NEW DATA ON THE HISTORICAL DISTRIBUTION OFBLUEFIN TUNA (*THUNNUS THYNNUS*, L.) IN THE ARCTIC OCEAN

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SUMMARY

*Knowledge on historical distribution of Atlantic bluefin tuna (*Thunnus thynnus*) is still largely incomplete and very partial, because documents are very poor and often confused. The recent data mining activity carried out by the ICCAT-GBYP is revealing new information and data, particularly from areas where the most intense fishing activity was carried out. Some data are showing-up from ancient books and one of them, related to a trip made by Friederick Martens in 1671, is reporting a very unusual distribution area at that time, confirming a location of one recent pop-up tag and enlarging the old distribution area to the extreme North. While checking this information, it was interesting to note that, exactly in these old years, the temperature in Greenland had a positive peak and this fact supports, implicitily, bluefin tuna presence reported in this historical scientific work.*

RÉSUMÉ

*Les connaissances sur la distribution historique du thon rouge de l'Atlantique (*Thunnus thynnus*) restent très parcellaires étant donné que les documents sont rares et souvent confus. Les récentes activités d'exploration des données réalisées par l'ICCAT-GBYP ont fait apparaître de nouvelles données, notamment en ce qui concerne des zones ayant connu les activités de pêche les plus intenses. Quelques données proviennent de livres anciens et l'un d'entre eux, concernant un voyage réalisé par Friederick Martens en 1671, fait état d'une distribution spatiale très inhabituelle pour cette époque, confirmant un emplacement d'une marque pop-up récente et étendant l'ancienne zone de distribution à l'extrême Nord. Lors de la vérification de cette information, il a été intéressant de relever qu'à cette époque-là, la température au Groenland présentait un pic positif, ce qui vient étayer implicitement la présence du thon rouge détaillée dans le présent travail historico-scientifique.*

RESUMEN

*Los conocimientos sobre la distribución histórica del atún rojo del Atlántico (*Thunnus thynnus*) son aún muy incompletos y parciales porque los documentos son escasos y a menudo confusos. Las recientes actividades de minería de datos llevadas a cabo por el GBYP-ICCAT están revelando nueva información y nuevos datos, especialmente de zonas donde se llevaba a cabo una actividad pesquera más intensa. Están apareciendo algunos datos en libros antiguos y uno de ellos, relacionado con un viaje realizado por Friederick Martens en 1671, informa sobre una zona de distribución muy inusual en esa época, confirmando una localización donde emergió una marca pop-up recientemente y ampliando la zona de distribución antigua hacia el extremo septentrional. Al comprobar esta información fue interesante observar que, exactamente en aquellos años, la temperatura en Groenlandia tenía un pico positivo y este hecho respalda, implícitamente, la presencia de atún rojo comunicada en este histórico trabajo científico.*

KEYWORDS

Bluefin tuna, Atlantic, Arctic Ocean, Greenland, distributrion range, historical biogeography bibliography, climate changes, fishery

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1. Introduction

The natural history of bluefin tuna (*Thunnus thynnus*, Linnaues 1758) is only partly known, besides more than 2000 years of written documents, studies and researches (Mather III *et al*., 1974, 1995; Doumenge, 2008a, 2008b; Rooker *et al*., 2007; Di Natale, 2010). While bluefin tuna fishery is now much more defined for the historical periods (Di Natale, 2011), the bluefin tuna distribution, either historical or recent, still presents several undefined situations and various grey areas.

ICCAT SCRS (Anon., 2009b) already identified and defined the geographic distribution of fisheries in the last 60 years (**Figure 1**), but fisheries are not always representing the real distribution of the species.

The ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP), among various objectives, has the goal to recover as much as possible also historical data and this data mining is providing a huge amount of "new" old information, improving the general knowledge on bluefin tuna particularly for the last 500 years.

The distribution of Atlantic bluefin tuna, including all records known until 2009 (before GBYP), is summarised in a recent image provided by Fonteneau (2012) herewith reported as **Figure 2**. This Figure includes most of the available information on Atlantic bluefin tuna, but it is clear that parts of the map, not showing any presence of bluefin, should be further investigated.

As a matter of fact, the first year activity of GBYP improved the knowledge both about the bluefin tuna distribution in historical times in Norway, with a lot of new details, and the current distribution of bluefin tuna along the Western African coast, demonstrating that a migration course exists from somewhere in central-eastern Atlanting (but still with unknown origin), moving along the cost of Senegal northwards, reaching Mauritania and the coasts of Morocco, where many tunas are know caught in tuna traps and other gears since decades (De Buen, 1922, 1923a, 1923b, 1923c, 1925, 1926, 1928, 1931; De Louriero, 1922, Marchand, 1926; Anon., 1927; Dollfus, 1927; Manso, 1927; Fournestin and Dardignac, 1962; Abid and Idrissi, 2010) confirming ancient exploitation in the same area in Phoenician times (Aubet, 1987; Curtis, 1988, 1991; Santos Castroviejo, 1990; Habibi, 2011).

