

North Sea fish and their remains



KEES (C.J.) CAMPHUYSEN & PETER A. HENDERSON

With major contributions from:

Estefania Velilla, Suse Kühn, Mardik (M.F.) Leopold & Robin Somes

Royal Netherlands Institute for Sea Research & Pisces Conservation Ltd, 2017

Our aim was to produce a book to aid the identification of marine and estuarine fish in the **North Sea**. We have used a combination of identification keys, simple line drawings, sometimes annotated photographs of fresh fish, and concise descriptions. What is unusual about this book is that we have added detailed information on the identification of *fish remains* (i.e. various fish bones, otoliths, and scales). Fish remains may be encountered when the diets of marine predators (cetaceans, seals, seabirds and predatory fish) are studied, during archaeological excavations, or geological reconstructions (from deposits). The material presented in this book should be useful to identify fish based on small fragments of the skeleton, to reconstruct species composition, and sometimes even the size and age of fish found during these studies. It is the first time that such a comprehensive overview of fish bones of North Sea fish species has been put in to print.

Study area and selected fish species - The **North Sea** is a shallow semi-enclosed shelf sea in the north-east Atlantic that was formed as a consequence of sea level rise following the last Glacial Maximum, when seas began to flood the European Continental Shelf, over the past 15,000 years. The North Sea is located between Norway, Denmark, Germany, the Netherlands, Belgium, northern France and Great Britain (**Fig. 1**). The sea floor is sandy in most places, with scattered patches of gravel and silt. Fishing techniques most commonly deployed nowadays include otter trawls, pelagic trawls, purse seines, beam trawls (including shrimpers), Danish seine (snurrevad), and set-net fisheries.

Based on water depth, the area may be subdivided into the **southern North Sea** (to the south of the Dogger Bank where the water depth is mostly less than 50 m), the **central North Sea** (depths ranging mostly from 50 - 100 m), and the **northern North Sea** (depths ranging from 100 - 200 m). A fourth, and generally much deeper, region is the **Norwegian Deep** that connects to the **Skagerrak** (200 - 700 m) in the north-eastern part of the North Sea.

This book will focus on fish species that are commonly found in habitats ranging from the upper shore to depths of about 200 m. This includes the international **Wadden Sea**, a shallow coastal sea area along the northern and western coasts of the Netherlands, Germany, and Denmark. This ~10,000 km² area (500 km long, on average 20 km wide), is separated from the North Sea by a row of barrier islands and sand banks. Deep tidal channels connect the North Sea and the Wadden Sea, and these channels branch into numerous gullies and creeks within the Wadden Sea.

Not all North Sea fish species included in this book have been given a full species account. We simply listed most (rarer) species that could potentially occur within the North Sea at large, and this includes species that are more typically found in deeper waters, or that have a more southerly, northerly or oceanic distribution.

Readership - The book is intended for everyone with an interest in the identification of fish, including anglers, professional fishermen, fish merchants, naturalists, students, post-graduates and professional biologists. Some features, such as the more specific explanations, will probably only be used by professional biologists, bioarchaeologists or palaeontologists, but most of the text is kept as simple as possible and has been written for those without expert knowledge.

Sources of information - The natural world is constantly changing, and recent research has greatly expanded our knowledge. The information provided in this book on the identification of fish is based largely on experience gained by the Pisces team over nearly 40 years of regular monthly sampling of the inshore fish at a wide range of localities around the British Isles. Throughout this period we have used the excellent works of Alwyne Wheeler. His large book, *The Fishes of the British Isles and North West Europe*, was published in 1969, and the smaller field guide, *Key to the Fishes of Northern Europe*, in 1978. Both these books have been out of print for a long time, and the key has become expensive and difficult to obtain. It has been apparent for some time that there was a need for a new book on NW European fish that used both photographs and diagrams to aid identification. In this book, we have photographed most specimens out of water, as this is where most identification occurs, and when it is possible to arrange the fish to show and label diagnostic features. Photographs alone are often insufficient, as they cannot display all the fins and other diagnostic features, and so they are supported with line drawings showing the layout of the fins and body shape.

Kees Camphuysen and Estefania Velilla have reorganised the text, deleted parts that were more typical for the UK, and added information that was more relevant for the North Sea. In this edition, we did not include distribution maps or graphs presenting seasonal patterns in abundance. Instead, with regard to “Distribution and seasonality”, we have chosen to rather concisely describe the overall distribution, largely with reference to the recently-published and highly comprehensive “*Fish atlas of the Celtic Sea, North Sea, and Baltic Sea*” (Heessen *et al.* 2015). This atlas presents a unique set of abundance data, based on quantitative information on some 200 fish taxa derived from 72,000 stations fished by fisheries research vessels during the period 1977 - 2013 to describe the spatial, depth, size, and temporal distribution of demersal and pelagic fish species over an extensive marine area, including the entire North Sea, together with accounts of

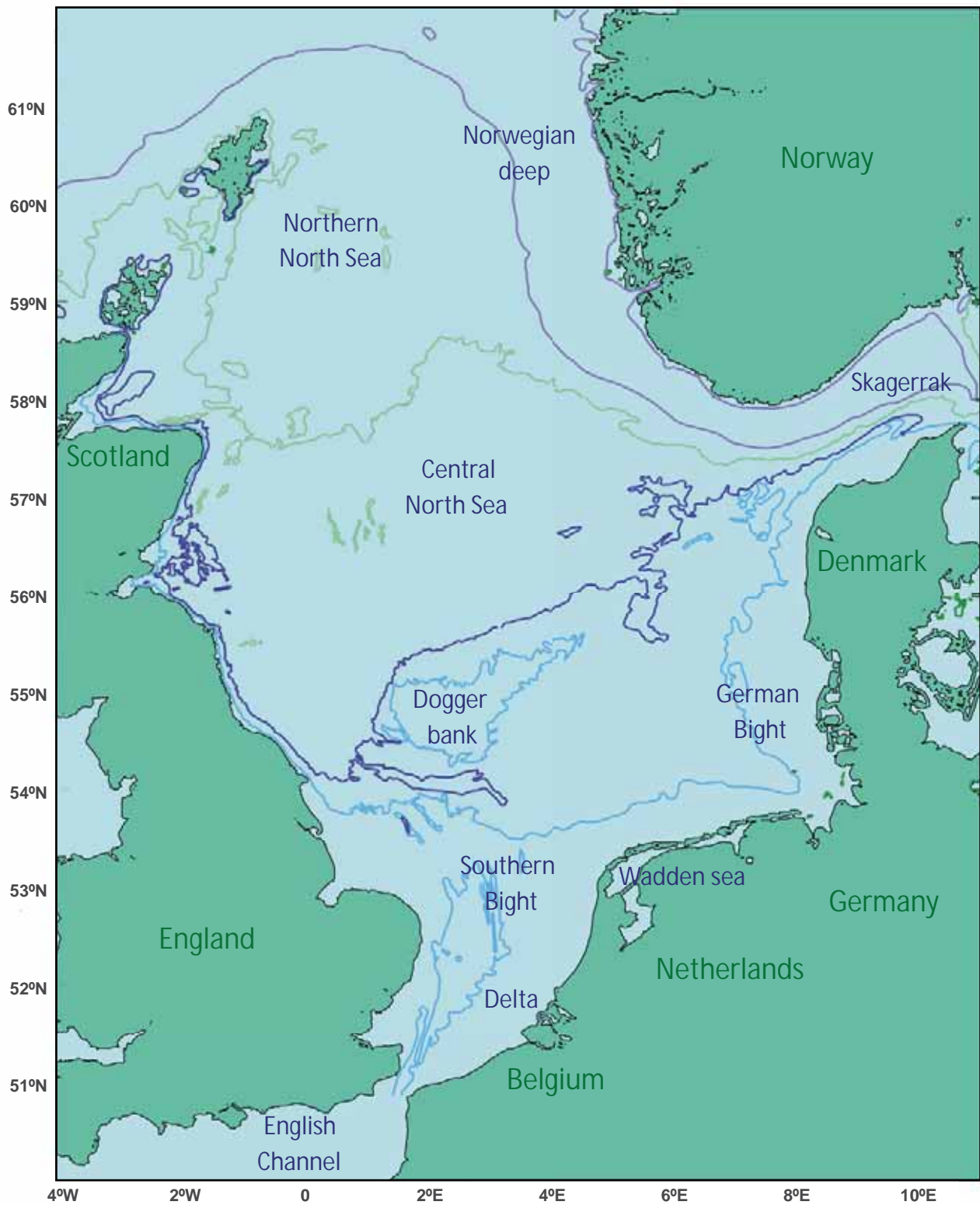


Figure 1. Map of the North Sea with the 200 m depth contour in purple, and major regions referred to in this book.

their biology. Because this atlas is based on quantitative information derived from bottom trawl and groundfish surveys, other sources were consulted where needed to describe the distribution patterns of, for example, pelagic and estuarine fish species (see References).

In addition, we provided seasonalities and trends in catch rates of fish entering the western (Dutch) Wadden Sea based on the constant effort site (the “NIOZ fish fyke”) off Texel (see photo p. 9). Since 1960, this kom-fyke trap has been operating at the entrance of the Marsdiep basin (Van der Veer *et al.* 1992). The kom-fyke consists of a 200 m long and 2 m high leader which starts above the high water mark and ends in two chambers in the subtidal region with a mesh size of 10 x 10 mm. Fishing normally started in March - April and lasted until October. In winter, the trap was usually removed



Sieme Gieles operating the NIOZ fish fyke. Photo: Threes Anna.

because of possible damage by ice floes and, from 1971 onwards, no fishing took place during part of the summer because of clogging of the net by macroalgae. Normally, the kom-fyke was emptied every morning, except when bad weather prevented this. Overall, these fyke catches show that fish stocks in the western Wadden Sea have declined: a 95% drop in biomass over the past 50 years.

The information on the identification of fish remains is based largely on experience gained by Kees Camphuysen (NIOZ) and Mardik Leopold (WMR), together with numerous students at both institutes and colleagues, over 30 years of diet studies of North Sea seabirds and marine mammals. Throughout this period we have used the excellent work of Härkönen (1986) *Guide to the Otoliths of the Bony Fishes of the Northeast Atlantic*, the ICES report of Watt and co-workers (1997) *Guide to the identification of North Sea fish using premaxillae and vertebrae*, Leopold's (2001) digital publication on *Otoliths of North Sea fish*, and several more obscure publications. These books or reports have long been out of print, and the software used on the CD does not work on modern computers.

