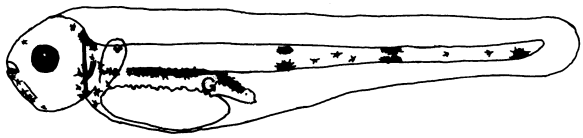
STAGES



Newsletter of the AFS Early Life History Section

Volume 18, Number 3 Jan 1998

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Abstract Deadlines:

ASIH: March 13
to be held July 13-16, 1998 on the campus of the University of Guelph, Guelph, Ont

22ndLarval Fish Conference - May 1
to be held July 9-13 on the campus of the University of Michigan. see Page 10.

PRESIDENT'S MESSAGE

The 22nd Annual Larval Fish Conference (LFC) will be held this year on 9-13 July in Ann Arbor, MI, under the stewardship of local host Ed Rutherford. I am especially looking forward to the conference this year, as it is the first year in several that the LFC will not meet in conjunction with ASIH's annual gathering. I enjoy the focus on tiny fishes that meeting separately allows, and this year's program will not disappoint. Nevertheless, I want to take this opportunity to personally thank ASIH for allowing us to share the stage, and to encourage joint meetings in the future, perhaps every couple of years or so.

There are two important items of section business that we must address in the coming months. The first is the election of new officers. Nominations for President-Elect, Secretary-Elect and Regional Representatives should be sent to Jim Cowan, c/o Dauphin Island Sea Lab, P.O. Box 369-370, Dauphin Island, AL 36528 or by e-mail to jcowan@jaguar1.usouthal.edu. Nominations will be accepted through 15 April, 1998. Remember that nominees must be members of the ELHS and the AFS, and that officers can be re-elected. In addition, past officers can be nominated to serve again in any office, including the one that he/she formerly held.

The second concerns section governance. A sub-committee of the Section's EXCOM met at the Dauphin Island Sea Lab on February 20-22 to prepare a draft of the Standing Rules to be considered for approval by ELHS members at the business meeting in Ann Arbor. Standing Rules supplement the section's by-laws and formerly establish duties of officers and committee responsibilities. After comment from the full EXCOM, an approval draft of the Standing Rules will be made available to section members in advance of the business meeting,

22nd Annual Larval Fish Conference
July 9 - July 13, 1998 — Ann Arbor, MI
See page 10 for meeting details.

Masthead

perhaps in the next issue of Stage's, or as part of the LFC registration materials in Ann Arbor.

Finally, I want to take a minute to personally congratulate Ed Houde for his receipt of the Beverton Medal, given this past summer by the Fisheries Society of the British Isles, for outstanding contributions to studies of larval fish ecology and fisheries science. Ed's work has inspired and challenged us all, and has provided more than inspiration to those whom have been lucky enough to work closely with him. Fortunately, I count myself among the latter group; thus, while I admittedly am not without bias, I cannot think of a more deserving Beverton Medalist.

Jim Cowan

NEWS FROM THE REGIONS

Northeast Region - Ben Letcher, Population Ecology Section Leader, National Biological Service, S. O. Conte Anadromous Fish Research Center, One Migratory Way, P. O. Box 796, Turner Falls, MA 01376. (Phone: (413) 863-8995 ext. 34, E-mail: bletcher@external.umass.edu).

New Brunswick Coop Fish and Wildlife Research Unit-University of New Brunswick.

E*arly life history studies: Winter habitat and survival of YOY smallmouth bass in New Brunswick*

The smallmouth bass in New Brunswick is at the northern extent of the species range. Harsh winter conditions of this north temperate region limit the survival of young-of-the-year (YOY) through their first winter and therefore may govern regional population strength and viability.

Smallmouth bass typically over winter in a semi-torpid "hibernating" state, relying heavily on stored energy reserves to maintain minimal metabolic activity. Theory in part suggests that for YOY these energy reserves are in short supply (in relation to their higher rate specific metabolism), and consequently, starvation may explain the substantial winter mortality evident in seasonal collection surveys.

As part of our studies of NB smallmouth bass, we are evaluating the importance of YOY body condition and wintering

(Continued on page 4)

January 1998

Location http://www.eos.ubc.ca/afs_early

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Welcome to the

EARLY LIFE HISTORY SECTION (ELHS)

Of the American Fisheries Society

Welcome to our new home page! The purpose of these pages is to provide a rapid means to disseminate information to ELHS members and anyone looking for information about the ELHS section. As such, these pages will complement Stages, our official newsletter

We are currently testing an online version of Stages. Follow the ELHS Newsletter link in the Directory on the left of the screen

Although still under construction, we hope you will find these pages informative in their present form. If you encounter any problem in viewing this page, please let me know (include the size and resolution of the monitor in your message).

Some of the items currently under consideration for inclusion in these pages are a searchable (and updateable) membership list, downloadable (pdf) versions of older issues of Stages, and an archive of larval fish images and drawings. If you have any comments on these or other elements of these pages, or if you have an ELHS web-page you would like to see linked under the "Other Links" section, please email me.

John Dower
ELHS Webmaster

Visit to new ELHS Homepage!!
The site contains full details of meetings, a membership directory and back issues of Stages!!!

(Continued from page 2)

habitat in their quest for winter survival. To do so, seasonal habitat requirements are surveyed by direct underwater observation and trapping, and natural field experiments are used to test YOY winter survival among variable winter habitat treatments.

The effects of land use on early life history stages of brook trout (Salvelinus fontinalis) on Prince Edward Island.

W. Scott MacNeill and R. Allen Curry. have been investigating the early life history of brook trout on Prince Edward Island (PEI). PEI's recreational fisheries resources have been significantly degraded by the construction of dams, pollution from agricultural runoff, and soil erosion from land cultivation. Erosion is considered the most serious environmental problem facing PEI streams. We are examining the effects of land use practices on the early life history stages of brook trout (*Salvelinus fontinalis*). We observed a lower density of juveniles in watersheds with a greater proportion of land in agriculture (80% vs. 60%). Survival to emergence increased as the proportion of agricultural land decreased (0-20% vs. 50-65%), except in areas of high ground water discharge.

The large agricultural industry on Prince Edward Island (PEI) has created serious problems for the conservation of its natural resources. Freshwater fisheries resources dependent on the maintenance of natural conditions have been significantly degraded by the construction of dams, pollution from agricultural runoff , and soil erosion from land cultivation

This study examines the impacts of sediment on brook trout reproductive success, the mechanisms of the impacts, and potential interim remedial actions to mitigate the effects of excess stream sedimentation.

All field experiments were conducted on two Prince Edward Island watersheds (the West and the Wilmot Rivers). The Wilmot River is located in an area with intensive agriculture (heavy siltation) and the West River has a more forested drainage basin (little siltation). Potential spawning sites were identified by the presence of suitable spawning gravel, groundwater seepages, and newly emerged fry.

Trout redds were located and mapped by foot surveys, and identified for: 1) groundwater discharge and chemistry; 2) temporal changes in substrate composition during incubation; 3) survival from egg to alevin emergence from the gravel.

It is anticipated that we will determine the overall impacts of sediment on brook trout populations in PEI streams and the relative importance of spawning habitat sedimentation and juvenile rearing habitat sedimentation in limiting brook trout populations. In addition, we will determine the extent to which spawning in spring-influenced areas reduces the impact of sedimentation on brook trout reproductive success, or whether insufficient availability of such areas force brook trout to spawn in poor areas where reproductive success is lower.

For more information on any of the work described above, please contact:

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Biological Sciences, Rutgers University

Judith Weis's lab at Rutgers has been studying effects of embryonic and larval exposures to toxicants on larval behavior. Tong Zhou finished her Ph.D. thesis last June examining the development of feeding and anti-predator behavior in mummichogs and looking at the effects of methylmercury exposures during embryonic and/or larval stages on the behavior. She also compared effects on populations from clean vs. polluted environments. Some population differences can be attributed to the environmental history of the fish, but other differences may be inherent. She has also anlayzed the neurotransmitters in control vs. treated larvae and found differences which may be associated with the behavioral effects. Papers are in press in "Aquatic Toxicology" and others are in the process of being

submitted and/or revised.

Jennifer Samson has been looking at behavior in zebra danio larvae after embryonic exposures to methylmercury. It is clear that successful hatch after low-dose exposure does not mean that everything is all right. The feeding and/or predator avoidance behavior of larvae may be severely compromised even though they hatched out at the appropriate time and look totally normal.

For more information, please contact:

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University of Rhode Island, Graduate School of Oceanography

Grace Klein-MacPhee and Barbara Sullivan are conducting experiments on predation rates of the planktonic hydroid, *Clytia gracilis* on cod and haddock in the MERL mesocosms. This hydroid has been found in large numbers on Georges Bank overlapping spatially and temporally with cod and haddock larvae. Preliminary small scale experiments showed that hydroids were capable of capturing and ingesting cod larvae and had the potential to be important predators and/or competitors of cod and haddock on Georges Bank. Grace and Barbara are continuing large scale mesocosm experiments on the effects of turbulence on predation rates of the hydroids on cod larvae. This is part of the predation component of the Georges Bank GLOBEC studies which are designed in part to address the question of how global climate change might effect the distribution abundance and production of animals in the sea. Zooplankton and ichthyoplankton are the focus because they form links between the phytoplankton and higher trophic levels. Research efforts are focused on the dynamics of zooplankton and larval fish populations on Georges Bank in order to yield new insights into the coupling between physical and biological rocesses.

