STAGES

VOLUME 42 (1&2) July 2021

INSIDE THE ISSUE

ELHS Back in the Days

10 years ago: First all-electronic version of STAGES

14 years ago: At least one participant of the 31. LFC in St. Johns, Newfoundland flies into St. John, New Brunswick

25 years ago: Sally L. Richardson Award becomes self sustaining

MESSAGE FROM THE SECRETARY

As I write this, life as an early life history scientist is slowly returning to a sense of the elusive "normal", although we still have many strides. In May, for the first time in over a year, my team and I were in the field to sample the larval fish community in the Gulf of Alaska! This trip was really only possible because of the strides that have been made by scientists with the development and distribution of not one, but multiple vaccines, across the globe! It was sad to miss seeing the larval fish community in person for another year, but Hannes and the co-organizers planned an excellent virtual conference for our Section. The Gatherly sessions also did an excellent job of capturing some of the in-person feel and it was wonderful to catch up with the larval fish community! This year's virtual conference featured 90 presentations (a mix of posters and talks) with over 240 participants from about 28 different countries. This highlights just how international the reach of the Early Life History Section of AFS has become as well as one of the benefits of the past year: more engagement at conferences when travel in a "normal" year would have been impossible due to finances and/or field obligations. I was excited to learn about all of the amazing research our Section has been up to since last year, despite all of the professional and personal challenges we have faced due to the pandemic.

It is also exciting that the STAGES editorial team is now complete with Drs. Peter Konstantinidis (Oregon State University) and Simon Geist (Texas A&M University Corpus Christi). They have some great plans for making each edition dynamic so please contact them if you have a picture of a cool larva you want featured. Also, remember to reach out to the Regional Representatives to get your latest research, experiment, or publication highlighted.

Stay safe!

Ali (Secretary, AFS ELHS)

AFS ELHS SOCIAL MEDIA STATEMENT

The American Fisheries Society (AFS) Early Life History Section (ELHS) is a diverse group of researchers who span every continent on the globe. As such, social media is a great opportunity for our section's researchers to connect and engage with each other outside of our annual meeting.

The ELHS's Early Career Committee manages our social media platforms. Their goal is to feature and promote the great work (current and upcoming) that our members are doing. As our section continues to grow, we want to grow our social media presence, too. We need your help to do this!

If you, or anyone in your research group, has content that may be relevant to the AFS ELHS please email it to **afs.elhs@gmail.com.** Some examples would be photos of you in the field, newly published papers, a blurb

about a recently funded grant, etc. This is a great opportunity for you to share your research to a broader audience and to connect with others studying the early life stages of fishes. When possible, include photos, videos, links to papers, and a caption (max 280 characters). Also provide the names of any accounts you would like us to tag. We will review these materials and if the content aligns well with our section, we will post it to our Twitter and/or Facebook page.

If you post elsewhere, please consider using the **#AFS_ELHS** hashtag or tagging us (**@AFS_ELHS** on Twitter; **@earlylifehistory** on Facebook) in relevant content so we can better engage with you.

Finally, if there are any accounts that you feel are relevant to the AFS ELHS that we are not already following, please tag us.

Thank you, in advance, for engaging with us!

The AFS ELHS Early Career Committee

NEWS FROM THE REGIONS

Northeast Region
Katey Marancik

Award winning student paper

Corinne Burns, a PhD candidate at the Université du Québec à Rimouski under the direction of Dominique Robert, was recently awarded the 2021 David Cushing Prize by the Journal of Plankton Research for her paper "Interannual variability of diet composition and prey preference of larval redfish (*Sebastes* spp.) in the Gulf of St. Lawrence". The prize, named in honor of the journal's Founding Editor, is awarded annually to the best paper by an early career stage scientist (30 years of age or younger) published in the Journal of Plankton Research in the last year. The paper, co-authored by Félix Lauzon, Stéphane Plourde, Pascal Sirois, and Dominique Robert, proposes an important trophic link between the survival of newly-extruded redfish larvae and the consumption of their primary prey, eggs of the calanoid copepod, *Calanus finmarchicus*. Corinne was also recently accepted into the inaugural cohort of the American Fisheries Society's Climate Ambassadors Program. The objective of the program is to train the ambassadors in effective means of science communication in order to educate various audiences, from the general public to policymakers, on climate change science.

The winning article has been made available for "Open Access" reading at: https://doi.org/10.1093/plankt/fbaa040

The official editorial article describing the award and the awardee can be found at:
https://doi.org/10.1093/plankt/fbab005
More information about the AFS Climate Ambassadors Program can be found at:
https://climate.fisheries.org/meet-our-climate-ambassadors/

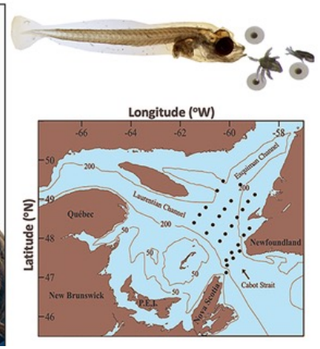

Figure 1: From the JPR editorial: Corinne Burns and her study subject, larval redfish and prey, in the Gulf of St. Lawrence

European Region
Catriona Clemmesen

Understanding changes in the functioning of nursery habitats for juvenile fish in the Wadden Sea (southern North Sea)

Suzanne Poiesz, Henk van der Veer, Johan van der Molen, Myron A. Peck

A considerable amount of research on fish early life stages is ongoing in the Wadden Sea, the largest tidal flat system in the world. This includes research on connectivity patterns, growth-survival mechanisms and fish community composition.

In her PhD thesis conducted at the Royal Netherlands Institute for Sea Research (NIOZ) Department of Coastal Systems (COS) and the University of Groningen, Suzanne Poiesz is using data collected from the long-term 'kom-fyke' monitoring program near the western-most entrance to the Wadden Sea (Fig 2A). The kom-fyke is a passive fish trap consisting of a 200-m net running from the beach towards deeper waters (the stretched mesh size is 20 mm). This net guides migrating fish towards 2 chambers and into a fyke (Fig 2B). The kom-fyke is emptied each day in the spring (March-June) and autumn (September-November) and is removed in the summer (due to algae) and winter (due to storms). All fish are identified to the species level, counted and their length measured (Fig 2C). Selected species/individuals are frozen for subsequent diet, age (otolith) and maturity analyses. Also, muscle samples are taken for stable isotope ($\delta^{15}N$ and $\delta^{13}C$) analyses. The 'kom-fyke' monitoring program is one of the longest running (60+ years) European time series examining marine fishes.