Taxonomy and Latin names - The system of Latin names was originated by the Swedish natural scientist Carl Linnaeus in 1753. As well as having common names, such as Cod or Whiting, all species have a Latin or 'scientific' name, a two-part name which indicates the species and the genus (the next taxonomic level up) to which it belongs. A genus can contain a single species, or many. By convention, Latin names are written in italic script, with the generic name capitalised. When a name is given for the second and subsequent times in a text, the generic name may be abbreviated to the initial letter. As an example, the Latin name of the Cod is *Gadus morhua*. The first part, *Gadus*, is the name of the genus, *morhua* indicates the individual species. The genus *Gadus* contains four species, Atlantic cod, *G. morhua*, Pacific cod, *G. microcephalus*, Greenland cod, *G. ogac*, and Alaska pollock, *G. chalcogrammus*. The genus *Gadus*, in turn, is a member of the family Gadidae, which contains a total of 13 genera. Those genera include many other familiar fish, such as the Haddock, Whiting, Hake, Pollack, Saithe, Norway pout, Pout and Poor cod.

When Latin names are used, the authority and the date of publication are often given. The authority is the name of the person who first described and gave a Latin name to the species, and the date is of the first publication of that description. For instance the full Latin name of the Sea lamprey is *Petromyzon marinus* L., 1758. L. stands for Linnaeus, and 1758 was the date of publication of Linnaeus's description of the fish. Species may be moved from one genus to another, and hence their Latin names changed, for instance when new research challenges the accepted knowledge on the familial relationships between different species. Usually, the specific name (*morhua*, in the case of Cod) remains the same, while the generic name is changed. When the Latin name of a species has been changed, this is indicated by placing the authority in brackets. For instance, the full Latin name of the Corkwing wrasse is *Symphodus melops* (L., 1758). Linnaeus first named the species *Labrus melops* in 1758; since then it has been moved to several other genera, including *Crenilabrus*, *Lutjanus*, and most recently, *Symphodus*, by other scientists. Linnaeus, however, remains as the authority, the first describer of the species.

Language abbreviations - We have used the following abbreviations for the regional common names of fish: Du: Dutch, Ge: German, No: Norwegian, and Da: Danish.

Online resources - There are many online resources on fish, commercial fisheries and angling. We have generally found the following pages interesting and useful:

+ Food and Agriculture Organization of the United Nations (FAO) - Fisheries and Aquaculture Department: www.fao.org/fishery/en

+ FishBase: www.fishbase.org/search.php

+ Marine Life Information Network (MarLIN): www.marlin.ac.uk

+ Marine Species Identification Portal: <http://species-identification.org/>

+ Marine Biodiversity and Ecosystem Functioning: <http://marbef.org/>

Acknowledgements - A book of this scope requires the support of a team of ichthyologists as well as marine ecologists. Everyone at Pisces Conservation Ltd was involved in collecting and photographing specimens. At the Royal NIOZ, a reference collection of fish bones became established and numerous new additions were included during the preparations of this book, notably as a result of dissections, careful identification, storage and digital photography by Estefania Velilla (NIOZ) and Suse Kühn (WMR). The Pisces team, Mardik Leopold (WMR) and Hans Witte (NIOZ), have all helped to collect and identify the fish. Numerous people have helped to collect fresh fish to support us build the reference collection and too many people were involved to even just name them all. We are particularly grateful to Hans Witte (NIOZ) and the fishermen of the NIOZ fish fyke: Sieme Gieles, Wim Jongejan, and Marco Kortenhoeven to keep an eye open for 'unusual fish' for us to dissect and study. Tycho Anker Nilssen (NINA, Norway) and Henrik Skov (DHI, Denmark/Sweden) kindly corrected the Norwegian and Danish names of the fish species, Suse Kühn commented on the German names. Nelleke Krijgsman and Kees Camphuysen designed the lay-out of this book. The text was subsequently corrected, checked, and improved by the authors with an additional reviewing and corrections by Suse Kühn (WMR). Henk van der Veer (NIOZ) was the initiator of the project and kept the financial oversight.

Copyright of images - Most of the images in this book were taken by authors, by members of the Pisces team, or by NIOZ or WMR staff members, and are acknowledged as such in the text. Occasionally we have used images by other photographers, and have provided acknowledgment of the copyright holder. In particular, we thank Greg Woodford, Noble's Fishing of Blackfield, Hampshire, Art Savage of Private Venture II, Les Jones of White Maiden, Mike Thrussell, and Bo Delling, for the use of their images. Where the copyright holder has issued a Creative Commons licence for free acknowledged use of the work, this is indicated thus: (CC). In a few cases, (such as Corbin's sandeel, Redfish and Norway haddock), the copyright holder was unknown, had chosen to be anonymous, or did not respond to requests for permission to use the image. In each case we have done our best to identify and contact the author, but have not always been successful. Specific acknowledgements: Porbeagle - Greg Woodford; Blonde ray - Noble's Fishing, Blackfield, UK; yellow Stingray - Mike Lawrence; Conger - Noble's Fishing, Blackfield, UK; Ling - Les Jones, www.sea-fishing.net; Saury - Greg Woodford; Spiny seahorse - Dr Ken Collins; Bluemouth - courtesy of Mike Thrussell; Diminutive goby - Sue Scott; Wolf fish (2 images) Henk Jenner; Spotted dragonet - © Bo Delling, Swedish Museum of Natural History, Dept. of Zoology.; and Sunfish - Art Savage.

Chapter 11

Codfish - Gadiformes

The **codfish** order Gadiformes (Anacanthini) holds 9 families and 75 genera of fish, including several species that are important for human consumption, such as **Cod**, *Gadus morhua*, **Haddock**, *Melanogrammus aeglefinus*, **Hake**, *Merluccius merluccius* and **Pollack**, *Pollachius pollachius*. They have soft-rayed fins and no spines; some species can grow large if given the chance (greater than 1 m long). They are mostly cold-water fish. The **grenadiers** or **rat-tails** (Macrouridae) are deep-water species and are not included in this book. The families represented in this chapter are the **hakes** (Merlucciidae) (1 species), and the **Codfishes**, Gadidae. They are all demersal species, found throughout the North Sea, including shallow waters where they occur mostly as juveniles. Smaller **rocklings**, a subfamily of the Gadidae, may also be found in numbers in rockpools along rocky shorelines. Another subfamily, the **phycid hakes** (represented by the Greater fork-beard) is also not included given their primarily deep-water distribution.

We provide considerable material of the remains of codfish, including a multi-species composite (p. 99), because small gadoids are important prey fish for numerous marine predators, including larger gadoids. The codfish have relatively low lipid contents (0.7 - 2.8%) and moderate calorific values (3.9 - 5.5 kJ g⁻¹). The **otoliths** are large in relation to fish length (except in the case of rocklings) and the outside of the otoliths is often strongly lobed, in contrast to the otoliths of most other fish species. Gadoid **vertebrae** have a distinct waist in most species, one or more prominent ridges or a network of lines of ossification, and have a very narrow spinal foramen. Vertebrae are generally robust and strongly ossified. Both the neural and haemal spines depart from the anterior side of the centrum, and are thick at the base. The **premaxillae** are distinct, often easy to find, and hold important characteristics, but break easily as part of the digestive process. The **cleithra** are distinct for the group, but species are more difficult to separate on the basis of these bones alone.



*Rowena Henderson with a large Cod caught at Sizewell on the Suffolk coast.
Photo Robin Somes.*

Key to species

- 1 With a long tapering tail **Rat-tails** – deep-water species (not in this book)
or Possessing a normal caudal fin 2
- 2 Possessing 3 dorsal & 2 anal fins 3
or Possessing 1 or 2 dorsal fins & 1 anal fin 11
3. Anal fin long beginning in front of or under the 1st dorsal 5
or Anal fin short, beginning behind the 1st dorsal fin 17
- 5 Anal fin begins in front of 1st dorsal fin origin **Blue whiting**, *Micromesistius poutassou* (p. 109)
or Anal fin begins under or behind dorsal fin origin 6
- 6 Dark spot at base of pectoral fin 7
or No dark spot 10
- 7 Barbel missing or minute **Whiting**, *Merlangius merlangus* (p. 106)
or Barbel conspicuous 8
- 8 Body deeper than head length, anal fin begins near middle of 1st dorsal fin base **Pout**, *Trisopterus luscus* (p. 115)
or Body depth less than head length, anal fin begins in space between 1st & 2nd dorsal fins 9
- 9 Lower jaw projects beyond upper jaw **Norway pout**, *Trisopterus esmarkii* (p. 113)
or Upper jaw projects beyond lower jaw **Poor cod**, *Trisopterus minutus* (p. 117)
- 10 Lower jaw projects strongly beyond upper jaw, lateral line curved and dark **Pollack**, *Pollachius pollachius* (p. 110)
or Jaws equal, lateral line straight and white **Saithe**, *Pollachius virens* (p. 112)
- 11 1st dorsal fin well-developed 18
or 1st dorsal fin reduced to 1 long ray or minute 12
- 12 At least 3 barbels, 1st dorsal fin reduced to 1 ray and a row of hair-like rays 13
or No barbels, 1st dorsal fin minute, head large and body tadpole-shaped **Tadpole fish**, *Raniceps raninus* (p. 119)
- 13 3 barbels, 1 on chin, 1 on each anterior nostril 14
or 4 or 5 barbels 15
- 14 Dark uniform colouration, pectoral fin 15 - 17 rays **Shore rockling**, *Gaidropsarus mediterraneus* (not in this book)
or Brown blobs on a pink background, pectoral fin 20 - 21 rays **Three-bearded rockling**, *Gaidropsarus vulgaris* (p. 127)
- 15 4 barbels **Four-bearded rockling**, *Enchelyopus cimbrius* (p. 125)
or 5 barbels 16
- 16 Fringe of papillae along upper lip, body colour pink-brown **Northern rockling**, *Ciliata septentrionalis* (p. 124)
or No fringe of papillae, body colour golden-brown **Five-bearded rockling**, *Ciliata mustela* (p. 122)
- 17 Barbel long, no black blotch on sides **Cod**, *Gadus morhua* (p. 102)
or Barbel minute, black blotch on sides **Haddock**, *Melanogrammus aeglefinus* (p. 104)
- 18 Lower jaw without barbel **European hake**, *Merluccius merluccius* (p. 100)
or Lower jaw with large barbel **Ling**, *Molva molva* (p. 128)

Not included in this book:

Grenadiers or rat-tails Macrouridae

Roundnose grenadier, *Coryphaenoides rupestris* – a deep-water species common in the Norwegian Deep.

