

3rd CORONA meeting 28-31 July 2004
Marine Biological Association, Plymouth

Day 1 - 29/07/2004

Introductory talks

Introduction to Plymouth and MBA (www.mba.ac.uk)

History, current research and long-term data sets – Steve Hawkins, MBA

Director (sjha@mba.ac.uk)

The Marine Biological Association was formed in 1883 by a group of scientists and men of affairs who were interested in fisheries and the study of marine life. One of the most active members of this group was E. Ray Lankester who became honorary secretary of the Association when it was formally constituted on 31 March 1884, with T.H. Huxley as the first President. It was decided to build a laboratory in Plymouth, where there was a great variety of marine life. The Laboratory was opened in June 1888, and from the beginning the investigations in marine biology were multidisciplinary, ranging from fishing to physics.

In 1965 administration of the government grant to the MBA was transferred from the Development Commission to the Natural Environment Research Council (NERC), who gradually increased their financial assistance and involvement in the research undertaken. In 1988 most of the environmental work of the MBA was amalgamated with that of the NERC Institute for Marine Environmental Research, (established in Plymouth in 1971) to form the Plymouth Marine Laboratory (PML). The MBA retains its own independent research programme, funded by a grant-in-aid from the NERC and by grants from other Research Councils and from private foundations. The work continues the MBA tradition of individually motivated, curiosity driven, research into fundamental questions in marine biology, through a Fellowship programme that is closely interwoven with the visitors' programme.

The MBA is governed by a distinguished Council of leading scientists and public figures keen to promote the development of marine biology, and has played a very active role in the affairs of the Association. More than 170 Fellows of the Royal Society have worked at the laboratory and benefited from its creative atmosphere and the Association has contributed to the work of no less than 13 Nobel Prize winners.

Current and past research at the MBA – long-term data sets: squid, neurophysiology research (started in 1935), cephalopod neurophysiology and behaviour, cell physiology,

virus ecology and climate, reproductive and developmental biology, experimental ecology, fish behaviour and ecology, fisheries investigations (started in 1889).

From the MBA website.

The Sir Alister Hardy Foundation for Ocean Science (www.sahfos.org)

Long-term broadscale surveys of the Atlantic – Chris Reid, SAHFOS Director
(pcre@sahfos.ac.uk)

Continuous Plankton Recorder survey started in 1931, when herring was the major fishery. The CPR is towed by voluntary merchant ships across the North Atlantic ocean. The primary survey was done in the North Atlantic. Large changes in organisms seem to be due to changes in water temperature. The phytoplankton colour is also an index of phytoplankton biomass. Strong links have also been demonstrated between the plankton and Northern hemisphere temperatures, the NAO and sea surface temperatures. It seems that cold water species of plankton are retreating, while an opposite pattern appears on the other side of the Atlantic (colder species go further south). Changes in phytoplankton have a crucial impact on cod, they are much smaller than before.

In conclusion, plankton is sensitive to climate change; there is a good evidence of regime shift in North Atlantic; there is a northerly movement in plankton and fish, and reverse in west.

Questions: top-down effect? R: environment is the dominant factor. Demonstration of the database. C. Reid: we need datasets in parts of the world where they don't exist. Comment by A. Richardson: there are 50 species of phytoplankton, it is going to be a long time before we have information from the satellites on all the species.

Plymouth Marine Laboratory (PML)

Work on Biodiversity and ecosystem functioning/shelf ecology – Paul Somerfield
(pjso@pml.ac.uk)

PML originally formed by merger of different institutes. It is one of the world's first truly multidisciplinary marine research centres. PML is now a NERC collaborative centre. PML is a company limited by guarantee, with charitable status. Its core mission concerns the issues of global change, pollution and sustainability. PML is an independent impartial provider of scientific research in the marine environment. The core strategic research focuses on: the functioning and health of estuarine and coastal systems; patterns in biodiversity and the functional consequences of change; quantifying biogeochemical processes, exchanges and controls; forecasting the role of the oceans in the Earth System; expertise from remote sensing of the earth to molecular biology, taxonomic discrimination to ecosystem modelling, viruses to socio-economics; scaling biodiversity and the consequences of change.

How to measure biodiversity, and extrapolate across different scales of phylogeny and space to detect change? What are the functional consequences of changes in biodiversity at different levels of biological organisation? Traditional identification techniques are used, underpinning a range of research areas: electron and enhanced light microscopy; image analysis; development of methods manuals and identification guides. Also CytoSub: an *in situ* flow cytometer and molecular identification of *Calanus* species. Development of electronic 'intelligent' keys; virtual collections; Internet based (www.pml.ac.uk/nematode). Measures of biodiversity based on relatedness of species: directly reflect (phylo)genetic diversity e.g. 5 species in one genus are less 'biodiverse' than 5 in different orders; independent of sample size or sampling effort (comparable for historic datasets with unknown/uncontrolled effort); statistical framework for departure from expectation.

Example of applications: geographical comparisons, regional/local relationships; rapid assessment of biodiversity (evaluating surrogates); prediction, e.g. of the effects of climate change. Examples of other work: Isles of Scilly species inventory ('ATBI'); quantitative benthic video imaging ('ABISS'); fractal properties of spatial distributions; interactions between organisms of different sizes; costing the impacts of fishing disturbance (Cost-Impact); climate-change effects on intertidal organisms. Regime shifts: CPR data compared to Defra data.

University of Plymouth

Work on marine biodiversity and ecology – Richard Thompson

(r.c.Thompson@plymouth.ac.uk) www.plymouth.ac.uk/mberg

60 staff are part of the Marine Biology and Ecology research group.

. Martin Attrill: Community dynamics of estuarine organisms in relation to environmental variables – climate; ecology and biodiversity of temperate and tropical seagrass beds

. Pete Cotton: Behavioural ecology; climate change and avian reproductive phenology, distribution of basking sharks; trait compensation of defence mechanisms in marine gastropods and hermit crabs.

. Jason Hall-Spencer: Ecology and conservation of North Atlantic coral reefs and maerl beds

. Andy Foggo: Marine macroecology

. Dave Bilton: Understanding the role of historical factors and dispersal in shaping the distribution of aquatic organisms (population genetics/phylogeny/community ecology)

. John Bishop: Patterns of genetic diversity in marine species; spermcast mating of sessile invertebrates; introduced species in sessile biotas

. John Spicer: Physiological diversity: its ecological & evolutionary implications; biodiversity & ecosystem function – the strandline as a model system

. Ross Coleman: Foraging behaviour of shorebirds; intertidal ecology - linking predator behaviour to community ecology; multi-trophic consequences of induced defences in algae

. Simon Rundle: Evolution and ecology of phenotypic plasticity in aquatic organisms; cross-aquatic system comparisons; threatened aquatic ecosystems

. Richard Thompson: fate of plastics in the marine environment; ecology & conservation of intertidal habitats (Ecology of marine biofilms, trophic interactions with grazers); biodiversity of man made habitats

Formal session – Long-term change in the North-Atlantic

The effect of NAO on Atlantic circulation, with focus on the North-Atlantic – Charles Greene (Chg2@cornell.edu)

US Globec (start: early 90s). NW Atlantic/George Bank (Gulf of Maine) field study 97-99 (video acoustic survey with BIOMAPER II, and net sampling with MOCNESS). *Calanus finmarchicus* population dominates spring time. Zooplankton biomass and production of many North Atlantic shelf ecosystem, including the Gulf of Maine + George Bank. It is not a shelf species. It is a slope species, and thus a good indicator of change.