2. Bluefin tuna in the extreme North and its biology, physiology and ecology

Bluefin tuna is a species living mostly in temperate waters, but its histotrical distributrion includes also waters with cold temperatures, like the Black Sea (where several northern areas can reach temperatures close to 0°C in January-February), the North Sea, up to the northern part of Norway (including a part close to the edge of the Arctic Ocean), a part of the Baltic Sea (in the '60s) and Iceland, where temperatures are also very low. Even the northern Adriatic Sea, where bluefin tuna is present, can reach very cold temperatures in winter time. It distribution in the North and its fluctuations have been recently studied (Anon., 2009a; Ravier and Fromentin, 2003, 2004; Fromentin, 2009). Internal archival tags demonstrated that bluefin tunas can regularly dive in waters having a temperature close to 2,8°C (Block et al., 2001).

Some years ago, a pop-up tag deployed and set on a bluefin tuna close to Gibraltar showed a very strange course, reaching the Greenland Sea at 75°125 N - 1°095 E (**Figure 3**) (De Metrio *et al*., 2002 and 2005; Rooker *et al*., 2007) after 239 days at sea, and the common understanding by SCRS scientists was that this tag was possibly detached from the fish and passively transported to this area by currents or that this fish was eaten by a killer whale moving to this area. Another tag, set along the Spanish Mediterranean coast by the same team, popped-up south of Iceland after 62 days.

As a matter of fact, besides these recent pop-up data and the previous reports of catches from the northern part of Norway collected under the GBYP framework (Tangen *et al*., 2010), information of bluefin tuna distribution in extreme NW areas of the Atlantic Ocean and in the Arctic Ocean was completely missing and this was thought be caused by the unsuitable oceanographic conditions for this species.

But, a bluefin tuna is a species having very peculiar characteristics: if it lives both in cold waters and in tropical or equatorial waters, the reason is the well-known capacity to keep its body temperature within acceptable limits. It is commonly believed that bluefin tuna is a homeotherm species, but the reality is much more complex. It is also an endothermic species, because, thanks to its *rete mirabile*, bluefin tuna has the capacity to regulate the internal temperature using metabolic processes**,** and this is very important particularly around and along the vertebral column, where this *rete mirabile* is diffused in muscles.

The result is not only that bluefin tuna is able to thermoregulate certain areas of its body, but also to increase the basic metabolic temperature. Then, bluefin tuna is able to split ATP at a higher rate and ultimately can swim faster, covering very long distances for various reasons (migration feeding, reproduction). In addition, bluefin tuna has pecilothermic capacities in the external parts of the body, able to keep these parts in thermic equilibrium with the external environment.

In the natural history of bluefin tuna, we should also consider the possibility that this species might be influenced by the Bergmann's Law[2]. If bluefin tuna was reported to have very large individuals in the past (there is the "legend" of a specimen of about 1 ton caught in the Black Sea[3] and another over 950 kg mentioned in Canadian waters) these huge sizes might be caused by the distribution of bluefin tuna in cold waters or also in high latitudes in some times of his natural history.

All these are points for further reflections and analysis, if other historical data will be available.

3. Bluefin tuna in Greenland

Besides the single recent information coming from the pop-up tag showed-up in the Greenland Sea in the Arctic Ocean, no other data were available on bluefin tuna in this part of the Arctic.

ICCAT GBYP includes some studies on bibliography, with the purpose to find data on bluefin which are not incorporated in the ICCAT BFT data base. During one of these bibliographical analyses, it was found an extremely interesting description of the bluefin tuna historical presence and fishery in Greenland, never mentioned before in any recent review.

The description is included in one of the most famous historical description of the Arctic environment, made by Friederick Martens in 1671 and firstly edited in German in 1675. This book was then edited in Italian (1680), in English (1694), in Dutch (1685, 1710 and 1750), in Latin (1704) and in French (1715 and 1732), while a Spanish edition is not confirmed. The number of translations and editions reveals the high relevance of this book at that time. All editions have slight differences in the title and in the first name of the Author. The Italian edition (1680) was used to prepare this paper (**Figure 4a**).

This book was one of most known report on Arctic regions at that time. The core of the book is the whaling, but another important part is the description of the birds, quadrupeds, fish and rare plants living in that area.

Martens (who was born in Hamburg in 1635 and died in 1699) was clearly a naturalist and an explorer, described by somebody also as a "barber and a surgeon", which are not unusual description for a scientist at that time. He was able to provide detailed descriptions of vegetables and plants, revealing a solid scientific background. He carried out his voyage moving from Spitbergen to the limit of the polar pack ice, up to 81° N, from April 15 to August 21, 1671. In making this travel, he sailed on board of the whaling ship "Jonas" in the Greenland Sea, leaving south the isle of Jan Mayen (71°N)[4]. This is something to be taken into account to understand where the bluefin tuna was reported.

On page 69 of the Italian edition (**Figure 4b**), Martes mention "many bluefin tunas and other big fish" as lucky signs for the navigations. On pages 191 and 192 (**Figure 5**), Martens reports the presence of big bluefin tuna in Greenland, having a length between 170 to 270 cm[5], stating that this fish is very well known by local fishermens, because there are great quantities in the Greenland Sea and tuna usually jumps out of the surface. This description is possibly related to a feeding behaviour. As concerns the fishery, there is only one sentence in the text, stating that this fish is caught by case, without a great effort.

As far as is known, Martens' description is the only one historically reporting bluefin tuna in Greenland waters.

