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INTRODUCTION

This guide was developed as a working tool for those involved in the fisheries sector in Namibia, including researchers, technicians, observers collecting statistics on board fishing vessels, inspectors, and students in marine and fishery science. It includes species of seaweeds, crustaceans, cephalopods, cartilaginous and bony fishes, seabirds, and marine mammals, that are believed to be of present or potential economic interest, or that represent important elements in the marine ecosystem of the Namibian shelf and slope areas.

Fisheries represent an important sector in the Namibian economy. Following independence in 1990, the sector grew until around 800 000 t were harvested in 1993 (Fig. 1) and fish products accounted for more than 20% of Namibian exports. Despite a decline in the total catch over the next few years, the export value remained high and by the end of the 1990's fisheries were worth more than N$2 billion per annum.

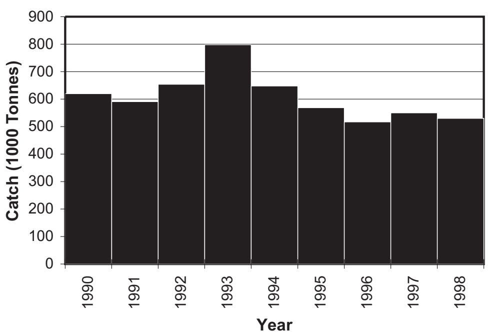


Fig. 1 Commercial landings

The coast and shelf topography

Namibia has a coastline of about 1 500 km, running in a north-south direction, with few bays and indentations. The coastal plain is 100 to 200 km wide and is hyper-arid, receiving a mean rainfall of less than 100 mm per annum. This is the Namib Desert. The Kunene River and the Orange River are the only perennial rivers in the region and they form natural boundaries with Angola and South Africa, respectively (Fig. 2).

The shelf area from the shore to a depth of 200 m is approximately 110 000 km^2, and about double as much to 1 000 m. The shelf is widest off the Orange River and off Walvis Bay, and narrowest off Kunene River to Cape Frio. The depth of the shelf edge varies, averaging about 350 m. Two pronounced double shelf breaks occur at depths of 140 and 400 m in the Walvis Bay region (Fig. 2).

The bottom sediments form textural zones parallel to the coast, becoming finer seawards. This pattern is altered inshore by the presence of rivers and biological deposition. A significant feature is the presence of a mud belt in the midshelf, between Cape Frio and Conception Bay, about 500 km long. The sediments are mainly of biogenic origin, resulting from the high productivity of the upwelled waters of the Benguela system.

Environmental regimes

The coastal waters of Namibia are part of the Benguela system, one of the 4 major eastern boundary current systems of the world. This is a region of cool upwelled coastal water found approximately between 15°S and 34°S and generated by the intense equator-ward wind stress pattern of the Benguela system. The northern boundary corresponds to the frontal zone between the Angola and Benguela currents, located off