The group presented papers at the 1997 ICES Annual Science Conference in Baltimore Maryland September 25-October 3 (See Sept 1997 Stages for Meeting Review). The paper presented by Grace Klein-MacPhee was entitled "Mortality of larval cod related to predation by the hydroid, *Clytia gracilis*, on Georges Bank" . Co-authors were B.K. Sullivan, D. Van Keuran, E. Horgan and E. Klos. A companion paper focusing on field data of hydroids, cod and haddock was presented by Barbara Sullivan. The paper was entitled "Abundance and distribution of planktonic hydroids with respect to larval fish and hydrographic features on Georges Bank". Co-authors were J. Williams, D. Van Keuran, R.G. Lough and J. Manning.

Grace Klein-MacPhee is conducting research on the tautog, *Tautoga onitus*, as a new species for aquaculture. She has been looking at larval survival and growth on different artificial diets, the effects of different anesthetics on larvae and production of eggs by a captive broodstock. An undergraduate Coastal Fellow, Richard Lovett, assisted in the research and focused on the anesthesia studies and larval growth and survival. A summer volunteer student Brian Walker from Roger Williams University also assisted in larval diet evaluation. The research is supported by a Rhode Island Ocean Technology Center Grant.

Grace has also been working on the effects of temperature and salinity, and the effects of timing and frequency of feeding on growth of summer flounder juveniles. This is part of a summer flounder aquaculture project sponsored by Rhode Island Sea Grant. Grace has been assisted by Riley Young and Brian Murphy, graduate students at URI Fish Veterinary and Animal Science Department.

For more information on any of these projects please contact:

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Maurice Lamontagne Institute, Department of Fisheries and Oceans Canada, Mont-Joli, Quebec, Canada.

This report summarizes some of the larval fish research being conducted at IML, by three research groups.

From the laboratory of Patrick Ouellet

Patrick has been conducting an extensive research program on maternal influences on egg quality in Atlantic cod, lobster and crab as a part of a larger collaborative project. The research programme is aimed at providing information on the causes of the recent collapse of the northern Gulf of St. Lawrence cod stock. Along with the decline in abundance, fisheries data revealed that the characteristics of the fish were changing, e.g. smaller and lower condition of the spawning cod. Moreover, from 1993 to 1995 a series of cruises in early spring over one cod spawning ground in the northeast Gulf reveal that cod eggs were more abundant below the surface within the cold (0°C) water layer. This observation suggested a low buoyancy problem for these eggs since such low water temperature is detrimental to successful development. In order to understand how smaller size and/or the lower nutritional condition of female cod can be responsible for lower egg quality, Patrick began a series of experients on cod egg characteristics and viability relative to female size and condition, in collaboration with colleagues at IML. In 1995 and 1996, cod of different size classes were conditioned at two (low vs. high) feeding regimes and two temperatures (~2°C - ~6°C) to produce a range of maternal condition (see Dutil et al. 1998). Over the two spawning seasons, subsamples of eggs from every egg batch spawned from 44 females (a set of 22 different females each year) were analyzed for egg size, dry mass, energy content and, in some case, density measurements (i.e. specific gravity). In addition, a total of 54 egg batches from 24 individual females (about 2 egg batches/female each year) were used to monitor development rate and survival from day one to hatching at two temperatures (~0°C - ~4°C). The experiments produced a large data set on which analysis is as yet incomplete. Nevertheless, a masters thesis was produced in 1997 and two primary publications are in preparation for 1998 (see bibliography below).

Briefly, the results to date indicate that female size and condition combined influence mean egg characteristics (size, dry mass) and hatching success was weakly related to female condition; hatching was better in egg batches from females in higher pre-spawning condition (Ouellet et al. in prep.).

Another aspect of the project on cod eggs deals with the effect of temperature on egg yolk osmolality, and hence buoyancy. A partial loss of osmotic control at low temperature was advanced as one possible cause of the low buoyancy in cod eggs observed in the northeast Gulf. The hypothesis was tested by measuring yolk osmolality of cod eggs incubated at the same and constant salinity and at two temperatures (0°C - 4°C). The experiment showed that cod eggs incubated at low temperature acquired higher osmolality and the differences between treatments increased with time, i.e. developmental stage (Bérubé et al. in prep.). Moreover, egg diameter appears to be an important factor for the control of egg osmolality. In parallel experiments, larger eggs showed less changes in yolk osmolality when transferred to different salinity (Bérubé et al., in prep.). Since egg size is a variable, at least in part, determined by maternal phenotype, the results suggest that such maternal effects must be considered when considering the overall influence of environmental factors on fish eggs and larvae dynamics.

The work on cod eggs is part of a broader program on maternal effects. Maternal effects on snow crab and lobster egg and larval characteristics are now being investigated. The rationale for this approach is that exploitation alters greatly the demographic structure of a population, not only the numbers of adults (spawners) is reduced but also it is possible to observe changes in size at maturity, condition, etc. Those conditions must affect egg production in populations both quantitatively and qualitatively. Environmental influences on early life history stages can be compared to a screening process where only the luckiest or more fit survive. The research effort presented here can contribute to re-introduce the spawning stock into the recruitment equation. Spawning is when heterogeneity is created

Located outside of Rimouski, Quebec, The Maurice Lamontagne Institute is the Regional Science Directorate of Fisheries and Oceans - Canada, Laurentian Region. Research is conducted at IML on Fish and Marine Mammals, Invertebrates and Experimental Biology, Habitat Management and Environmental Sciences, and Ocean Sciences. The institute was inaguarated in 1987.

in egg/larval populations. Understanding that moment of the life cycle can only improve our understanding of how environmental factors ultimately determine the number of survivors.

For more information on any aspect of this work, please contact Patrick directly, at

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or see any of the following publications that have resulted from this work:

Bérubé, I., Ouellet, P. and Brêthes, J.-C. (in prep.). Effects of egg size and water temperature on yolk osmolality in cod eggs (*Gadus morhua* L.).

Bérubé, I. 1998. Effet de la taille et de la condition des femelles de morue franche (*Gadus morhua*) sur la qualité des oeufs et sur leur capacité de maintenir leur équilibre osmotique. Mémoire de maîtrise. Université du Québec à Rimouski. 90 pp.

Dutil, J.-D., M. Castonguay, M.O. Hammill, P. Ouellet, Y. Lambert, D. Chabot, H. Browman, D. Gilbert, A. Fréchet. J.-A. Gagné, D. Gascon & L. Savard. 1998. Environmental influences on the productivity of cod stocks: some evidence for the northern Gulf of St. Lawrence, and required changes in management practices. *Department of Fisheries and Oceans (Canada). Atlantic Fisheries Research Document* 98/18: 42p.

Ouellet, P., Lambert, Y., and Castonguay, M. 1997. Spawning of Atlantic cod (*Gadus morhua*) in the northern Gulf of St. Lawrence: a study of adult and egg distribution and characteristics. Can. J. Fish. Aquat. Sci., 54: 198-210.

Ouellet, P. 1997. Characteristics and vertical distribution of Atlantic cod (*Gadus morhua*) eggs in the northern Gulf of St. Lawrence, and the possible effect of cold water temperature in recruitment. Can. J. Fish. Aquat. Sci., 54: 211-223.

Ouellet, P., Lambert, Y., and Bérubé, I. (in prep.). Cod egg characteristics and viability related to maternal size and nutritional condition.

From the laboratory of Jean-Denis Dutil and Yvan Lambert

Jean-Denis and Yvan have been studying thermal tolerance of redfish larvae. Recruitment has been poor in redfish stocks for a long period. Though this may have resulted from high rates of fishing mortality among heavily exploited adult segments of the population, unfavorable environmental conditions may also have contributed to a lower survival rate of larvae and juveniles. Larval redfish in the Gulf of St. Lawrence are released below the cold intermediate water layer (CIL) and presumably have to make their way through near 0°C waters in order to reach surface waters where feeding and growth take place. CIL waters have been colder than

normal since the 1980's and this may have had an impact on larvae of *Sebastes mentella* and *Sebastes fasciatus* moving up the water column. These two species may also differ in their thermal requirements.

Laboratory experiments have been conducted to assess the thermal tolerance of redfish larvae. Gravid females were collected in May 1996 and May 1997 and tolerance tests conducted on larvae extruded from the ovaries. The 96-h tests were conducted at several temperatures, ranging from 0 to 18°C, both on freshly released larvae and on larvae deprived of food during 4 days. Lethal temperatures will be compared to the range of temperatures encountered by the larvae in the field. Samples were also collected in the laboratory to assess the effect of temperature on the rate of lipid and protein utilization. Field samples collected in the period between late-April and late-June will allow an estimate of the maternal and hatching time effects on the size of larvae and on the level of lipid and protein stores.

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From the laboratory of Howard Browman

Howard has been conducted research into three general areas that will be of interest to readers of Stages.

