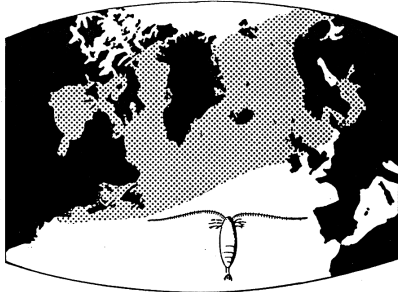


# *TASC Symposium Special*

*a combined TASC and ICES/GLOBEC Newsletter*



*Number 13, September 1999*



Number 5, September 1999

## **Read all about the Trans-Atlantic Study of *Calanus***

This Newsletter is largely taken up with personal views of the recent TASC Symposium, which took place in Tromsø in late August. Abstracts for the papers and posters can be found on the TASC website:

[calanus.nfh.uit.no/htmldocs/symposium99/](http://calanus.nfh.uit.no/htmldocs/symposium99/)

The Proceedings will be published in the ICES Journal of Marine Science in due course.

Much of the work carried out in the TASC programme was funded by national GLOBEC programmes and all of it fitted within the scope of work set out in the International GLOBEC Science and Implementation Plans (IGBP Reports 40 and 47). The relationship between TASC and the ICES/GLOBEC

programme has been a very close one. The aims of TASC and of the Cod and Climate Change programme are complementary, as the Introduction to the TASC Symposium by the Convenors made clear.

The TASC Symposium provided us with an enormous amount of new information about the population dynamics of *Calanus* and its relationship with its physical environment, prey and predators. A major challenge over the next few years is to bring this knowledge to bear on questions about marine ecosystem and fisheries assessment and

management. There are a number of ways in which ICES can continue to foster such integration, beginning with proposed Theme Sessions at next year's Annual Science Conference. During the final discussion session at the Symposium a request was presented asking ICES (see box) to continue to support the science arising from TASC.

An innovative element of the Symposium programme was an evening session featuring a talk on Biotechnology and Plankton (Adrianna Ianora) and one on Plankton and Fisheries: Connections in theory and practice (Jeff Runge). It was held in a local pub/restaurant, to which the public were invited.

The TASC Symposium was scientifically intense, because the topic was fairly narrow; the participants knew the background well and had collaborated on much of the work being described. It was also very enjoyable thanks to excellent preparation, warm hospitality and enough clear, sunny weather (between the showers) to appreciate how beautiful the area around Tromsø is.

### **A message from the TASC Symposium**

Results presented at the TASC Symposium represent a major contribution to the ICES scientific objective of understanding the physical, chemical and biological functioning of marine ecosystems. The Trans Atlantic Study of *Calanus* demonstrates the value of interdisciplinary, international marine science projects in carrying out very large scale research.

We would encourage ICES to continue to support the science arising from TASC and to help link it with studies of fisheries dynamics, through programmes such as GLOBEC.

This Newsletter also has information about other developments which are relevant to the ICES/GLOBEC programme and its future course.

## Themes from the Last TASC (ICES) Symposium at Tromsø

by Charlie Miller

First, hearty thanks to Kurt Tande, Elisabeth Halvorsen and all the folks at Tromsø for the generous, enjoyable Last TASC Symposium. They raised almost all the money, hired the buses and organized every detail. Recurring provision of food kept all our budgets under control and allowed us to enjoy each others company in many settings. The final party was a touch of Norwegian life, I think; nothing like it could have happened in, say, America. Bravo, Kurt, Elisabeth, beautifully done. Second, my personal thanks to NSF and NOAA in the U.S. for providing part of the money for general organization of the meeting, and thanks to all the sources in Europe, the EU MAST programme and especially Norway, for providing most of it. Third, thanks to all the speakers, especially the invited speakers, for the excellent talks, and thanks to all the poster makers for interesting tales well told. Both the science and the presentations were great.

I gave myself the next to last word at Tromsø on 27 August. The weather had turned lovely, and all of us had sat through as much *Calanus*-talk as could possibly be absorbed. We needed to get out under the sun. So, I would like to repeat the generalizations I saw arising, adding a few more. Not everybody's contribution is included, and many that were important to my thinking aren't mentioned specifically. Sorry, it was too much even to mention it all.

I. We agreed at the first TASC Workshop in Oslo, in March 1994, that understanding the diapause process in *Calanus finmarchicus* is a key to understanding its scheme of adaptations for life in the subpolar North Atlantic. We have come through Euro-TASC's Year of *Calanus* and the GLOBEC NW Atlantic program with at most modest new insight about this diapause. Nancy Marcus made a strong point in our discussion on the 27<sup>th</sup> of August, that it must be viewed as a *developmental* diapause, that many life activities including escape responses and even occasional

