

# Acute toxicity of individual polycyclic aromatic hydrocarbons (PAH) to early life stages of commercial marine organisms, zooplankton and phytoplankton

R. Beiras, J. Bellas, L. Saco-Álvarez, J.C. Mariño-Balsa, P. Pérez, N. Fernández

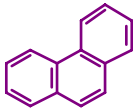
*Universidade de Vigo, Laboratorio de Ecoloxía Mariña (LEM), Facultade de Ciencias do Mar, E-36310, Galicia.*

(VEM2003-20068-C05-02)



# Ecotoxicological evaluation

## 1. Reference toxicants: medium MW PAH

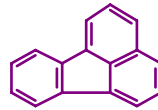


Phenathrene

14 C

178 MW

435 µg/L solub.



Fluoranthene

16 C

202

260



Pyrene

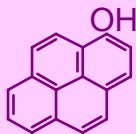
16 C

202

133

- Degradation products

*still on progress*

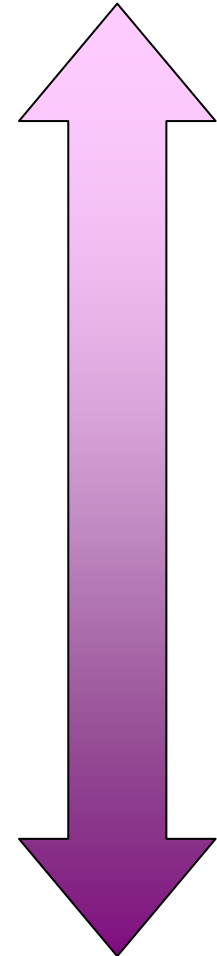


1-OH Pyr

## 2. Water-accommodated fraction of the fuel (WAF)

## 3. Seawater from affected coastline

*simple  
controlled  
artificial*



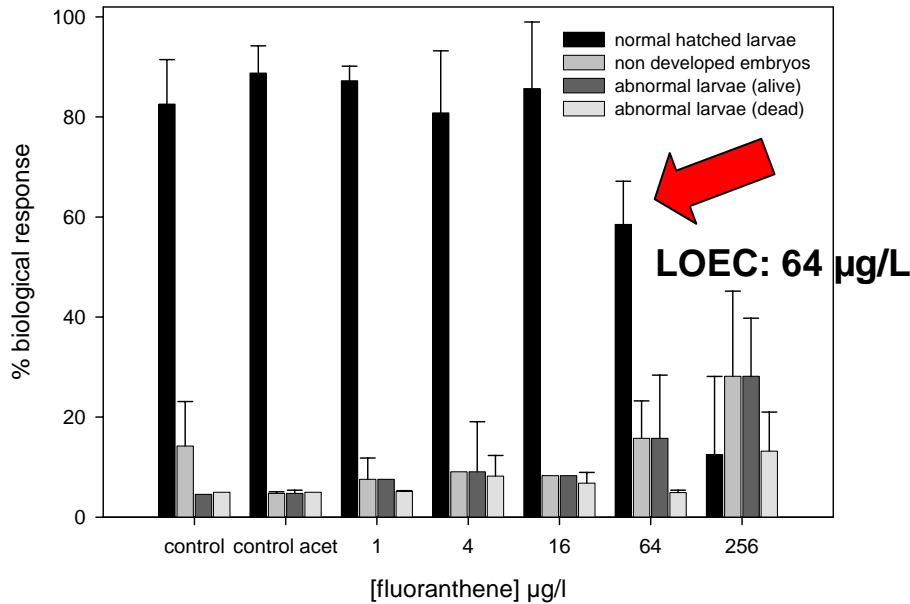
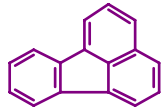
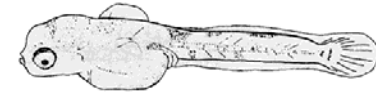
*unreproducible  
environmentally relevant*

# 1. Ecotoxicological evaluation of medium MW <sup>(1)</sup> PAHs

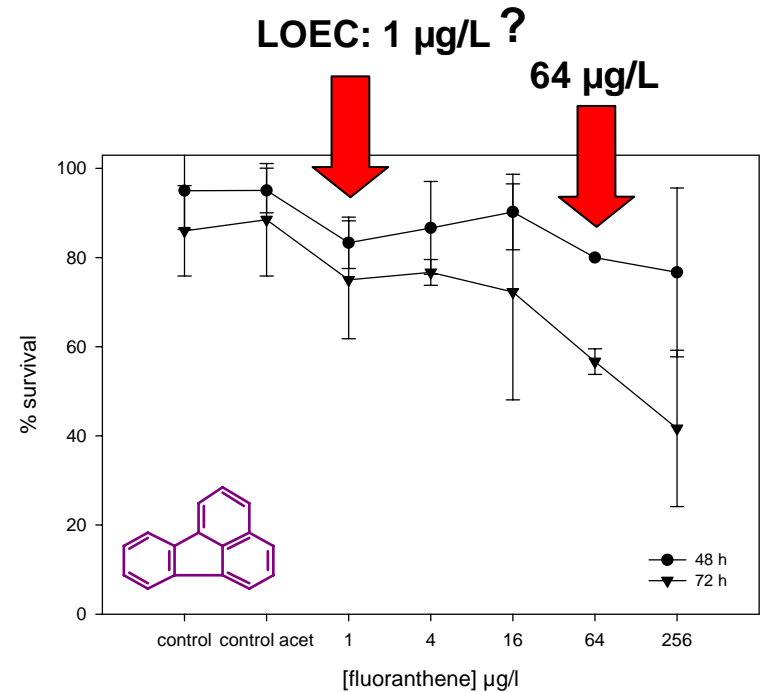
<sup>(1)</sup> Low molecular weight aromatics are too volatile and very high MW aromatics too insoluble (Neff & Stubblefield, 1995)

