Chapter 2
Some Characteristics of the Bluefin Tuna. Its Geographical Distribution, Areas and Fishing Systems

Abstract Some characteristics of bluefin tuna are described relating to its biology (growth, reproduction, migrations and ethology), physiology, geographical distribution and fishing. Regarding the latter, the evolution of bluefin tuna fisheries over the last seven decades is analyzed, with descriptions of the various fleets working in different regions over this period.

The Atlantic bluefin tuna belongs to the family of the Scombrid fishes (Scombridae) (Collette and Nauen 1985). It can weigh over 725 kg (Crane 1936; Lebedeff 1936; Heldt 1938), reach lengths of 3.3 m (Cort et al. 2013) and live over thirty years (Neilson and Campana 2008). In general, during its fattening phase in the first year of life it reaches 53 cm (4 kg); at age 10, 204 cm (170 kg); at 20 years, 273 cm (410 kg); and at 30 years, 301 cm (550 kg). The official record of the largest ABFT captured in the western Atlantic is 679 kg, a fish caught in Nova Scotia waters (Canada) in 1979 (Fraser 2008). This catch also stands as the current Guinness world record. It forms large shoals and feeds mainly on other fishes, cephalopods, small crustaceans such as *krill* (Euphausiacea) and pelagic crabs, *Polybius henslowii* (Leach), (Estrada et al. 2005; Sarà and Sarà 2007; Logan et al. 2010). Its shape is highly hydrodynamic, as it is entirely adapted to mobility.

ABFT inhabits temperate waters of the North Atlantic and Mediterranean Sea (ICCAT 2010). It is found in the eastern Atlantic from Senegal (Ngon Sow and Ndaw 2010) and Cabo Verde (15º N), the Mediterranean and Black Sea (Zaitsev 2003), almost as far as the Arctic Circle (75º N) where temperatures of 5 ºC are recorded (De Metrio et al. 2002; MacKenzie and Myers 2007; Di Natale 2012a), and in the western part from Brazil (Takeuchi et al. 1999, 2009) to Newfoundland (Hurley and Iles 1980). It is also found in the southern Atlantic (Di Natale et al. 2013).

Its bloodstream forms the core of a highly evolved heat exchange system, and so its internal temperature can be maintained at up to 21 ºC higher than that of the water surrounding it (Carey et al. 1969; Carey and Lawson 1973). This is one of the reasons for its wide distribution in the ocean. ABFT can appear in the warm waters of the Bahamas at close to 30 ºC (Rivas 1954) and 50 days later in Norwegian waters, where the temperature hardly rises above 10 ºC (Mather III 1962).

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ABFT migrations depend on the age and length of fishes and are mainly related to spawning and the search for food. This behavioural change confirms the theory of the Norwegian scientist J. Hamre (cited by Tiews 1963), which states that ABFT behaviour changes with age, as was eventually shown years later (Lutcavage et al. 2013).

Migrations of adult fishes (fishes > 40 kg) towards spawning areas in the Mediterranean and their return to the ocean for feeding have been known for thousands of years. Today thanks to electronic tagging (Tensek et al. 2018) great advances have been made on this important facet of its biology. Its migrations get longer as its size increases. In order to spawn the tunas emigrate in great shoals (Arena 1979) that choose the most appropriate areas depending on numerous ecological and environmental variables (Alemany et al. 2010).

In general, ABFT migrations, both in adults and juveniles, appear to be associated with large oceanic current systems (Fig. 2.1). Mather III et al. (1995) presented the results of diverse recoveries of large spawning tunas tagged in the Bahamas and recovered a few weeks later in Norwegian waters, which fits this theory as they appear to have followed the Gulf Stream to the north.