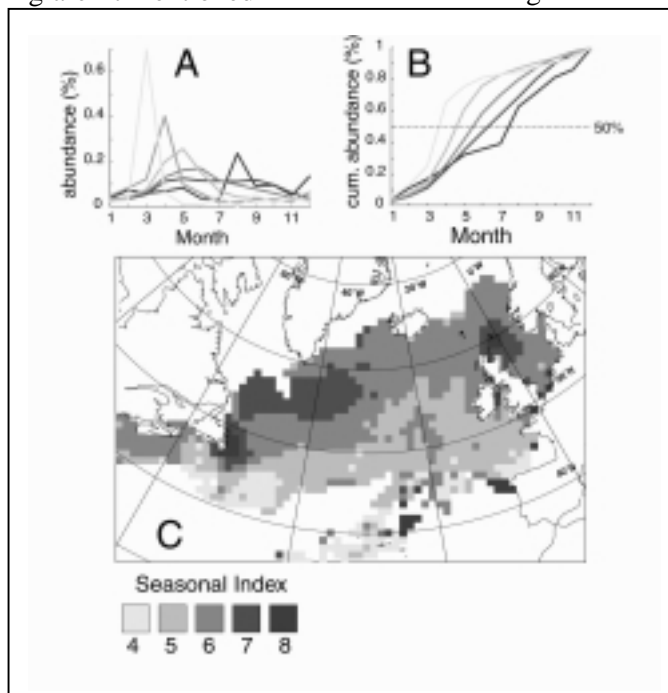
feeding continue. Unfortunately, the cues for onset of rest and arousal from rest remain obscure to us. We have found nothing to tell us with assurance what path a given C4 or C5 will take, whether it will mature immediately or enter diapause. We do have more certain data showing that at the end of G1, some C5 take each option. Ian McLaren suggested in a question period that G1 is standard while G2 is merely an epiphenomenon. Perhaps, but a very large part of the resting stock in many locations is produced from G2. The relative pay-off to strains resting after G1 and strains maturing to produce G2 probably varies from year-to-year. Immediate maturation of significant fractions of G2 also occurs in places, so perhaps diapause is the epiphenomenon.

In the Gulf of Maine stock it appears that all G1 move from C4 to C5, so that the C4 in the resting stock come from G2 (or possibly G3). We know that culture conditions, even mesocosms in very high latitudes (69.5N) push most individuals to mature, while the stock in the field mostly starts rest. Thus, we don't, yet, have particularly good culture conditions for study of diapause. We know from Benjamin Planque's work (nicely updated in his talk) with CPR data that different North Atlantic regions have different schedules of arousal and of population maxima (see figure). All of the reports from our recent observations confirmed those specific scheduling differences. There are strong clues in those regional differences, but we still have to figure out just what they mean. Aljona Arashkevich showed strong correlation of gonad and jaw

development at the end of the resting stage in the Norwegian Sea, a correlation not found by Jennifer Crain in the Gulf of Maine. The latter site probably differs in having so many individuals enter diapause despite substantial development of their gonads toward maturation. At least the observations agree to the extent that individuals developing new teeth are out of diapause and moving quickly to maturation.

We have far to go with

understanding this diapause, and we need a new approach.



II. Many symposium reports (Hirche, Melle and Ellertsen, Baier and Napp, ...) suggested that *matching* between *Calanus* life history timing and production cycles is between the spring bloom and progress of the copepod stock from N6 into the early copepodite stages. There are areas, such as the Gulf of St. Lawrence, in which egg production is delayed until the spring bloom, but those seem to be exceptional. Sites like Weather Station M in the Norwegian Sea have enough of some food to support egg production until the bloom enables development into and through the copepodite stages. Dian Gifford reported feeding observations showing that *Calanus* eating natural suspended matter prefer protozoans, and suggested that chlorophyll concentration is not a good measure of food availability. That can be true even if growth in the copepod population waits for the bloom as evaluated by us with chlorophyll, since the bloom is certainly a time of generally high production in the lowest trophic levels, including protozoans. While we can draw a crossbar through chlorophyll as the favored diet, it should be kept in mind that *Calanus* does eat phytoplankton in considerable quantities when it is available and as shown by Bettina Meyer-Harms, without much selection.

III. We saw good progress in explaining the relation of stock size to the North Atlantic Oscillation (variation in the barometric pressure difference between Iceland and Portugal). An elegant model by Mike Heath reiterated the ICOS/TASC result discussed in Denmark in January 1997: the North Sea stock of *C. finmarchicus*, which has been low during the recent spell of high NAO index, is controlled by the amount of resting stock moving south in Norwegian Sea deep water passing over the Iceland-Scotland ridge. With a high index, deep convection is less, southward flow over the ridge is less, advection of resting stock is less, so the early spring inoculum of females flowing into the North Sea is less. Fewer mothers, fewer young, less biomass of *C. finmarchicus*.

