Explaining the mass occurrence of a deepwater scyphomedusa in Norwegian fjords

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Periphylla periphylla

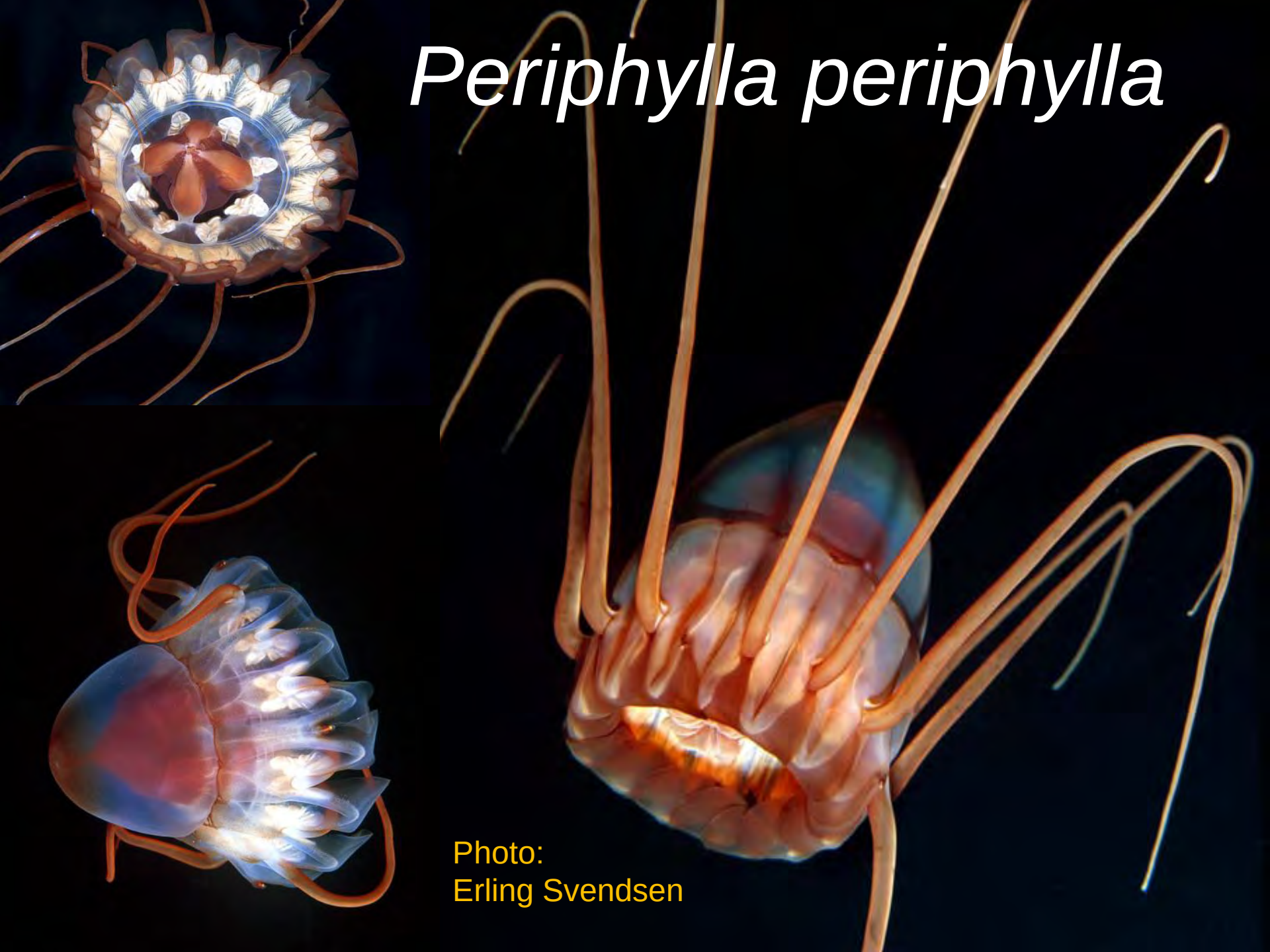
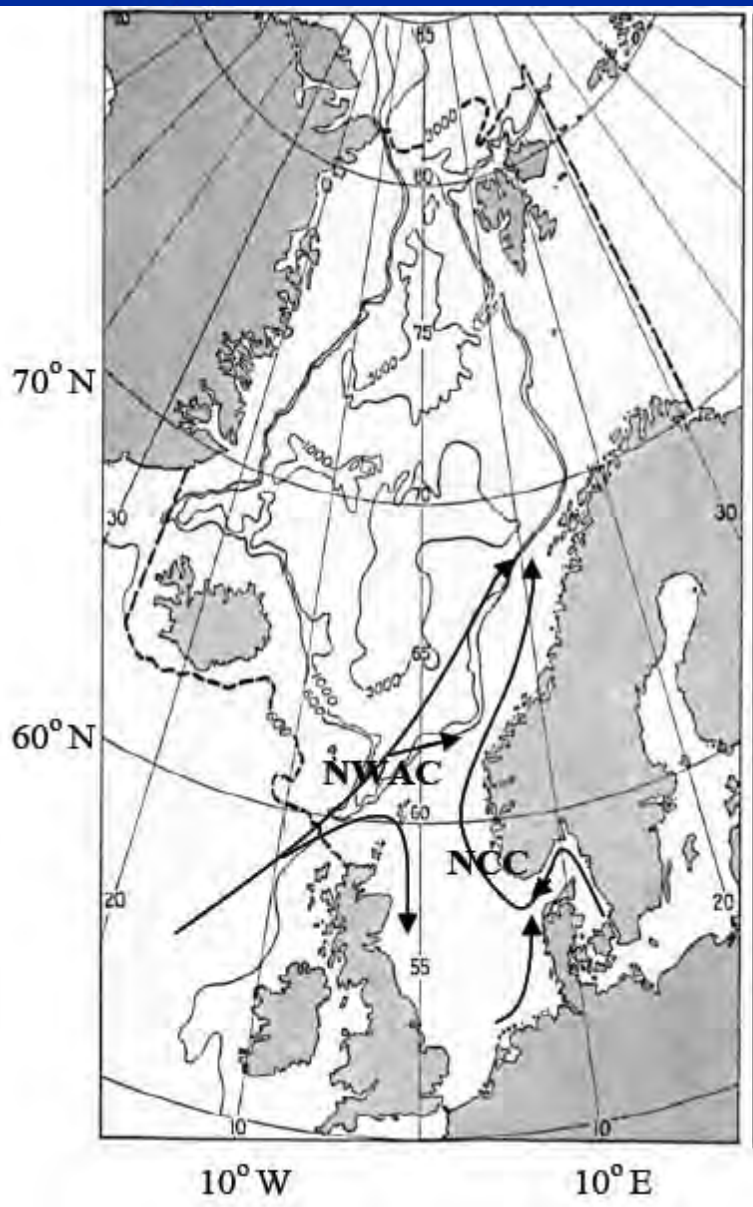
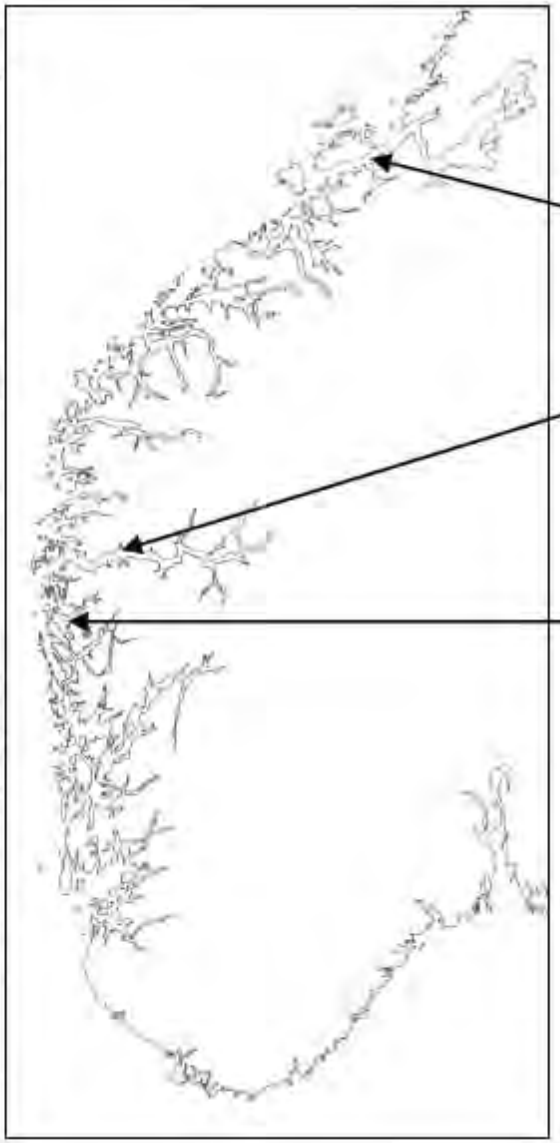