# Fish embryos and larvae (cod)

Dr. J. Bellas, *Kristineberg Marine Station, Suecia*



One week old *Gadus morhua* embryos exposed to fluoranthene for 7 days

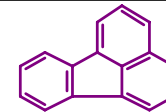
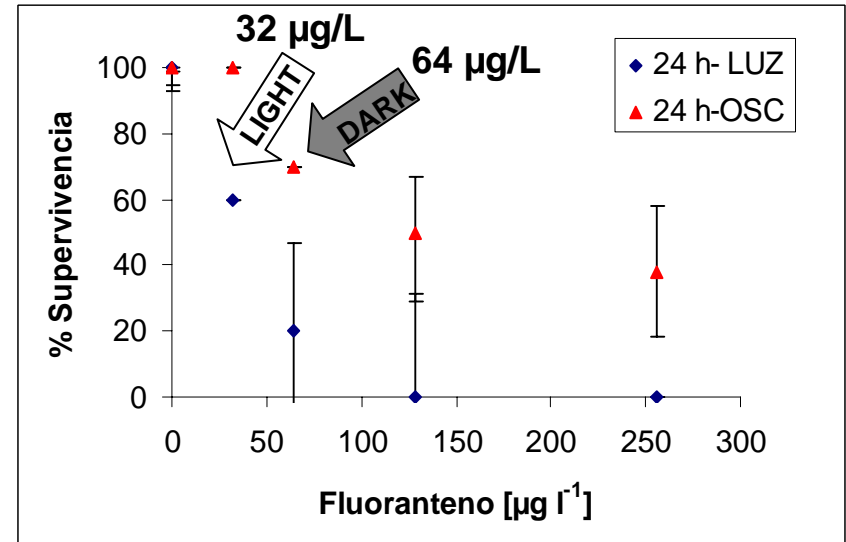
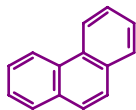
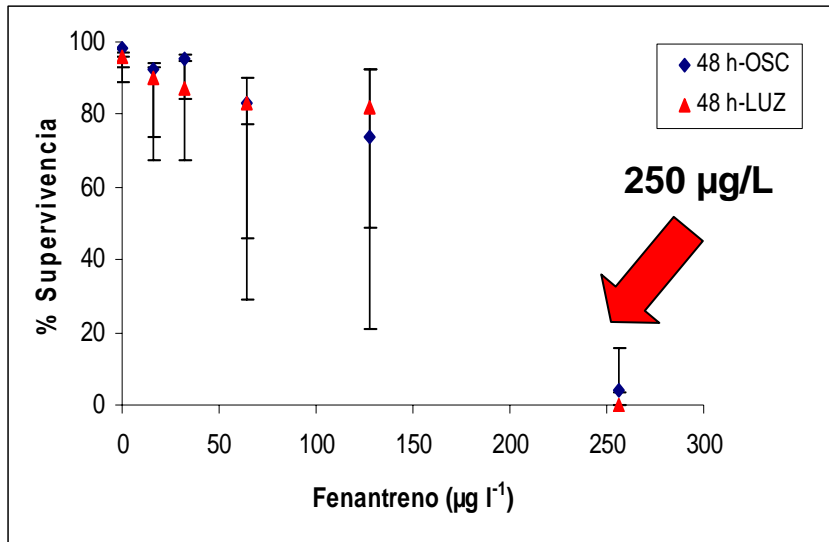
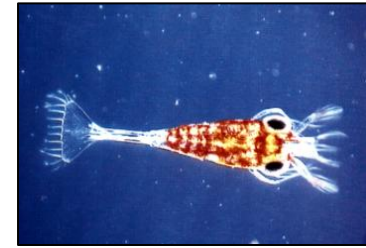


One day old *Gadus morhua* larvae exposed to fluoranthene for 72 h.

# Crustacean larvae (*Palaemon serratus*)

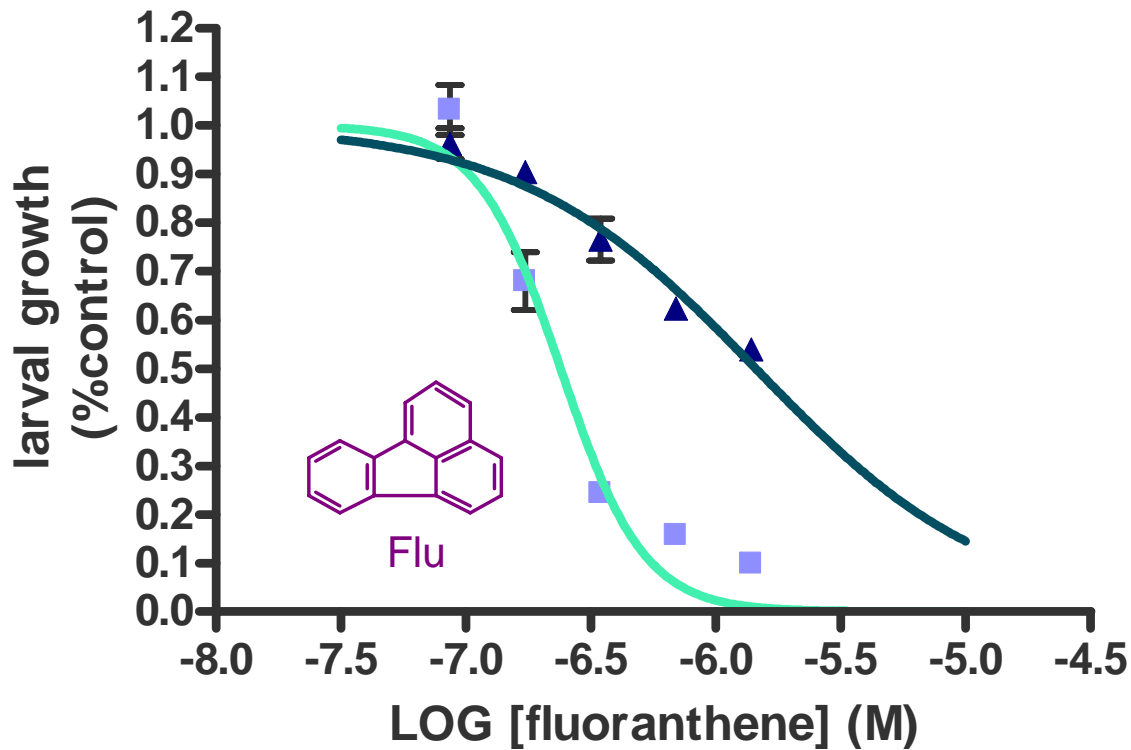
Dr. J. C. Mariño-Balsa.

