

Marine biodiversity:

ICES, Johannes Schmidt, and the Carlsberg connection

Michael Sinclair explains why 2010 – International Year of Biodiversity and the culmination of the first Census of Marine Life – is a great year to celebrate the Carlsberg contribution to our knowledge of marine science.

On 11 January 2010, the United Nations inaugurated the International Year of Biodiversity in Berlin. Also, by coincidence, 2010 is the final year of the Census of Marine Life, the focus of which has been to provide a global picture of marine biogeography and biodiversity, based on a decade of international research (with major financial support from the Sloan Foundation). The final activities are being held in London in early October.

It is thus fitting that several themes of the ICES Annual Science Conference 2010 in Nantes focus on this field of study, and that a special showing of the film “Oceans”, which captures visually the remarkable diversity of life in the sea, will be featured.

I would like to look back at some of the earlier activities of ICES in this broad field of research, which has been revitalized during the past decade or so. Further, I will provide a sketch of the ICES-related work of Johannes Schmidt and the financial support that was provided by the Carlsberg Laboratory and the Carlsberg Foundation. Today, we tend to associate Carlsberg with the Liverpool football team, while giving less attention to their support of science and the arts. I hope to provide a more balanced picture of the influence this brewery has had on society (at least among the ICES community!).

I was stranded in Copenhagen for five days last April, as a result of flight cancellations caused by volcanic ash. After surviving the initial irritation of uncertain travel arrangements and cancellation of commitments in Canada, I realized that the delay provided a good opportunity to follow up an earlier interest in the “racial investigations” led by Schmidt and published in a Carlsberg Foundation journal. Why did a brewery foundation fund research on marine biodiversity so generously? And, more specifically, what were the scientific justifications for what might be considered esoteric questions to the Foundation? At this stage, I do not have the answers, but I hope that this brief summary of Schmidt’s remarkable career in marine science (and the support from Carlsberg) will be of interest.

Johannes Schmidt and ICES Committee “A”

Johannes Schmidt was a student and research assistant of Johannes Petersen, Director of the Danish Biological Station at the turn of the 20th century and one of the founders of ICES when it was established in 1902. Petersen promoted a multidisciplinary oceanographic approach to fishery problems and was responsible for the Danish contribution to the work of ICES Committee “A”, whose remit was to explain decadal fluctuations in the yield of fisheries.



▲ RV "Thor" in Icelandic waters in 1903. It is anchored alongside a French fishing schooner.

Schmidt participated in (or led) six expeditions on the RV "Thor" between 1903 and 1908, conducting early life history surveys (plankton and oceanographic observations) covering the broad area from Iceland to Spain. He was subsequently the principal author of an extensive and influential 1909 ICES report that presented a synthesis of the aggregated results of the Danish expeditions as well as surveys by other ICES Member States.

It is of historical interest that the sampling design and protocols first used by Schmidt to investigate the fluctuations in the yield of fisheries (i.e. plankton and oceanographic observations at a grid of fixed stations) set a precedent for the 1914/1915 Hjort expedition off the Scotian Shelf and in the Gulf of St Lawrence, and for the CalCOFI monitoring programme established by Sverdrup to improve understanding of sardine and anchovy fluctuations in the California Current. Thus, Schmidt, perhaps influenced by Peterson and Hjort, appears to have been the father of large-scale multidisciplinary surveys to investigate population dynamics of fish species.

Key findings of this first basin-scale biogeographic study of fish eggs and larvae in the Northeast Atlantic were: (i) spawning locations differed between gadoid species; (ii) within the distributional range of a species, spawning occurred at several precise locations; and (iii) the geographic areas of spawning were very small

compared with the distributional area of the species. These expeditions were an important contribution to Hjort's grand synthesis in 1914, which provided the present interpretation of the causes of temporal trends and variability of fishery landings (i.e. species consist of populations, or "races", which have year classes that vary in abundance). Schmidt was a key player in the work of Committee "A", and the successful completion of the Committee's initial remit was critical to the future existence of the organization. On the other hand, the ICES experience was very influential on the future directions of Schmidt's career with the Carlsberg Laboratory.