[2] In homeothermic species, the size of individuals increase in increasing the latitude or with the distribution in areas with cold temperatures, because there is a better relationship between body volume and body surface, resulting in decreasing the thermic dispersion.
[3] This information is reported in some Turkish papers (Akyuz and Artuz, 1957; Devedjian, 1926; Karahis, 1915)), without a precise reference.
[4] The Isle of Jan Mayen ("isle of Maien" in the original text from Martens) is a small island now belonging to Norway.
[5] "from 5 to 8 feet" in the text; the German foot at that time was usually about 34 cm.

4. The climate situation in Greenland around 1671

There are several studies about the evolution of temperature in Greenland during the last 1000 years, particularly for researches concerning the global sea-level change.

A recent study (Kobashi *et al*, 2009), provides a comprehensive overview of the surface temperatures in Greenland in the last 1000 years from isothopes of N_2 and Ar in air bubbles in an ice core.

According to the study, which demonstrate that temperatures in Greenland and northern hemisphere changed synchronously at periods of about 20 years and 40-100 years, there was a warmer period during the first part of the millennium, followed by a cooling after the 15th century towards the 18th century (the so called "Little Ice Age"), and a temperature increasing from the late 19th century to the 20th century.

The travel by Martens was made during one of the coldest centuries, but carefully checking the data it is very clear that the second part of the 17th century was characterised by a positive peak in temperatures (about +2°C compared to the lowest peak) for more than 20 years, particularly around 1670, exactly when Martens went to Greenland.

The highest peak of temperatures in Greenland in the last 900 years was around 1940 on, with a good correlation with the peak of bluefin tuna fishery in Norway and in the North Sea.

These data, even if only indicative, can theoretically support a possible explanation for the presence of bluefin tuna in the Arctic Ocean, at least in those two periods (1671 and 1950).

5. Discussion and conclusion

The rediscovery of this old information (which was hidden inside this "whaling" book) about the presence and fishery of bluefin tuna in the Greenland Sea, well inside the Arctic Ocean, provides a new perspective about the natural history of this highly migratory species, enlarging its historical distribution area far North and linking this change in distribution to environmental factors (which are not only necessarily limited to temperature but also to possible changes in the food web).

It is extremely interesting that this historical information is concerning the same geographical area were recently there was a pop-up tag showing-up, originally thought to be detached from the fish because of the too hight latitude and the low speed (5 knots). Due to the lack of any previously known occurrence in the area well north of the Jan Meyen Isle, in the middle of the Greenland Sea, in the Arctic Ocean, nobody was available to trust this location, which now, after rediscovering that this was as an ancient area of presence of bluefin tuna (at least in 1671), appears under a new light. It is also interesting to note that Martens travels was from spring to summer and the recet tag went to the far North at the beginning of spring (late March).

If we think about the fact that long-term data for bluefin tuna exist only for the trap fishery, while most of the other fisheries are documented by short-term series (when they exist!), it is clear that we are missing many parts of the complex figure of the bluefin tuna natural history.

Recent events in the last 50 years demonstrate that bluefin tuna can have important changes in its distribution, not necessarily linked to human exploitation, or at least not only due to human activity.

The disappearance of bluefin tuna off Brazil after the '60s, the progressive disapperence of bluefin tuna off Norway after its sudden peak of presence and fishery in the '50s with a distribution going well inside the Arctic Ocean (Anon., 2009a, Fromentin, 2009; Ravier and Fromentin, 2003, 2004; Tangen *et al*., 2010) (**Figure 6**), the unknown origin of important quantities of bluefin tuna coming into the Moroccan traps in the last 15 years (Abid and Idrissi, 2010), at the beginning of the last century and during the ancient Phoenician times (Habibi, 2011), the recent confirmation of bluefin tuna moving along the western African coast (Senegal and Mauritania, here taken mostly as by-catch by pelagic trawlers), the bluefin tuna moving somewhere towards the central-southern Atlantic after the spawning season (de la Serna et al., 2004, De Metrio et al., 2001, 2002, 2003, 2005), the very recent anecdotical information (not confirmed so far by any scientific data) about important quantities of bluefin tunas off the western-central African coast, the catches anecdotally reported by South African sport fishers, the presence of several adult bluefin tunas having natural marks of *Isistius brasilensins* (cookiecutter shark) which are caught in the Mediterranean Sea since decades revealing a possible South Atlantic origin of a part of the

spawning stock, the recent rediscovery of central-North Atlantic movements of medium and giant bluefin tuna during the spawning season (already noticed by De Buen, 1927, and Mathers III, 1995) which are not coming to the Mediterranean during the spawning season, the sudden disappearance of the ancient bluefin tuna population from the Black Sea and its possible slow coming back in very recent years (Di Natale, 2010), the old and new questions concerning the current population structure of Atlantic bluefin tuna (Galuardi *et al*., 2010), are all elements suggesting that our current understanding of bluefin tuna distribution and biology need several refinements, which might improve the current "scientific knowledge".

As reported several times, a comprehensive reading of the already existing huge scientific literature, together with the collection of fishery-independent data, will bring more light in the very foggy situation we have since years, because fishery data only are not able to catch the natural complexity and variability, particularly for a species having a huge distribution like the bluefin tuna.