Centro de Repoboación de Especies Mariñas,  
Muxía



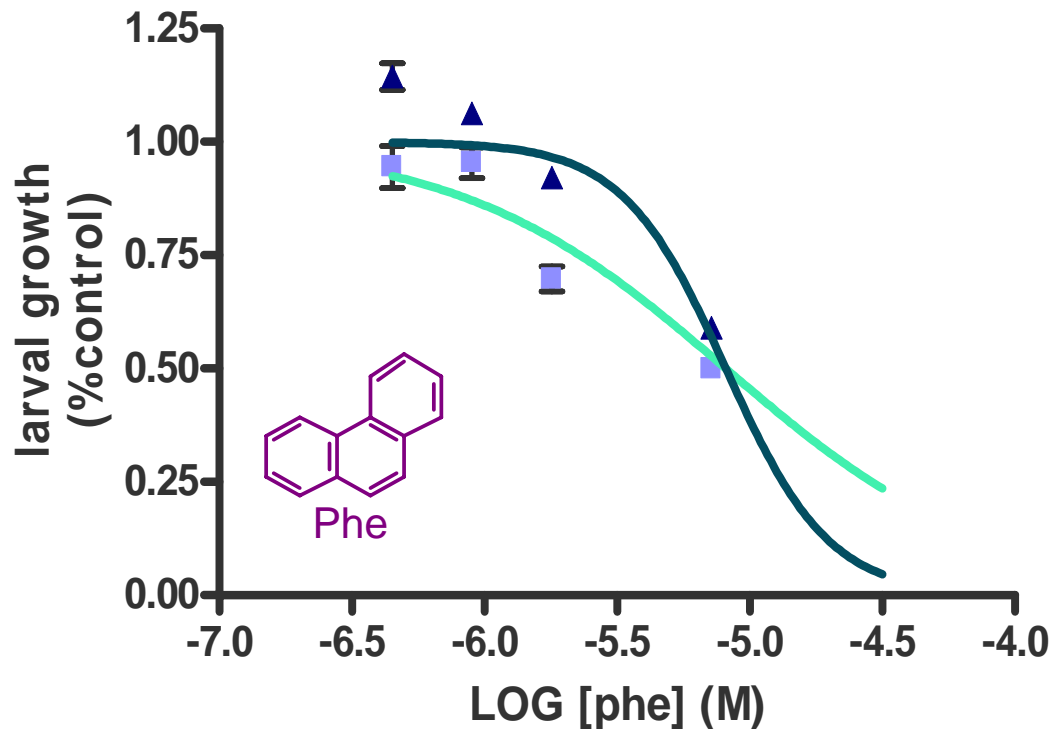
## Larvas de erizo - PAHs

L. Saco-Álvarez, *Universidade de Vigo.*



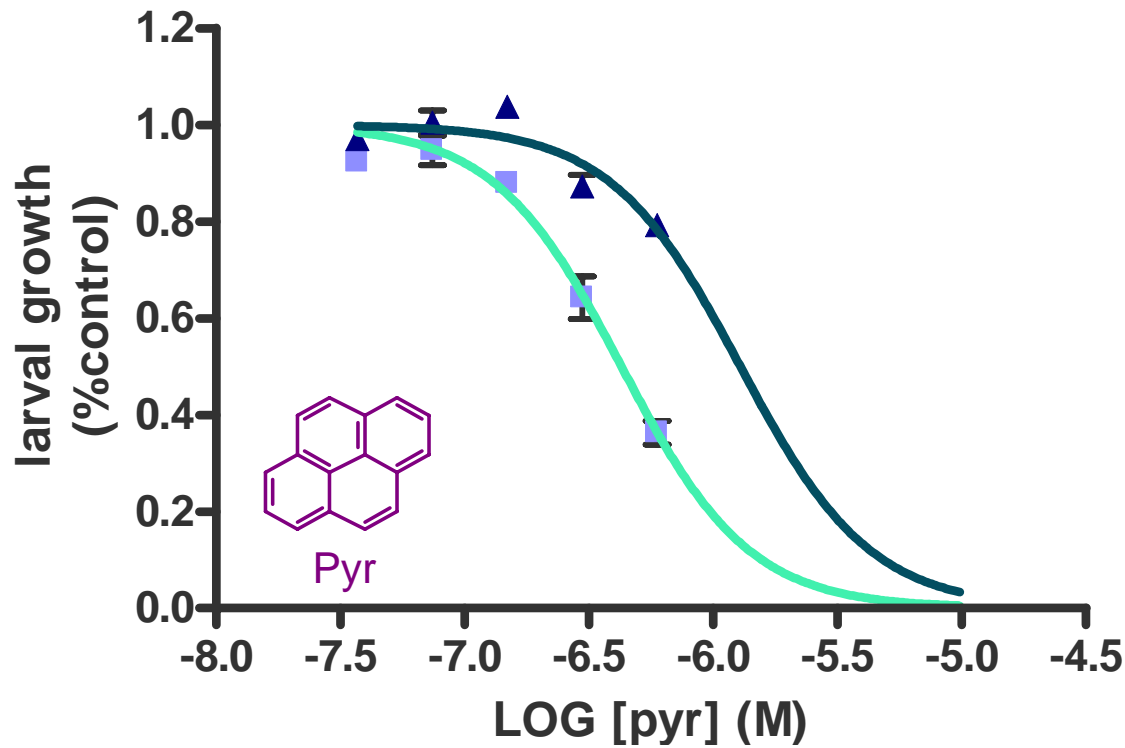
## Larvas de erizo - PAHs

L. Saco-Álvarez, *Universidade de Vigo*.



## Larvas de erizo - PAHs

L. Saco-Álvarez, *Universidade de Vigo*.



■ LIGHT  
 ▲ DARK

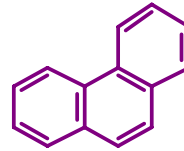
	EC50	
LIGHT	4.275e-007	***
DARK	1.285e-006	



# Phytoplankton (*Isochrysis galbana*)

P. Pérez, Univ. de Vigo

## Phenanthrene

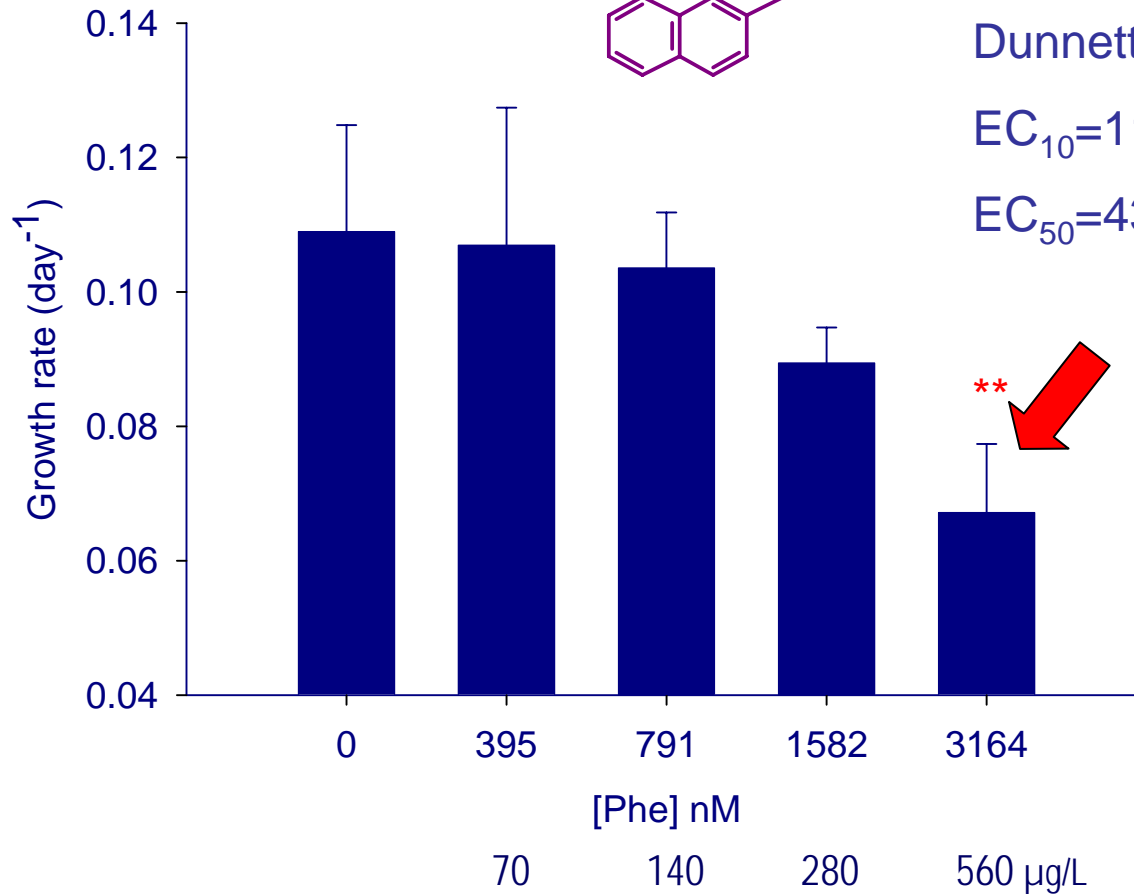


ANOVA:  $p < 0.05$

Dunnett test \*

$EC_{10} = 1169 \text{ nM}$ ,  $208 \mu\text{g/L}$

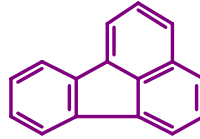
$EC_{50} = 4320 \text{ nM}$ ,  $768 \mu\text{g/L}$