Photo:
Erling Svendsen

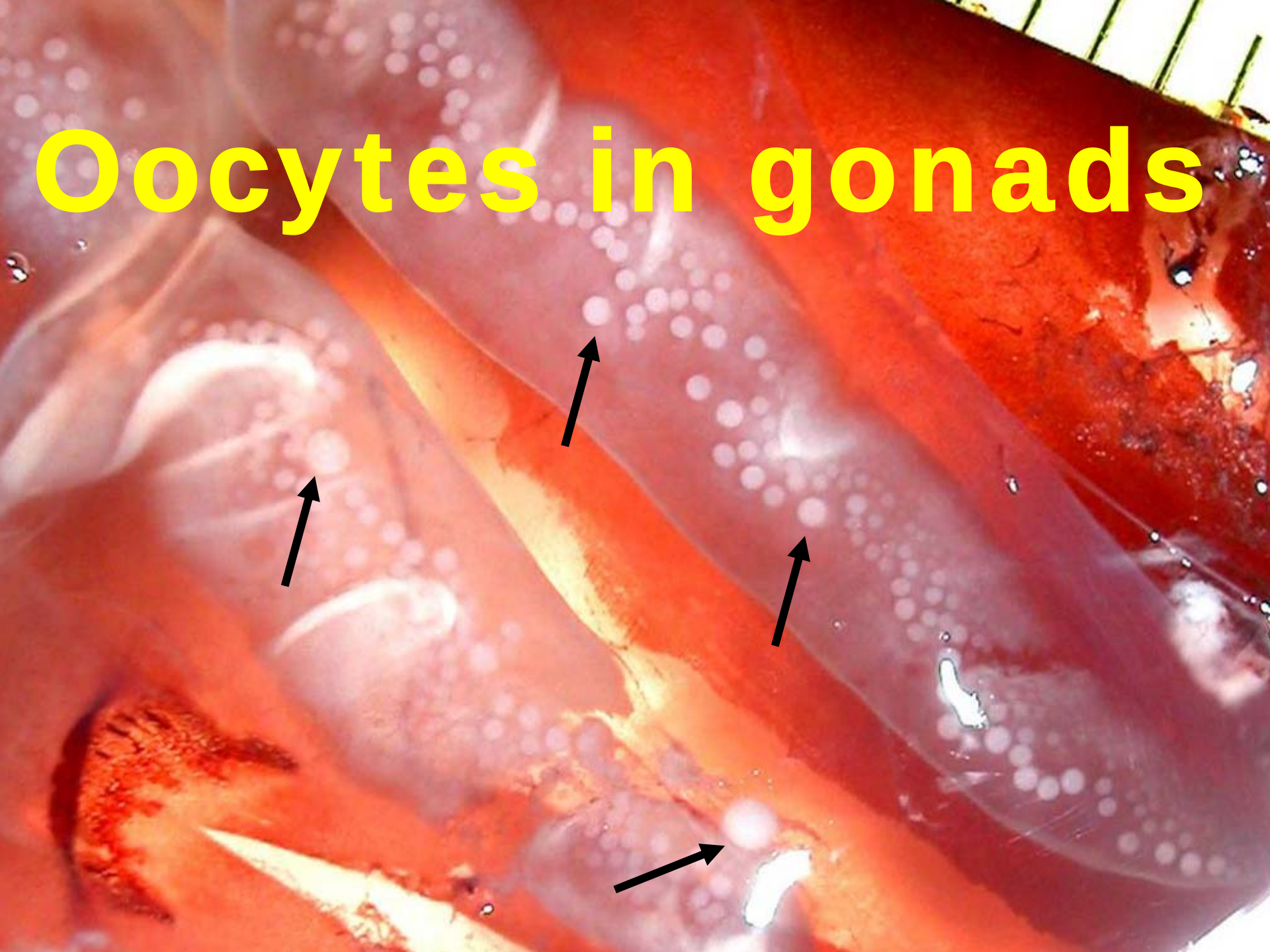

70° N
60° N
10° W
10° E
NWAC
NCC


Halsafjorden
Sognefjorden
Lurefjorden

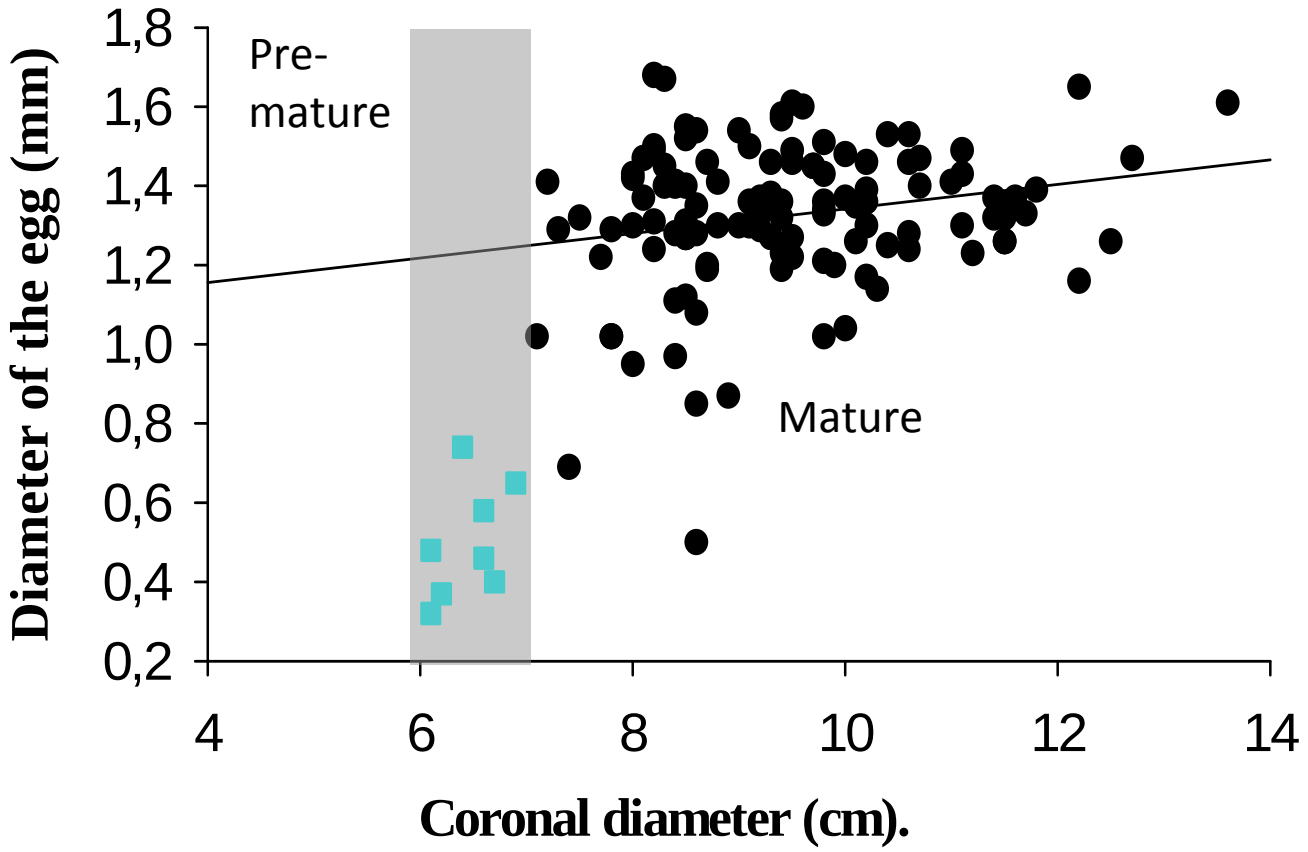
ROV Aglantha

Photo: Per R. Flood, © Bathy

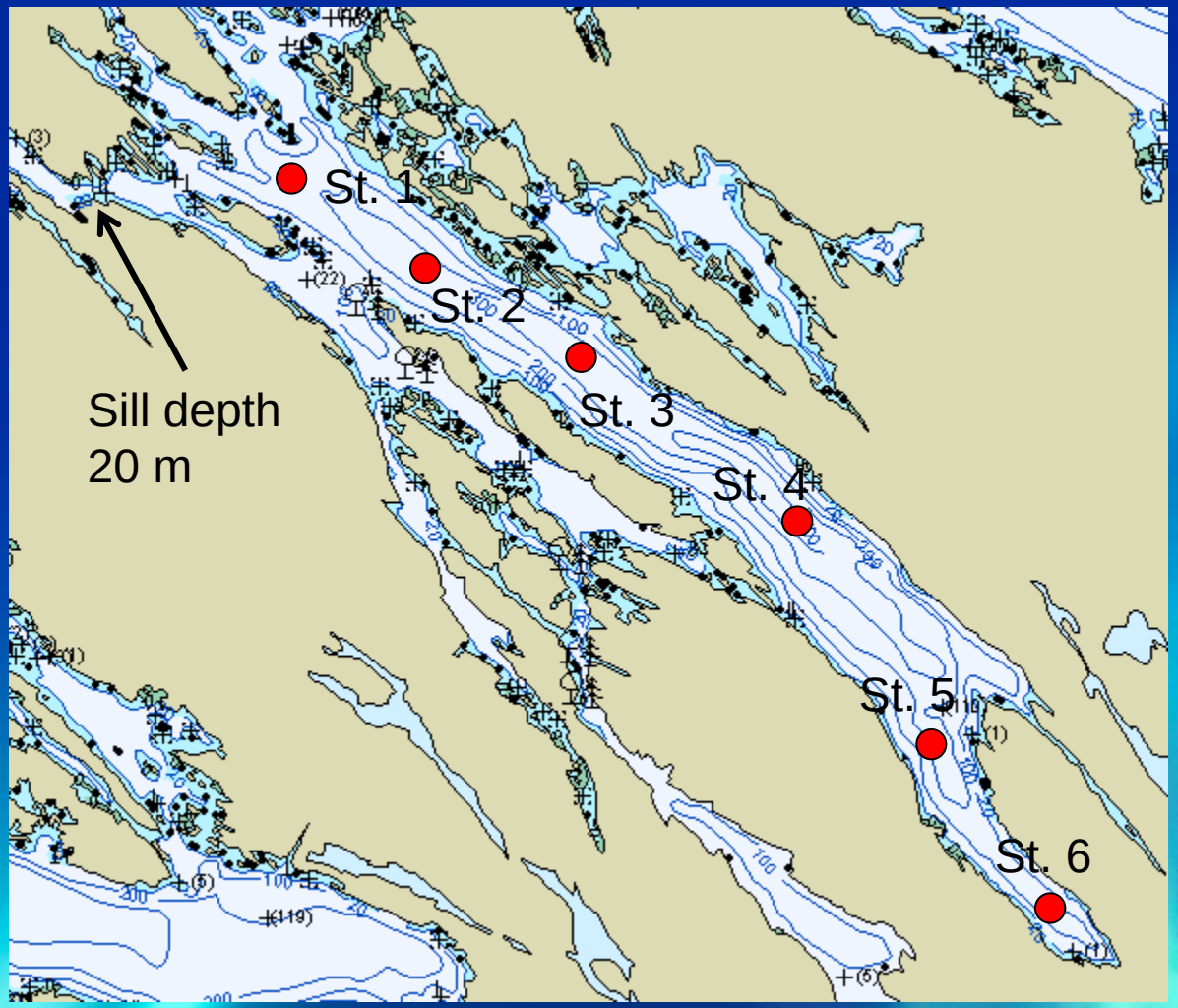
Oocytes in gonads

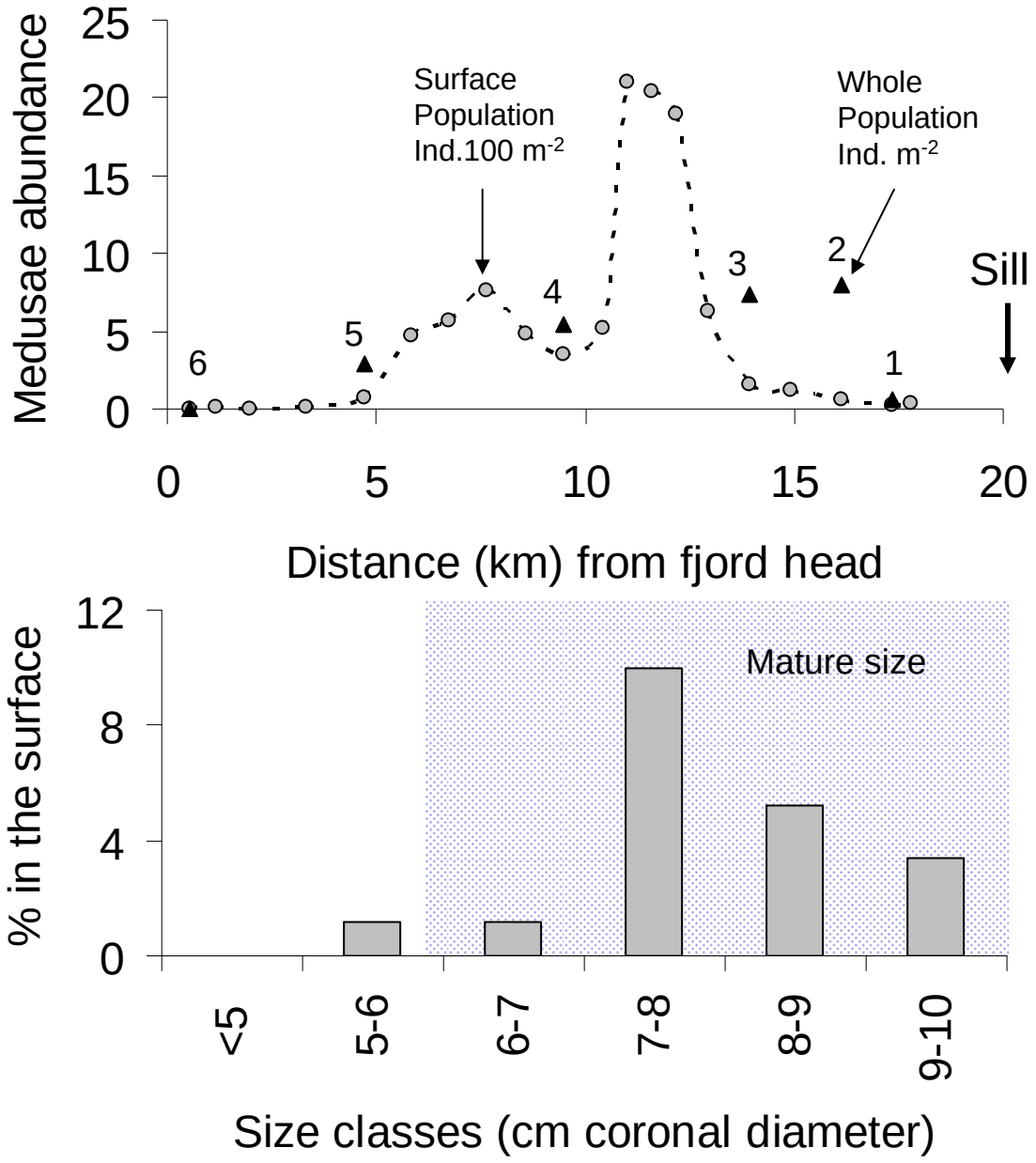