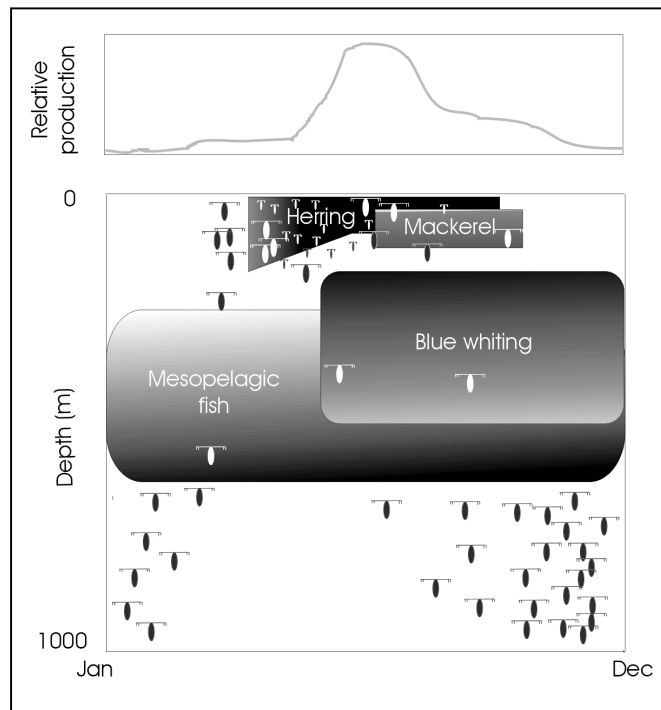
This appears to contrast with the Gulf of Maine situation, where interannual stock variation may be

under “bottom-up” control. David Mountain has found a strong, positive correlation between average, regional salinity and spring plankton biomass, which is dominated by *C. finmarchicus*. Salinity is high when water entering the gulf comes in at depth in the northeast channel from northwest Atlantic slope water. It is low when the gulf is supplied at the surface from the Nova Scotian shelf current. The deeper source carries more nutrients, the shallower one less. More nutrients allow more production and more *Calanus*, and vice versa. Dr. Mountain has sent his result, which appears as a note in this issue of *TASC Newsletter*. A symposium poster by Charles Greene and Andrew Pershing, however, suggests that stock variation near Georges Bank (from a regional CPR study) may be advectively controlled by inputs from the northeast (the abstract isn't explicit and I don't have the poster). Probably

we can find a test to eliminate one of these competing hypotheses. In any case, we are starting to understand how climate variability and changing ocean conditions affect plankton stocks, particularly *Calanus*. We have far to go. Benjamin Planque showed that time series of stock variation have several more patterns across the full range, patterns for which we need causal understanding.

IV. Many talks emphasized the controlling role of predation, of *mortality risk* as Dag Aksnes put it, as opposed to *mortality rate*.

Stein Kaartvedt calculated that the food requirements of the Norwegian Sea herring stock alone are about equal to the production of *C. finmarchicus*. Indeed, Emma Orlova and her PINRO colleagues showed us that those herring (and capelin, too) do eat *Calanus* as a principal dietary item. Stein suggested that the timing of life history events may well be driven by the timing of herring migrations, allowing at least some *Calanus* to be out of the herring's path (see figure). He also suggested that the great depth of the diapause stock in the eastern North Atlantic may have evolved because it puts resting *Calanus* below most midwater fish populations. He showed a case (with an unfortunate data gap, ouch) where depth of the resting population seems to have responded directly to predator distribution. These possibilities



are obvious, but hard to study and thus tempting to ignore. The mention of herring brought out a story at coffee of a *Calanus* patch under direct observation over Georges Bank that was eliminated in a few hours by a passing school of herring

Talks by Espen Bagøien and Ketil Eiane compared *Calanus* mortality patterns between fjords with differing predators, showing different mortality schedules over the development sequence. This was a partial test of the general notion that mortality risk drives evolution of life history and behavior patterns, and the notion passed. Trina Dale showed that subtle diel vertical migration (DVM) of late copepodite stages persists above the Arctic circle during continuous daylight, partly because low sun angles over some hours each day produce substantial darkening in the ocean, and thus a temporal refuge for near-surface activity. The migration pattern was subtle with included progressively deeper mean depths for later stages during both day and night and an apparent reverse migration of late stages nearshore. The trick will be to show how all those changes relate to interactions with specific predator stocks. Expanding our information base to entire pelagic communities from surface to near-bottom, so that the role of *mortality risk* in the evolution of phenology and behavior can be seen, is a daunting prospect.

V. According to Mark Ohman, there is progress in determining the age partitioning of mortality rates in *Calanus* populations. The strongest result is that mortality of eggs and early nauplii is extremely high compared to any rate for later stages. The estimate for the Georges Bank area is 27% die per day for a combined group from eggs through N2. Since these stages take a half week or so, the impact is enormous, greater than 3/4 of newly spawned eggs. The comparison comes to mind which Sabatini and Kiørboe gave us to species with egg-carrying females. *Calanus* has a careless, wasteful mode of

reproduction. Another peak of mortality comes at N6, completion of which involves a substantial metamorphosis. It will be exciting to see how well these estimates from vertical life tables will hold up when the basis of the calculation is presented fully. As I said at Tromsø, I remain a severe skeptic, but I will strive for an open mind.

