ROSEMEB

(Role of Secondary Metaboltes in Ecosystem Biodiversity)

kick-off Meeting

Ischia 3, 4 November 2005

AIM: Integrate Activities on Chemical Ecology within the MarBEF NOE

Presentations
Training Courses, Workshops, Sabbaticals
Other Activities (writing of position papers, exchange of information, data and samples)

List of Participants

- Stazione Zoologica of Naples, Italy
- Roscoff Marine Laboratory, France
- Institute of Bio-Molecular Chemistry, Pozzuoli (Naples)
- Helgoland Marine Station (AWI), Germany
- Tjärnö Marine Laboratory, Sweden
- Centro Interdisciplinar de Investigação Marinha Ambiental(CIMAR)/ Instituto Nacional de Engenharia, Tecnologia e Inovação (INETI), Portugal
- Max-Planck-Institute for Marine Microbiology, Germany
- Villefranche Marine Station, France

MORNING SESSION

9:30 **Adrianna Ianora** Diatom-copepod chemical interactions, a historical perspective
9:50 **Serge Poulet**, Diatom-copepod chemical interactions, more recent advances in this field
10:10 **Raffaella Casotti**, The effects of diatom secondary metabolites on other phytoplankton
10:30 **Giuliana d'Ippolito**, Natural products chemistry of diatoms

11:00 Coffee Break

11:30 **Maarten Boersma**, Chemical ecological studies at AWI
11:50 **Gunilla Toth**, Chemical interactions in benthic macroalgae and macroinvertebrates
12:10 **Helena Gaspar**, Chemical ecological studies of Portugese invertebrates
12:30 **Friederike Hoffmann,** Bacteria-sponge interactions

13:00 light lunch at a nearby restaurant

14:30 **Ernesto Mollo**, Chemical ecology of alien species
14:50 **Christina Buia**, Chemical ecology of benthic algae
15:10 **Angelo Fontana**, Natural products chemistry of benthic invertebrates

AFTERNOON SESSION

15: 30 Informal discussion will be conducted on integrating activities (i.e. training courses, workshops, sabbaticals, exchange of information, data and samples) within ROSEMEB.

16:30 Coffee Break

17:00 continuation of the discussion on activities

Friday 4 November

9:30 Informal discussion on the review paper

The Role of Organismal Chemical Interactions in Estuarine and Coastal Processes
Invited Odum Essay for the journal ESTUARIES

11:00-11:30 coffee break

Possible sections in this review paper are listed below but other suggestions are welcome
Microalgal-Herbivore Interactions in the Plankton
Macroalgal-Herbivore Interactions in the Benthos
The Role of Allelopathy in Microalgal Interactions
Quorum Sensing in Marine Bacteria
Natural products chemistry of Marine Organisms
The Nutritional Component of Marine Plant-Herbivore Interactions

13:00 lunch

Continuation of this discussion after lunch if necessary

The Paradox of Diatom-Copepod Interactions: A Historical Perspective

Adrianna Ianora Stazione Zoologica “Anton Dohrn”
Napoli

MARINE ECOLOGY PROGRESS SERIES

Inter-Research
Marine Ecology Progress Series

MEPS 157:287-293 (1997) Abstract

The paradox of diatom-copepod interactions*

Syuhei Ban[1], Carolyn Burns[2], Jacques Castel[3], Yannick Chaudron[4], Epaminondas Christou[5], Ruben Escribano[6], Serena Fonda Umani[7], Stephane Gasparini[3], Francisco Guerrero Ruiz[8], Monica Hoffmeyer[9], Adrianna Ianora[10], Hyung-Ku Kang[11], Mohamed Laabir[4], Arnaud Lacoste[4], Antonio Miralto[10], Xiuren Ning[12], Serge Poulet[4,**], Valeriano Rodriguez[13], Jeffrey Runge[14], Junxian Shi[12], Michel Starr[14], Shin-ichi Uye[15,***], Yijun Wang[12]

[1]Plankton Laboratory, Faculty of Fisheries, Hokkaido University, Hokkaido, Japan
[2]Department of Zoology, University of Otago, Dunedin, New Zealand
[3]Centre d'Océanographie et de Biologie Marine, Arcachon, France
[4]Station Biologique, CNRS, BP 74, F-29682 Roscoff, France
[5]National Centre for Marine Research, Institute of Oceanography, Hellinikon, Athens, Greece
[6]Universidad de Antofagasta, Facultad de Recursos del Mar, Instituto de Investigaciones Oceonologicas, Antofagasta, Chile
[7]Laboratorio di Biologia Marina, University of Trieste, via E. Weiss 1, I-34127 Trieste, Italy
[8]Departamento de Biologia Animal Vegetal y Ecologia, Facultad de Ciencias Experimentales, Jaen, Spain
[9]Instituto Argentino de Oceanografia, Av. Alem 53, 8000 Bahia Blanca, Argentina
[10]Stazione Zoologica, Villa comunale 1, I-80121 Napoli, Italy
[11]Korea Iter-University Institute of Ocean Science, National Fisheries University of Pusan, Pusan, South Korea
[12]Second Institute of Oceanography, State Oceanic Administration, 310012 Hangzhou, Peoples Republic of China
[13]Departamento de Geologia y Ecologia, Faculdad de Ciencias, Malaga, Spain
[14]Institut Maurice-Lamontagne, Pêches et Océans Canada, BP 1000, Mont-Joli, Québec, Canada G5H 3Z4
[15]College of Oceanic & Atmospheric Sciences, Oregon University, Corvallis, Oregon, USA

