AFS PRESENTATION SO-17-21

(Shortened website/email version)

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Speculations on adaptive strategies and survival of anguillid leptocephali in relation to long-term trends in ocean-climate change

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FUNDAMENTAL 'BIOLOGICAL' QUESTIONS AND POSSIBLE ANSWERS

- *Emphasis on Atlantic spp, but PARALLELS with A. japonica, etc*
- *Relevance to management???*

Basic assumptions:

- Very unusual biology and '*catadromous*' life cycle MUST be adaptive

But data are lacking:-

- Spatio-temporal sampling biases (to 'central' Sargasso & to 1910-20s & 1980s periods of poor recruitment)
- Lack of long-term & robust datasets (cf DOI & BATS data)
- Fragility of leptocephali (cf more robust Elopomorphs, e.g. congers)

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Qu.1 Why breed in the oligotrophic STG?
Qu. 2 Why have such long migrations to continental waters?

- Must be adaptive, Anguillids radiated 20-45 mya,
  N. Atlantic spp. separated ~ 10 mya
  i.e. they've survived Continental Drift and Ice Ages
  (and should survive 'localised' fishing pressures???!!)
- Adaptiveness of '*catadromous*' life cycle
  - Resource partitioning
- Breeding in the Subtropical Fronts in the oligotrophic Sub-Tropical Gyre (STG)
  - Lack of predators
  - Specialised nutritional conditions
- Growth stages in productive coastal/estuarine waters, (plus OPPORTUNISTIC USE OF FRESHWATERS?)

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Qu.3 (Elopomorph) leptocephalus adaptations?

- Transparent and laterally compressed
  - Predator avoidance
  - High SA:volume ratio ⇒ gas exchange (+ nutrition)
- Rapid development of central acellular gelatinous core (~50% of DBM)
  - Rapid increase in length
  - Reduces predator size-spectrum
  - Support & movement – but thin layer of white muscle can only support fast-burst swimming

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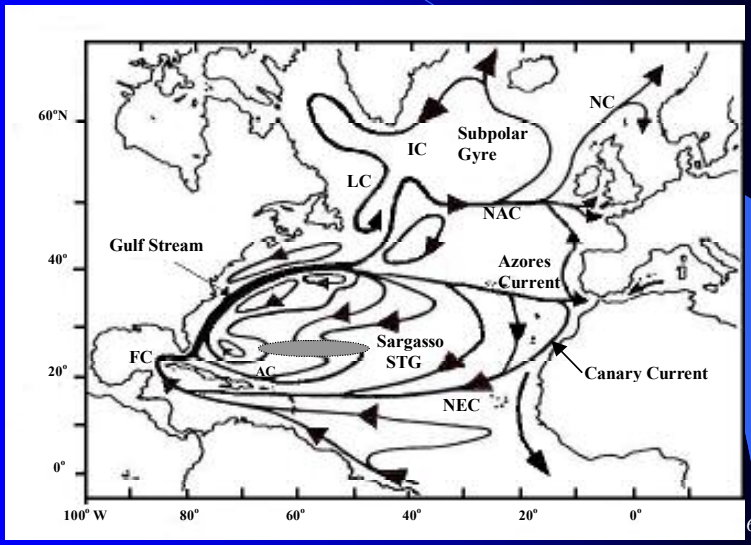
- Rapid (<1 to 1.5 year) drift immigration via STG currents?
- Silver eels return via Deep Water Boundary Currents?
- Possible explanations for species and 'racial' separations?



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Qu.4 NUTRITION IN OLIGOTROPHIC WATERS?

NB no plankton found in guts + lack of feeding in propagation

NB importance of pico/nanoplankton/diazatrophs & short 'microbial loop' food web

COULD 'MARINE SNOW' BE IMPORTANT?

- Marine snow = fragile/fractal (biogenic) aggregates
  - Type A = Larvacean 'houses' (+ faecal pellet, etc. POM)
  - Type B = POM aggregates, formed by electrochemical & adhesive processes (especially phytoplanktonic TEP & protistan secretions)
- BOTH form:-
  - 'Scavenging' microhabitats (high POM & DOM)
  - Bacterial populations & metabolism increase by orders of magnitude (+ low C:N ratios)
- Leptocephali catch houses via specialised teeth ⇒ foregut suction ⇒ pinocytosis & intracellular digestion?