1.) The influence of maternal condition and thermal history on larval performance in Atlantic cod

The number of individuals that survive through the larval period is a major determinant of recruitment in many marine fish populations. Current hypotheses on the underlying mechanisms of variability in survival and recruitment in fish populations concentrate on the importance of differential growth and survival of individual larvae [e.g. the "Stage Duration" and the "Bigger is Better" hypotheses]. Maternal environmental and nutritional histories are likely related to the viability of individual larvae, yet fisheries scientists have only recently begun to examine these relationships in detail. The Maurice Lamontagne Institute's multidisciplinary research program on cod represents an attempt to evaluate these relationships.

Cod females are highly fecund, determinate spawners that release their eggs in batches. The relationships between female condition and the number and quality of eggs that they produce have only recently been characterized for cod. For females in good condition, these studies indicate that (1) 17-19 egg batches are spawned per female over a period of four to six weeks, (2) the number of eggs liberated in each batch varies significantly and generally follows a smooth dome-shaped curve, (3) egg size and dry mass decrease from the first to the last batch, (4) egg diameter of the first batch is positively correlated with female length and (5) there is an inverse relationship between egg diameter and mortality. Further, cod females with high condition factors produce more previtellogenic oocytes and use a larger fraction of them during vitellogenesis than females with low condition factors. Overall fecundity is also related to female condition; females with low condition factors produce fewer eggs than those with high condition factors.

Inter-batch and inter-female differences in egg quality may be translated to the larvae that they produce. Preliminary evidence indicates that the feeding performance (numbers of prey ingested) of cod larvae hatching from small eggs is poorer than that for larvae hatching from larger eggs. Similar results have recently been reported for other species. Further, eggs liberated towards the end of a given female's spawning cycle (i.e. those from the last few egg batches) appear to produce larvae whose overall activity is less than that for larvae from earlier egg batches. Because activity and feeding rates translate into rates of growth and survivorship, these observations imply that cod larvae hatching from different egg batches, and/or from different females, may be more-or-less viable.

Spawning in batches over a relatively long 4-6 week period is thought to increase the chances that the larvae of any given female will encounter feeding conditions adequate to support rapid growth

and an increased chance of survival. However, the preliminary results outlined above indicate that, for example, larvae produced from eggs released late in a female's spawning cycle will be less likely to take advantage of good feeding conditions than larvae released during the middle of the same female's spawning cycle.

Following from the above, the major thrust of this project was to test the following null hypotheses.

(1) Female nutritional and thermal histories are not related to the performance of early larvae that they produce ;

(2) Female spawning and nutritional history are not related to the performance of early larvae.

Experiments were conducted during 1995-1996. Fertilized eggs were obtained from spawning couples that had been maintained under different feeding and thermal regimes (see Dutil et al. 1998). Egg batches were transferred to an incubation system within a few hours of their release. At hatching, larvae were transferred to 60 litre black rearing basins. The rearing basins were stocked with algae (*Nanochloropsis sp.*) and larvae were fed nutritionally enriched (Artemia Systems' Super Selco) rotifers (*Brachionus sp.*). Eggs and larvae were handled so as to maintain those from any given male-female cross and spawning batch event in isolation. Temperature was held at 6 °C and photoperiod was 14 h L : 10 h D.

We attempted to fill a 2 X 2 X 2, three replicate experimental design, for a maximum of 24 larval groups. In 1995, the treatments were: maternal ration (condition) X maternal thermal history X egg batch number. In 1996, the treatments were: maternal ration (condition) X maternal size X egg batch number. Three of the five or six male-female pairs from each of the four ration-temperature treatment groups (in 1995), or ration-size treatment groups (in 1996) were targeted as sources of fertilized eggs. Measurements of egg quality on these same groups were also carried out (see Ouellet's report above, and Dutil et al. 1998). Two egg batches from each of these females were targeted, the second or third (typically of relatively poor quality) and the fifth or sixth (typically of relatively high quality) of any given female's spawning. All of the experiments were conducted at 6 °C.

Larvae from all targeted groups were subsampled at various intervals. Larval size was determined from measurements on live larvae under a microscope. Immediately after the standard length measurements, specimens were dried at 50°C for 24 hours and then weighed on an electrobalance to the nearest 0.001 mg. Drying was continued until there was no further change in mass. For each egg batch, 10 to 12 larvae were collected from the rearing basins at approximately 6 days post-hatch (DPH). At least three such measurements were obtained prior to 20 DPH. Mean length and dry mass were used to calculate the specific growth rate for mass (SGR_m) and for standard length (SGR_l).

The overall activity levels (percent time actively swimming) and swimming patterns (swimming speed, frequency and duration of stops, repositioning turn angles) of the larvae were evaluated, at 3 & 6 DPH, using silhouette video photography (SVP). An SVP recording platform, along with a computer-controlled motion analysis system, were used to obtain these data. These observations were conducted on free-swimming cod larvae in a 20×20×20 cm aquarium. Path analysis was used to evaluate whether there were any discernable differences in activity levels or swimming patterns among the treatment groups. Fifty larvae were used in each trial, and there were three replicates per trial. All data were evaluated by two way ANOVA. At this writing, only the observations obtained during the 1995 field season have been analyzed. We expect to complete the 1996 analysis by late summer 1998.

The range of pre-spawning condition factors (Fulton's K, based upon total mass) in the females for which larval groups were followed varied between 0.88 and 1.25. There was no significant relationship between the SGR (based upon either dry mass or total length) of larvae and female condition factor or thermal history. Nor was there any significant relationship between larval activity or larval swimming speed and female pre-spawning condition factor, at 3 or 6 DPH or thermal history. There was a mildly significant ($p = 0.038$) treatment interaction effect (female ration with temperature) on larval SGR.

The results for 1995 indicate only a weak effect of female condition factor and thermal history

(Continued on page 12)

Call for Abstracts

22nd Annual Larval Fish Conference
University of Michigan
Ann Arbor, MI
July 9 - 13

For full details of the meeting please visit the meeting web site at

www.snre.umich.edu

The organisers encourage talks on all aspects of larval biologt, but are particularly interested in talks that emphasize processes affecting survival or potential recruitment in both marine and freshwater ecosystems. In conference will feature sessions on otolith chemistry (see opposite), modeling studies in early life history (Jim Cowan <Jcowan@jaguar1.usouthal.edu>), zooplankton / larval fish interactions (Dave Wahl <d-wahl@ux1.cso.uiuc.edu>, Tom Miller <miller@cbl.umces.edu> and Randy Claramunt <Randy_Claramunt @nbs.gov>) and early life history of fishes of the Great Lakes (Dave Jude <djude@umich.edu>). If you are interested in being a part of one of these session, please contact the session chairs. Contributed sessions will also be held.

The format for submitting abstracts will be outlined on the Web page. The page is designed so that one may register and submit abstracts via the web page.

All abstracts are due by May 1.

The registration fee for the meeting has not yet been established, but will be announced on the web.

The organising committee has reserved up to 200 beds in the university dorms. The prices range from $34.50/night for singles, and $44/night for doubles. The number and person to call for reservations will be listed on the web page. Attendees also can book reservations at local hotels. Some which are within walking distance include the Campus Inn (20 available rooms), the Michigan League (where the talks will be), the University Tower. Phone numbers for these places, and a general 800 number to contact other hotels in the area. will also be provided These other places will be much more expensive.

No provisions have been made for meals. There are a number of restaurants within a short walk of the dorms and the meeting location, with a cafeteria and 2 fast food joints based in the same building as the meeting.

For students traveling to the meeting, travel grants are available from ELHS- see page 12.

January 1998

Otolith Chemistry Symposium, July 9-13, 1998

The 22nd Annual Larval Fish Conference will include a symposium on ***Otolith Chemistry***. Presentations will include:

E. Beary[1], K. Murphy[1], S. Thorrold[2] and S. Shuttleworth[3], [1]*NIST,* [2] *Old Dominion University* and [3]*Washington University of St. Louis.* Analysis of trace elements in otolith and water samples using ion chelation chromatography and isotope dilution ICPMS.

S. Campana, *Department of Fisheries and Oceans, Canada.* Otolith elemental fingerprints as biological tracers of fish stocks.

G. Forrester[1], S. Swearer[2], M. Steele[1], A. Brooks[2] and D. Lea[2], [1]*UCLA* and [2]*UCSB.* Trace-elemental fingerprinting using ICP-MS: are differences among sites in otolith chemistry consistent over time and among species?

B. Gillanders and M. Kingsford, *University of Sydney.* Determining linkages between estuarine nursery areas and coastal adult populations using isotopes in otoliths.

B. Kennedy[1], R. Harrington[2], C. Folt[1], J. Blum[1], and P. Chamberlain[1], [1]*Dartmouth College* and [2]*University of Wyoming.* Tracing the tributary origins and movements of anadromous Atlantic salmon (*Salmo salar*) through the use of stable isotopes.

K. Limburg, *University of Stockholm.* Testing life history theory with otolith elemental ratios: juvenile American shad migration in the Hudson River Estuary, New York.

W. P. Patterson, *Syracuse University.* Early life history of Laurentian Great Lake Fishes from stable isotope ratios of carbon and oxygen: advances in computer-assisted micromilling.