Maximum size of eggs in gonads

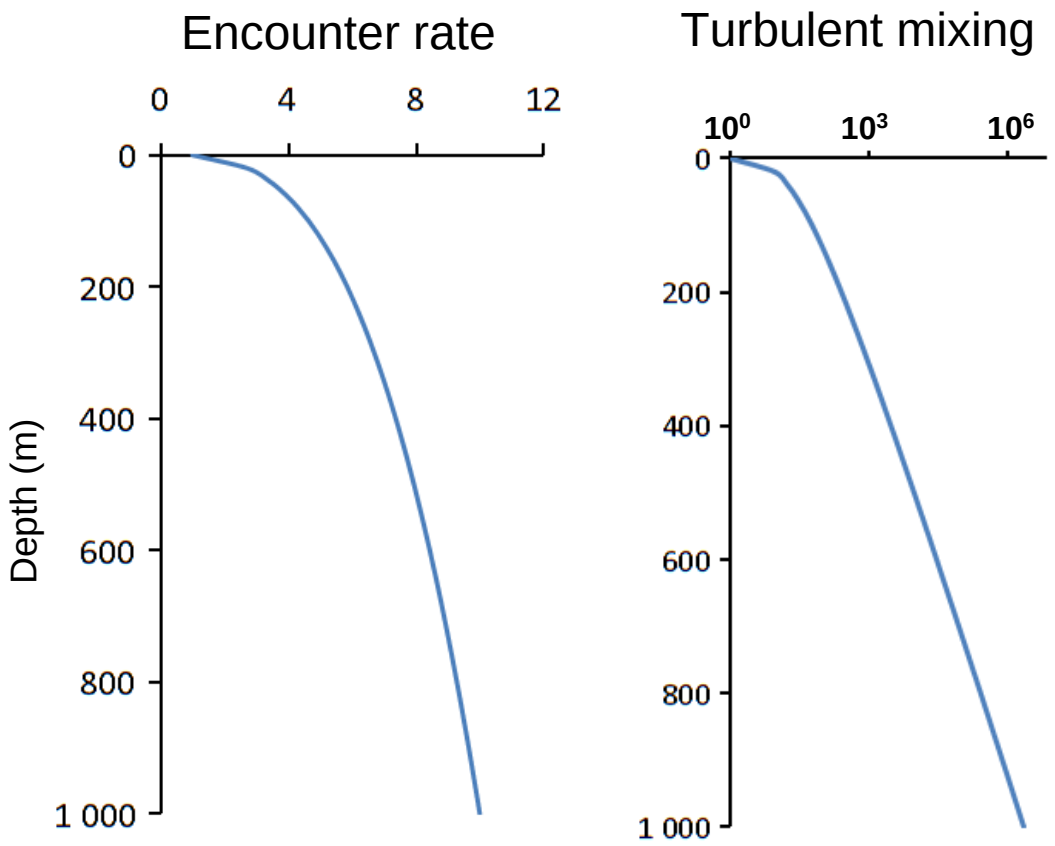


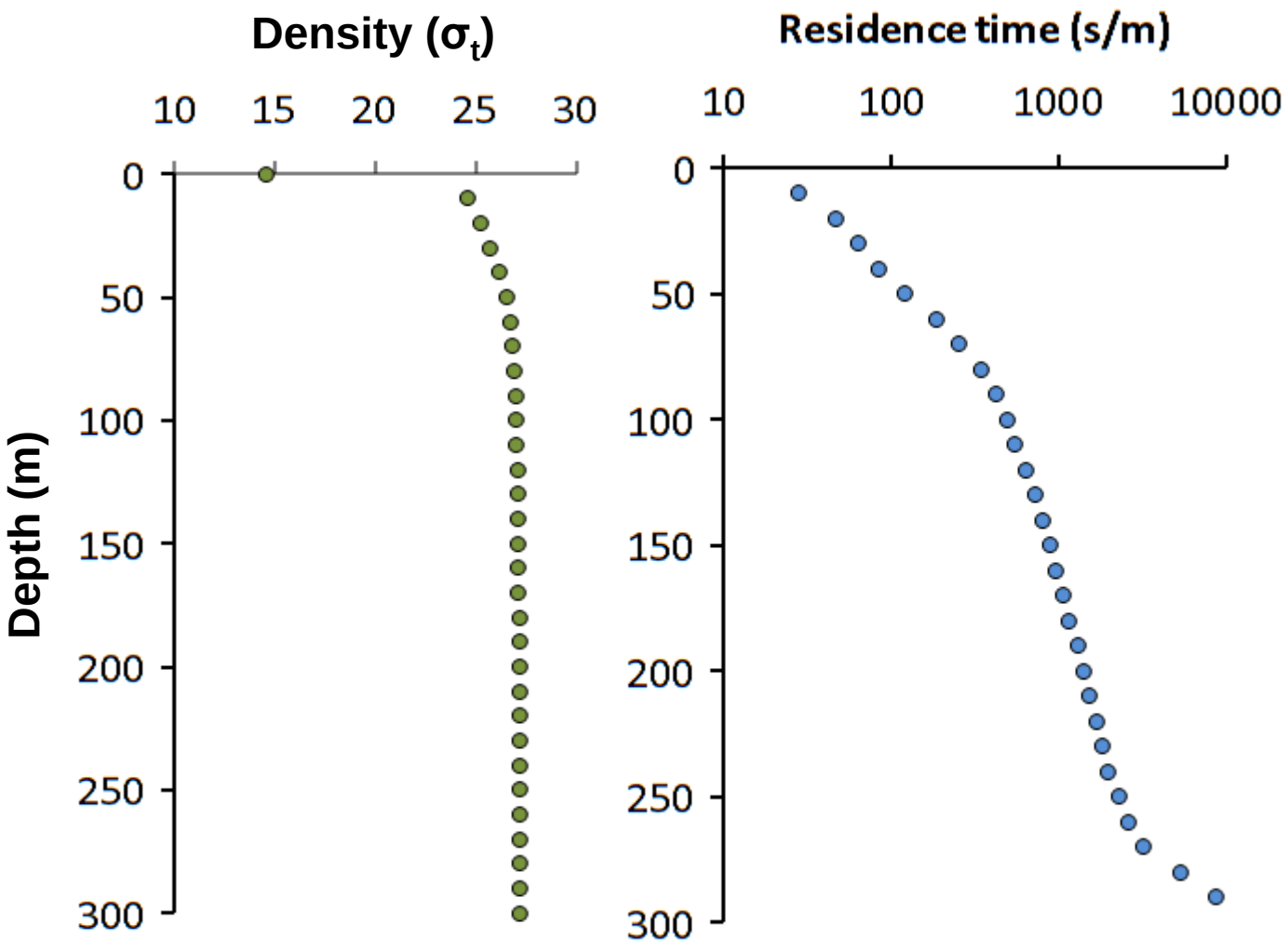
Lure-fjorden

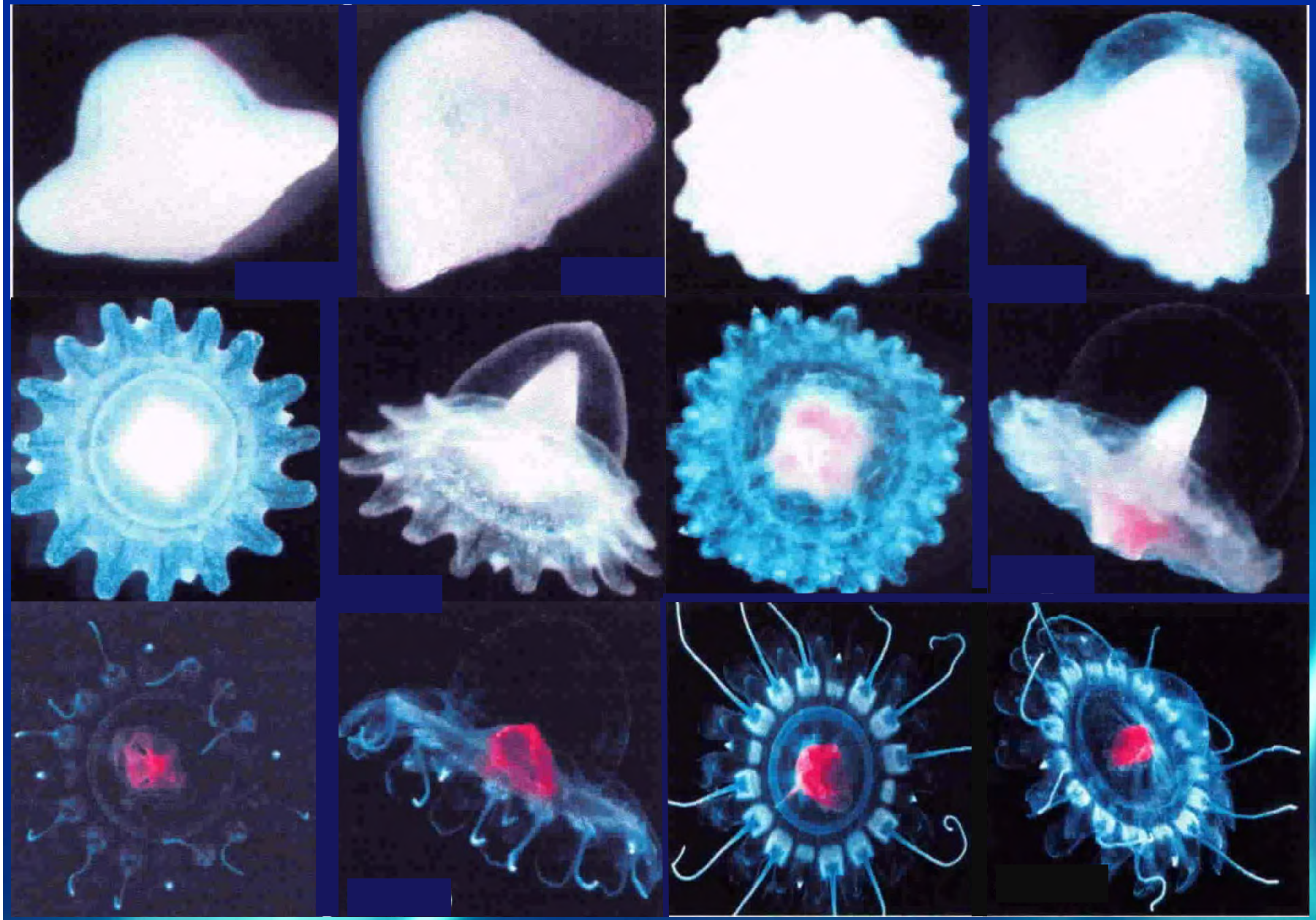



Medusae abundance
25
20
15
10
5
0
Surface
Population
Ind.100 m-2
Whole
Population
Ind. m-2
Sill
6
5
4
3
2
1
0
5
10
15
20
Distance (km) from fjord head
