

# The Comprehensive Italian Annotated Bibliography on Tropical Tunas

Antonio Di Natale



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## Abstract

The Italian scientists have a long tradition of studies and research on the many large pelagic species, including also the tropical tuna species. Even if tropical tunas are important for the Italian industry since more than a century, they

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A. Di Natale (✉)

Aquastudio Research Institute, Via Trapani 6, 98121 Messina, Italy

e-mail: [adinatale@acquariodigenova.it](mailto:adinatale@acquariodigenova.it)

were only occasionally studied by Italian researchers. This paper attempts to list together the papers published so far by Italian scientists, concerning the biology of these species, the fisheries and many other scientific and cultural issues. The aim of this paper is to provide an annotated bibliography, with specific keywords in English, even if the bibliography is surely incomplete, because some papers are very difficult to be find. This annotated bibliography, which includes 88 papers, was set together to serve the scientists and help them in finding even some rare references that might be useful for their work.

### Keywords

*Acanthocybium solandri* • Annotated bibliography • Atlantic Ocean • Bigeye tuna • Biology • Black skipjack • Blackfin tuna • Canning industry • Catches • Cero • Contaminants • Eastern Pacific bonito • Economy • *Euthynnus affinis* • *Euthynnus lineatus* • Feeding • Fishery • Food safety • Genetics • History • Indian mackerel • Indian Ocean • Kawakawa • King mackerel • *Katsuwonus pelamis* • Longlines • Longtail tuna • Mediterranean Sea • Migrations • Nomenclature • Narrow-barred Spanish mackerel • Pacific Ocean • Purse-seines • Reproduction • *Rastelliger kanagurta* • *Sarda chiliensis* • *Scomberomorus brasiliensis* • *Scomberomorus cavalla* • *Scomberomorus commerson* • *Scomberomorus regalis* • *Scomberomorus tritor* • Serra Spanish mackerel • Skipjack tuna • Southern bluefin tuna • Systematics • Techniques • Technology • *Thunnus albacares* • *Thunnus atlanticus* • *Thunnus maccoyii* • *Thunnus obesus* • *Thunnus tonggol* • Tropical tunas • Tuna industry • Wahoo • West African Spanish mackerel • Yellowfin tuna

## 1 Foreword

Several species belonging to the tropical tunas have been traded since the early beginning of the twentieth century by the Italian canning industries, mostly for increasing the tuna availability on the domestic market. They also raised the curiosity of some Italian scientists when they had the opportunity to carry out research campaigns in tropical waters, particularly at the time when Italy had some colonies or, in more recent times, during international cooperative activities.

This paper would like to provide the annotated overview of the Italian literature on several species of tropical tunas: skipjack tuna, *Katsuwonus pelamis* (Linnaeus, 1758) (FAO code: SKJ), narrow-barred Spanish mackerel, *Scomberomorus commerson* (Lacépède, 1800) (FAO code: COM), West African Spanish mackerel, *Scomberomorus tritor* (Cuvier, 1832) (FAO code: MAW), serra Spanish mackerel, *Scomberomorus brasiliensis* Colette, Russo and Zavala-Camin, 1978 (FAO code: BRS), cero, *Scomberomorus regalis* (Block, 1793) (FAO code: CER), king mackerel, *Scomberomorus cavalla* (Cuvier, 1829) (FAO code: SSM), wahoo, *Acanthocybium solandri* (Cuvier, 1832) (FAO code: WAH), Indian mackerel, *Rastelliger kanagurta* (Cuvier, 1816) (FAO code: RAG), black skipjack, *Euthynnus*

*lineatus* (Kishinouye, 1912) (BKJ), kawakawa, *Euthynnus affinis* (Cantor, 1849) (FAO code: KAW, yellowfin tuna, *Thunnus albacares* (Bonnaterre, 1788) (FAO code: YFT), bigeye tuna, *Thunnus obesus* (Lowe, 1839) (FAO code: BET), blackfin tuna, *Thunnus atlanticus* (Lesson, 1831) (FAO code: BLF), southern bluefin tuna, *Thunnus maccoyii* (Castelnau, 1872) (FAO code: SBF), longtail tuna, *Thunnus tonggol* (Bleeker, 1851) (FAO code: LOT), and eastern Pacific bonito, *Sarda chiliensis* (Cuvier, 1832) (FAO code: BEP). Usually, some RFMOs<sup>1</sup> group the tropical tuna species under the general code TRO.