VI. The very high frequency data shown us by Hans-Jürgen Hirche (and attributable to many others as well) show the extraordinary power of continuous station occupation for revealing oceanic ecology. At stations well out in major ocean gyres, population variability is dominated by biological processes, not advection. In other words, the same population levels and processes occur far enough upstream that they can be quantified in a time series from a single point; they are not obscured by an advective sequence of radically varying patches. The success of the work at Weather Station Mike suggests this approach should be extended. Since the Norwegian Sea and Irminger Sea are the key sites of convective ventilation of the world oceans (recall the symposium talk by Jan Backhaus), there are physical

as well as biological reasons to study them year-around for a number of years. Old proposals to establish deep-sea observatories (DSO's) by converting free-floating, drilling platforms should be dusted off. A joint North American-European project of this kind could produce the best possible studies of oceanic climate change and seasonal biotic cycling. Who will lead?

VII. Many talks at the symposium showed that we are ready for breakthroughs in the basic biology of *Calanus*. Penny Lindeque is leading the way in establishing the developmental genetics of *Calanus*, which will eventually provide clues to control of phenological events. Ann Bucklin showed the promise of

population genetics, that we have far to go but also the tools for rapid progress. As Ann showed, there is hope from molecular genetics for dating the

### Ian McLaren

Professor Emeritus, Biology Department  
Dalhousie University

These days I only attend conferences that are focused on one of my several narrower interests. Copepods are among these, although I might better be rated as a pseudo-*Calanus* researcher, and have not hitherto been involved in TASC. I think the Tromsø meeting was simply one of the best I have attended - wondrous setting, superb organization, and very substantial. I sensed a central issue throughout the meetings. There is still much to be learned from the tedious counting of plankton samples, specification of diets, and identification of genetic haplotypes. However, it seems to me that the future belongs to the new generation of physical oceanographers engaged in detailed modelling of water-mass movements. How much more must we biologists do so that they may tell us what we need to know about the distribution and abundance of *Calanus finmarchicus* - and accordingly about so much of importance to the natural and human communities of the North Atlantic? My own sense is that physics will explain most of the variance. We'll have a better idea when TASC completes its tasks.

“vicariance” events leading to the modern species of *Calanus*. There is reason to suppose her application of Cunningham’s molecular-distance to fossil age correspondence from hermit crabs could be misleading due to the lesser generation times of copepods, but new and better molecular clocks will test that. Xavier Irigoien, Jen Crain, and Nancy Marcus showed us a longer start on understanding the mechanism and evolutionary logic of male-to-female sex switching in *Calanus*. Particularly, it is now clear that it really is a switch of young in some sense genetically male to development as functional females. Xavier’s suggestion that completing development as males requires high quality, copious food is a great lead that will be followed up. Stig Skreslet and Rachel Shreeve showed some of the potential of fatty-acid analysis for revealing trophic links. The list is longer, some of the best studies must be left out here.

VIII. The posters and talks on August 27<sup>th</sup> about other species allowed an induction: populations of many, if not all, species of the *Calanus helgolandicus* species group are bound to continental shelves. Shinichi Uye showed it for *C. sinicus* on the Asian shelf; Jenny Huggett presented similar data for *C. aghulhensis* in the Aghulhas gyre and Marina Sabatini did the same for *C. australis* on the Patagonian shelf. There is reason to think stocks of *C. pacificus* are relatively neritic, and that *C. helgolandicus* itself isn’t very abundant across the center of the Atlantic. As always, systematic relationship predicts similarity in characters, behavior and ecology.

The TASC Symposium gave me the odd feeling of being with a big crowd of my best friends, odd because I was meeting about half of you for the first time. It comes I’m sure from getting together with so many of the few (given 6+ billion out there) folks who know and care about copepods in the ocean. Thank you all for coming so far and being so involved.

## **Impressions about observations and modelling**

**Ketil Eiane**

Judging from the presentations at the meeting it must be concluded that the TASC field programs have been very successful in accumulation of data describing the distribution and succession of *Calanus* populations in the Northern Atlantic Ocean.

Modelling has of course been an important component of the program right from the planning phase. The particle tracking techniques utilised by Heath, Slagstad and others and the increasing biological detail (of which Carlottis efforts may be a good example) implemented in such models do provide us with fairly powerful tool for approaching the extensive spatially resolved data sets.

However, as someone who tries to approach the mechanistic explanations behind the fluctuations of zooplankton populations over time, I am equally fascinated by what seems to me to be an increasing emphasis on quantifying the variability in the underlying, and driving, processes of the dynamics of populations. During this meeting we have been presented with more sound work relating to the quantification of fundamental biological processes than I can remember ever having seen before.

Campbell and Durbin, for instance gave a good impression of how developmental rate varies between individual organisms. Aksnes, Bagøyen, Kaartvedt and Ohman focused their talks on the importance of understanding predation and mortality and how the experienced mortality rates may vary considerably with space, time, and development. Irigoien & co-authors, and Marcus & co-authors presented work on how environmental forcing may affect the sex ratio in *Calanus*. Furthermore, Miller & co-authors provided us with insight in how the individual variability of content of storage lipid in stage five copepodites may affect the time of descent and thus presumably the phenology of the species.

