

Minutes

Morning session, Saturday, April 12, 2002.

Start/Introductions

Cliff Cunningham - Structure of summer meeting

Aug. 20-23rd Shoals marine lab (Appledore Island) only 80 people, space limitations, put off until end of day.

Now, we first need to come up with a list of trans-Atlantic species. The guides are usually specific to North America or Europe, not trans-Atlantic, so we need a trans-Atlantic list of biota. Gary Rosenberg has a molluscan database...

How are we defining the North Atlantic?

Cliff Cunningham – the cold temperate north Atlantic, species found not too far south of Woods Hole (maybe down to NJ); most species that are trans-Atlantic aren't found south of about New Jersey;

How far south in Europe? –

Jeanine Olsen, Diarmaid Ó Foighil and Chris Maggs - Roscoff, Algarve in Iberia... northern Portugal is a major transition zone. The Mediterranean should NOT be included. It has a different story.

Les Watling - as far as Cape Hatteras ... many of these trans-Atlantic species go as far south as Cape Hatteras.

Discussion of deep water taxa – many are trans-Atlantic – what about them?

Geerat Vermeij - I think these are definitely worth worrying about; the things you rarely see in intertidal but are trans-Atlantic, as far down as bathyal – certainly the shelf needs to be included.

John Wares- if we find different patterns in deeper and shallower water, that's interesting; these deeper taxa still are Pacific from trans-Arctic.

Cliff Cunningham – We should make the compilation of species lists as comprehensive as possible – call attention to these groups (this is part of purpose of this project) so the existence of the species list itself is important; the ecology is generally easier (more well-known) in shallower water;

Gary Rosenberg – The shelf provides an escape in depth from glaciation; more continuously distributed populations with more potential for panmixia than you might see in shallower water ... it might be a control for species you know were influenced by ice.

Cliff Cunningham – Sally was saying to me last night that she thinks soft sediment species might have been more limited in Europe than in North America during the last glaciation;

Jon Witman – It's quite likely that shallow benthos recolonized from the deep water .

Geerat Vermeij - things that we think of as intertidal animals are also subtidal. Very few animals are just intertidal. Many can go down to the 200m contour that defines the shelf;

Gary Rosenberg – A depth restriction is not important for taxonomic database ... most databases deal on a taxonomic basis

Les Watling – In the history of North American phylogeography, there's not much compiled for deep water. There were samples taken by NMFS, etc., and the specimens

deposited, but we're just beginning to track specimens down – for example, deep water corals, also shrimp, etc. People have known about them for a long time, but no one has tracked them down.

John Wares – We need to make a coordinated bibliography, so that's it easy to find information on geology, paleontology, etc. for the North Atlantic so you can find the literature and records easily.

Les Watling - OBIS – Ocean Biogeographic Information System – was to compile this sort of information; if there's more money – it would be good to get info into a database; Gary Rosenberg [answering a question about point records]– I don't include point records in my molluscan database

Species lists and databases – information for compiling trans-Atlantic distribution data: Les Watling, Gary Rosenberg, Chris Maggs, Agnar Ingólfsson, Jeanine Olsen

Chris Maggs: Phycologists have already been compiling this sort of information. In 1986, they published South and Tittley's distributional checklist of the North Atlantic (British Museum of Natural History and Huntsman Marine Lab) updated by Ian Tittley – the update was finished 3-4 years ago, but not published yet. North East Algal Society (NEAS) Algae of New England – a book published approximately 2000 or a bit earlier. It's geographically organized, has full ranges of species, all the algae were documented. Cliff Cunningham– how much information is there about substratum? [see meeting summary for full citations]

Chris Maggs - NEAS includes ecological information; someone else to include is Mike Guiry. He has a website at seaweed.ie, an algae database- Mike has links to all the other seaweed sites in the world. He has every seaweed in the world on his list right now - ~5000 spp., the flora here is subset of European species – (<1/4 of spp. in Europe are here- several hundred)

Geoff Trussell – Will this compiled species information be on the web?

Cliff Cunningham – yes

John Wares – we should invite Garbary – he has a book on algal biogeography from 1991(?)

[someone] – suggested Lüning be included in the network, also, he has a book called *Seaweeds: their biogeography and physiology* [see meeting summary for full citation]

Diarmaid Ó Foighil– how well does macroalgae fit with the trans-Arctic interchange?

Chris Maggs – the majority looks like the tail end has come through from the Pacific – exceptions – *Fucus*, *Ascophyllum* which are Atlantic centered genera, Atlantic radiations

Chris Maggs[?] - Sandra Lindstrom is an expert on Alaskan/Canadian coastline in Pacific, she has an updated book on the Algae of Alaska, as well as a review of algae going from Pacific to Atlantic (in *Journal of Biogeography*) [see complete citation in meeting summary]

Jeanine Olsen- biogeographic element – historically started by phycologists (Chris Van den Hoek, Lüning, etc.) started compiling these lists that culminated in these algae

publications. They did a huge amount of work, in a time when there was no access to molecular data, ways of dealing with taxonomic problems that are easy now weren't there then. Basically all the phylogeography in algae – ITS, rubisco, RAPDs, DNA hybridization – 75% came out of Chris and Jeanine's extended lab groups – now we have microsatellite data, etc. more horsepower – we're [phycologists] a little behind but coming up fast in terms of molecular work

Les Watling – trans-Atlantic species – BIOICE – uniting Gulf of Maine project with BIOICE and having these species lists together

Les Watling – BIOFAR started with funding from Nordic council 6-7 years ago (Danes, Norwegians and Swedes) Ole Tendal – works with odd groups – wanted to get animal species lists from shelf, from Norway, northern Europe and extend it across the north Atlantic and extend it across the to the southern terminus – comprehensive sampling in some of these areas – Norwegian coast pretty well known – Torlev Brattegard (?) defined 26 units along Norwegian coast, and the presence of species was recorded in each of these units out to the shelf. There are 4000 spp., on this list; then BIOFAR came along – biological oceanography of the Faroe islands (Faroes are on the ridge between Norway and Iceland); the Faroese have a very maritime history – fishing. Through the Nordic council, 680 bottom samples were taken from 60m to 900 or 1000m at greatest depth. They had a little lab, hired a lot of local people to process benthic samples, shipped out to 120 taxonomists around the North Atlantic to analyze samples. They have tremendous distribution information. There's going to be a summary meeting in the Faroes in 2003 – a synthesis symposium. For cumaceans for example, they also collected good oceanographic and sediment data – the fidelity to ocean water mass was unbelievable – you could predict where you'd find species as you'd go up from channel to sill, etc. – can track water masses with certain benthic crustaceans – new BIOFAR initiative in shallow waters around islands. The original BIOFAR started 7 or 8 years ago – a lot of publications in *Sarsia* on BIOFAR; extension to BIOICE – fauna around Iceland – 3 or 4 years of sampling

Agnar Ingólfsson and Les Watling - started in 1992 – (actually BIOFAR is older than BIOICE) not quite as comprehensive, but close to BIOFAR – BIOICE is a 10 year program, sampling is ending about now or next year – taking about 1200 samples, depth range 5-500m, various sampling methods according to bottom type; so far 2000 spp. have been identified – just the macrofauna - using .5mm sieve; 40% of these spp. were not previously known from Iceland; so far 25 new spp. have been described, but so many more need to be described – brings home how little we really know; what about meiofauna???? You can take sample of harpacticoids – up until recently about 100 spp. known; decided to do a survey of single pool(?) found 70 spp. most unknown from Iceland, several undescribed; 25 new spp. have been described;

Jon Witman – What about shallower than 50 m?

Agnar Ingólfsson – Nothing comparable unless you go as shallow as the intertidal.

Cliff Cunningham – does this imply that there are easily compilable spp. lists for intertidal? –

Les Watling – It depends on where you are... There's talk about BIOGREEN, which would do same thing for Greenland. A few fjords are being studied extensively from northern Greenland; almost nothing known from the Labrador coast; for Newfoundland

there are moderately good records from the Canadian DFO (Dept. of Fisheries and Oceans); Pierre Brunel –author of Catalogue of St. Lawrence; Gulf of St. Lawrence deep at entrance, and has deep arctic water in bottom; on Georges Bank, Antarctic intermediate water comes up past equator to about 30°N; sub-Antarctic biota replaces the arctic fauna about 1000m depth on Georges Bank and canyons; (this data is from Oceanographer Canyon) the Canadians farther north aren't seeing any of this, but they're working at shallower depth; US East coast slope and rise study (Jim Blake) sampled from about 40° N to South Carolina at bathyal depths – from about 600m to 2200 m – some was published in Deep Sea Research, a lot is still unpublished; again I did cumaceans, but found break at 39° N – no physiographic reason for this break;

The Gulf of Maine has all sorts of substrates , Detmar Schnitker has worked with benthic forams and diatoms – worked out retreat of glaciation – freshwater to brackish lagoon shows change in diatom signature 8 kya; before isostratic rebound, water was 25-30 mi. inland; Cape Cod wasn't there, so get Virginian fauna tracking up northward – up into Gulf of St. Lawrence – about 5 kya; A.E. Verrill assumed that everything [every specimen] he got was new – described a huge number of species – some are probably synonyms of European species, a lot of his stuff is at Yale and Smithsonian and at Harvard (this is deep water stuff);

Current Gulf of Maine species list – no one's compiled all the historical stuff; USGS did some stuff, but only partial sorting of specimens – the polychaetes were never done, amphipods were done just for Georges Bank, etc.; Les Watling has species lists for his work; most of Gulf of Maine (80%) is below 70m depth; so most of fauna is cold in nature; most originally described up in Davis Straits area; huge subarctic boreal component in Gulf of Maine; Georges Bank is a true barrier to this boreal fauna – distinct zoogeographic boundaries north and south of G. Bank;

As for the shelf off NJ, there have been cruises, but not easily accessible reports, or the info from them; it's doable – there's a huge amount of data, but going to take funding – Ole Tendal collected 30 spp. of sponges in 2 dives, and over half were originally described in the Ingolf Reports from the Davis strait and hadn't been seen since. They're found in the Gulf of Maine because in that area of the Gulf rocks are 2 m in diameter, so can't trawl.