*Authors given in alphabetic order.
**Addressee for correspondence. E-mail: poulet@sb-roscoff.fr
***Present address: Faculty of Applied Biological Science, Hiroshima University, Higashi-Hiroshima, Japan

ABSTRACT: Traditionally, diatoms have been associated with productive

Seasonal Changes and Breeding of the Holoplankton

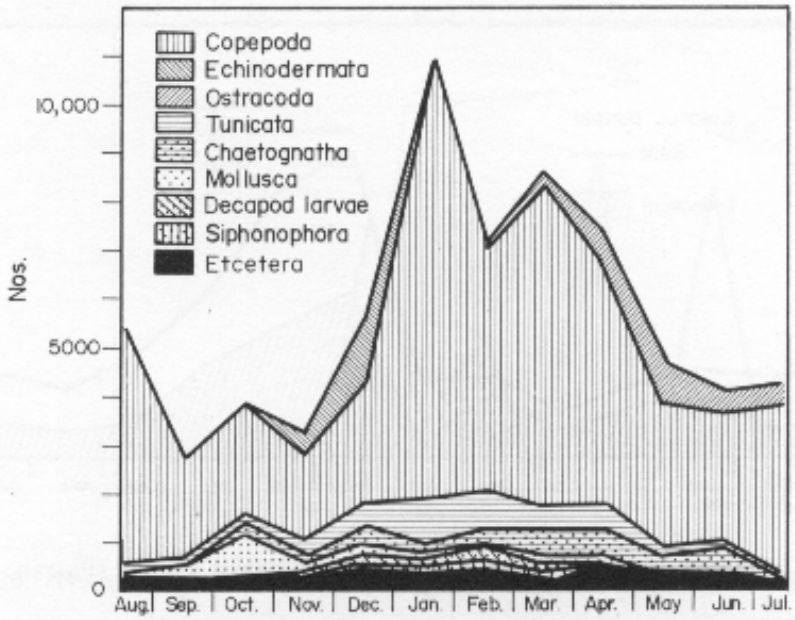
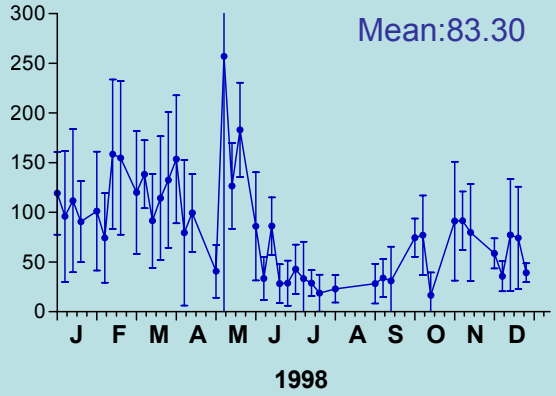
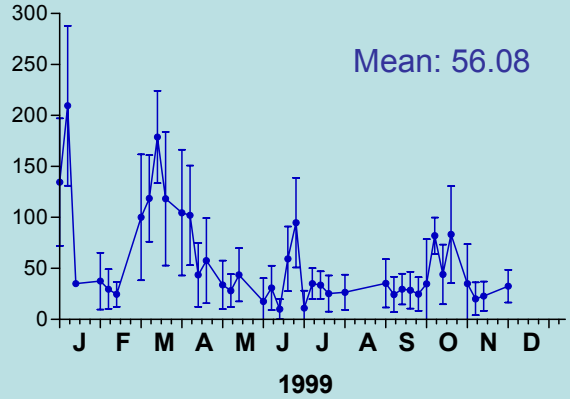


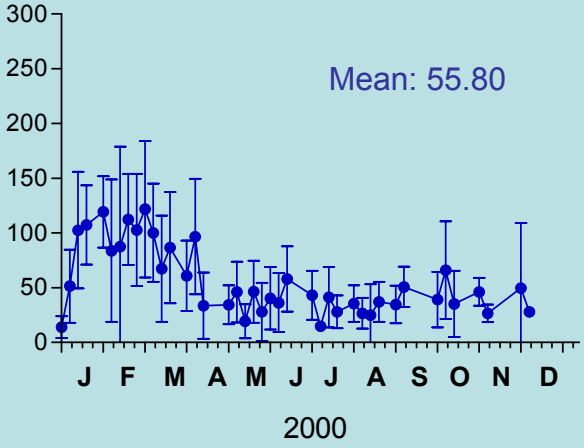
Fig. 3.23. The composition of the average catches of zooplankton for each month in vertical hauls with a coarse silk net near Low Isles, Great Barrier Reef lagoon (Russell and Coleman, 1934).