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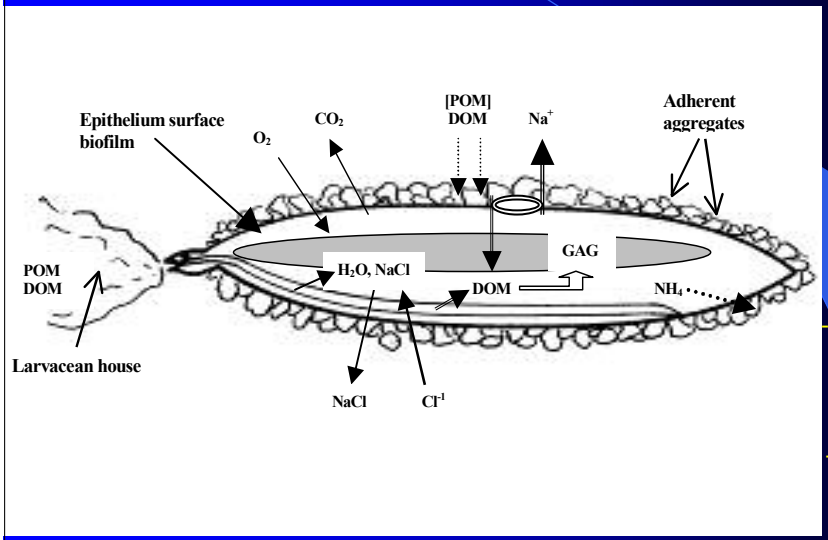
Qu.5 As well as ingesting snow, can leptocephali build up epithelial aggregate-microbial biofilms?



-ive charge

- High SA, thin, microvilli
- Active cutaneous uptake of DOM
- Can seek & accumulate fresh aggregates
- 'Recycling' of N

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Qu.6 CAN MARINE SNOW MEET NUTRITIONAL NEEDS?

From energetic estimates, leptocephali need;-

- **10 - 100 houses day^{-1}**
- **'Biofilm' thickness > 2 mm meets needs of 15-20 mm post-yolk sac larva, > 1 mm for BL > 28 mm**
- **GAGs/lipid reserves support small leptocephali for ~ 1-2 days, larger ones ~ 3 months**
- **BUT Q_{10} = 2.5, so requirements decline at higher latitudes/lower temperatures**

BUT NEED:-

- **Early feeding success/growth**
- **To synchronise breeding with spring plankton & POM/DOM/cyanobacteria 'bloom'**
- **To optimise use of (seasonal) gyre currents/avoid recirculation into summer hyper-oligotrophic STG**

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Qu. 7 MAJOR QUESTION OF THE MOMENT

Why has recruitment of eels (and other fish species) declined since the late 1970s in Europe, N. America & Japan?

Ocean-climate change?

e.g. Den Oever recruitment index *v.* North Atlantic Oscillation (1938-2002) correlations

(PLUS anecdotal historical evidence)

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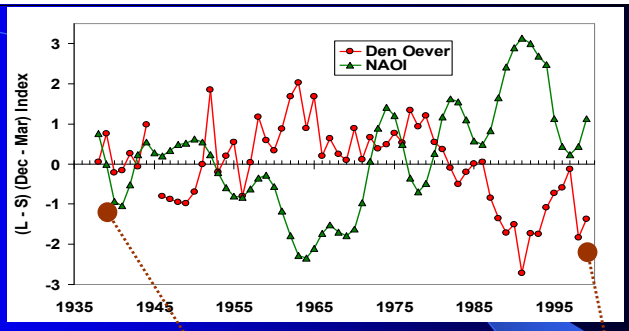
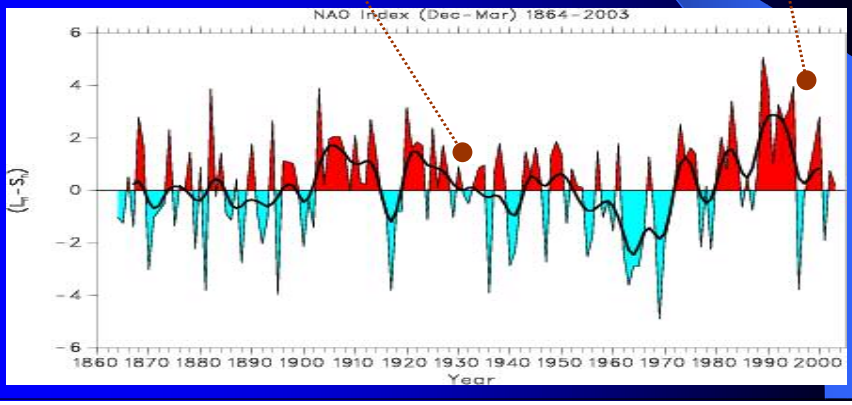
NAO index Values (NAO/DOI 0.30-0.50)