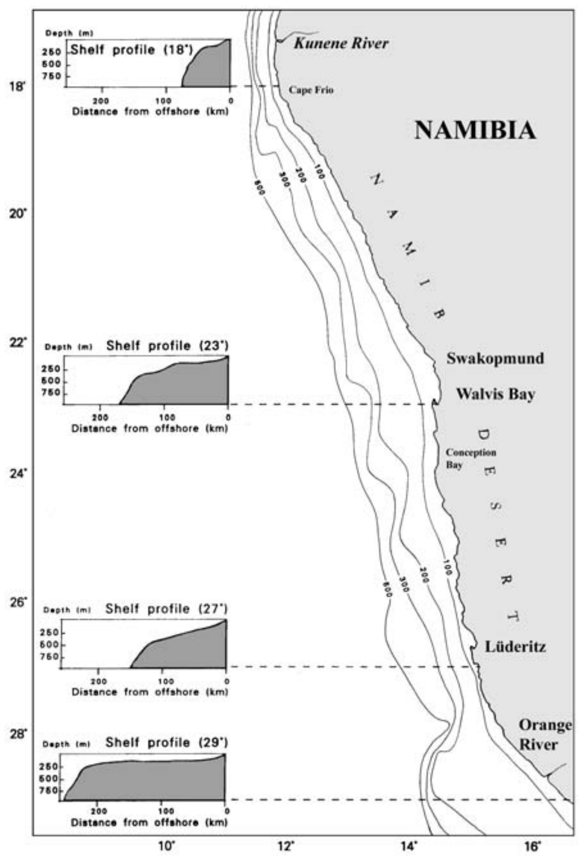


Fig. 2 Coastal configuration and continental shelf bathymetry off Namibia

southern Angola (Fig. 3). The southern boundary of the Benguela system is the warm retroflection zone or return current of the Agulhas System. Upwelling intensity is not uniform in space or in time, as there are short-term and seasonal differences in the wind regime, and because of coastline and shelf topography. The major centre of upwelling off Namibia is from Lüderitz to the Orange River and is believed to effectively divide the Benguela system into 2 regions, acting as an environmental barrier for some key species. Upwelling cells of lesser intensity also occur further north, the most notable being off Cape Frio.

The South Atlantic high pressure system is a permanent feature of this region, and it is subject to seasonal shifts of its centre, from about 30°S in summer to 26°S in winter. The anti-clockwise flow of air around this high pressure cell is nearly parallel to the Namibian coast. These winds are usually present throughout the year, being strongest in winter and spring. This makes the northern part of the Benguela region somewhat different from the southern region (the west coast of South Africa) where upwelling is seasonal and present mainly in spring and summer. Here, westerly winds unfavourable to upwelling prevail in wintertime.

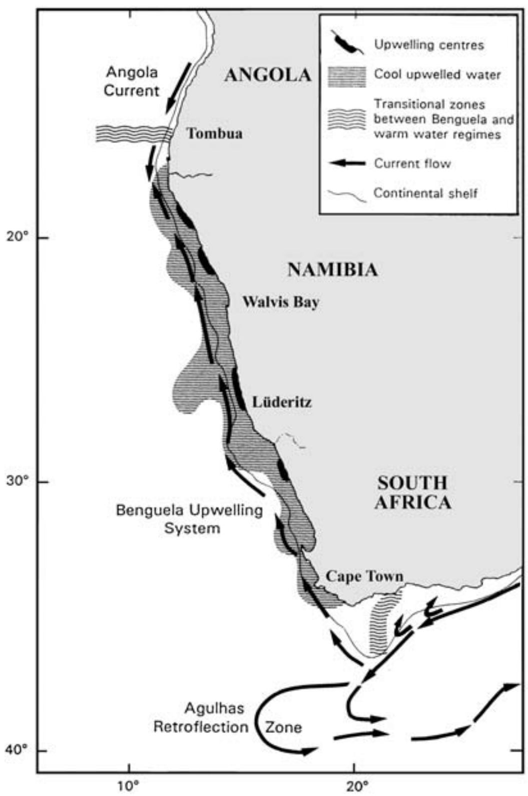


Fig. 3 Schematic diagram of major oceanographic features off southwestern Africa (redrawn from Payne and Crawford, 1989)

The strong upwelling brings nutrient-rich water to the surface and forms the basis of the high primary production that sustains large zooplankton and pelagic fish stocks. However, this bottom water can sometimes be virtually anoxic due to high sedimentation rates and the subsequent degradation of organic matter, possibly supplemented by intrusions of bottom waters with low concentrations of dissolved oxygen from the Angola Dome region. In some areas, especially in the central region, sulphate reduction by anoxic bacteria is the source of "sulphur eruptions"; typified by a "rotten egg" odour. This can result in mass moralities of fish and other marine organisms, caused by these organisms being trapped against the coast by these toxic and often anoxic waters. This phenomenon only affects a limited part of the shelf, particularly the coastal waters around Walvis Bay. Most of the shelf and bottom slope off Namibia are inhabited by a rich demersal community.