During the second expedition on the RV "Thor", in 1904, a single larva of the freshwater eel (*Anguilla* spp.) was caught. This was the first eel larvae observed in the Atlantic Ocean, although eel larvae had been found in the Mediterranean Sea a few years earlier. This observation appears to have turned on a light, as it were, that led Schmidt on a somewhat obsessive odyssey that dominated the rest of his all-too-short life. Thanks to his connection with the Carlsberg family, this single observation of an eel larva led to the first global expedition on marine biodiversity and biogeography. It is a remarkable story that has been well documented.





▲ Between 1920 and 1922, the 550-tonne, four-masted motor schooner RV "Dana 1", explored the North Atlantic and the West Indies.



▲ On the deck of RV "Thor" in 1903. Left to right: Ove Paulsen, Johannes Schmidt, and J. N. Nielsen.

The Carlsberg Laboratory: engaged in marine biodiversity (1910–1933)

Marine research was a major focus of the Carlsberg Laboratory, and of the Carlsberg Foundation, for 23 years (from 1910 to 1933). During this period, Johannes Schmidt was head of the Physiology Department of the Laboratory. Regrettably, he passed away after a short illness in 1933, at the age of 56 and at the peak of his career. During these two decades, Schmidt carried out a broad programme of research on marine biodiversity and biogeography, with the generous financial support of the Laboratory and the Foundation.

Schmidt was only seven years old when his father died, and he moved to Copenhagen, with his widowed mother and brothers, to live with his uncle, the famous Danish chemist Johan Kjeldahl (head of the Chemistry Department at the Carlsberg Laboratory). He later married Ingeborg Kühle, the daughter of the administrative director of the "Old Carlsberg Brewery". Although these family connections no doubt provided privileged access to funding, he also had warm support from the board (e.g. Professor Johannes Eugenius Bülow Warming and Rudolf Koefoed, the Director of the "Old Carlsberg Brewery"). Koefoed stated at a board meeting that Schmidt should be permitted to continue working on marine biological research and remain a member of ICES. Schmidt used this fortuitous situation of generous research support over two decades to the great benefit of science and society at large.

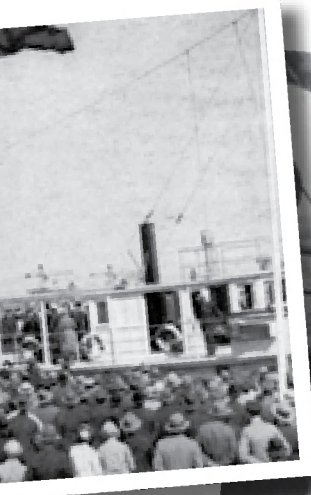
The expeditions led by Schmidt and supported, in whole or in part, by Carlsberg sources include:

- 1910: the "Thor" expedition, in the western Atlantic and Mediterranean
- 1920: the "Dana 1" expedition, in the North Atlantic
- 1928–1930: the "Dana 2" expedition, "The Carlsberg Foundation's Oceanographical Expedition Round the World"

Schmidt's papers were influential beyond the marine science community

The RV "Dana 2" was provided by the Danish government, but all other expenses for the three-year global expedition were provided by the Foundation. The collections from all of Schmidt's expeditions were initially housed at Charlottenlund Castle, the location of the ICES Secretariat at that time. The work of sorting the samples lasted nearly four decades, and the data were published in 83 data reports (also sponsored by the Foundation).

The single eel larva observation in 1904, through a combination of Schmidt's drive and Carlsberg's support, resulted in a global investigation of the biogeography of the genus and family that lasted three decades, and along the way, a rich diversity of other work was undertaken. For example, an incidental discovery of the "Dana 1" expedition was the existence of the Mid-Atlantic Ridge, which led to benthic studies and contributed to fundamental changes in geological interpretations of the seabed.



▲ RV "Dana 2" on its triumphal return to Copenhagen on 30 June 1930, after completing its circumnavigation of the globe.



▲ Schmidt on board the RV "Dana II" with a ringnet of his own construction.



▲ The Carlsberg Laboratory, flanked by the two directors' residences.

Thus, 2010 is the 100th anniversary of the "Thor" expedition on eel early-life history in the Northeast Atlantic, the 90th anniversary of the "Dana 1" expedition on the biogeography of fish eggs and larvae in the North Atlantic, and the 80th anniversary of the completion of the "Dana 2" global expedition on marine biodiversity. As it is also the International Year of Biodiversity and the culmination of the first Census of Marine Life, it is a great year to celebrate and acknowledge the Carlsberg contribution to our knowledge of marine science.