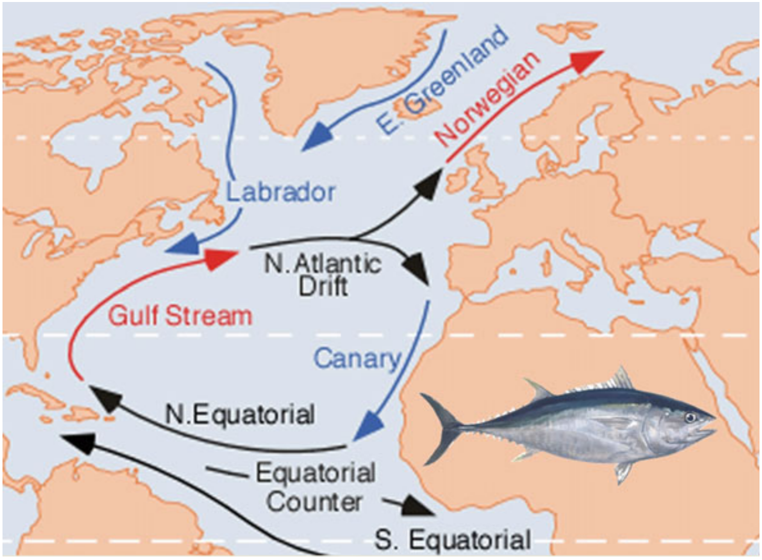

Fig. 2.1 Distribution of marine currents. https://commons.wikimedia.org/wiki/File:Corrientes-oceanicas.png. Red arrows: warm currents; Blue arrows: cold currents; Black arrows: general surface currents

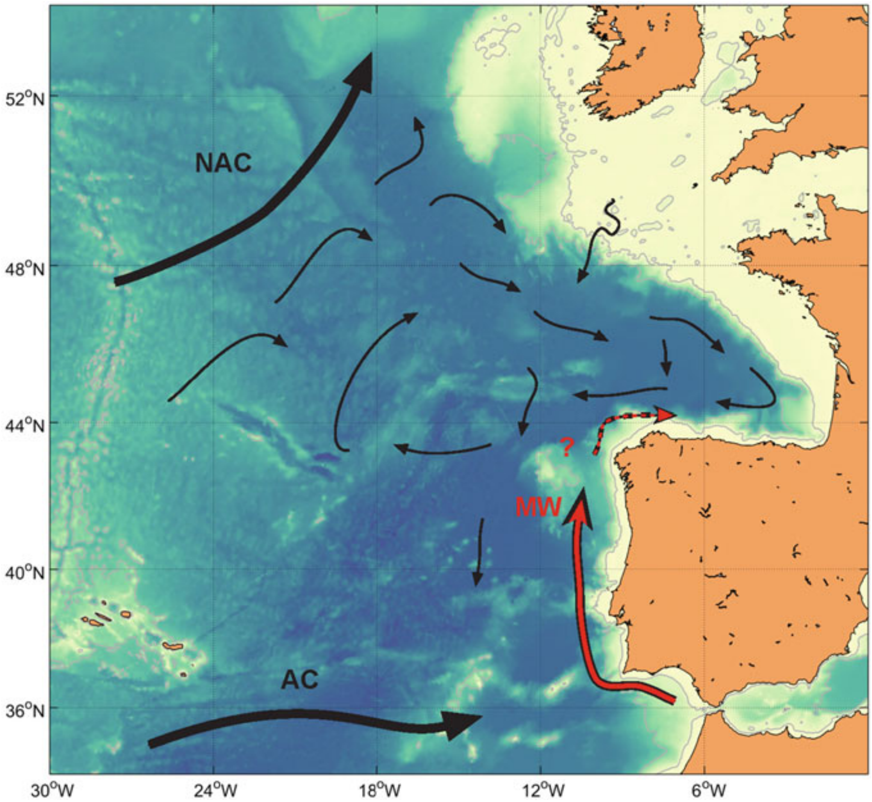

Fig. 2.2 Distribution of currents in the Northeast Atlantic. *NAC* North Atlantic current; *AC* Azores current; *MW* Mediterranean water

There are also juvenile fishes tagged off the eastern coasts of the U.S.A. whose transatlantic migrations from the western to the eastern Atlantic (Mather III et al. 1967) can be related to the North Atlantic Current (NAC), Fig. 2.2; adapted from González-Pola et al. (2005).

Rodríguez-Roda (1967) determined the age at which they reach the first spawn and the age of absolute fecundity. According to this author, ABFT reach full maturity at 5 years of age (130 cm, 50 kg), the age at which a female lays 5 million eggs. At 13 years (230 cm, 250 kg) it lays 30 million eggs. Before him, however, other Portuguese and Italian scientists had established the first sexual maturity at age 3 years and full sexual maturity at age 4 (Frade 1935; Sarà 1961; Scaccini 1965). These data have been confirmed by other authors for the Mediterranean (Piccinetti et al. 2013).