Shelf assemblages

Changes in the distributions of demersal fauna occur mainly along the depth gradient and with latitude. The following description of the main demersal assemblages is based on a preliminary analysis of the bottom-trawl data collected by the RV 'Dr. Fridtjof Nansen' and therefore does not include near shore grounds. This vessel has been operating in Namibian waters since 1990. The major faunal boundary appears to be depth-related and corresponds to the shelf edge (at depths averaging 300-350 m), separating shelf from slope assemblages (Fig. 4).

Main associations found on the shelf are distributed along a latitudinal gradient and the most important faunal boundary appears to be at about 27°S. The assemblage of the central shelf area north of Lüderitz (Fig. 4,a) is dominated by Cape hake *Merluccius capensis* and pelagic goby *Sufflogobius bibarbatus*, and has a low species diversity, consistent with the presence of hypoxic waters throughout. This region (between 20° and 27°S) is the main area of oxygen-deficient shelf water in the Benguela system. Higher species diversity is found on the shelf south of Lüderitz (Fig. 4,b). Here, a number of species reach their northernmost limit, having their main distribution off South Africa. Although oxygen content is also low, the conditions are probably not so extreme as in the northern shelf region. Dominating fish species are: hakes *Merluccius paradoxus* and *M. capensis*, silver scabbardfish *Lepidopus caudatus*, Cape bonnetmouth *Emmelichthys nitidus nitidus*, Cape John dory *Zeus capensis*, Cape gurnard *Chelidonichthys capensis*, kingklip *Genypterus capensis*, snoek, *Thyrsites atun*, and Cape elephantfish *Callorhinchus capensis*. The inverte-

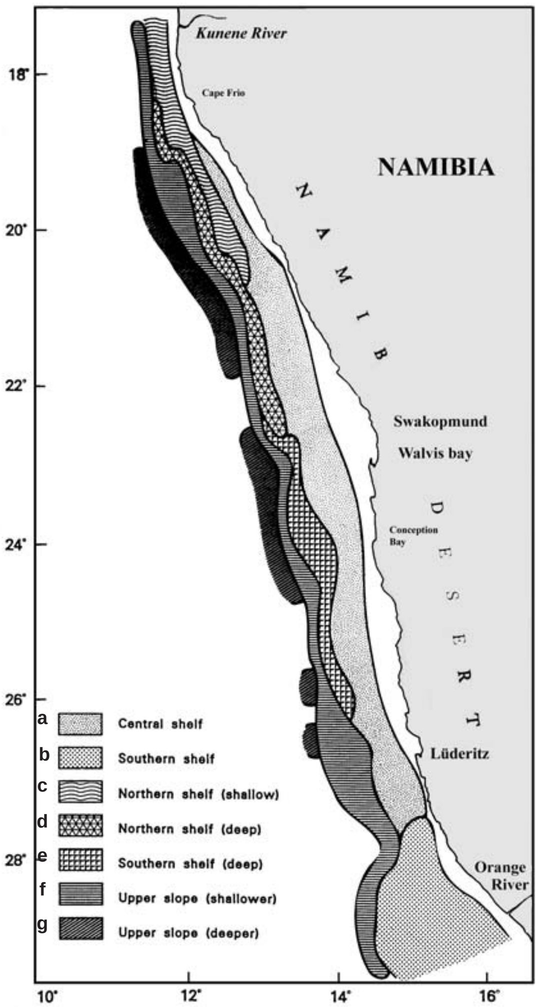


Fig. 4 Distribution of main demersal fauna assemblages off Namibia

brates are mainly represented by a number of species of squid and cuttlefish: *Loligo reynaudi*, *Todaropsis eblanae,* and *Sepia australis*.

