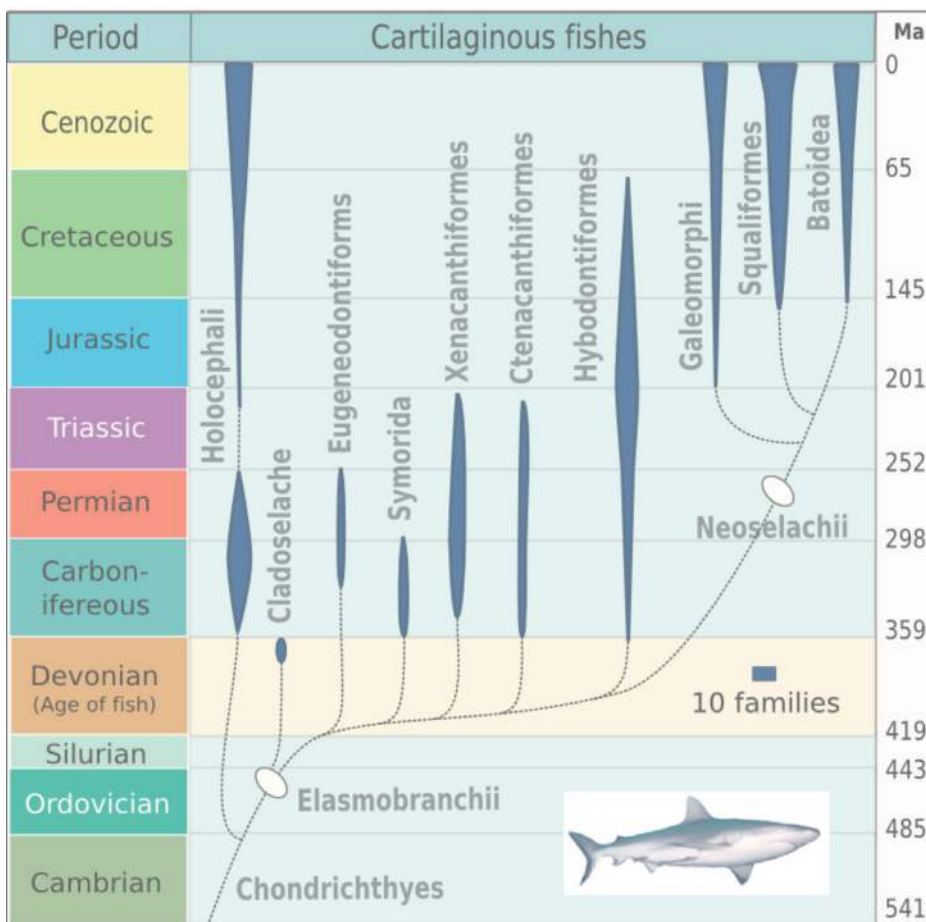


Jack Cooper, an FSBI funded PhD student, describes how the functional diversity of modern sharks is depleted when set in the context of their history over the last 66 million years



New research sponsored by an FSBI PhD studentship has found that sharks retained high levels of functional diversity for most of the last 66 million years, before steadily declining over the last 10 million years to its lowest value in the present day.

Modern sharks are among the oldest and most evolutionarily distinct of marine vertebrates

on Earth. They are also among the most threatened, with over a third of species being threatened with extinction, primarily due to overfishing. However, throughout their long evolutionary history – of at least 250 million years – they have notably survived multiple extinction events across all sorts of environmental changes.

Today, sharks are more than

500 species strong and those species play a variety of different ecological roles. For example, some species are apex predators while others are lower-level predators that partake in local nutrient cycling.

Ecological roles can be quantified by combinations of species' traits such as body size and diet. Measuring the diversity of these traits therefore showcases the range of ecological roles in a community, which is commonly referred to as functional diversity. As such, quantifying functional diversity through time using trait combinations allows scientists to assess the extent in which sharks contributed to marine ecosystem functioning, and the ecological effects of past extinctions.