Centropages typicus

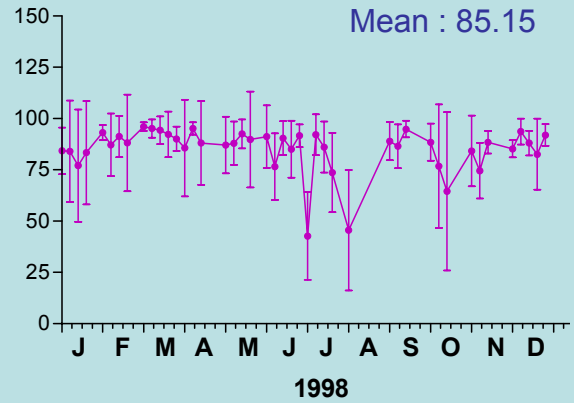
Eggs female^{-1} day $^{-1}$

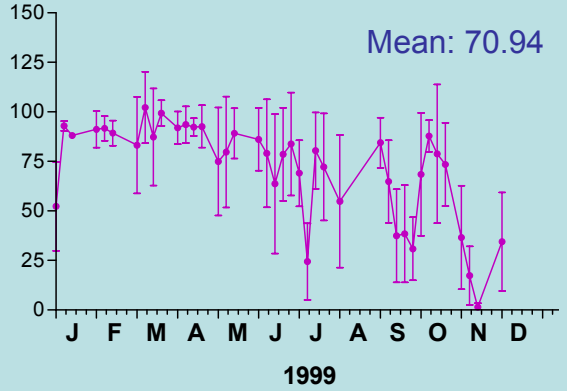


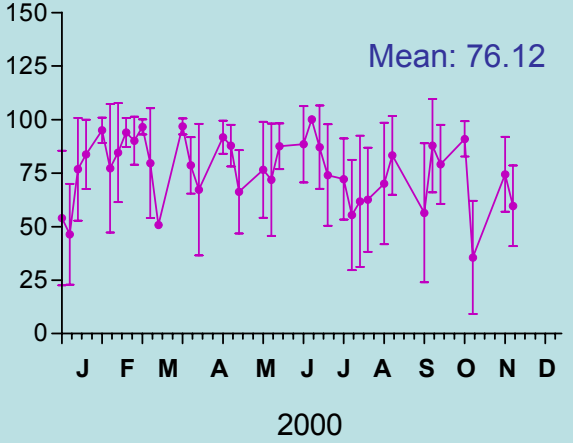




% egg viability

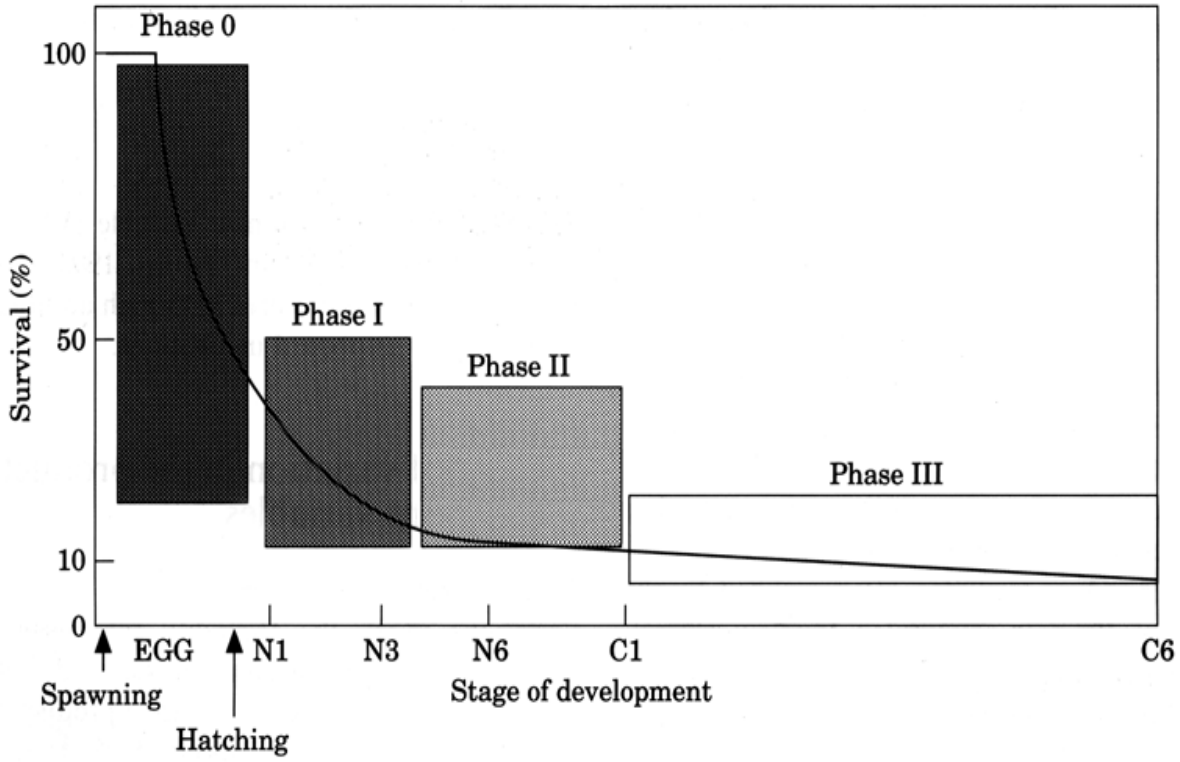






Ianora (unpubl data)