In the northern shelf region, from the Kunene River (the border with Angola) to about midway to Walvis Bay (Fig. 4,c), the assemblage has a number of species that reach their southernmost distribution. These include large-eye dentex *Dentex macrophthalmus*, thinlip splitfin *Synagrops microlepis*, and a little deeper (Fig. 4,d) longfin bonefish *Pterothrissus belloci* and African mud shrimp *Solenocera africana*. The southernmost extent of these species is variable however, depending mainly on the strength of upwelling. During Benguela Niño events, they may be observed as far south as Walvis Bay. The dominant species in trawl catches are Cape hake and Cape horse mackerel *Trachurus capensis*. Common in the deeper part of the shelf in the area just south of Walvis Bay (Fig. 4,e) are pelagic goby, Cape hake (these latter 2 are also found in the adjacent shallower shelf area), Cape monk *Lophius vomerinus*, Angola flying squid *Todarodes sagittatus angolensis*, blackbelly rosefish *Helicolenus dactylopterus*, and lanternfishes (family Myctophidae) and a few other deep-water species.

Upper slope assemblages

The upper slope assemblages (Fig. 4,f and 4,g) include a number of species also found on the shelf as well as more typical slope species that become predominant at about a depth of 500 m. In the former group are deepwater Cape hake *Merluccius paradoxus*, Cape hake, blackbelly rosefish, grenadiers (*Caelorinchus simorhynchus* and *Nezumia* spp.), lanternfishes, smallscale slimehead *Hoplostethus melanopus***,** and African sawtail catshark *Galeus polli*. Discrete aggregations of orange roughy (*Hoplostetus atlanticus*), have recently supported a new fishing industry. These are found at the shelf-break between 600 m and 1000 m, each aggregation typically being only a few kilometers in extent and separated by some 200 km from the next aggregation. Alfonsino *Beryx splendens,* cardinals *Epigonis* sp.*,* and oreos (mainly *Allocyttus verrucosus*) are also found in high densities at similar depths, but have yet to be found in sufficient quantities to support a commercially viable fishery. Other typical slope dwellers include lightfishes (family Phosichthyidae), roughsnout grenadier *Trachyrincus scabrus*, squalid sharks *Deania calcea* and *Centrophorus squamosus*, and striped red shrimp *Aristeus varidens*.

Pelagic species

The main pelagic species are southern African pilchard *Sardinops ocellatus* and southern African anchovy *Engraulis capensis* (referred to here sometimes simply as pilchard and anchovy respectively) which are found throughout the temperate regions of southern Africa. However, their distributions are not uniform and 2 distinct populations of anchovy and pilchard are separated by the presence of the main upwelling centre off Lüderitz. In years when upwelling diminishes, movement of fish between the 2 populations may occur. Spawning and nursery areas of the Namibian stocks appear to be in the vicinity of, and north of, Walvis Bay. Two main spawning grounds were identified for the pilchard (Fig. 4); younger fish spawn in the warmer waters of the north and older pilchard in the vicinity of Walvis Bay. Spawning grounds of anchovy appear to coincide with those of younger adult pilchard. Recruitment for both species takes place in autumn and winter off Walvis Bay (Fig. 5).

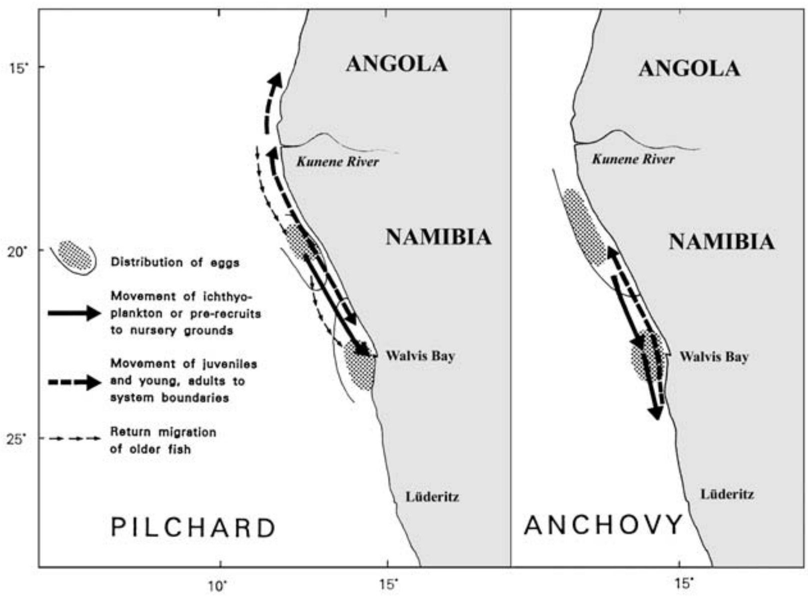


Fig. 5 Movement patterns of various life stages of the pilchard *Sardinops ocellatus* and the anchovy *Engraulis capensis* off Namibia (redrawn from Payne and Crawford, 1989)