One inherent problem is that measuring traits directly in extinct sharks from the geological past is notoriously difficult. Shark skeletons are made of soft cartilage, which decomposes after death and so making it impossible to measure traits such as body size. However, shark teeth provide proxies for these traits. For one they are much harder and are continuously shed by sharks throughout their lives, making them both well preserved and highly abundant in the fossil record. Furthermore, ➤



measurements such as a tooth's size, shape or presence or absence of structures such as cusplets or serrations can broadly reflect traits such as a shark's body size, what its favourite food was, and how it ate. As such, combinations of shark tooth measurements serve as proxies for quantifying trait combinations and therefore functional diversity through time.

I investigated this, with the help of my supervisor and co-author Dr Catalina Pimiento, by measuring more than 9,000 shark teeth – from both fossil and living specimens – from literature and museum collections worldwide. These were then used to quantify functional diversity of sharks across the entire Cenozoic era –

ranging from 66 million years ago to the present day.

Most of the Cenozoic sharks were found to have had relatively high functional diversity – essentially, a wide range of different ecological roles. This peaked in the Miocene epoch, about 20 million years ago, where sharks would have made widespread contributions to marine ecosystem functioning. However, after this peak, the extent of ecological roles played by sharks underwent a steady and consistent decline over the last 10 million years, with this being lower today than at any point in the last 66 million years.

To investigate why this decline had occurred, Pimiento

and I quantified the ecological contributions of individual shark species. This revealed that the observed decline was driven by the loss of species that were ecologically unique or specialised – those with either extreme trait combinations or trait combinations highly dissimilar to other species.

A key example of this was the extinction of the megalodon shark about 3.5 million years ago. Megalodon (*Otodus megalodon*) is famous for having been the largest shark that ever existed and ecologically, it was a gigantic species over 20 m long that gorged itself on large whales and even other predators. This equates to an ecological role as an apex super predator, one that is not played by any shark species living today. As such, this specialised ecological role went extinct alongside megalodon and thus lowered functional diversity of all sharks.

The main implication of these results is that ongoing human threats facing sharks such as overfishing are likely to further erode an already diminished functional diversity, worsening the ability of sharks to contribute to ecosystem functioning more widely.

The paper describing this work has now been published in the journal *Global Ecology and Biogeography* and will serve as a key chapter of my PhD thesis. Many thanks to the FSBI for their ongoing sponsorship of my research.



Artists impression of a megalodon shark attacking a whale.

Editorial



The accompanying photo was taken 30 years ago at the 1994 FSBI Summer Symposium, held in Glasgow and organised by Felicity Huntingford. For those of you of the right age, there will be people you can recognise, some of course, who are no longer with us. The president of the Society at that time was John Blaxter sitting in the middle next to Felicity with Robin Gibson, the Secretary, on his left. There are four successive presidents of the Society in the same row as John; myself, Inigo Everson, Felicity Huntingford and Iain Barber. David LeCren is in the fourth row slightly to the right of John with white hair and a tie. The number of delegates at this meeting was good compared to many at that time but is small when compared with the number who attended the Bilbao meeting.

As the Society has grown the nature of the conferences has changed. Until recently each conference has focused on a particular topic, for example, and no criticism intended, the meeting in Cambridge organised by Inigo Everson on polar biology. This focus limited the attractiveness of the meeting to members and non-members alike. The recent trend has been towards more general topics and this has increased the number of delegates. The meeting in Bilbao was focused on one aspect, eDNA, but this is a topic of such wide application that it clearly attracted many delegates. Keeping this balance between generality and widespread attractiveness is a difficult task but one that needs to be developed if the Society's annual gathering is to maintain its attractiveness

to the membership and the wider fish biology community. At the same time the conference does not need to become like the American Fisheries Society's meetings with over 1000 delegates. These require a huge commitment from an organising team and as a delegate, it is often hard to navigate the myriad diversity of talks and sessions.

From the accounts of David Mackenzie and Goshi Kato, the meeting in Bilbao was clearly a great success both scientifically and culturally. There must be few places in Europe that could provide such an attractive setting.