Results to date suggest a steady decline in the mean daily catch over the past decade, and that only a few key prey species fuel this temperate coastal fish community (Poiesz et al. 2020b). Recent work has also compared fish catches in the fyke with estimates of fish presence using eDNA (van Bleijswijk et al. 2020). Young juveniles of various marine fishes are often captured in the spring such as Atlantic herring (*Clupea harengus*), plaice (*Pleuronectes platessa*), European flounder (*Platichthys flesus*) and dab (*Limanda limanda*). In the autumn juvenile Atlantic herring and European sea bass (*Dicentrarchus labrax*) are routinely captured (Fig. 2C). At the time of writing this, the kom-fyke is just starting its spring sampling of 2021.

A second, active area of research is examining the transport patterns of early life stages of plaice (*Pleuronectes platessa*) and other flatfish species from offshore spawning sites to juvenile settlement areas in the Wadden Sea. Field samples of newly settled, juvenile plaice were collected at stations along the Dutch and Wadden Sea coast during 23 sampling campaigns conducted across 6 years. A total of 200 juvenile plaice were collected at each of 23 locations between Cadzand (Netherlands) to Fanø (Denmark) (Fig 3). From every other sampling location, 100 plaice from various length classes were selected for further analysis. Each individual fish was measured and both sagittal otoliths were removed for otolith microstructure analysis. Post-settlement daily growth rings of more than 7000 different otoliths have been counted. Post-settlement rings were counted directly after the accessory growth center (Fig 3: insert) as well as the age at settlement by back-cal-

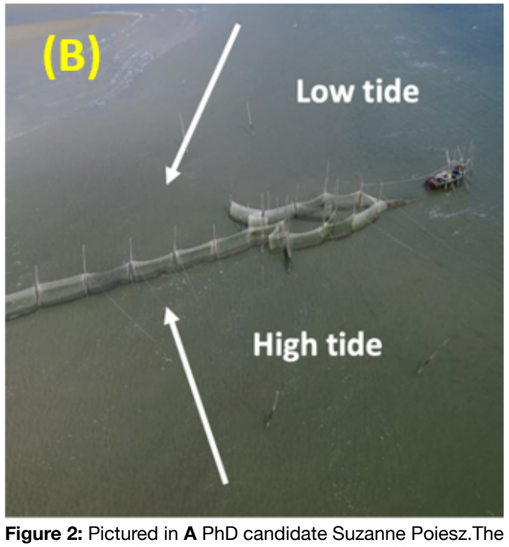

Figure 2: Pictured in **A** PhD candidate Suzanne Poiesz.The kom-fyke near the entrance of Wadden Sea catches migrating fishes during the ebb (low) and flood (high) tide (**B**). (**C**) typical catch showing late juvenile stages of various marine fishes.

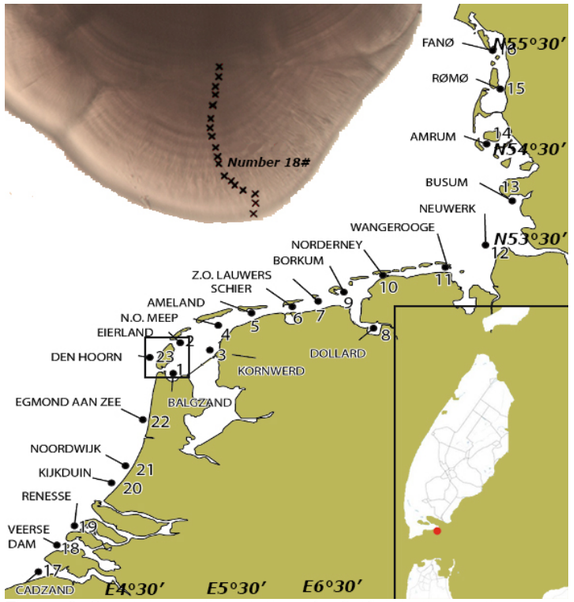

Figure 3: Coastal sampling stations for flatfish in the southern North Sea within the Netherlands, Germany and Denmark. The red circle indicates the location of the kom-fyke near the western entrance of the Wadden Sea. Top picture: plaice otolith with daily rings marked (black crosses) after the first accessory growth center until the edge of the otolith (18# days post-settlement).

culation of catch date minus the age in days.

Preliminary results indicate that cohorts of plaice settle over several weeks with considerable temporal variability across the spatial range of sampling. Individuals settling near Fanø (Denmark) and Cadzand (the Netherlands) are likely originating from different spawning stocks and grounds. The contributions of various spawning grounds to settlement patterns in each year are being established by combining otolith microstructure analysis with particle tracking using hydrodynamic models. Some recent work on the dynamics of young flatfish in Wadden Sea nursery habitats shows reduced growth rates in summer (Poiesz et al.2019; 2020a). The work is advancing knowledge on the metapopulation dynamics of plaice in the North Sea.

For more information on how to get involved with NIOZ fyke research on juvenile (pre-recruit) fish, please contact Dr. Anieke van Leeuwen (anieke.van.leeuwen@nioz.nl). For more information on flatfish otolith analyses, please contact Suzanne Poiesz (suzanne.poiesz@nioz.nl) or Henk van der Veer (henk.van.der veer@nioz.nl). For more information on hydrodynamic modelling, please contact Johan van der Molen (johan.van.der.molen@nioz.nl). For general information on NIOZ COS and research collaboration, please contact the department head Myron Peck (myron.peck@nioz.nl).

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Growth and Survival of Atlantic Bluefin Tuna

Edurne Blanco & Patricia Reglero, Spanish Institute of Oceanography (Spain)

In 2011, a group of researchers from the Spanish Institute of Oceanography, Edurne Blanco, Aurelio Ortega, Fernando de la Gándara and Patricia Reglero began a fruitful collaboration that is still ongoing. The aim was to boost experimental work to investigate the underlying physiological and behavioral mechanisms driving growth and survival of Atlantic bluefin tuna (ABFT, *Thunnus thynnus*) and Atlantic bonito (AB, *Sarda sarda*) larvae. Despite the ecological importance and interest of the two species, we felt there was an important lack of knowledge regarding their development during the early life stages. It was that year when the success in the captivity rearing of the two species encouraged us to try new experimental work. We had to deal, still have, with the challenges associated with handling before and during any laboratory trial because larvae are very sensitive to manipulation, as pointed out in Blanco et al. (2020).

During these 10 years we have learnt a lot about the larval physiology and behavior moving into building predictive models that can help us to understand mechanistically the species responses to perturbations and can result in more reliable indices of annual recruitment. Our experimental work has encompassed studies on the effect of temperature variation on growth, development and metabolism as well as the transition to piscivory (Fig.4).

Two of our most recent studies address metabolic rates and thermal effects on egg and larval fitness. In collaboration with experimental researchers from Norway, Marta Moyano (University of Agder) and Arild Folkvord

Figure 4. The experimental studies on Atlantic bluefin tuna larvae have been run at the facilities that the Spanish Institute of Oceanography have in Mazarrón (Spain). The work to date has been focused on studying the effect of temperature variation on growth, development and metabolism as well as the transition to piscivory.

