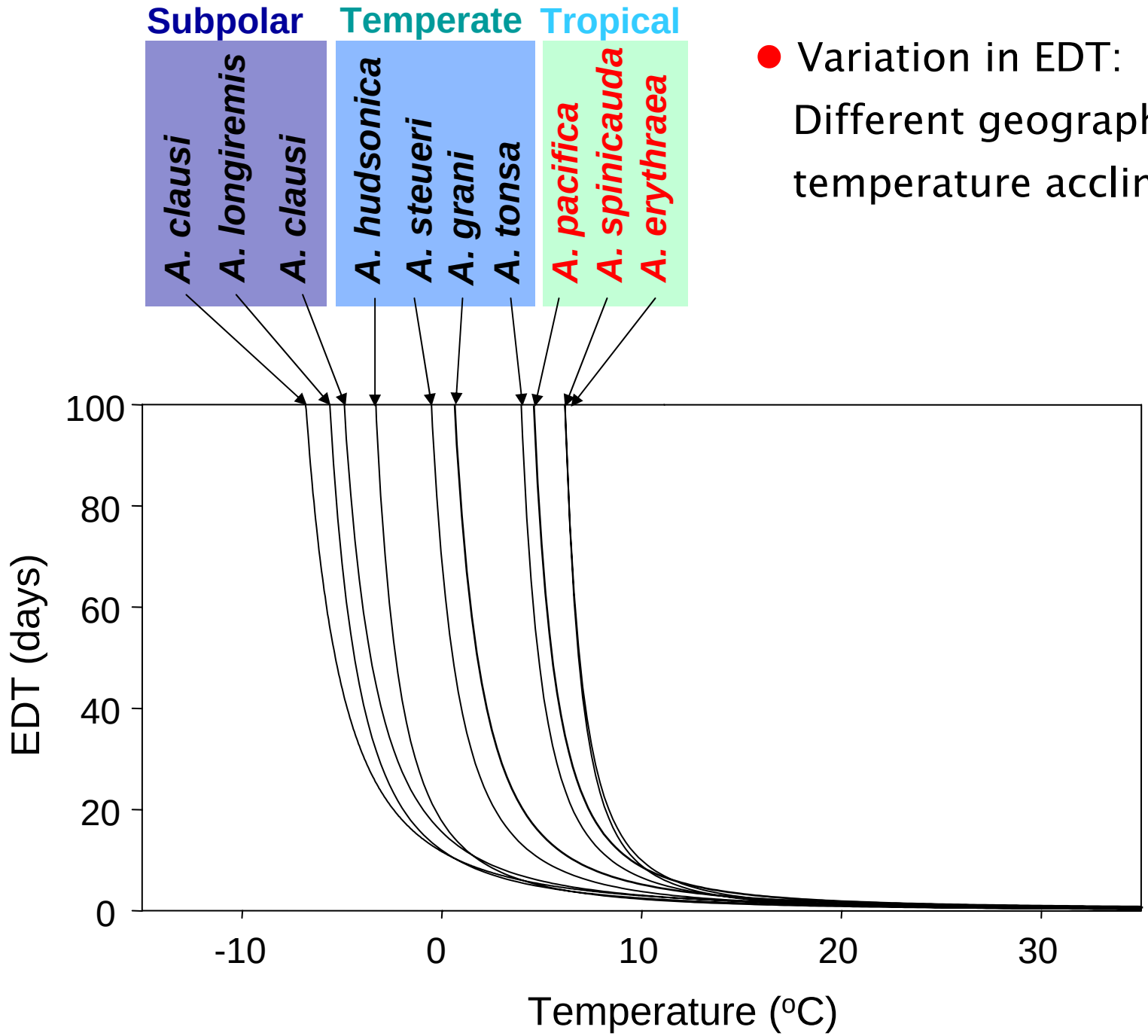
High temperature
Low salinity

Temperature-salinity distribtuion of *A.pacifica* and *A. spinicauda*

(Yoshida et al. 2006)