# Phytoplankton (*Isochrysis galbana*)

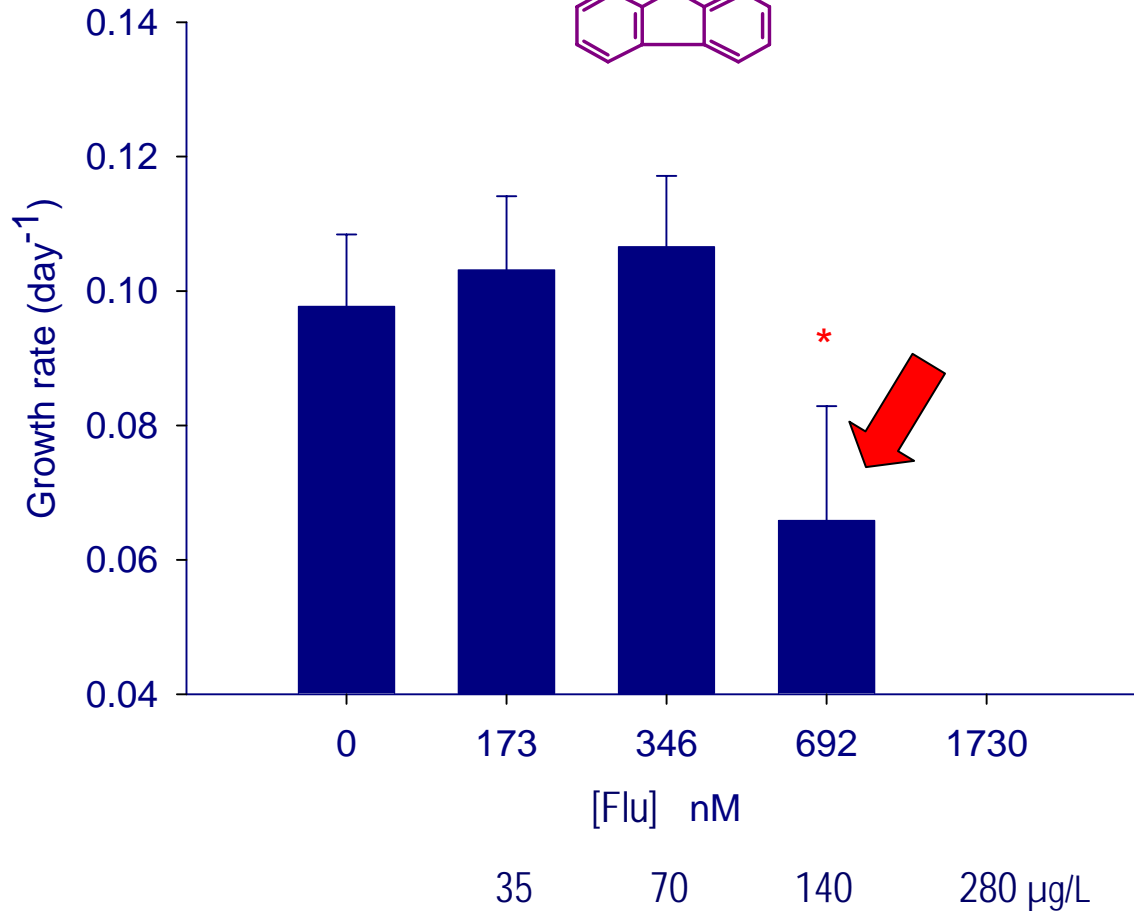
P. Pérez, Univ. de Vigo

## Fluoranthene



ANOVA:  $p < 0.05$

Dunnett test \*



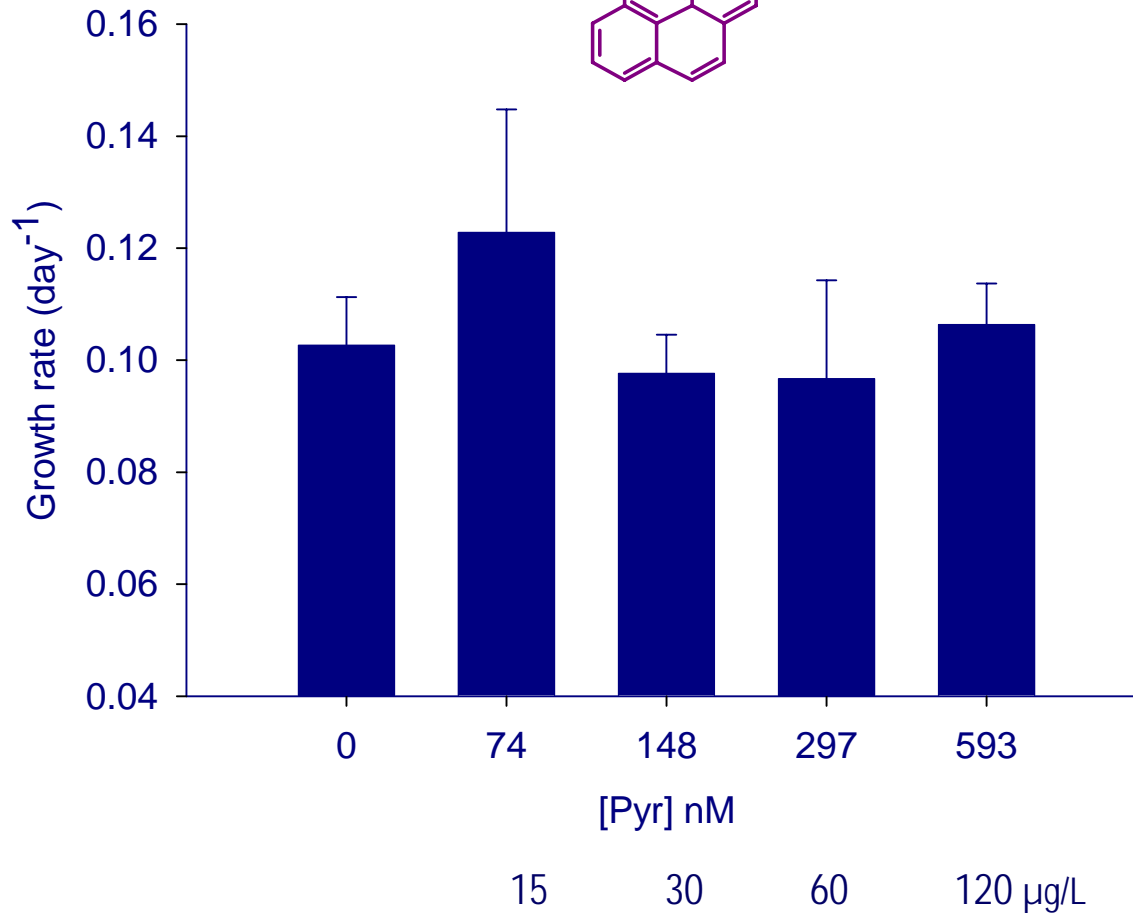
# Phytoplankton (*Isochrysis galbana*)