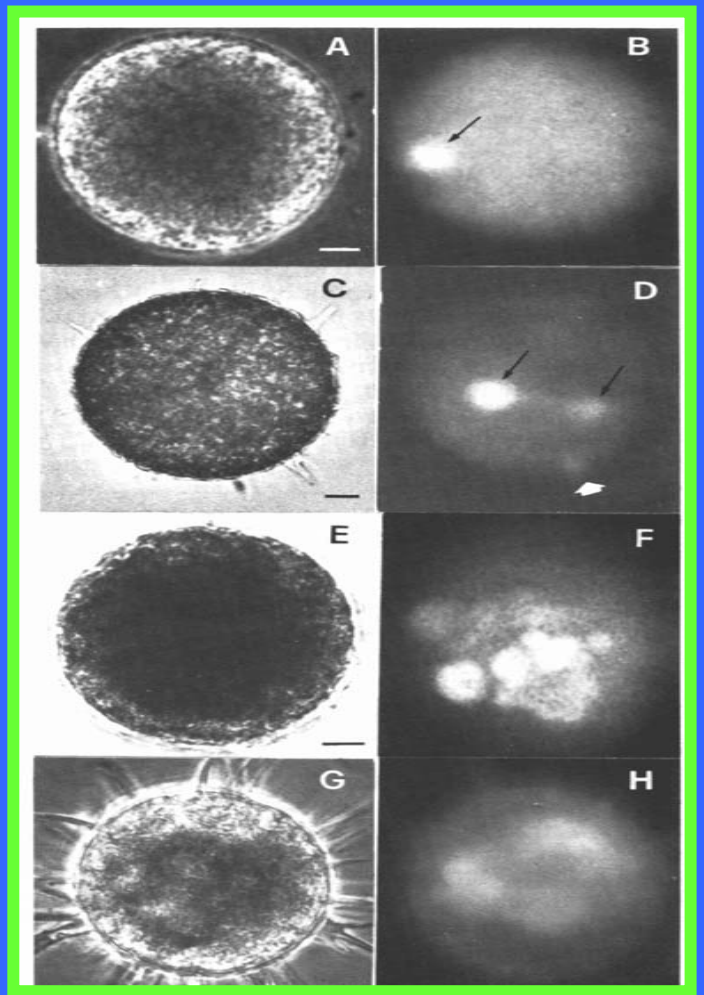
SURVIVAL RATES OF COPEPOD DEVELOPEMENTAL STAGES



Phase 0 is the egg from laying to hatching; Phase I is the NI to NIII, the NI and NII being non-feeding stages; Phase II is the NIII to CI; Phase III is the CI to adult.This curve does not take predation into account. (from Poulet *et al.*, 1995a.)