Some papers were written in Italian, a language which is now not on the list of the three official languages (French, English and Spanish) used in ICCAT<sup>2</sup> and in other tuna RFMOs, and therefore, possibly some foreign scientists have problems in understanding the contents.

Another reason for setting-up this Italian annotated bibliography is because some papers are not available in electronic format, and therefore, some young researchers, who are no longer used to studying and mining in traditional libraries, could be likely unable to detect the various studies that have been carried out so far on these species.

Therefore, it is a sort of national proudness trying to set-up the list of papers on these species that it was possible to find so far, annotating them with keywords in English for improving the opportunities to detect them with an electronic searching engine.

A very first and limited Italian annotated bibliography on tropical tunas was tentatively provided by Di Natale (2020), even if some annotated papers were already included in the fundamental work on tuna species provided by Corwin (1930) and later updated by Van Campen and Hoven (1956). An indexed bibliography including tropical tunas, limited to tagging, was published by Bayliff (1993). Not-annotated literature reviews including also tropical tuna species were provided by Collette and Nauen (1983), Pillai and Mallia (2007) and Collette and Graves (2019).

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## 2 Criteria

The bibliography on tropical tunas (skipjack tuna, narrow-barred Spanish mackerel, West African Spanish mackerel, serra Spanish mackerel, cero, king mackerel, wahoo, Indian mackerel, kawakawa, black skipjack, yellowfin tuna, bigeye tuna, blackfin tuna, southern bluefin tuna, longtail tuna and eastern Pacific bonito) included in this work was selected when an Italian scientist was the only author of a paper or when one or more Italian scientists were among the authors of collective papers.

This was the primary criterion used for selecting the many titles, independently if they were peer-reviewed papers, books, not-peer-reviewed papers, papers presented in conferences or meetings or congresses, reports to public administrations

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<sup>1</sup> RFMOs: Regional Fishery Management Organisations.

<sup>2</sup> ICCAT: International Commission for the Conservation of Atlantic Tunas.

or project reports. A secondary criterium for paper selection considered those documents directly related to the target species, even if, in some cases, the tropical tunas are concerned by just a part of the text.

When vernacular names or old scientific names were used in the original paper, they were possibly listed in the annotation. The annotations required each paper to be checked in detail and this implied a huge workload.

The annotations show the main subjects in the content, and the descriptors proposed by ASFIS (Fagetti *et al.*, 2009) have been mostly used, adding additional descriptors when necessary. As concerns the main species included in each reference, we used both the international common name(s) and the Latin name(s).

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### 3 Discussion

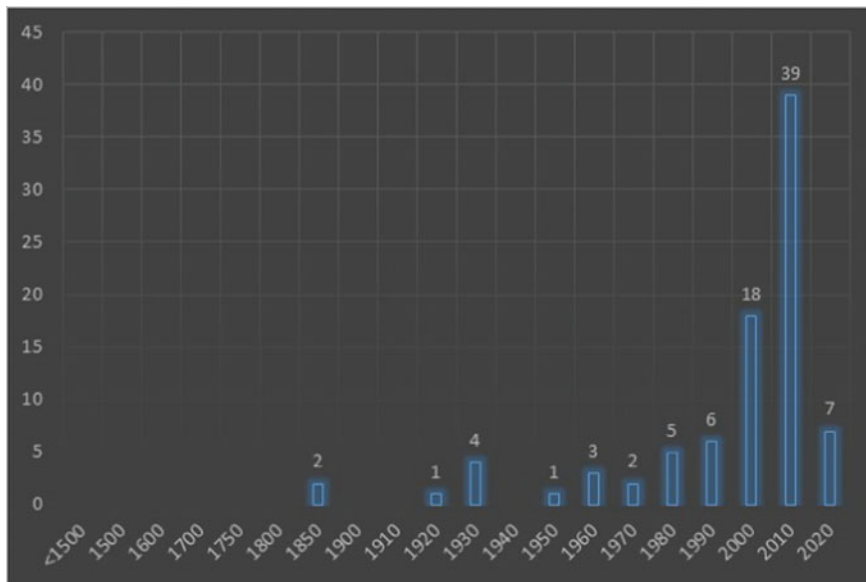
Even if most of the scientific efforts of the Italian scientists over the years were devoted to the Mediterranean species, some of them worked also on tropical tuna species, thanks to the interest of the tuna industry to use these tunas. Very few research campaigns were targeting tropical tunas in the past, even if some Italian vessels were fishing also in tropical areas. The interest, in recent years, has been mostly for management or conservation studies, food safety issues and for genetic research.