Paul J B Hart
Leicester 12th August 2024
Next deadline: 1st November 2024

David Mackenzie, Vice-President of the FSBI gives his account of the FSBI 2024 Annual Symposium at Bizkaia Aretoa Conference Hall, Bilbao, Spain. The organising group was led by Naiara Rodríguez-Ezpeleta (AZTI)



The 2024 Annual Symposium was the first FSBI symposium held outside the British Isles that took place with in-person delegates, on the theme *Advancing fish ecology, management and forecasting through omics*. The Symposium welcomed about 150 delegates from 31 different countries across five continents, to the splendid Bizkaia Aretoa Conference Hall in the centre of Bilbao.

Talks were held in the large and comfortable Mitxelena



Naiara Rodríguez-Ezpeleta and her colleague Meritzel González-Intxausti.

auditorium, while pre-conference workshops and the posters were in a large meeting room upstairs. The coffee breaks and delicious pintxo lunches were served in that same room and delegates could step out onto a large balcony with spectacular views of the Guggenheim Museum. There was a packed scientific and social programme, organised flawlessly by our charming and welcoming hosts from the AZTI research centre, especially the convenor of the Local Organising Committee, Dr Naiara Rodríguez-Ezpeleta, along with her AZTI colleagues, particularly Meritzel González-Intxausti. With the warm and friendly atmosphere typical of FSBI symposia, the meeting was truly excellent.

Although the Symposium had a well-defined theme, omics is quite a broad field of research reflected in a busy program comprising six plenaries and 74 ten-minute oral presentations, organised into sequential sessions from Tuesday to Friday lunchtime. These were run very smoothly, presenters did an admirable job of keeping to an eight-minute talk with two minutes for questions. The Symposium was opened with a welcome from AZTI and an arraesku folk dance,

followed by the Jack Jones Lecture by Gary R. Carvalho from the University of Bangor. Prof Carvalho highlighted how the use of omics had progressed over four decades of his career, during which he has fostered the inclusion of genetics into management of commercially exploited fishes, with major leaps forward that now support concrete real-time fisheries management. This lecture was the basis for a session entitled *Leveraging Connectivity, Mixing, and Biomass for Better Management* with talks on uses of omics for management of diverse species, mostly in marine ecosystems. The day



Gary Carvalho with the chair of the conference organising committee Naiara Rodríguez-Ezpeleta.

concluded with an animated poster session comprising 29 presentations.

Wednesday morning started with the FSBI Spawning Run, brave souls met at 7 am to run five kilometres along the river. The first session, *Disentangling species interaction dynamics*, started with a keynote by Kerry Naish from the University of Washington, who considered eco-evolutionary dynamics in managed and unmanaged systems, with case studies on Pacific salmon. The ensuing talks on species interactions had a focus on fish hosts and their microbiota, pathogens or parasites. The afternoon session, *Understanding the mechanisms of development and adaptation*, was anchored by a plenary on evolutionary processes in fish vision, by Zuzana Musilova from Charles University in Prague, who described molecular mechanisms of adaptations for seeing in the dark, comparing deep sea fishes to benthic cichlid species in the African rift lakes. The following talks, on mechanisms of development and adaptation in fishes, ranged from the ever-present Atlantic salmon to the elusive Greenland shark.

Thursday began with *Capitalizing on environmental DNA for biodiversity research* and a keynote by Sophie von de Heyden from Stellenbosch University on marine eDNA biomonitoring for conservation of biodiversity in South Africa, and the need for effective and efficient eDNA sampling strategies to fill large knowledge gaps. The talks also focused on the potential for using eDNA for monitoring species abundance and distribution. The afternoon was occupied with *Exploring the genomic signatures of connectivity and adaptation*, with a plenary by Sissel Jentoft from the University of Oslo about genomic architecture, subpopulations and cryptic ecotypes of Atlantic cod, revealing abundant genetic differentiation across its range, with Baltic cod as outliers and a fjord-specific cod in deep waters. The session continued with talks on genomic diversity within species from the poles to the tropics, and links to life-history diversity, responses to anthropogenic stress, or fishery management.