Being presented with good evidence that the variability of all these essential parameters seem to vary by up to – or even more than - an order of magnitude, makes one wonder how one is going to be able to put together a theory of the driving forces behind the population dynamics of *Calanus*. It looks to me that if we are to try to implement all this variability into our models of the population dynamics we will have to reconsider much of the underlying assumptions we usually apply when thinking about these matters. I can for instance not see that classical population models, driven as they are by mean value estimates for forcing parameters as growth, developmental and mortality rates can possibly resolve the complexity of traits expressed by the *Calanus*.

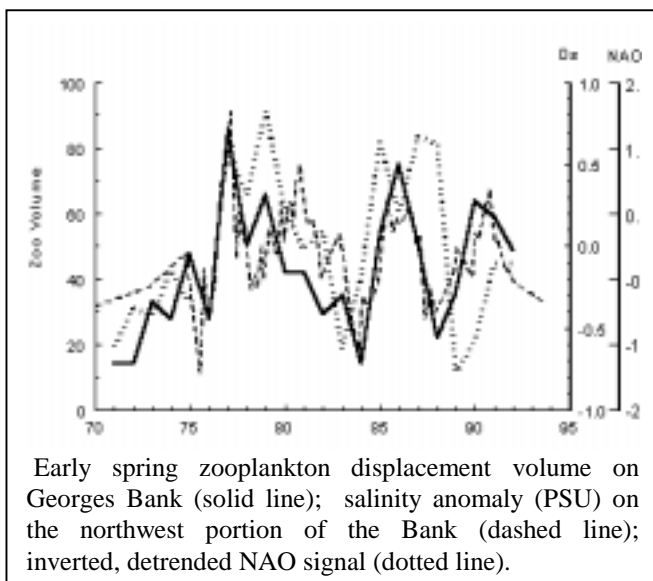
During the closing discussion Ted Durbin suggested the behaviour we observe might be the result of adaptation to environmental variability, rather than to a specific environmental regime. In my view this implies that what we observe when studying *Calanus*

may reflect a range of plasticity of traits that have proved robust to the environmental stochasticity experienced by this species over evolutionary time. By his adaptive model of phenology, Fiksen utilised precisely this concept and showed that populations may adapt to a variable and unpredictable modelling environment. His model ended in "optimal" solutions with high individual variability of traits. The associated cost when applying such modelling techniques however appears to be a substantial reduction in analytical power.

## Zooplankton Variability in the Northwest Atlantic

David Mountain

The Northeast Fisheries Science Center has monitored the water properties and zooplankton community on the northeast continental shelf of the United States for more than two decades. A simple, integrated measure of the zooplankton community abundance is provided by the displacement volume from standardized bongo net tows. The time series of displacement volume in the early spring on Georges Bank has been reported by Sherman et al. (1994), and is plotted in the figure (solid line). Also plotted in the figure is the anomaly in salinity for the waters on the northwest portion of the Bank (dashed line), calculated relative to a baseline established for the period 1978-1987 (from the MARMAP data set). Both series exhibit similar large amplitude, long-term variability. The maximum zooplankton value is more than seven times the minimum.



Early spring zooplankton displacement volume on Georges Bank (solid line); salinity anomaly (PSU) on the northwest portion of the Bank (dashed line); inverted, detrended NAO signal (dotted line).

Measurements from the U.S. GLOBEC program (Smith et al., 1999) show that the salinity variability in the Gulf of Maine/Georges Bank region is due in

large part to variation in the relative contribution of the two main sources of water to the region – cool, low salinity water that enters the Gulf of Maine in the surface layer around Cape Sable, Nova Scotia (Scotian Shelf Water) and warm, higher salinity Slope Water that enters the Gulf at depth through the Northeast Channel.

**\*\*ICES CRR 234 PUBLISHED SEPT 99\*\***  
**Ocean Climate of the NW Atlantic during the 1960's and 70's and consequences for Gadoid Populations 85 pp**  
buy it from the ICES web site

While the similarity of the time series in the figure does not provide any understanding of a relationship between the physics and the biology, it does suggest that there is a relationship to be understood. The salinity variability is likely a proxy for some other mechanism. Changes in the source waters could involve changes in the plankton populations and nutrient levels brought into the Gulf of Maine system, and changes in salinity could influence winter convective mixing and circulation within the Gulf. Georges Bank is sufficiently distant in travel time from the entry of the waters into the Gulf system (> 6 months on average), that simple advection of more/less zooplankton from outside the region seems an unlikely explanation. Instead, some bio-physical and tropho-dynamic interaction within the Gulf of Maine/Georges Bank system seems to be required.

The NAO index also bears resemblance to the zooplankton (and salinity) variability, once the increasing trend over the last 25 years has been removed and the residual series is inverted (dotted line in figure). An important point of the NAO relationship is the absence of a time lag, suggesting that large-scale propagation/advection of the physics or the biology (e.g., from the Labrador Sea) is not involved. This points, instead, to a local response within the Gulf of Maine/Georges Bank system to atmospheric variability.