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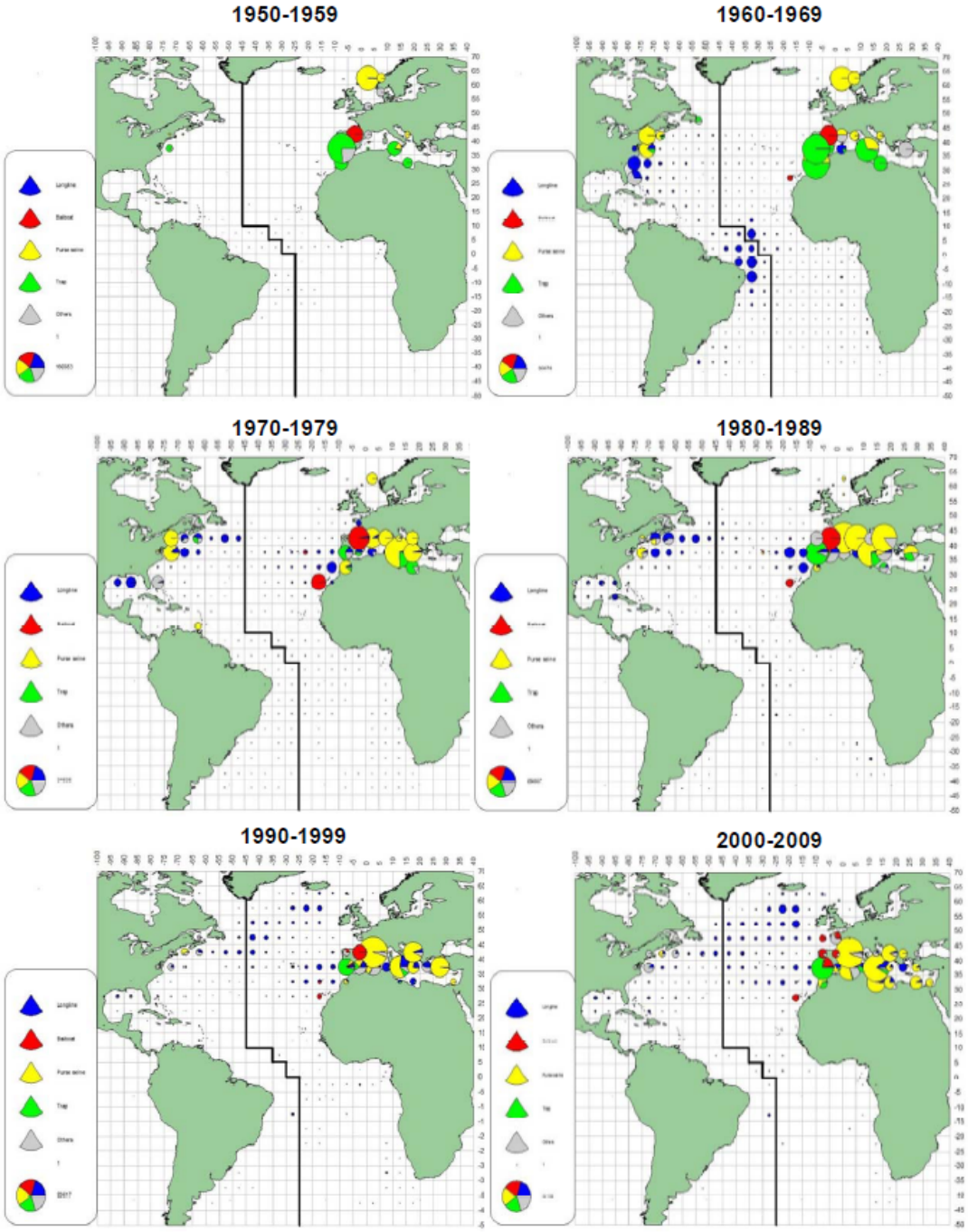


Figure 1. Distribution of fisheries and fishing effort by decades for Atlantic bluefin tuna, from 1950 to 2009 (from ICCAT-SCRS, 2010).