Poulet et al. ICES J.Mar.Sci. 1995

Centropages typicus viable and nonviable eggs



Ianora et al. J.Plankton Res. 1992

Temora stylifera hatching success

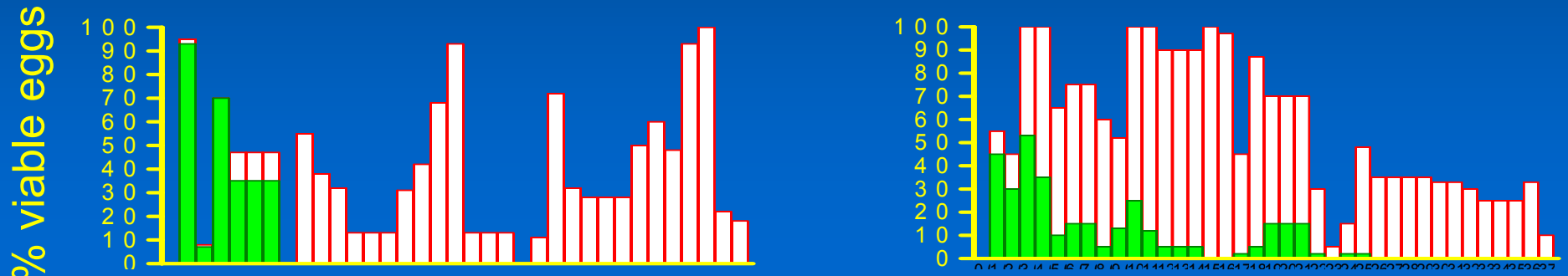
Non-viable eggs

Viable eggs

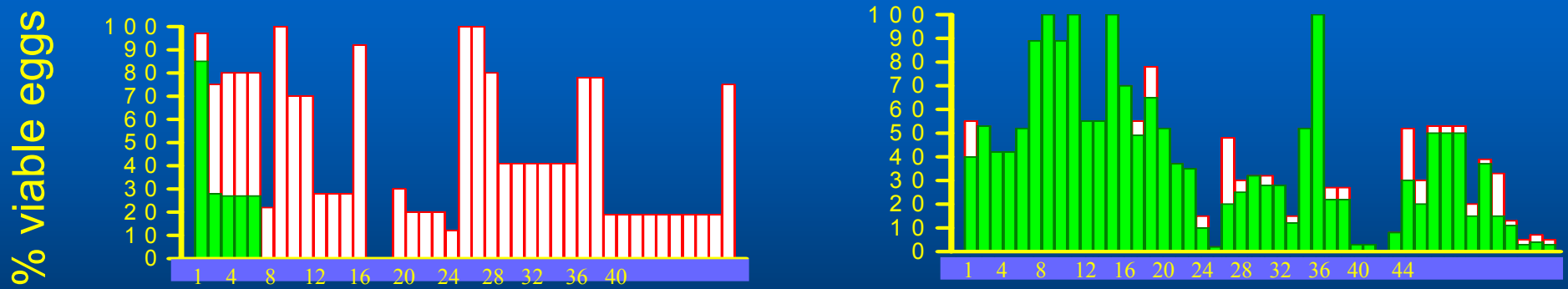
Females alone

THA

with males



PRO



Days

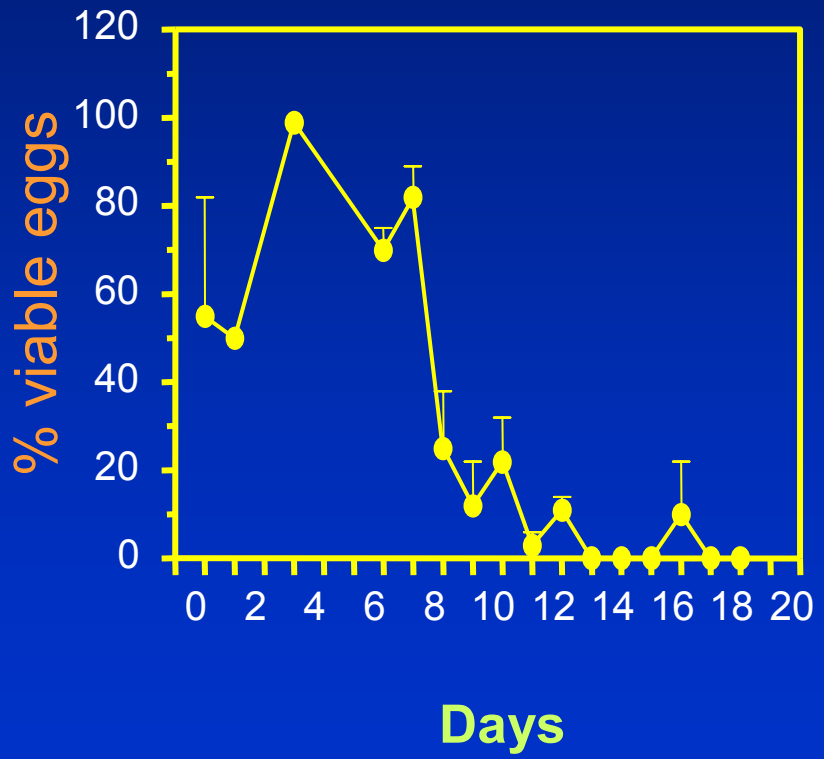
Days

Ianora and Poulet Limnol Oceanogr. 1993

Chemical composition	*P. minimum*	*T. rotula*
Chl *a*	11.71±2.56	6.56±0.34
C	274.19±2.53	157.62± 15.37
N	45.22±0.46	32.73 ± 3.3
C: N ratio	6.06±0.10	4.82±0.02
Proteins	98.53±3.44	63.45 ±6.69
Free amino acids (22 AA)	128.13± 17.66	111.67±17.37
Free amino acids (9 essential AA)	40.74+1.04	34.30±12.85
Vitamins (ascorbic+dehydro-ascorbic acids)	45.57 ±6.41	17.32±0.88
Fatty acids	14.9±3	12.3±0.82
Saturated fatty acids (%)	24.15	51.40
Polyunsaturated fatty acids (%)	74.60	48.55

Ianora & Poulet Limnol.Oceanog. 1993

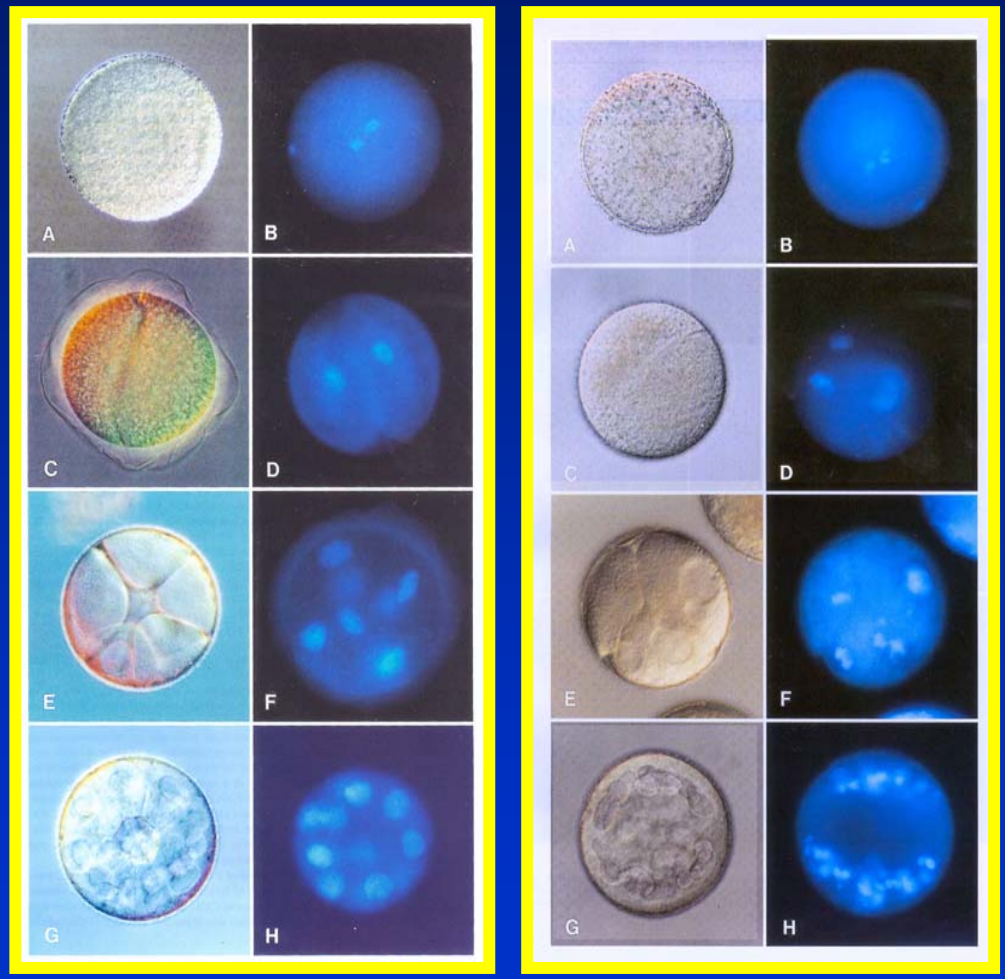
Calanus helgolandicus **fed** ***Phaeodactylum tricornutum***