Hollowsnout grenadier, *Coelorinchus caelorhincus* – an Atlantic deep-water species.

Softhead grenadier, *Malacocephalus laevis* – an Atlantic deep-water species

Codfishes Gadidae

Silvery pout, *Gadiculus argenteus* – deep-water species, edge of the Continental shelf.

Tusk, *Brosme brosme* - non-shoaling, deep-water species, rocky bottoms northern North Sea.

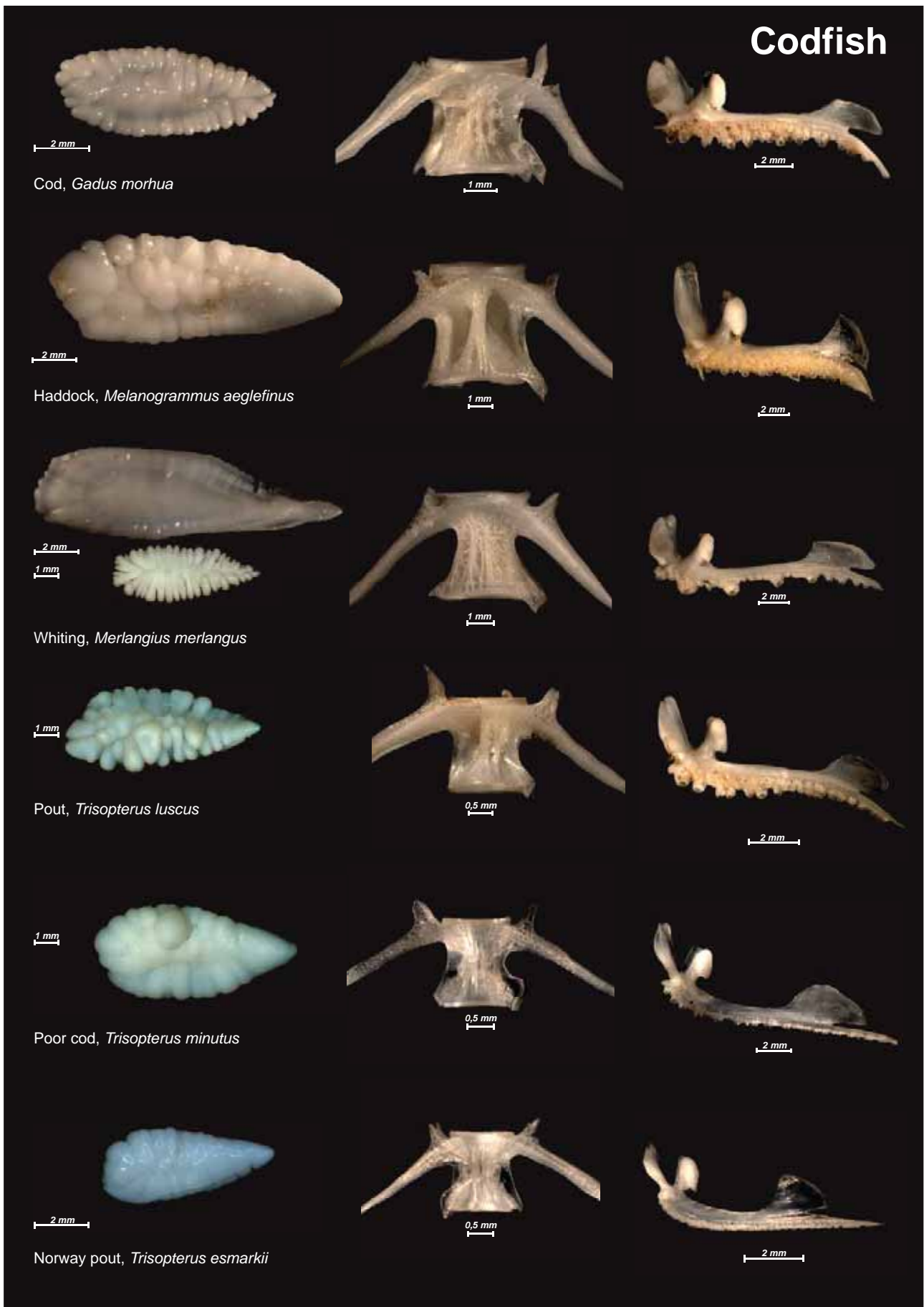
Bigeye rockling, *Gaidropsarus macrophthalmus* – probably rare, from more southerly waters.

Shore rockling, *Gaidropsarus mediterraneus* – probably rare, from more southerly waters.

Blue ling, *Molva dypterygia* – a deep-water species found in the Norwegian Deep.

Greater fork-beard, *Phycis blennoides* – a deep-water species from the Continental slope.

Codfish

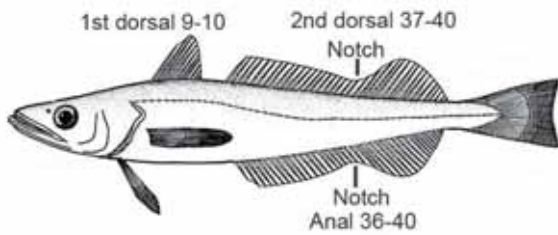


Comparison of remains of typical codfish species (Gadidae) that are common within the North Sea, showing the lobed outside of otoliths, anterior caudal vertebrae and premaxillae of Cod, Haddock, Whiting, Pout, Poor cod, and Norway pout. Note difference between small and larger Whiting otoliths. Photos Suse Kühn & Estefania Velilla.

The hakes or Merlucciidae

European hake or Hake, *Merluccius merluccius* L., 1758

Du: Heek, Ge: Seehecht, No: Lysing, Da: Kulmule



Diagnostic features	A slender and round-bodied fish with large mouth and sharp, long teeth. There are 2 dorsal fins, the first triangular, the second long-based. One long-based anal fin. No chin barbel present.
Size	To about 140 cm in length. In shallow inshore waters they are often 15 to 30 cm in length. A weight in excess of 5 kg is rare, but a fairly recent (1997) boat record of 11.7 kg is known.
Colour	The back is grey or blue-grey, shading to silver along the sides and silver-white on the ventral.
Similar species	Not readily confused with any other inshore species. Look for the elongate and rounded body form, a large mouth with long, needle-sharp teeth, and the characteristic arrangement of fins.
Food and bait, predators	Active open water predator of fish (including their own species, other gadoids, Herrings Sprats and Pilchards) and squid. Young feed on krill and other crustaceans. Preyed upon by piscivorous cetaceans such as Common dolphin and Harbour porpoise, occasionally by Harbour seals. Hake have the lowest calorific value of all codfish described in this book (~3.7 kJ g ⁻¹).
Distribution and seasonality	Essentially an offshore fish, demersal as well as benthopelagic, favouring depths of 165 to 550 m. Distributed mainly in deeper waters, so rarely encountered in the southern North Sea. The European hake is most abundant in the northern North Sea and Skagerrak. Catch rates have been found to be highest on the outer shelf and upper part of the slope. May come further inshore during cool climatic conditions. A single catch in the western Wadden Sea in the NIOZ fish fyke (April 2011).
Life history	Hake spawn off the south west and west coasts of the British Isles in waters with depths of around 200 m. The eggs are pelagic. Males are mature in their 3rd or 4th year, while females mature at a larger size in their 8th year. The larger females can reach a length of 1 m and a weight of 5 kg.
Commercial fishing and human consumption	Hake is an important commercial species which has been heavily exploited; as a result, the size of fish landed has greatly declined.



Typical immature **Hake** caught inshore in the Bristol Channel (UK). Photo Peter Henderson.

Fishing methods

It is caught with trawls, gill nets and longlines. Only occasionally caught by shore anglers. Boat fishing in midwater at night in waters 200 m or more deep is required to catch large specimens. Hake move from the sea bed to midwater at night to feed.

Remains

Not commonly encountered as a prey fish in most studies, but the **otoliths** are ovally to nearly kite-shaped, with a well-developed and wide sulcus, closed at the cauda, running over almost the whole length. $FL^{(cm)} = -4.35 + 2.66OL^{(mm)}$. In contrast to the other Gadiformes included in this book, **vertebrae** of European hake are poorly ossified, very light in weight, and have an almost spongy texture with deep oval depressions on either side of a distinct central rib. $\ln FL^{(mm)} = 4.4327 + 0.9916 \ln VL^{(mm)}$.



The Hake's mouth, showing its sharp teeth. Photo Peter Henderson.



Hake, Aquarium Finisterrae, Corunna, Spain. Photo Drow Male (CC).

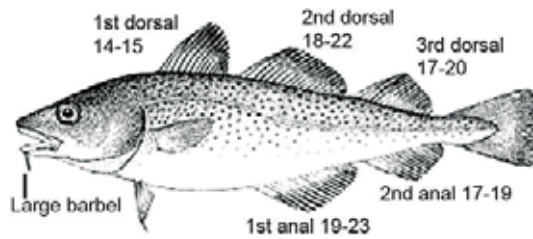


Hake otoliths, inside (left), outside (right), showing overall shape, distinct sulcus and lobed margins. Photos Estefania Velilla.