Fisheries

The high productivity of the Benguela system supports large commercial fish stocks. Three major resource groups have contributed to almost 90% of the total catches since the 1960's: the epipelagic shoaling fishes pilchard, anchovy, and young horse mackerel, the midwater Cape horse mackerel, and the Cape and deepwater Cape hakes. Two major industrial fisheries were established off Namibia in the 1950's and 1960's: an inshore pelagic fishery for pilchard and anchovy, mainly exploited by a Namibia-based purse seine fleet, and an offshore trawl fishery for the hakes and Cape horse mackerel, exploited by a number of nations' distant water fleets.

The epipelagic species have been exploited mainly by purse seiners. Pilchard catches peaked at 1.4 million t in 1968, but following several collapses and recoveries, declined to 11 000 t by 1980 (Fig. 6). Despite a brief recovery in the early 1990's the stock collapsed again in 1995, such that the 1996 catch was a mere 2 000 t. Anchovy (Fig. 7) and juvenile horse mackerel catches have provided some stability to the pelagic industry, although the total catch of all species has varied between 107 thousand t (in 1996) and over 1.5 million t (in 1968). The Benguela Niño events in 1972, 1984, and 1995 have doubtless had an impact on the status of these stocks, however, the main cause of each of the collapses of the pelagic stocks, especially pilchard, is believed to be over-

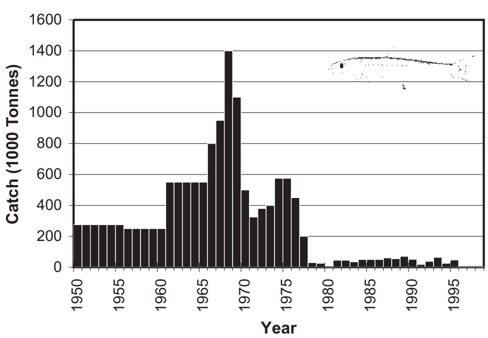


Fig. 6 Commercial landings of the pilchard (*Sardinops ocellatus*)

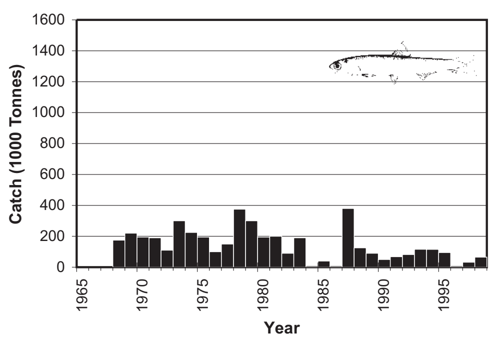


Fig. 7 Commercial landings of the anchovy (*Engraulis capensis*)

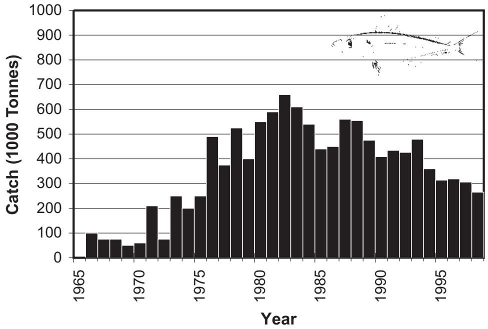


Fig. 8 Commercial landings of the Cape horse mackerel (*Trachurus capensis*) (purse seine and trawl catches combined)