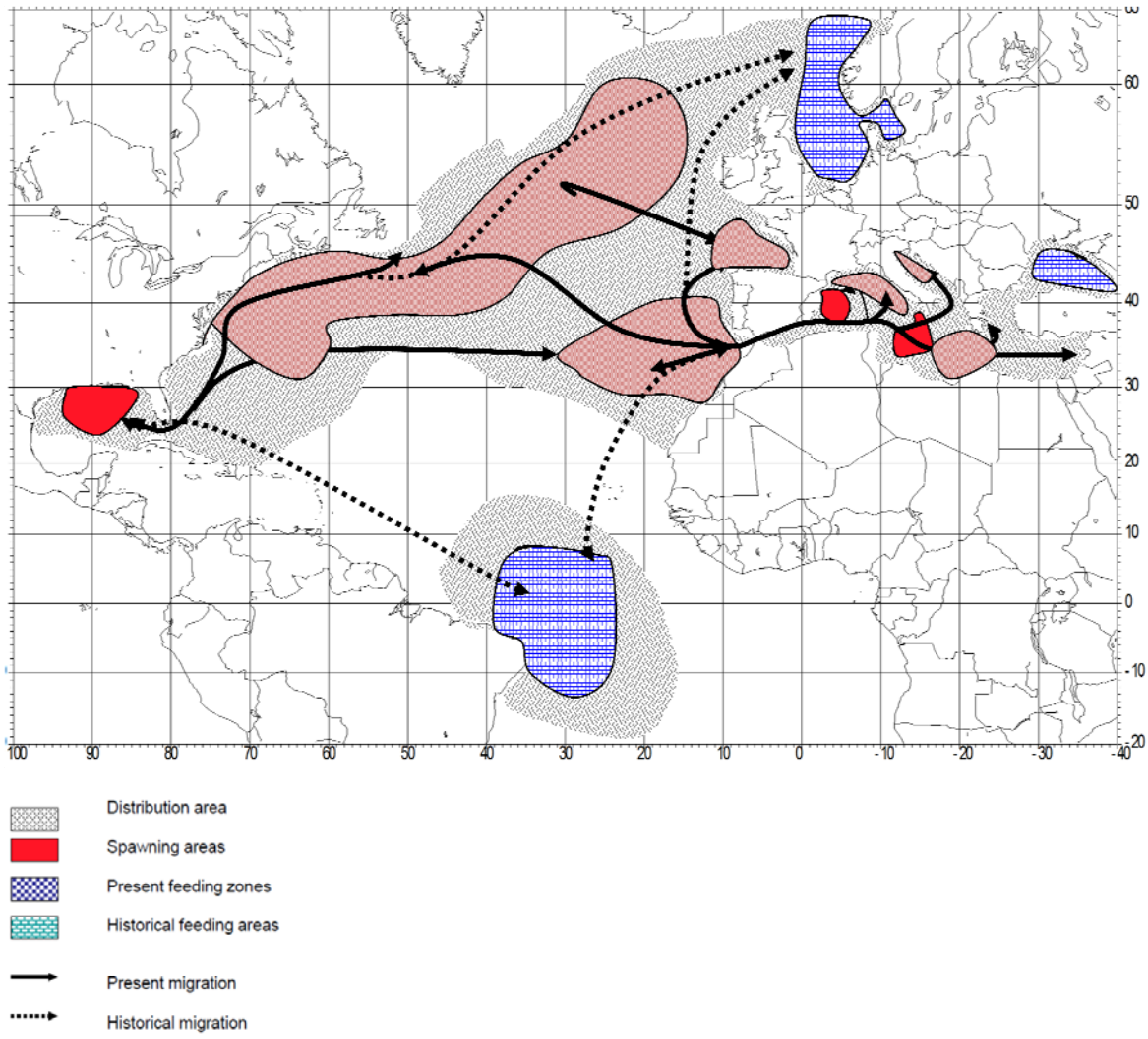


Figure 2. Historical distribution and migratory courses of Atlantic