

*Coelacanths have been in existence now for more than 400 million years. Scientists have investigated the way of life of this ancient, nocturnal fish*

## **Diving Expedition to a Methuselah of the Sea**



Illustrations: Fricke/Schauer (p. 14; Schauer (pp. 15; 16)

By Karen Hissmann and Hans Fricke

There is an ancient inhabitant of the ocean, one that has maintained a cryptic lifestyle and remained largely in hiding: it is the coelacanth (*Latimeria*), the only known representative of a group of bony fish extant since the middle Devonian (ca. 400 million years ago). Discoveries of fossil coelacanths have shown that this group of fishes, comprising more than seventy species in several genera, were common worldwide well into the middle Cretaceous. The fossil records indicate that these early fishes became „extinct“, like their dinosaur contemporaries, approximately 65 million years ago. There-

fore, the scientific discovery of a living coelacanth was a zoological sensation. Marjorie Courtney-Latimer, curator of a small museum in the South African town of East London, discovered the unusual looking fish in 1938, among the by-catch from a trawler. An ichthyologist, who later described the fish as *Latimeria chalumnae*, exclaimed „I could have hardly been more surprised had I encountered a dinosaur on the road“.

An extraordinary feature of coelacanths is the presence of muscular lobed fins that are reminiscent of the legs of early terrestrial vertebrates. In fact, coelacanths and lungfishes are close relatives of those bony fish with limb-like fins that were the first

vertebrates to venture onto land during the early Devonian. When compared to their fossil relatives, the living coelacanths have remained largely morphologically unchanged and are therefore of great significance in the study of evolutionary biology.

Fourteen years passed after the Courtney-Latimer discovery before the next coelacanth appeared. This time, fishermen from the Comoro Archipelago, using wooden dug-out outrigger canoes, had caught a coelacanth as by-catch of their traditional deep-sea line fishing. Since then, the Comoro Islands, between East Africa and Madagascar, have been considered the home of this truly „living fossil“. The local fisher-

They are living “dinosaurs” of the sea. A coelacanth swimming at a water depth of 200 metres, along steep volcanic slopes, off the Island of Grand Comoro, in the western Indian Ocean. Right: Using the submersible JAGO, in calm and stormy seas, the German scientific team studies the life style of a coelacanth population off the coast of South Africa.

men hauled up the large and heavy (up to 190 cm and 100 kg) fish to the surface, from depths of between 150 and 500 m. These caught specimens were sent around the globe to museums and scientific institutions. *Latimeria* thus became one of the anatomically most thoroughly studied fish species. However, the way of life of these unusual fishes remained virtually unknown.

This situation changed in 1987 when marine biologist Hans Fricke and his team from the Max Planck Institute for Behavioral Physiology in Seewiesen (Germany) brought a manned submersible to the Comoros and filmed the ancient fish in its natural habitat for the first time. The very first encounter indicated immediately that this heavy fish uses its pectoral and pelvic fins synchronised diagonally in an alternating rhythm, similar to terrestrial tetrapods, but not for locomotion on the sea floor. Instead, the coelacanth glides slowly over the rocky substrate, appearing virtually weightless. However, when suitable prey fish swim past their mouths, they can suddenly propel themselves forward with a single powerful stroke of their broad tailfin. With a lightning-fast combination of snapping and suction, facilitated by a joint between the upper jaw and cranium – which has since been lost in all other fishes – prey disappears within split seconds behind the sharp teeth of this predator. During the day, the nocturnal coelacanths retreat to caves, located between 150 and 250 m below the sea surface at the Comoros. In these, often spacious, caves coelacanths congregate in groups of up to sixteen individuals.

Because of their „sluggish“ lifestyle in water temperatures which average 15 to 20 °C, coelacanths require relatively little food. This ena-



Illustration: Hissmann



Illustration: Hissmann



Illustration: Schauer

bles them to survive in a habitat of limited food availability. They have apparently found a perfect niche for their survival, far away from the more intensely competitive conditions in shallower water.

From the submersible, some coelacanths were tagged with ultrasonic transmitters that would be shed automatically after a few weeks. These experiments indicated that the fish leave their caves individually, shortly after sunset, to search for food at depths down to 700 m. With the first light of the morning they return to their respective caves. During this nocturnal foraging, they do not move more than a few kilometres away from their resting caves.

Coelacanths have a characteristic pattern of white spots making it possible to distinguish individuals and so to follow them over an extended period. Coelacanths are site-faithful; they have been observed to occupy the same caves over many years, possibly even for their entire lives, which may last longer than hundred years. The catalogue of described individuals, compiled by the submersible team, now numbers 127 specimens from the Comoros alone, and, over the years, some of these fish have become „old acquaintances“. Indeed, the coelacanth community studied at the Comoro Archipelago, with an estimated 500 to 600 adult animals, is a small but stable population, as long as there are no dramatic intrusions into the habitat to threaten their survival.