The final session, *Harnessing DNA for species identification and phylogenetic analyses*, began on

Friday morning with a plenary by Stefano Mariani from Liverpool John Moores University, with a DNA journey through the seafood trade and a plethora of fascinating and revealing research on labelling of fish for human consumption, which reflects international trade regulations and how these are used and misused. Talks then focussed on DNA metabarcoding to understand patterns of diversity in fishes, for example larval stages in temperate coastal ecosystems or the fossorial and aquifer-dwelling fishes of Southern India.

Overall, delegates feasted for four days on the uses of omics for fish ecology, management and forecasting. Many presentations were by early career researchers and the Local Organising Committee and FSBI Officers judged these to award prizes at the closing ceremony, to M. Lisette Delgado for best talk and Gaëlle Brahy for best poster, and to Maddalena Tibone and Oriol Canals for best runner-up talk and poster, respectively. Beyond omics, the 2024 medal winners, Skúli Skúlason (Beverton Medal), Peter Henderson (Le Cren Medal), Erika Eliason (FSBI Medal) and Michael Grant (Huntingford Medal) – see the previous Newsletter for biographies – described their scientific journeys on Wednesday morning, followed by the AGM where five new members of Council were elected.

Our hosts organised a full social calendar for the evenings, ➤



The 2024 medallists. From left to right: Peter Henderson, LeCren Medal; Erika Eliason, FSBI Medal; Skúli Skúlason, Beverton Medal and Michael Grant, Huntingford Medal.



FSBI President, Holly Shiels, presenting the FSBI, medal to Erika Eliason.

with visits for pintxos at the Bilbao Maritime Museum ITSAS museum, a pub quiz, a boat trip with pintxos through Bilbao that was preceded by some fascinating txalaparta percussion music, and then a super gala dinner where the highlight was the presentation of the 2024 prizes by Holly Shiels, FSBI President.

The Symposium was preceded on the Monday by well-attended workshops, starting with a demonstration of eDNA sampling technologies. This was followed by a publishing and science

communication workshop chaired by FSBI social media coordinator, Will Perry. Major elements were a talk on publishing by *Journal of Fish Biology* Chief Editor, Michel Kaiser, and presentation, by Will Perry, of the new FSBI Mastodon server #FishSci. All fish biologists are encouraged to join this server, Will tooted (yes, that's the term) regularly during the Symposium, if readers wish to catch up or remind themselves of the good times had. The final workshop was on equity, diversity and inclusion, led by FSBI EDI committee chair, Katie

Longo. This discussed potential EDI initiatives for the FSBI and unveiled the FSBI EDI survey, which members are encouraged to take by following this QR code.

A short video of the conference is at <https://www.youtube.com/watch?v=1pKEYd6o-qc>



Goshi Kato from Tokyo University of Marine Science, Japan, represented the Japanese Society of Fisheries Science at the 2024 summer symposium. Here, he gives his account of the meeting



I would like to congratulate Dr. Naiara Rodriguez-Ezpeleta a chair of the organizing committee and Professor Holly Shiels president of FSBI on the successful organization of the FSBI Annual Symposium 2024. I would like to thank, and the members of the local organizing committee for inviting me to such a great symposium. I attended the meeting from 15th-19th July at Bilbao, Spain, as a young scientist representing the Japanese Society of Fisheries Science. There were six keynote talks and more than 70 oral presentations plus 29 posters under the symposium theme “Advancing Fish Ecology, Management and Forecasting through OMICS”. I gave an oral presentation entitled “Transcriptome analysis of

Flavobacterium psychrophilum infected and proliferated in ayu *Plecoglossus altivelis* in session 2, *Disentangling species interaction dynamics*. I would like to thank the organizers for giving me the opportunity to give a talk on my study, and I had fruitful discussions about my work with the attendees throughout the symposium period.

