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FOREWORD

Shark, skate and ray research at the MBA and Cefas

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For many decades, scientists at the Marine Biological Association (MBA) in Plymouth and the Centre for Environment, Fisheries and Aquaculture Science (Cefas), formerly the Directorate of Fisheries Research, at Lowestoft have undertaken considerable research into the ecology and life histories of elasmobranch fish around the British Isles.

Based at Plymouth, E. Ford (1921) published one of the earliest accounts of the more common dogfish, including their population structure, reproductive biology and feeding habits. The first information on the breeding grounds of dogfish were also reported (Ford, 1921; Orton, 1926). At this time, R.S. Clark undertook several studies on the skates and rays occurring in the waters of the British Isles, focusing on the egg-capsules and early life history stages (Clark, 1922, 1927) and providing detailed accounts of their general biology and morphology (Clark, 1926). Subsequent studies on skates and rays were undertaken by G.A. Steven, who examined commercial catches and undertook studies on their feeding ecology, reproductive biology and movements (Steven, 1930, 1931, 1932, 1933, 1934, 1936, 1947). Around this time, much of the fisheries research conducted at Lowestoft was concerned with commercial teleosts, though C.F. Hickling undertook biological sampling of spurdog *Squalus acanthias* and other squaloids during a series of cruises collecting information on hake in the Celtic Sea (Hickling, 1930, 1963).

Commercial fisheries expanded greatly after the Second World War, including fisheries for spurdog and various skates and rays. During the 1960s and 1970s Lowestoft initiated a programme of elasmobranch research, which was led by M.J. Holden, who was one of the first scientists to highlight the susceptibility of elasmobranchs to overexploitation (Holden, 1973, 1974, 1977). This period of research resulted in numerous publications regarding the age, growth, reproductive biology and feeding habits of a variety of skates and rays (Holden, 1963, 1972, 1975; Taylor & Holden, 1964; Holden et al., 1971; Holden & Vince, 1973; Holden & Tucker, 1974) and spurdog (Holden, 1960, 1964, 1965a,b, 1967a,b, 1968; Holden & Meadows, 1962, 1964; Tucker, 1985; Vince, 1991), and much of the biological knowledge gained from these studies remains invaluable today. Despite the increase in biological studies, effective management plans for elasmobranchs in European waters were not brought in, and subsequently Lowestoft scientists provided the first documentation of the disappearance of common skate *Dipturus batis* from coastal waters of the United Kingdom (Brander, 1981).

Though the Lowestoft laboratory had a large research programme for skates, rays and coastal dogfish, less research had been focused on pelagic sharks. J.D. Stevens, working with Q. Bone at the MBA, began studies to improve our biological knowledge of blue shark *Prionace glauca* and other pelagic species in the early 1970s (e.g. Stevens, 1973, 1974, 1975, 1976, 1990). Our present knowledge of the movements, migrations and population structure of blue shark in the north-east Atlantic still relies heavily on this work. In more recent years, the MBA has undertaken much research into the movements and behaviour of several elasmobranchs, notably the basking shark *Cetorhinus maximus* and lesser-spotted dogfish *Scyliorhinus canicula* (Sims, 2003). Improved understanding of the free-ranging behaviour of basking sharks for instance, has contributed important new information relevant to national and international conservation efforts.

Since becoming an Executive Agency of the Department for Environment, Food and Rural Affairs (Defra) in 1997, Cefas has continued to undertake research on elasmobranchs, with Cefas scientists involved with the ICES Working Group on Elasmobranch Fish (WGEF), and the EC-funded project 'Development of Elasmobranch Assessments (DELASS)' (Heessen, 2003). There have also been MBA–Cefas research collaborations, most notably on Defra-funded satellite-tracking studies of basking sharks (Sims et al., 2003).

The biological characteristics of elasmobranchs, including a late age at maturity, slow growth rate, low fecundity and long gestation period, result in a low rate of population increase, thus making this group of fish particularly vulnerable to fishing pressure. Recent studies by Cefas and MBA scientists have documented long-term changes in the distribution and relative abundance of a variety of elasmobranchs in the waters around the British Isles, and related such changes to the intrinsic vulnerability and extrinsic mortality imposed by fishing (e.g. Dulvy et al., 2000; Rogers & Ellis, 2000; Genner et al., 2004; Ellis et al., 2005). Indeed several species of elasmobranch, such as angel shark *Squatina squatina* and white skate *Rostroraja alba*, have declined dramatically in the north-east Atlantic and are now rarely observed. Many

other species that are landed in mixed and targeted commercial fisheries have been over-fished, including spurdog (Hammond & Ellis, 2005) and various skates, and appropriate management measures are required to ensure the sustainability of these stocks. It should also be noted that many elasmobranchs are important target species for recreational fisheries and, from a socio-economic aspect, some species may be more valuable to these fisheries than to the commercial fleet.