Calanus **eggs**

controls

exposed to diatom extracts



Poulet et al. Mar.Ecol.Prog.Ser. 1995

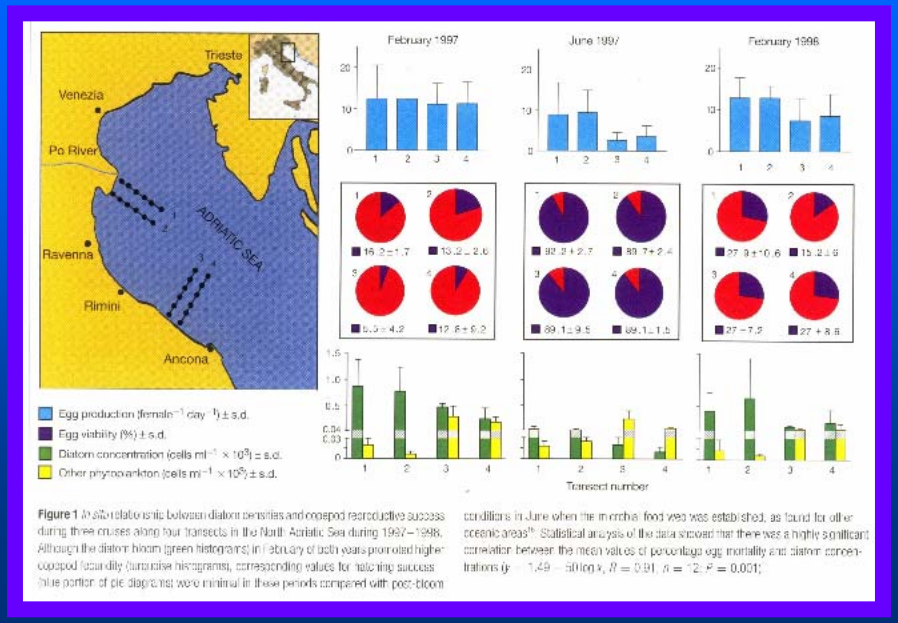


Figure 1 Relationship between diatom densities and copepod reproductive success during three cruises along four transects in the North Adriatic Sea during 1997–1998. Although the diatom bloom (green histograms) in February of both years promoted higher copepod fecundity (fuchsia histograms), corresponding values for hatching success (blue portion of pie diagrams) were minimal in these periods compared with post-bloom conditions in June when the microbial food web was established, as found for other oceanic areas[18]. Statistical analysis of the data showed that there was a highly significant correlation between the mean values of percentage egg mortality and diatom concentrations ($y = 1.49 - 5.01\log x$, $R = 0.91$, $n = 12$, $P = 0.001$).

The insidious effect of diatoms on copepod reproduction

A. Miralto*, G. Barone†, G. Romano*, S. A. Poulet‡, A. Ianora*, G. L. Russo§, I. Buttino*, G. Mazzarella§, M. Laabir*, M. Cabrini‖ & M. G. Giacobbe¶

* *Stazione Zoologica "A. Dohrn", Villa Comunale, 80121 Naples, Italy*
† *Dipartimento di Chimica Organica e Biologica, Università di Napoli "Federico II", Via Mezzocannone 16, 80134 Naples, Italy*
‡ *Station Biologique de Roscoff, CNRS, Place Georges Teissier, 29682 Roscoff, France*
§ *Istituto di Scienze dell'Alimentazione, CNR, 83100 Avellino, Italy*
‖ *Laboratorio di Biologia Marina, Via August Piccard 54, 34040 Trieste, Italy*
¶ *Istituto Sperimentale Talassografico CNR, Via San Ranieri 86, 98122 Messina, Italy*