There were many presentations of eDNA studies at the conference, and I was very impressed by them. eDNA metabarcoding is a novel method of assessing biodiversity with samples taken from the environment. It is very important to prove that eDNA result are linked to the actual existence of living organisms in the environment. Perry *et al.* compared the results of 12S metabarcoding studies and estimated Atlantic salmon biomass modelled from rod catch records and showed the significant spatiotemporal relationship between the eDNA and actual biomass data. eDNA metabarcoding also suggested the dynamic movement of schooling fish in the lower and upper parts of an estuary, along with data on current and tide in the estuary (Jackman *et al.*). The integration of fisheries resource analysis

and molecular biological method provides powerful insights in Fisheries Science.

The poster session was also very interesting and exciting, with many outstanding, distinctive, and fantastic works! I really enjoyed a story of fish “Personalities” in group behaviour analyzed using a clonal fish species, the Amazon molly, together with “the Robofish” (Papadopoulou *et al.*). The study that attempted to estimate the fish stress by telomere length was very interesting (Brahya *et al.*). It was great fun to discuss delegates scientific story with the aid of their beautiful posters and I would like to thank every poster presenter for giving me such an interesting time.

I found that the young generation is very active in the FSBI!! I am the former chairperson of the young scientist committee of the Japanese Society of Fisheries Science, and so I feel it is very important for young researchers to know each other and to discuss their research. These interactions will lead to new international collaborations, and so I hope we can continue the wonderful exchange of researchers between the Fisheries Society of British Isle and the Japanese Society of Fisheries Science.

Travel Grant Reports

Badiozaman Sulaiman, a PhD student at the University of Manchester, UK, used a travel grant to attend the SETAC Europe 34th Annual Meeting (5-9th May 2024) in Seville, Spain.

I was super excited to be at the SETAC Europe 34th Annual Meeting between 5th-9th of May 2024 in Seville, Spain, the largest and most diverse conference I have attended. I presented my PhD work on the uptake and trophic transfer of microplastic in an urban river community and received much positive and constructive feedback. There was a massive group of people working on microplastic, and I had many fruitful discussions between the poster presentation sessions and social networking events. I also gained new insight into the latest developments within the broader themes of environmental pollution research from the keynotes and lectures by the leading experts, platform presentations by participants and showcases by the people in the industries. In addition, I met a few early-career researchers from several universities and government agencies, who gladly shared career-building tips and made friends with fellow students from across Europe to as far as Southeast Asia, where we exchanged contact and started to build a small network of our own. It was a wholesome experience to share and learn from such a fantastic research gathering. I am very grateful to the Fisheries Society of the British Isles for providing me with the travel grant to attend this conference.

Madleen Grohgan, a PhD student at the University of Bristol (UK), School of Earth Sciences, Palaeobiology Research Group.

She is studying the evolutionary origin of teeth in

fossil as well as recent jawless fish (lampreys).

This June I attended EuroEvoDevo 2024 in Helsinki, which is the biggest conference on evolutionary developmental biology in Europe. I gave a talk on the first results of my research project on lamprey toothlets and how they can help us to elucidate the evolutionary origin of teeth based on detailed study of their morphogenesis, replacement mechanism and molecular genetics. The conference included a fish satellite meeting packed with interesting talks on fish evo-devo and important discussions about the past, present and future of our field and common challenges we face. The main conference offered talks and posters from a wide range of evo-devo research topics allowing me to broaden my horizon (beyond fish evo-devo) and to learn about new wet lab and computational methods to apply in my own research. In addition, the conference provided me with ample networking opportunities. I was able to catch-up with existing collaborators as well as to establish new connections with researchers from other institutions and to discuss potential funding and postdoc opportunities. EuroEvoDevo 2024 was a fantastic conference to learn about a variety of evo-devo research topics as well as to establish and strengthen my connections within the fish evo-devo community.

Armando J.Cruz Laufer, a PhD student at Hessel University Belgium, used his travel grant to give a conference talk at the 99th Meeting of the American of Parasitologists (ASP) in Denver, Colorado, and went on to spend a two-month research stay in the United States hosted by the lab of Chelsea Wood at the University of Washington in Seattle.