Elasmobranch fish possess several biological characteristics that make them of fundamental scientific interest. For example, they have advanced sensory modalities, relatively large and structurally complex brains, the capability for complex behaviours such as social systems and sexual segregation, internal fertilization and diverse reproductive strategies ranging from egg-laying to live-bearing. Scientific research is shedding light on these and many other aspects of elasmobranch biology. An improved biological knowledge of these species is a fundamental requirement for the management of elasmobranch stocks, especially with regards to greater understanding of their movements, reproductive biology and population structure.

There are 23 papers on elasmobranchs in this special issue of the *Journal of the Marine Biological Association*, discussing a range of elasmobranch species and various aspects of their biology, including migrations, reproductive biology, population structure and diet. Migrations and movements are discussed for several species, including thornback ray *Raja clavata* in the outer Thames Estuary (Hunter et al.), greater-spotted dogfish *Scyliorhinus stellaris* (Sims et al.), basking shark *Cetorhinus maximus* (Southall et al.) and blue shark *Prionace glauca* (Queiroz et al.). Aspects of the reproductive biology are discussed for narrownose smooth hound *Mustelus schmitti* in the south-east Atlantic (Oddone et al.), black-mouth catshark *Galeus melastomus* in Portuguese waters (Costa et al.), various skates and rays (Koop), spurdog *Squalus acanthias* in the eastern Mediterranean (Chatzispyrou & Megalofonou), Port Jackson shark *Heterodontus portusjacksoni* (Jones et al.), lantern sharks *Etmopterus* spp. (Coelho & Erzini) and a possible new species of gulper shark *Centrophorus* cf. *uyato* from the Cayman Trench (McLaughlin & Morrissey). Age, growth and other aspects of the population structure have been discussed for *R. clavata* in the Irish Sea (Whittamore & McCarthy), *Psammobatis extenta* off Brazil (Martins et al.), and sandbar shark *Carcharhinus plumbeus* (Torres et al.). The feeding habits of various elasmobranchs are discussed, such as white shark *Carcharodon carcharias* (Martin et al.) and the electric ray *Discopyge tschudii* (Arrighetti et al.).

Freshwater and estuarine elasmobranchs are often regarded as of particular conservation concern, as reviewed by Martin. Both fisheries and habitat degradation, can affect populations of these species, especially since their distributions are relatively small. The low fecundity of many deep-water sharks (e.g. McLaughlin & Morrissey) means that many of these species may need very conservative management if they are able to support fisheries, especially since our current knowledge of the stock structure of deep-water elasmobranchs is so poor. Fisheries management for some elasmobranchs is slowly improving, but is hampered by a lack of species-specific landings data, and uncertainty in both stock identity and population structure, and so the assessment methods widely applied to commercial teleosts cannot yet be applied to most elasmobranchs. Demersal elasmobranchs may be sampled in trawl surveys (Ellis et al.), though not all species and life history stages are sampled effectively, and catch rates can be highly variable. Given that many demersal elasmobranchs, which include many species of conservation concern, are taken in mixed fisheries, improved estimates of survivorship are required if quotas or size restrictions are to be effective management measures. Rodríguez-Cabello et al. have shown that *Scyliorhinus canicula* discarded from trawlers have a high survivorship, though estimates of discard mortality are lacking for most other species and gears. In addition to fisheries impacts on elasmobranch stocks, the recent expansion of wind farms in marine environments and the potential impacts of such activities on fish and fisheries has attracted much interest in recent years, as reviewed by Gill & Kimber.

An improved biological knowledge of elasmobranchs is required to facilitate appropriate management of their stocks, so that the biodiversity of this group of fish can be maintained, and that commercial and recreational fisheries for elasmobranchs can be managed sustainably. The MBA and Cefas are pleased to produce this special issue on elasmobranch fish, with many of these papers arising from the 8th European Elasmobranch Association Conference, held from 21–24 October 2004 at the Zoological Society of London, and organized by the Shark Trust (www.sharktrust.org) and Zoological Society of London (http://www.zsl.org/). To complete this special issue, various papers on teleost fish have also been included. All the papers have been subjected to *JMBA* review.

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