It is not uncommon in nature to find that island animal populations are restricted in size and distribution. Thus, for a long time it was assumed that coelacanths occurred only off the Comoros; the specimen collected off South Africa in 1938 could have been a solitary stray displaced by currents. This theory, however, sustained the first crack with the accidental catch of a pregnant female off the coast of

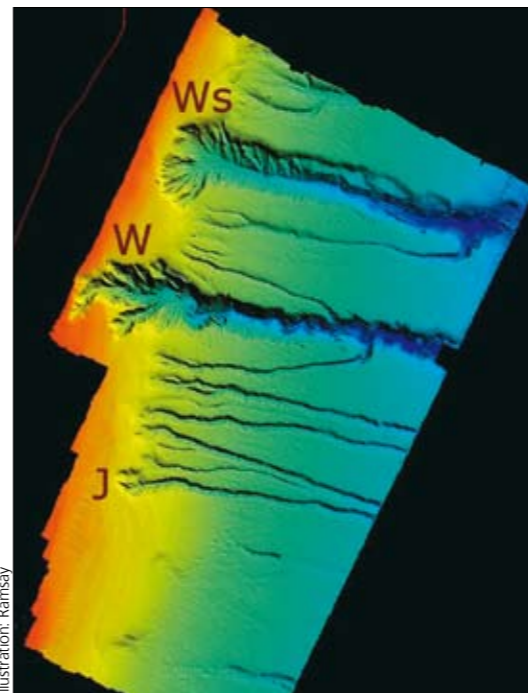
Mozambique in 1991, although genetic investigations did not reveal significant differences between the Mozambique specimen and specimens from the Comoros. Then, accidental coelacanth catches were also reported from the southwest coast of Madagascar, and finally, in 1997, an American couple made a surprising discovery of a coelacanth at a fish market on the Indonesian island Sulawesi. Shortly thereafter, and not far away, another specimen was caught in a deep-set shark gillnet. This catch removed all doubts: there had to be an independent coelacanth population in the western Pacific. Again, the German submersible team got involved, this time in Sulawesi. There, in a deep limestone cave, 155 m below sea level, the team found two coelacanths that were morphologically indistinguishable from the Comoran specimens.

**In order to study the lifestyle of coelacanths, the fish were fitted with ultrasonic transmitters and their behaviour observed.**

Molecular biologists found only minor genetic differences between the new Indonesian specimen and samples from the Comoros, but these were sufficient

to distinguish the Indonesian fish as a novel species, *Latimeria menadoensis*. Since then there have been two known living coelacanth species, separated by 10,000 km.

In 2000, a team of deep-water divers – who dived regularly in the submarine canyons in the South African Saint Lucia Marine Reserve, south of the border with Mozambique – made the next coelacanth discovery. At the upper crest of a canyon, the divers observed several coelacanths in a karstic cave. This prompted the South African Government to establish a programme that was set up not only for environmental protection and educational measures, but also to study the lifestyle of coelacanths off the South African coast. The German coelacanth experts, with their submersible, became partners for three years in the „African Coelacanth Ecosystem Programme“. It was found that the „sluggish“ coela-



canths are able to survive in an area strongly influenced by the powerful Agulhas Current because they find sufficient shelter in the submarine canyons along the continental shelf. Within these canyons, currents are reduced or absent. Like their Comoran cousins, the South African coelacanths spend their days in caves, however, in shallower water of only about 100 m.

One specimen tagged with a transmitter demonstrated that the South African coelacanths need not venture to great depth for foraging, because a sufficiently large supply of prey fish exists within reach of their daytime rest caves along the edge of the canyons. A specimen register currently includes 26 South African coelacanths, distributed over three submarine canyons.

Using their submersible, the German Team developed a non-injurious method for removing single scales from coelacanths for use in molecular genetic studies. In cooperation with the Biocenter of the University of Würzburg, almost fifty tissue samples of specimens from the Comoros, South Africa, Madagascar and Mozambique have so far been studied.

Left: A multibeam chart indicates the underwater canyons off South Africa. Next: South African schoolchildren receiving educational instruction onboard research vessel ALGOA. Bottom left: DNA being isolated from coelacanth scales for population genetic studies. Coelacanth marked with an acoustic transmitter.

Despite the differing origins of the samples, there exists considerable genetic conformity among the animals. Because very old and long-separated populations would be expected to be genetically far more variable, reflecting numerous mutations to their genetic material, these coelacanth populations must be relatively young and have separated only recently. The possibility that individual communities are in constant genetic exchange with each other becomes rather unlikely when considering both the West Indian Ocean current configuration and the strong site fidelity of the fish. A minor genetic difference within the Comoran population, which has a tendency towards inbreeding, further suggests that colonisation of these islands occurred relatively recently. American molecular biologists have calculated that *Latimeria chalumnae* and *L. menadoensis* have been genetically separated from each other by at least 4.7 to 11 million years. On the other hand, Grand Comoro and Anjouan, the two Comoran islands which are inhabited by coelacanths, are estimated to be only a few million years old. Thus, if formed only after the separation of the two *Latimeria* species, these islands may well have been colonised with coelacanths from another, still unknown population in the Indian Ocean. Therefore, more surprises are expected for the future.

Authors are: Dipl.-Biol. Karen Hissmann, IFM-GEOMAR Kiel / Prof. Dr. Hans Fricke, Max-Planck-Institut für Ornithologie, Seewiesen.

Contact: Dipl.-Biol. Karen Hissmann, Leibniz-Institut für Meereswissenschaften, Universität Kiel, Wischhofstr 1-3, 24148 Kiel.