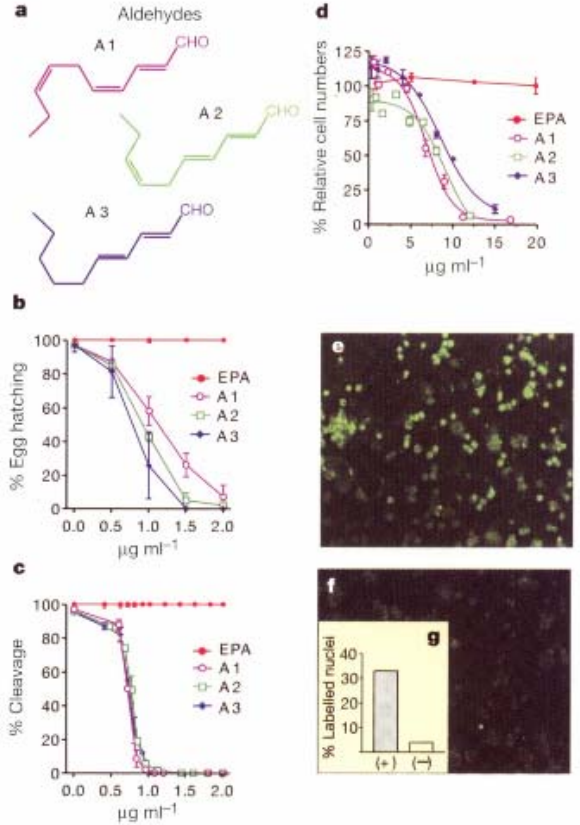


Figure 2 Effect of aldehydes on cell division. Aldehydes A1 (pink), A2 (green) and A3 (blue) (**a**) markedly reduced the percentage hatching success of newly spawned copepod eggs (**b**), cleavage of sea urchin embryos (**c**) and growth of Caco2 cells (**d**). The related compound EPA (red), used as a negative control, had no effect on cell division. Cells incubated with 5 µg ml^{-1} of A1 (**e**) underwent apoptosis after 48 h of treatment compared with control untreated cultures (**f**). Thirty-three per cent of the nuclei were positive for nuclear staining with TUNEL (**g**). All results are expressed as means ± s.d. for triplicate determinations.

Miralto et al. Nature 1999

Aldehyde suppression of copepod recruitment in blooms of a ubiquitous planktonic diatom

Adrianna Ianora[1], Antonio Miralto[1], Serge A. Poulet[2], Ylenia Carotenuto[1], Isabella Buttino[1], Giovanna Romano[1], Raffaella Casotti[1], Georg Pohnert[3], Thomas Wichard[3], Luca Colucci-D'Amato[4], Giuseppe Terrazzano[5] & Victor Smetacek[6]

[1]*Ecophysiology Laboratory, Stazione Zoologica "A. Dohrn", Villa Comunale, 80121 Naples, Italy*
[2]*Station Biologique de Roscoff, CNRS, Place Georges Teissier, 29682 Roscoff, France*
[3]*Max Planck Institute for Chemical Ecology, Hans Knöll Strasse 8, D-07745 Jena, Germany*
[4]*Institute of Endocrinology and Experimental Oncology, CNR, Via Pansini 5, 80131 Naples, Italy*
[5]*Department of Cellular and Molecular Biology and Pathology, University of Naples, Via Pansini 5, 80131 Naples, Italy*
[6]*Alfred Wegener Institute for Polar and Marine Research, Am Handelshafen 12, 27570 Bremerhaven, Germany*