Sherman, K., J. Green, A. Solow, S. Murawski, J. Kane, J. Jossi and W. Smith. 1994. Zooplankton prey field variability during collapse and recovery of pelagic fish in the northeast shelf ecosystem. ICES C.M. 1994/L:18.

Smith, P.C., R.W. Houghton, R.G. Fairbanks and D.G. Mountain. 1999. Interannual variability of boundary fluxes and water mass properties in the Gulf of Maine and on Georges Bank: 1993-1997. Deep Sea Research (in press).

## Important Milestones at the Conference

### Kurt Tande

To mirror the highlights of the meeting in a balanced way is not easy and straightforward, since there was a very high quality on talks and posters all the way through at the meeting. Since there is a more detailed summing up in other articles in this issue, I will have the freedom to give you my personal thoughts.

TASC has developed evidence for a species adapted to an oceanic habitat, with a life cycle perfectly evolved to fit to the deep water setting in the North Atlantic. The shelves around may not be important for the species, but have, in a historic perspective, received a lot of attention, due to the proximity of the research laboratories. Thus our understanding of its ecology has been gained through research on the shelves and not so much in its proper habitat. This may have hampered our progress in understanding its ecology.

TASC has convinced me that the main strategy for *Calanus finmarchicus* is a univoltine generation pattern, with a subsidiary less quantitative important one in the summer. Only approximately 10-15 per cent of the G<sub>1</sub> does continue into G<sub>2</sub> in summer (July-August). This process is linked to the uppermost 200 m of the water column, concomitant with descend of the majority of the lipid rich individuals to deep waters. The strategy is centred on early spawning in order to ensure that the developing cohort (as CI-CIV) matches in time with the spring bloom (May) in oceanic water. This differs from the shelves where the spring bloom comes earlier in the season (April) forcing the recruiting copepodids to coincide in time more with the culmination of the spring bloom. These two different settings provide high variability in recruitment and mortality schedules, processes which still remains to be understood.

The Symposium identified new research avenues, in particular new methodology relevant for zooplankton ecology in a broader context. New technology platforms, such as OPC and VPR, have strong potential for future measurement of plankton on mesoscale and large scales, and provide possibilities to estimate population dynamic processes at a new level. Models have been put forward to map water masses in 3D, calculate rates of growth and mortality, which enable us to understand the links between physical oceanography, food environment and productivity of copepods in a more appropriate way. The need to bring in chemistry and cell biology in order to understand the mechanisms for variability

in copepod egg hatching and nauplii recruitment was clearly demonstrated, and will soon be part of our working tools in marine plankton ecology.

By analysing data from the Continuous Plankton Recorder (CPR), long-term trends in the copepod community have been identified. A dramatic decline in the abundance of important copepod species, and in particular *Calanus finmarchicus*, occurred from 1958 to 1997. The rate of decline was particularly high after 1980 and *Calanus* declined by 60 % in abundance, while the other copepod species declined by about 30 %. This decline of copepod abundance in the CPR study region is amazing, and although other areas in these three gyres may not demonstrate exactly a similar pattern, it is a challenge for the future to actually attack the possible mechanisms in operation. TASC managed only to set the stage.

## Second IGBP Congress

### Towards a Synthesis of a Decade of Global Change Research

#### Keith Brander

The Congress, attended by over 300 participants, took place in Shonan Village, Japan from 7-13 May 1999. It was the first time that GLOBEC had taken a full part in an IGBP Congress. I was invited to attend the International GLOBEC SSC meetings and to make a presentation during a synthesis session on "Food and fibre supply in terrestrial and marine ecosystems".

For those not familiar with the International Geosphere Biosphere Programme the best starting point is probably their publication "Global Change: Reducing Uncertainties" (ISBN 91-630-1086-0) although it is somewhat out of date. The first ICES/GLOBEC Newsletter carried a schematic showing the IGBP programme elements, and is available at:

[www.ices.dk/globec/newslet/news1/news1all.html](http://www.ices.dk/globec/newslet/news1/news1all.html)

I will not attempt to describe or summarise the huge range of science presented at the meeting but will report on a few items which are relevant to ICES. An overview of the Congress and of the main themes can be found in the IGBP Newsletter 38: [www.igbp.kva.se/NewsLetter38.pdf](http://www.igbp.kva.se/NewsLetter38.pdf)

IGBP is becoming increasingly involved in the application of its science and with integration across the existing programme elements (terrestrial, atmospheric, marine, etc). Some of the integration can occur most effectively at the regional scale.

For example there was an excellent regional presentation on Southern Africa (south of the equator), which described atmospheric controls by anticyclonic curvature of the wind field, transport of aerosols and trace gases, interaction between the haze layer generated and terrestrial and marine ecosystems, aeolian nutrient transport, changes in vegetation, land use and cover, water cycle and finally a holistic overview of the system.

Regional bodies such as ICES obviously play a leading role in such scientific integration and also have a role as organisational nodes for the multiplicity of international programmes, project and activities; ICES does this to some extent, by acting as a kind of "one stop shop" linking marine scientists in the North Atlantic countries to many international programmes. The Mini-Symposium at the 1999 ICES Annual Science Conference on "Plans for Major International Programmes in the North Atlantic Region over the Next Decade: Should ICES Be Involved?" is co-chaired by Dr Mike Reeve (NSF) and Prof. Peter Liss (UEA), former Chairman of IGBP, and will be an opportunity to discuss these issues.