% in the surface
12
8
4
0
Mature size
<5
5-6
6-7
7-8
8-9
9-10
Size classes (cm coronal diameter)

Benefit from vertical migration

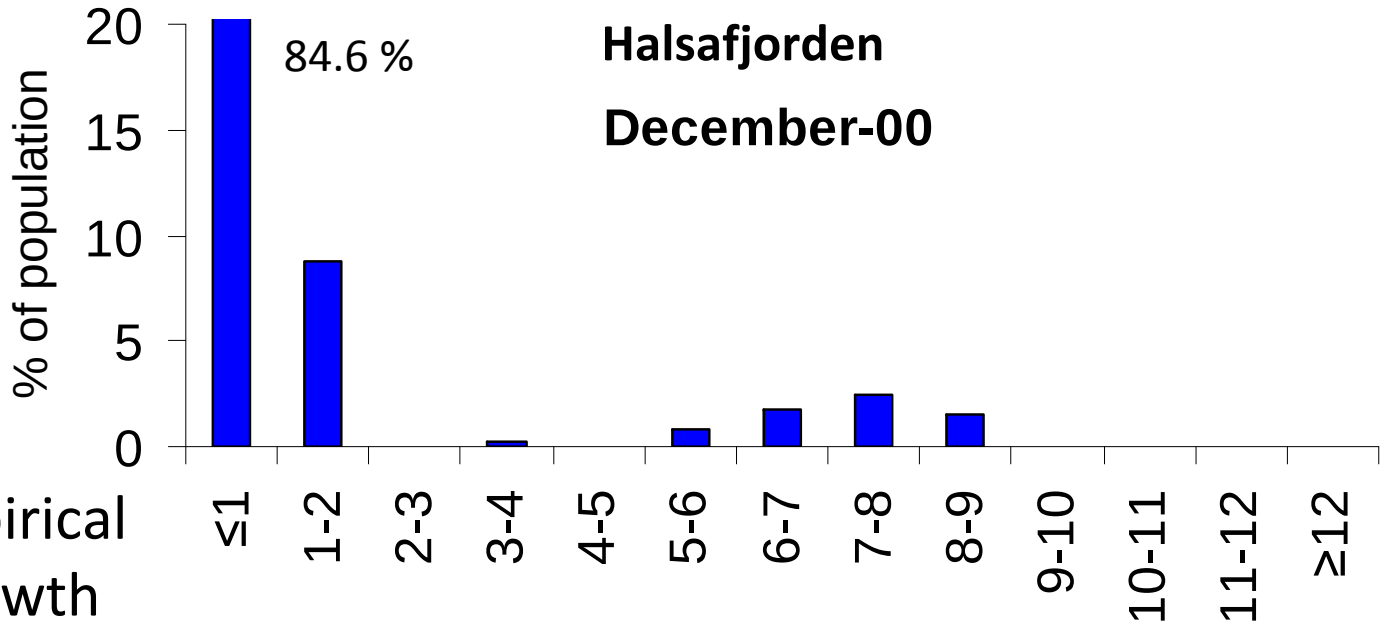



Density (σt)
10
15
20
25
30
Residence time (s/m)
10
100
1000
10000
Depth (m)
0
50
100
150
200
250
300

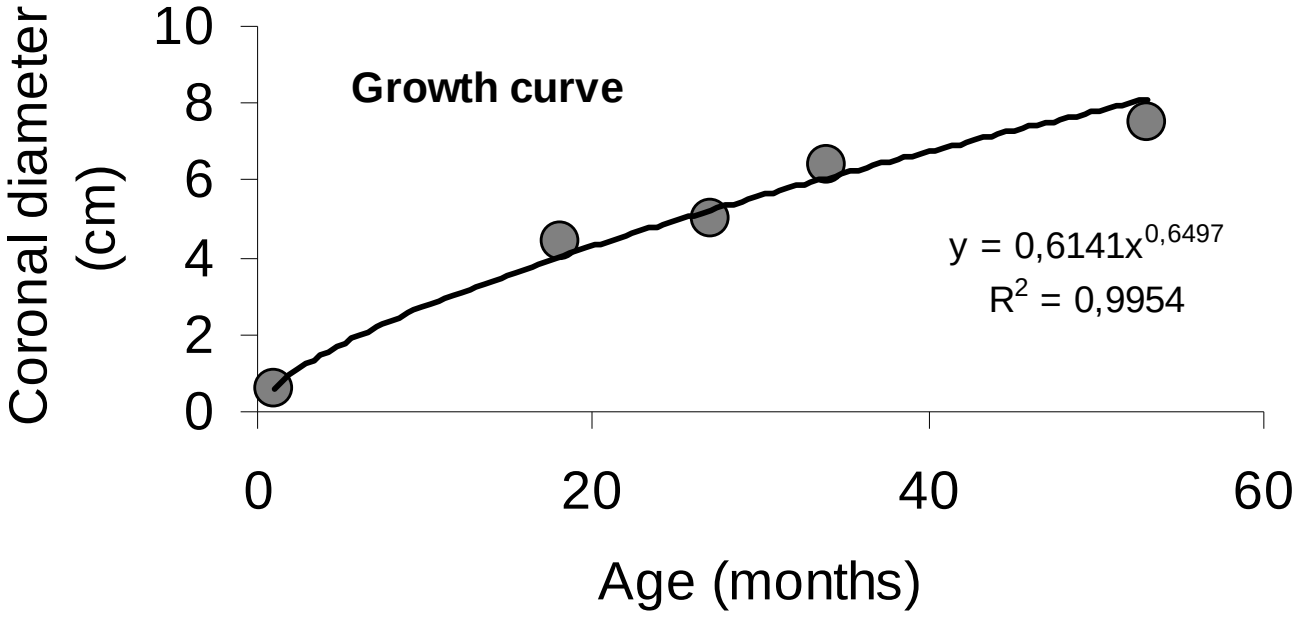


Conclusions on reproduction

- Migration to the surface increases the probability of encounters between mature males and females
- Fertilization of freely released eggs is dramatically improved if mating occurs in the surface water
- Rapid sinking of the eggs to midwater depth reduces the risk of benthic and pelagic predation