The titles which are now available surely constitutes a very useful reference list for all the researchers working on tropical tunas (skipjack tuna, narrow-barred Spanish mackerel, West African Spanish mackerel, serra Spanish mackerel, cero, king mackerel, wahoo, Indian mackerel, black skipjack, yellowfin tuna, bigeye tuna, blackfin tuna, southern bluefin tuna, longtail tuna and eastern Pacific bonito) and it also includes some rare papers. The opportunities provided by the web are improving the number of available articles on these species and their fisheries.

In most of the cases, when checking a document, it was possible to discover additional literature which was previously not available, transforming a part of this work as a continuous journey following Ariadne's thread.

At the same time, during this bibliographic research, it was amazing to learn so many additional details about these species. Going through the various titles (and the text behind) in the bibliography, it is possible to find important information on many aspects of their life history and fisheries.

This work provides a list of 88 papers, all published between 1884 and 2020 (Fig. 1). Very generic references to tropical tuna species sometimes exist or can be suspected in older papers, even in the sixteenth century, but they are too imprecise and generic, and therefore, these works were not listed in this bibliography. The very first specific reference is by Premi (1884), followed by Pavesi (1887). No papers on tropical tunas were published in the first two decades of the twentieth century, 1 paper was published in the '20s, 4 papers were published in the '30s, when several fish were imported to Italy from the Italian colonies or from the Atlantic Ocean and when there was a specific interest from the tuna industry. Again, there was another decade without any paper in the '40s, due to the 2nd

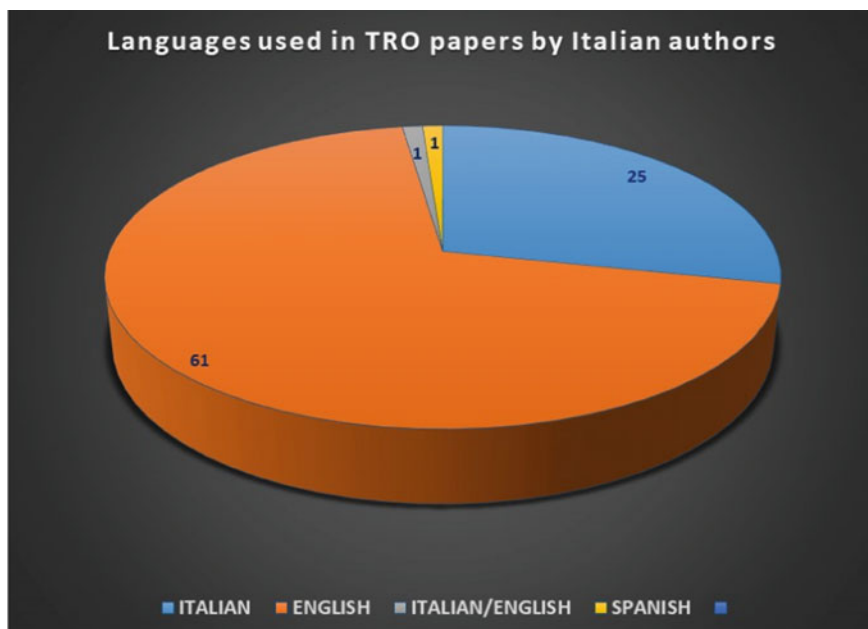


**Fig. 1** Number of the papers published on tropical tunas species by Italian authors over the years

World War. The Italian scientific production on tropical tunas very slowly resumed after the '40s, smoothly growing till the '90s, when 9 papers were published. Then, due to the growing scientific and commercial interest, 18 papers (20.45%) were published between 2000 and 2009, peaking at 39 papers (43.32%) in the last decade, mostly due to conservation issues. Additional 8 papers were published in 2020.