The application of science usually requires regional cooperation and integration, although most decisions about management are taken at national level. IGBP perceives the need for stronger links with "Application Oriented Organisations" such as ICES, which have many years of experience of the interface between science and management.

Another example of integration across IGBP programme elements is described by Chris Crossland in IGBP Newsletter 38 on "Courting Coastal Collaboration" between LOICZ (Land Ocean Interactions in the Coastal Zone) and GLOBEC. Two joint task groups were established dealing with 1) teleconnections (and societal relevance) and 2) typology approaches. The latter will link activities in areas of typology and database development and applications, combining GLOBEC databases and LOICZ methodologies and approaches. These initiatives should see a closer blending of cause-and-effect relationships between coastal changes and fisheries resources, and improved ways to assess, scale and represent the information.

I was very impressed by a lecture by John Schellnhuber of the Potsdam Institute for Climate Impact Research in which he talked about the emerging science of Earth System Analysis and I would highly recommend his book with the same title (edited by H.J. Schellnhuber, V.Wenzel ISBN: 3540580174). In spite of the sales blurb, [*the authors create a paradigm for this transdisciplinary science - the co-evolution of nature and anthroposphere within a geo-cybernetic continuum of processes - based on a structured manifold of partial paradigms with their specific ranges*] this is not a completely incomprehensible work. It contains many (for me) new ways of viewing the complicated systems (including fisheries) on which we depend. It is clearly written, beautifully presented and carries the resonance of Schellnhuber's style and wit.

## **ICES/GLOBEC Working Group on Cod and Climate Change**

**Chair: Dr. K. Drinkwater, Canada**

It is proposed that the WG will meet in Dartmouth, Nova Scotia, Canada from May 11-12, 2000 to:

- a) review and evaluate work carried out to date on Cod and Climate Change by the workshops (Environmental Data in Stock Assessment, Decadal-Scale Ocean Climate Fluctuations, Backward Facing III and IV) and subsequent follow up activities;
- b) produce a short synthesis of the major findings from the programme and prepare a plan for a more complete synthesis of results;
- c) plan and prepare workshops over the next two years on Applying Environmental Data in Stock Assessments (possibly examining the transport of cod larvae between Iceland and West Greenland as a specific example) and on Long-Term Climate Change and Prediction;
- d) foster interaction with the Working Groups on Comprehensive Fishery Evaluation, Zooplankton Ecology, Recruitment Processes and Shelf Seas Oceanography regarding data requirements and joint activities.

### **Continuation and future funding for the ICES/GLOBEC office**

These issues will be reviewed and discussed at the Annual Science Conference in Stockholm. A report by the Steering Group for the office (ICES CM 1999/C:12) presents the views of current and past funding agencies and makes a recommendation concerning future organisation and funding.

## **Workshop on the Dynamics of Growth in Cod**

**Co-convenors: N. Andersen (Denmark), G.  
Ottersen (Norway), D. Swain (Canada)**

The following is an abridged version of the announcement about a proposed workshop: The workshop, proposed by the ICES/GLOBEC Working Group on Cod and Climate Change will be held in Dartmouth, Nova Scotia, Canada on May 8-10, 2000, and will be followed by the annual meeting of the Working Group on May 11-12. The terms of reference for the workshop are:

- a) to develop models of growth in order to improve the quality of stock forecasting;
- b) to describe major sources of uncertainty in further improving the prediction of growth rate and advise on further studies to reduce the uncertainty;
- c) to assess the contribution of growth rate variability to the observed variability in stock biomass and stock forecasts; and
- d) to recommend standard methods for comparing growth rates.

Growth rate varies widely among cod stocks. Large changes in growth rate have also been observed within many cod stocks. This variation in growth rate has important consequences for the productivity of these stocks. Variation in growth rate may reflect effects of temperature change, density dependence (i.e., changes in per capita prey availability due to variation in prey or cod abundance), changes in maturation schedules, changes in size-selective fishing mortality, or genetic variation. An understanding of the causes of variation in growth rate among and within cod stocks may lead to improved forecasts of stock biomass and productivity, and is required to assess the likely impacts of climate change on cod populations.