Empirical growth estimate



Conclusions from growth estimates

- *Periphylla periphylla* has a deepwater life cycle with slow growth and high longevity
- An individual needs 3.5 years to reach the size of first reproduction
- It takes more than 8 years to reach 12 cm diameter
- The biggest ones in the fjords are expected to be 10-15 years old

Estimating recruitment

Recruitment rate:

$$Recruits\ female^{-1}\ day^{-1} = n/(N \bullet t)$$

n = abundance of individuals ≤ 1 cm diameter

N = abundance of mature females

t = time (days) from hatching to 1 cm diameter, which is around 120 days in Lurefjorden

Average recruitment rate for the three fjords

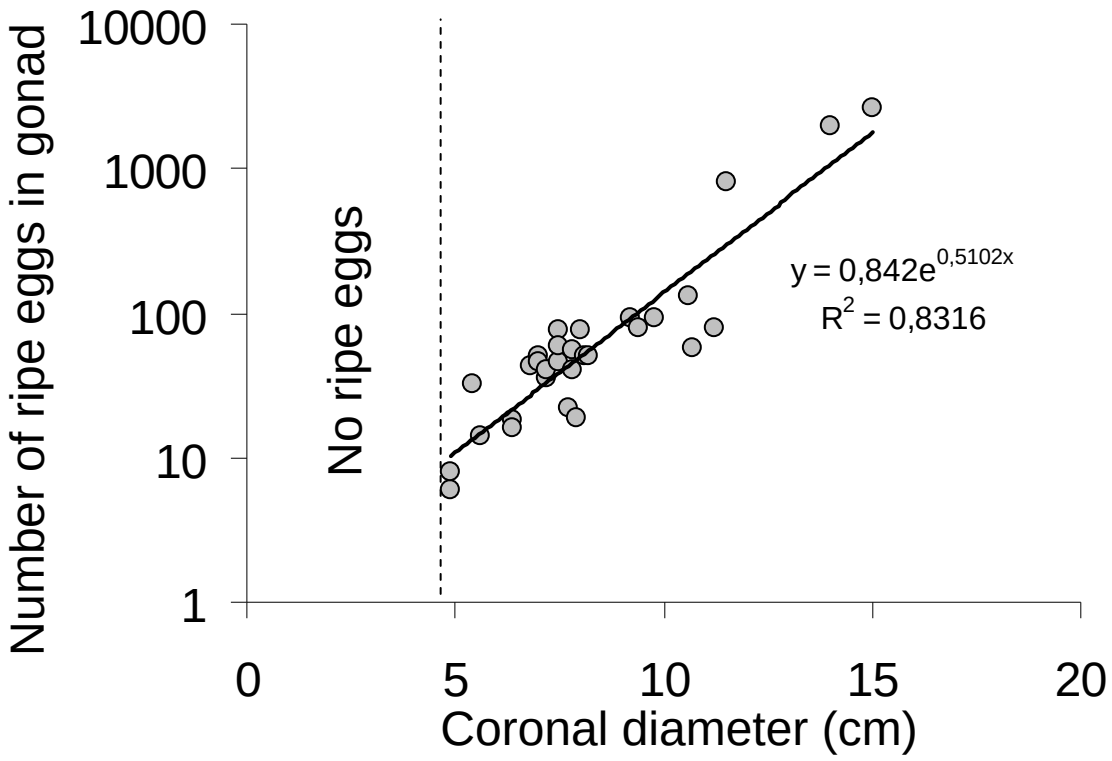