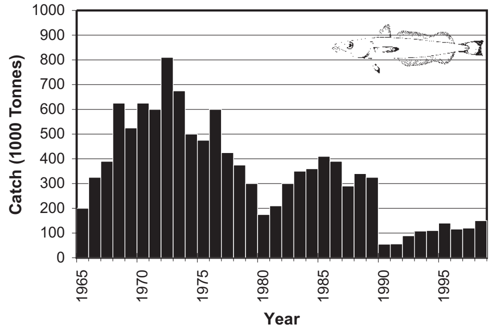


Fig. 9 Commercial landings of the hakes (*Merluccis capensis* and *M. paradoxus*)

fishing. Total allowable catches for the pelagic resources have been drastically reduced in recent years, but this has not so far lead to any sustained recovery.

Cape horse mackerel are exploited by 2 different components of the fisheries. As juveniles (first 2 years of their lives) they are caught by purse seiners (catches sometimes exceeding 100 000 t). Adult horse mackerel are caught by midwater trawlers. Two species of horse mackerel overlap off southern Angola and northern Namibia; the main area of distribution of the Cunene horse mackerel *Trachurus trecae* is Angola and northward to the Gulf of Guinea while the Cape horse mackerel is found from northern Namibia, to the Agulhas Bank. Catches of the latter species were about 46 000 t in 1969 but they increased to about 600 000 t in the middle of the 1980's, because of the parallel increase in effort of the Polish and Soviet fleets (Fig. 8). Chub mackerel and snoek have been important bycatches of the midwater fishery, but in recent years have been rarely caught in any quantity. Snoek is also fished by line gear, both commercially and as part of the popular recreational fishery.

The bulk of the bottom trawl fishery consists of the 2 species of hake, *M. capensis* and *M. paradoxus*. The latter occurs in deeper waters but both species overlap at intermediate depths. The identification of the 2 species is very difficult and in fishery statistics the 2 have been treated together. Hakes are found close to the bottom during daytime but rise to intermediate waters during nighttime, probably following their prey. The fisheries off Namibia started in the early 1960's and the catches climbed from about 45 000 t in 1964 to 850 000 t in 1972 (Fig. 9). Since then, catches decreased and a major task of the Namibian fishery authorities after independence has been to promote recuperation of this previously over-exploited stock.

There are demersal species caught with bottom trawls and with line gear, that are not as abundant as hake but are of significant economic importance because they command high prices, particularly Cape monk.

Prior to independence monk was caught as a bycatch of the hake trawl fishery. Recently a monk-directed fishery using bottom trawls has developed. During the second half of the 1990's catches averaged around 10 000 t per annum, of which a third is still taken by hake trawlers. Several other species form a small bycatch of the demersal trawl fishery, notably kingklip, sole (*Austroglossus microlepis*), and various redfishes ("reds"), such as jacopever (*Helicolenus dachylopterus*) and large-eye dentex (*Dentex macrophthalmus*).

In 1994 commercially viable quantities of orange roughy were discovered on the Namibian shelf-break. By the end of the 1990's 4 spawning aggregations had been found in Namibian waters, supporting a small but economical deep-water trawl fishery. Catches exceeded 12 000 t per annum between 1996 and 1998, but are expected to decline thereafter as the stock reaches its optimal sustainable biomass. Exploration for further aggregations is actively encouraged by the Namibian authorities, while catches of alfonsino (*Beryx splendens*), cardinals (Epigonidae) and oreos (Oreosomatidae) suggest that the deep-water fishery may diversify in future.

The West African geryon crab *Chaceon maritae* forms the basis of the largest crustacean fishery of the northern Benguela System, with annual catches approaching 10 000 t in the 1980's. The catch had declined to around 2 000 t per annum by the late 1990's.

Another important invertebrate resource is Cape rock lobster *Jasus lalandii*. This species, found mainly in the southern part of Namibia, represented the world's largest catch for any single *Jasus* species. Catches were high from the beginning of the 1950's to the 1960's, ranging from about 4 000 to 13 000 t, but dropped in the 1970's to about 1 500 t and have decreased further in recent years (Fig. 10). In the mid-1990's the catch has generally been less than 250 t per annum.