I presented at the 99th Meeting of the American of Parasitologists (ASP) in Denver, Colorado. ASP is the largest parasitological society in North America with about 700 members and celebrates its 100-year anniversary in 2024. This conference stay was embedded in a two-month research stay in the United States hosted the lab of Prof Chelsea Wood at the University of Washington in Seattle.

My presentation titled “Adaptive evolution of stress response genes in two monogenean parasite lineages aligns with their respective host niche diversity” highlighted the link between the high ecological diversity of the cichlid fish in the Great East African Lakes on the adaptive potential of their parasites. Cichlid fishes are one of the prime model systems in evolutionary biology and include many economically highly relevant species. In this presentation, I drew a comparison of stress response genes in the flatworm parasites (*Cichlidogyrus*) infecting the gills of cichlids and those (*Kapentagyris*) infecting the gills of African freshwater sardines (Sub-family Pellonulinae), a highly ecologically conserved group of fish. We detected copy number differences in heat shock (*Hsp70*) and detoxification enzymes (*Gst*) and signals of adaptive evolution in heat shock proteins (*Hsp40/Hsp60*) through whole genome sequencing of the parasites.

I would like to express my gratitude for the support of FSBI, which was crucial for my attendance at this conference. It enabled me to expand my network across the Atlantic, which might be especially useful in the context of my ongoing research on the effect of overfishing on fish disease ecology in African mangrove ecosystems.

Notices

Make your life better with an FSBI Training Grant

Training is essential for all stages of career development and the rapid development of technologies particularly in all methods from sampling to analysis make “keeping up” essential for researchers and practitioners, especially in the early years. The FSBI offers training grants of up to £1000/person open to all its members, and now to all Institute of Fisheries Management students through the Joint IFM/FSBI studentship. The applications are competitive but generous and criteria are set out on the FSBI website, where you will easily find the application forms. There are three calls a year and next one ends on 1st October 2024. We want to help you and welcome applications; so why not take the opportunity, submit the application form with a supporting reference letter through MySociety and get on that course that could change your life!

If you have queries about the application please contact Beth Glyn-Ramsden (theteam@fsbi.org) who handles FSBI's member-

related business, or Dr Brian Hayden (brian.hayden@unb.ca) chair of the Training Grants Committee.

About Mastodon

The FSBI would like to welcome you to its Mastodon server!

The FSBI is an international, non-political, learned society based in the United Kingdom, that supports scientific activity in fish biology and fisheries science through charitable activities including grant funding, travel awards and conference sponsorship, and through the publication of the Society's official journal, the *Journal of Fish Biology*.

Although hosted by the FSBI, this server is open to anyone interested in science and the natural world, however, you may find there is a distinctly fishy flavour!

As a Society, we felt that it was important to provide an online platform for people to gather and exchange ideas in an environment that was free from spam, adverts and malicious content, as well as escaping the influence of billionaire

tech giants. We therefore established this server based on the Society's commitment to principles of knowledge, learning, collaboration, transparency, open access, equality, diversity and inclusion.

Code of conduct

We ask that you familiarise yourself with our server rules, which aim to build a community based on respect and inclusion. The administration of the service reserves the right to revoke any user's access permissions, at any time, for any reason, except as limited by law.

Reporting harassment

To report harassment, please send an email to perryw1@cardiff.ac.uk. If you believe anyone is in physical danger or doing something against the law, please notify appropriate emergency services first by calling the relevant local authorities.

Policies

Your continued use of this server implies your agreement with our policies. For further details about how we manage the data related to this server, please refer to our privacy policy.

Information Desk

For all membership enquires please contact the FSBI office at:

Fisheries Society of the British Isles

1 Naoroji Street, London WC1X 0GB

Registered Charity No: 256475

VAT No: 433 4571 60

All enquiries: 020 3925 3477

theteam@fsbi.org.uk

Contact person: Beth Glynn-Ramsden

See <https://fsbi.org.uk/membership/> for further information.

Secretary: Dr Ian Winfield

E-mail: secretary@fsbi.org.uk