C. finmarchicus is an expatriate species in the Gulf of Maine and George Bank and must be supplied from oceanic source regions. The supply side ecology hypothesis is that recruits from the Gulf of Maine drive interannual variability in the population dynamics of *C. finmarchicus* on George Bank. *C. finmarchicus* diapaused (means they go deeper in the water: 1500-1700m in the Gulf of Maine) stock in the Gulf of Maine crashed during the Autumn of 1998. Integrated abundance in George basin/Jordan Basin/Wilkinson basin. Hypothesis (1998): *C. finmarchicus* could be an indicator of climate driven changes in ocean circulation. Moreover, unusual behaviour of the NAO during the last decades.

NAO +: oscillations in pressure in North Atlantic. Higher pressure in subtropical: Strong H and L pressure cells; Westerlies strengthens; Strong track shift north. NAO-: Weak H and L pressure cells (less pressure gradient); westerlies weakens; storm track shifts south. Therefore in winter time, colder conditions (++ snow), and dryer conditions and extreme cold weather in Europe (eg. 1995-96). Response to the NAO: +NAO: strong winds Labrador Sea; enhanced production of LSW and intensification of DWBC; Labrador current weakens; Gulf Stream shifts to the North. -NAO: reduced production of LSW and weakening of DWBC; Labrador current intensifies (most of it moves offshore); Gulf Stream north wall shifts south.

The Winter NAO index: from 1860, a lot of variability, a lot more positive years. 1960s, negative period, and 1970s, transition again to predominant NAO+. Major mode of variability of climate in the North Atlantic.

Q: What is the mechanism of NAO? R: people think it is related to the stratosphere. But from what can be seen in the last 3 decades, it is difficult to predict what is going to happen.

NW Atlantic's coupled slope water system: Atlantic slope water: bottom water are warmer than surface waters in the Gulf of Maine (only because it is saltier); LSSW:

minimal modal state (associated with NAO-). Slope water system works in a way that it is coupled.

- Maximum modal system associated with NAO+
- ATSW: only water that can influence in NAO+

The Winter NAO index: the largest drop of the century was in 95-96.

- Progress of LSSW along continental margin; it takes about 1h-1h1/2 for the slope water to move and go to the coast.
- Intrusion of LSSW into the Gulf of Maine. Bottom waters are warmer (and saltier) than less deep.

Comment C. Greene: the change in 1995-96 is very close to what happened in the whole 60s when we would have called that a regime shift.

Time series of the NAO and the regional slope water temperature measurements in the Gulf of Maine. PCA on time series: very strong relationship between NAO and RSW temp. index. Modelling the response of the coupled shore water system to the NAO. Now: trying to determine how these changes influence *C. finmarchicus* and then how *Calanus* influence the success of various fish stocks.

Q C. Cunningham. Benthic survey on this coast. 2 signals. Focusing on the NAO; the *Calanus* is probably the important.

In the 80s, more fresh water in the Labrador Sea, which is one of the most sensitive areas of the North Atlantic to climate change. In Europe, more warming or becoming warm current near Iberian coasts. The regional effects are very different.

Comment Robin Pingree: NAO + index stronger so gyre ++; NAO- therefore weakening of gyre.

North Sea population of *Calanus* dropping but thriving in the Gulf of Maine.

Q J. Olsen: work on physical geography related to NAO? R: reference to Bob Dixon and a book by J. Hurrell.

Q: trends, magnitude of the changes? Things were more variable; even with NAO + not major shifts in the Labrador Sea?

Marclim

Re-surveying British and Irish rocky shores– Nova Mieszkowska (nova@mba.ac.uk)

2001-2005 project. Multifunded. Studies necessary as climate is changing very quickly. The main point is to use the time-series collected, and the broad-scales surveys since 1950-60s. Long-term network over Britain.

Outline:

- dataset: 50 years barnacle data (Crisp & Southward)
- limpet data 1980-2003
- topshell data (Kendall and Lewis)
- Resurvey of all above
- repeat broadscale survey of 1930s-50s.
- synthesise and interpret historical and new data

Range extension of southern species: good coverage in South-west and North Wales.

Osilinus: northern Ireland, recolonising north Wales. *Bifurcaria*: ++ range shift Devon.

Barnacles: north Sea. (*Balanus perforata*: significant range shifts southern England-north France).

Various shifts:

- retreat of north populations in the South-West (northern barnacles spreading south)

Ongoing research:

- formal analysis of historical/time series data & environmental variables.
- Experimentation to determine putative mechanism with respect to climate
- Predictive modelling under future climate scenario (cf Mike Burrows talk).

Comment about the various responses between southern and northern species and life spans. Other comment about small range extensions, environmental and biological effects. Other comment about the distribution and thermal boundaries but no evidence that they moved.

Comment by Cliff Cunningham: it would be interesting to study not only which are the marker species but also which are the characteristics associated with particular conditions.

Phenology and climate change in the plankton – Anthony Richardson and Martin Edwards (anr@sahfos.ac.uk)

Impact of climate change on phenology (ie. Study of the timing of recurring natural phenomena (in relation to climate change): appearance of snowdrops, emergence of peacock butterfly, arrival of barn swallow). The majority of the studies are based on single species, not communities, and mostly of terrestrial origin. They do not investigate ecological interactions.

In temperate marine systems, there are two production peaks in the annual cycle, in spring and autumn. The approach is based on data from the CPR, which are monthly data and the focus is on 66 taxa. Multiple trophic levels (functional groups). An index for the phenology is calculated for each year.

No changes have been observed for spring and autumn, but changes have appeared for summer. The spring bloom might be related to light-limitation and germination of some diatoms.

Q: Are phenological shifts in summer related to temperature? R: There seems to be a good concordance.

Conclusion: the responses are different seasonally. The phytoplankton seems to be moving more than the zooplankton. There is a possible implication for energy transfer through food webs.

- 2-4 degrees rise in NE by 2100; potential for mismatch between phyto and zooplankton.
- Implication for fish feeding?

Comment about biogeographical changes. Other comment by J. Hilbish on the separation between the species that shift and the ones that don't. R: not done but interesting.

Modelling intertidal species in relation to climate – Mike Burrows (mtb@sams.ac.uk)

- . The types of models used are: statistical relationships; population mechanisms/processes; integration and complementarity:
 - . Maps: the abundance of barnacles can be related to temperature. Wave exposure index (based on Thomas (1986): two-scale search. Wind energy data and wave fetch for every cell...and then gives a map of coast wide patterns of wave exposure. Wave exposure indices for each site can be obtained using GIS to assign sites to coastal cells.
 - . Models of abundance categories (warm water (*Patella depressa*, *Chthamalus stellatus*, *Chthamalus montagui*) and cold water (*Semibalanus balanoides*, *Pelvetia caniculata*, *Alaria esculenta*) species) are prepared: distribution maps and predicted probabilities.
 - . Frequency distributions of abundance of barnacles (*C. stellatus*, *C. montagui*, *S. balanoides*) at UK sites show a bi-modal system of the response. Cold-water species start to decline.
 - . Use of charts presenting data from 1950-1990, at low-, mid- and high-shore levels, for *S. balanoides* and *Chthamalus* sp.
 - . *S. balanoides* on the south coast: negative correlation with previous spring: (poor survival of O-group in warm late-spring temperatures?; (mortality of new settlers often observed above zone); larval phase does better in cold years?
 - . use of a 2-species barnacle interaction model
 - . Hierarchy of interaction models:
 - temperature inhibits *S. balanoides* recruits/competition by space pre-emption only/populations show much shorter-term variability
 - temperature inhibits *S. balanoides* recruits/larvae – stock size effect /gregariousness/space pre-emption/longer term changes in population reproduced. Little change in *Chthamalus* (much free space)
 - temperature inhibits *S. balanoides* recruits/larvae – stock size effect /gregariousness/space pre-emption/*S. balanoides* effect on survival of *C. montagui*/longer term changes in population reproduced. *S. balanoides* produces much greater *Chthamalus* fluctuations.
 - . This allows mapping biological communities on coast-wide scales, and forecasts 21st century.
- Comment by Steve Dudgeon, by Dave Reid (high shore location – lower shore *Semibalanus* resists), by Peter Lawton (different phasing in broad scale). Reply/comment by Charles Greene: comment about time lag in populations. Shelf populations: time series

changes but different types of phases are seen. One species can be affected. Comment about Nova's talk: any effect in predation?