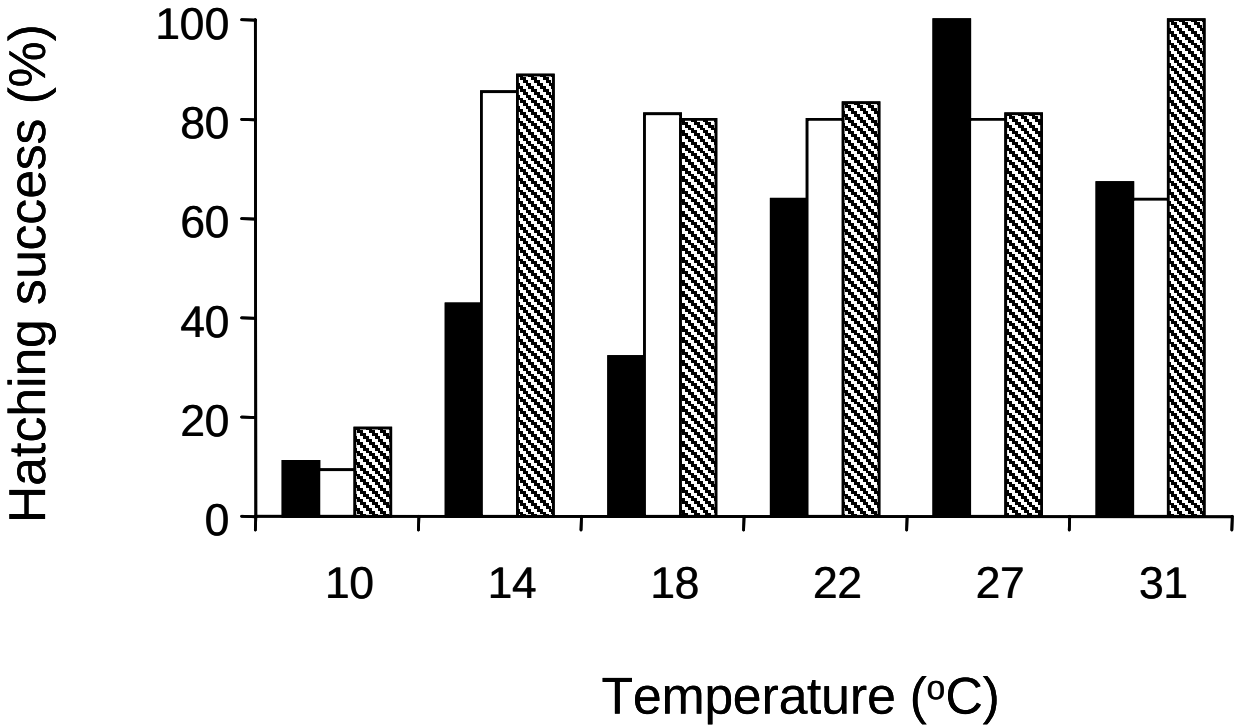


Average surface salinity in the Straits of Malacca



- Variation in EDT: Different geographic temperature acclimations

Hatching success



Mean hatching success (14–31 °C)

A. erythreae	61 %
A. pacifica	78 %
A. spinicauda	87 %

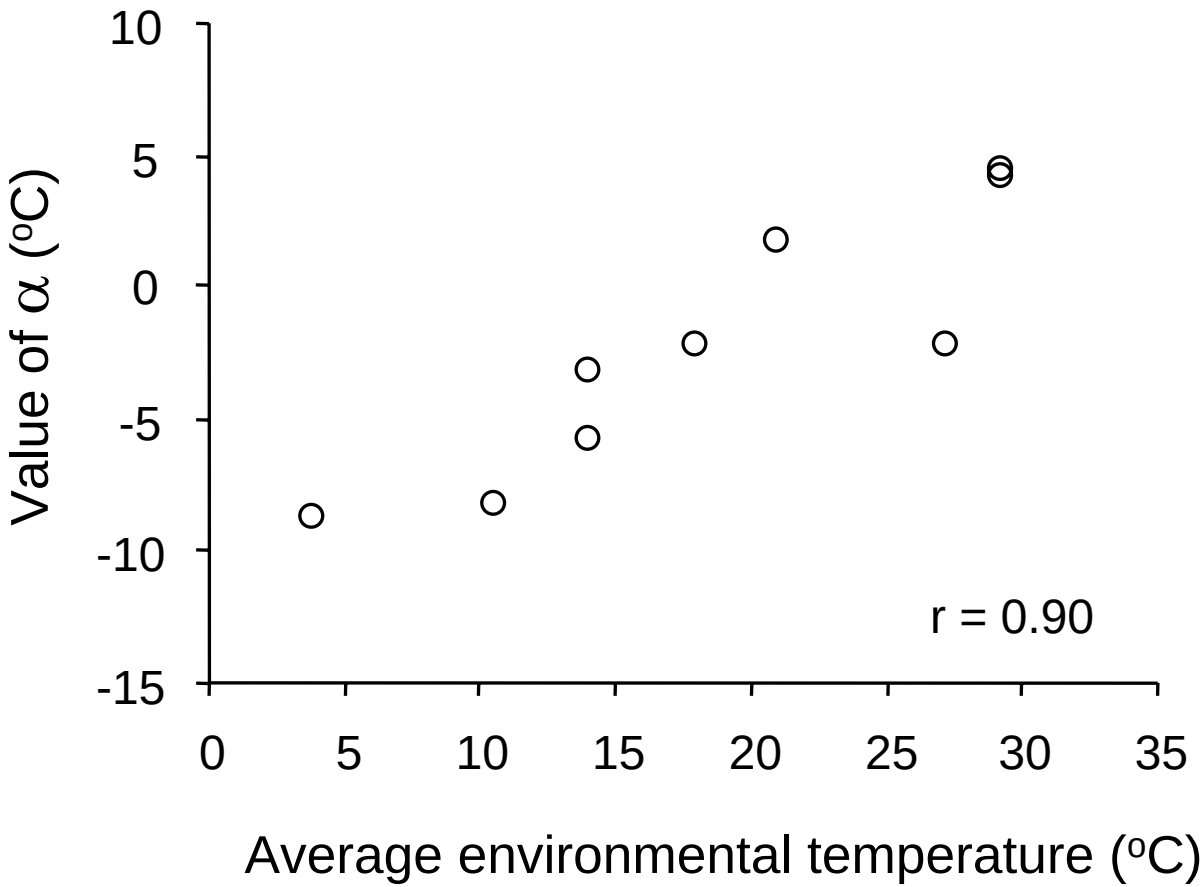
Other studies:

A. clausi
>80 % at 18–25 °C
0 % at 5 °C
(Uye & Fleminger 1976)

A. steueri
>80 % at 10–25 °C
(Uye 1980)

A. tonsa
60–90 % at 12.4–22.4 °C
0 % at <10 °C
(Holste & Peck 2006)

‘Biological zero’ & environmental temperature



Conclusions

- EDTs of the three *Acartia* species are closely described as functions of temperature.
- Variation in ‘bio-zero’ between species reflect differences in geographic temperature adaptation.
- High hatching success over wide temperature range characteristic of coastal species.
- Variance in development rates present even within tropical regions.