In the West Atlantic there are two spawning areas, one in the Gulf of Mexico (Richards 1977; Mather et al. 1995; Rooker et al. 2007; ICCAT 2010) and another in the Slope Sea (Northwest Atlantic) according to Richardson et al. (2016). Spawning extends from May to early June in the Gulf of Mexico and between June and August in the Slope Sea. In the western and central Mediterranean Sea the spawning period runs from May to early July (Tiews 1963; Corriero et al. 2005; García et al. 2005; Medina et al. 2002) and from May to early June in the Levantine Sea according to Karakulak et al. (2004). Other possible spawning areas have been cited in the Ibero-Moroccan Bay (Rodríguez-Roda 1969; Di Natale et al. 2017).

The trophic migrations of spawners begin once the spawning period has finished and many of these ABFT return to the Atlantic Ocean (Rodríguez-Roda 1964; Tensek et al. 2018). After crossing the Strait of Gibraltar, the shoals disperse and fishes head both north and south between June and December (De Metrio et al. 2002; Aranda et al. 2013). In the 1960s North American scientists (Mather III 1962) found evidence of 'direct' transatlantic migrations of large spawning bluefin tunas tagged in Bahamas (June) that were recovered in Norwegian waters 50 days after, indicating a migration of 7800 km (155 km/day).

The migrations of juvenile fishes (<40 kg) are generally shorter than those of larger fishes, though they also make transatlantic migrations in both directions. The first scientists to demonstrate this were North Americans in the 1960s, when they recaptured ABFT in the Bay of Biscay that had been tagged off the eastern coast of the U.S.A. years earlier (Mather III et al. 1967). Soon afterwards French and Spanish scientists showed that this migration also occurred in the opposite direction (Aloncle 1973; Cort 1990). In recent years, in projects financed by ICCAT-GBYP, other specimens tagged in the Bay of Biscay migrated across the Atlantic (Tensek et al. 2018). Recent studies on the chemical composition of otoliths have shown that transatlantic migrations of ABFT juveniles take place in some years in very significant numbers (Rooker et al. 2014).

ABFT frequent surface waters both in the spawning and trophic seasons (Fig. 2.3). Electronic tagging studies also reveal that they often dive to great depths, sometimes to over 800 m (Block et al. 2005).

The evolution of bluefin tuna fishing in the north Atlantic has gone through different phases over the last seven decades (Fig. 2.4). In this figure it can be seen how fishing for this species has changed since 1950, the first year of the ICCAT data base. It can be seen how in the 1950s they were mainly caught in the eastern Atlantic with TR (Cort et al. 2012; Pereira 2012), PS (Hamre 1960; Tangen 2009) and BB (Le Gall 1951; Cort 1990), and in the Mediterranean with TR (Di Natale 2012b) and PS (Piccinetti 1980); in the western Atlantic there were catches with TR (Dean et al. 2012), recreational, small nets and harpoon (Hurley and Iles 1980). The most remarkable in the 1960s was the development of the Japanese LL, which stretched as far as the southern hemisphere off Brazil (Takeuchi et al. 2009) and also PS in western fisheries (Sakagawa 1975; Porch 2005). In the 1970s fishing using TR diminished in the Strait of Gibraltar (Rodríguez-Roda 1977) and in the Mediterranean (ICCAT 2010), whereas the use of PS fell in the north of Europe (Nøttestad et al. 2009). In the same decade PS (Farrugio 1980) and LL (Rey 1980) developed in the Mediterranean.

Fig. 2.3 Bluefin tuna in trophic migration *Artist*: Lineke Zubieta (Santander, Spain) (Documentary archive, *IEO*)

In the 1980s PS disappeared in the north of Europe (Nøttestad et al. 2009) while it continued to proliferate in the Mediterranean (Farrugio 1980; Arena 1982, 1988). From the 1990s the use of PS continued to increase in the western Mediterranean (Liorzou and Bigot 1993; De la Serna and Platonenko 1996) and eastern Mediterranean (Libya and Turkey) according to ICCAT (2010) and Karakulak (2003). Japanese longline also increased in the central and eastern Atlantic (Kimoto and Itoh 2017). These modern systems took over in the last century to become the most commonly used gears (ICCAT 1980). In more recent years (2000s) the greatest fishing effort is exerted in the Mediterranean (Fig. 2.5), where purse seine is used to catch fishes for fattening farms (Deguara et al. 2010; Galaz 2012; Hattour and Kouched 2013; Gordoa 2014, 2017), though in the Strait of Gibraltar fishing with traps continues (De la Serna et al. 2012; Santos et al. 2016).