P. Pérez, Univ. de Vigo

Pyrene



ANOVA:  $p > 0.05$



# Summary

sp	endpoint	incubation	parameter	Phenanthrene			Fluoranthene			Pyrene		
				µg/L	µM	% sat	µg/L	µM	%sat	µg/L	µM	%sat
cod	embryogenesis	7d, dark	LOEC	n.t.			64	0.32	24.6%	n.t.		
urchin	larval length	2d, dark	EC10	90	0.51	20.7%	40	0.2	15.4%	n.t.		
	larval growth	2d, dark	EC10	n.c.			27	0.13	10.4%	70	0.34	52.6%
		2d, light	EC10	113	0.63	26.0%	21	0.1	8.1%	23	0.12	17.3%
copep.	egg production	2d, dark	EC50	231	1.3	53.1%	87	0.43	33.5%	51	0.25	38.3%
shrimp	larval survival	3d, dark	LC50	132	0.74	30.3%	94	0.47	36.2%	>128		
		3d, light	LC50	91	0.51	20.9%	<32	<0.16	<12%	>128		
phytop.	growth rate	3d, light	EC10	208	1.17	23.0%	99	0.49	38.1%	>120		

## Conclusions on individual PAHs

-Medium MW PAHs cause toxicity on early life stages of marine organisms at concentrations in average 0,8 µM for Phe, 0,3 µM for Flu and 0,2 µM for Pyr, which corresponds to approx. 30% saturation for the three PAHs

-Light enhances the toxicity of Flu and Pyr but not Phe

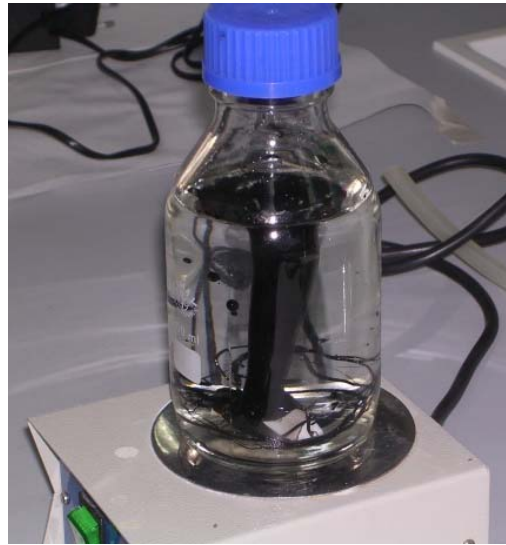
## 2. Ecotoxicological evaluation of WAF



# Preparation of water-accommodated fraction (WAF)



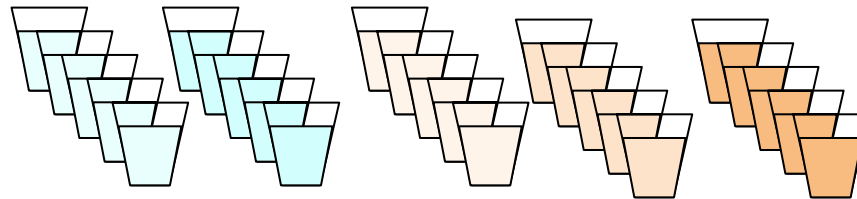
**1. mixing *Prestige* fuel oil with filtered seawater (40 g/L)**



**2. magnetic stirring (24 h)**



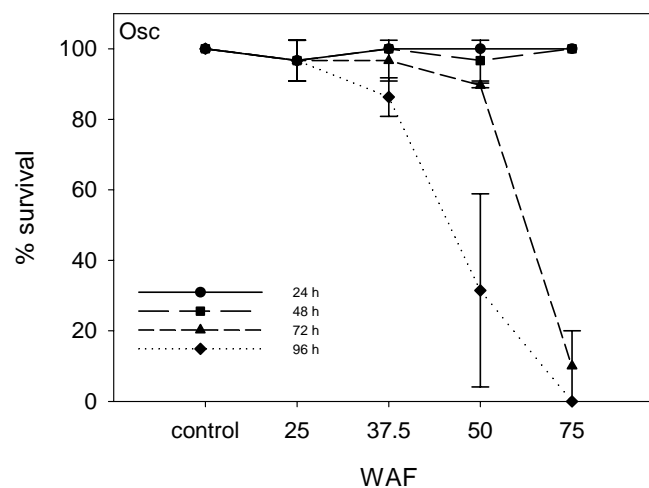
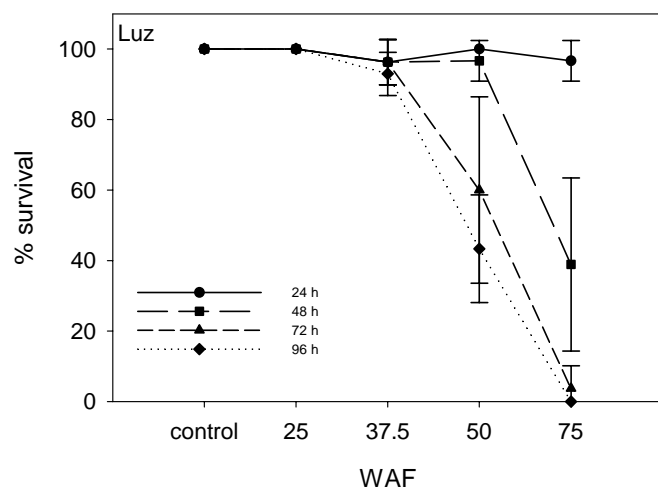
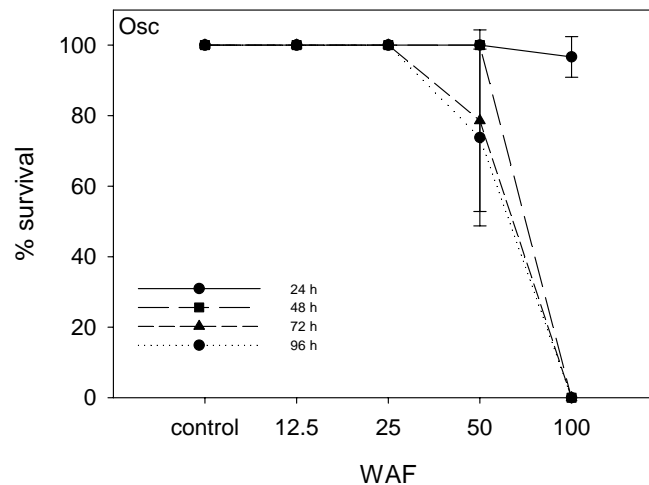
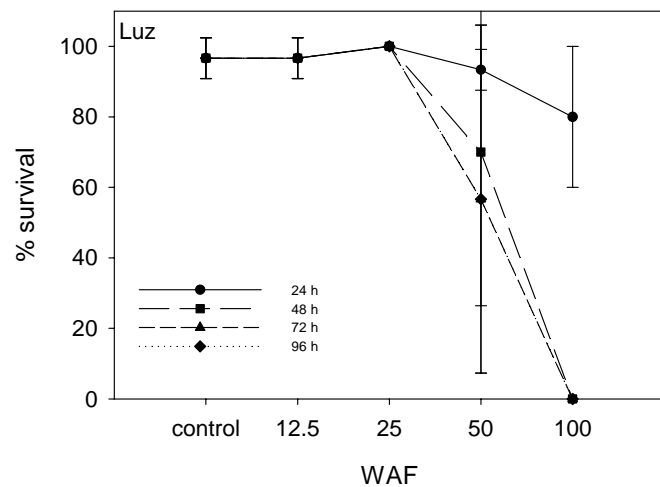
**3. GF filtration**