Lurefjorden: 8 recruits per year

Halsafjorden: 18 recruits per year

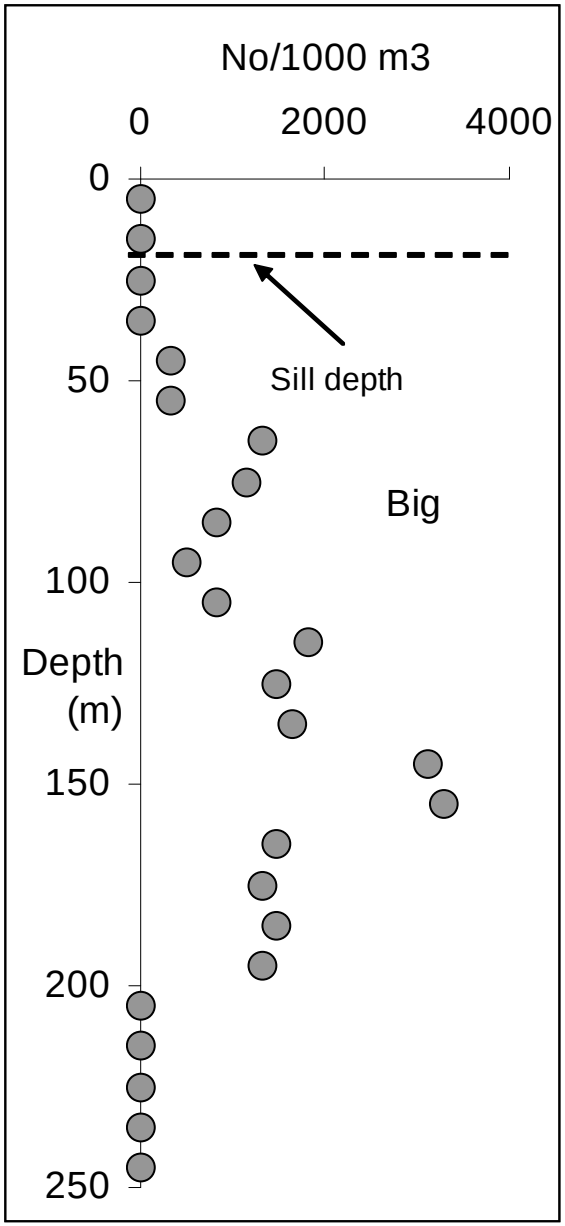
Sognefjorden: 669 recruits per year

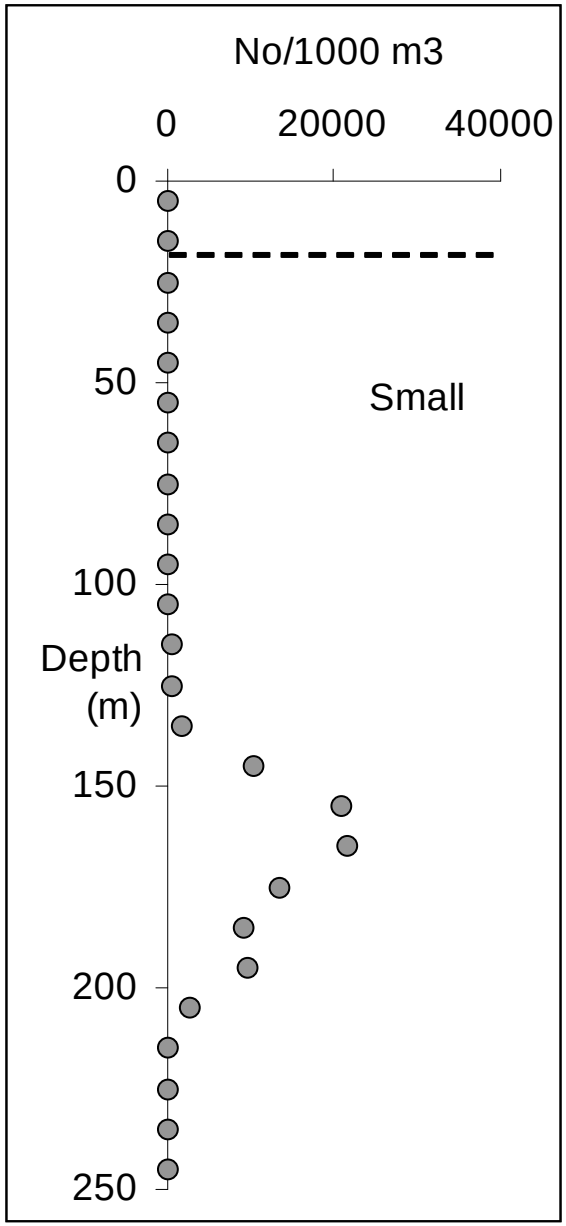
Fecundity considerations

- The number of empty egg follicles in female gonads can be used to quantify the number of eggs recently released
- Preliminary microscopic surveys indicate a size-dependent production of eggs
- The egg-production rate is several thousands per female per year in large females

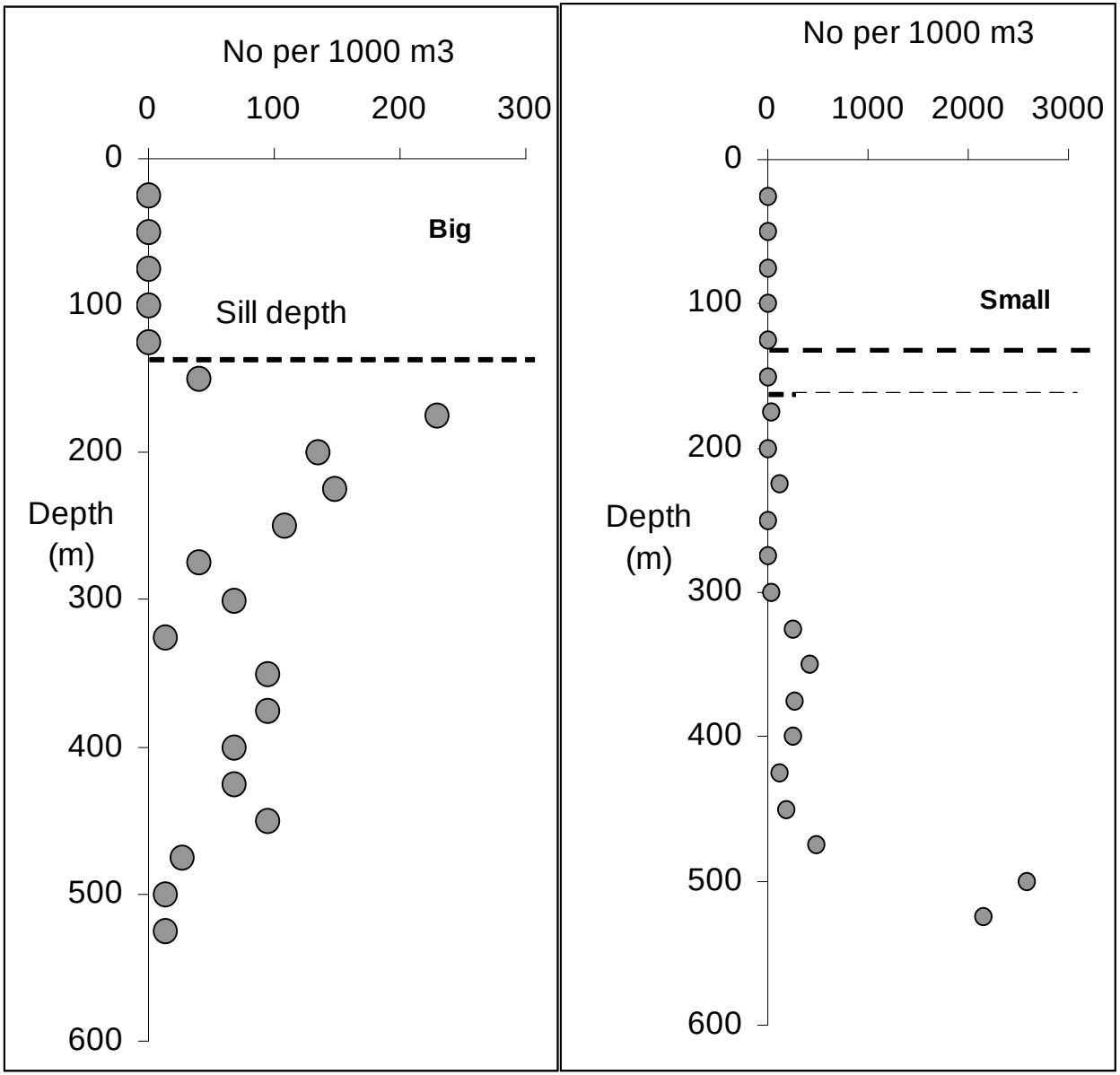

Number of ripe eggs in gonad
10000
1000
100
10
1
No ripe eggs
y = 0,842e^0,5102x
R^2 = 0,8316
0
5
10
15
20
Coronal diameter (cm)