bluefin tuna (Fonteneau, 2012).

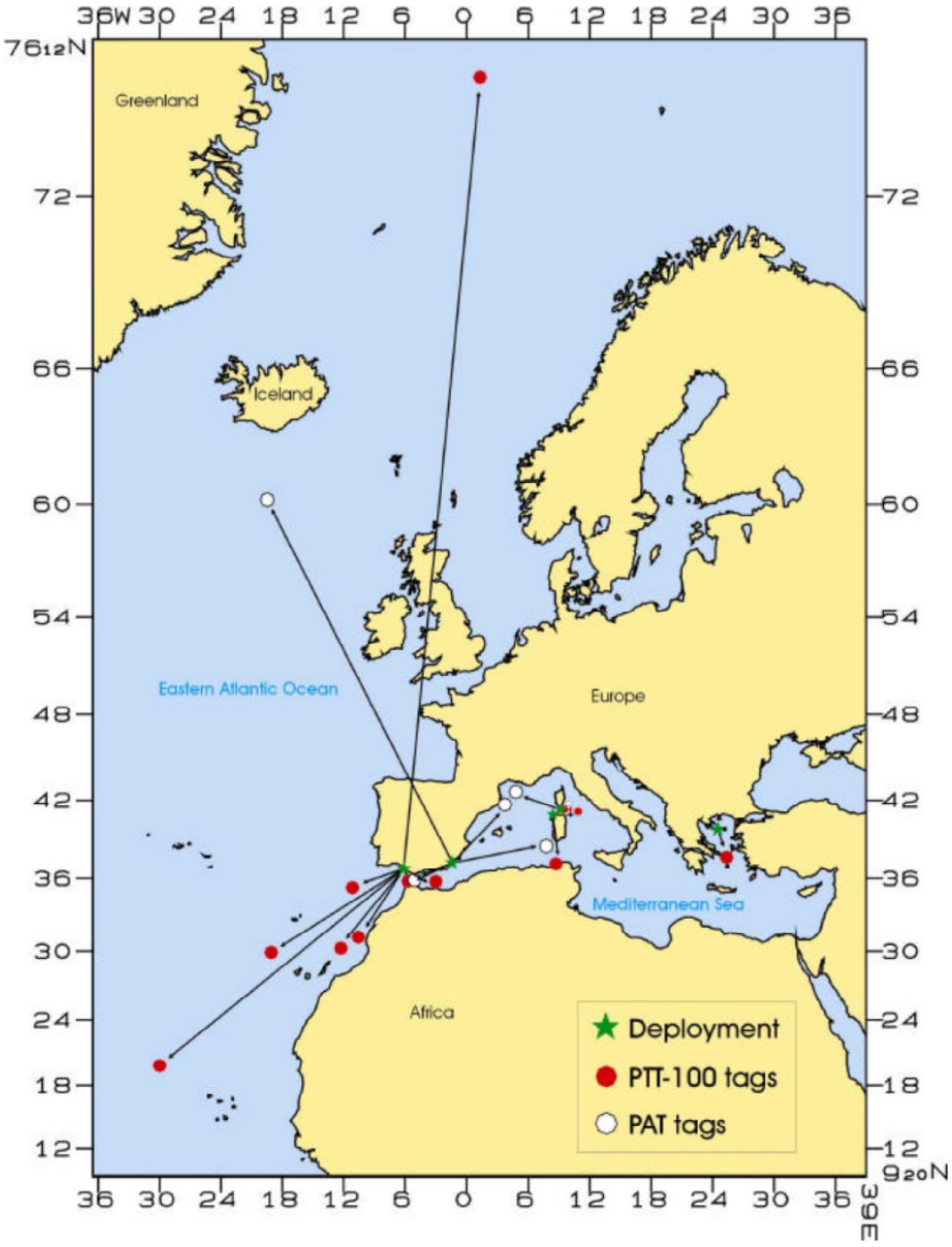
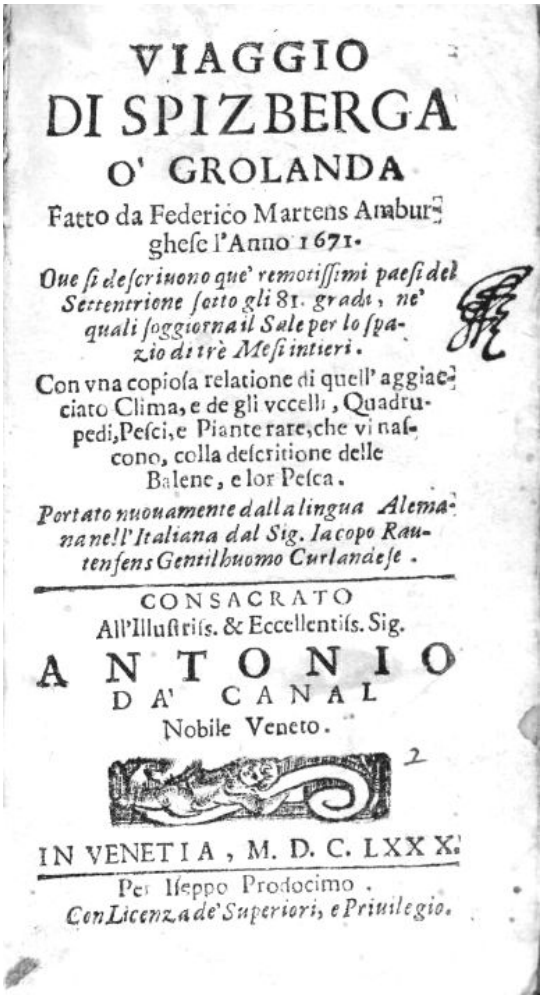