Cliff Cunningham - Mark Costello, the director of the Huntsman Marine Lab, runs the European Register of Marine Species. He's from Ireland, eager to take species lists and compile them. He wants to make Huntsman the center of this, he's really eager to compile this info.

Les Watling – The European Register is out in book form, it's just a list of species. There are two broad categories – Atlantic and Mediterranean – ostensibly goes from shore to mid-Atlantic ridge – comprehensive list of names of any species in any group – only register that actively pursued meiofaunal taxa – a gigantic number of taxa included; something like 200 taxonomists involved; taxonomic name and authority and date – a similar effort in the U.S. by the North American Fisheries Society – scientific and

common names of animals and plants – 2nd edition came out in 1998 – [Donna] Turgeon was the coordinator [see summary for full citation]– these things are of limited utility – just list of names – initially the effort was to stabilize common names – for molluscs this may be fairly important for shell collectors as well as for the benefit of legislators – BUT can only contain current name, so if there's been synonymization then out of luck.

Gary Rosenberg - There are several different databases for molluscs currently – Greenland to Antarctic western Atlantic molluscs (this is Rosenberg's project for last 10 years) are in Malacolog – on web in version 3, <http://data.acnatsci.org/wasp> (wasp stands for western Atlantic species)

CLEMAM - checklist of European marine molluscs – Serge Gofas

OBIS – Ocean Biogeographic Information System - also working on database of Indo-Pacific molluscs – database of hexacorals, also a portal for the OBIS project at Rutgers-trying to bring together the data from all these different databases – can get maps of point records – maps at CSIRL in Australia, database is in Rutgers, other portals in other places – so technology is there to consolidate a variety of different types of databases together; there was no species list of Caribbean molluscs, and this frustration led to Malacolog – so since molluscs have big biogeographic ranges, you can build up geographic ranges summing across synonyms – have list of synonyms and recording of location of each range from each synonym – no point records – but does have overall bathymetric data; some species submerge as you go south ex. *Buccinum undatum* – species supposedly recorded from New England and south of Cape Hatteras but nowhere in between – gaps in ranges – either true gaps or gaps in sampling.

Gary Rosenberg - Malacolog does capture misidentifications – if there are several different meanings, only one of which is correct, you should get multiple hits – Malacolog is up to date for current taxonomy

Geerat Vermeij – databases need to be checked and verified

Gary Rosenberg – needs to be updated and annotated by specialists, and need to maintain history of updates to databases. Pulling the information on any one taxon is incredibly labor intensive – involves pulling together papers from various sources over a couple of hundred years; can give data in Gary Rosenberg's database- of ranges, farthest east, west, north south, depth – if you put into GIS system you could establish list of polygons of distribution and look for disjunctions – ex. pteropod spp. with disjunct distributions had to list as separate subspecies to get disjunction represented accurately in database; can use dataset to search for taxonomic artifacts; sum diversity by latitude – can get diversity patterns – pattern that looks like a series of peaks, also can plot size of geographic range versus midpoint of the geographic range; this allows you to pick out anomalous points so you can go back and look at records more carefully for misidentifications, etc.;

Cliff - if a species is trans-Atlantic can you pull up locations in Europe?-

Gary - no; also CLEMAM doesn't have distributions, only synonymy; mine [Malacolog] has amph-Atlantic species – there's a code for Eastern Atlantic, Western Atlantic, Azores, St. Helena, but really nothing specific in Europe;

Jeanine Olsen - in Europe there is there is a a more specific list that they're working on – an EU approach to put things in a pan-European context – EUCLIM or EUROCLIM or something like that – There's a list of everything in the flora of the British Isles – get at it through MNCR (Marine Nature Conservation Review) (can get at this through Google);

synonymy ratio – 1:1 synonym to real name in North America, in Europe 4:1; in Indo-Pacific less than 1:1;

deep water - not much work since Verrill's time; amphi-Atlantic – really haven't been American researchers that have put a lot of attention into this fauna – 2 Frenchmen have (Philippe Bouchet; Anders Waren)

Les Watling – Verrill described a lot of things from areas of the Gulf of Maine that have been very heavily fished – but they may already have gone extinct. It would be nice to know if these old Verrill species still exist – probability that they don't is pretty high; Procter's data – very detailed spp. list in Gulf of Maine Frenchmen's Bay, around Block Island; Clench-Bullock manuscript – key to identification of molluscs of New England – has gastropod key but no distributional data; but whole deep New England gastropod fauna off the coast.

Cliff Cunningham- Ann Bucklins' ZooGene- same with my hydrozoan database – links to genetic data from taxonomic/distributional databases;

Gary Rosenberg – the question is not the technology – it's the funding; either need funding for a portal to bring data together, or for people to bring data together into a monolithic structure

Gulf of Maine database (at U of Southern California) OBIS structure – take old NMFS data – bycatch from groundfish surveys – put into OBIS framework, adding on other data-

Geerat Vermeij – I have a nagging worry about database proliferation. What's the point?? Collecting data for collecting data's sake is a bit of a modern disease. If we get involved in this massive data collection we need to keep in mind what it is we really want to know.

Cliff Cunningham– A list of trans-Atlantic fauna is useful for knowing and comparing what species there are to be compared. The inaccessibility of these species lists have been a problem for my research; it's collecting data for interesting organismal hypotheses that can be attacked once you have this info;

Geerat Vermeij – I would say it's easy to figure out what amphi-Atlantic species there are – pairs of species that are the same species or represent subsequent speciation events- query database for two species on both sides of the Atlantic.

Diarmaid Ó Foighil– Your choice of study taxa is critical to what kind of conclusions you can make – choice of organisms you choose critical from the beginning –

Gary Rosenberg - if you can include biological characteristics- then can look for patterns to test, etc.

Cliff Cunningham– I agree with Geerat – I think this is a fairly tractable thing – bring the info together about these species and then get on with it – things like BIOICE and BIOFAR give ecological information that will add depth to study – lets get it done

Emmett Duffy – There is the issue of how we maintain quality control of these identifications – as you get into more obscure groups – for example crustacean groups that haven't been studied well – I don't believe anyone's records of *Synalpheus* but my

own – if you're going back to these records where someone described the distribution of these difficult to distinguish polychaetes 30 yrs ago, do you trust them?

Diarmaid Ó Foighil–Don't get hung up on taxonomy, but deal with molecular data

Chris Maggs – If you leave behind all of historical taxonomy and what goes with it – you leave behind a lot of information – to say that anything has a certain distribution today doesn't mean that that it has/will remain the same

Sally Woodin – Are there taxonomically based databases of literature – there is for polychaetes (Ward compiled a list of all literature on polychaetes – not just systematics, but all literature on polychaetes)

Cliff Cunningham – also a hydrozoan database on web

Sally Woodin – not just geographic databases – but for groups for which these geographic databases don't exist, these literature databases do exist.

Geerat Vermeij –I worry about intensive sampling of the literature – some these lists miss 25% of the literature.

Jerry Hilbish – When you have taxonomies of dubious merit, and only believe your own ID's – coupled with problems of historical distribution – does an old record of something mean anything to me?

Thierry Backeljau– even if you do ecological work, you should have voucher specimens

Cliff Cunningham - Is voucher info included in Malacalog?

Gary Rosenberg – no.

Chris Maggs – one voucher of that you worked on should be available

Gary Rosenberg – one discussion – what are museums going to do with the massive amount of specimens?

Jeanine Olsen – For most of the(non-taxonomic) work, there are no vouchers even today in my lab

Gary Rosenberg – if a taxonomist revises a group, they should be updating the records – they should reassess the distribution of the species

Geerat Vermeij – list location of types today -

Gary Rosenberg and Jeanine Olsen – that's OK for a lot of groups, working on tying it in

Jerry Hilbish – types are only part of what you want to have – want basically community vouchers

Rowan Lockwood – this is the sort of information you can get from listserves – they do have bulk samples, but you wouldn't find it by catalogs, literature or word of mouth – museums of paleontology are throwing out bulk samples – they don't have space –

Chris Maggs – also formalin regulations... there are mass collections - bulk samples that are unsorted

Sally Woodin – There are bulk samples at the Smithsonian

Gary Rosenberg – You can pull isopods, etc. out of samples collected for another purpose...