Phylogeography and population genetics and taxonomy

The phylogeography of *Osilinus* – Jo Preston (jopre@mail.pml.ac.uk)

Osilinus is interesting for studying speciation in the marine environment. There are 6 *Osilinus* species in total: a cluster of 5 species in Atlantic and Mediterranean, and the 6th species *O. kotschy* has only recently been described to the genus by Herbert (1994). It is the only Indian Ocean representative of the genus, and thought to be the sister taxa to the Atlantic-Med *Osilinus*.

There was taxonomic confusion, and a classification defined mainly by geographical distribution but with morphological ambiguities. The overview of the research was to establish the number of species within the *Osilinus* complex, and resolve their phylogenetic relationships; to determine if *Osilinus kotschy* is the sister species to the Med/Atlantic complex; to estimate the geographic pattern of speciation driving the evolutionary radiation of *Osilinus*.

. For phylogenetic analyses, 6 potential outgroups species from 4 genera representing the geographic range of the *Gibbulini* tribe were chosen. (Map of distribution of *Gibbulini* taxa included in the analysis): genera from the *Gibbulini* tribe tend to exhibit restricted geographic patterns.

. Use of 16S mitochondrial DNA sequences, maximum parsimony exact branch- and-bound consensus phylogeny. Total length of trees: 439. *G. umbilicalis* is the most appropriate outgroup taxa for resolving interspecific relationships. The Med-Atlantic *Osilinus* and the *O. kotschy* do not constitute a monophyletic group.

. based on shared common ancestry as a criterion of taxonomic division, *O. kotschy* is misclassified within the *Osilinus* genus. It is NOT the sister taxa to the Atl.-Med *Osilinus* and therefore the Indian Ocean *O. kotschy* is not an indication of the tethyan origin of the Atl-Med *Osilinus* cluster.

. radiation of the Atl-Med *Osilinus* species complex has a non-tethyan origin? *O. kotschy* is an ancient relic of the eastern indo-pacific species of the *Gibbulini* tribe?

Q and Comments: C. Cunningham about the geographic progression and the type species.

Small effective population size in marine fishes: fact of fiction? – Gary Carvalho

(g.r.carvalho@hull.ac.uk)

Recent trends discovered in microsatellite diversity. What kind of biological mechanisms are involved?

. Census population size is N ; and effective population size is N_e (reproductive component of a population). N_e is estimated from temporal fluctuations in allele frequencies. In Tasman Bay, strong decrease in N_e . In Hauraki Gulf, decrease, then increase in N_e .

. Using molecular methods, it is possible to determine genetic drifts in population of a New Zealand snapper. Indicator of the number of individuals contributing to the gene pool. Microsatellite analyses of a time series of archived scales demonstrated a significant decline in genetic diversity during its exploitation history.

. Comparison of different age-classes of fish. Use of archive otoliths. Temporal analysis of archived samples indicates marked genetic changes in declining North Sea cod. Microsatellite data indicated a significant reduction in genetic diversity between 1954 and 1970, and a subsequent recovery between 1970 and 1998.

Generally all indicate that N_e is significantly smaller than N (10^{-2} – 10^{-5}). Why is N_e so small? The effect of population size is so small; this leads to loss of diversity. With low N_e/N ratios, many exploited marine fish stocks may be in danger of losing genetic variability. Large population resilient. Contribution in improving the estimates.

N_e/N ratios of 10^{-3} – 10^{-5} in other fish, incl. vermilion, snapper, anchovies, sardines, red drum, North Sea cod: typical for highly fecund species with high larval mortality?

. variation in lifetime reproductive success/ variance in family reproductive success / reproductive ecology / recruitment failure / impact of overfishing.

Questions/Comments: D. Wetthey: ideas about what may contribute to these discrepancies? Common points between different species? R: among the assumptions is that there is a relatively close population. Comparison of satellite data with isolation data. Additional comment by C. Cunningham. Comment by Mark Costello. Q. Jeff Mitton: it would be interesting to test on 1-2 species with low fecundity, like the blue shark, because they are still fairly spread. Other comment: how much time is necessary to recover for a species falling into bottleneck? R: this could be modelled, but quantitative characters can take up to 10x longer.

Determinants of genetic structure in dogwhelk populations (*Nucella lapillus*) –

Isabelle Colson (i.colson@bangor.ac.uk)

Nucella lapillus is a predatory marine gastropod populating North Atlantic rocky shores.

1. local adaptation. Different morphology of dogwhelk according to the place. Use of microsatellite loci to investigate the genetical variation (15 individuals/population, and 9 microsatellite loci). In sheltered ecotype, ecotype parapatry and exposed ecotype.
 - a. Genetic differentiation between sheltered and exposed ecotypes: 2 loci out of 9 show significant differentiation.
 - b. Correlation between morphological and genetic variables (Silleiro): $r = -0.401$, $p = 0.02$. The amount of genetical differentiation is probably quite big.
2. extinction (TBT: antifouling paint leading to female sterility in many gastropods. In 1987-88, TBT was banned and some dogwhelks have recovered; vacant sites have been recolonized). Use of 24 animals per population, and 6 microsatellite loci. *N. lapillus* lacks a planktonic larval stage and is therefore expected to have limited dispersal ability. Relatively fast re-colonization of some sites, however, contradicts this assumption. Genetic diversity and structure compared between recolonized sites and sites that showed continuous population at 3 localities across the British Isles: no increase except in Plymouth (decrease in genetic diversity and increase in genetic structure in recolonized populations), but differences between inside and outside Plymouth Sound. Hypothesis: arrival by boat? Transplant by scientists? Lower genetic structure than expected for a direct developer.
3. phylogeography: preliminary studies as well to investigate. However the recolonization of vacant sites was probably accomplished by a relatively high number of individuals originating from different sources populations.

Q. J. Mitton: is this species the one that has 5 different Robertsonian polymorphisms? R: yes, but mainly observed in the south British coast.

Patterns of gene flow in the planktonic developing, Macaronesian periwinkle, *Tectarius striata* – Thierry Backeljau (Thierry.Backeljau@naturalsciences.be)

Tectarius is an endemic species of the Macaronesian archipelago (Azores, Madeira, Canary Islands and Cape Verde Islands). A large-scale survey (allozymes were used to investigate the genetic structure) has been conducted (42 populations). High dispersal and gene flow were expected because of its planktonic development, and therefore little population genetic differentiation. Indeed, at the beginning, very little variation was noted. No significant genetic differentiation could be detected among populations, at any of the hierarchical levels. There was a tendency of some sorts of isolations (Cape Verde with highest mean number of alleles per locus) but not significant. After an analysis of the DNA, 53 different haplotypes were distinguished, but there was no clear separation in their distribution. A geographical effect has been suggested, but because of the low frequency at which these alleles occur, their influence on the genetic population structure is negligible.