Figure 3. Pop-up locations of tags implanted on bluefin tuna during trials carried out from 1998 to 2000 (from De Metrio et al., 2002). The most northern tag is in the same geographic area, north of the Jan Mayen Isle, where bluefin tuna fishery was reported by Martens in 1671.



VIAGGIO
DI SPIZBERGA
O' GROLANDA

Fatto da Federico Martens Amburghese l'Anno 1671.

Oue si descriuono que' remotissimi paesi del Settentrione sotto gli 81. grado, ne' quali soggiorna il Sole per lo spazio di trè Mesi intieri.

Con vna copiosa relatione di quell' aggiacciato Clima, e de gli vccelli, Quadrupedi, Pesci, e Piante rare, che vi nascono, colla descritione delle Balene, e lor Pesca.

Portato nuouamente dalla lingua Alemanna nell' Italiana dal Sig. Iacopo Rautensens Gentilhuomo Curlandese.

CONSACRATO
All'Illustriss. & Eccellentiss. Sig.
ANTONIO
D A' C A N A L
Nobile Veneto.

IN VENETIA, M. D. C. LXXX.

Per Iseppo Prodocimo.
Con Licenza de' Superiori, e Priuilegio.

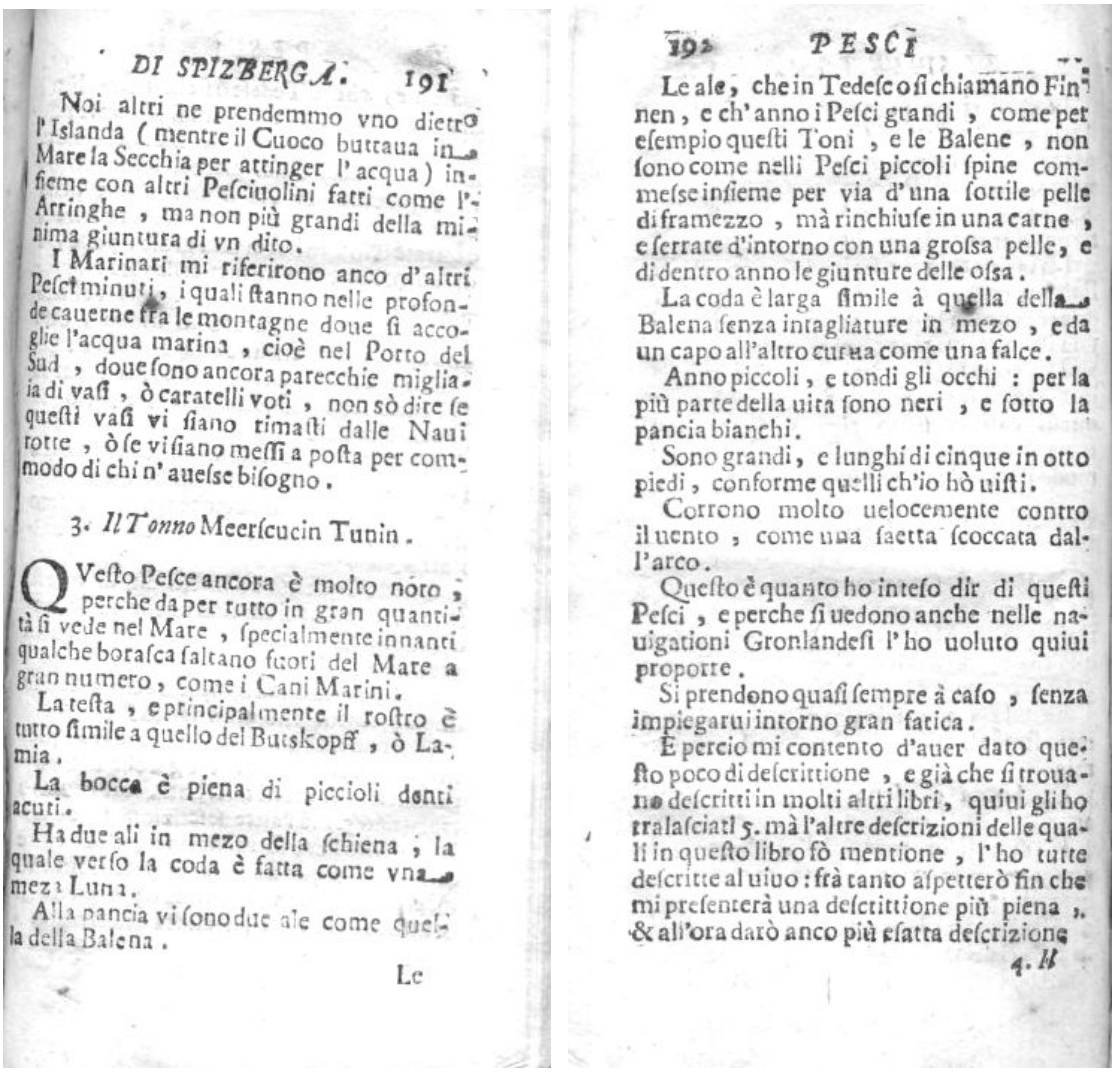
Durante la fortuna, & anco dopō rengono alle volte visitate le Naui da londi, Pigozzi, e varij altri vccelletti, quali smarita la terra per le tempeste, isuggono alle Naui per campar la vita; altri suolazzano tanto sopra il Mare, sin che vi s'affogano.

Li Smerghi, *Lumben*, & altri Vccelli acquatici non s'appressano à noi: la qual cosa auuertisco, per mostrare erronea l'opinione d'alcuni, che stimano, che il ricouerarsi de' sopradetti Vccelli alle Naui, sia qualche mal'augurio di vna ricina tempesta.

I seguenti segni però sono la più parte veri presaggi di qualche fortuna auuenire: cioè quando molti Tonni, & altri Pesci grandi intorno alla Naue appariscono. E mentre così saltano, e si dibattono, sopr'acqua, puol' essere, che non sempre lo facciano per solazzarsi scherzando, mà che sentano qualche dolore ne' loro corpi: si come vedemmo certe Balene infuriate di modo, quasi che già contrastassero con la morte.

Inquietandosi il Mare, bisogna sapere, che ciò non deriua solamente dall' istesso Mare, mà che vi segue presto vn fiero vento, il quale, come forieri, manda nanzi i caualloni, finche egli stesso con la tempesta vi giunge: con tutto ciò questo si hà da intendere della Marca, ch' è trà Islanda, e Spizberga, e non del

Figure 4. Front page of the Italian edition of Friederich Martens' book, edited in Venice in 1680 (4a, left) and the first citation of bluefin tuna in the middle part of page 69 (figure 4b, right).



DI SPIZBERGA. 191

Noi altri ne prendemmo vno dietro l'Islanda (mentre il Cuoco buttaua in Mare la Secchia per attinger l'acqua) insieme con altri Pesciuolini fatti come l'Arringhe, ma non più grandi della minima giuntura di vn dito.

I Marinari mi riferirono anco d'altri Pesci minuti, i quali stanno nelle profonde cauerne fra le montagne doue si accoglie l'acqua marina, cioè nel Porto del Sud, doue sono ancora parecchie migliaia di vasi, ò caratelli voti, non sò dire se questi vasi vi siano rimasti dalle Naui rotte, ò se vi siano messi a posta per commodo di chi n'auesse bisogno.

3. *Il Tonno* Meerscucin Tunin.

QVesto Pesce ancora è molto noto, perche da per tutto in gran quantità si vede nel Mare, specialmente innanti qualche borasca saltano fuori del Mare a gran numero, come i Cani Marini.

La testa, e principalmente il rostro è tutto simile a quello del Butskopff, ò Lamia.

La bocca è piena di piccioli denti acuti.

Ha due ali in mezo della schiena, la quale verso la coda è fatta come vna mezza Luna.

Alla pancia vi sono due ale come quella della Balena.

Le

192 PESCI

Le ale, che in Tedesco si chiamano Finnen, e ch'anno i Pesci grandi, come per esempio questi Toni, e le Balene, non sono come nelli Pesci piccoli spine commesse insieme per via d'una sottile pelle di framezzo, mà rinchiuse in una carne, e serrate d'intorno con una grossa pelle, e di dentro anno le giunture delle ossa.