Fish

Brian Bowen – fish – All the species are identified; depending on where you look there are about 600-800 species in the North Atlantic boreal cold temp. zone; pretty up on the curve as far as describing species; west vs. east Atlantic – the level of endemism is about 35-50% - the rest are closely related sister species. There are many fish books; Bigelow and Schroder; fishes of the British Isles; Sears books; I'm not sure how good the sister species are... As far as phylogeography and genetics goes, the good news is there's lots

of it – driven by fisheries, etc. – but on very localized scales; ex. Baltic, Gulf of Maine; still done as allozymes even today – so difficult to compare between studies, but there is a bright ray of light – people are converting to seq. data; if people looking at cod and herring in the northeast and northwest Atlantic can use the same sequences, we can get the result we want; Joe Quattro is publishing primers for DNA sequences that work across all fish – there are not a lot yet, so even if they're not consciously trying, people end up using the same sequences; there should be a lot of good stuff in the next few years. As far as the pelagic zone - do we care?

Cliff Cunningham – As for the plankton researchers it's tough to get them interested in our interests, and vice versa –

Brian Bowen – what we have is pretty much what Ann Bucklin, etc. has found – little structure

Jeanine Olsen – We have a couple of projects dealing with flatfish – flounders – trying to do some taxonomic work; we found that as we were reviewing the plaice population structure in North Sea – if you get them from the continental shelf of Europe, there's no structure, but get over to the Faroes and Iceland, you find shallow population structure. Wares – Ecologically, even though they're pelagic as adults, they still spend time as estuarine larvae. As far as benthic ecology, they play a good role, and tie into this.

Brian Bowen – Evidence for trans-Arctic exchange more recently than 3.5 Mya – Stu Grant(?) is looking at the trans-Arctic exchanges of cod, halibut, etc. – gone both ways through Arctic; Pacific herring around Norway - ? Pacific cod in Hudson Bay? Cod were called a different species, but very similar to Pacific; dates with allozymes to 1.5 Mya (?)

Cliff Cunningham – *S. droebachiensis*, *Mytilus*, are recent migrants from the Pacific
Geerat Vermeij – Not every organism that lives in the Arctic has trans-Arctic interchange

Brian Bowen – there is a fauna that has entered recently from South Africa – warm-temperate fishes; true pelagic wanderers- shallow population structure between North Atlantic to southern hemisphere, Australia and beyond – this is a major consideration for fish but not really for the other organisms we've discussed so far

Cliff Cunningham – Jerry, you're interested in this for *Mytilus*...

Jerry Hilbish – keep in mind *Mytilus* is just a datum; we know very little about directionality, timing – it's more complicated than some of the literature might lead someone to believe.

Jeanine Olsen – There's often less sampling in the southern hemisphere – can't get access to samples – ie. South America

Jerry Hilbish and Diarmaid ÓFoighil – every country except Brazil is eager to collaborate, though

Brian Bowen – looking further south to reef organisms – deep evolutionary separations between east and west Atlantic; stepping stone models have not held up; so skeptical that it will be as simple as stepping stone from east to west in north Atlantic

Diarmaid Ó Foighil – We found the same thing

Brian Bowen – How deep are we considering? What about the mid-Atlantic ridge, thermal seeps? Are they beyond our current considerations?

Cliff Cunningham – Well, it depends on interest

Jon Witman – There are people at Rutgers doing biogeography of hydrothermal vent faunas.

Brian Bowen – As we go down in size – no structure in swordfish, some in cod – small fish that aren't interesting commercially – but give us a sharper phylogeographic signal.

End of first session.

Afternoon Session, Saturday, April 12, 2002.

Glacial maximum and refugia

On the European side of things, temperature is the determining factor for the distribution of extant forms, where you get a southern and northern temperature boundaries for marine seaweeds – current view for last glacial maximum - think perennial sea ice extended from Bay of Biscay or northwest corner of Spain. The North Sea, English Channel didn't exist at all; *Ascophyllum* is a cold water plant, doesn't like above 10 degrees – whole Brittany peninsula has the highest allelic diversity – edges of the 10 degree isotherm around corner of Spain, but these are really scraggly populations; move back north of Brittany – gets depauperate; think that refuge in Canary islands, Cape Verde islands;

Geerat Vermeij-based on the endemic faunas in the Cape Verde's I have a problem with that

Jeanine Olsen – Canaries have a weird mix

Chris Maggs – replace that - use Canaries instead as refuge

Geerat Vermeij – use Mauritania, just not Cape Verdes

Geoff Trussell- how far south does *Fucus* come down?

Jeanine Olsen – depends on the species – some species go down as far as Mauritania

Diarmaid Ó Foighil – Is there evidence for a secondary contact zone?

Jeanine Olsen – Brittany – the diversities of all species are high in Brittany

Diarmaid Ó Foighil- could it be a contact zone in Brittany?

Jeanine Olsen – maybe this area wasn't really covered in ice

Geerat Vermeij- I thought there were terminal moraines in Holland – and sea ice wouldn't have gotten farther south from that.

Chris Maggs – *Palmaria*- greatest genetic diversity in same area as *Ascophyllum*

Jeanine Olsen – share haplotypes between regions, so just have higher diversity in Brittany

Jon Witman – is submergence of *Fucus* related to temperature or salinity in the Baltic?

Jeanine Olsen- we think it's salinity...

Sally Woodin- I think I'm confused – you're saying maximum diversity was in Brittany which was covered in ice?

Jeanine Olsen – We don't know – the refugium might have been in Brittany or in the Canaries – and could have since moved back up and the populations in the Canaries have gone extinct because it was too warm

Jerry Hilbish – if you look at Hewitt's data – it's terrestrial - you have multiple expand/retreat cycles, and can get multiple zones of contact – go forward and back repeatedly, repeated episodes of divergence.

Cliff Cunningham – *Nucella*...

John Wares – doesn't share mitochondrial haplotypes between France and Ireland. Kirby has shown that there are coadapted gene complexes... Also area where *Mytilus edulis* and *galloprovincialis* come together? yes – where was the other refugium???

Jerry Hilbish – the hybrid zone in *Mytilus* is paralleled across the channel in southwest England do you see the same in algae?

Jeanine Olsen – no – we don't see the Brittany pattern in Southwest England; no evidence for a northern refugium

John Wares – seems more likely that somewhere in northern Europe there was a refugium than North America

Jerry Hilbish – what about Mediterranean?

Jeanine Olsen- In one reconstruction of the ice, there was one glacial sheet – the tip of Ireland was not covered – maybe the tip of Ireland was available. But most people don't believe that.

Jerry Hilbish – why is the Mediterranean out?

Geerat Vermeij – In the Mediterranean Pleistocene, there are good examples of boreal European organisms- *Buccinum undatum*, etc.- obvious Mediterranean was cold – might be a problem going through..

Jeanine Olsen – OK, so maybe Mediterranean was a possible refugium, you still have a southern refugium – still no possibility of northern refugium

Jerry Hilbish – then you don't need a northern refugium – could have a Mediterranean refugium and northern African refugium – then re-expand, and contact in Brittany.

Geerat Vermeij - when did the Bering Strait actually open – I want to fill in people who don't know the literature. It turns out 3.5 Ma is probably incorrect – now 5.3 Ma – latest Miocene earliest Pliocene time to 3.58Ma- mid-Pliocene

Marincovich – this second event has to do with the closing of the isthmus of Panama, which caused changes circulation

When did the strait open and when the migration occurred are 2 different questions!!!

Two different things to identify as separate questions – 1. Where were/are present day and previous barriers and 2. Where are the source populations – partly a refuge question,, but partly not. Where are the barriers????

John Wares – an ability to identify source populations in certain regional scales would give further evidence for northern and southern refugium on north American coast; a talk by Laurent Excoffier – can you use genetic data to reconstruct source populations?

Vermeij- first sign of a source population is abundance

John Wares – but so many confounded issues genetically with abundance. For example, *Littorina littorea*

Geerat Vermeij – New England has to be on the whole where organisms can have big populations today - source population– Look at effective population size and how it changes on latitudinal gradient in North America and Europe- very valid way to look at this

Diarmaid Ó Foighil- It's very different, though, from the phylogeographic way of looking at this which is historical

John Wares – for a long time we've thought of this as an historical question, but more useful direction that phylogeography could go is the actual dynamics – both the history of those populations as well as possible future outcomes

Diarmaid Ó Foighil – abundance has potential problems – range expansions – if in novel habitat that's great – can achieve new abundances, etc.

Gary Rosenberg – Hasn't Carlton shown rarity versus abundance doesn't affect likelihood of something being introduced?

Jerry Hilbish – For a lot of these species, if they have the capacity to be very fast reproducing species, if they reoccupy a region they've been exterminated from and fill it up fast - marine spp. refugium could be a handful of individuals – given group of species within a genus that coalesces shallowly – this is a generalized pattern in marine organisms; explanations can include localized extinction/recolonization patterns, can also include sweepstakes recruitment, etc. – can be surviving in batches – can document this in striped bass, most of the progeny can come from one or two day window when propagules were in right stage for recruitment – sweepstakes recruitment. There's temporal or geographical instability in these populations, on much shorter time scale even than glaciation – really widespread pattern in mtDNA, how about nuclear data – preliminary sense is not yet(?)

Jerry Hilbish – third hypothesis might be selective sweep. One of the real pluses for a selective sweep – if they have a huge population size, then responsive to small advantage in selective sweep – can sweep very fast; also depends on them being very very fecund
Cliff Cunningham – problem with selective sweep is that there's so little - almost no - evidence for positive selection in mitochondria – either nearly neutral or slightly deleterious

Jerry Hilbish – I don't think there's a database to say it's not in the nuclear genome
Geerat Vermeij – one more point – one really nice way of identifying refuges is to look at the former fossil distributions of living and fossil species. If you look in the North Sea basin – see lots of taxa that are today found from Brittany south – strong indications of where the refuges at least are not – identification at least of refuge sand of barriers can be greatly enhanced by looking at fossil distributions – if you want to understand what the distributions are north or south today – think about where they were in the past.