**4. dilutions with FSW**

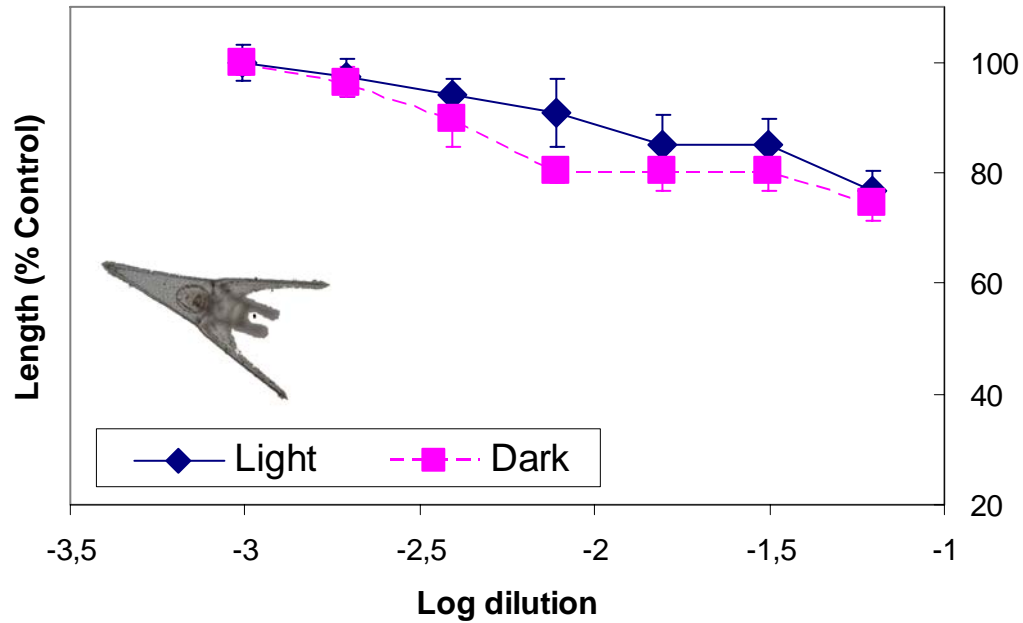
# Fish larvae (*Cyprinodon variegatus*)