The Codfish or Gadidae

Cod, *Gadus morhua* (L., 1758)

Du: Kabeljauw, Ge: Kabeljau, No: Torsk, Da: Torsk



Diagnostic features	A heavy-bodied fish with 3 dorsal and 2 anal fins. There is a large barbel on the chin. The upper jaw extends beyond the lower jaw.
Size	Usually to about 70 cm in length. Cod can get considerably larger, up to at least twice that length, but as a result of overfishing, the larger fish have become much less common in the North Sea in recent decades. Recent record catches included individual Cod of 20 and 26.5 kg in weight.
Colour	A pale olive-brown background colour, which shades to silver-cream on the lower surface of the belly. The upper surface has a characteristic mottled brown-yellow camouflage.
Similar species	Young fish might be confused with other gadoids with a chin barbel. Note the mottled colouration, heavy build, white lateral line and the presence of the large chin barbel.
Food and bait, predators	A major predator in marine ecosystems (certainly prior to overfishing) eating a wide range of invertebrates, becoming more piscivorous with increasing size. Important fish prey for mature Cod include other gadoids including young Cod, herring-like fish, sandeels, flatfish and Mackerel. In turn, young Cod are an important prey fish for numerous seabirds and marine mammals throughout the North Sea. A fish low in lipid contents, of moderate quality as a prey species (~4 kJ g ⁻¹).
Distribution and seasonality	Listed as 'Vulnerable' on the 2016 - 1 version of the IUCN Red List of Threatened Species. A widely-distributed fish occurring throughout the North Sea and Skagerrak. Adult Cod can reach depths of 600 m, but, the majority of catches occur within depths of <200 m. Shallow upper estuarine waters are used mostly by juveniles. In the southern North Sea it is found inshore during the winter. The juveniles enter estuaries in June and may remain within the estuary over the following winter. Year-round catches in the western Wadden Sea NIOZ fish fyke, with no distinct seasonal pattern (about 1 - 3 fish day ⁻¹ year-round), but with rather higher catch rates in 1979 (8.6), 1985 (29.3), and 2006 (10.0 fish day ⁻¹) in all other years (remainder 1960 - 2015 mean = 1.38, standard deviation = 1.23, n= 52).
Life history	Primarily a demersal species, with loose schools hunting over the sea bed and in mid water. Cod are migratory fish moving between nursery, feeding and spawning grounds. Spawning occurs on the European continental shelf to a depth of 200 m between February and April. The eggs are pelagic and widely dispersed. The larvae initially feed on copepods, and gradually switch to larger crustaceans as they grow. Cod grow rapidly, and have the potential to live over 15 years and reach 150 cm in length. Growth rates differ per region and between years. Cod in the southern North Sea grow faster initially, but to a smaller



A young Cod caught inshore on the Suffolk coast. Photo Peter Henderson.

ultimate size than those in the north. The proportion reaching sexual maturity at 2 years old has increased between the 1970s and the 2000s.

Commercial fishing and human consumption Cod are one of the most important commercial fishes in the world, and have been an important food resource to Europeans for thousands of years. They are mostly caught in trawls, although longlining for larger fish is also practiced. There has been a great reduction in Cod abundance over the last 30 years, almost entirely due to over-fishing and incompetent fisheries management.

Fishing methods Beach & boat fishing, bottom-trawling, gill netting, seine netting, longlining. Regularly targeted by both shore and boat anglers for recreational fishing.

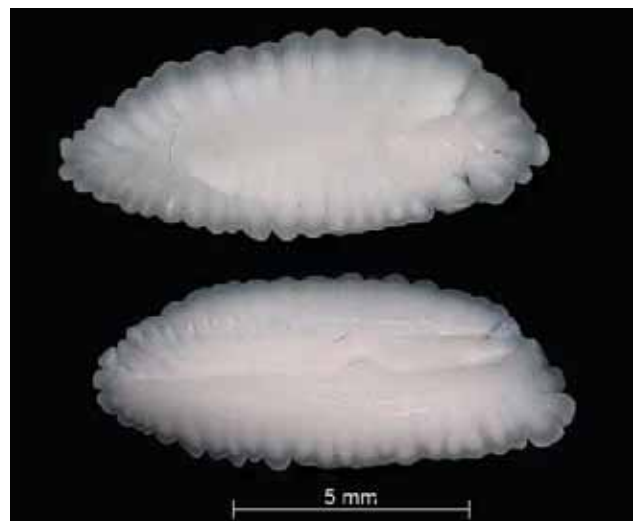
Remains Both the **dentary** and the **premaxillae** have distinct, sharp teeth, but the connections with the sockets is loose and teeth are usually missing in prey samples. The inside of the thick and oval **otolith** is convex and the outside strongly concave and heavily lobed, certainly in older specimens, so that viewed from the side, the otoliths are curved. The sulcus is closed, but runs over almost the whole length of the otolith. $FL^{(cm)} = -6.64 + 3.49 OL^{(mm)}$. The otoliths of Cod are difficult to distinguish from those of Haddock, but they are wider overall (length/width ratio 2.0-2.4). The **cleithrum** of Cod, as in the other gadoids, is a distinct and characteristic bone, but is of limited use to distinguish between related species. In the **vertebrae**, the centra are fairly short (VL~VH) with 2 - 4 distinct horizontal lines of ossification forming ridges but with a network of interconnecting structures. The anterior horns (DPrZ and VPrZ) are relatively short. Easily confused with Whiting vertebrae, but these have relatively longer centra. $\ln FL^{(mm)} = 4.3513 + 0.9202 \ln VL^{(mm)}$.



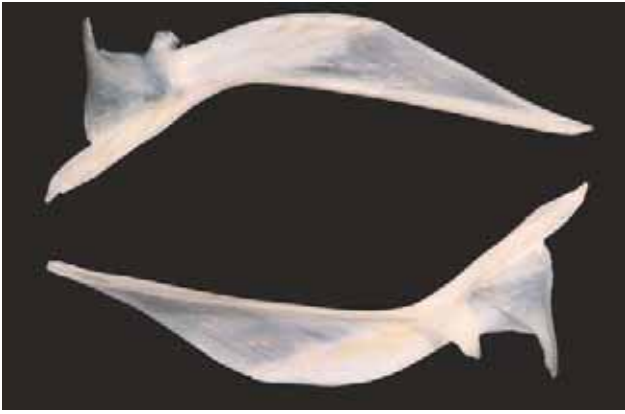
Head of Cod. Photo Peter Henderson.



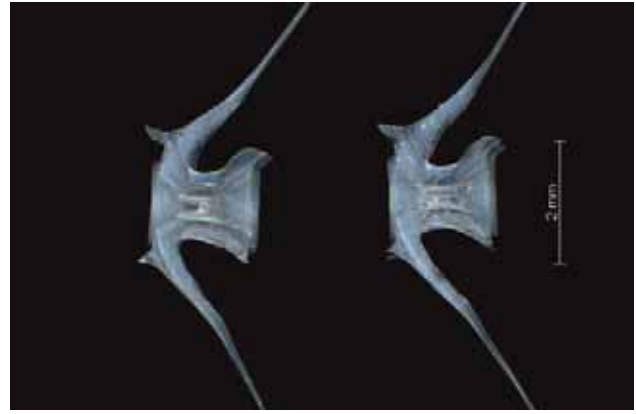
Cod **premaxillae**, inside (top) and outside (bottom), with some loose teeth remaining. Photo Suse Kühn.



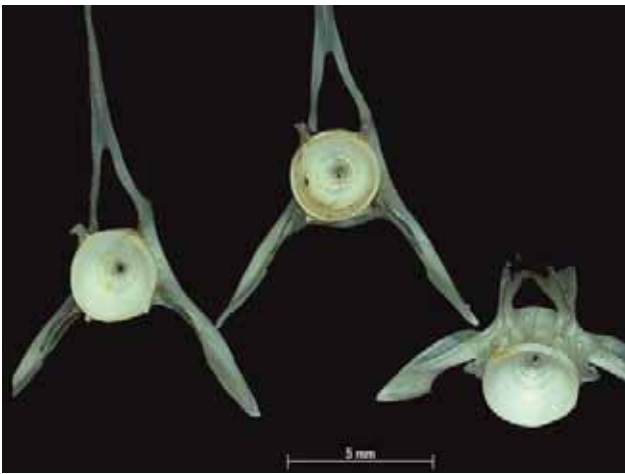
Cod **otoliths**, showing lobed outside (top) and distinct sulcus on the inside (bottom). Photo Suse Kühn.



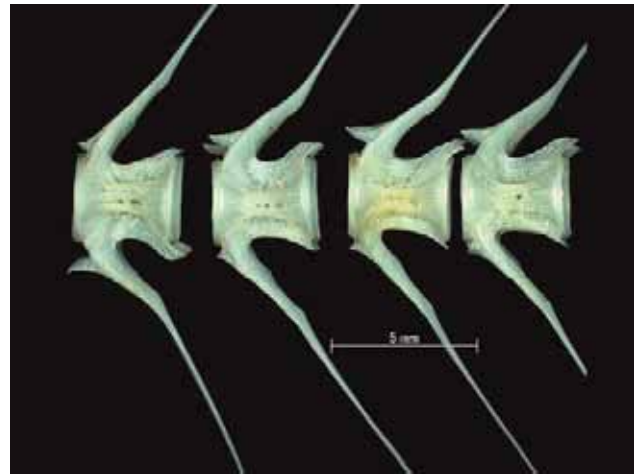
Cod *cleithra*, with a shape highly characteristic for the gadoid group, but, certainly if not pristine, hard to separate from cleithra in related species such as Whiting, Haddock and Pouts. Photo Anne Ausems & Suse Kühn.



Lateral view of *caudal vertebrae* of a very young Cod (FL 110 mm). Photo Suse Kühn.



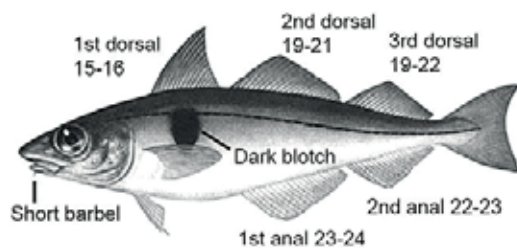
Rear view of *abdominal vertebrae* in Cod, showing pinhole spinal foramen. Photo Suse Kühn.



Lateral view of *caudal vertebrae* in Cod, showing complex rib structures and absence of neural foramen. Photo Suse Kühn.

Haddock, *Melanogrammus aeglefinus* (L., 1758)

Du: Schelvis, Ge: Schellfisch, No: Hyse, Da: Kuller



Diagnostic features

A codfish with 3 dorsal and 2 anal fins. First dorsal fin triangular with notably long fin rays. Short but visible chin barbel. Lower jaw clearly shorter than the upper jaw. Lateral line clearly visible and black.

Size

Can reach about 75 cm in length. Recent record catches included Haddock of 3 (shore) to over 6 kg (boat).

Colour

Dark green-brown dorsal and cream belly. Characteristic dark blotch above the pectoral fins.

Similar species

Young Haddock can be confused with other gadoids such as Whiting and Cod, but the dark blotches and the dark lateral line are distinctive. The lateral line of Cod is white.

Food and bait, predators

A demersal species that feeds primarily on benthic invertebrates. It will take a wide range of baits, including mussels, ragworm, lugworm and fish strips. As a food fish primarily known from diet studies of scavenging seabirds (discards), but also taken by auks and marine mammals (mostly seals). Low in fat and moderate in calorific value (~4 kJ g⁻¹).



Haddock caught off the north-east English coast. Photo Peter Henderson.

Distribution and seasonality Listed as ‘Vulnerable’ on the 2016-1 version of the IUCN Red List of Threatened Species. Found nowadays primarily in the northern North Sea, from 40 to 300 m. Archaeological records and historical commercial fisheries statistics suggest that Haddock were once common in the southern North Sea prior to the mid-1960s. Rarely caught in the English Channel. Haddock live close to the sea bed, where they feed. They enter shallow coastal waters in summer and retreat deeper in winter. Unrecorded since 1960 from the western Wadden Sea NIOZ fish fyke.