(University of Bergen) we have measured metabolism during the larval stage. Understanding the energy balance between growth and metabolism is especially relevant as the two species need to support growth rates exceeding 60% their body weight per day. We explore how body size affects the oxygen consumption of fish larvae during the piscivorous stage using respirometry (Blanco et al. 2020). The results show a higher oxygen demand during the piscivorous stage compared to other species and an isometrical increasing with body size. Currently we are exploring the effect of temperature on eggs and larval fitness. Egg hatching was monitored at controlled incubation temperatures between 18,5 – 33,5ºC and the results showed that they can hatch from 18.5 to 33.5 ºC but below 21 ºC and above 30 ºC at least 50% of the hatched larvae are abnormal and below 19 ºC and above 33 ºC, larvae have no chance to survive. The time to hatch at any temperature is longer than in other tuna species. These studies are helping us to identify key instants in energy demands and compartmentalization.

We feel the experimental work during the last years is improving our understanding of the species biology and ecology as well as the techniques for aquaculture production. These relationships are being used to develop indices of annual recruitment and predictions of reproductive timing under future climate warming scenarios. During the following years, we are planning to focus on

the mechanism of energy expenditure and storage, continuing with the research of the different metabolisms of the species.

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Covid19 fast-tracks the development of the online tool SmartDots for identification of fish eggs and larvae

Matthias Kloppmann (Thünen-Institute, Bremerhaven, Germany), Cindy van Damme (Wageningen Marine Research, Ijmuiden, The Netherlands) and Carlos Pinto (ICES, Copenhagen, Denmark).

As a positive result of the Covid19 measures, an online tool has been developed to aid calibration of fish egg and larvae identification. SmartDots was originally designed for fish ageing and maturity calibration exercises. But the travel restrictions due to the pandemic aided a quick expansion of the application to egg and larvae identification.

The ICES Workshop 2 on the Identification of Clupeoid larvae (WKIDCLUP2) was scheduled to meet beginning of September 2020 in Bremerhaven, Germany, to calibrate clupeoid larvae identification. Because of the Covid19 pandemic and associated travel and meeting restrictions, the workshop had to be postponed to 2021. However, and as an add on, in order to provide potential participants with urgently needed advice for clupeid larvae identification, a video conference was scheduled. The meeting was chaired by Matthias Kloppmann. In total, 27 persons representing 13 institutes from 11 countries participated in the online workshop. The majority of the time at the workshop was spent identifying fish larvae. For this, prior to the workshop, the WebApplication SmartDots http://www.ices.dk/data/tools/Pages/smartdots.aspx was adapted to be utilized for ichthyoplankton identification based on images.

The SmartDots age reading platform is an open source solution originally developed by ILVO (Flanders research institute for agriculture, fisheries and food, Belgium). All source code is publicly accessible. The SmartDots web application was further developed in cooperation by ILVO, ICES, DTU-Aqua (Denmark) and IMR (Norway) to aid (inter)national maturity and age reading exchange, training and workshop events. The development of SmartDots within ICES is guided by the working group on SmartDots Governance (WG-SMART). The main aims of the SmartDots platform are to allow the community to store and update readers' expertise, create and organize events, and uploading and storing samples and images. The SmartDots database is developed in Microsoft SQL and can be accessed by a Web interface or WebAPI.

When it became clear, that a video conference was planned to partly replace last year's physical WKIDCLUP2 meeting, it became desirable that SmartDots would be adapted to also aid ichthyoplankton identification events based on microscopic images of fish eggs and/or larvae. Scientists from DTU-Aqua, Wageningen Marine Research (the Netherlands), Thünen-Institute of Sea Fisheries (Germany) and in particular the ICES datacentre were involved to adapt SmartDots.

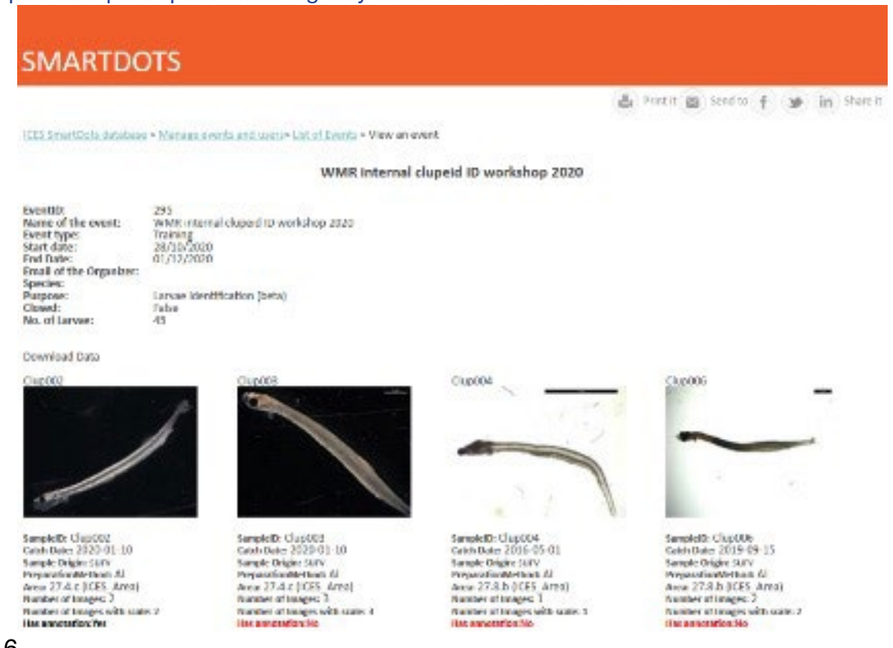


Figure 5. View of SmartDots event as participant.

An organizer of an ichthyoplankton event on SmartDots should upload sample information (e.g. catch date, species, stock code, length) and the images for the samples. It is possible to upload more than one image of an egg or larva for each sample, e.g. at different lighting or magnification. The organizer can set a scale to each of the microscopic images enabling participants to undertake direct measurements on the larvae, e.g. of total length, standard length or head length. The event organizer will need to add the participants to the event. Currently, anyone in the community can get a username and a password at ICES and request the organizer to be added as a participant to an ichthyoplankton event. Once the organizer finishes setting up the event, it can be opened for participants, who can view and start annotating online, in their own time and at their own speed, as long as the event is opened.