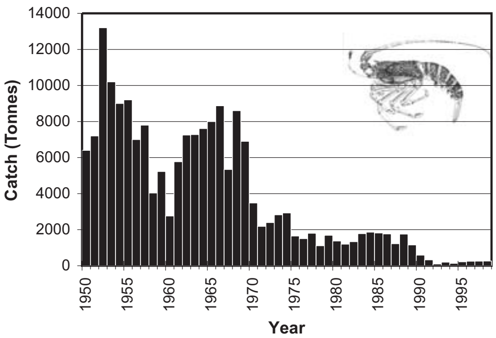


Fig. 10 Commercial landings of the Cape rock lobster (*Jasus lalandii*)

Namibia also posses an important shore-based recreational fishery. Kob and steenbras are the main species caught, primarily by beach anglers. Sharks and galjoen are also popular target species. Kob is also caught by recreational fishers on ski-boats and commercially from handline vessels.

The taxa included in this guide

The species included in this guide are those considered to be of present or potential interest to fisheries, or those that may be important in fisheries production or for fisheries management. Not included in this guide are organisms that are normally too small to occur in fisheries or are of only minor importance in Namibia. Some species are included because they occur frequently in the catch of fisheries or may be important in the food chain of fisheries organisms. Monitoring of abundances of these species may be useful in fisheries management for explaining and predicting population fluctuations of target species.

How to use this guide

This guide is divided into major taxonomic groups that can be located according to either the written index or the pictorial index to families. The major resource groups and the orders, families, and species included in them are listed in approximate evolutionary or phylogenetic order. This order was chosen instead of alphabetical order so that taxa with similar body shapes would usually be found in 1 section. This facilitates location and comparison of similar groups of taxa.

The components of this guide are interrelated and sometimes several sections should be consulted to ensure accurate identification. These components include a "Pictorial Index to Divisions, Orders, or Families," a "Guide to Orders and Families," and a "Guide to Species." In addition, each major resource group begins with an illustrated glossary of the important technical terms and measurements relevant for identification. It is useful to become familiar with these terms before attempting to make an identification.

It is often essential to identify an organism to its family level before attempting to determine its species name. This is because **many of the important characters listed in the "Guide to Families" are not listed again in the "Guide to Species."** In some a case, the family identity will be obvious simply by consulting the "Pictorial Index to Families." If not, the "Guide to Orders and Families" and "Guide to Species" provide key characters that will allow identification to family and species level. Each major resource group is introduced with a "Guide to Orders and Families" unless there are only a few families and species (the seaweeds, sea turtles, sea birds, and marine mammals) where it is most convenient to begin directly with a "Guide to Species." In a case where there is more than 1 order listed in the "Guide to Orders and Families," the order should first be determined. This is done by comparing the appropriate features of your organism with the order characters (Fig. 11). When there are multiple families included under each order, 2 types of captions are provided. Captions listed in uppercase, bold, and highlighted in grey are the key characters that can be used to distinguish between the orders in each major resource group. These characters are listed only once, usually under the first family appearing in the order. Begin with the first order listed and continue comparing features of your organism until a match is found. Once the order is known, use the same method to determine the family within the order using the family key characters. These are the characters listed in normal lower-case typeface. If species within that family are considered of importance to fisheries, they are included in the guide to species and the page number listed in the guide to families directs the user to the appropriate section. The species can then be identified within the guide to species by matching the key characters with the features of the specimen (Fig. 12).

the **FAMILY CHARACTERS** are listed in boxed captions in normal lower-case type for each family figure

the **ORDER CHARACTERS** are listed both in the Order Box and in boxed captions in **BOLD UPPER-CASE** type at the figure representing the first family of the order

the **ORDER BOX** contains the Order scientific and common names, the important order characters, and the number of families found in Namibia