W. F. Patterson III[1], J. Cowan, Jr.[1], B. Lyons[2], and E. Graham[2], [1]*University of South Alabama* and [2]*University of Alabama.* Otolith microchemistry fingerprints of age-0 red snapper, *Lutjanus campechanus*, in the northern Gulf of Mexico.

S. Swearer[1], J. Harlan[2], J. Caselle[1], D. Lea[1], & R. Warner[1], [1]*UCSB* and [2]*NOAA/University of Colorado.* Island wakes and environmental markers: Using otolith elemental fingerprinting in studies of larval dispersal and recruitment of coral reef fishes.

S. Shuttleworth[1]and S. Thorrold[2], [1]*Washington University of St. Louis,* and [2]*Old Dominion University.* High-resolution spatial sampling of the trace element chemistry of otoliths using laser ablation magnetic sector ICPMS.

R. Thresher, B. Bruce and C. Proctor, *CSIRO Division of Marine Science, Australia.* Direct measurement of rates of larval exchange among populations of the temperate shelf fish, *Nemadactylus macropterus*, based on larval distributions and analysis of otolith composition.

For more information on the Symposium, contact Simon Thorrold (thorrold@estuary.amrl.odu.edu)

(Continued from page 9)

(combined) on the larval performance variables that were measured. This result conforms with those reported by Ouellet (see Ouellet's report above, and Dutil et al. 1998): for 1995 there were only weak effects of maternal condition and thermal history on the egg quality variables measured. There are a number of likely explanations for the lack of a more consistent effect: the fact that the majority of egg groups that we followed were the progeny of females with relatively high pre-spawning condition factors; the relatively small range of pre-spawning condition factors for these females; the fact that we were unable to follow the full complement of egg groups.

The relationship between larval SGR, overall activity and swimming speed were also evaluated. With only one exception (dry mass vs. larval activity at 3 DPH), all of these were significant: there were direct relationships between larval SGR and both activity and swimming speed. The significant positive relationships between larval SGR and activity or swimming speed support the use of these variables as reasonable indicators of larval performance.

Albeit tentative, these results represent one of the first demonstrations of a link between female condition and the performance of her progeny. The condition factors of the females for which egg batches were followed in 1996 were considerably greater than those for 1995 and included more egg groups from those in poor condition. We are hopeful that this will allow us to discern more conclusive effects of maternal condition and spawning history on larval performance. We will also determine, for 1995 and 1996, whether there is any relationship between the larval performance variables that we measured and post-spawning female condition factor.

2.) The impact of ultraviolet radiation on marine zooplankton and ichthyoplankton: radiometry, attenuation coefficients, mortality effects, biological weighting functions and DNA damage.

Over the past 10 - 15 years, levels of solar ultraviolet-B radiation (280-320 nm, UVB) incident at the Earth's surface have increased significantly over mid-latitude areas of the Northern and Southern Hemispheres. These increases in UVB are linked to reductions of stratospheric ozone.

A growing number of studies indicate that UVB radiation, at current levels, is harmful to aquatic organisms and may reduce the productivity of marine ecosystems. Such UV-induced reductions in productivity have been reported for phytoplankton, heterotrophs, and zooplankton, the key intermediary levels of marine food. Analogous studies on fish eggs and larvae, although rare, indicate that exposure to levels of UVB currently incident at the Earth's surface results in higher mortality that may lead to poorer recruitment to adult populations.

Attention students going to Ann Arbor!!

The ELHS announces the availability of two (2) travel grants, each for $300.00, to provide assistance for student travel to the Annual Larval Fish Conference in Ann Arbor, MI. Applications for grants must include 1) a letter of request from the student; 2) a copy of the abstract of the paper to be given by the student in Ann Arbor; and, 3) a letter of recommendation from the student"s major professor or faculty advisor indicating that the student is in good standing and in need of support to attend the Annual Larval Fish Conference. Student applicants must be members of the ELHS. Based upon the above criteria, grants will awarded by committee decision.

Send completed applications by the deadine for abstract submission to the 22nd Annual Larval Fish Conference to:

Dr. Jim Cowan
Dauphin Island Sea Lab
P.O. Box 369-370
Dauphin Island, AL 36528

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In some regions of the Gulf of St. Lawrence, Canada, the late spring and summer water column shows a pronounced thermocline between 10 and 30 m. A cold intermediate layer (-1 to +1 °C), situated at depths of 30 - 100 m and composed of relatively fresh water, separates the warm mixed layer near the surface (14 - 16 °C in summer) from the waters at depth (6 °C). As a result of the spring-through-fall presence of this intermediate cold layer, the most important (productivity-determining) biophysical interactions occur in the upper 10 to 30 m of the water column. During summer, the mixed layer in these waters can be as shallow as 10 m. The eggs and larvae of several commercially important marine invertebrates and fishes are found in this layer.

Measurements of the diffuse attenuation coefficients for solar UVB at various locations in the estuary and Gulf of St. Lawrence indicate maximum 10% depths (the depth to which 10% of the surface irradiance penetrates at a given wavelength) of three to four meters at a wavelength of 310 nm (Kuhn et al. 1998). This represents a significant percentage of the summer mixed-layer water column. In clear tropical ocean waters the 10 % depth at 310 nm can be as deep as 15 m. UVB-induced damage to the DNA of fish eggs and larvae has been detected in samples collected from depths of up to 20 m. Thus, the early life history stages of the crustacean and fish species that are present in the shallow mixed layer of the water column may be particularly susceptible to increasing levels of UVB.

The reproductive season for Atlantic cod (*Gadus morhua*) in the Gulf of St. Lawrence begins early in the spring and continues through late June. Spawning occurs in deep water (> 200 m) and cod eggs, which are typically positively buoyant, ascend to the surface mixed layer over a period of two to ten days. A significant proportion of all cod eggs present in the water column occur in the 0 - 25 m depth stratum off the Newfoundland, off Greenland and Labrador, on southern Georges Bank and in the northern Gulf of St. Lawrence. On clear summer days, when wind speed is low, the highest egg concentrations are observed near the surface. The early larval stages are also typically present in the surface layer.

Following from the hydrographics of this region, and given the planktonic character of the early life stages of cod and many other fish and crustacean species, this system offers an appropriate opportunity to assess the impacts of solar UVB radiation on temperate-latitude marine ecosys

Within this context , we investigated potential impacts of UVB radiation on the early life stages of cod. The goals of this study were to 1) evaluate the effect of UVB radiation on mortality in the eggs of cod and determine whether developmental state affects susceptibilty to UVB, 2) generate dose-response relationships and test the principle of reciprocity, which states that the UVB-induced mortality effect on cod eggs will be dose but *not* dose *rate* dependent, 3) derive a biological weighting function (BWF) for the effect of UVB on mortality in cod eggs, and 4) present a preliminary assessment of the potential impact of solar UVB on the early life stages of cod in the subarctic marine ecosystems of eastern Canada.

Laboratory experiments using a xenon arc lamp-based solar simulator revealed that cod embryos were highly susceptible to UVB, resulting in high wavelength-dependent mortality. The strongest effects occured under exposures to wavelengths below 312 nm. This susceptibility was also dependent upon developmental stage; mortality was particularly high during gastrulation. At the shorter wavelengths (< 305 nm) UVB-induced mortality began at unweighted cumulative doses of approximately 1000 kJ m^{-2} and was strongly dose-dependent with 100 % mortality occuring at doses near 15000 kJ m^{-2}. Dose-dependence of UVB-induced mortality was not significantly influenced by dose-rate. The biological weighting function (BWF) derived for UVB-induced mortality in cod eggs is similar to that reported for naked DNA. This suggests that the UVB-induced mortality effect on cod embryos is a direct result of DNA damage. This contention is further supported by an experiment - conducted in collaboration with Russell Vetter at the NOAA-NMFS laboratory in La Jolla - on DNA damage in cod embryos exposed to UVB radiation. Results from this experiment showed that damage to the DNA of cod embryos was significantly higher than control groups (held in the dark)

only at wavelengths below 320 nm.

Calculations based upon the BWF indicate that, under current noon surface irradiance, 50% of cod eggs located at or very near the ocean surface will be dead after 42 h of exposure. Under solar spectral irradiance simulating a 20% decrease in ozone layer thickness, this time drops to 32 h. These are first-order estimates based upon irradiance taken at a time of day during which the values would be maximal. Nonetheless, they illustrate the relative changes in UVB impacts that will result from ozone layer depletions expected over the coming decades.

3.) Predatory behaviour of Paraeuchaeta norvegica feeding on Atlantic cod (Gadus morhua) larvae

In collaboration with Jeannette Yen (State University of New York, Stony Brook), and using a silhouette video optical system, we made the first ever direct observations of the predatory feeding behaviour and attack sequence of *Paraeuchaeta norvegica*, a carnivorous copepod, feeding on yolk sac stage Atlantic cod larvae. *P. norvegica* perceive cod larvae using their tactile sense. As a result, location distances are small and the cod larva must be moving to be perceived. As a result of these small location distances, encounter rates will be low. Attack speeds were extremely high: much higher than the escape velocities of which cod larvae are capable. *P. norvegica* requires approximately 10 min. to consume an entire cod larva.