For the Clupeoid Larvae workshop, participants were enabled to do annotations. Annotations were done for each sample (larva) and included:

- Select the species name from a dropdown menu
- Count myotomes of either the trunk or between pylorus and pelvic fin directly in an image by setting dots
- Measure total, standard or head length of a larva by creating polylines in an image.
- Make a comment

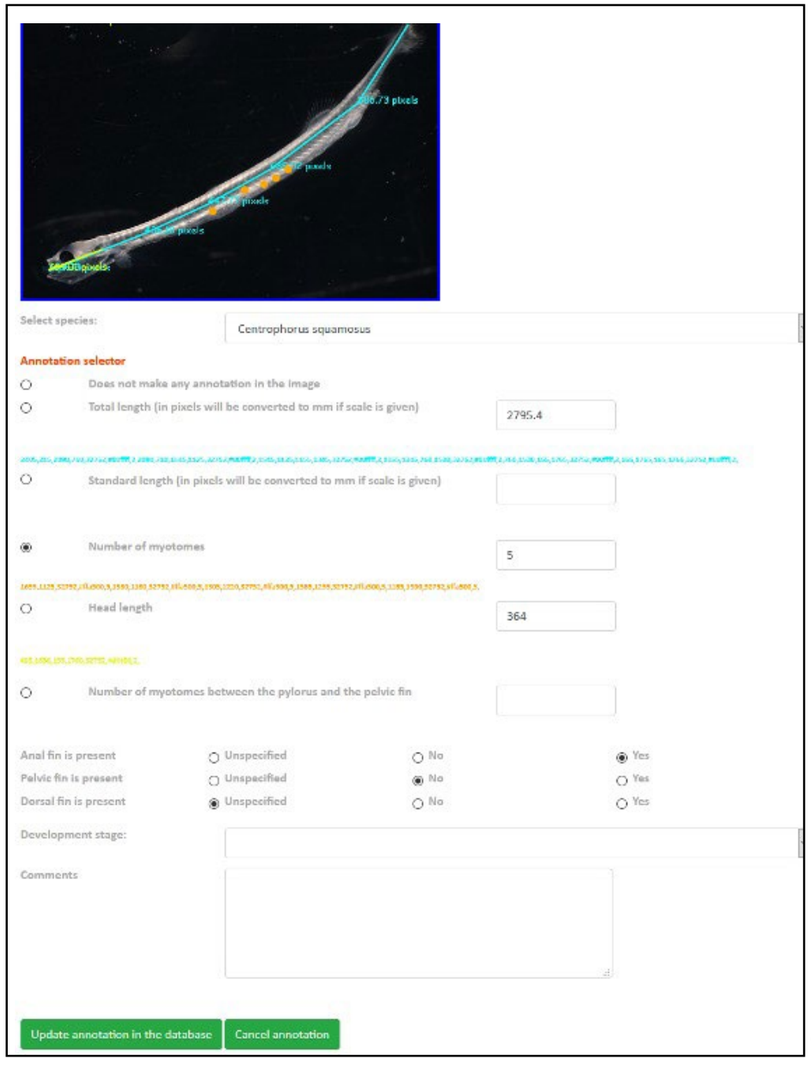


Figure 6. Anotation view of in the WebApplication SmartDots.

The organizer can follow the participation during the event and see how many annotations have been entered for each sample. Once all participants have finished their annotations the organizer closed the event. The organizer can download all results of the event for further analyses. But as soon as the event is closed participants can see their own and other participants results by sample and compare his/her annotations to others. This allows for learning and discussions on specific samples.

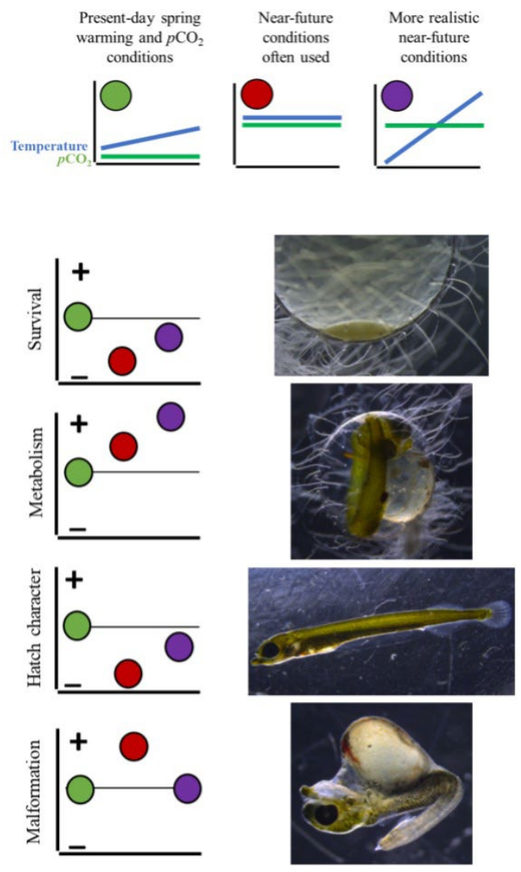
All participants of the event were positive about the SmartDots application, although there were of course multiple suggestions for modifications. They found it easy to work with after a 10-minute instruction presentation. Of course, a lot depends on the quality of the images that are available. For this event, up to three images of a larva with different lighting (top-light, transmitted, polarized) or magnification were available. The results of the WKIDCLUP2 were analysed in the traditional way using modified Excel tables. Overall agreement in identifying clupeid and discriminating them from other, non-clupeid larvae among all participants was 81.7 %. Agreement for herring larvae was 86 %, for sprat 80 %, for sardine 86 % and for anchovy 71 %. Subsequent analysis of the myotome counts, which was also facilitated through the SmartDots WebApplication, showed that particularly in those specimens that showed low agreement in correct identification, variation of myotome counts was high.

In 2021 the ICES community will organise another clupeid larvae event, as well as an egg identification event, focussing on mackerel, horse mackerel, hake and similar eggs. In the future WGSMART also wants the possibility to create a reference collection of images of known species to aid identification.

Comparison between different warming scenarios and pCO_2 levels on garfish, *Belone belone* larvae in temperate habitats.

Katharina Alter & Myron Peck

For the past two years Katharina Alter has been working as a post-doctoral researcher in a collaborative EU ERANet project "CLIMAR" (Climate driven changes in habitat suitability of marine organisms) bringing together ecophysiologists in Germany, Italy, Chile and Argentina. CLIMAR was designed to gain a more mechanistic understanding of how climate change will redistribute economically and ecologically important marine species. The group created and applied a standardized experimental design to measure how critical thermal limits changed in marine species exposed to high pCO_2 (ocean acidification, OA). These results were used in oceanographic models to make physiology-based projections of climate-driven changes in suitable habitats. In the group of Myron Peck at the University of Hamburg, Katharina worked on embryos of the garfish, *Belone belone*. Garfish is not commercially important but plays an important role as a piscivorous predator in the Baltic Sea.