Life history Spawning February to June, but mostly in March and April. The eggs float; the larvae are pelagic, and have been found in association with jellyfish. Haddock may live for 14 years and reach sexual maturity at 4 - 5 years (at 41 cm for males, 46 cm for females). One year-old Haddock in the North Sea is 16 - 18 cm, 2 year-old Haddock reach 25 - 30 cm, so that the youngest fish appearing in commercial landings are usually 2 - 3 years old. The main spawning grounds are in the northern North Sea and in the Atlantic, off Rockall, Faroe, and Iceland.

Commercial fishing and human consumption An important commercial species particularly favoured in the north of Britain. Haddock are often sold smoked.

Fishing methods It is captured by trawling and also longlining. Targeted by boat recreational anglers in the north of Britain.

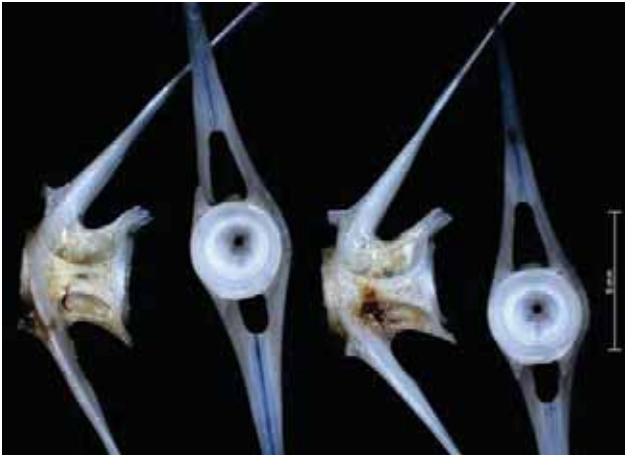
Remains Intact **premaxillae** would give an easy clue, given that the most anterior process, or ‘ear’ (ASP) is considerably larger than that in Cod, while the ramus is relatively shorter. The **otoliths** are difficult to distinguish from those of Cod, but are narrower (length/width ratio 2.35 - 3.50) and more strongly curved in lateral view. The sulcus is well-developed, closed, and runs over almost the whole length of the otolith. $FL^{(cm)} = -3.27 + 2.53OL^{(mm)}$. Ribs on the centra of all **vertebrae** are more pronounced and more strongly ossified than in those of the other gadoids. Both anterior and posterior caudal vertebrae are fairly short, but the mid-section has relatively long centra. $lnFL^{(mm)} = 4.3571 + 0.9701 lnVL^{(mm)}$. Haddock **cleithra** are shown on p.17.



Haddock premaxillae, outside view (for inside view see p. 99). Photo Suse Kühn.



Haddock otoliths (lobed outside upper, inside lower image) showing typical outline, lobed margins and distinct sulcus. Photo Suse Kühn.



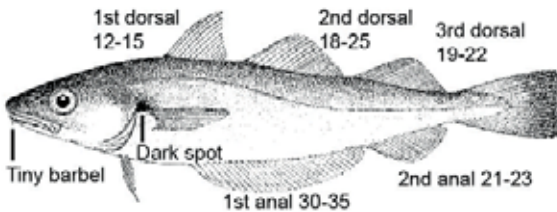
Central *caudal vertebrae* of Haddock in lateral and posterior view showing small spinal foramen and characteristic rib structure. Photo Suse Kühn.



Posterior *caudal vertebrae* and *urostyle* of Haddock. Photo Suse Kühn.

Whiting, *Merlangius merlangus* (L., 1758)

Du: Wijting, Ge: Wittling, No: Hvitting, Da: Hvilling



Diagnostic features

3 dorsal and 2 anal fins and a slender head. Only small fish possess a chin barbel, even in these it is minute. The upper jaw extends beyond the lower.

Size

Length to 70 cm; usually smaller, especially males. Recent record catches were fish ranging from 1.8 (shore-based) to 3.3 kg (boat) in weight.

Colour

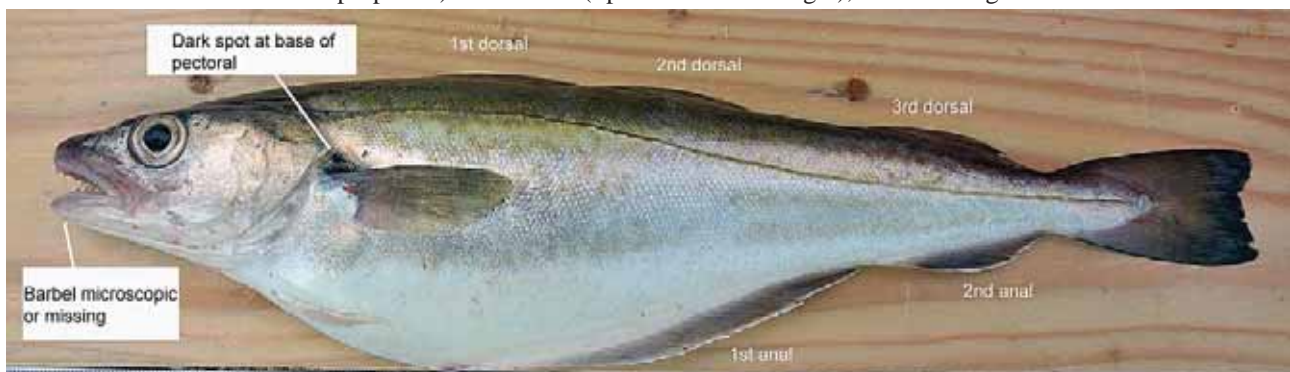
A pale olive brown-yellow back and cream belly. The bright colouration of live fish quickly fades. A characteristic dark spot at the base of the pectoral fin.

Similar species

The young can be confused with other gadoids such as Norway pout, Blue whiting and Poor cod. Note the dark spot at the base of the pectoral fin, the lack of chin barbel, and the 3 dorsal fins with little or no gap between their bases. Adults can look similar to Pollack; the jaw alignment easily distinguishes the two (p. 107).

Food and bait, predators

A general predator on shrimps, crabs, molluscs, small fish, polychaetes and cephalopods. The young feed on crustaceans, moving on to fish such as Sprats and sandeel as they grow. They will take a range of baits including lugworm, ragworm, Mackerel strip and squid. As a food fish, primarily known from diet studies of scavenging seabirds, particularly in the south-eastern North Sea, where beamtrawlers and shrimpers dump large quantities as discards. Also frequently taken by auks and marine mammals (notably by seals and porpoises). A lean fish (lipids 0.7% wet weight), 3.9 - 4.3 kJ g⁻¹.



Mature *Whiting* caught inshore on the Suffolk coast. Photo Peter Henderson.

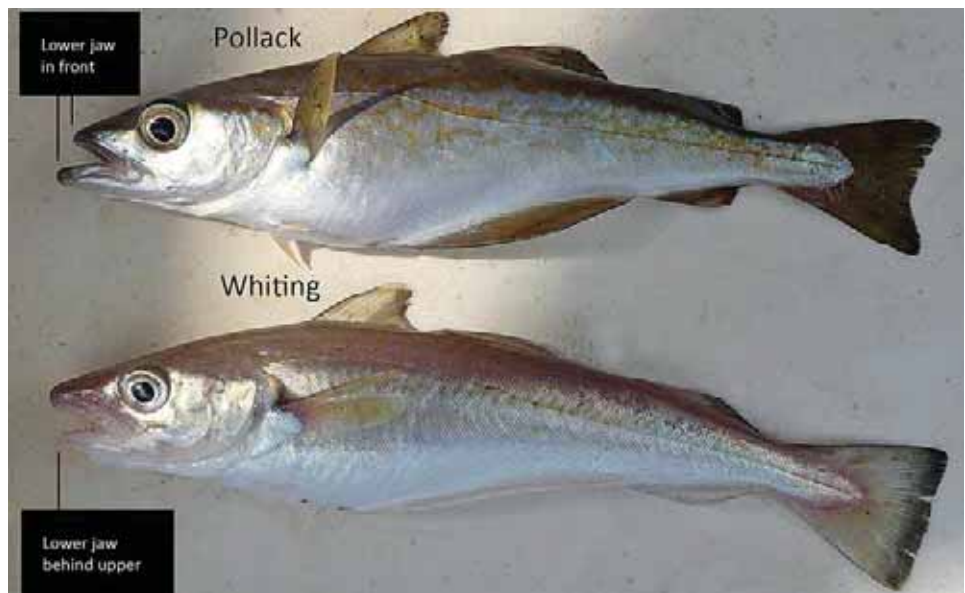
Distribution and seasonality Whiting is one of the most widely-distributed species and the commonest member of the cod family in many inshore waters. Found in large numbers throughout the North Sea and Skagerrak. The juveniles are highly abundant in estuarine habitats. Listed as ‘Least concern’ on the 2016 - 1 version of the IUCN Red List of Threatened Species, but concerns were raised suggesting that ‘Vulnerable’ would be more appropriate for the southern North Sea. Although it occurs to a maximum of 550 m, the majority are caught between 30 - 150 m. Adults most commonly found from 30 to 100 m over mud or gravel bottoms, occasionally sand and rock; most abundant inshore during winter. Juveniles penetrate far up estuaries, migrating to the open sea only after the first year of life. Year-round catches in the western Wadden Sea NIOZ fish fyke, but with low catch rates in spring (<1 fish day⁻¹), higher catches during June - December, notably in October - November (6 - 8 fish day⁻¹). Autumn catches rather higher October - November 1974 - 90 (average 13.8 day⁻¹, Standard deviation = 14.47, range 3.2 - 63.8 fish day⁻¹, n= 17) in comparison with earlier and later years.

Life history Larvae and juveniles are known to associate with jellyfish, using the tentacles as protection from predators, apparently unharmed by their sting. Spawning begins in the south in January and in the north may occur as late as July. The main spawning period is April/ May; spawning takes place in open water and the eggs are pelagic. Females may live for 7 or 8 years.

Commercial fishing and human consumption An important food fish, though not widely favoured because it lacks the firm flesh of Cod or Haddock.

Fishing methods Caught by bottom-trawling and longlining. Taken by recreational fishermen both from boats and from the shore.