La coda è larga simile à quella della Balena senza intagliature in mezo, e da un capo all'altro curua come una falce.

Anno piccoli, e tondi gli occhi: per la più parte della uita sono neri, e sotto la pancia bianchi.

Sono grandi, e lunghi di cinque in otto piedi, conforme quelli ch'io hò uisti.

Corrono molto uelocemente contro il uento, come una saetta scoccata dall'arco.

Questo è quanto ho inteso dir di questi Pesci, e perche si uedono anche nelle nauigationi Gronlandesi l'ho uoluto quiui proporre.

Si prendono quasi sempre à caso, senza impiegarui intorno gran fatica.

E perciò mi contento d'auer dato questo poco di descrittione, e già che si trouano descritti in molti altri libri, quiui gli ho tralasciati 5. mà l'altre descrizioni delle quali in questo libro fò mentione, l'ho tutte descritte al uiuo: frà tanto aspetterò fin che mi presenterà una descrittione più piena, & all'ora darò anco più esatta descrizione

4. *Il*

Figure 5. Description of bluefin tuna and its fishery in Greenland waters by Martens (1680).

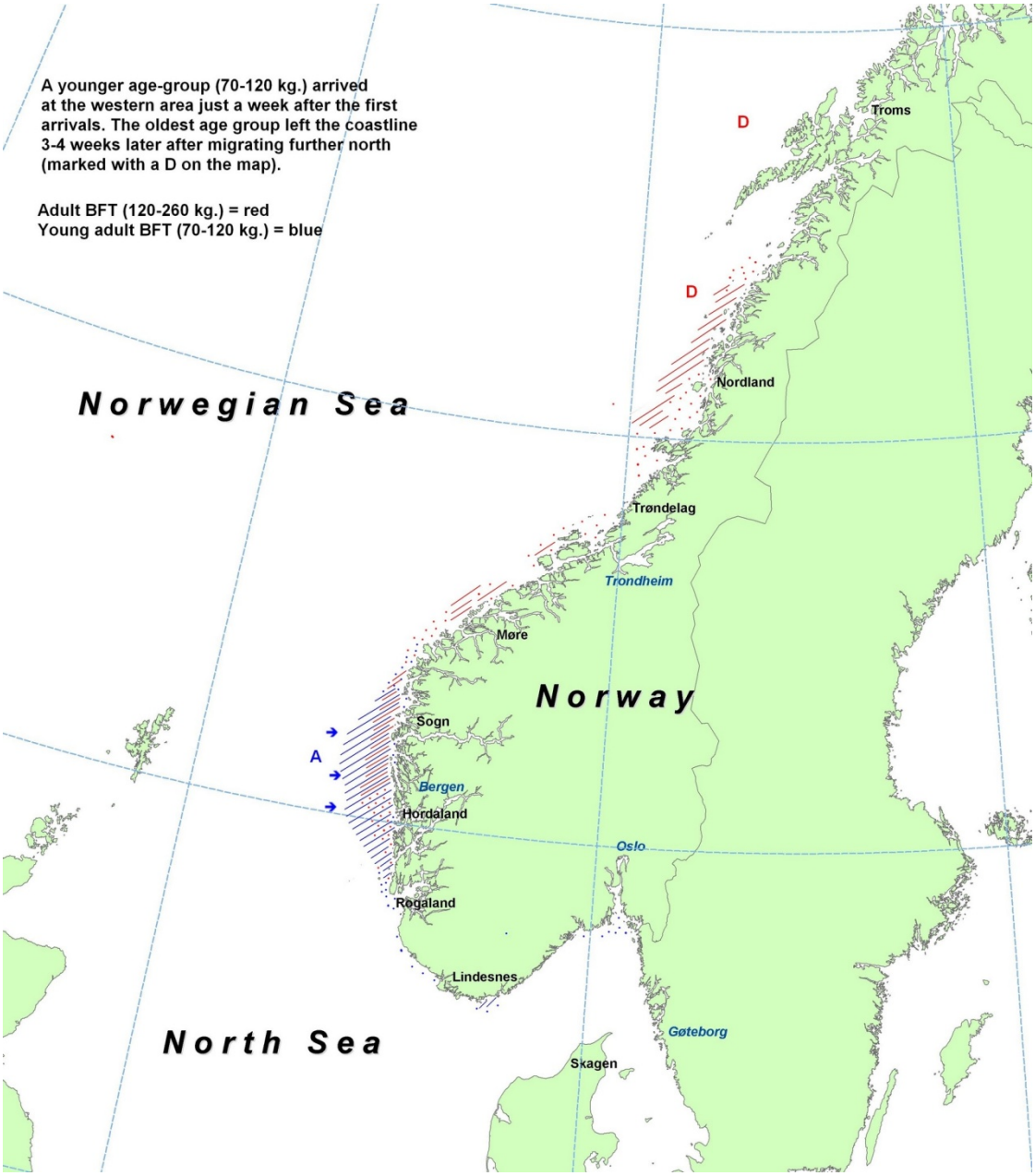


Figure 6. Distribution of bluefin tuna in Norway at the beginning of the '50s, according to the very recent data recovered by GBYP in Phase 1 (from Tangen et al., 2010). The size distribution along the northern coast, in the Arctic Ocean, is within the same size range reported by Martens in 1671.