Garfish embryos were artificially fertilized and reared until hatch in a full factorial design with two pCO_2 x three temperature treatments. The two pCO_2 levels were 400 µatm (present-day) and 1300 µatm (projected in an IPCC scenario for the year 2100). Three temperature treatments were: i) warming from 13°C by 0.1°C/day, ii) warming from 13°C by 0.3°C/day, and iii) a constant 17°C. The in situ temperature of parental fish was 13°C and 0.1°C/d is the average spring warming rate in nature. A previous study (von Westernhagen 1974) reported peak embryonic survival of *B. belone* from the Western Baltic Sea at 17°C, a temperature that also represents the 4°C increase projected in the worst case IPCC greenhouse gas scenario (RCP8.5). Apart from measuring critical thermal limits also survival, developmental rate, metabolism (heart rate), hatching success, and morphology were examined to determine if the expected positive effect of increased temperature on these parameters would be constrained by exposure to OA. Survival was drastically reduced at the future pCO_2 level and at the constant high temperature while the highest survival in any treatment was observed in the +0.3°C/day warming treatment. The proportion of embryos with morphological deformities increased with elevated pCO_2 but not temperature. On the other hand, hatch characteristics and physiological measures such as heart rate and critical thermal limits were not sensitive to OA but were influenced by temperature.

Our results suggest that garfish in the Baltic Sea will benefit from the increased rates of spring warming but not the concomitant increase in pCO_2 projected in 2100. Based on the results of previous OA studies on other resident fishes in the Baltic Sea (Frommel et al. 2013; Glippa et al. 2017; Sswat et al. 2018), this piscivorous fish is at higher risk compared to its prey which may have broader implications for the future trophodynamic structure and function of the coastal food web. Our study is an example of using an experimental design that incorporates changes in abiotic factors (T and/or pCO_2) naturally experienced by early life stages of fish in temperate habitats. This study is currently under peer review.

Figure 7: The top three panels show (left) current, present-day temperatures and pCO2 experienced during the spring in the Baltic Sea, (middle) commonly used, static treatment levels representing climate change, and (right) projected increases in spring warming and OA used in the garfish study. The bottom panels show changes (relative to control, green) in survival, metabolism, hatch characteristics and malformation studied at different life stages (right hand photos). Ocean acidification (increased pCO2) but not elevated spring warming threatens garfish embryos from the western Baltic Sea.

In her current post-doctoral position with Myron Peck at the Royal Netherlands Institute for Sea Research, Katharina Alter will continue examining the ecophysiology of early life stages of coastal fishes. Emphasis will be on measuring aerobic scope and the ontogeny of swimming ability in the larvae of fish from the Dutch Wadden Sea.

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From Namibia

Historically the first Ichthyoplankton study in Namibia commenced in 1960 (Le Clus, 1990) during September to April, sampling intensified between 1972 and 1974 (O'Toole, 1977) during the South West African Egg and Larval Survey (SWAPELS) focusing on *Trachurus trachurus* and again from 1978 to 1985 (Badenhorst and Boyd). These surveys covered the area from the Kunene River to 26°S, where a study on these samples was done by King in 1977, who focused on the early stages of *Sardinops sagax* and *Engraulis encrasicolus*. Olivar & Futuno (1985, 1987, and 1990) studied the Ichthyoplankton distributional patterns and species assemblages in the Benguela region from samples obtained between 17°30'S and 36°S placing particular emphasis on the Northern Benguela system. Different German vessels such as the Meteor also did Ichthyoplankton studies along Namibia in the early 90's to the late 2010s (Ekau & Geist). The R/V Fridjof Nansen also conducted studies on Horse mackerel, Sardine and Anchovy fish larvae in the early 90's (Stenevik & Sundby) and in 2001-2005 during the months of January-April which covered the Namibian coast and Angolan waters (Kreiner *et al.,* 2014). The Ministry of Fisheries and Marine resources in Namibia initiated a fish egg sampling program using the Continuous Underway Fish Egg Sampler (CUFES) which was led by Dr. Anja Kreiner in 2005. The CUFES machine has an inlet pump with a flow rate ranging from

Figure 8: R/V Mirabilis

600-800 liters/min and a concentrator with an oscillation of 500µm nitex mesh net, the samples are collected at a depth of 2-3m after every 30 minutes, and then samples are preserved in 5% formalin.

Presently the fish egg sampling program is led by Miss Josephine Edward a Fisheries Biologist, and her team consisting of a Technician Mr. Leevi Mwaala and a Technical Assistant Mrs. Nelda Uris for the past 8 years. Through this program the team initiated the first fish larval studies in 2013 with the assistance of Dr. Simon Geist onboard R/V Mirabilis. The samples were collected using a Ring trawl provided by the Tropical Center for Maine Research (ZMT) in Germany. Most of the Ichthyoplankton data collected is limited to the pelagic layer as we do not have a multinet to do vertical sampling. The aim of the fish egg and fish larvae studies is to determine the spawning areas and nursery grounds along the Namibian coastline of different fish species. The scientific data and results are used in providing scientific information and recommendation to Management and used in Total Allowable Catch (TAC) reports. Management is provided with this information in order to carry out sound decisions which protect, preserve and contribute to a sustainably utilization of marine resources for the benefit of current and future generations.

Josephine and her Team started the first Ecosystem Approach to Fisheries (EAF) Dr. Fridjof Nansen Ich-

Figure 9: Miss Josephine Edward

thyoplankton Training and Analysis Workshop on 17. - 28. of September of 2018 at NatMIRC, funded by the Food and Agriculture Organization (FAO). This workshop gathered ichthyoplankton scientist from Norway and Benguela Current Large Marine Ecosystem countries (BCLME) South Africa, Angola, Namibia to provide training in fish egg and fish larvae identification, standardize the identification method for the BCLME countries, build capacity and foster strong collaborations between researchers from all the participating countries. The fish species of commercial and ecological importance such as Sardine, Anchovy, Horse mackerel, Hake and Goby etc were identified to species level. The data results were used to create an identification guide for the BCLME region and map spawning areas in the BCLME region. Furthermore, the Ichthyoplankton dataset is also provided to students from different tertiary institutions e.g., the University of Namibia (UNAM), for their research projects and capacity building, focusing on female students, to increase the participation of women in the field of Marine research.

During these unprecedented times of the pandemic which has resulted in COVID-19 restrictions, sea going activities have been limited, hence the focus now is to statistically analyze the CUFES dataset and publish in internationally recognized journals. Efforts are being made to collect historical Ichthyoplankton dataset collected in Namibia in order to establish an Ichthyoplankton time series of all the data collected in Namibian waters.