Jerry Hilbish – How well do we understand barriers today?

Geerat Vermeij – I don't think we do – Point Conception, Cape Hatteras and elsewhere – what in the world is separating Florida from the Caribbean ????. There are many barriers in Pacific that we don't know how they work.

Jerry Hilbish – There's very little evidence that a hydrodynamic barrier alone can separate anything – has to be reinforced with temperature, etc. – ex. Cape Hatteras

Geerat Vermeij – that's the old idea at any rate – also currents diverging from coastline

Jerry Hilbish – if we understood the ecology of modern extant barriers to any degree – then the ability to extrapolate to paleo. times – need to know more about ecological barriers

Cliff Cunningham – What about species range limits??

Geerat Vermeij – species range limits are fluid, change from time to time – they're worth looking at – *Mytilus* across Cape Hatteras – occasionally they get through - why does it work most of the time? We don't know.

Les Watling - you could get a pseudo population of *Mytilus* established – Wells' work – get this periodic influx of larvae of *Mytilus* around Cape Hatteras – mouth of Delaware bay – big mussel reefs offshore – water temperature is 27 degrees – I don't think any of

those mussels reproduce – but always have reefs there; populated by larvae from north – not an issue of whether they're present or not.

Jerry Hilbish – I think Wells data is a perfect illustration of movement across Hatteras – north to south – there must be circulation eddies – then the temperature hammers them

Les Watling – Hutchins 1947 - for every individual species – optimal temperature for growth vs. reproduction – both max and min. – this is where organismal stuff needs to be addressed; for many benthic osctracods, no evidence of reproduction because of high summer temps – along coast to NJ – other spp. temp never got warm enough – limit of Virginia provinces

Jeanine Olsen – classic work for seaweeds –for more than 100 spp – minima and maxima – done across the Atlantic.

Les Watling – with our modern technology, we're forgetting our basic biology which is often very perceptive -what are the barriers for the seaweed distribution – where do the gradients become steeper, where do they stop becoming reproductively viable – these seaweed data could be used to predict animal distributions

Jeanine Olsen – lots of that stuff from our group – in the lab - data on acclimatization, light, 30 year studies, et c.

Les Watling – winter cold temperatures, summer high temperatures; then take physiological data that is known for algae for these things – can find where these limits are, and test with animals;

Chris Maggs – There's an extremely strange paper – Steneck and someone else – incomprehensible – uses abundance data for this sort of thing - Journal of Phycology [Complete reference is W.H. Adey and R.S. Steneck. 2001. Thermogeography over time creates biogeographic regions: a temperature/space/time-integrated model and an abundance-weighted test for benthic marine algae. J. Phycol. 37(5): 677-698.]

Summer meeting structure

Cliff Cunningham– The summer meeting will be held at Shoals, and there is limited space. This was deliberate. It will be larger than today –I'd like us to do some brainstorming about the need for whole group plenary sessions, if any, small group workshops, etc. – what do people think???

Geoff Trussell – It would be good to have some sort of forum for people to represent the ideas they would like to pursue if they have specific experiments or hypotheses in mind – to let them throw it out to the group at large and get other people interested.

Cliff Cunningham– how would it work?

Geoff Trussell– A series of 20 min presentations by single or several authors who want to take the point on a particular issue.

[someone] – too long!

Jon Witman – logistically, at Shoals there are 2 or 3 areas for working groups plus a space for us to meet as a big group at Shoals.

Geoff Trussell – I've learned more in the past two or three hours than in the last three months – my particular experiments that I already have in mind I could present and Geerat could say it's bullshit, don't do that experiment!

Rowan Lockwood – We need a way to vet ideas beforehand or are going to have overlap – we need to keep it from being a free for all

John Wares – For anything we come up with– if want to do a study in Maine, there needs to be sister study in Europe – could ask - is there someone who wants to do the same thing as me but in Europe??? Specific ideas in research coordination but in Europe.

Emmett Duffy – It would be useful in the beginning of meeting for experts on various habitats or ecosystem types to say these are the major animals and what they're eating – give an ecological perspective – those of us on one side would know what to expect on the other side - sort of a class lecture on such and such an idea.

Diarmaid Ó Foighil – ultimately, science is question driven - can we identify 1, 2, 3 questions that we are interested in for the north Atlantic biota that we are all interested in? - the meeting could help produce that.

Rick Wahle – three questions – one of taxonomy, bookkeeping, one of phylogeography – reconstructing the historic past – third is really ecological process – dispersal, ecological processes compared on the two sides of the pond – maybe these could be themes we work on during the summer meeting.

Sally Woodin – what are we trying to compare – what is our comparative basis – we've been talking two sides of the Atlantic, and we talked seaweeds, mostly hard substrate organisms for a while, I hate to raise the ugly prospect of sediments, but here is another comparison to be made within habitat and across the Atlantic- sedimentary versus hard substrate comparison which may be much more revealing than any of these other comparisons; I don't know that there is any reason to suspect there is any difference on rock for seaweed versus animal – but there are also definitely questions about hard substrate versus soft

Cliff Cunningham – I definitely want this on ecology day.

Geerat Vermeij – We know of virtually no Pleistocene global extinctions of marine invertebrates – where did you move to is really the question. Biologists in general have been really infatuated with the last glacial maximum – but it's not really a problem in the global sense

Geerat Vermeij – there were restrictions to be sure, but no extinctions.

Rowan Lockwood – the evidence for the northwest Atlantic restrictions is genetic Cliff Cunningham-right, and in most cases we aren't sure they were here before.

The way we like to phrase it is this class didn't survive, this class did.

John Wares – I think the important stuff in terms of this goal is – in what ways do North America, Europe, Iceland act as a single unit, and in what ways do the east and west Atlantic act as simply a replicate of each other?

Soft versus hard substrate – haven't been historically connected – but historically and functionally connected.

Jerry Hilbish – Add temporal scale to that – functional ecological dynamics – looking at a structure that is to some significant degree set by Pleistocene and post –Pleistocene events; but Atlantic had biota in it before that.

Les Watling – We need to be encouraging someone to put together the paleontological data

Cliff Cunningham – it's always easy to set a priority someone else is going to do

Diarmaid Ó Foighil – what are the most outstanding unanswered questions in North Atlantic?

Brian Bowen – refugia

Geoff Trussell – trophic interactions – linkage

Sally Woodin –soft sediment why is the eastern Atlantic depauperate

Rowan Lockwood - why is the western Atlantic depauperate

Jeanine Olsen – there’s a relationship between biodiversity and climate change – theme that comes up again and again – in a phylogeographic context, if you can make some estimates of past geographic process, can we use that demographic data to make forecasts of how things will behaving the future, as far as climate change – a huge horrible question – but coming up repeatedly in the EU framework.

Geerat Vermeij – whenever things warm up, it’s just great – you get diversification, you get evolution, you get everything good happening

Cliff Cunningham – trans-Atlantic species – get replication on both coasts

Jon Witman – what’s the ecological consequence of greater regional diversity on the eastern Atlantic?

Sally Woodin – that is NOT TRUE OF SOFT SEDIMENTS!!!!

Cliff Cunningham – I completely agree and would like soft sediments to contribute a great deal more to this network – you’re absolutely right – on a genetic basis McCune at Hamilton; probably should have Reise; Piersma;

Jerry Hilbish – have this pattern on hard substrates – western Atlantic is depauperate, eastern Atlantic is source; have a start, but just start on recent biogeographic rationale for hard substrate pattern; have very little data on the soft substrate pattern; what you need is a large research initiative on these two substrate types and whether the speciosity of these is the result of glaciation

Cliff Cunningham – I’d like to summarize where we are going – the structure of the meeting will be a series of group symposia - working group type things based on many of these subjects– if we were going to having one discussing the forces responsible for soft vs. hard substrates, how should that be structured????

Geoff Trussell – 10 minute talks

Sally Woodin – all of us can be interesting for 10 minutes

Les Watling – If you want to establish the bases for these questions – you need to have a series of talks to establish the information for everybody on the topics – if only ten minutes, then people need handouts;

Chris Maggs – without actual projection – old-fashioned

Rowan Lockwood– the only way no powerpoint didn’t work was with the maps – all joking aside, it was hard to understand

Geoff Trussell – I do think projecting a power point presentation would be a good idea – we’re going to have more than just us there –

Cliff Cunningham – people like the 10 minute talk idea – then have symposium organizers that are responsible for giving us maybe an hour of talks –

Edie Zipser – should there be questions?

Geerat Vermeij – my experience is that people talk through questions

Cliff Cunningham – that can be handled at the level for the organizer

Geerat Vermeij –I want to emphasize how important it is for giving lots of time for informal discussion

Jerry Hilbish – I don’t agree with that – if you have a body of talks, a quick coffee break for silly questions then when you come back, have a free for all discussion – the private talks over in the corner don’t fan the flames of conversation at large

Cliff Cunningham – It does spill over into the talks at large

Cliff Cunningham – the question of 80 people – how do we deal with that??

Sally Woodin – why 80?? 50 is still a tractable number – can still do single session;

Cliff Cunningham – only 40 more people could come...

Diarmaid - that's OK

Geoff Trussell– the bigger it gets, the lower the probability of it working

Jon Witman – I really like the idea of a general session so it can be really interdisciplinary

Rowan Lockwood – my fear is that if we break up into smaller groups we'll have people divide themselves taxonomically.