Dr. J. Bellas, I. Fernández-Méijome,  
Univ. de Vigo



## Sea-urchin larvae -WAF

I. Fernández Méijome, A. Méndez, *Universidade de Vigo.*

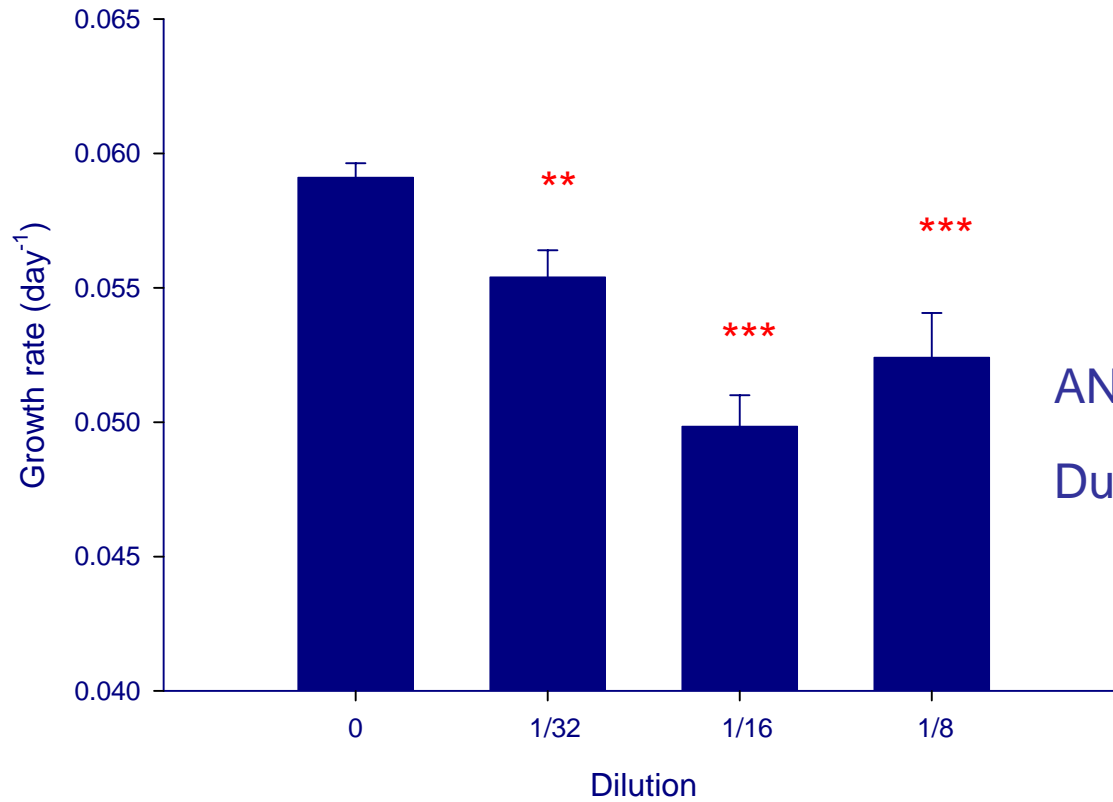




# Phytoplankton (*Thalassiosira rotula*)

P. Pérez, Univ. de Vigo

WAF

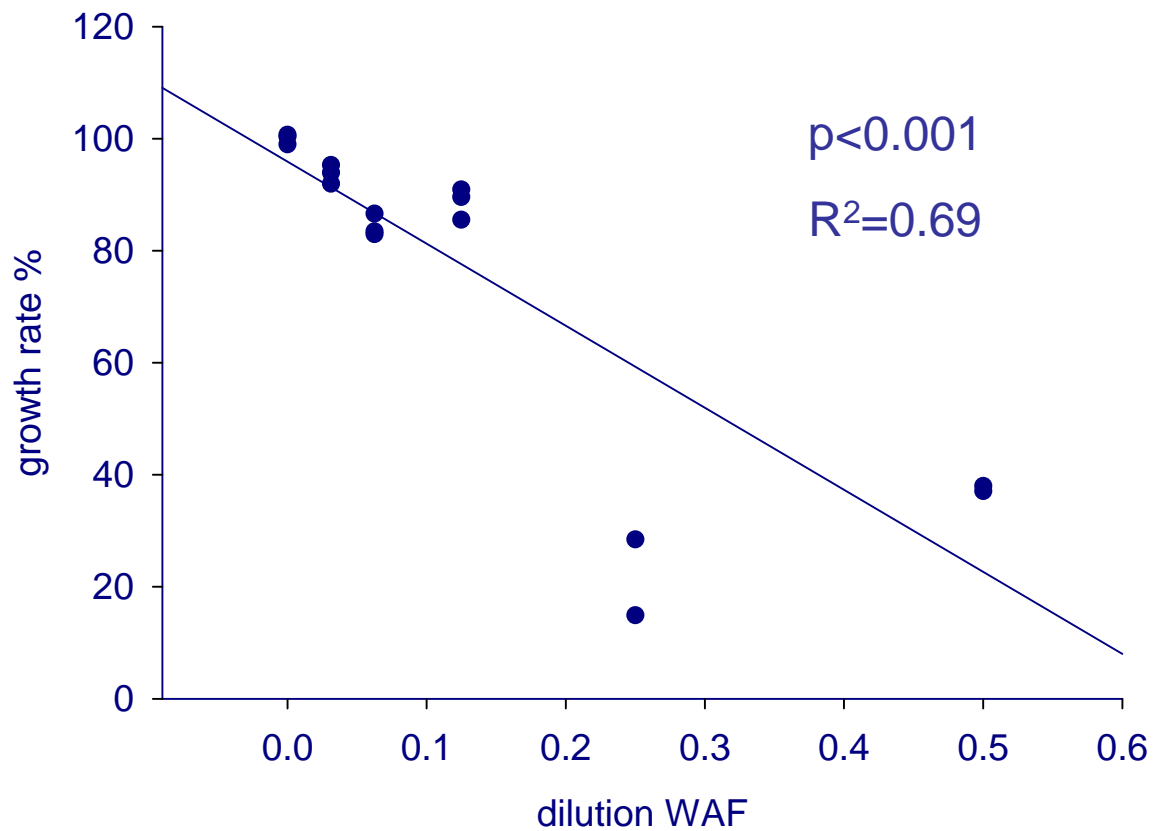


ANOVA:  $p=0.000$

Dunnett test \*

*Thalassiosira rotula*

*Thalassiosira rotula*



# Summary

sp	end point	incubation	parameter	WAF dilution	TU
<i>C. variegatus</i> (fish)	larval survival	4d, dark	LD <sub>10</sub>	0.35	2.9
		4d, light	LD <sub>10</sub>	0.34	2.9
<i>P. lividus</i> (urchin)	larval growth	2d, dark	ED <sub>10</sub>	0.0076	249
		2d, light	ED <sub>10</sub>	0.0042	131
<i>T. rotula</i> (phytop.)	growth rate	3d, light	ED <sub>10</sub>	0.04	25

## Findings on WAF

-Whilst the sensitivity of marine organisms to PAHs was very similar among phyla, **large differences in sensitivity to WAF** are appreciated, with urchins the most and fish the less sensitive

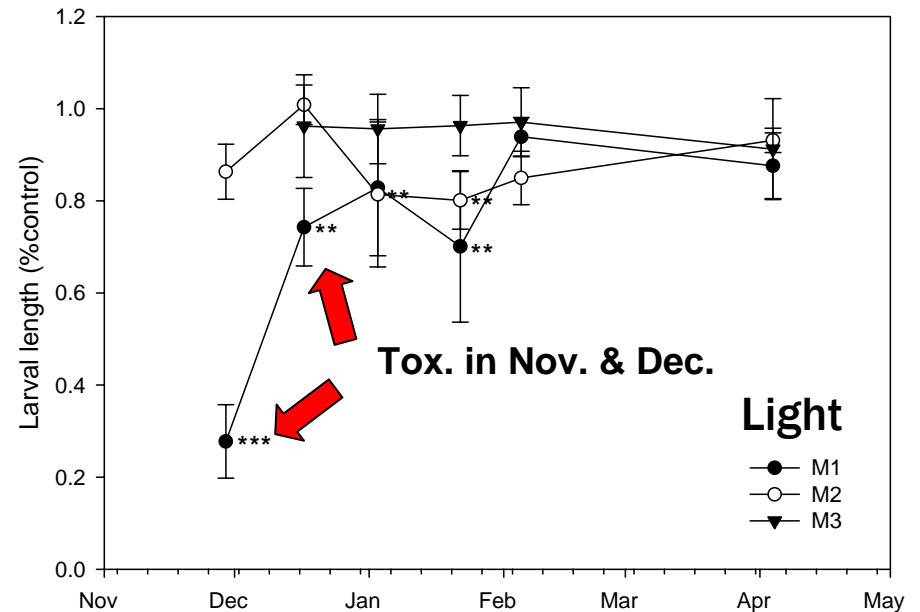
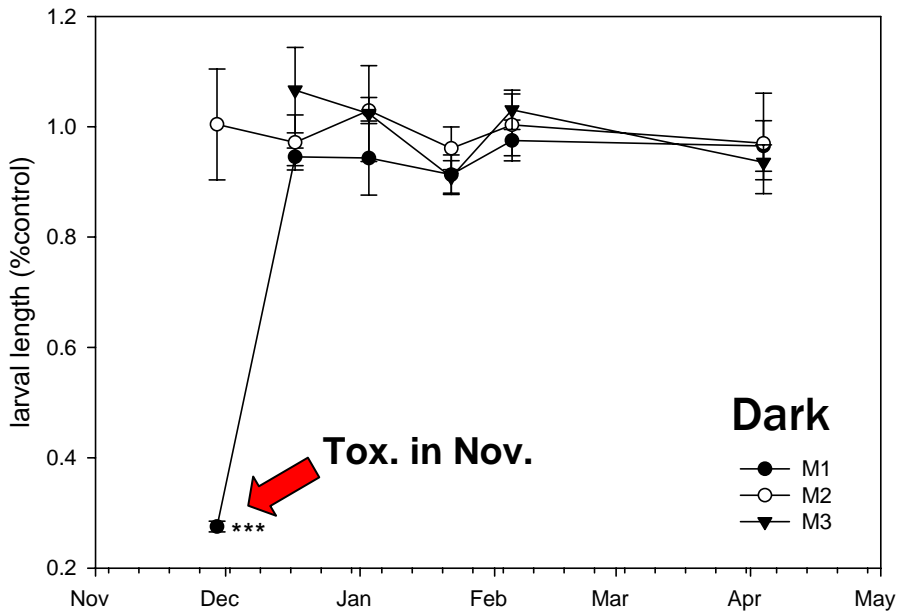
-**Light** moderately **enhances the toxicity** of WAF

-If we multiply the WAF dilutions shown above by the concentrations of medium MW PAHs measured in WAF from Prestige fuel oil (J.J. González et al.) the PAH concentrations obtained are orders of magnitude below the toxicity thresholds. Thus medium MW **PAHs alone are not responsible for the toxicity of the WAF** on marine organisms.