Figure 10: FAO Nansen Ichthyoplankton identification training workshop

Figure 11: Laboratory at Natmirc Swakopmund

Pacific Rim Region
Akinori Takasuka

Entrainment coastal fish larvae by the East Australian Current

Iain Suthers[1], Paloma Matis[2], Charles Hinchliffe[1], Tony Miskiewicz[1,3]

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Research Vessel Investigator is 150 km off Brisbane and North Stradbroke Island (3 May-4 June) to retrieve and re-deploy the 6 deep ocean mooring array, that monitors the East Australian Current. While the mooring crew rests, the nocturnal plankton crew keep the ship busy towing a 70 cm diameter bongo net, to complement the long-term observing at the IMOS national reference mooring off North Stradbroke. Until the September 2019 voyage, there has never been a survey of larval fish off SE Queensland, when PhD student Charlie Hinchliffe and the IMOS researcher Dr Paloma Matis discovered a multitude of sardine, anchovy and mackerel (*Scomber*) in a frontal eddy, that scooped them off shelf just south of Fraser Island. We are addressing the hypothesis that frontal eddies are an offshore nursery ground for larval fish.

This year we have a similar frontal eddy just east of North Stradbroke Island, which we will sample next week as we head inshore, to pick up moorings closer to the shelf. Our voyage left Hobart last week and we sampled adjacent to the Maria Island mooring near Hobart (37 degrees S); then the Port Hacking mooring off Sydney (34 degrees S); and then in the inner shelf water off Port Macquarie (just south of Smoky Cape, 31 degrees S) where we estimate over 2,000 larvae in a 15-minute tow (1000 m^3). Off Brisbane (27 degrees S), the EAC has swept down from the southern GBR; we picked up a dramatic post-larval *Beryx* larva (a deepwater fish; Fig. 13). We are finding many eel leptocephali which Tony Miskiewicz is working through with John Pogonowski in Hobart; and many tropical reef fishes in the EAC which transport them to characteristic locations in south eastern Australia (tropicalisation).

Our small publicly available IMOS-larval fish monitoring (ILFM) dataset is growing; we have nearly 485 net tows, sorted 553 samples; and nearly 40,000 larvae on record, distributed across 218 standardised taxa (and up to 240 taxa with improving knowledge, imagery and genetics, including rare and endangered taxa) back to 1983; and monthly since 2015; and all carefully aligned with zooplankton and oceanographic data. A recent summary can be found in Hinchliffe et al. 2021.

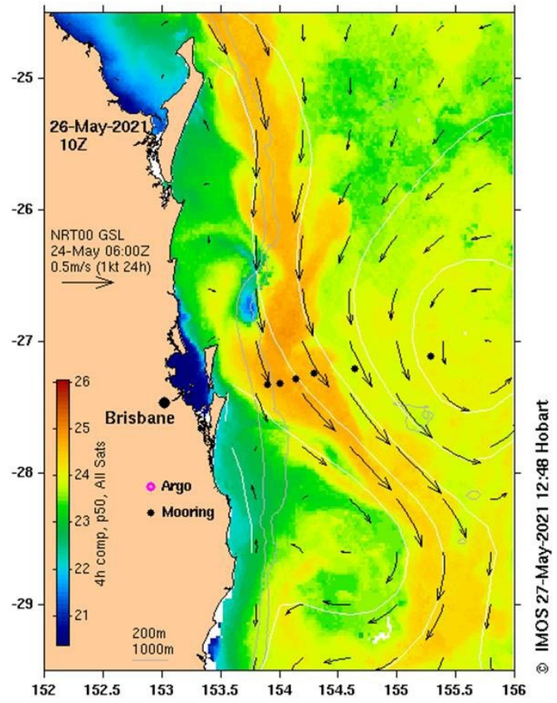

Figure 12: SST image of eastern Australia, also showing estimated geostrophic velocity (black arrows indicate the path something would travel over a 24hr period); grey lines are 200 m and 1000 m isobaths; white lines are Sea level height (GSLA plus Mean Dynamic Topography): white contours every 0.1m (www.ocean-current.imos.org.au).

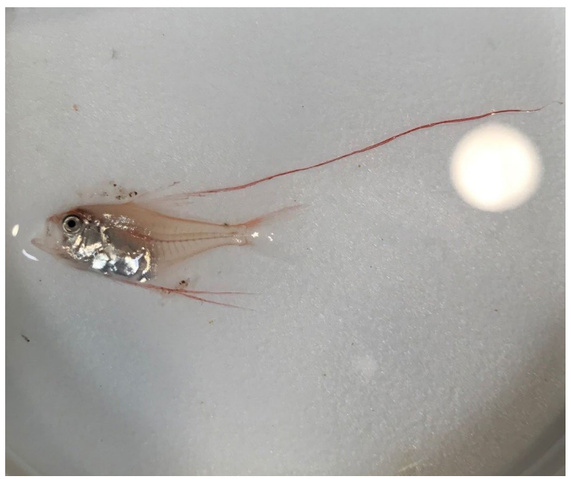

Figure 13: Post-larval Beryx (identified by Jeff Leis).

Reference

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High abundance of congrid-eel *Ariosoma scheelei* larvae at shallow depths of the NW Coral Sea

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Few studies have been conducted on the detailed vertical distributions of leptocephali, the unique larvae of elopomorph fishes, because most depth-stratified sampling for fish larvae are conducted with small mouth-opening net-systems, which larger leptocephali can usually avoid. A unique opportunity resulted from a May 1997 survey to study lobster larvae in the NW Coral Sea (NWCS) (Dennis et al. 2001) that fished a 2-mm mesh 70 m^2 mouth-opening trawl with a multiple opening-and-closing codend system at 13 areas (Fig. 14A). The fish larvae by-catch of the survey were transferred to the Australian Museum (AM) and this included about 40,000 leptocephali, which were unexpectedly abundant due to large catches of *Ariosoma scheelei* leptocephali. MJM used an AM Collections Fellowship Grant to visit the museum and obtain data from a subset of the overall stations at each of the depth layers for 2 night stations per area. The ~10,000 leptocephali at those stations consisted of 73% *A. scheelei* larvae, and interestingly 76% of the larvae were in the 0–12 m depth layer at night (Fig. 14B) (Miller et al. 2021), but they were also present at that depth during the day. Pre-metamorphosing larvae were present in all areas, and metamorphosing larvae were most abundant near the large shelf area in the northwest.

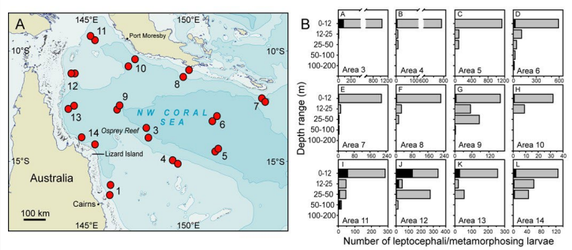

Figure 14: Map of the sampling stations used by Miller et al. (2021) (A), and the catches of *Ariosoma scheelei* leptocephali at each depth in the NWCS (B, black shows metamorphosing larvae).