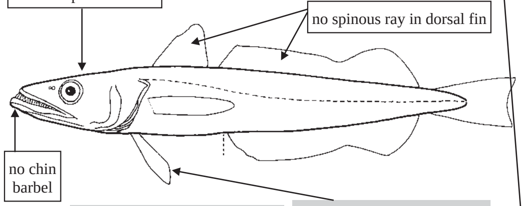
Order GADIFORMES - **Hakes, Cods, and allies**
Pelvic fins situated in front of or below pectoral fins, with up to 17 rays; fins without spines except first 2 rays spinous in dorsal fin of macrourids; adipose fin absent. Three families reported from Namibia.

the scientific and common **FAMILY NAMES** are listed above a brief **FAMILY DESCRIPTION** that mentions the number of species in Namibia, habitat type, and maximum length

MERLUCCIIDAE

Hakes

Three species of *Merluccius* reported from Namibia; 2 of these species are the most important in trawl fisheries of Namibia, the third (*Merluccius polli*) infrequently caught in the northern part of Namibia. Benthopelagic between depths of about 50 and 900 m. Maximum size to 1.2 m total length.



the corresponding **PAGE NUMBER** in the "Guide to Species"

Fig. 11 The "Guide to Orders and Families"

SPECIES CHARACTERS that help distinguish it from other species in the family are listed in boxed captions

the 3-letter statistical code is included for important species normally reported by observers

the **FAMILY NAME** appears in the upper right corner for each species; the first time it is listed, it is highlighted in grey

scientific species name

Merluccius paradoxus Franca, 1960 **(plate V, 36)** HKO **MERLUCCIIDAE**

official FAO names in English, French, and Spanish

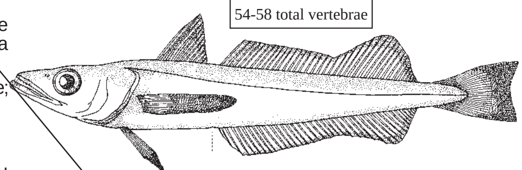
local names in English, Afrikaans (Ak), German (Gr), and Spanish (Sp), (local names are not repeated if they are the same as official FAO names); when no local names are known this is left blank to allow the user to write in a local name when determined.

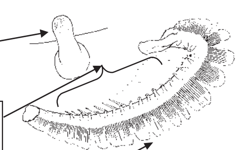
FAO names: **En** - Deepwater Cape hake; **Fr** - Merlu profond; **Sp** - Merluza de cantil.

Local names: Deepwater hake; Diepwater-stokvis (Ak); Tiefenwasser-Kapseechecht (Gr).

Size: To 115 cm.

Fisheries: Caught with bottom trawls, and rarely as bycatch of the midwater and deep-water fisheries. An important species to the Namibian demersal fishing industry.





Habitat and biology: Generally in deeper waters than *M. capensis,* between depths of 200 and 1 000 m. Juveniles feed mainly on crustaceans, adults on mesopelagic fishes, and hake. Juveniles of deepwater hake are preyed upon by adults of Cape hake.

detail of an important anatomical feature

Merluccius polli Cadenat, 1950 **MERLUCCIIDAE**

maximum size in total length unless otherwise noted

information on fishing gear and fisheries

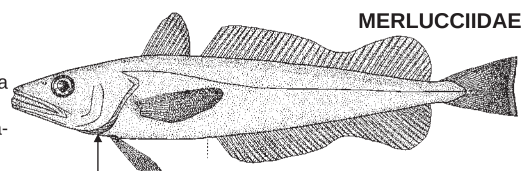
information available on habitat, depth, distribution, and pertinent biology

FAO names: **En** - Benguela hake; **Fr** - Merlu d'afrique tropicale; **Sp** - Merluza de Benguela.

Local names: Stokvis (Ak); Benguela-Seehecht (Gr).

Size: Maximum to 80 cm, common to 38 cm.

Fisheries: Occurs outside of the demersal fishing grounds.



Habitat and biology: Demersal from depths between 50 and 550 m. This is the least common of the hakes in Namibia and is mostly confined to the extreme northern part of Namibia.

Fig. 12 The "Guide to Species"

click for next page