Schmidt's "racial studies"

In addition to his investigations of eel biogeography, Schmidt's second passion was the search for general laws to account for the diversity of spatial patterns in populations of species and their genetic basis (his "racial" studies). I would suggest that both his brewery connection and his experiences with Hjort in Committee "A" were the foundation of this second research theme. Hjort's insights and the ICES fieldwork experience provided the new paradigm on the very nature of species, while the practical breeding work to increase the efficiency of the brewery at the Carlsberg Laboratory provided him with state-of-the-art genetic tools.

Schmidt's early experimental studies at the Carlsberg Laboratory were on the cultivation and crossing of hops, and he established a greenhouse for hops breeding at the laboratory in Copenhagen. The results led to a theoretical understanding of selection and its practical applications to production. No doubt, this practical work on selection and genetics in general, as well as an in-depth knowledge of the literature and tools of applied genetics, contributed to Schmidt's comparative studies on the population richness of marine species.

From his study of the expedition collections, which included a large number of specimens of the European eel (*Anguilla anguilla*), he concluded that there were no "racial" differences in this species. This was an unexpected result, given his observations on other species, both terrestrial and marine, and contrasted with the observations on the common blenny (*Zoarces viviparus*). This pattern, from the panmictic eel to the population-rich blenny, led to an ambitious programme of field and laboratory work, aimed at teasing out the genetic and environmental influences on the morphological characteristics of fish. In addition to these two species, the "million" fish (*Lebistes reticulatus*), the common trout (*Salmo trutta*), and the Atlantic cod (*Gadus morhua*) were part of his comparative study. The central thrust of his research was to investigate the relationship between the environment and the genotype. Experimental procedures included traditional measurements of body shape and meristics for fish from different locations and ages, as well as breeding in the laboratory and transplantations of fish from one location to another under natural conditions.

The results of these diverse early studies on the population genetics of marine fish species were published in the "racial investigations" series of the *Comptes-rendus des Travaux du Laboratoire de Carlsberg*. Within the context of the history of ideas, it is of interest to access the Carlsberg archives and investigate the project applications for funding. What were his thoughts on the topical research priorities of his time and on what basis was the work funded?

Schmidt's second passion was the search for general laws to account for the diversity of spatial patterns in populations of species and their genetic basis

Søren Anker Pedersen, Project Coordinator at ICES Secretariat, has received full access to Schmidt's research proposals from the Foundation and is currently studying the material. We do know that Schmidt was seeking general laws to account for the differences between species in their degree of population richness. To my knowledge, he was the first marine ecologist to explicitly state the nature of the problem.

It is noteworthy that Schmidt's research on population genetics between 1910 and 1933 preceded the definition of the "biological species" concept by Ernst Mayr (as part of the "modern synthesis" of evolutionary thought, introduced in his landmark book *Systematics and the Origin of Species* in 1942). In this sense, Schmidt was perhaps thinking outside the box. His papers were influential beyond the marine science community, insofar as Mayr cites Schmidt's work on comparative population patterns in *The Growth of Biological Thought*, published in 1982. I think Schmidt is the only marine fishery ecologist cited by Mayr in his synthesis.



Concluding thoughts

During this International Year of Biodiversity, which also marks the completion of the Census of Marine Life, it is timely to recall the influential and visionary early work of Johannes Schmidt, as he is perhaps not sufficiently recognized today. ICES was a key part of his career, and he, in turn, was instrumental in setting the research directions of our international organization. The ICES flag was flown on the "Dana 2" during the global expedition.

Schmidt was elected a Vice-President of ICES in 1932, but never really took up this role because of his death early the next year. This was a great loss, given that he was in the process of synthesizing the results of the "Dana 2" expedition, and was in full force as a leading thinker of his generation. In addition to the legacy of his ideas, Schmidt mentored many young Danish marine scientists, such as Steemann Nielsen, the creator of the radioactive method of measuring primary production, and Anton Bruun, the scientific leader of the Galathea expedition on the bottom fauna of the deep-sea trenches. Schmidt was a big thinker and encouraged his younger colleagues to take on the difficult scientific challenges of the day.