Lure-fjorden March 2003

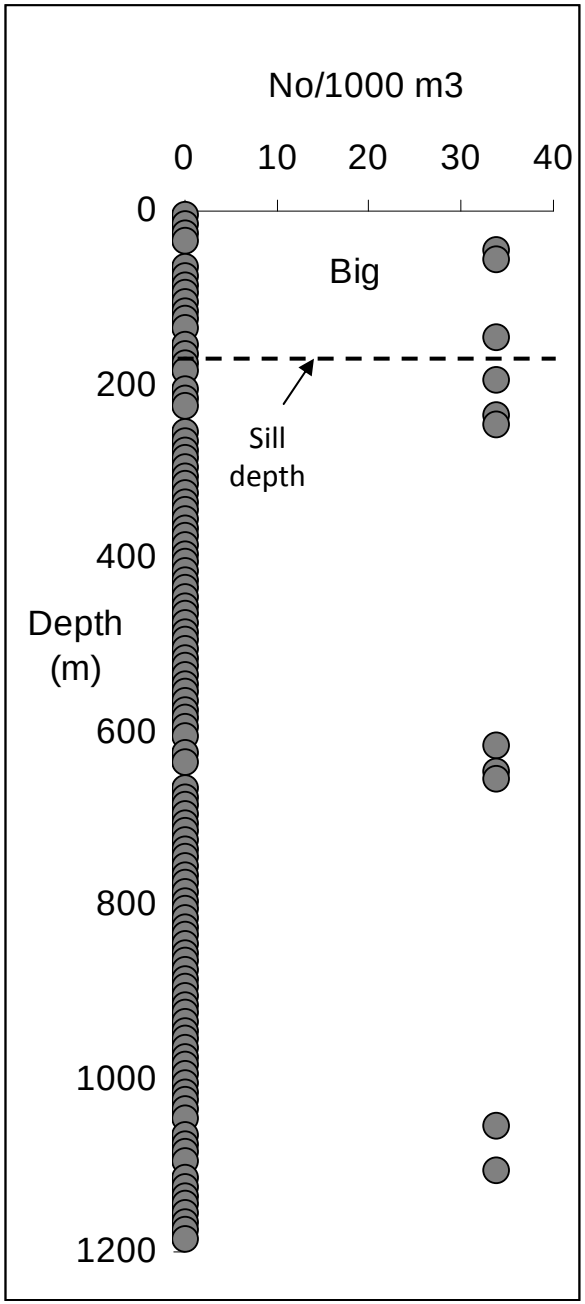


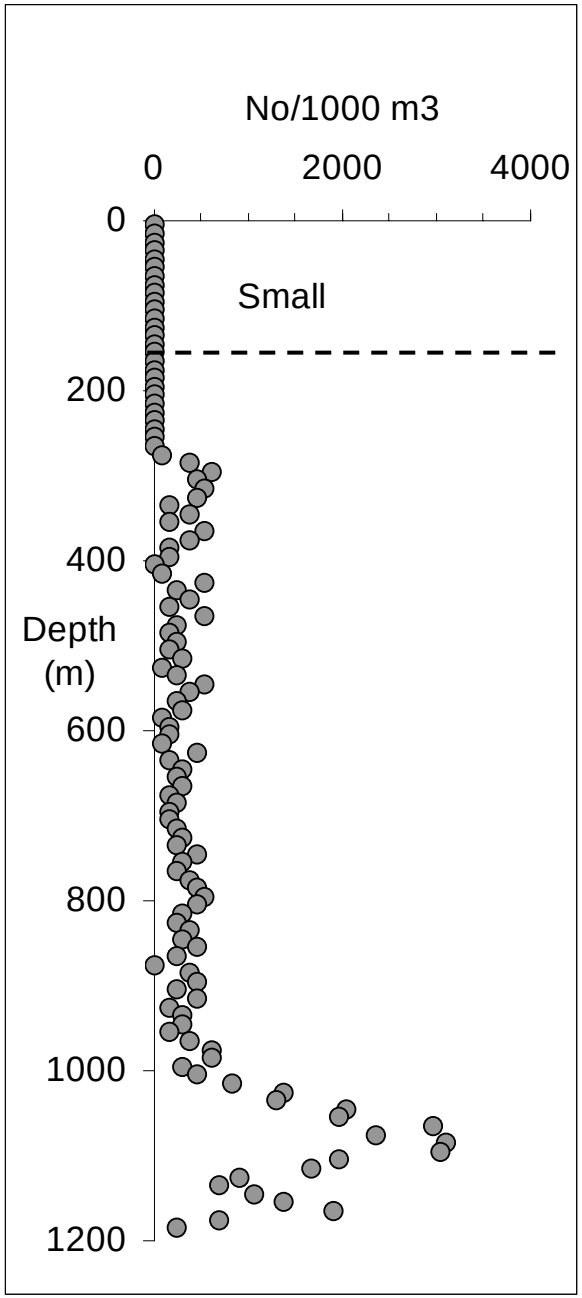


Halsa-fjorden December 2000



Sogne-fjorden June 2002





Differences between the three fjord populations

- Abundance 10-20 m^{-2} in Halsafjorden, 20-50 m^{-2} in Lurefjorden, and 100-300 m^{-2} in Sognefjorden

- Largest proportion of big individuals in Halsafjorden, and an enormous dominance of small individuals in Sognefjorden

Potential factors controlling abundance and population size structure in *Periphylla periphylla*

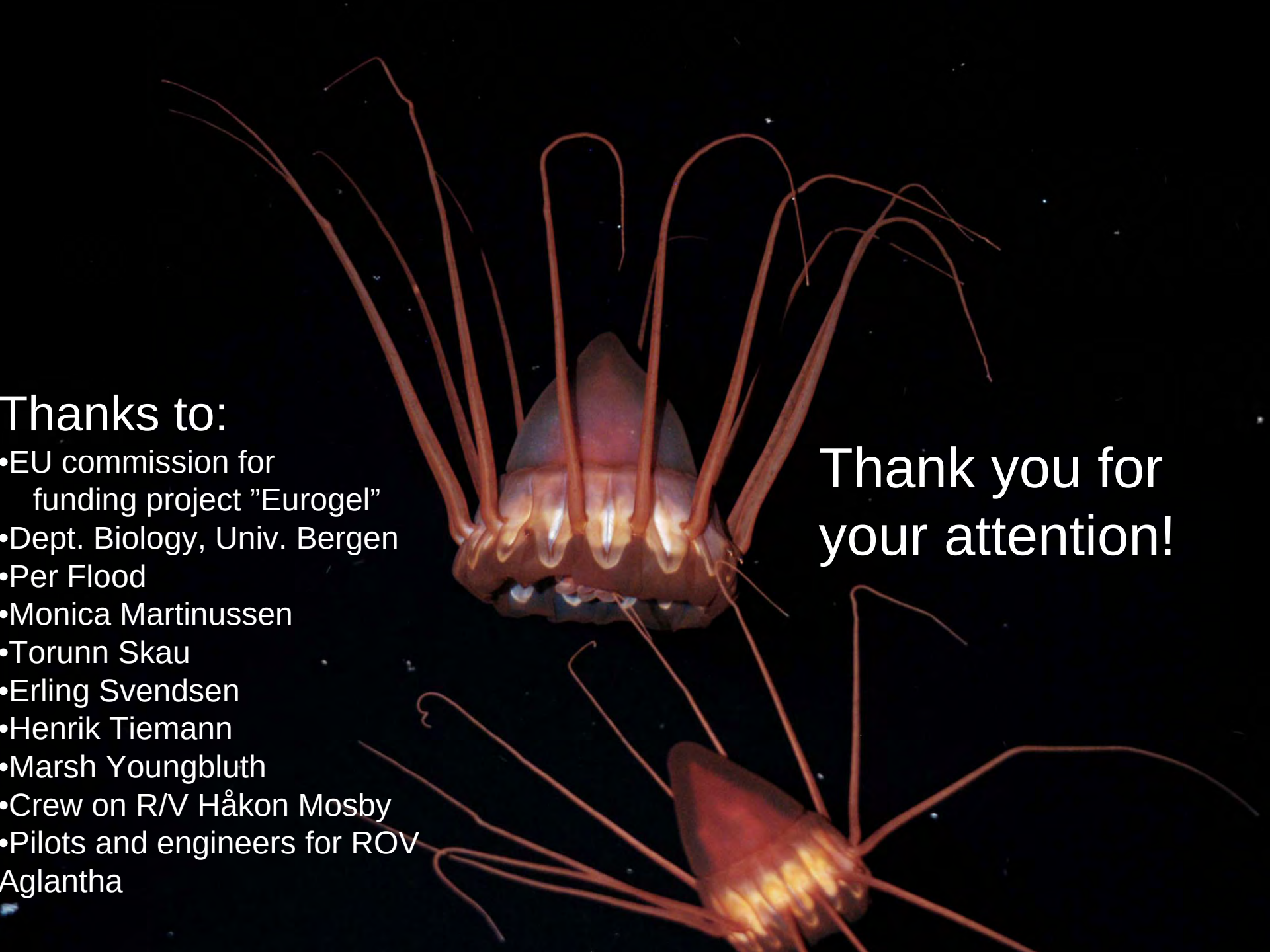
- Sill depth and distribution in the fjord
- Vertical migration at an ontogenetic scale
- Growth rate, longevity and fecundity
- Hydrographic stability and deepwater renewal frequency
- Mortality over the life cycle

Explaining population differences

- No genetic differences between fjord populations, implying similar life cycles
- Medusae ≤ 1 cm diameter are subject to heavy mortality and/or advection loss in Lurefjorden and Halsafjorden, 40-84 times higher than in Sognefjorden
- Only 1 % of the population in Sognefjorden is > 2 cm in diameter, indicating heavy loss of bigger individuals, probably as a consequence of advection

General conclusions

- Hydrographic, topographic and trophic conditions favour the mass occurrence of *P. periphylla* in some Norwgian fjords
- A deep habitat (e.g. Sognefjorden, 1300 m) gives the best shelter for new recruits
- Advection is the main explanation for loss of bigger medusae that migrate vertically
- Deepwater renewal with a frequency of << 6 months explains lack of recruitment
- High longevity, lack of predators and competitors and reduced advection facilitate sustainable high abundance with very low recruitment rate



Thanks to:

- EU commission for funding project ”Eurogel”
- Dept. Biology, Univ. Bergen
- Per Flood
- Monica Martinussen
- Torunn Skau
- Erling Svendsen
- Henrik Tiemann
- Marsh Youngbluth
- Crew on R/V Håkon Mosby
- Pilots and engineers for ROV Aglantha

Thank you for your attention!