Qu.8 POSSIBLE ASSOCIATIONS BETWEEN NAO & RECRUITMENT?

- ❑ Prolonged Azores high v Iceland low air pressure
- ❑ Associated with STG warming/polar cooling
- ❑ Deeper STG thermocline & nutricline
  - ➢ Reduced winter overturn & nutrient recycling
  - ➢ Reduced (spring/eukaryotic) primary production, POM/DOM and P ⇒ cyanobacteria 'bloom'
- ❑ Increased Westerly & Trade winds
- ➢ Strength of STG anticyclonic currents & eddies

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Correlations between NAO and Sargasso Sea parameters

	Location (years)	NAO	SST	Temp (0-100m)
Sea surface temp. (SST)	Hydrostation S (1954-1998)	0.42	-	-
	BATS (1988-1998)	0.40	-	-
	Sargasso Sea (1952-1995)	0.47	-	-
Mixed layer depth[b]	Hydrostation S (1955-1998)	-0.47	-	-
	BATS (1988-1998)	-0.32	-0.56	-0.45
Primary production	BATS (1988-1998)	-0.33	-0.51	-0.64

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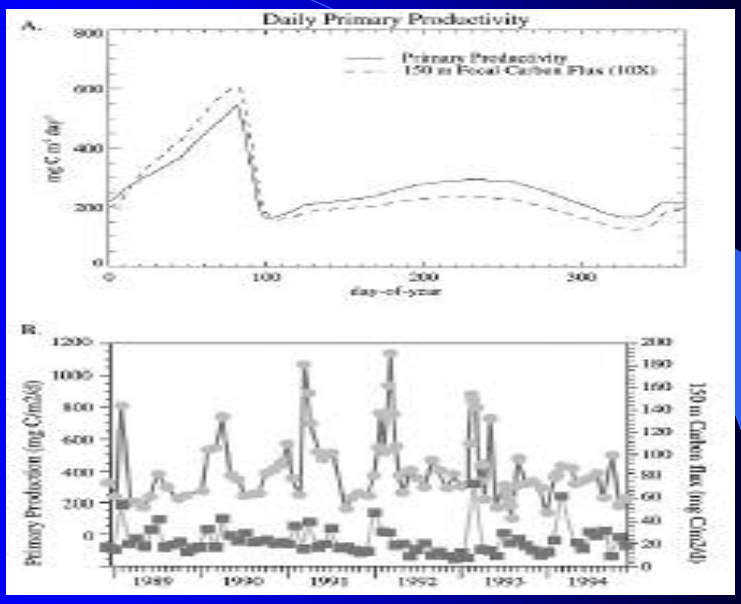
Annual cycle of primary production and POM carbon flux at BATS (1989-1994) (Bissett *et al.*, 2001)



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ALSO – increased vorticity carries more 'vagrant' larvae back into the STG?

- (Gulf Stream/NAC slide showing warm and cold core rings and streamers removed for brevity)

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Qu.9 How is the Anguillid life cycle adapted to long-term ocean-climate fluctuations?

- **DENSITY-DEPENDENT coastal/estuarine⇒freshwater MIGRATION and SEX DETERMINATION??**
  - **i.e. low recruitment ⇒ low density ⇒ biomass to carrying-capacity ⇒ less pressure to migrate further upstream**
    + more larger/fecund females (1→ 10+ m eggs)
- **Related to;-**
  - **Ease of recruitment from Atlantic**
    (e.g. SW England/Biscay *v.* N Sea *v.* Baltic)
  - **Coastal *v.* estuarine ecosystems *v.* distance upstream in freshwaters, e.g.;-**

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