Apparently the markers would suggest a nice exchange between the archipelago.

Questions/comments: Don Levitan: would have something to deal with larval development? R: it is difficult to quantify. Comment Jeanine Olsen: linked to the sea surface temperature. Could be related to the local fluctuations.

Marine phylogeographical research on *Pomatoschistus* and European Eel – Filip Volckaert (Filip.volckaert@bio.kuleuven.ac.be)

(Work on marine species like goby, eel, sole and sea bass, but goby was studied quite extensively.)

There is a clear distinction between organisms in Mediterranean and south of North Sea. After a look at the combinations, at the mitochondrial level, 2 haplotypes appear clearly. In the Med., distinct groups.

Now, a higher level of resolution is reached by using microsatellites, to analyse the differences between the northern and southern species. Sand gobies live in metapopulations. Combination of markers to help investigate. Both markers were congruent in revealing significant differences between sample and a pattern of isolation-by-distance. At geographical scale, significant differentiation. Temporal variation significant at 12 locations. The temporal factor in the distribution of the European eel thus seems to be more significant than the geographical scale.

Extraction of temporal patterns from the genome.

Time-scale: Pleistocene-Holocene-Historical. Otoliths still contain DNA (fisheries collections).

Q: group going north, unlikely to go towards the Bay of Biscay (mitochondrial level analysis). Q: Lou Van Guelpen about eel and geography. R: yes and no; the ocean shows a lot of diversity of structure. The same place is not the same place! Q: Vicky Albert about isolation by distance pattern and species effect. R: in the data, different life stages are mixed. Effect of geography less important than the life stages. Comment by Steve Hawkins about the effect of warmer waters. R: it is quite complex. Comment by Jeanine Olsen about the time-frame of refuge species. R: eel is not too good an example.

Phylogeography of the red seaweed *Palmaria palmata* reveals marine glacial refugia

– **Christine Maggs** (c.maggs@qub.ac.uk)

They have been able to determine the species that colonised an island that erupted in Iceland about 30 years ago. After 34 years, *Palmaria palmata* had not managed to cross 2.7 nautical miles. *Palmaria palmata* can be found even when conditions are very harsh, like under 1-m ice (in Canada), or at very low salinity (e.g. in the Baltic Sea).

The genetic structure of the population was studied for the North Atlantic. No variations appeared, so a wider analysis, with 40 populations, was conducted.

- Amplifying plasmid DNA: various haplotypes found. The haplotype found in North America was the same as the one in Europe (but was the only one in North America). The highest biodiversity was found in the English Channel (EC).

- Using nuclear markers: North America presents a different nuclear mark to main Europe and the Iberian Peninsula. The results found were considered incongruent.

- Mitochondrial markers were then used (sea-urchin graph), and they found that the EC had 6 of the 7 haplotypes found. They also tried a marker that was developed by Joe Zuccharello, which amplified sequences between COX II and COX III. The results, which should be interpreted with caution, show that the N. American group (with a couple of mutations) is separate to that of the European with the EC again containing the main haplotypes and demonstrating its importance. A coalescent analysis was undertaken: the problem is that still not enough variation in the data. The results show that since expansion began there have been 136000 generations with the plasmid markers, 171000 with mitochondrial markers, and 465000 with nuclear markers.

Therefore the N. American plants predate the last glacial maximum, and when it occurred in Europe the EC was land all through the last glacial maximum and the receding one.

They think they have found now the EC glacial refugium (the Hurd Deep). It is a paleo river that used to run through the EC during the last glaciation, with the profile showing it was 169-m deep which remained marine with ice over it when *Palmaria palmata* survived the harsh environment during both glaciations.

Question Gerald Boalch: would have Hurd Deep been ice at that time? R: it would have been flooded anyway.

Molecular markers reveal cryptic species – Jeffrey Mitton (mitton@colorado.edu)

. *Mytilus edulis*?/*galloprovincialis*?/*trossulus*? In the South, *M. galloprovincialis*, and in the north of San Francisco, *M. trossulus*, and they hybridise for an extensive proportion of the range.

. A study of DUI in *Brachidontes pharaonis*, at the University of Palermo, produced unexpected results. It is supposed to have arrived through the Suez canal, which opened in 1885 [1869?]. The Italian colleagues looked at the Sicilian species. We decided to have a look at a wider geographical scale. It was discovered that Sicily and Israel species had almost exclusive haplotypes though: very unexpected because they came in through the Suez canal.

. Therefore different names were given: *Brachidontes pharaonis* and *B. variabilis*. There was a strong suspicion that this was not 1 species at all. . In fact it is not 1 but 3 species. Using the CO I sequences, it has been determined that there is one cluster in the Mediterranean and the Red Sea, for *B. pharaonis*.

In Madagascar, there is 17% difference with what there is in the Med. and the Red Sea, and 20% with what there is in Hong-Kong.

. Therefore, Med. + Red Sea: *B. pharaonis*; Madagascar, *B. variabilis*; Hong-Kong: other name to give (new).

They are fairly old cryptic species.

. Different questions raised: what is the geographic range? Do they hybridise? Do they present a different ecology?

Question by P. Kelley: wonder whether there is a functional variation.

Effect of intertidal rocky shore landscape on fine-scale genetic structure of *Gracilaria gracilis* – Myriam Valero (Valero@sb-roscoff.fr)

. Distributional range is influenced by the species' geological age, genetic variability, physiological tolerance and mode of reproduction and dispersal. There are many examples on geographical patterns of genetic diversity at a large scale for different intertidal species. Interaction of climate and timing of low tides creates a complex mosaic of thermal environment (Helmuth)

. Therefore what is the impact of the intertidal landscape on fine-scale genetic structure?. *G. gracilis* has a complex haploid-diploid life cycle typical of red seaweeds, including two free-living stages of different ploidy levels—a diploid (tetrasporophyte) stage and a haploid (gametophyte) stage—and three dispersal units: tetraspores, carpospores and spermatia. Moreover, there is a clonal multiplication via the cystocarp and probably as described in other seaweeds, vegetative propagation via thallus fragmentation. Haploid and diploid individuals are found in scattered rock pools that are formed at ebb tide in the intertidal zone. . Heterogeneous and dynamic environment implies duration and frequency of emersion increases with increasing height on the shore:

. high-shore positions undergo longer periods of isolation along with large, daily fluctuations in temperature, salinity, light intensity, compared to the immersed, open, relatively buffered low-shore positions. Moreover, if the transport of spores and gametes occurs predominantly at low tide when small streams flow from high- to lower-shore pools, higher pools will be relatively isolated from gene flow compared to lower pools.

High shore populations are physically daily isolated from the sea.

On the other hand, low shore pools are more often submerged than emerged; therefore, they are open to migrants, not only from run-off from higher pools, but also from pools at the same shore level. Microgeographic genetic differentiation, even within a single shore, is therefore possible (Engel, et al., 1997).. Sampling in northern France.

Result: significant genetic differentiation by distance, but does not follow a pattern of isolation by distance. Use of Discriminant Function analysis (regression graph %individuals assigned to their pool of residence/mean %time in emersion; $r^2=0.84$, $p=0.01$). High-shore individuals were more frequently assigned to their pool of origin than low-shore individuals. Therefore high-shore pools receive few extra-population spores and gametes while low-shore pools receive a substantial proportion of immigrants.