### 3. Ecotoxicological evaluation of environmental samples



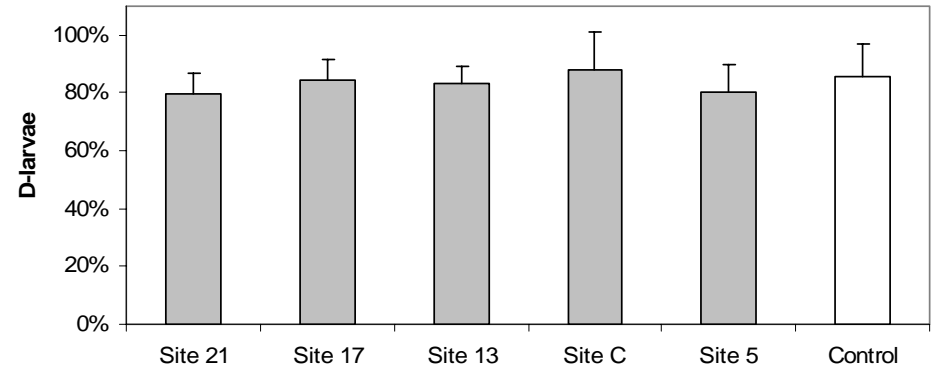
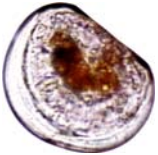
Natural seawater from coastline  
 affected by the oil-spill  
 L. Saco Álvarez, *Univ. de Vigo*



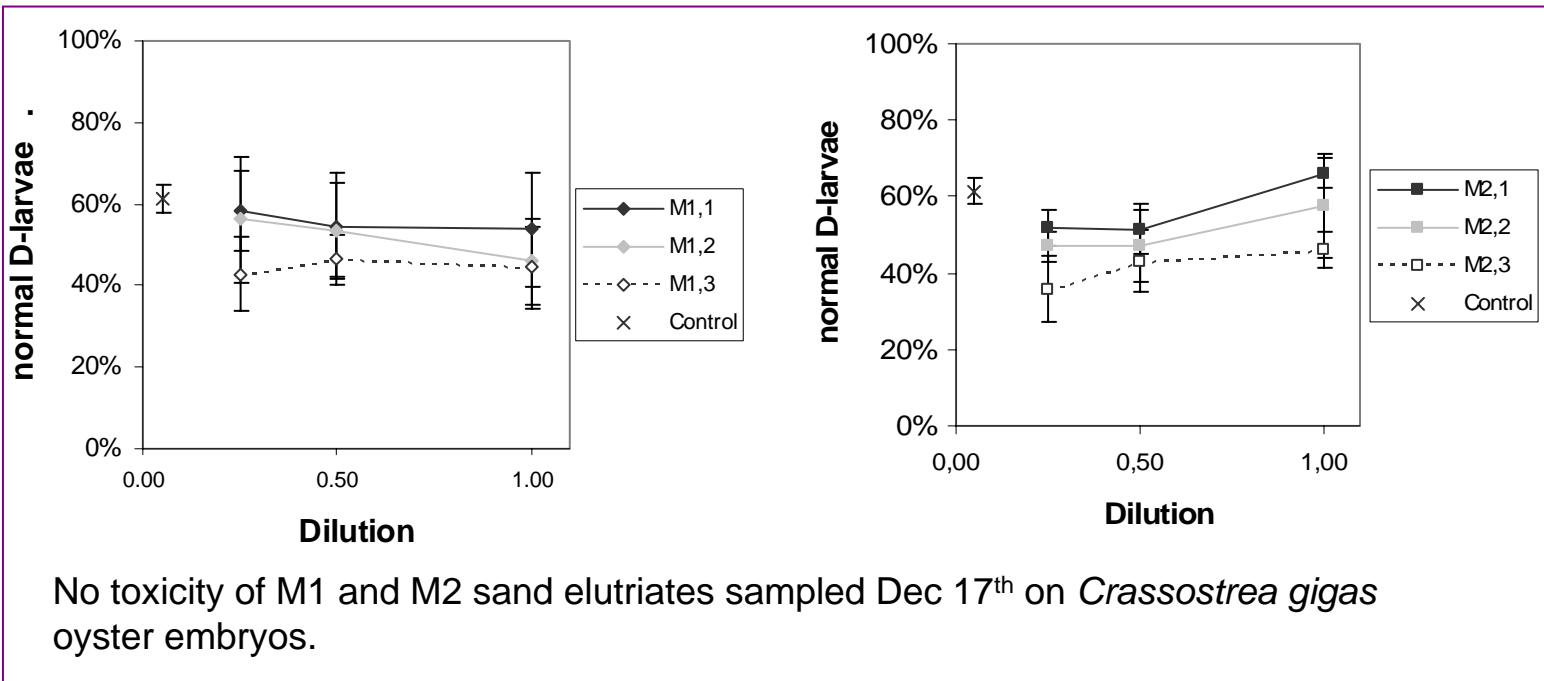
Light-enhanced toxicity of M1 seawater sampled in Nov and Dec 2002 on *Paracentrotus lividus* sea-urchin embryos.

## Sediment elutriates from coastline affected by the oil-spill

Dr. R. Beiras, *Univ. de Vigo*



No toxicity of sediments from the Galician shelf (9 to 13<sup>th</sup> Feb 2003, IEO cruise) on *V. pullastra* clam embryos



## Findings on natural samples

-We present direct evidence of **toxicity of seawater** taken the first few weeks from impacted sites on water-column organisms.

-In contrast the fraction of weathered **fuel accumulated in the sand** as solid particles and tar balls, visually much more conspicuous, **lacked toxicity** to water column organisms

## Final Conclusions

- Except for phytoplankton (less sensitive), toxicity of Phe, Flu and Pyr is very similar for very different marine organisms, and it appears at concentrations around **30% saturation** in seawater.
- The toxicity of the Prestige fuel oil **WAF** is much more selective (organism-specific) and it cannot be explained on the basis of its content in medium MW PAHs alone.
- Our findings stress the **impact to water column organisms** of the less conspicuous and frequently overlooked water-accommodated fraction, rather than the more visible oil slick



**NUNCA MAIS**