Sally Woodin –I just ran one of these under the biocomplexity issue – the path by which you got to the final product was more interesting than the final product was

the second day we didn't want to break up into smaller groups because we all wanted to follow the final logic of how everyone got to their final conclusions!

Les Watling – We want to have an organizing committee that will go out and twist arms of people to give syntheses; in order to have a fruitful discussion we need to have a broader education – synthesis talks need to really compile information so that when you come to this meeting there is no disputing these basic underlying facts – what's the state of the knowledge in this field to start with; can't do that in a 10 minute talk; need half a dozen longer talks.

Cliff Cunningham – So, topic driven sessions, long breaks, handouts – how should 10 minute talks fill in with the 6 longer talks – what's the role?

Sally Woodin – I'm not sure I see longer talks – do you think people want to go in more detail?

Geerat Vermeij – I'm always in favor of short talks if you want a synthesis, have people hand out not a full-fledged review paper, but a few references and a summary.

Mark Bertness – 10 minute talks will get more opinions out and then we won't have to listen to Geerat Vermeij too much. ☺

John Wares – We need to get rid of overlap – if we divide it up right, then we could have a product at the end

Chris Maggs- like undergrad seminars where everyone understands that they have to read and review papers on the plane on the way here (maybe 4 papers);

Cliff Cunningham – how do we keep it down to 50 people without making people feel that they're excluded from some kind of club?

Geerat Vermeij – By being discriminating and elitist ☺

Cliff Cunningham – Some kind of application process? On the web – here's who I am and my research coordination interest, here are the people I've networked with, here's what I'm bringing to the table.

Gary Rosenberg – I think there are enough meetings that people won't be hurt if they don't get invited

Edie Zipser – Do mention that space is limited, though.

Thierry Backeljau– there are enough workshops, first come first serve, have committee deciding which talks

Jeanine Olsen– The point of the meeting – one point is networking – one aspect is proving that people are networked.

Geerat Vermeij – my worry is that there are some disciplines that are not represented here at all, and most of us will not think of those fields because we don't know them well

enough – need oceanography and real geologists; I think physical oceanography is also important

Cliff Cunningham – There's a guy from Newfoundland who'll be invited

Geerat Vermeij – I don't think first come first serve will do this at all

Rowan Lockwood – We need to break this down by scientific topic and then make a list of who you want to invite, and then go from there if you have extra places.

Cliff Cunningham – So you want to start by invitation only

Jon Witman – What about the Europeans as far as funding?

Cliff Cunningham – we can get travel money for about half of the participants – I think I can pay for about 40 people's travel; I think there should be a group of two or three of us to oversee the budget

Rowan Lockwood – does anyone see the need for a very informal poster session to see what everyone's up to?

Emmett Duffy – During all the sessions we should have an easel nearby

Cliff Cunningham – We're going to return to this at the end of the meeting tomorrow – how about we make that the final set of what the sessions are going to be; think about that and what the sessions should be and what you are going to volunteer to run

Geoff Trussell – and think about who should be invited

Cliff Cunningham – we had some talk about what the database problems are –

Les Watling – Need meiofauna

Emmett Duffy (?) – That's kind of opening a can of worms

Geerat Vermeij – not meiofauna but yourofauna

Jon Witman – is it worth thinking about writing a review paper or two from the steering group about what 's known about the paleontology etc. we have a lot of people right here

Mark Bertness – or maybe that to start with but a book somewhere down the road

Cliff Cunningham – I think a book is a perfectly reasonable thing to aim for.

Jon Witman – if we're going to be getting together on a regular basis it would be nice to have a tangible product

Mark Bertness – a TREE paper would be nice

Geoff Trussell – if we do a review, how do we break it down – substrate perspective; the big dogs come up with a concise synthesis of the papers – sounds redundant – have everyone dealing with specific areas and then have people to tie things together

Edie Zipser – that's something that has struck me as an outsider – because the discussions are not related and it's good to bring it together

Jeanine Olsen – I was part of Deep Green for a while – there were specific tasks – deliverables – it was very structured – in some of these big partnerships, they want to see what you're doing

Cliff Cunningham – within phylogeography – I'd like to divide up the ocean, have people say I'd like to do the polychaetes.... have people make commitments to what they're going to do in x amount of time

Jeanine Olsen – we have these basic questions – what is it we want to know with all this stuff – can we bring generality, forecasting, hindcasting – if we want to understand more about the hard and soft bottoms, the latitude, etc. then we have to think about all sorts of dichotomies, etc.

John Wares – if someone has an idea, should we all 20 or 25 be authors on a paper?

Chris Maggs- deliverables – they do pay for them in our system – they aren't paying for it here, they're paying for us to get together and talk

Jeanine Olsen – common markers, taxon sampling, whose doing morphology and molecules...

Cliff Cunningham – These kinds of things I was hoping to get together in the August meeting.

Gary Rosenberg – We need stratified sampling procedures – need to identify which taxa are most profitable to study, want to identify which ones are best, whole geographic scope – sampling different geographic areas – is it possible to identify a series of taxa and areas that could be done in concerted way

Jeanine Olsen – you're funded on this side of the pond – if there is a little bit more structure, we might be able to get the complementary network through the EU.

Cliff Cunningham – Would it be possible to get research funds that way? We have the meeting funds...

Jeanine Olsen – The potential is there. The network money is probably there; integrated projects – need more money to get there.

Sally Woodin – We may need structure even on level of review papers. Even if you say to people that they're going to write a review on a very small topic – GSA made me think about an area I hadn't thought about and summarize it.

Cliff Cunningham – It was a short paper?

Sally Woodin – 40 pages or so; made me think in a direction I hadn't been thinking.

Cliff Cunningham – how do people feel about getting assigned synthesizing the hard bottom records, for New England, etc....

Les Watling – get some working groups organized to do exactly those things (just not by August) to synthesize literature –

Cliff Cunningham - things that would be useful to have in one place- ie. I need data to further my research that isn't put together

Les Watling – pattern reviews

Cliff Cunningham – Geerat and Agnar have been good at taking species lists and making interesting conclusions from the lists themselves even without molecular and ecological data.

Diarmaid Ó Foighil– Are there any groups with functional ecology that we can look at?

Geerat Vermeij – In a biological context – I think identifying a couple of distinctive environments might help our focus – hard substrate, salt marshes, eelgrass beds, soft substrate shelf...

Mark Bertness - Saltmarshes would be interesting ecologically

Rick Wahle – cobble-dwelling organisms

Jon Witman – rocky subtidal amphi-Atlantic *Modiolus* beds – Gunnar Thorson's work – there are whole assemblages with a lot of amphi-Atlantic species

End of Day 1 sessions.

Morning session, Sunday April 13, 2002.

Ecology Day

Stephen Hawkins – I'll start with a summary of what's been done in Europe recently; there was a meeting on grazing(?) interactions in 1990 trying to figure out what's going on in different parts of world – a review on northeast Atlantic and northwest Atlantic; Oxford publishers 1992; I wrote the review on northeast Atlantic; thought about balance between seaweed and grazers in Europe. In 1995 a call came out for proposals – and EUROROCK was funded – making comparisons on European scale on factors affecting ecology; participants include Ireland, Sweden, Wales, England, Isle of Man, Spain, Portugal, Italy. Guido Chelazzi was overall coordinator; did comparisons between east and west, Mediterranean and Baltic. Looked at individual level, primarily behavioral interactions – Chelazzi has done good stuff on foraging behavior; also population level and community level – modeling component that interacted various levels and quite a few papers have come out from individual and population level, a few community level papers; I'm writing up the overall community paper; trying to integrate the three different levels – patch dynamic modeling papers.

We made simple comparisons – comparing grazing intensity in the Isle of Man, England Spain and Portugal using a simple technique – dental wax set into plastic screw caps, assay the number of times a grazer (*Patella*) hit it; and look at microbial films, etc. same limpet grazing experiment; interested in how grazing affected algae at different parts of latitudinal gradient; put gently sloping barnacle covered rock in intertidal; but no limpets in Sweden; Talked to Tony Underwood on how to do this – small patches on shores, replicate shores, replicate areas in countries; in the north it's horrible and nice in south – but opposite if you're algae; did the initiations in winter and summer; Underwood selected random dates ; We also had different patches – winter and summer patches; kept out limpets, and controls; we created lots of magnetic anomalies – put lots of steel in the shore.

Devon came out more like Spain than the Isle of Man; sharp biogeographic boundary between north and south in Great Britain. In the north in the Isle of Man there was a lot of noise, everything quickly went to 100% *Fucus*; in southwest England a bit shorter than that; in south you've got a lot more trajectories as you go south but it didn't seem the Portuguese were sloppy with their stratification; grazing experiments, barnacle settlement; papers in MAPS and JEMBE; canopy removal experiments - especially *Ascophyllum*; it's easy for everyone to do – one big fairly blunt manipulation; or some fairly structured manipulation stuff

we don't have any decent grazers on this side – no patellid limpets – they increase grazing from protected to exposed shores, which is the opposite of what we have here; they think grazing intensity is temperature dominated; also diatoms were more light dominated; compare wax disks – any lag if these patterns exist; in plankton the difference between phytoplankton being light and temperature difference is bloom intensities, etc. John Raven was getting excited about it yesterday. Huge project in October – BIOCLIMA – the object is to look at effects of climate change on marine biodiversity using intertidal organisms as a model system – also as a way of unravelling the direct and indirect of effects of how these things work – didn't get funded, but good scientific marks – this is the sort of project that could have a counterpart

on the other side of the Atlantic. We have lots of battleground data for major species, now we want to resurvey it and understand some of the processes that drive change and some of the consequences – reconstruct past changes and get some idea to get how connected populations are sort of at the edge of their extremes – do they backfill? The way that Europe works is quite slow. I reckon if we get it would be about 2 years to start. It would be quite good to say there's an international dimension; it's €15-20million; probably 3 or 4 subprojects, more oceanography and archeologists, paleontology in the next one, probably 4 or 5 submodules, each will probably correspond to smaller scale projects – parallels on this side - we'll be working on this for the next few months – expression of interest in by June; if we get past that we'll be in a hotel room in Amsterdam writing the proposal in October. I've got copies of the BIOCLIMA proposal here with me.