. In conclusion, reproduction is essentially sexual in *G. gracilis* and the effect of the cystocarp on genotypic diversity is low; the intertidal landscape imposes asymmetrical migration between high and low-shore pools and suggests that limited gene flow into

high-shore pools could promote local adaptation to high-shore ecological conditions (e.g. large daily fluctuations in temperature, salinity, luminosity, etc..)

Questions/Comments: about the tidal cycle. R: More fertilisation at low tide than high tide but very variable according to the position on the shore.

Molecular ecology and formalin fixation – Richard Kirby (rrk@mba.ac.uk)

Genetics methods and the CPR (Continuous Plankton Recorder, with long-distance transects) allow the study of the population structure of the plankton.

. Use of the formalin: maybe formalin does not degrade the DNA but prevents its amplification. At low pH a formaldehyde group is added to the amino group of a DNA base such as cytosine or to a protein in the form of N-methylol (N-CH₂OH). Then slow condensation by electrophilic attack of N-methylol on a neighbouring amino group results in a methylene bridge and the liberation of water.

The reactions with proteins and DNA can be reversed so DNA can be extracted and studied. Methylol groups are removed from DNA bases at high pH in formalin-free buffer

Methylene bridges (protein-DNA and DNA-DNA interactions) can be broken by high temperature and hydrolysis.

You can therefore get the sequence of the organisms off the CPR silk.

Comment by Jeffrey Mitton about a paper in *Biotechniques* about 2 years ago.

Fertilization biology and mating systems

Testing hypotheses that might explain the evolution of gametic compatibility by examining regional differences in the patterns of intra and interspecific compatibility – Don Levitan (levitan@bio.fsu.edu)

Cross-fertilizations were undertaken with 3 coexisting species of sea-urchins, red, purple and green. Laboratory fertilization assays. Hybrid fitness tested. The green urchin show very little distinction between conspecific and heterospecific sperm to fertilize, the red urchin presents an intermediate susceptibility, and the purple one rarely cross-fertilizes. In the field, the green urchin is often surrounded by heterospecific urchins.

- . Comparative heterospecific fertilization egg-centric view//sperm-centric view
- . Conclusion: Density-dependent sexual selection can produce gamete traits that do well under either sperm limitation or sperm competition.
- . A consequence of selecting for easy conspecific fertilization is easy heterospecific fertilization.
- . Sexual selection under sperm competition and female choice has been thought to contribute to increased reproductive isolation.
- . In contrast, sexual selection under sperm limitation may weaken isolating mechanisms.
- . The action of sexual selection on reproductive isolation may depend on the continuum of sperm limitation to sperm competition.

Questions/Comments: C. Cunningham: could be compared to Scandinavia? R: yes but had no time yet. Other comment: green urchins surrounded by purple urchin in south Columbia. Comment by Jeff Mitton.

Compatibility within and between populations of compound ascidians – John Bishop (jbis@mba.ac.uk)

Many marine organisms have an alternative way of getting fertilization: they release sperm, which travel to another individual that has retained its eggs for fertilization (eg: bryozoans, ascidians, sponges, corals, hydroids, and many red algae).

. colonial ascidian *Diplosoma listerianum* is cultured in the lab. Cloned genotypes are used. The first population was from Swansea. Then every possible cross was made between 3 populations: Swansea, Plymouth and Menai. Incompatibility, low compatibility and full compatibility were determined, in terms of progeny.

In ascidian, sperm has to move up oviduct (fertil canal) to reach oocytes. Incompatible sperm is blocked fraction of way up to oviduct, and phagocytosed.

Self sperm but also non-self. Extensive incompatibility between +/- unrelated individuals in all 3 study populations.

Broadcast spawning: loss of eggs when not fertilised – wasted reproductive effort.

Ascid and bryozoan have mechanism that banishes that possibility: receipt of sperm triggers eggs.

Question/Comments: Jeanine Olsen: Mixed sperm. If sperms are compatible, eggs will be fertilised. Other comment by Vicky Albert about band and gels.

Gametic compatibility regarding breeding experiments with different populations of *Celleporella hyalina* – Roger Hughes (r.n.Hughes@bangor.ac.uk)

This species has a very wide geographic distribution.

Celleporella hyalina is a bryozoan that encrusts macroalgae. The phylogeny showed the existence of 10-15 clades. The trials depended on the ability to develop *Celleporella*.

Use of two types of controls. Different tries between different populations (interchanging sperm) (Ireland, Wales, Spain, *reticulata*).

Tries:

Ireland x Spain: Ireland produced, Spain no.

Reticulata x Spain: Reticulata produces, Spain no.

Reticulata x Wales: Reticulate produced, Wales no.

Another mating experiment was conducted with the Welsh population in relation to co-ancestry (with John Bishop).

Questions/Comments: D. Levitan. Jeff Mitton: what is the level of difference in clades?

Blue mussels study – Michael McCartney (mccartneym@uncw.edu)

Common benthic inhabitants. Recent work has proved that there are three distinct species within the *Mytilus edulis* complex: *M. edulis*, *M. trossulus*, and *M. galloprovincialis*.

Hybridization has been documented in all cases where the ranges of two of these species overlap.

. Results 2001: in general, both *M. edulis* and *M. trossulus* eggs were poorly fertilized by heterospecific sperm. But 2 of 5 *M. edulis* females were highly compatible with *M. trossulus* sperm.

. Selection to avoid hybridisation: - studies of reproductive character displacement
- cross-species compatibility of *M. edulis* eggs inside and outside of the hybrid zone.

. Results 2003: no strong signal of reproductive character displacement within the Gulf of Maine.

Those same crosses, as F20 values (a low F20 indicates less sperm required to achieve 20% fertilization, and a high F20 means more sperm required to achieve that same level of fertilization), give plots of frequency of cross at a particular F20 value. First comparing between sites – because many heterospecific crosses showed strong blocks to fertilization, with little to no fertilization – those crosses were given an F20 value greater than the mean dry sperm concentration for all crosses performed. Within the hybrid zone only 3 heterospecific crosses, or 19% of the crosses showed this strong block – in contrast – outside the zone heterospecific crosses were much more strongly blocked with 13 blocked crosses, or 35% of the total heterospecific crosses blocked. A comparison of median F20's between sites indicates that while conspecific crosses do not differ, there is a significant difference in heterospecific F20 values, with Whaleback Beach having a significantly higher F20. Incompatibility of *M. edulis* egg greater outside of the hybrid zone: opposite to what we would expect under a process of reinforcement. And while a higher percentage of crosses were blocked in Whaleback Beach – a higher percentage of heterospecific crosses showed compatibility within the hybrid zone, compared to outside. Introgression of genes controlling egg compatibility.

. The Gulf of Maine hybrid zone is strongly bimodal

Comment by Cynthia Riginos about the tremendous influx from the hybrid zone.

Comparing closely related species with contrasting mating systems (*Fucus spiralis* and *Fucus vesiculosus*) – Ester Serrao (eserrao@ualg.pt)

Why have so many similar species and contrasting mating systems evolved despite occurring together? If they hybridize, why do they remain as different species?

. Comparing fertilization ecology in hermaphroditic vs dioecious when sympatric. 3 quadrats per treatment (natural, transplant, control), at each site (Tagus, Ericeira).

Determination of the settlement (no. of eggs) related to the tide, the moon. There are actually 10 days +/- when they do it. The eggs were sampled every 30 minutes, using settlement discs (from sunset to sunrise).

. Use of microsatellite for *Fucus vesiculosus* and *Fucus spiralis*: same kind of pattern.