Remains The **premaxillae** are more fragile than in Cod or Haddock, and with the anterior processes, or ‘ears’ set rather wider apart. The **otoliths** are in fact unmistakable, sharp and pointed as they are, but unfortunately, the tips break rather easily. Otoliths from small fish, FL 8 - 15cm, tend to have more strongly-lobed ventral and dorsal margins (as well as on the

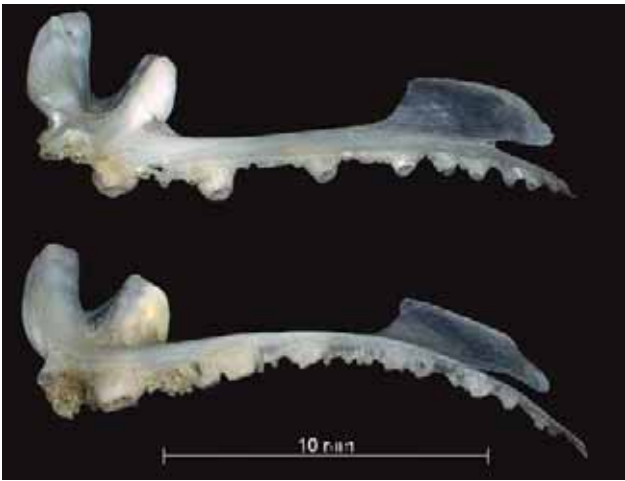


A comparison of **Pollack** and **Whiting** of similar size. Photo Peter Henderson.

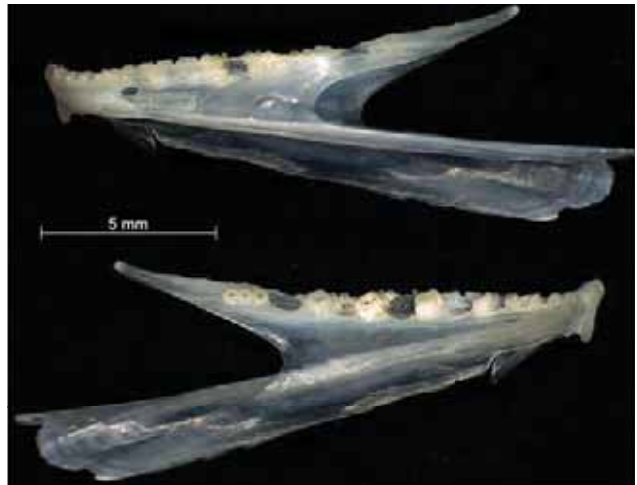


Comparison of **Whiting** and **Blue whiting**. Photo Peter Henderson.

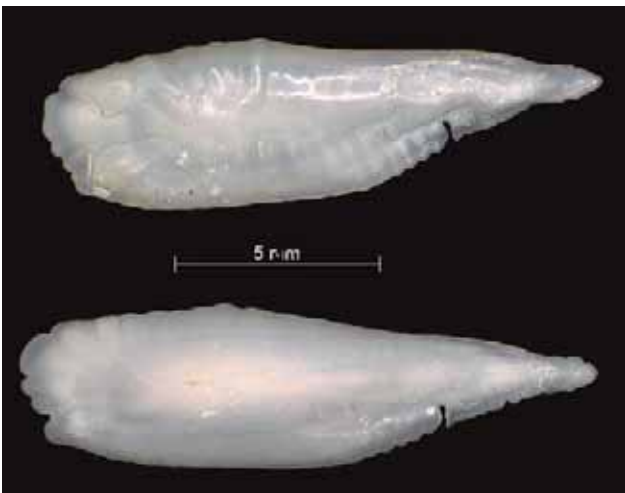
anterior round tips) than larger fish. To calculate fish length from otolith size, use $FL^{(cm)} = 0.81 + 1.73OL^{(mm)}$, but because the slender tip of these otoliths is almost invariably broken, using otolith width can be more practical: $FL^{(cm)} = -2.97 + 6.74OW^{(mm)}$. The surface of the strongly-waisted centrum of the **vertebrae** has a fine network, a gross-grained appearance of fine ribs with many tiny interconnecting septa. The vertebrae are relatively longer (VL/VW ratio) than the otherwise rather similar vertebrae of Cod and Pollack. The ventral anterior horns (VPrZ) are shorter than in Blue whiting. $FL^{(mm)} = 1.906 + 73.108VL^{(mm)}$



Whiting **premaxillae**, outside view below, inside view above, showing relatively short 'ears' and longer ramus in comparison with those of Haddock. Photo Suse Kühn.



Outside (top) and inside (bottom) view of Whiting **dentaries**. Photos Suse Kühn.



Whiting **otoliths**, inside view below, outside view on top, showing typical outline and sharp, pointed posterior end of a fairly large animal (FL 265 mm). Photo Suse Kühn.



Whiting **otoliths**, inside view on top, outside view below, typical lobed margin of a small specimen (FL 125 mm). Photo Suse Kühn.



Abdominal **vertebrae** of Whiting showing typical network structure on centra and tiny spinal foramen. Photo Suse Kühn.



Caudal **vertebrae** of Whiting, showing diablo shape, prominent horns, and fine network structure on centra. Photo Suse Kühn.

<i>Acantholabrus palloni</i>	223	Blue-mouth	169
<i>Acipenser sturio</i>	59	Bluntnose sixgill shark.....	31
Acipenseridae.....	59	Bogue	232
Acipenseriformes.....	59	Bonito.....	272
Agonidae.....	186	<i>Boops boops</i>	232
<i>Agonus cataphractus</i>	168, 186	Bothidae.....	276, 289
Albacore.....	272	<i>Brama brama</i>	244
Allis shad.....	74	Bramble shark.....	32
<i>Alopias vulpinus</i>	31	Bramidae.....	241, 244
Alopiidae.....	31	breams.....	232
<i>Alosa alosa</i>	74	Brill.....	278, 283
<i>Alosa fallax</i>	68, 72	Brook lamprey.....	27
Alpine bullhead.....	181	<i>Brosme brosme</i>	98
<i>Amblyraja hyperborea</i>	45	Brown trout.....	90
<i>Amblyraja radiata</i>	46	<i>Buena jeffreysii</i>	196
<i>Ammodytes marinus</i>	16, 219	<i>Buglossidium luteum</i>	278, 307
<i>Ammodytes tobianus</i>	16, 20, 23, 216, 217	Bull huss.....	38
Ammodytidae.....	215	Bull rout.....	172, 181, 213
Anarhichadidae.....	249, 255	Bullet mackerel.....	272
<i>Anarhichas denticulatus</i>	249	Bullhead.....	181, 213
<i>Anarhichas lupus</i>	255	butterfish.....	253
<i>Anarhichas minor</i>	249	Butterfish.....	16, 20, 23, 253
anchovies.....	69	Callionymidae.....	266
Anchovy.....	69	<i>Callionymus lyra</i>	16, 18, 20, 23, 266, 270
Angel shark.....	44	<i>Callionymus maculatus</i>	268
angel sharks.....	44	<i>Callionymus reticulatus</i>	269
Anglerfish.....	130	Carangidae.....	241
anglerfishes.....	130	Carchariformes.....	31
<i>Anguilla anguilla</i>	61, 65	Carcharinidae.....	31
Anguillidae.....	61	Catfish.....	255
<i>Anguilliformes</i>	61	catsharks.....	31
<i>Aphia minuta</i>	195, 197	<i>Centrolabrus exoletus</i>	223
Arctic blennies.....	249	<i>Centroscyrnus coelelepis</i>	32
Arctic char.....	89	Cetorhinidae.....	32
Arctic ray.....	45	<i>Cetorhinus maximus</i>	32
<i>Argentina silus</i>	84	<i>Cheilopogon heterurus</i>	143
<i>Argentina sphyraena</i>	18, 84	<i>Chelidonichthys lucerna</i>	20, 21, 172, 175, 178
argentinians and smelts.....	84	<i>Chelon labrosus</i>	16, 20, 23, 133, 140
Argentinidae.....	84	<i>Chirolophis ascanii</i>	252
<i>Argyrosomus regius</i>	245	Chlamydoselachidae.....	31
<i>Arnoglossus imperialis</i>	276	<i>Chlamydoselachus anguineus</i>	31
<i>Arnoglossus laterna</i>	17, 277, 289	<i>Ciliata mustela</i>	16, 121, 122
<i>Arnoglossus thori</i>	276	<i>Ciliata septentrionalis</i>	18, 121, 124
<i>Artediellus atlanticus</i>	181	<i>Clupea harengus</i>	18, 19, 20, 23, 68, 75, 81, 82
<i>Aspitrigla cuculus</i>	173	Clupeidae.....	72
<i>Aspitrigla obscura</i>	173	Clupeiformes.....	67
<i>Atherina boyeri</i>	141	Cod.....	18, 25, 97, 99, 102, 116
<i>Atherina presbyter</i>	16, 18, 20, 23, 141	codfishes.....	97, 102
Atherinidae.....	141	<i>Coelorinchus caelorhincus</i>	98
Atheriniformes.....	141	Comber.....	237
Atlantic bluefin tuna.....	275	Common goby.....	195, 199, 202
Atlantic croaker.....	245	Common skate complex.....	47
Atlantic flying-fish.....	143	Common smooth-hound.....	31
Atlantic hook-ear sculpin.....	181	<i>Conger conger</i>	16, 64
Atlantic salmon.....	89	Conger eel.....	16, 64
Atlantic saury.....	145	conger eels.....	64
<i>Auxis rochei</i>	272	Congridae.....	64
<i>Auxis thazard</i>	272	Corbin's sandeel.....	222
Baillon's wrasse.....	223	Coregonidae.....	89
<i>Balistes capriscus</i>	317	<i>Coregonus oxyrinchus</i>	89
Balistidae.....	317	<i>Coris julis</i>	223
Ballan wrasse.....	18, 223, 227	Corkwing wrasse.....	224
Basking shark.....	32	Cottidae.....	181
Bass.....	16, 18, 20, 23, 140, 237	<i>Cottus gobio</i>	181
<i>Belone belone</i>	20, 23, 143, 146	<i>Cottus poecilopus</i>	181
<i>Belone svetovidovi</i>	143	<i>Cottus perifretum</i>	213
Belonidae.....	143	Couch's goby.....	196
Beloniformes.....	143	cow sharks.....	31
Bib.....	15, 16, 99, 115	<i>Crenilabrus melops</i>	224
Big-eyed rockling.....	98	Crystal goby.....	195, 196
Bigeye tuna.....	272	<i>Crystallogobius linearis</i>	195, 196
Bighead goby.....	213	<i>Ctenolabrus rupestris</i>	225
Big-scale sand-smelt.....	141	Cuckoo ray.....	49
Black goby.....	195, 209	Cuckoo wrasse.....	230
Black sea-bream.....	232, 235	Cyclopteridae.....	188
Black skate.....	45	<i>Cyclopterus lumpus</i>	188
Black-bellied angler.....	130	Dab.....	17, 277, 278, 297, 299, 303
Black-mouth dogfish.....	31	<i>Dalatius licha</i>	32
Black-striped pipefish.....	156	Darkie Charlie.....	32
blennies.....	258, 263	Dasyatidae.....	57
Blenniidae.....	258, 263	<i>Dasyatis pastinaca</i>	57
Bloch's topknot.....	289	Deal-fish.....	95
Blonde ray.....	50	deal-fishes.....	95
Blue ling.....	98	<i>Deania calcea</i>	32
Blue shark.....	31	Deep-snouted pipefish.....	162
Blue whiting.....	107, 109	Dentex.....	232