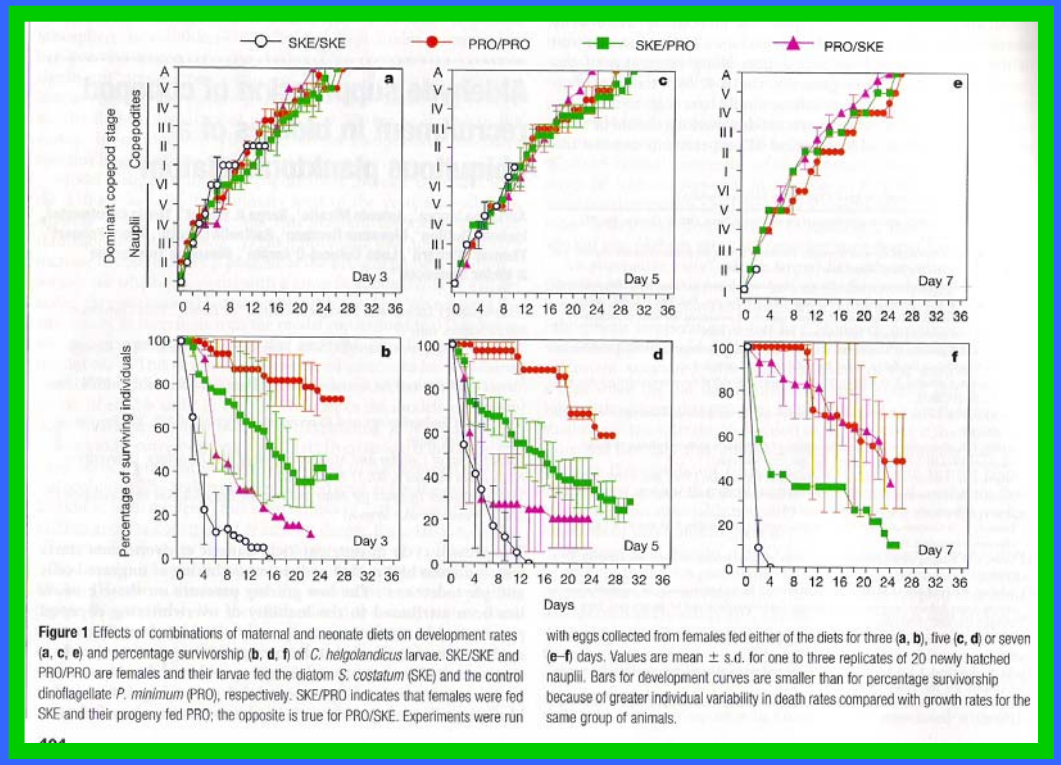


Figure 1 Effects of combinations of maternal and neonate diets on development rates (**a**, **c**, **e**) and percentage survivorship (**b**, **d**, **f**) of *C. helgolandicus* larvae. SKE/SKE and PRO/PRO are females and their larvae fed the diatom *S. costatum* (SKE) and the control dinoflagellate *P. minimum* (PRO), respectively. SKE/PRO indicates that females were fed SKE and their progeny fed PRO; the opposite is true for PRO/SKE. Experiments were run with eggs collected from females fed either of the diets for three (**a**, **b**), five (**c**, **d**) or seven (**e**–**f**) days. Values are mean ± s.d. for one to three replicates of 20 newly hatched nauplii. Bars for development curves are smaller than for percentage survivorship because of greater individual variability in death rates compared with growth rates for the same group of animals.

Ianora et al. Nature 2004

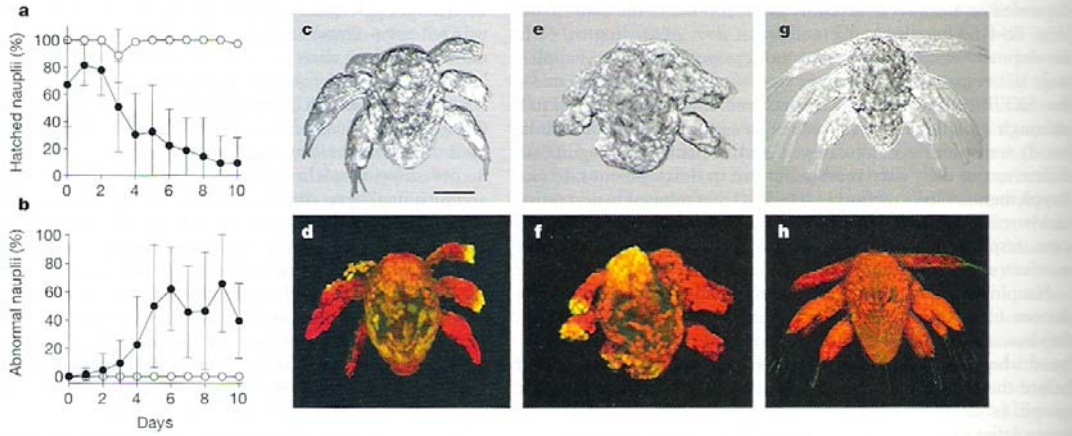


Figure 3 Effects of diet on *C. helgolandicus* offspring fitness. **a**, After ten days of feeding, the viability of eggs spawned by *C. helgolandicus* females fed the diatom *S. costatum* SKE (filled circles) dropped to <20% compared with >95% with the control dinoflagellate *P. minimum* PRO (open circles). **b**, After five days of feeding on SKE, 45–65% of the hatched nauplii were abnormal. **c**, **d**, Such nauplii had deformed limbs that were positive for TUNEL staining (yellow, **d**) specific for apoptosis. **e**, **f**, After nine days of feeding on SKE, the degree of teratogenesis increased and nauplii were strongly deformed. **g**, **h**, Nauplii generated from females fed the control PRO diet appeared normal and stained negatively with TUNEL (**h**), indicating that nuclei were not apoptotic. Scale bar, 90 μm.

CONCLUSIONS

(1) Diatom-Copepod interactions in the plankton are much more complex than was generally believed

(2)similar to what occurs in higher terrestrial plants, diatoms produce secondary metabolites as chemical defenses

(3) these chemicals (unsaturated aldehydes) reduce grazing impact by suppressing population growth (anti-proliferative compounds)

(4)recruitment rates of copepods will largely depend on the presence of these compounds in the diet, and the copepod's capacity to detoxify them.

Dott. Antonio Miralto
Resp. Lab. Ecofisiologia

D.ssa Adrianna Ianora
Senior Scientist

D.ssa Giovanna Romano
Associate Scientist

D.Ssa Raffaella Casotti
Associate Scientist

D.ssa Isabella Buttino
Associate Scientist

D.ssa Ylenia Carotenuto
Associate Scientist

Dott. Francesco Esposito
Technologist

Mario Di Pinto
Technician

Massimo Perna
Technician

Flora Palumbo
Technician

Francois Ribalet
PhD student

D.ssa Giuliana D'Ippolito
Phd student

Principal External Collaborators

Angelo Fontana (Institute of Biomolecules, Italy) - Serge Poulet (Roscoff Marine Station, France) Jeff Turner (University of Massachessetts, USA) Georg Pohnert (Max Planck Institute Jena, Germany) - Victor Smetacek (AWI, Germany) - Shin Uye (University of Hiroshima, Japan)

Vittoria Roncalli
Undergraduate student