. Then analysis of sexual phenotypes and fitness of hybrids and parental species

. *Fucus spiralis*: Most loci fixed within population but different alleles fixed/ Highest allelic diversity-N Portugal/ Historical, transition, hybridization

. *Fucus vesiculosus*: Lowest allelic diversity per population in Portugal but populations are very different/ N. Portugal also transition zone

Questions/Comments: Chris Maggs, Filip Volckaert. Steve Hawkins' comment about the sites sampled.

Mating patterns in the red algae species: *Gracilaria gracilis* – Myriam Valero

(Valero@sb-roscoff.fr)

In sessile organisms: mating success depends on : 1. Probability of chance encounters of male and female gametes; 2. Genetic factors: incompatibility reactions; 3. Sexual selection: male-male competition / female choice

Sexual reproduction in *Gracilaria gracilis*: males gametes aren't flagellated (are there consequences of passive transport on mating patterns?) and have to find the female; then pre-fertilization: adhesion on female gamete (trichogyne); then fertilization & zygote maturation (cystocarp) (zygotic spores; cystocarps can be used to trace the movements of male gametes within a population). Male and female are haploid which facilitates paternity analyses. The study of a population (1995 results) has shown that there are variations in male mating success and shows temporal stability. Moreover the inter populations gene flow via male gametes is relatively low. There is also an excess of mating events at short distances. Distance accounts for a significant amount of variation.

What can species inventories tell us about the evolution of marine biodiversity ? –

Mark Costello (m.costello@auckland.ac.nz)

Macroecology: patterns of species distributions at regional scales. Phylogeography: distribution of related populations and species. The questions are: How complete is the inventory? Are some areas isolated for a long time? Are there centres of species origin (speciation)? The analysis concerns the discovery rates, the areas with high endemism, the gradient from areas with more species per genus to areas with a few of the same species.

Oceans have fewer species but greater phylogenetic (evolutionary) diversity than land faunas and floras and therefore oceans provide a better testbed for phylogeography than land.

The rate of species discovery in Britain and Ireland are very variable. 24-26% of the oligochaetes were known in 1900 compared to 90% of eg. fish or bivalvia.

We know that species rich taxa are known least, and many new species have to be discovered in best known seas. However human are already impacting on oceans as they did on land millennia ago. Testing theories: Island biogeography: is immigration and extinction a lottery determined by dispersal and area size? Ecological: are distributions explained by species traits and habitat needs? Evolutionary: are distributions primarily explained by speciation and dispersal? It seems that at macroecological scales: All benthic and pelagic habitats are available; distribution is determined by climate, primarily temperature; salinity is only important in estuarine situations; food supply limits abundance but not distribution; deep-sea (500m+) is isolated on evolutionary time scales from coastal waters; pelagic biodiversity operates at different spatial scales than benthic and so should be considered separately.

Thus community composition is determined by dispersal (immigration) and speciation; survival (extinction); time (glacial refugia, climatic optimum refugia?); sampling effort? Comments on the distribution of species by F. Volckaert and S. Hawkins.

Hypothesis: If within a species there is more genetic variability on the East than West North Atlantic, and the E populations are a subset of the W, then there will be *proportionally* more species per genus, and more genera per family on the W than E North Atlantic. (Example of amphipod crustaceans. Determination of the ratio of species per family in North Atlantic to ERMS).

Further analysis: checking correctness of inventories; checking comparability of inventories; separating Mediterranean from NE Atlantic; comparison of within NE Atlantic inventories (e.g. Ireland, Britain, Norway) [e.g. *find at what spatial scale*

habitats become important]; collaborate with experts in different taxa, and with within-species data.

Questions/Comments: Paul Somerfield, and more. Comment M. Costello: need a group of people who work on different taxa.

Marine Genomic Programme – Filip Volckaert (fillip.volckaert@bio.kuleuven.ac.be)
<http://www.sb-roscoff.fr/marine-genomics-europe/index.php>

Use genomics as a tool, a way to look at the DNA code at a large scale. Possibility of marrying marine biologists to genomics people. Proposal for EU accepted on 01/03/2004. Gathers 44 partners, in 3 groups: microbes and algae, invertebrate and non economical vertebrates, fish and shellfish economically orientated. Divided in 3 groups: Functional, comparative and environmental genomics (variation with genomic tools).

Target species: *Mytilus*, European sea bass. Geographical area: North Atlantic, Med., Antarctic.

Collaborations is encouraged!

MARBEF – Jeanine Olsen (j.l.olsen@biol.rug.nl)

<http://www.marbef.org/>

Programme runs for 5 years. Consortium of many laboratories. 3 themes: patterns, function, and socio-economics. Get the link between patterns and function. In patterns, about 6 subjects: taxonomy, diversity, genetics (link to marine genomics; with comparative phylogeography, species). In “Functions”: long-term changes, community assemblages (also linked to genetics). CORONA is also linked.

The idea is “integrating and spreading”. Unfortunately not for post-docs etc.

REBECCA – Phil Williamson (p.Williamson@uea.ac.uk)

<http://www.mba.ac.uk/rebecca/>

The idea is to bring together different research groups, with an emphasis on rocky shore intertidal.

Did not get the money but are going to try again, and send the proposal to NERC for the 1st of December. It is a very open programme, whose strong selling point is the fact that it goes back in time, for climate models (changes in sea-levels, temperature...)

Day 2 – 30/07/2004

Comparative Ecology, over space and time, part I

Development and comparative experiments of eelgrass community control in the Baltic Sea and the Chesapeake Sea – Per-Olav Moksnes (p.moksnes@kmf.gu.se)

A loss of 58% of seagrass habitats in Northwestern Sweden in the last 15 years has been observed (Baden et al. 2003). The causes are unknown, but thought to be related to eutrophication. Large mats of macroalgae are common during the summer. Concurrent loss of large predators (due to over fishing; Svedang et al. 2001) from the coastal system indicate that top-down processes could play an important role in the loss of eelgrass beds. A very low abundance of grazers has also been observed. Still little is known regarding the trophic interactions in Swedish seagrass systems.

The disappearance of seagrass habitats is a global problem. It can be due to eutrophication, nutrient pollution (“bottom-up”): decreasing light availability to the leaves through increased phytoplankton production and turbidity, and in particular through epiphyte leaf fouling and shading from associated ephemeral algae. An alternative or complementary explanation is a “top-down” model of regulation, and trophic cascades: due to overfishing, large predators decrease, thus increase of small predators, thus decrease of mesograzers, thus increase of epiphyte fouling (Heck et al. 2000).

Use of caging experiments to facilitate the comparisons. Commercial fertilizers were used, and after 3 weeks of treatment *Enteromorpha* +++(only if nutrients +, but grazers -). The trophic interactions are as follows: cod-small fish (like black goby)-amphipod-epiphyte. If you add nutrients, cod disappears but small fish +++, therefore amphipod disappears, and epiphytes +++. The results indicate that small epibenthic predators keep the abundance of key grazers species low, allowing growth of large algal mats in eutrophicated eelgrass systems in western Sweden. Another experiment was done to compare bottom-up and top-down control in 3 different eelgrass communities in the Baltic Sea. This year the treatments (caging techniques) will be standardized.

Another study is the comparison of relative predation rates on juvenile portunid crabs on the Swedish westcoast and in Chesapeake Bay. In Sweden, 5-10% mortality d^{-1} , whereas in Chesapeake, mortality 70-90 d^{-1} , for the same eelgrass habitat.