<i>Dentex dentex</i>	232
Derbio.....	241
<i>Dicentrarchus labrax</i>	16, 18, 20, 23, 140, 237
Diminutive goby.....	195, 199, 207
<i>Dipturus batis</i> s.l.....	47
<i>Dipturus cf. flossada</i>	47
<i>Dipturus cf. intermedia</i>	47
<i>Dipturus linteus</i>	45
<i>Dipturus nidarosiensis</i>	45
<i>Dipturus oxyrinchus</i>	45
dogfish.....	31, 32
dories.....	147
Dover sole.....	16, 278, 312
Dragonet.....	16, 18, 20, 23, 266, 270
dragonets.....	266
drums or shade-fishes.....	245
Eagle ray.....	45
<i>Echlichthys vipera</i>	20, 260
<i>Echinorhinus brucus</i>	32
Eel.....	61, 65
Eelpout.....	20, 249
eelpouts.....	249
eels.....	61
Electric ray.....	44
electric rays.....	44
<i>Enchelyopus cimbrius</i>	121, 125
Engraulidae.....	69
<i>Engraulis encrasicolus</i>	69
<i>Entelurus aequoreus</i>	150, 156
Etmopteridae.....	32
<i>Etmopterus spinax</i>	32
European eel.....	61, 65
European hake.....	100
<i>Euthynnus alletteratus</i>	272
<i>Eutrigla gurnardus</i>	16, 18, 23, 21, 172, 177
Exocoetidae.....	143
False catshark.....	31
Fifteen-spined stickleback.....	149, 154
Five-bearded rockling.....	16, 121, 122
flatfish.....	276
Flounder.....	277, 278, 301, 305
flying-fish.....	143
Four-bearded rockling.....	121, 125
Four-horn sculpin.....	181
Fourspot megrim.....	279
Fries' goby.....	195, 212
Frigate mackerel.....	272
Frilled shark.....	31
frilled sharks.....	31
<i>Gadiculus argenteus</i>	98
Gadidae.....	102
Gadiformes.....	97
<i>Gadus morhua</i>	18, 25, 97, 99, 102, 116
<i>Gaidropsarus macrophthalmus</i>	98
<i>Gaidropsarus mediterraneus</i>	98
<i>Gaidropsarus vulgaris</i>	121, 127
<i>Galeocerdo cuvier</i>	35
<i>Galeorhinus galeus</i>	39
<i>Galeus melastomus</i>	31
garfish.....	143
Garfish.....	20, 23, 143, 146
Gasterosteidae.....	149
Gasterosteiformes.....	149
<i>Gasterosteus aculeatus</i>	18, 20, 23, 149, 150
Giant goby.....	196
Gillthead.....	16, 18, 232
<i>Glyptocephalus cynoglossus</i>	292
gobies.....	195
Gobiidae.....	195
<i>Gobius cobitis</i>	196
<i>Gobius couchi</i>	196
<i>Gobius cruentatus</i>	196
<i>Gobius gasteveni</i>	196
<i>Gobius niger</i>	195, 209
<i>Gobius paganellus</i>	195, 208
<i>Gobiusculus flavescens</i>	195, 199, 205
Golden grey mullet.....	25, 138, 140
Goldsinny.....	225
Greater pipefish.....	23, 158
Sea lamprey.....	29
Greater argentine.....	84
Greater forkbeard.....	98
Greater sandeel.....	18, 216, 221
Greater Weever.....	18, 258
Greenland Halibut.....	276
grenadiers or rat-tails.....	98
Grey gurnard.....	16, 18, 23, 21, 172, 177
grey mullets.....	133
groupers or sea perches.....	237
Guillet's goby.....	196
Gunnel.....	16, 20, 23, 253
gurnards.....	173

gurnards, bullheads, lumpfish, poachers & snailfish.....	168
<i>Gymnammodytes semisquamatus</i>	215, 220
<i>Gymnocephalus cernuus</i>	237, 239
Haddock.....	17, 99, 104
Hagfish.....	26
hagfish and lampreys.....	26
Hake.....	100
hakes.....	100
Halibut.....	296
<i>Helicolenus dactylopterus</i>	169
Herring.....	18, 19, 20, 23, 68, 75, 81, 82
herring-like fish.....	67
herrings.....	72
Hexanchidae.....	31
<i>Hexanchus griseus</i>	31
<i>Hippocampus guttulatus</i>	165
<i>Hippocampus hippocampus</i>	166
<i>Hippoglossoides platessoides</i>	294
<i>Hippoglossus hippoglossus</i>	296
Hollowsnout grenadier.....	98
Hooknose.....	168, 186
Horse mackerel.....	16, 18, 20, 23, 140, 241, 248
hound sharks.....	31
Houting.....	89
<i>Hyperoplus immaculatus</i>	222
<i>Hyperoplus lanceolatus</i>	18, 216, 221
Icelidae.....	168, 186
Imperial scaldfish.....	276
<i>Isurus oxyrinchus</i>	31
Jeffrey's goby.....	196
Jelly cat.....	249
John Dory.....	18, 147
<i>Katsuwonus pelamis</i>	272
Labridae.....	223
<i>Labrus bergylla</i>	18, 223, 227
<i>Labrus mixtus</i>	230
Lake trout.....	29
<i>Lamna nasus</i>	34
Lamnidae.....	31, 34
Lamniformes.....	31
<i>Lampetra fluviatilis</i>	27
<i>Lampetra planeri</i>	27
lampreys.....	27
Lamprididae.....	95
Lampriformes.....	95
<i>Lampris guttatus</i>	95
lantern sharks.....	31, 32
Launce.....	18, 216, 221
<i>Lebetus guilleti</i>	196
<i>Lebetus scorpioides</i>	195, 199, 207
Left-eyed' flatfish.....	276, 279
Lemon sole.....	277, 300
Leopard-spotted goby.....	196
<i>Lepidorhombus boschii</i>	279
<i>Lepidorhombus whiffiagonis</i>	279
<i>Leptoclinus maculatus</i>	249
Lesser argentine.....	18, 84
Lesser pipefish.....	160
Lesser sandeel.....	16, 20, 23, 216, 217
Lesser spotted dogfish.....	36
Lesser weever.....	20, 260
<i>Lesueurigobius friesii</i>	195, 212
<i>Leucoraja circularis</i>	45
<i>Leucoraja fullonica</i>	45
<i>Leucoraja naevus</i>	49
lightfishes.....	93
<i>Limanda limanda</i>	17, 277, 278, 297, 299, 303
Ling.....	128
Liparidae.....	191
<i>Liparis liparis</i>	172, 191
<i>Liparis montagui</i>	193
<i>Lipophrys pholis</i>	263
Little tunny.....	272
<i>Liza aurata</i>	25, 138, 140
<i>Liza ramada</i>	133, 136, 140
Long rough dab.....	294, 299
Long-fin tuna.....	272
Long-finned gurnard.....	173
Long-nosed skate.....	45
Long-spined sea scorpion.....	16, 168, 172, 183
Lophiidae.....	130
Lophiiformes.....	130
<i>Lophius budegassa</i>	130
<i>Lophius piscatorius</i>	130
Lozano's goby.....	195, 199
<i>Lumpenus lampretaeformis</i>	253
lumpfish.....	188
Lumpsucker.....	188
Lythe.....	107, 110
Mackerel.....	16, 20, 23, 140, 272
mackerel sharks.....	31
mackerels and tunnies.....	140, 272