4.) Relocation to Norway and work there

Some STAGES readers will already know that I will be relocating to Norway in March 1998 to take up a research position with the Institute of Marine Research. I will be a member of a group studying the biology and ecology of early life stages and intend to develop several lines of research that follow from those on which I have been working over the past 15 years. Stay tuned.

For more infomation on any of Howard's research, please contact him at:

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Recent publications from Howard Browman's lab

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Southern Region - Jon Hare, NOAA / NMFS, Beaufort Laboratory, 101 Pivers Island Road, Beaufort, NC 28516. (Phone: (919) 728-8732; Email: jhare@hatteras.bea.nmfs.gov).

Department of Biological Sciences, University of South Alabama, Mobile

Judith Shardo, formerly at the University of Massachusetts, is continuing her research on the comparative embryology of teleost fishes at the University of South Alabama. Using scanning electron microscopy (SEM), Judith produces detailed descriptions of morphological development in teleost embryos and larvae. Morphological ontogenies of extant teleosts are the result of adaptive and evolutionary changes modifying the ancestral developmental pattern. Comparisons of patterns of development among descendant species of a common ancestor can be used to reconstruct the history of changes and adaptations in teleosts. The initial step is to devise a comparative staging system that is able to identify comparable levels of development in embryos of very different species, essentially homologous stages. Each stage of the system is defined by one or two morphological criteria that are widespread fundamental features of teleostean development. The number of criteria defining a stage is limited because developmental rates of different embryonic structures often times vary within a species, so that a group of morphological features that characterize a stage in one species may be dispersed among several stages in a different species. All developmental features other than the criteria defining the stage are treated as concurrent features that are not necessarily coupled to the defining criteria of that stage and thus may show a change in the timing of their appearance in different species. Age or size as a measure of development, are generally not comparable among species and are treated as concurrent features.

Judith devised an initial staging system based on American shad (*Alosa sapidissima*) development and is now using data on Atlantic salmon (*Salmo salar*) development to modify the system. Preliminary comparisons of homologous stages in these two species indicate distinct differences in gill and opercular formation, and in the overall level of morphological development at hatching. Studies are needed to determine the possible adaptive significance of these differences. Recent NSF support will allow expansion of the study and several species, including the bay anchovy (*Anchoa mitchilli*) and channel catfish (*Ictalurus punctatus*), will be added this year.

Andrew Woodard, an undergraduate student working in Dr. Shardo's lab, is in the process of applying the morphological staging system to embryonic and larval red snapper (*Lutjanus campechanus*). Samples were collected at the Alabama Marine Resources facility in Gulf Shores. Red snapper will be the first marine species to be completely categorized by this staging system. Andrew is using both light microscopy and SEM to describe the development of this species. Red snapper have small eggs (0.72mm) and different techniques had to be devised to physically manipulate the eggs and critical point dry specimens for examination with SEM. Chemical drying agents have been used with some success on the early embryonic stages, while work continues on improving methods for drying the post hatch specimens.

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Report from south-eastern Australia

Everyone is away right now, after their successful Australian Research Grant foraging trips last year. Both Jeff Leis (Australian Museum) and Mike Kingsford (University of Sydney) scored 3 year grants to examine larval behaviour around tropical reefs, and right now is peak larval production time. Mike has just returned from a 3 month study leave in Spain, and now has another 3 months in New Zealand, where one of his objectives is to complete a book on techniques in coastal ecology.

Iain Suthers spent 7 months working in Bergen and Rekjavik (finishing up more neat cod growth histories), before settling in at Dalhousie University in Halifax, Canada with Chris Taggart, working up plankton particle size distribution data in various shallow and deep island wakes from the Great Barrier Reef. We collected 38 families of neustonic larval fish while we towed an optical plankton counter, and found two groupings of larval taxa correlated with either "small" (300-500 µm diameter bugs found near the surface) or "medium" zooplankton (500-1200 µm bugs usually found near the bottom, except where there was tidal stirring and uplifting). The plankton distribution was seen to evolve during both flood tides that we examined, resulting in a 3-4 fold concentration of zooplankton by the end of the tide, about two island diameters downstream. The average concentration of larval fish (300 per 250 m^3), with an equivalent spherical diameter between 2,500-5,000 µm, fitted neatly onto that predicted from the exrapolated size spectrum of zooplankton! Around other reefs, we found zooplankton concentrated in zones of low tidal flushing, as predicted by oceanographic models. The size distribution of zooplankton biomass is now being examined as a measure of production, in relation to recent otolith growth.

Iain also worked at the Bedford Institute of Oceanography, examining the increment width series of the otolith as a means of calibrating some larval condition indices with actual back-calculated growth. A number of larval species (Australian bass, and snapper, *Pagrus auratus*), along with Atlantic cod, show a rapid response in increment width to feeding and starvation events - but there seems to be a size dependency! The full story will be told at the 2nd World Otolith symposium in Bergen - hope to see you all there.

The 3rd International Larval Biology Conferenc

This conference was held in Melbourne from January 13 to 16, 1998. There was a good representation of larval fish talks, especially in the symposium "Larval behaviour: is it important to dispersal and recruitment?". A number of talks concentrated on the dispersal and recruitment of coral reef fish while talks on temperate species were also well represented. Invited speakers in this symposium with fish related talks were Dick Forward, Peter Doherty, Jeff Leis and Greg Jenkins (together with Alan Shanks, Edwin Bourget, Ib Svane and Dick Zimmer-Faust talking about invertebrates). Other mini-symposia were: "Evolution of Larval Form", "Chemical Ecology" and "Larval Nutrition", together with a large number of general session talks. As with the first two conferences, this meeting provided an opportunity for larval fish and invertebrate workers to "cross-pollinate" ideas and was enjoyed by all. The 4th meeting is scheduled for California in 1999.

For more information on this meeting, please contact:

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MEETING REVIEWS

21st Annual Larval Fish Conference

The 21st Larval Fish Conference in Seattle was a great success. The LFC is the Section's principal meeting each year. It is a great opportunity to hear what is going on at the cutting edge of our field, make new friends and meet existing ones. However, it is impossible for all ELHS'ers to attend the conference. In an attempt to ensure that everyone gets an idea of the flavour of the meeting STAGES will carry a rewiew of each conference. In the pages that follow Art Kendall and Ann Matarese with input from Morgan Busby, Ric Brodeur, Francis Juanes, and Darrel Snyder, provide their perspective of the events in Seattle

The 21st annual Larval Fish Conference of the Early Life History Section (ELHS) of the American Fisheries Society was held in conjunction with the 77th annual meeting of the American Society of Ichthyologists and Herpetologists 26 June-2 July, 1997, on the campus of the University of Washington (UW) in Seattle, Washington. More details about the meeting can be found at the meeting website: http://artedi.fish.washington.edu/asih/asih97.html. Among the over 1700 participants in the meetings, about 188 registered for the Larval Fish Conference. Bill Rugen, AFSC, designed the meeting logo, and several items with the logo were available for sale during the meeting including T-shirts, insulated travel mugs, and chocolate medallions.

The poster session included 28 entries. The poster session finale was a reception sponsored by Research Nets, Inc.

A banquet for the EHLS participants took place on Monday evening. Dr. Milton Love provided a highly entertaining banquet address reminding us of why we became biologists, and why we study fishes. Another highlight of the banquet was the presentation of an award of appreciation to long-time active ELHS member, Gail Theilacker.

The Sally L. Richardson Award was presented during the EHLS banquet for the best student paper given at the Larval Fish Conference. There were 32 entries in the competition this year, the highest number ever. This years award was shared by two co-winners Jennifer Caselle-Reinhardt (University of California, Santa Barbara) for the presentation "Density dependent early post-settlement mortality in a coral reef fish and its effect on local population size" which was given during the juvenile symposium, and Ulrich Reinhardt (University of British Columbia) for the presentation "Size-dependent foraging behaviour and use of cover in juvenile coho salmon under predation risk" which was given in the salmon symposium. Co-honorable mention went to Jay Rooker (University of Texas, Austin) and Jason Rogers (University of North Carolina). The Richardson raffle attracted over 50 excellent items, and generated $1000 for the award fund. The drawings for the raffle occurred during the ELHS banquet during which Clark Hubbs greatly expanded his wardrobe of fish related T-shirts and hats.

Oral sessions and symposia began on Friday afternoon with a keynote address by Dr. George Boehlert who spoke on AEarly life history: Is it the key to understanding fish population processes?@ A total of 90 oral presentations followed over the next five days, as the LFC part of these meetings. Additionally, a number of papers of interest to people working on early life history were also given in other sessions of the ASIH meetings.

Three symposia were held during the meeting. Highlights of each symposia follow.