Figure 2.6 shows the panorama of ABFT fishing in the middle of the 20th century when the fisheries, which had renewed their activities following the Second World War, were at their height, as was the case of the northern European fisheries and a little

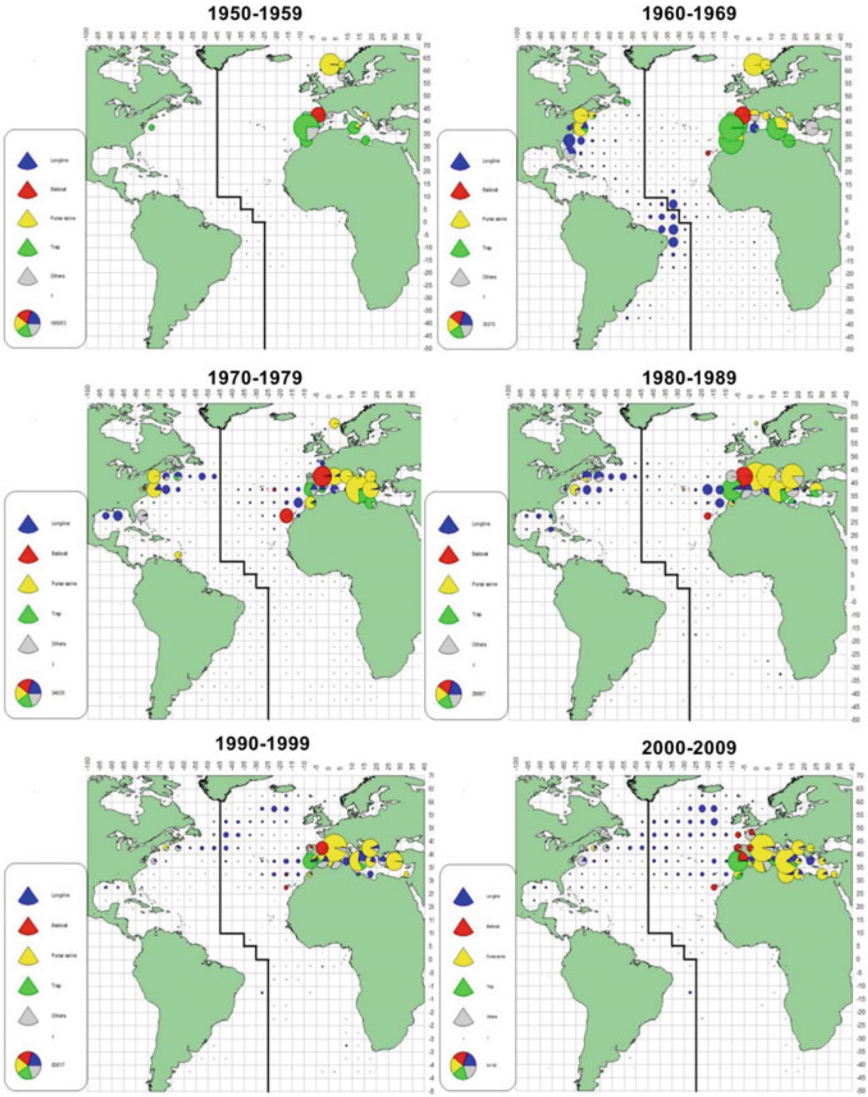

Fig. 2.4 Distribution of bluefin tuna fishing by decade [Blue, longline (LL); Red, baitboat (BB); Yellow, purse seine (PS); Green, trap (TR); Grey, others] (Courtesy of ICCAT)