To facilitate the exchange of data and ideas, a Discussion/Bulletin Board for the workshop is being maintained at the ICES/GLOBEC Internet site ([www.ices.dk/globec/globec.htm](http://www.ices.dk/globec/globec.htm)). Topics for consideration at the workshop include:

1. Tests of explanatory variables for interannual variation in growth within cod stocks. Ideally the same suite of explanatory variables should be tested for all stocks.
2. Single growth model covering all stocks. Data sets to allow comparisons between all cod stocks

(23 at the last count) are being assembled on the web site

3. Estimation of “ambient” temperature. What is the best measure of temperature for use in growth models and tests? How well does interannual or geographic variation in “environmental” temperature reflect variation in the temperatures occupied by cod (i.e., “ambient” temperature, or “cod-weighted” temperature)? How should seasonal variation in the temperature distribution of cod be incorporated in growth models and tests, especially when feeding rates vary seasonally (i.e., there is a distinct feeding season)? How well do snapshots of cod temperature distribution from research surveys reflect the temperature distributions indicated by data-storage tags or suggested by isotopic analyses of otoliths?
4. Effects of size-selective fishing mortality and backcalculation studies. Effects of size-selective fishing on apparent variation in growth rate have rarely been considered. Recent backcalculation studies have indicated a strong effect of variation in size-selectivity by the fishery on variation in size-at-age for this stock.
5. Effects of variation in growth on stock biomass. Does variation in growth rate contribute strongly to variability in stock biomass and production? Can forecasts of stock biomass be improved by incorporating predicted growth rates? How well can growth rate be forecast?
6. Environmental and density-dependent influence on growth during the early pelagic life stages and the consequences of this on later abundance and size. Is early growth density-dependent and/or environmentally determined? Is size as pelagic 0-group an indicator of size at later stages? Is size as pelagic 0-group an indicator of abundance at later stages?
7. Bioenergetic models. Developing and calibrating models for cod; using these models to test whether cod appear to be food or temperature limited in the wild. Lab studies on cod growth. Interaction between temperature and ration; optimal temperatures for growth at different rations. How do lab results relate to field observations (e.g., on temperature effects)?
8. Genetic variation of growth. To what extent does genetic variation for growth occur among cod populations? Have there been genetic responses to size-selective fishing?

## **Proposed Theme Sessions for the 2000 ICES ASC**

### **Fish-Zooplankton Linkages**

The ICES/GLOBEC Working Group on Cod and Climate Change proposes a Theme Session on the Fish-Zooplankton Linkages at the 2000 ICES Annual Science Conference under the co-chairmanship of J Runge (Canada) and K Tande (Norway).

The objective is to improve our understanding of the relative importance of zooplankton as a key component of the marine ecosystem and in determining the variability in fish abundance and production, in particular.

Justification: During recent years many regional and national GLOBEC programs have focused upon zooplankton dynamics. Efforts are required to establish quantitative links between zooplankton, and fish in order to make full use from the fisheries perspective of the information gathered within these GLOBEC programs. Equally important are establishment of the diet of cod larvae, including the main zooplankton species eaten and the relationship between larval condition and survival with possible physical-induced changes in diet.

### **Environmental Effects on Plankton Communities**

Co-Conveners: K. Drinkwater, (Canada), P. Wiebe (USA)

Considerable research is being conducted in ICES member countries, on the interannual and longer-time scale variability in plankton species. Many of these indicate significant climatic influences on these species. This theme session will provide a forum to review and synthesize these findings. This is particularly important in view of the planned effort under the different modules of GOOS.

### **Spatial and temporal patterns in recruitment processes**

Co-Conveners: E. Houde (USA), P. Pepin (Canada), P. Munk (Denmark)

The processes leading to recruitment of fish and shellfish are temporally and spatially variable. Hydrography, trophic relationships, and reduced stock abundance (due to fishing) all act and interact to determine recruitment abundances, distributions, and trends therein, in space and time. Our understanding of these processes is limited, but critical to evaluate dynamics of stocks and their management. The theme session will seek contributions to address issues of patterns, trends, and scale in recruitment with respect to hydrography, predator-prey and stock abundance as well as other climatic or environmental factors. The development of new methodological approaches to the study of spatial-temporal variability (e.g., remote-sensing, spatial statistics, data visualisation methods) are among the topics for inclusion. The relationships between settlement, recruitment, and habitat suitability are also subjects to be addressed under this theme.

## **Further information about ICES reports and events**

You can obtain copies of most recent ICES/GLOBEC related reports from [www.ices.dk/reports/occ/](http://www.ices.dk/reports/occ/)

The week prior to the ICES ASC is not a good time to be compiling information about dates of meetings and terms of reference, since they will only be discussed, amended and approved during the meeting. You should consult the ICES Web Pages ([www.ices.dk](http://www.ices.dk)) for the latest information. Here is the latest proposal on meetings:

April 2000	Working Group on Zooplankton Ecology	Hawaii <a href="http://www.ices.dk/committe/occ/wgze.htm">www.ices.dk/committe/occ/wgze.htm</a>
May 8-10	Workshop on Cod Growth	Halifax <a href="http://www.ices.dk/globec/wkgrowth.htm">www.ices.dk/globec/wkgrowth.htm</a>
May 11-12	Cod and Climate Change Working Group	Halifax <a href="http://www.ices.dk/globec/wgccc.htm">www.ices.dk/globec/wgccc.htm</a>

If you are interested in contributing to or taking part in one or more of the above Working Groups and Workshops, please get in touch with the (ICES/GLOBEC Coordinator) Dr K. Brander ([keith@ices.dk](mailto:keith@ices.dk)) for further details. You should note that attendance is restricted and that participants pay their own expenses.