Juvenile Fish Studies: Contributions to Early Life History and Recruitment Pro-

cesses (organized by Ric Brodeur and Brenda Norcross):

From the very beginning of early life history and recruitment studies, most of the emphasis has been on the egg and larval periods as being the *critical* stages, with the later post-metamorphic stages being virtually ignored. For many fish species, especially those subject to heavy predation, it has become apparent that substantial interannual variability in survival can occur in the juvenile stage, and for these species this stage may be a missing link in recruitment studies. Many recruitment programs now advocate a more balanced approach examining survival mechanisms right up to the time of recruitment. In species which settle out of the plankton and, particularly those which may have certain habitat requirements such as flatfishes and reef fishes, many studies have show density-dependent growth or survival in juveniles which has not often been observed in larvae. In some species, the biomass of a particular cohort actually peaks during the juvenile stage and this, coupled with their high growth and turnover rates, makes juvenile fishes an important trophic link both as predator and prey in many ecosystems. This symposium was an attempt to fill in some of the gaps in our understanding of early life history and recruitment in the juvenile stage.

The symposium consisted of a main session of eight invited speakers followed by two contributed sessions consisting of 18 oral presentations. There were also a number of posters dealing with this topic. Dr. Susan Sogard from the Hatfield Marine Science Center in Newport, Oregon was the first invited speaker and presented a stimulating paper on "Size-selective mortality in the juvenile stage of teleost fishes: A review". Dr. Robin Gibson of the Dunstaffnage Marine Laboratory in Scotland presented an overview of his work entitled "Movement patterns of juvenile plaice: balancing feeding opportunity and predation risk". Dr. Greg Jenkins and coworkers of the University of Melbourne, Australia, next presented their findings on "Factors influencing recruitment of a demersal fish to seagrass beds in a temperate bay". A more tropical example entitled "Neglected variations in juvenile nursery habitat: the Hawaiian pink snapper as an example" was presented by Ed DeMartini of the NMFS Honolulu Lab. Dave Conover of SUNY-Stony Brook presented many years of work by he and his collaborators in the next paper "Advection, piscivory, and estuarine-dependency: the role of early juvenile stages in recruitment of the bluefish, *Pomatomus saltatrix*". Steve Ralston of the NMFS Tiburon Laboratory provided an overview of his research on "Interannual variability and coherence among the pelagic juvenile rockfishes of Central California". Dr. Yoshiro Watanabe of the Ocean Research Institute in Tokyo next presented a more oceanic perspective in his paper "What determines juvenile production of saury in the Kuroshio-Oyashio waters: larval production or early mortality?". In the final invited talk, Jim Cowan and coworkers provided an interesting model application to study the importance of the juvenile stage in their presentation "Cohort biomass, prey consumption and density-dependence during ontogeny of marine fishes: a case study of bay anchovy". Both the invited and contributed sessions were well attended and all speakers are to be commended for their outstanding talks in this, the first ELHS symposium on juvenile fishes.

Ontogeny of North Pacific Scorpaeniform Fishes (organized by Morgan Busby and David Ambrose):

This symposium was comprised of five talks on sculpins (family Cottidae) and two on rockfishes (family Scorpaenidae, genus *Sebastes*). Danny Kent of the Vancouver, B.C. Public Aquarium opened the symposium with an very interesting talk on interspecific nesting in marine fishes: AS-pawning of the spinynose sculpin *Asemichthys taylori* on the eggs of the buffalo sculpin *Enophrys bison*@. Enzo Acua followed with a talk on larval development of the red rockfish off Northern Chile. Deborah Blood from NOAA=s Alaska Fisheries Science Center then spoke on identification and development of *Triglops* larvae from both the North Pacific and Atlantic Oceans. Amy Cook from U.C. Irvine followed with the first student presentation entitled AOntogeny of Skull Morphology in Cottid Fishes@ - which focused on some interesting differences in shape and growth characteristics between

ram and suction feeding sculpins throughout development. The following talk, also focusing on cottids, was given by Rick Feeny of the Los Angeles County Museum, and titled "Near Shore Distribution of and Abundance of Sculpin Larvae (Scorpaeniformes: Cottidae) in the Southern California Bight". Fumihito Muto, a doctoral student at the Hokkaido University Laboratory of Marine Zoology, spoke on the identification and comparison of morphological development of early stages of fishes of the genus *Myoxocephalus* (Teleostei: Cottidae) from Japan. The final presentation was given by Cindy Taylor, a student from San Diego State University on her study that is being conducted in conjunction with scientists from NOAA=s Southwest Fisheries Science Center entitled "Larval Identification of Rockfishes (genus *Sebastes*) using mitochondrial DNA Techniques". The symposium was well attended and all speakers did an outstanding job on their presentations.

Habitat use and diel activity patterns in juvenile salmon: comparisons of Atlantic and Pacific species (organized by Francis Juanes and Scott Hinch)

There has been much emphasis on habitat use of stream-dwelling salmonids, only more recently has that work extended to juvenile stages of Atlantic (*Salmo salar*) and Pacific salmon (*Oncorhynchus spp.*). A clear understanding of habitat use patterns is critical as stream habitats continue to change necessitating intervention and restoration. However, we still know relatively little about macrohabitat selection and ontogenetic shifts or diel patterns in habitat use. The hope was that this session would bring together researchers focusing on these less-well described aspects of habitat use and focusing on recent approaches that include energetics and individual-based modeling.

The session attracted 8 talks, 6 on Pacific salmon and 2 on Atlantic salmon. Four of the talks were presented by graduate students. The session began with three talks describing work at the University of British Columbia. The first by Scott Decker and Scott Hinch entitled "Seasonal changes in juvenile coho salmon biomass from groundwater side channels: the role of fish size and primary production," the second by Guillermo Giannico and Scott Hinch entitled "The effects of woody debris addition on movement in and out of groundwater fed side-channels by juvenile coho salmon during winter," and the third by Ulrich Reinhardt and Mike Healey entitled "Size-dependent foraging behaviour and use of cover in juvenile coho salmon under predation risk." Ulrich went on to share the Richardson award for best student presentation. The next two talks focused on habitat use by juvenile salmonids in Washington State and Oregon. The first by Lauri Freidenburg, Gilbert Pauley and John Emlen entitled "Habitat use of juvenile salmonids: the effects of scale and method of habitat assessment," the second by Mario Solazzi and co-authors entitled "Habitat Use by Juvenile Salmonids in Oregon Coastal Streams." The next two talks focused on daytime sheltering of juvenile Pacific and Atlantic salmon in British Columbia and Vermont respectively. Paul Higgins and Mike Bradford presented a talk entitled "The role of photoperiod, temperature and food availability on daytime concealment behaviour of juvenile Pacific salmon," and Gabe Gries and Francis Juanes (presented by Juanes) spoke on "Microhabitat use by daytime sheltering juvenile Atlantic salmon during summer." Finally, Keith Nislow and Carol Folt summarized their energetic-based approach in a talk entitled "Supply and demand in the study of habitat suitability for first-year stream salmonids." The talks were all presented very professionally (particularly those by students) and appeared to address common themes. It was clear that researchers working on both Atlantic and Pacific salmon are asking similar questions and that future interactions would be fruitful. The session was well-attended. For more information, please contact :

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or any of the other speakers if you have any questions or comments.

Three workshops were also held in associa-

tion with the meetings:

Larval Identification:

This workshop, orgainized by Morgan Busby, provided an opportunity for people to bring samples of unknown fish larvae and receive help identifying them. Microscopes were available for viewing specimens, and a wide assortment of literature was on hand. A video setup allowed simultaneous group observation of specimens. Collections from several parts of the world were examined in an informal setting. About 50 people attended all or part of this 2-hour workshop.

Preservation and Curation of Early Life Stages of Fish, Amphibians, and Reptiles: (Organized by Alexandra M. Snyder of the Museum of Southwestern Biology, University of New Mexico, and Darrel E. Snyder of the Larval Fish Laboratory, Colorado State University):

This workshop on problems, concerns, and techniques related to the preparation and care of preserved early life stage collections was jointly convened on behalf of the American Society of Ichthyologists and Herpetologists (Collections Committee) and ELHS Larval Fish Conference. The afternoon workshop was divided into three sessions: (1) elasmobranch, amphibian, and reptilian early life stages; (2) teleost early life stages; and (3) an open forum. Attendance varied according to topics of interest but at times was standing room only. Presentation abstracts are being prepared for the ASIH Curation Newsletter and both the ASIH and ELHS websites (http:// www.utexas.edu/depts/asih/, Curatorial Information; http:// www.cnr.colostate.edu/ ~desnyder/elhshome.htm, Conferences, Symposia, and Workshops).

Lex Snyder opened the workshop with a welcome introduction and a discussion of the need to properly document the preservation and preparation history of specimens from original fixation and preservation on field notes through subsequent preparation and changes in preservative as the collections are processed and accessioned. She stressed the importance and value of "accession files" for maintaining this and related collection documentation.

The first session opened with a presentation on the "collection of reptilian embryos: methods, standards, and ethics" by Alan H. Savitsky (Old Dominion University; co-author, William A. Velhagen, Jr., James Madison University). Alan noted that this is a neglected area of biodiversity sampling and discussed the special procedures, preservatives, and concerns required to obtain quality preserved embryos from oviparous and viviparous species. Steven W. Gotte (USGS-BRD, National Museum of Natural History; co-author, Robert P. Reynolds) continued with a paper on tadpole preservation techniques and their "observations on the effects of alcohol versus formalin storage of amphibian larvae." Noting the world-wide decline in amphibian populations, he emphasized the importance of well-preserved larvae for accurate identification; larvae are often the only life stages accessible during field investigations. Currently recommended practice is to fix and maintain specimens in 10% buffered formalin rather than transfer them to 70% ethanol. The session concluded with an overview of techniques for "preservation of embryonic and fetal elasmobranch tissues" by Madeline Oetinger (Kentucky Wesleyan College).