He contributed knowledge at two levels of biodiversity: population (genetic) and species. It is tempting to conclude that his genetics work on improving beer led in some way to the definition of the biological-species concept, but perhaps this is going too far. Most certainly, the profits of the Carlsberg brewery, through both the Laboratory and the Foundation, have contributed enormously to our present knowledge of marine biogeography and biodiversity. Let's drink to that!

◀ Johannes Schmidt in 1929 on the island of Koh Chang, Thailand, with Nai Sug. The photograph was taken during RV "Dana II's" circumnavigation of the globe between 1928 and 1930. Nai Sug assisted Schmidt in his studies of the Thai flora during Schmidt's first expedition, thirty years earlier. Schmidt recalled the reunion in his diary entry of 8 May 1929. "I was photographed with my old helper whose name is Sug, now: Nai Sug Sugsai, Koh Chang, Changwad, Chantaburi, Siam, and of course, I will send him the picture. He did not look old and, in spite of being over fifty years old, he had no gray hair, though the hair was somewhat thin on the forehead and his one leg was not strong. Never in all these thirty years has he left Kho Chang! He had several sons. In the village there is now a Wat [a Buddhist monastery]".

Michael Sinclair is ICES President. His early research was on phytoplankton dynamics in estuaries. This was followed by work on herring stock assessments and fish life histories. He has more recently contributed practical suggestions for the implementation of the ecosystem approach to integrated management of ocean uses. The history of ideas, particularly with respect to marine ecology, is an ongoing hobby.

Acknowledgements

Information about Johannes Schmidt comes from several sources, including the centenary volume of the Foundation (The Carlsberg Laboratory 1876/1976, edited by H. Holter and K. Max Møller), as well as personal communication with Søren Anker Pedersen, which is very much appreciated.

Literature

Hjort, J. 1914. *Fluctuations in the great fisheries of northern Europe. Rapports et Procès-Verbaux des Réunions du Conseil Permanent International pour l'Exploration de la Mer*, 20:1–228.

Holter, H., and Max Møller, K. (Eds). 1976. *The Carlsberg Laboratory 1876/1976*. Rhodos, Copenhagen, Denmark.

Mayr, E. 1942. *Systematics and the Origin of Species, from the Viewpoint of a Zoologist*. Harvard University Press, Cambridge, MA.

Mayr, E. 1982. *The Growth of Biological Thought*. Belknap Press, Cambridge, MA. 974 pp.

During my few extra days in Copenhagen, I found time to visit the Carlsberg Visitor Centre, hoping to see some reference to Schmidt, “Dana 2”, or perhaps even ICES. The Carlsberg contribution to marine science and the associated societal benefits are not on show and perhaps have been forgotten. That said, the visit was of great interest. If you have a couple of hours to spare, I highly recommend the tour. The Visitor Centre provides an interesting introduction to the contribution of the Jacobsen family, through the Foundation, to art in Copenhagen. After the tour, I began to notice marvellous works of art at many different locations. The entrance fee includes a choice of two specialty beers, and my selection was very tasty. It is to be hoped that, in future, we can rekindle the Carlsberg interest in marine biodiversity, in parallel with their support of football teams such as Liverpool.

For information about planning a trip to the Carlsberg Visitor Centre, go to <http://www.visitcarlsberg.dk/>.

◀ Visiting Seydisfjord, Iceland, in 1904. Left to right: Captain Søren Jørgensen, J. N. Nielsen, editor Skapti Josephson, Johannes Schmidt, A. Strubberg, Ove Paulsen, and Bjarni Sæmundsson.

Iceland's first fishery biologist Bjarni Sæmundsson (1867–1940) had been engaged in fishery research on his own initiative since 1895, working voluntarily in his spare time, without any organized support. In 1902, the fishery adviser to the Danish Government asked Sæmundsson to suggest a branch of research that would assist the Icelandic fisheries. In response to Sæmundsson's suggestions, the Danes made a practical contribution by sending an expedition to study the fishing grounds off Iceland, which was part of the kingdom of Denmark at the time. RV “Thor” arrived in Iceland in summer 1903 and spent three summers conducting research.

Sæmundsson participated in the research that laid the foundation for ocean and fishery research off Iceland, as well as for Icelandic international cooperation in this field. Sæmundsson was the only Icelander engaged in ocean and fishery research until 1930, and until 1923, he did it while engaged full-time as a high school teacher.