Leptocephali of this species may typically be distributed at shallow depths, because *Ariosoma* are the most frequently collected leptocephalus taxa in neuston nets (Miller et al. 2006), as overviewed in a recent review that includes the vertical distribution of leptocephali (Miller and Tsukamoto 2020). *Ariosoma scheelei* leptocephali were also the most abundant species around Sulawesi Island, Indonesia, in intensive 8.7 m^2 midwater plankton trawl surveys (Miller et al. 2006, 2016). Those studies and the present study in the NWCS seem to indicate that these small eels that as adults burrow in soft sediment in shallow protected areas such in the Great Barrier Reef, may be present in much greater numbers than is presently known, as discussed in the recent paper (Miller et al. 2021).

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LARVAE OF THE ISSUE

Figure 15: Unidentified squirrelfish larva from the Museum national d'Histoire naturelle. Photo by Nalani Schnell

This unidentified squirrelfish specimen (MNHN 2018 1011, 5.9 mm SL without spine) was found in the Paris MNHN larval fish collection and has been collected in 1977 in the Pacific Ocean. The Holocentridae comprise two subfamilies, the Holocentrinae (squirrelfishes) and the Myripristinae (soldierfishes).

Larvae of both subfamilies are characterized by elaborate head spination comprising a distinctive rostrum formed by the nasal bones; a very long, serrate spine at the angle of each preopercle; a medium-sized, serrate opercular spine; and a median, serrate supraoccipital spine. Larvae of the two subfamilies are readily distinguished by differences in their rostral morphology and pelvic-fin development; Holocentrinae have a single, median rostral spine and late forming pelvic fins, whereas Myripristinae have a bilaterally paired rostral spine and early forming pelvic fins. We can identify and homologize head spines among different larval taxa, but their function and adaptive significance remain poorly understood. In any case the rostrum in the here shown specimen is one of the longest we have encountered while working on the development of the spines in this group (Johnson and Schnell, 2015).

Larval development of different holocentrid species has been described by several authors (McKenney, 1959; Jones and Kumaran, 1962; Aboussouan, 1966 ; Leis and Rennis, 2004). However, holocentrids are very similar morphologically with little meristic variation and much work is needed to establish a comprehensive larval identification key.

Figure 16: This is the picture of a Lake Sturgeon (*Acipenser fulvescens*), this larvae was captured by a Bongo net in the St. Lawrence River (Québec, Canada).

The Quebec Ministry of Forests, Wildlife and Park (MFFP) is conducting spring and early-summer ichthyoplankton sampling in the Lake St. Pierre Archipelago, a region of the St. Lawrence River (Québec, Canada). Fish monitoring in this highly dynamic and complex ecosystem, representing a mosaic of streams, wetlands, shallow channels and the deeper St. Lawrence River, offers the possibility to sample early life stages of over 30 fish species, including the Lake Sturgeon (*Acipenser fulvescens*). This Lake Sturgeon larvae picture was taken by Sarah Aubé, one of the MFFP technicians working on the complex task of larvae sorting and identification. This annual sampling is providing a unique opportunity for the monitoring of rare and threatened species as well as early detection of invasive species.

Larval Fish Collection of the Issue

Peter Konstantinidis

Oregon State University, Dept. of Fisheries & Wildlife, Corvallis OR

In this new rubric we would like to introduce a natural history collection in each STAGES issue that has an ichthyoplankton collection. The idea dates back a few years ago and was born out of an issue, I experienced firsthand and heard about from colleagues: The disconnection between different fields of early life history research and larval fish collections in form of a university research collection such as Oregon State University fish collection (OSUIC) or a Natural History Museum. It took until 2016 when I met Simon Geist, our new co-editor, when he participated in a larval fish identification workshop at the Virginia Institute of Marine Science (VIMS). Simon, newly appointed at Texas A&M Corpus Christ after working at the Leibniz Zentrum für Marine Tropenforschung, Bremen, had worked on larval fishes from the Benguela Current, since 2009. The two of us began talking about the importance of collections as a repository for larval fish samples such as Simon's from the Benguela Current as the final and concluding step of any ichthyoplankton research that includes sampling.

So, what do we mean with 'disconnection' between research labs and collections? A common research project in our field involves collecting samples, in some cases over multiple years. Naturally, the PI or researcher wants to hang on to the samples to extract all the data that are necessary to conclude the proposed project. But what happens with the physical samples after the project comes to an end, or in long term projects when the data from a year of sampling are available and the samples are no longer of use? Usually nothing! They are either stored until the research lab bursts out of its seams or the PI under whom the samples were collected, moves on to a new job or retires. This is usually the time when curators get contacted from a lab member or a facilities manager, whether you are interested in taking those samples over. Ironically, between the first contact and when the samples must leave the current storage is usually only a few weeks, which is in most cases too short of a time frame to organize a proper move. This puts curators and collections managers in a dilemma because they don't like to discard anything, really.

However, these ichthyoplankton samples do not turn useless after a project is concluded but they are going to deteriorate in a non-climate-controlled storage facility without a dedicated curatorial hand. The samples are of great value and worth preserving for posterity as vouchers for the incredible research they were part and as temporal and spatial witnesses. This column is an attempt to spark future alliances between those in our community involved in ichthyoplankton research and those working on the long-term preservation of these samples. We would like to motivate researchers to think of the transfer and the long-term storage of the specimens as part of the research project and begin early to find an appropriate collection, before the project starts, to give collections managers time to figure out storage space and logistics. Some funding agencies, as well as most Animal Care and Use Proposals (ACUP) now demand a justification what happens with collected material after completing a project and many journals will not publish a manuscript when the samples used for a study are not accessioned in a collection or museum.

Here at OSU Peter established early on (before he had the job offer) a connection with our well known colleagues Drs. Su Sponaugle (Oregon State University, Dept. of Integrative Biology) and Robert Cowen (director of the Hatfield Marine Science Center; HMSC) (Plankton Ecology Lab), to integrate samples to the fish collection. An ideal symbiotic interaction exists between the Alaska Fisheries Science Center and the fish collection of the Burke Museum in Seattle. There are more examples than the aforementioned, but we need more of these connections to protect and safeguard the precious larval fishes in your "drawers".

The Oregon State University Ichthyology Collection (OSUIC)

OSUIC was established in 1935 and is the largest in the state of Oregon with about 250.000 adult fishes. OSUIC holds the world's most complete library of fish biodiversity from Oregon and serves as a major repository from throughout the Pacific Northwest. OSUIC has holdings from around the world, for example Antarctica, the Mediterranean, Iran, Peru, African continent, and

Figure 17: A fraction of the larval fish samples that are going to be accessioned in the fish collection and made available to the scientific community.

South America just to name a few.