Grace Klein-MacPhee (University of Rhode Island) opened the teleost session with a presentation entitled "The trouble with ctenophores: ichthyoplankton preservation problems." Ctenophores in ichthyoplankton collections coalesce into "blobs" of material which not only make sample sorting difficult but readily absorb formaldehyde often leaving fish eggs and larvae in poorly fixed condition; likewise for oil in collections for oil-spill areas. To help assure dequate fixation, Grace recommended rins-

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ing samples well with as many as four changes of the preservative. David G. Smith (National Museum of Natural History; co-author Carole C. Baldwin) followed with a slide show on and discuss of "color in larval fishes: occurrence, importance, and preservation." Color patterns, especially from red and yellow chromatophores, can be valuable diagnostic characters but rapidly fade and are normally lost in formalin and alcohol-preserved larvae. David explained that they've had considerable success in using the antioxidant BHT to retain color for at least several months and also recommended recording color patterns by photographing freshly collected larvae.

Darrel continued the session by briefly reviewing the contents of "a list of larval fish collections" he was preparing for the workshop and ASIH and ELHS web sites and newsletters. At the time the list covered about 40 collections from North, Central and South America, Europe, and Australia, with many more to be abstracted from a database on U.S. and Canadian fish collections assembled by Stuart Poss and Bruce Collette (see Copiea 1995:48-70). Records include name and contact information for the host organization and responsible persons, permanency, size, nature, geographical coverage, and catalog status of the collections.

The final three papers dealt with the effects of preservation or preparation techniques on the lengths of fish larvae. Jennifer M. Bayer (USGS-BRD, Columbia River Research Laboratory; co-author Timothy Counihan) reported on "length changes in white sturgeon (*Acipenser transmontanus*) larvae: effects of ethanol and formalin." After 95 days in preservative, they found an average of just 0.4 to 1.0% shrinkage for 1 and 7-d old larvae in 10% formalin but 2.4 to 3.4% shrinkage for 14-d old larvae in 10% formalin and all three age-groups in 95% ethanol. John. F. Dower (Queens University, Ontario; co-author William Leggett, same; first author Pierre Pepin, Fisheries & Oceans, St. John's) discussed "changes in the distribution of larval fish body length following preservation" with formalin for the wild-caught larvae of nine coastal species. They found significantly increased post-preservation length for individuals initially up to 6 mm standard length, decreased length for those initially greater than 7 mm, and increased variation of length about the mean (for each 1-mm initial size interval) which also increased with increasing initial size. Finally "the effects of clearing and staining on fish length" was addressed by Edward S. Warren (San Diego State University; co-authors Eron Aldridge and Paula Mabee). For Tilapia initially 6 to 62 mm standard length, fixed in 10% buffered formalin, then transferred to 70% alcohol, they found that clearing and staining for bone and cartilage caused significant shrinkage which increased with initial size.

Questions or comments regarding the above and other topics were discussed during the open forum. One topic of particular interest to many participants was the possible use of plastination (polymer impregnation) as a dry, odorless, and durable alternative to maintenance fish larvae in fluid preservatives, especially for heavily used reference and study series. Darrel briefly discussed the process which is used for medical school cadavers and displayed a few sets of larval fish speci-

Affiliate Members!

We have completed a project to update our database of full and affiliate members to make contacting section members more efficient. This list will allow us to contact voting members at election time and to send out reminder notices to affiliate members in a more timely and efficient manner. Until now, we have had a policy of sending out copies of Stages to all affiliate members in good standing as of December 1995. Now all affiliate members will be receiving dues reminder notices as their membership expires. We ask that you please submit your dues to Kathy Lang, the section treasurer. Kathy is continuing to find ways to ease payment for our foreign affiliates, until that time, cheques and money orders only please. If we do not hear from you we will stop sending the newsletter!

mens (one with larvae just 4 to 5 mm in total length) that were plastinated experimentally for this workshop by William D. Martin (West Virginia School of Osteopathic Medicine).

Application-specific Computer Image Analysis (Convened by Darrel E. Snyder of the Larval Fish Laboratory, Peter Hagen of the Alaska Department of Fish and Game, Morgan S. Busby of the NMFS Alaska Fisheries Science Center, and Craig Pfaff, Dennis Kaill, Straton Spyropoulos, and Christian Erbe of Optimas Corporation):

Use of computer image-analysis techniques in the study of fishes and fishery resources is steadily increasing and diversifying. The benefits of such techniques in investigations of the early life stages of fish are particularly promising, but there remain many limitations and problems, and sometimes just a lack of "know-how." This all-day event was intended to address some of the limitations, problems, and solutions for three specific applications related to work with early life stages of fishes through a pre-workshop session, consecutive workshops dealing with each of the three applications. Each workshop consisted of three sessions: formal presentations, open computer, and open forum. The open computer sessions (combined for the smaller second and third workshops) provided opportunities for individual or small group hands-on experience, demonstration, and experimentation, as well as the exchange of programs, utilities, and macros. The open forums (also combined for the second and third workshops) provided opportunities to address questions remaining after the formal presentations as well as additional concerns and matters not covered by those presentations. Despite the event being held at a remote location, the Western Regional Center of the NOAA National Marine Fisheries Service (transportation provided from and back to the University), and on the final day of the conference (otherwise reserved for field trips), over 80 persons participated, including several from overseas. The workshops were open to all interested persons but targeted those with at least some computer image-analysis experience. Attendees were asked to be prepared to discuss related problems they'd experienced in applying image analysis to their investigations, share their solutions to problems, and demonstrate and exchange useful (public) programs, macros, or approaches they developed or refined. Although some techniques or approaches presented and discussed in these workshops were necessarily specific to Optimas or other image analysis programs, whenever possible, discussions were generic and directed towards image analysis in general. Printed handouts complemented several presentations. For presentations and use during the open forums, Optimas and other programs were installed on a computer connected to a display projector. Ten computers were setup in a separate room for the scheduled open computer sessions and for use during breaks. A complete image-analysis system with frame grabber and camera connected to a dissecting microscope was also available.

Darrel Snyder opened the event with a general welcome, review of the day's agenda, and recognition of co-conveners and others that made the event possible. The pre-workshop session which followed was presented by Straton Spyropoulos and provided a brief introduction to image analysis and some of the procedures and tools useful to all three of the subsequent workshops. Macros and image enhancement were emphasized.

The first and largest workshop, Otolith, Scale, and Related Analyses, was lead by Peter and intended to cover recovery of age, growth, and other information (e.g., tags, stock identification) from the otoliths, scales, or other bony structures of larval and juvenile fishes. Peter introduced the workshop by recounting the history of this image-analysis application. Simon Hickinbotham (University of York, England) then discussed "Automated fish scale analysis," a texture analysis and neural net approach to identifying annuli in scales. Next up was Dr. Valsilikov who discussed use of "spectral analysis to count increments" and demonstrated the IM System, prototype software for imaging and automating diagnosis of calcified structures. Christopher J. Donohoe (Oregon State University) discussed a procedure and macro he developed (and offered to participants) for counting and measuring intervals "from core to edge at high magnification, linking measurements from sequential images. Al-

though scheduled to present "miscellaneous imaging snippets in the service of otoliths and scales", Peter Hagen yielded the floor for the final presentation of the morning to Dean Courtney (NMFS Auke Bay Laboratory) who discussed juvenile "salmon scales and otoliths Optimas macros" for increment counts and measurements. The workshop's open computer session was held conurrent with an extended lunch break. During the open forum after lunch, participants discussion centered on a wish list for Optimas; internet communications via Optimas web and ftp sites, an e-mail listserve, and a hypernews group established by Peter; tips for image enhancement, and use of marker flags.

The two afternoon workshops covered use of computer image analysis for sample processing (automated or semi-automated counts and measurements of batches of fish eggs, larvae, or juveniles) and descriptive and taxonomic analysis (automated or semi-automated analysis for descriptive or specimen-identification purposes). After a brief introduction to both workshops by Darrel Snyder, David J. Harshany (Florida Marine Research Institute) discussed and demonstrated a user interface (dialog box) and set of macros he was developing to replace the standard Optimas program menus and semi-automate otolith marking, oocyte staging, and oocyte and general measurements by persons with little or no instruction. Straton Spyropoulos then summarized various procedures in Optimas (and many competing programs) useful for "automated counts and measures of batches of fish eggs, larvae, or early juveniles."