Questions: Ladd Johnson: Chesapeake Bay – in the Baltic, competition with other species.

Q Jeanine Olsen: density-dependent measurements for the different animals? Lighter canopy? R: a lot of things to think about. Try to standardize. The biggest problem is to remove the grazers. Use of pesticides, of cable ties systems...

Comment Mark Costello: macroalgae, amphipods and fish in other areas? R: picture complicated in Western Coast! Other comment about the difference of mortality %.

When it is low, it is also because of the predation by bigger animals. The bigger crabs go deeper than the shallow waters where the small crabs are.

Pre- and post-settlement processes in lobster – Richard Wahle (rwahle@bigelow.org)

Focusing on nursery grounds to understand the recruitment processes, over the years suction sampling has expanded to some 65 sites over 13 regions. The eastern ME gap - limited by larval supply. This is the baseline for cohort abundance, and basis for comparisons to later benthic stages. Pattern seeking a process: the American lobster harvests about 30-40x greater than the European lobster.

What is driving the pre-settlement process? What is the influence of oceanography?

One of the aims was to determine the fish predation rate (video surveillance). Another spin-off was an effort to sample the same habitats in the European sites (cobble-dwelling decapods). They are more diverse in Europe than in New England, but are collectively about as abundant. *Homarus* and *Cancer* dominate the New England fauna, but are relatively rare in European cobble beds.

Tried to build a network to answer the driving questions: Do species interactions within the cobble nursery habitat prevent European lobster populations from realizing greater ecological success? What are the causes and consequences of differences in diversity and abundance of decapod taxa on the two sides of the Atlantic?

Research support can be attracted through the assemblage focus (cobble dwellers), the commercial species focus, and the invasive species focus. Moreover cobble is tractable for monitoring and experimentation.

Questions/Comments: Species? R: Zanthids, etc.: all of them are like aggressive dwellers defenders. Competition for space. Different experiments made (Removal, caging experiments...). Question Tom Trott; R: juveniles very difficult to distinguish. Other comment about the data from the Southampton Oceanographic Centre. Other question: use of larvae? If use of recruitment relation, will get the fisheries agencies support.

Question Jeff Mitton: predators or competitors for habitats? R: predators reinforce the association of the habitat.

Predator-prey interactions in the fossil record: naticid gastropod drilling in time and space – Patricia Kelley (kelleyp@uncw.edu)

The questions deal with what controls evolution and does ecology matter? There is a couple of hypothesis: biotic factors like co-evolution (reciprocal adaptation) and escalation (evolution in response to the enemies); and physical factors.

How to tease apart co-evolution and escalation? Predator-prey systems with unequivocal predation traces; observable morphological or behavioral responses; assessment of other agents of selection.

Several graphs: naticid gastropod predator-prey evolution (work at the level of the individual)/ drilling on Cretaceous – recent mollusks/ Drilling on paleogene mollusks (count the shells and holes in shells): drilling remains high from Paleocene, Eocene, Oligocene.

Hypotheses based on Cretaceous - Paleogene Data: Drilling cycles controlled by mass extinctions; preferential extinction of escalated prey; temporal increase in effectiveness of prey defenses (incomplete drillholes); latitudinal increase in drilling in Eocene Cook Mountain Formation (30% in Virginia and 18% in Gulf Coastal Plain). More graphs: drilling on Neogene – recent mollusks; drilling frequencies: turritellids vs all gastropods; and corbulids vs all bivalves. Escalation of bivalves, and gastropods across mass extinction boundaries. Comment C. Cunningham about how does she know the relations with predation; Patricia replies that it is from the literature.

The question is to what extent are temporal patterns environmentally controlled? Anyway it is a slow process; predators are at risk during the time of the drilling. This risk may vary with latitude. Drilling may also vary with latitude. Latitudinal effects of drilling were also tested.

The future work plans to investigate the effect of migration on predator-prey relationships and couplets; the effect of a predator invading a community; the effect of introducing new prey into a community. Seeking advice from CORONA group regarding taxa, geologic formations.

Comment by C. Cunningham about the scale of her study. Q. by Jeff Mitton about her samples, and by Alan Southward.

Grazers & intertidal microbial films: a highly tractable system for trans-Atlantic comparative ecology – Richard Thompson (r.c.Thompson@plymouth.ac.uk)

Biofilms are found on any hard surface immersed in water. They are grazed by all sorts of grazers. They are photosynthetic and a major source of primary production. They are replicated in larval settlements and are also very seasonal. Biofilms are easy to manipulate, and after 2 weeks of experiments, one can observe very rapid variations on a range of variables (diatoms, cyanobacteria, macroalgal germlings...). Grazing rates can also be determined by wax discs. These are very easy to replicate, and this shows changes according to latitude. Trans atlantic comparisons were undertaken, and gross differences in radula morphology were observed.

Questions/Comments: Can you determine who the grazer was on the disc? R: yes, but has to be done in the lab.

Comment by R. Thompson: taxonomy expertise is required especially in macroalgae.

Comment by C. Cunningham. Other comment about how long-living is biofilm.

Failure to accept vs. failure to reject – Sarah Ann Woodin (woodin@biol.sc.edu)

Interest in various biogenic alterations: feeding, defecation, irrigation, cleaning up of the sediment surface... However it is hard to quantify the frequency of these processes, and particularly difficult to target organisms in the field. Some experiments can be done in the lab. [video]: side view picture of *Arenicola marina*, taken with a medical ultrasound machine. *Arenicola* comes up and takes up the sediment, and after there is a “hurricane” showing the exhaling expansion. *Arenicola* repeats this process every 12-20 minutes. This happens in the field at a much larger scale.

Other process: *Macoma baltica* feeding on the surface [video fails]. *Macoma* acts as a “vacuum cleaner”, covering the equivalent of a handful in 20 minutes. The interesting fact is that it makes a hole, feeds a little and while it pulls back down it blows water over the surface and latter the siphon comes out at a different spot (4-5 cm away from the previous one), and repeats the process several times again. There is an enormous amount of activity on the surface, which changes the sediment surface. It would be interesting to see how many species are involved in the disruption of the surface, and be able to do it in a marine habitat rather than in the laboratory. Fundamental procedures of all these organisms can be used (like movement, feeding, defecation...) as they all involve frequently a change in pressure (valves pushing water, blowing holes, etc.)

These signals may propagate 20-40 cm.

- It is known that shorebirds and fish respond to this kind of vibrations, so certainly they are important to predators, but we don't know yet whether the infauna themselves respond to this kind of vibration and in future plans we will have to see whether this fits into the picture.

Questions/Comments about density, about species specific and activity specific. Other comment about the signal of other animals.

Comparative Ecology, over space and time, part II

Report on pilot work underway on both sides of the Atlantic – Stuart Jenkins

(sjen@mba.ac.uk) **and Geoff Trussell** (g.trussell@neu.edu)

Collaboration organised to study the effect of biodiversity loss on ecosystem functioning.

Use of rock pools on both sides of the Atlantic.

The rockpool model is very good because it is marine, tractable, mesocosm like features when emersed but open to marine environment when immersed, dominant biota can be easily manipulated including consumers, measure range of relevant response variables- primary production, nutrient cycling, community respiration.

Shifts or extension of the existing diversity patterns can be observed. The productivity of the system can be determined by incubation.

Questions/Comments: Grazers or nutrient treatments in the rock pools? R: it was chosen to manipulate the grazers. It is quite a rapid system. Jeff Mitton: how do you make those pools? R: they are natural pools, but have been sometimes manipulated (use of concrete) to try to standardize them. Comment by Alan Southward about pictures by DP Wilson.