Les Watling– What about the North Atlantic Oscillation??

Stephen Hawkins – There was a nice paper published on squid in the Royal Society – Southward did some nice work on barnacles – he's been recording *Semibalanus balanoides*, and *Chthamalus stellatus*; which he split half way through his time series; from 1950 to the late '80's Plymouth was on a boundary area – if we look at the last 100 years of data on Plymouth – cool period warmed from 1930's to 1950's – we have offshore plankton data, and some shore data from the 1950's. About 1962-3, there was a sudden shift - a lot of noise- '80's things started getting warm again, and the British government started to stop funding it just when it was getting interesting; measuring time vs. temperature.

Geoff Trussell – when did the government cut the temperature funding out?

Stephen Hawkins – that was nasty mature Thatcher

Geoff Trussell – Biscay is roughly in phase to Plymouth, and they have barnacle data in sync form 1950 to 1988; I have restarted from about 1997 – a bit of gap in the data, but Alan showed nice correlations between seawater temperature and recruitment. I've got funding to restart the plankton work; we have fish data going back to 1930; recorded every squid captured for scientific research for 1950 and 1993(????) when he retired. A squid paper came out relating North Atlantic oscillations to squid migrations – in warm years, they end up arriving off Plymouth 150 to 120 days earlier than in cold years; the Nobel Prize winning work on squid giant axons would never have gotten done if they hadn't come in the 1950's – warm years – found two year lag in Cs+Cu/Sb (where C's are *Chthamalus* and Sb is *Semibalanus balanoides*)

Les Watling – Context is important in a large multifactorial experiment. If you're trying to understand amphi-Atlantic relationships you might get a picture of one kind in a warm period, or a different picture in a cold year. I take an invert zoology class to the rocky intertidal in Maine very year, there's no quantitative data, but qualitatively, there are years when *Nucella* is everywhere. About two years ago there was a massive set of *Mytilus* from the top to bottom of the intertidal zone – you have these kinds of patterns you're putting on top of whatever you're trying to understand in ecological relationships – and need to take this into account.

Stephen Hawkins – We have photographs of the shore from 1980 that show the balance of fucoids on the rocky shores; some one else has this in UK. If you do two experiments

where you think you're getting a big effect, you might encounter noise – just need to be aware it's going to occur.

Chris Maggs – You need to know quite a lot of natural history

Summary by Ecology break off group

Geoff Trussell – I'm going to give a broad overview of what we think would be a good overall approach to take – a few things emerged immediately.

1. large scale coordinated simplicity – people tend to think more grandiose right off the bat – we need to keep things simple at the start – not just the questions but also experimental design. PISCO – west coast monitoring project, funded by the Packard Foundation - \$20 million; it's a coordinated network including the University of Washington, Oregon State, Santa Barbara, Santa Cruz, and Stanford; a large research program of latitudinally based studies.

Mark Bertness – They're mostly looking at linkages from the water column to the benthic community, bottom-up effects with latitude, recruitment. What facilitated this thing happening on the west coast compared to the east coast is the continuity of shores on the west coast – we have on the east coast a shift in habitats. Getting these large-scale projects funded is a really difficult thing; Bruce and Jane were trying to do this and getting frustrated before tapping in to the Packard Foundation and getting the money – this is sort of an escape hatch for them to do large scale stuff and not have to deal with NSF.

Jerry Hilbish – In the Pacific, they have a realistic ability to be able to couple nearshore to benthic systems – the California current is thought to drive the coastal stuff, upwelling systems.

Hawkins – northwestern Spain, and Portugal there are similar upwelling patterns

Cliff Cunningham – At the ocean science meeting – Chuck Greene talked about the tongue of cold water that came in the Gulf of Maine – there's definitely a coupling of the oceanographic processes – that's a lot more complicated on this coast?

Jerry Hilbish – I think what's different here is that in the California system as you go from the oceanographers up they believe they are developing mechanistic links between ENSO, atmospheric conditions, the California current system and regulation of recruitment – they want to be able to look at satellite images and tell how barnacle recruitment is going to occur.

Jon Witman – there are all sorts of oceanographic processes that can be observed from space

Jerry Hilbish – GLOBEC has the only realistic proposal

Sally Woodin- The benthic community was left out of GLOBEC ; we have not exploited the oceanographic stuff some of that is who the physical oceanographers are some have used meroplankton as signals on west coast (meroplankton – larval form of benthic adult form) and that's not true of the east coast.

Geoff Trussell - a study on sea cucumbers on the east coast – it's again just understudied...

Susan Brawley – all the new ocean buoy systems in the Gulf of Maine – I was hosting a guy from Dalhousie – there's a whole set in Nova Scotia; these buoys measure all sorts of variables: current direction, velocity, wind speed, temperature, etc. the fine scale picture

of the oceanography that we need as benthic ecologists on the east coast is going to be available.

Rick Wahle-GOMOOS – Gulf of Maine Ocean Observation System: gomoos.org – can tap into all info online; can look at SSTs all over the globe, although you can't get bottom temps and intermediate temps;

Cliff Cunningham – Pershing and Greene paper in your packets – there's a paper on this...

Les Watling – almost all this physical oceanography is near surface oceanography ; 3 water masses in the Gulf of Maine; bottom water is influencing almost all that happens in terms of benthic recruitment; there is a phenomenon that's happening – pandalid shrimp – went to NMFS a couple of years ago; they took casts on fall and spring surveys – can get bottom temps from survey reports – NAO phenomenon – bottom temperatures sit around 4-6, maybe 7°C over most of the distribution, but suddenly a few years ago, the temperature went up to 11°C – so all the pandalid shrimp are being compressed into areas where warm water doesn't reach; the problem with GOMOOS is that there are no sensors near the bottom; not just fisheries but a lot of organismal distributions that are ampho-Atlantic are subarctic cold boreal things but if the bottom waters heat up every once in a while – every 25 years or so based on the shrimp data – these shrimp could be indicators for the very high saline Gulf Stream-derived fauna in bottom of Gulf of Maine.

Sally Woodin – We need to remember that Gulf of Maine is a cool place but we decided to go south to Hatteras.

Emmett Duffy- Even if we don't have the information for deep benthos, the surface temperatures will be useful for the intertidal.

Jerry Hilbish – Still problem with inferring stuff from onshore or offshore buoys about the intertidal itself.

Susan Brawley – used buoy wind speed, wave velocity, light to predict fucoid recruitment on shore

Stephen Hawkins – satellite SST info, for a lot of biogeographic purposes is extremely useful – especially if compared with chlorophyll data; it's also getting physical oceanographers interested in things on the shelf; if the fisheries people tend to have a lot of information about physical forcing, etc. – perhaps that's a community you need to get in touch with ;

Jon Witman – one name – Dan Lynch at Dartmouth – does circulation in Gulf of Maine
Geoff Trussell – big names – Wally Broecker at Columbia – knows a lot about circulation

PISCO – what Stephen 's talking about has been done in North America, but in the Pacific;

Cliff Cunningham – but PISCO is not doing the experimental stuff

Stephen Hawkins – They did it first.

Geoff Trussell – broad areas we hope to address – pretty much predicated on the fact that species composition is more diverse in Europe than here at least in hard substrate stuff
The green crab has been in Europe longer than here; we can see differences in 50 years between Nova Scotia and Maine.

Community assembly rules between European and North American intertidal communities – important foundation species, important macroalgae, etc..... recruitment variation, differing in consumer pressure, mostly herbivorous grazing, also positive-

negative interactions – Mark’s done a lot of this on a broad latitudinal scale in the Gulf of Maine; and niche differentiation; more species in Europe – so we suspect narrower niches – these are the sorts of things we’d like to look at – something as simple as having small and large scale patches with and without grazers on both coasts, replicated, short and long term time scales;

Stephen Hawkins – it’s really easy to do isotope analysis – if you look at C and N isotope ratios, get some idea of how they’re being moved up food chains – can look at dietary overlap- this is fundable.

we kept trying to look for differences between species; they were doing the same thing – everything eats the same thing no matter what they use to eat it.

Geoff Trussell – you do see large differences around here – the *littorea* have a huge impact on the recruitment of *Ascophyllum* and *Fucus*, but...

Stephen Hawkins – same thing happens with patellids, assemblage of grazers – a whole bunch of gastropods and patellids, etc., with very different feeding mechanisms, but all doing very very similar things – the differences between *obtusata* ...

Geoff Trussell – *L. obtusata*’s role may be different

Stephen Hawkins – don’t think so; *L. mariae*...