Jennifer M. Bayer (Columbia River Research Laboratory, Washington) opened the third workshop by relating her "use of image analysis for morphometric investigation of chiselmouth and northern squawfish larvae." Using Jandel software, she splices anterior and posterior half images of the subject larva together, identifies calibrated landmark coordinates, and from these calculates desired lengths and other measurements. Similarly, Morgan S. Busby described "a macro for collecting morphometric measurements of larval, juvenile, and small adult fishes" in Optimas. The macro semi-automates or consistently guides the user through the process with prompts. Based on his work using image analysis to classify snowflakes, Edmond W. Holroyd (U.S. Bureau of Reclamation Remote Sensing and Geographic Information Group, Denver) discussed the probable steps involved of using "outline matching techniques for computer identification of larval and older fish." He also described the progress he had made towards developing an algorithm for automatically measuring the total length of bent and curved fish larvae, a problem that has long delayed automated batch counts and total length measures. Finally, Straton Spyropoulos discussed "pattern recognition (and other) techniques for automated (semi-automated) specimen identification", particularly the use of object classes in Optimas. With the end of afternoon presentations, attendance rapidly declined and relatively few participants remained for the combined second and third workshop open forum and open computer sessions.

WHEN DO FISH BECOME JUVENILES?
Looking beyond metamorphosis to juvenile development
The 1st International Workshop of The Fish Ontogeny Network of Europe (FONE)

Convened by Gordon H. Copp (Hatfield, UK) and Vladimir Kovac (Bratislava, Slovakia), the 1st FONE Workshop was held at the Druzba Hotel in Bratislava (September 1
primarily a self-funded workshop, a small grant gratefully received from the European Commission made it possible for a number of colleagues from Central and Eastern Europe participate in the workshop. Originally initiated as a result of recent studies of the early ontogeny of roach (*Rutilus rutilus*), the aim of the workshop was to re-evaluate metamorphosis and the transition from larva-to-juvenile development in fishes. As such, the workshop aimed to define better the events marking the onset of the juvenile period. This is important for (1) the use of ontogenetic scales for inter-specific comparisons of morphological development, (2) the study of evolutionary trajectories, (3) the identification of ontogenetic shifts in resource use, and (4) the refinement of fishery recruitment models.

The 35 participants represented 14 countries, including western, central and eastern Europe, as well as Japan, Canada and Australia. This variety contributed to a vigorous debate throughout the meeting, inspired by an informal and friendly atmosphere. The need for an holistic approach to the study of fish early life history, as well as for a long-awaited agreement between fish biologists and aquaculturists upon a standard terminology for intervals in development, were amongst the most compelling issues addressed by Eugene K. Balon (Guelph, Canada) in his keynote speech. All following communications and discussions, hinged on the main theme of the workshop, branched into four main directions: (1) ontogeny and life history traits, (2) larval and juvenile patterns of relative growth, (3) morphology, physiology, behaviour and niche, and (4) larva-juvenile shifts in resource use.

Lauri Urho (Helsinki, Finland), Dimitri A. Pavlov (Moscow, Russia), and Lorenzo Vilizi (Adelaide, Australia) collated and critically reviewed literature data on the early ontogeny of various freshwater and marine species, complemented by personal observations. These presentations brought to light stark discrepancies between authors as to the exact timing and succession of early life history intervals. These incongruities were found to be likely due to the existence of two contrasting schools of thought in fish early ontogeny studies: the gradualists and the saltationists. While gradualism holds that ontogeny occurs as a continuous succession of
arbitrarily selected moments in development, the theory of saltatory ontogeny purports that the spiral progression of an organism punctuated by far-from-stable thresholds, separated by stabilised states in development and organised in a hierarchical sequence of intervals (periods, phases and steps). Although experimental evidence has long favoured saltation as the mechanism responsible for observed changes in development, it emerged from the workshop that consensus among researchers is yet to be achieved. However, Gordon Copp emphasised that the two perspectives are not mutually exclusive, as attributes are developed/acquired gradually during the intervals delineated by saltatory thresholds.

One of the highlights of the workshop was the oral given by Karin Pittman and Jostein Solbakken (Bergen, Norway) about their collaborative research with fish culturists on the developmental biology and rearing of Atlantic halibut (*Hippoglossus hippoglossus* L.). All three communications supported the general view that the metamorphic process is a dramatic event, causing substantial morphophysiological and behavioural changes. This may be the reason why some biologists have proposed the term
of metamorphosis, to take account of the synergistic effect of the various factors at play during the transition from larva to juvenile. The interesting links between behaviour and physiology were also addressed in orals by Reiji Masuda (Argyll, UK), Jean-Marc Roussel (Rennes, France), and Yoshi-

taka Sakakura (Guelph, Canada).

Results presented by the two convenors and a number of other participants highlighted the need for an integrated analysis of the interactions between morphology, behaviour, function and environment for determining when a fish has breached the larva-juvenile threshold. Following their work on the morphology of roach during early ontogeny, Vladimir Kovac and Gordon Copp presented comparative studies on freshwater fishes that suggest that stabilisation of allometric growth, changes in functional morphology and shifts in microhabitat use can be used to identify the threshold between the larva and juvenile periods. A morphological and/or habitat approach to identifying the larva-juvenile threshold was presented in poster communications by Antje Bischoff (Berlin, Germany), Rodolphe E. Gozlan (Toulouse, France/Hatfield), Laura Old (Bratislava/ Hatfield), Martin Reichard (Brno, Czech Republic), Milica Stojanova (Skopje, Macedonia) and Jaroslaw Zelepien (Olsztyn, Poland). Relative growth patterns during metamorphosis n some marine species were also examined, in oral communications by Ivan Katavic (Split, Croatia) and Sergey Tsarin (Sevastopol, Ukraine).

Finally, ontogenetic shifts in microhabitat use by young-of-the-year (0+) fish were investigated by Etienne Baras and Joseph Nindaba (Liege, Belgium), Thomas Mehner (Berlin, Germany), Sirka Staff (Joensuu, Finland) and Josef Wanzenbock (Mondsee, Austria). These studies are a further indication of the importance to adopt an integrated approach to the study of fish early life history, as well as the need to evaluate the interactions between fish and prey populations.

On the afternoon of the Workshop's banquet, the convenors took the group on a field excursion to the Gabcikovo hydroelectric complex on the River Danube, which has recently been the subject of a trial at the World Court in the Hague. It was a rare opportunity for most participants to visit this eerie and uninspired engineering achievement, whose long-term effects on the fish fauna and freshwater habitats of the Piedmont zone of the Danube River have yet to be fully evaluated. The trip was topped off by an example of the local cultural integration that borders the Danube, the participants being served Hungarian purkurtt (internationally known as gulasz) with Czech-style dumplings, washed down with Slovak beer, wine or Kofola (the local type of cola).

The original objective of the first FONE workshop was to bring together

of different background and experience in fish biology, with the hope to foster discussions and suggest directions for future research. The Bratislava meeting no doubt has succeeded in both purposes, thanks to the enthusiastic participation of its contributors and the unstinting efforts of the organising committee. The progress made at this 1st meeting of the Fish Ontogeny Network of Europe is expected to be followed up in two years time with a 2nd workshop, tentatively to be hosted by Thomas Mehner in Berlin. Persons interested in FONE activities should join the EUROFISH eMail list, which acts as the forum for FONE exchanges of information, or alternatively contact Gordon Copp (g.h.copp@herts.ac.uk).

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UPCOMING MEETINGS

The Second International Congress on the Biology of Fishes

The Second International Congress on the Biology of Fishes will be held July 26-30, 1998 at Towson University of Maryland, Baltimore USA. This meeting is organized by the Physiology Section of the American Fisheries Society and is open to all researchers, teachers, managers and students who are interested in fish biology. Symposia to be held at the meeting include

Biology of Burbot;
Culture of Fish Eggs and Larvae;
Feeding Ecology;
Stress in Fish;
Smolt Physiology, Ecology and Behavior;
Tropical Fish Biology and Habitat Change;
Swimming Performance;
Fish Response to Toxic Environments;
Striped Bass Biology and Culture;
Ammonia Excretion and Toxicity in Fish;
Fish Cardiovascular Responses to Environmental Change and Indices of Fish Condition.

There will be a plenary session with lectures by distinguished fish biologists as well as general oral sessions and poster communications. Although there are specific symposia themes, communications and posters from all fields of experimental fish biology are quite welcome:

The venue of the meeting is the Burkshire Conference Center of Towson University, in Towson, Maryland a suburb of Baltimore. Registration packages will accomodate a variety of budgets. Suite accomodations are available at the Burkshire as well as at the Towson University dormitories and local hotels. Towson has convenient "light rail" access to the tourist attractions, restaurants and clubs of downtown Baltimore. Schedule your flights into Baltimore-Washington International Airport, if at all possible, but there are convenient rail/shuttle links from both Washington National and Dulles International Airports.

For more information, contact

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DATES TO REMEMBER

June 20-25, 1998	2nd International Symposium on Fish Otolith Research and Application	Bergen, Norway
July 9-13, 1998	22nd Annual Larval Fish Conference	Ann Arbor, MI
July 16-22, 1998	78th Annual Meeting of the American Society of Ichthyologists and Herpetologists	Guelph, Ont
July 26-30, 1998	Second International Congress on the Biology of Fishes	Baltimore, MD
August 23-27, 1998	American Fisheries Society Meeting	Hartford, CT

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