In the 1980's the OSUIC inherited a large marine collection from the School for Oceanography. Among the samples was a large ichthyoplankton collection that formed the basis for many important fisheries and ecological as well as taxonomic studies. These early holdings are linked to Sally L. Richardson, one of the first women in the field of larval fish research (Fig. 17). At her time at Oregon State University (1971 – 79), Sally rose from a Research Associate to Associate Professor-Senior Researcher (Collette, 1986), and has become the most recognized woman in the field of ichthyoplankton research (I have a photo of her from 1976). Her contributions encompass taxonomic, ecological and fisheries related themes. The Sally Richardson Award for the best student paper presented at the annual LFC was established to honor her substantial contribution to the ichthyoplankton field. With the support of undergraduate volunteers, I completed the transfer of Dr. S. L. Richardson's ichthyoplankton holdings from formalin to 70% ethanol, located the metadata and cruise reports that were assumed to be lost, and am currently in the process to accession the samples to make them available to the scientific community.

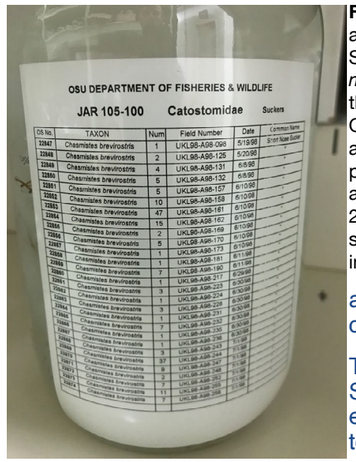

Figure 18: Accessioned and safely stored larval Shortnose suckers (*Chasmistes brevirostris*) from the Upper Klamath Lake, Oregon. The samples are part of a multi-year project that began in 1990 and was completed in 2013. These particular samples were collected in 1998.

The samples from Su Sponaugle and Robert Cowen belong to several research projects collected in the Atlantic, Straits of Florida, the Caribbean and the Gulf of Mexico. These collections comprise about 50,000 vials, some of them are sorted and identified and some of them are mixed species lots. These projects supported numerous students over the years and the publication rate is high across the different projects.

OSUIC houses the largest assemblage of freshwater ichthyoplankton from Oregon collected by Dr. Doug F. Markle (ca. 32,000 vials). A large portion of the collection originated from a multi-year collection event of the Upper Klamath Lake, Oregon to understand early life history of the endangered Shortnose and Lost River suckers (*Chasmistes brevirostris* and *Deltistes luxatus*). Among the larvae are specimens used for the first description of larval stages of the Oregon chub (*Oregonichthys crameri*), an endangered species endemic to the Willamette Valley. The collections include skeletal data from x-rays from 22,000 individuals.

Figure 19: The teaching collection is based on S. L. Richardson's reference collection of representatives of about 65 families. Families will be added from other the collections to establish a comprehensive teaching collection for the larval fish online course (FW 528) and the laboratory (FW 529) that are part OSU's course cataloge.

The samples are identified to the lowest possible taxonomic level and already sorted which makes cataloging easier and faster.

Sally L. Richardson started a reference and teaching collection that comprises 65 families that forms the basis for the annual ichthyoplankton identification course for students (FW 529) and workshop for professionals and for online course in ichthyoplankton evolution and systematics (FW 528) that will launch in the fall term of 2021.

Figure 19: Larval Fish Workshop 2019. The workshop was based on sorting real samples of mixed species vial from several larval fish surveys to expose the participants to a broad selection of larval fish diversity. The participants also presented on their research (in this photo: Solange K. Andrade Vera from the Galapagos Islands, Ecuador. Tony Miskiewicz (front right corner) was a surprise guest and his experience was a great additon to the course.

Announcements

Ai Nonaka, that you might all remember from her impressive presentation at last year's townhall meeting, M. Laura Habegger, and Miguel Montalvo launched a line of bamboo forceps (handmade by M. Montalvo) which are useful for handling larval fishes. The Bamceps are availabe in three sizes and two type of tips. The long tips can easily reach at the bottom of the small vials. And the flat spatula-like tips will allow for a delicate yet strong grip of your specimens.

The Bamceps are available on Etsy: https://www.etsy.com/listing/845235048/bamceps-fine-bamboo-forceps

Please contact japarco@outlook.com for any questions.

Larval Fish course in Concarneau, France

Dr. Nalani Schnell from the Muséum national d'Histoire naturelle, based in the wonderful town of Concarneau in Brittany had to cancel her larval fish course for the upcoming summer for the second time. The great news, however, is that the dates are set for the course in 2022! The course is a great combination of ichthyoplankton taxonomy, systematics, and ecology. Please contact Nalani Schnell (nalani.schnell@mnhn.fr) for further information.

Larval Fish Course

Postponed to 2022 !!!:
19th September - 30th September 2022,
Concarneau, France

STATION MARINE CONCARNEAU

We offer an international lecture and laboratory course at the marine station in Concarneau, France, based on samples from the Eastern North Atlantic and Pacific Ocean.

We provide:

1) **Labs on larval fish identification (~50 fish families)**
2) **Lectures on key identification features, systematics and ecology**
3) **Lectures on sampling and preservation methods**

Lectures and labs will be delivered by:
Catriona Clemmesen (GEOMAR, Germany),
Cindy Van Damme (Wageningen Marine Research, Netherlands),
Peter Konstantinidis (Oregon State University, USA),
Cyril Gallut (UPMC, France), and
Nalani Schnell (MNHN, France).

Places limited to 15 participants, course registration fee 850 € per person

For further information and registration please visit
https://sites.google.com/view/larval-fish-course/
or contact Nalani Schnell
nalani.schnell@mnhn.fr

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RAMBLE ON

Hello together, after Pierre Pepin's call in our virtual business meetings for a co-editor of the STAGES newsletter, I reached out to Peter Konstantinidis to see if he would be interested in my help and earlier this spring I received Claire Paris' approval as a co-editor.

We would like to apologize for the late release of this newsletter for different reasons, but we hope to have all material together in time for the next one scheduled for Fall. So please send us your contributions by **September 15**.

Short intro about myself, I am an Assistant Professor at Texas A&M University Corpus Christi where I lead the Early Life History or Larval Lab (www.geistlarvallab.com). Before I came to Texas, I worked in different projects located at the Leibniz Center for Tropical Research in Germany.

For our newsletter, I hope to be able to recruit early life history researchers from around the world, who may not be aware of our newsletter and are not yet active in our section. We will also reach out to the blackwater diving community to see if they are interested in joining in as well. Peter and I met for the first time at VIMS in 2016, despite being both from Germany and both working on larval fishes but coming from an ecology and a phylogenetic systematics background. Peter delivered the first contribution for the new column *Larval Fish Collection of the Issue* with the Oregon State University Ichthyology Collection, and we hope to present a new collection in each issue in hope to tie new bonds between different research groups.

Best,

Simon