Agnar Ingólfsson – the key here is that there is no *Patella* and no *L. littorea* in Iceland

Emmett Duffy – there’s not just one axis for niche differentiation- it’s more than just what they eat

Stephen Hawkins – it looks like a lot of species have come back together after speciating separately – accidentally just ended up being next to each other now – that weren’t next to each other 5,000 years ago – this is why I smile at niche differentiation

Jerry Hilbish – evidence?

Stephen Hawkins – probably refuged in different places during last ice age (ex. patellids) spreading at different rates out of different refuges;

Sally Woodin – we’ve been stressing consumer pressure and herbivores, but we really ought to deal with predators. One of the interesting thing in ssediments if you go down to Hatteras is that there’s an increase in digging predators that is very important in North America. There are many small fish and crabs on both sides of Atlantic, but Europe misses to some extent the impact of these digging predators.

Les Watling – Geerat Vermeij was saying yesterday that predatory snails seem to be very abundant on this side of the Atlantic – *Polynices* (?); etc – so the bivalves are under a much greater infaunal predatory pressure;

Rick Wahle – but fish predation is much greater on European side – something like 6 spp. of wrasse on the European side; whereas ...

Stephen Hawkins – but you need to keep in mind that Gulf of Maine is equivalent temperature wise to Scandinavia.

I think in some respects the rocky intertidal is quite tractable – we can think in the same way – schematics of who’s doing what to who, and say who is missing, who’s a recent invader – our rocky invaders – there are no top predators on our shore – oystercatchers, rats, etc.

Jerry Hilbish – south of Hatteras raccoons are great intertidal predator – if you detach a *Geukensia* and put it back, the raccoons have got it

Stephen Hawkins – the characteristics of the Gulf of Maine are similar to the west part of Scotland – you can find similar types of shores.

Susan Brawley – within northwest Atlantic - such great variations in how space is occupied – major fucoids reproductive almost 6 months out of sync; things will be very different on very short scale space – contrast in shore from east side to southwest side of Newfoundland – algal and invertebrate refugia are different; need to keep in mind that there is a great deal of very basic differences along the shores.

Jerry Hilbish – the same thing is true in the UK – north and south of Cornwall.

Sally Woodin – For terrestrial plants there have been very large studies that show that the number of species on islands change and is a function of habitat area; for sediments, I view one of the potential areas to exploit is a real contrast between sediments and rock – some of the forcing elements are potentially different between sediments and rock; for rock there are refugia south of Montauk Point, but very restricted in area compared to Europe; areal dynamics for rock and soft sediments – not sure this is very different – probably one of those fundamental rules we need to be thinking about – if you draw a line around rocky shore very crudely, how big is it?

Stephen Hawkins – from southern Britain down to __ the coast is all sand – 6-700km of sand on British east coast, no hard coast for quite a ways; the Netherlands coast has big sandy chunks of coast, but usually soft and hard intermittent

Sally Woodin – experimental manipulations - no one has directly done the comparison; lots of people use the other literature in their papers – but actually making that broad scale sweeping comparison is not done

Mark Bertness – there are some very conspicuous differences between European and North American salt marshes – most conspicuous – north of Portugal the marsh surface is not covered in fiddler crabs – so you don't have the top few centimeters being turned over – this has a massive effect on seedlings – secondary successions have a completely different flavor

Agnar Ingólfsson – if you're looking at rocky shores and want to compare North America to Europe, go to Iceland and northern half of Norway - don't go to Great Britain

Stephen Hawkins – there's a very sharp boundary zone – not the same boundary zone – but in the British Isles and Ireland there's a sharp transition of elements – but probably a bit less southern species than England has – British and Irish fauna has a lot of northern and southern elements

Jerry Hilbish – I find an idea of direct comparison confusing –

Stephen Hawkins – It seemed easy to compare the north of Europe with the south of Europe – there's a whole series of experiments you could do – like you were suggesting – *littorina*-fucoid interactions – similar kinds of experiments – I don't know how formally you could compare them – how long does it take after this manipulation for it to get back to normal, etc.

Chris Maggs – I think you've forgotten that we were supposed to be focussing on species that were shared

Emmett Duffy – I agree and with Jerry's point earlier – this is why I think a theme should be comparing systems that are as similar as we can find them but the western side is a depauperate subset of the eastern side's fauna – we can go pick areas that have the same physical conditions, we could do that within one ocean, too, but I think the interesting broad general questions that could also be informed by the evolutionary genetic stuff is what happens when you have this less diverse system - do you get stronger interactions over time?

Gary Rosenberg – I would question whether it's depauperate when you compare along the isotherms

Agnar Ingólfsson – definitely

Emmett Duffy – so it's possible to do the experiments, it seems

Les Watling - look at how invasive species get established – a number of species from amphipods to polychaetes have become established in European estuaries; but I don't know of any other species outside of green crabs that have become established in American estuaries – broad niche specialization that has to do with the trans-Atlantic exchange – Sally made the comment yesterday about whether there is a difference in species richness in soft sediment communities; also a lot of times we're talking about richness, but it's not necessarily the richness that's the issue but community structure that's the issue – dominance, diversity etc. may be the issues as to how these communities are put together – why have American estuarine species managed to escape lots of aliens?

Emmett Duffy – the dominant structure is important – but I would argue that that's sort of part of the response variable – a species can't be dominant if it's not there, so if you start with different species, they then accommodate one another

Jerry Hilbish – if you end up with very similar structure, that's interesting, if there are major differences, that's interesting, and can you account for differences?

Stephen Hawkins – *Littorina littorea* occurs in a variety of locations and conditions; looking at how general some of these general species are would be quite interesting ; also collapsing it and looking at crude things – ie. total grazing biomass, what the grazing pressure is, you could challenge different assemblages with the same task - give the same sort of test – do an experimental comparison – give an assemblage a job to do, and compare it.

Emmett Duffy- this ties right into the idea of ecosystem function and diversity –ie. does this ecosystem have higher grazing diversity and pressure?

Stephen Hawkins – where we have more species we can manipulate systems to be like North American stuff – eliminate *Patella*, etc.

John Wares – another spp. that might be good is *Idotea balthica*. It's competitively displaced in Europe , but found on *Fucus*; here it's found on *Chondrus*, *Ascophyllum*;

Stephen Hawkins – you start losing *Idotea* species as you go into Baltic

Rick Wahle – there are either species that are shared on both side, or sister spp. pairs – like *Homarus* – on one hand, they're very successful and abundant on the west side, and relatively rare or less abundant on the east side – these might lend themselves to manipulations more than others – allow us to see how these species interactions are affecting abundance, etc. ; only a handful of decapods on west side, a ton on the eastern side – a host of crabs, etc.

Jon Witman – horse mussel beds have a characteristic assemblage, many of same groups; community on European side is inhabited with more diverse fauna

After extended break for check-out

Susan Brawley – there is a key for algae of the northwest Atlantic; the easiest way to get a copy of this is to write to the UMass Dartmouth campus bookstore, the title is *Marine*

Algae from Long Island Sound to the Strait of Belle Isle. I think that the low intertidal zone is very different between the west and east Atlantic – *Fucus serratus* (dominant species in terms of biomass) was introduced into Northumberland Strait in the late 1800s and now has spread around Nova Scotia, Cape Breton – what's happening on shores that have been recently impacted by *Fucus serratus*... It would be interesting to pin down where *F. serratus* came from...

Jeanine Olsen – if we can get the sampling we can answer this question

Susan Brawley – we can look for additional species introduced with it, interactions

John Wares – how far down does *serratus* get?

Susan Brawley – you don't find it on the Maine shore

Cliff Cunningham – at the next meeting we're going to provide maps

Susan Brawley – It was introduced south of Prince Edward Island, and has moved up around Cape Breton, and we find it south down Nova Scotia to about Yarmouth; Prince Edward Island has an elevated water temperature.

Stephen Hawkins – It would be interesting to look at different bryozoan species pools that have colonized different habitat types – a very tractable type; in the UK it's difficult to distinguish between *littorina* ____ (?) and *mariae* – but *mariae* are associated with *F. serratus*, does a lot of damage;

Chris Maggs- I think I know how *Fucus serratus* got there – 50% of the ships from Ireland during the famine were wrecked in that area, and they had rocks as ballast

Susan Brawley – *Pelvetia* doesn't come over, *Fucus ceranoides* has to have nearly full salinity to reproduce; the reason it probably isn't found in the Baltic is a long low salinity gradient so doesn't have salinity gradient it needs to reproduce; *Fucus* project – come to better understanding of why we have what we have in western Atlantic and how it changes.....

Chris Maggs – invasive species – aliens are something we can't ignore – in Europe primarily the French and Belgians are blamed; French admitted it – they're legislating it – oysters can come in from Japan with no quarantine; *Codium fragile* – introduced from Japan to Atlantic – floats subsurface, and invariably festooned with other organisms; *Polysiphonia harveyi* I think was introduced with *Codium*; and these species will obscure our natural phylogeographic patterns – old invasives from Japan from early historical times and modern ones, in some cases we can look at genetic diversity...

Diarmaid Ó Foighil – oyster transport has been responsible for the transport of a whole bunch of ecosystems; the earliest allozyme work couldn't differentiate it, mtDNA do, no source population; suggests that cnidarian came along with it, cryptic introduction; temporal scale – most difficult to track;

Jon Witman – research opportunity – how does the success of the invaders depend on the diversity of the natural community?