Macrouridae.....	98	Pink salmon	89
<i>Malacocephalus laevis</i>	98	pipefish and seahorses	149, 156
Marbled electric ray	44	Piper	173
Marbled goby	196	Plaice	16, 18, 20, 23, 277, 278, 303, 304
Marsipobranchi	26	<i>Platichthys flesus</i>	277, 278, 301, 305
<i>Maurolicus muelleri</i>	93	<i>Plectognathi</i>	315
Meagre	245	<i>Pleuronectes platessa</i>	16, 18, 20, 23, 277, 278, 303, 304
Megrim	279	Pleuronectidae	276, 292
<i>Melanogrammus aeglefinus</i>	17, 99, 104	Pleuronectiformes	276
<i>Merlangius merlangus</i>	16, 20, 23, 25, 99, 106	poachers	186
Merlucciidae.....	100	<i>Pollachius pollachius</i>	107, 110
<i>Merluccius merluccius</i>	100	<i>Pollachius virens</i>	112
<i>Micrenophrys lilljeborgii</i>	184	Pollack	107, 110
<i>Microchirus variegatus</i>	309	<i>Polyprion americanus</i>	237
<i>Micromesistius poutassou</i>	107, 109	<i>Pomatoschistus lozanoi</i>	195, 199
<i>Micropogonias undulatus</i>	245	<i>Pomatoschistus marmoratus</i>	196
<i>Microstomus kitt</i>	277, 300	<i>Pomatoschistus microps</i>	195, 199, 202
<i>Mola mola</i>	315	<i>Pomatoschistus minutus</i>	16, 20, 23, 195, 199
Molidae	315	<i>Pomatoschistus norvegicus</i>	195, 199
<i>Molva dypterygia</i>	98	<i>Pomatoschistus pictus</i>	195, 199, 204
<i>Molva molva</i>	128	pomfrets.....	241, 244
Monkfish	130	<i>Ponticola kessleri</i>	213
Monkey goby	213	Poor cod	99, 117
Montagu's sea snail	193	Porbeagle shark	34
Moray eel	61	Portuguese shark	32
moray eels	61	Pout	15, 16, 99, 115
Moronidae	237	<i>Prionace glauca</i>	31
Moustache sculpin	186	<i>Proterorhinus semilunaris</i>	213
Mugilidae.....	133	<i>Pseudotriakis microdon</i>	31
Mugiliformes	133	<i>Pterycombus brama</i>	241
Mullidae	246	<i>Pungitius pungitius</i>	149, 153
<i>Mullus surmuletus</i>	18, 246	Rainbow wrasse.....	223
<i>Muraena helena</i>	61	Raitt's sandeel	16, 219
Muraenidae.....	61	<i>Raja batis</i>	47
<i>Mustelus asterias</i>	41	<i>Raja brachyura</i>	50
<i>Mustelus mustelus</i>	31	<i>Raja clavata</i>	52
Myliobatidae.....	45	<i>Raja microocellata</i>	45
<i>Myliobatiformes</i>	44	<i>Raja montagui</i>	53
<i>Myliobatis aquila</i>	45	<i>Raja undulata</i>	55
<i>Myoxocephalus quadricornis</i>	181	<i>Rajella tyllae</i>	45
<i>Myoxocephalus scorpius</i>	172, 181, 213	Rajidae	45
<i>Myxine glutinosa</i>	26	<i>Rajiformes</i>	44
Myxiniidae.....	26	<i>Raniceps raninus</i>	119
<i>Naucrates ductor</i>	241	<i>Ranzania laevis</i>	315
Nemichthyidae	61	rat-tails	98
<i>Nemichthys scolopaceus</i>	61	Ray's bream	244
<i>Neogobius fluviatilis</i>	213	rays.....	45
<i>Neogobius melanostomus</i>	195, 213	Red gurnard	173
<i>Nerophis lumbriiformis</i>	164	Red mullet	18, 246
<i>Nerophis ophidion</i>	163	red mullets	246
Nilsson's pipefish	160	Red scorpionfish	168
Nine-spined stickleback	149, 153	Red sea-bream	232
Northern rockling	18, 121, 124	Redfish	170
Norway bullhead	184	Red-mouthed goby	196
Norway goby	195, 199	Regalecidae.....	95
Norway haddock.....	171	<i>Regalecus glesne</i>	95
Norway pout.....	99, 113, 118	<i>Reinhardtius hippoglossoides</i>	276
Norwegian skate.....	45	requiem sharks	31
Norwegian topknot	286	Reticulated dragonet.....	269
Oarfish	95	Right-eyed flounders	276, 292
oarfish	95	River lamprey	27
<i>Oncorhynchus oxyrinchus</i>	89	Rock cook	223
Opah.....	95	Rock goby	195, 208
opahs.....	95	<i>Rostroraja alba</i>	45
Osmeridae	86	Rough pomfret	241
Osmeriformes.....	84	Round goby	195, 213
<i>Osmerus eperlanus</i>	20, 86	Round ray	45
Oxynotidae.....	32	Ruffe	237, 239
<i>Oxymotus paradoxus</i>	32	Sail ray	45
<i>Pagellus acarne</i>	232	Sailfin roughshark.....	32
<i>Pagellus bogaraveo</i>	232	Saithe.....	112
<i>Pagellus erythrinus</i>	232	<i>Salmo salar</i>	89
Painted goby.....	195, 199, 204	<i>Salmo trutta</i>	18, 23, 90
Pandora	232	salmon and trout	89
<i>Parablennius gattorugine</i>	264	Salmonidae.....	89
<i>Parablennius pilicornis</i>	258	Salmoniformes	89
Pearlsides	93	salmons	89
pearlsides	93	<i>Salvelinus alpinus</i>	89
<i>Pegusa lascaris</i>	310	<i>Salvelinus namaycush</i>	29
<i>Perca fluviatilis</i>	237, 239	Sand goby	16, 20, 23, 195, 199
Perch.....	237, 239	Sand sole	310
perches.....	237, 239	sandeels.....	215
Percidae.....	237, 239	Sand-smelt.....	16, 18, 20, 23, 141
<i>Perciformes [in 10 parts]</i>	195, 215, 223, 232, 237, 241, 245, 249, 258, 272	sand-smelts	141
<i>Petromyzon marinus</i>	29	Sandy ray	45
Petromyzontidae	27	<i>Sarda sarda</i>	272
Pholidae	249, 253	<i>Sardina pilchardus</i>	68, 78
<i>Pholis gunnellus</i>	16, 20, 23, 253	Sardine	68, 78
<i>Phrynorhombus norvegicus</i>	286	<i>Sarpa salpa</i>	232
<i>Phycis blennoides</i>	98	Saupe.....	232
Pilchard.....	68, 78	Scad	16, 18, 20, 23, 140, 241, 248
Pilotfish.....	241	scads and jacks	140, 241

Scaldfish	17, 277, 289	stingrays	45, 57
scaldfishes	276, 289	<i>Stizostedion cernuus</i>	237
Scale-rayed wrasse	223	Stomiiformes	93
Sciaenidae	245	Straight-nosed pipefish	163
<i>Scomber japonicus</i>	272	Streaked gurnard	173, 180
<i>Scomber scombrus</i>	16, 20, 23, 140, 272	Striped red mullet	18, 246
Scomberesocidae	145	Sturgeon	59
<i>Scomberesox saurus</i>	145	sturgeons	59
Scombridae	140, 272	Sunfish	315
Scophthalmidae	276, 279	sun-fishes	315
<i>Scophthalmus maximus</i>	281	<i>Symphodus bailloni</i>	223
<i>Scophthalmus rhombus</i>	278, 283	<i>Symphodus melops</i>	224
<i>Scorpaena scrofa</i>	168	Syngnathidae	156
Scorpaenidae	168	Syngnathiformes	149
Scorpaeniformes	168	<i>Syngnathus abaster</i>	156
scorpionfishes	168	<i>Syngnathus acus</i>	23, 158
sculpins	168, 186	<i>Syngnathus rostellatus</i>	160
Scyllorhinidae	31, 36	<i>Syngnathus typhle</i>	162
<i>Scyllorhinus canicula</i>	36	Tadpole fish	119
<i>Scyllorhinus stellaris</i>	38	<i>Taractes asper</i>	241
sea basses	140, 237	<i>Taractichthys longipinnis</i>	241
sea perches or groupers	237	<i>Taurulus bubalis</i>	16, 168, 172, 183
Sea snail	172, 191	Ten-spined stickleback	149, 153
Sea trout	18, 23, 90	Tetraodontiformes	315
<i>Sebastes norvegicus</i>	170	Thickback sole	309
<i>Sebastes viviparus</i>	171	Thick-lipped grey mullet	16, 20, 23, 133, 140
Serranidae	237	Thin-lipped grey mullet	133, 136, 140
<i>Serranus cabrilla</i>	237	Thornback ray	52
Shagreen ray	45	<i>Thorogobius ephippiatus</i>	196
Shanny	263	Thor's scaldfish	276
sharks	31	Three-bearded rockling	121, 127
Shore rockling	98	Three-spined stickleback	18, 20, 23, 149, 150
Short-beaked garfish	143	Thresher shark	31
Shortfin mako	31	thresher sharks	31
Short-snouted pipefish	156	<i>Thunnus alalunga</i>	272
Short-snouted seahorse	166	<i>Thunnus obsesus</i>	272
Shovelnosed shark	32	<i>Thunnus thynnus</i>	275
Silver pomfret	241	Tiger shark	35
silversides	141	Tompot blenny	264
Silvery pout	98	Tope	39
skates	45	Topknot	287
Skipjack tuna	272	Torpedinidae	44
skippers	145	<i>Torpedo marmorata</i>	44
sleepers sharks	32	<i>Torpedo nobilliana</i>	44
Slender sunfish	315	Trachinidae	258
Small-eyed ray	45	<i>Trachinotus ovatus</i>	241
Smelt	20, 86	<i>Trachinus draco</i>	18, 258
smelts	86	Trachipteridae	95
Smooth hammerhead	31	<i>Trachipterus arcticus</i>	95
Smooth sandeel	215, 220	<i>Trachurus trachurus</i>	16, 18, 20, 23, 140, 241, 248
snailfish	191	Transparent goby	195, 197
Snake blenny	253	Triakidae	31, 39
Snake pipefish	150, 156	Triggerfish	317
Snipe-eel	61	<i>Trigla lucerna</i>	20, 21, 172, 175, 178
snipe-eels	61	<i>Trigla lyra</i>	173
Softhead grenadier	98	Triglidae	173
Sole	16, 23, 278, 312	<i>Trigloporus lastoviza</i>	173, 180
<i>Solea solea</i>	16, 23, 278, 312	<i>Triglops murrayi</i>	186
Soleidae	307	<i>Trisopterus esmarkii</i>	99, 113, 118
Solenette	278, 307	<i>Trisopterus luscus</i>	15, 16, 99, 115
soles	307	<i>Trisopterus minutus</i>	99, 117
Somniosidae	32	Trout	18, 23, 90
Spanish mackerel	272	Tub gurnard	20, 21, 172, 175, 178
Spanish sea-bream	232	Tubenose goby	213
Sparidae	232	tunnies	272
Sparling	86	Turbot	281
<i>Sparus aurata</i>	16, 18, 232	Tusk	98
<i>Sphyrna zygaena</i>	31	Twaite shad	68, 72
<i>Spinachia spinachia</i>	149, 154	Two-spotted goby	195, 199, 205
Spiny seahorse	165	Undulate ray	55
spiny sharks	32	Variable blenny	258
<i>Spondylosoma cantharus</i>	232, 235	Velvet belly	32
Spotted catfish	249	Viviparous blenny	20, 213, 249
Spotted dragonet	268	weevers	258
Spotted ray	53	White skate	45
Spotted snake blenny	249	whitefish	89
Sprat	68, 80	Whiting	16, 20, 23, 25, 99, 106
<i>Sprattus sprattus</i>	68, 80	Witch	292
Spurdog	42	Wolf fish	255
Squalidae	32, 42	wolf fishes	249, 255
Squaliformes	31	Worm pipefish	164
<i>Squalus acanthias</i>	42	wrasses	223
<i>Squatina squatina</i>	44	Wreckfish	237
Squatinae	44	Yarrell's blenny	252
St Peter's fish	18, 147	Zander	237
Starry ray	46	Zeidae	147
Starry smooth-hound	41	Zeiformes	147
Sternoptychidae	93	<i>Zeugopterus punctatus</i>	287
Steven's goby	196	<i>Zeugopterus regius</i>	289
Stichaeidae	249	<i>Zeus faber</i>	18, 147
sticklebacks	149	<i>Zoarces viviparus</i>	20, 213, 249
Stingray	57	Zoarceidae	249