Report on current work underway: geography of marine larval dispersal – Jerry Hilbish (hilbish@biol.sc.edu)

40 years of research in SW England. Has studied the larval dispersal for a vast range of marine invertebrates. Larvae exploits plankton and may well influence phylogenetical processes. However the scale and predictability of larval dispersal and its regulation by physical circulation remains unknown due largely to the impossibility of measuring dispersal in open marine environments There are for example very discrete junctures in the distribution of *Mytilus galloprovincialis* and *M. edulis*. Strong genetic differentiation among marine mussel populations in southwest England was exploited to measure larval dispersal among adjoining genetic patches. This approach allowed estimates of larval dispersal over relatively great distances. These measurements were combined with results from a high-resolution model of coastal circulation to test the hypothesis that larval dispersal is regulated by physical circulation. Areas where the larvae were predicted to go according to the model were compared with the different frequencies of genotypes. There seems to be a very good correspondence between the model and the observations. Therefore we can make predictions, and a chart of larval dispersion. Larval dispersal almost never occurred over distances of 100km. It seems that larval dispersion has nothing to do with phylogeographic studies, and nothing to do with recolonization. Questions/Comments: there are 50000 points in the model. Such models can be used for different things. Comment F. Volckaert, Jeanine Olsen; R: the genetics has shown that the model works well, and there is no reason to suspect that it would not work for the larval dispersal. Questions S. Hawkins: no isolation by distance; estuaries are exactly unselected.

Report on current work underway: surf zone drag and lift – Dave Wethey

(wethey@biol.sc.edu)

With the use of a pointing stick from a computer keyboard, and a force sensor for measuring the attachment strength, records were taken for 2-4 months at 10Hz. The effect of wave force on mussels could therefore be tested. With a boulder-cam, we can also have the view from inside a rock. These are very complex forces. The larvae can come, crawl for a while and then leave. But can also stay.

The wave forces were measured at Whitsand Bay, Cornwall, UK between February and March 2003. 80,000 waves measured. The maximum forces: 4N drag, 8N lift, which will remove the weakest *Mytilus* individuals. Scaled to *B. amphitrite* cyprid size: 1.25 dynes drag, and 2.50 dynes lift. (Eckman et al 1990 – *B. amphitrite* attachment strength 1-6 dynes)

For 20 years Dave said he had wrongly assumed larval behaviour was not possible in the surf zone. Questions: J. Mitton (will allow to build the model), A. Southward, G.

Trussell, R. Wahle, R. Kirby and S. Hawkins: cyprid get very sticky. Is it size specific?

R: have to figure that out.

Overview of Canadian genetics – Vicky Albert (Vicky.albert@bio.ulaval.ca)

Université Laval, Québec. There are 5 general research areas: Genotype-environment interactions, particularly as related reproductively isolated populations that exploit distinct ecological resources; ecologic and genetic factors implicated in the reproductive success of natural populations; roles and impact of historical, contemporary and anthropogenic factors on the genetic structure of populations, as well as the genetic basis of local adaptation; bioinformatics computer software packages for parentage and population assignments based on individual multi-locus data; practices for improving freshwater fish production.

Two primary goals of the reproductive success studies are to investigate the sexual cohabitation in American lobster, and study the female ejaculate accumulation patterns in laboratory and female receptacle loads in field experiments

In terms of the genetic structure of populations, and the genetic basis of local adaptation, the main objective is Define the genetic structure of deep-water redbfish and infer the influence of dispersal, geographic distances, oceanic current and historical factors.

Another project is to characterise spatial and temporal patterns of genetic variation at two allozyme loci in the acorn barnacle (cf paper by Veliz et al.). Regional variation in the spatial scale of selection at *MPI** and *GPI** in the acorn barnacle *Semibalanus balanoides* (Crustacea) (*J. Evol. Biol.*, 2004, in press). There is no evidence for selection between microhabitats (at any sites), and similar genotype frequencies at settlement for both loci, and differential genotype frequency between regions established at both loci within a month. There are also significant differences in mean fitness values for MPI and GPI genotypes in some of the sites only.

Plenary session. Baltic and northern seas – Cynthia Riginos (riginos@duke.edu) and Stenseth, Olsen, Vainola, Moksnes.

Overview.

As deglaciation progressed, the Baltic Sea has evolved to more availability for marine species.

The « native » was invaded from neighbouring areas in successive waves, representing marine and freshwater taxa, of arctic and boreal characters. It became the largest body of brackish water in the world. There are however few survivors from each wave to date.

There are very distinctive patterns of Baltic and the North Sea.

Mytilus and *Macoma* of marginal seas (allozymes): Baltic bivalves are of the Pacific stock (and so are some of the White Sea).

Comment C. Cunningham: specific population of the Baltic, completely surrounded by North Atlantic, and then correspondence in the Canadian and around the Bering area. In some cases, Baltic Sea species can be found in the North Sea (cf cod). Comment C.

Cunningham about White Sea species. Comment Pieternella Luttkhuizen. Need to understand how things pop out of the Baltic and others just stay in. Comment T.

Backeljau about bivalves.

Comment J. Mitton: getting a whole community is not necessarily a quick process. The ice is important as a barrier as the species are there. But when the ice melts it is not necessarily when the species travel. Comment C. Riginos: yes but the Baltic was frozen apparently till the bottom. Comments by J. Olsen, S. Woodin. Maybe should be thinking about species that are continuous. Comment Pieternella and the different things in Canada that could be used. Comment about the phenology by Patricia Kelley.

In the Arctic, deep water species are not going to be especially well sampled. Comment by Mark Costello about the kind of species talked about. Comment Vainola: we don't know the time scale of the invasion. Other parallel with what happened in the Red Sea. Other comment that similar patterns can be found in Canada. Comment J. Olsen: should have a phylogeographic view at the beginning. Then, should try to get money to get some Arctic sampling and collect what we can find (primary seagrass). *Fucus* is a more complex story. There are many sympatrically occurring species. Concerning the Baltic Sea, *Fucus serratus* doesn't go as far as *F. vesiculosus*. In terms of *Zostera marina*, very low diversity in the Baltic (paper published about 3 years ago).

Influence of temperature stress – Paul Schmidt (schmidtp@sas.upenn.edu)

Work with G. Trussell, using comparative dataset with temperature focus. The temperature stressed was studied in various species: *L. littorea*, *L. saxatilis*, and focused on *L. obtusata*.

The temperature stress has a direct impact on the shell colour. The frequency of the colormorphs was determined between the North and the South of the Gulf of Maine, and on tidal river. Mannose Phosphate isomerase (MPI): on open coasts.

Comment by Sally Woodin: how much does the colour matters in terms of risks of predation?

An impact is predicted on fitness. 3 genotypes: low, mid, upper.

Use of different markers used for *saxatilis* and *obtusata* (reference to J. Hilbish talk).

Thus: comparison between the species, testing for genotypes and phenotypes (shell colours)

Question Richard Kirby: are there different shapes? R: unclear, but differences in shell thickness can be noted.

Paul Schmidt comments that it would be nice to have data from Norway to Portugal.

Jeanine Olsen to reply that through MARBEF programme it might be possible. Comment by Jeff Mitton about the blue mussels.

Conclusion – Cliff Cunningham (cliff@duke.edu)

2 years after the start of CORONA.

There are problems of funding between N. America and Europe

It is possible to compile a list of species.

Next summer in Roscoff, France (presentation Myriam Valero).