Chris Maggs- *Codium fragile* apparently grows completely differently over here

Jon Witman – few people have answered that question about how biodiversity affects success of invasions

Jerry Hilbish – to know about this we need to know about invasion failures

Les Watling – Japanese cumacean was introduced in the Puget Sound area – when salmon fry come down the rivers in the Pacific northwest, they eat harpacticoid copepods; but cumaceans are bigger than copepods, now salmon fry have almost

completely changed their diet to cumaceans – if you have old introductions you may have trophic relationships that aren't what they were – you may think you're dealing with a well-established relationship

Chris Maggs – North American coast of North Atlantic has relatively few invasives – only a few countries

Stephen Hawkins – getting Japanese tunicates in harbors – tractable assemblages to deal with – can weed out Japanese tunicates on settling plates, and can look at effects of invasives; there are quite a few cryptic invasives; *Mercenaria* and *Mya* docks in Swansea – coal fired power station – shut off that and the invasives disappear; *Crepidula* are a dominant thing on estuaries in a section of England – same into East Anglia with the Virginian oyster in the 1800s formed complete reefs

Jerry Hilbish – it's a phenomenal pest species – depletes the plankton, forms reefs

Stephen Hawkins – *Crepidula* finished off the native oyster – those previous oyster beds are completely smothered with *Crepidula fornicata*

John Wares – certainly there are negative consequences to introductions, but there's the potential for some really interesting evolutionary interactions to be found – presumed human introduction of *Littorina littorea* into North America; along with a few other species, *Littorina littorea* was present but marooned up in Nova Scotia – during last glaciation 40,000 years ago; so if it isn't a human introduction; then what released it from Nova Scotia? Human shipping, or currents, or changes in lobster farming; not really clear why – it's a potentially interesting question about New England communities – all these species that were restricted – truly cryptic genetic invasion of all these lineages – begin mixing again with population maintained in southern refugia – minor coadaptation, maybe some really interesting community genetics; all of fossil and subfossil evidence – restricted to Nova Scotia, and then was released – fossil evidence from mainland Nova Scotia; middens – Micmac Indians AD 1300;

Susan Brawley – hard to imagine the size of the *Fucus serratus* –

Stephen Hawkins – any good raised beaches from last interglacial period; death assemblages?

Cliff Cunningham– Wagner 1977 – one beach – dated 38,000 years ago, amino acid racemization said it was older, included *L. littorea*, *M. edulis*;

John Wares – raised beach terrace – 2 feet below Norse construction

Les Watling– sounds like the case of a species that was moderately rare suddenly becoming common

John Wares - when you look at the fossil records- it's an individual or so – Labrador or Newfoundland coast –

Susan Brawley – how do you know the expansion wasn't due to introduced *Littorina littorea*?

John Wares- we don't know that, but there was tremendous genetic diversity throughout range of *Littorina littorea*; not that it's just European lineages that have been introduced from south; genetically not linked to European populations

Rowan Lockwood – how different is the shell midden from today's intertidal?

Geoff Trussell - Cope McClintock was pulling mud out of area that's a marsh – specimens were *Littorina irrorata* - but I thought they were *Littorina littorea*

Stephen Hawkins – European middens in northern Spain – big switch between *Littorina littorea* and then another species – *L. littorea* went through big growth;

Geoff Trussell – you could look at sediment core samples from the shelf – if you catch one from any time period, then you know – but they're rare
Les Watling– no *Littorina littorea* from the Pleistocene – 1950's papers – Lake Champlain – huge number of species that we see in northern Labrador down, obviously quite cool in lake Champlain, but no *Littorina littorea*;
Rowan Lockwood – Horace Richards, unfortunately his taxonomy is suspect...
Susan Brawley– not eating *Fucus* except when very, very small, but take off diatoms and fouling green algae; shores would be more diverse without *L. littorea*;
John Wares – turns it into a monoculture within a few seasons

Sally Woodin – sediments – 1. started out talking about effects of glacier sheets and where refugia are – for sediments – quite different than rock particularly on the European coast – no discontinuity of habitat in Europe as compared to Atlantic; natural rock as substrate disappears south of Montauk Point, Long Island; have all sorts of habitats that can be classified as hard substrate but can't be classified as rock;

2. Are there functional lackings in the way assemblages are constrained or structured in sediments versus rocks on the two sides of the Atlantic – there are a number of experimental people on both sides of Atlantic (didn't get list) Middleberg[?], Delmgren[?], various experimental manipulations on the coast of Europe; browsing predators are important in both; are there species interactions that determine interactions, sure. biogenic refugium – refugium created by an organism – ex. oyster reefs, clumps of worm tubes, seagrasses

soft and hard substrates are fundamentally different in some people's eyes – structure is vertical down into the sediment - you don't get that in rocks

3. digging predators – not as large or abundant on European coast, also drop out as you go north on the North American coast; ex. skates, rays, *Limulus*, etc.

Jeanine Olsen – what about birds?

Sally Woodin – birds are important in both cases – they cause changes in structure, wiping out of parts of assemblage; both migrants and natives

John Grant at Dalhousie – experimental data; I can give you a list...

4. large infaunal bivalves- *Mya*, *Mercenaria*, *Spisula*; ;

Stephen Hawkins - we have one big European bivalve

5. Are there equivalent deep infaunal organisms – ex. *Arenicola* – that change the ways things are processed through whole assemblage on both sides – yes functional equivalencies – what's missing on two sides???? Probably the big digging predators is the biggest; Are there other things that strike me as being restricted to particular groups – by different genera on different sides of Atlantic – not to say that that functional equivalence doesn't occur on both sides the Atlantic – it does – on ecological basis – large organisms that seem to be potentially missing, particularly predators? yeah – large things like halinyces(?) are missing; difference in terms of responses to glaciation; most of the people in the room don't work on sediments, though one could argue that cobble is basically a sediment of one kind; sediments bring a comparison, but also a complication; when you expand to 50 people, you need to decide whether you want to decide whether you want to expand to 50 people that do the same organisms, or work on organisms that are quite different – infaunal bivalves, arthropods, worms, etc.

Cliff Cunningham– I'm very interested – do you see the possibility of putting together the network of soft sediment people?

Sally Woodin– the biocomplexity grants – half Europeans, half Americans – we have gotten together once as a large group, three times as a small group, and again this fall – a grant I helped write with two others that interfaces between biology and geochemistry – if you work in sediments one of the paradigms is biogenically structured sediments – geochemists and biologists don't typically talk; so we're building structure to talk around; it's NSF sponsored; we need fossil data; just as you need more paleontological information; we need more geochemistry

Emmett Duffy – that could be a real strength of including the soft bottom people – if you link the ecosystem process, nutrient remineralization – a lot of people are very concerned about that – it's a good selling point in grant proposals –

Sally Woodin– a very recent change in thinking about carbon processing in habitats recently - a huge change in thinking; macrofauna and meiofauna pass articles through their guts and do something to it. Biogenic structuring of sediment – how do organisms move material – did it move laterally; or bring it subsurface, lost some of it down there, and then bring it back up to the surface – the latter changes dramatically the way that nutrients move around; carbon initiatives specifically about that kind of cycling

Les Watling– the degree of heterogeneity in sediments is much greater than on rocky shores; broader scale – evidence – I had a student who did a masters' and investigated 11 tidal flats along the Damariscotta – at low middle and high tidal levels – at one scale they were all very different, another scale – 3 groups based on position in river; heterogeneity of tidal flats is very high; there was no way to make a prediction about the assemblage of one tidal flat and apply it to another tidal flat – certainly functional groups remain the same – surface and subsurface feeders. In contrast to the rocky shores, you have human impact issues to deal with – almost every soft bottom community along the east coast is an altered community, so making comparisons along soft bottoms is going to be very difficult

Jerry Hilbish – this is a global problem; the eradication of the major fish fauna of the north Atlantic must have consequences for every ecosystem.

Cliff Cunningham– I'd like to have this wrapped up by noon – Geoff has agreed to be point man for further ecological coordination, Agnar will think about Icelandic experimental ecologists that would like to join network.

Gary Rosenberg – I'd like to propose an acronym –CORONA – Coordinated Research on the North Atlantic

Emmett Duffy – It sounds better than NAP

Cliff Cunningham – I tried to have name short enough not to need an acronym
Geerat's idea was North Atlantic Science Coordination And Research – NASCAR

Summer meeting wrap up – We'll arrive the 20th and leave the 23rd of August; have two days of meetings.

Stephen Hawkins – It's possible to have 2 or 3 other people from Europe as broad representation for groups in Europe – that could expand the network

Cliff Cunningham – It's good idea to have subnetworks; as for meeting size, Reykjavík would be relatively small, Roscoff would be as big as they could make;

Stephen Hawkins – We need some of the European money people.

Jeanine Olsen – I think they would not come in August, but it's important they have the invitation.

Les Watling– I'm a member of an ICES working group – predominantly soft sediment – if you can send me by email a summary I can put it into the record – it's a benthic ecology working group – it's good place to advertise – usually starts with summaries of interesting meetings and workshops.

Chris Maggs – There's a position open in marine biology at my university; also as for swapping specimens – if anyone wants any specimens – provided they are reasonable requests, I can do that.

Stephen Hawkins – I have a blatant plug for the Marine Biological Society – we're trying to drop UK from the title of the Marine Biological Association; have conferences; and members can come work at our laboratory; we're keen to get more American and European members.

Sally Woodin – Thank you for organizing this!

End.