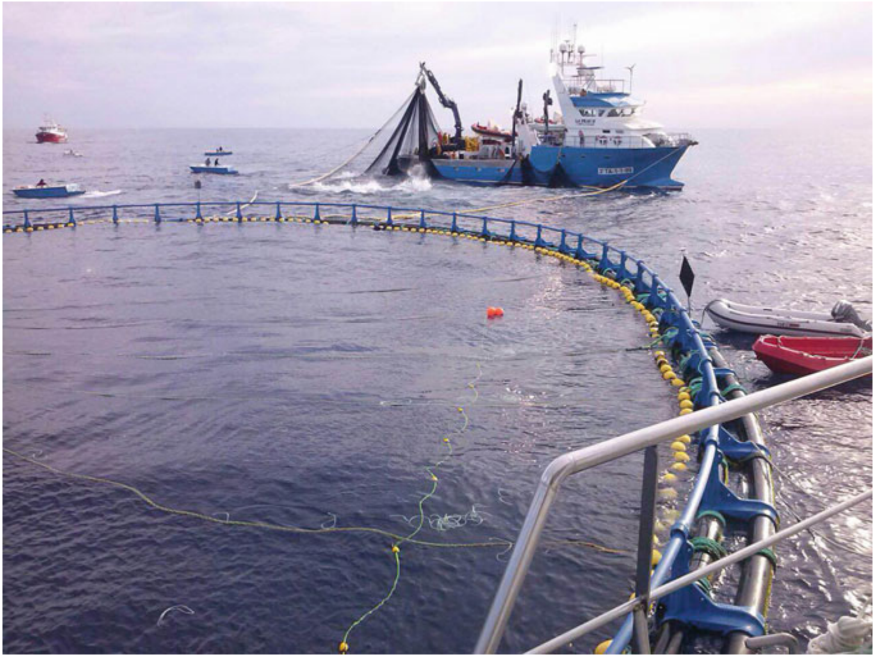

Fig. 2.5 Modern Spanish purse seiner in the western Mediterranean (Courtesy of *Grup Balfegó*)

later the Asian longline fisheries, mainly Japan. Also included are the purse seine fleets of the Mediterranean, whose rapid development began in the 1960s (Piccinetti 1980). The figure provides a vision of ABFT fishing when it was at its height and also its subsequent decline, using red circles to represent the fisheries that abandoned their activities following the overfishing of the 1960s in the eastern part of the Atlantic and Mediterranean, and in the 1970s in the western part of the Atlantic Ocean.

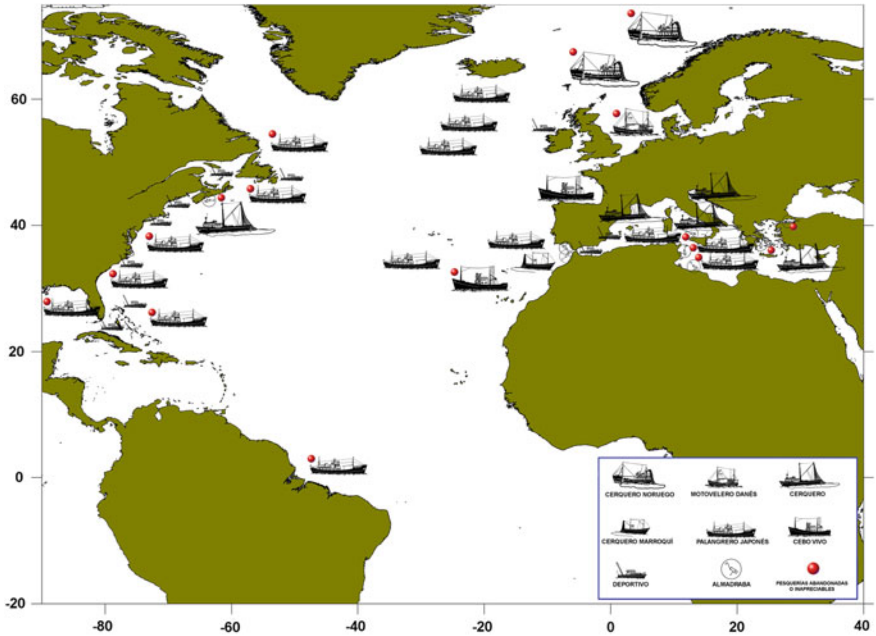

Fig. 2.6 Fleets both present and past targeting bluefin tuna. Small artisanal fisheries are not included (explanation in the text). Legend: Cerquero noruego = Norwegian purse seiner; Motovelero danés = Danish motorsailer; Cerquero = Purse seiner; Cerquero marroquí = Moroccan purse seiner; Palangrero japonés = Japanese long liner; Cebo vivo = Bait boat; Deportivo = Sportive; Almadraba = Tuna trap; Red bullet = Abandoned or almost unworkable fisheries

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