Most of the references (61 papers, 69.32%) are in English, mirroring the fact that the majority of the papers were published in very recent years. 25 papers (28.41%) are in Italian because these papers were published when the Italian language was mandatory, or when foreign languages were not used, or because they were Italian official domestic reports, and likely this fact makes them less usable. The remaining 2.27% of the papers are written in Spanish or in Italian/English (1 paper each). Figure 2 provides a graphic image of the languages used by the Italian authors in papers on tropical tunas which are listed in this annotated bibliography.

The annotations allow identifying most of the many themes included in each paper. Tables 1a and 1b shows the most relevant themes in the annotations and it is interesting to see how many aspects of the tropical tunas have been examined by the various Italian authors. Most of the papers are specifically related to the Atlantic Ocean (57 papers, 64.77%), but the studies include also the Pacific Ocean (47 papers, 53.41%), the Indian Ocean and the Mediterranean Sea (42 papers each, 47.73% each) and the Red Sea (3 papers, 3.41%).



**Fig. 2** Graphic proportion of the different languages used by Italian authors in papers related to tropical tunas

**Table 1a** Percentages of the different themes included in the annotations to the Italian bibliography on tropical tunas (first part)

Annotations			Annotations		
Theme	No	%	Theme	No	%
Nomenclature	5	5.68	Feeding	1	1.14
Official species names	1	1.14	Trophic chain	1	1.14
Systematics/synonyms	3	3.41	Stomach contents	1	1.14
Dictionary/glossary	2	2.27	Diet	1	1.14
Bibliography	3	3.41	Nutritional value	2	2.27
Species identification	2	2.27	Fish/flesh quality	6	6.82
Tropical tunas	16	18.18	Analyses	16	18.18
Scomberomoridae	1	1.14	Genetic	14	15.91
Skipjack tuna	26	29.55	DNA	7	7.95
Black skipjack	4	4.55	Genome	5	5.68
Yellowfin tuna	41	46.59	Bioaccumulation/contaminants	7	7.95
Bigeye tuna	22	25.00	Heavy metals	9	10.23

(continued)

**Table 1a** (continued)

Annotations			Annotations		
Theme	No	%	Theme	No	%
Albacore tuna	22	25.00	Mercury/Hg	9	10.23
Southern bluefin tuna	15	17.05	Food safety/security	10	11.36
Pacific bluefin tuna	10	11.36	Fleets/vessels	6	6.82
Blackfin tuna	4	4.55	Fishing gear	6	6.82
Longtail tuna	6	6.82	Fishing technique/strategy	5	5.68
Dogtooth tuna	1	1.14	Gear technology	5	5.68
Narrow-barred Spanish mackerel	4	4.55	Longlines	20	22.73
West African Spanish mackerel	3	3.41	Purse seine	14	15.91
Serra Spanish mackerel	2	2.27	Traps	10	11.36
King mackerel	3	3.41	Hand line/Troll line	9	10.23
Indian Spanish mackerel	1	1.14	Small-scale or artisanal fishery	4	4.55
Cero	2	2.27	Catches/yield	5	5.68
Wahoo	5	5.68	Statistics	3	3.41
Eastern Pacific bonito	3	3.41	Experimental fishery	3	3.41
Morphology	2	2.27	Fishery research	1	1.14
Description	2	2.27	Gear conflicts	1	1.14
Distribution	9	10.23	Gear impact	6	6.82
Migrations	9	10.23	Stocks	5	5.68
Populations	3	3.41	Stock assessment	3	3.41
Behaviour/Ethology	5	5.68	Stock structure	4	4.55
Biology	12	13.64	Tagging	4	4.55
Reproductive biology	3	3.41	Electronic/Satellite tagging/PSAT	4	4.55
Sex ratio	2	2.27	Conventional tagging	1	1.14
Reproduction	7	7.95	Environment	2	2.27
Gonads	2	2.27	Environmental impact	3	3.41
Gonado-somatic index	1	1.11	Oceanography	2	2.27
Spawning	7	7.95	Conflict with other activities	1	1.14
Fecundity	2	2.27	Gear impact	2	2.27
Eggs/oocytes/larvae	1	1.14	By-catch	7	7.95
Recruitment	1	1.14	Management	10	11.36
Juveniles	2	2.27	RFMO(s)	6	6.82
Growth	2	2.27	ICCAT	2	2.27
Size frequencies	2	2.27	IATTC	2	2.27

**Table 1b** Percentages of the different themes included in the annotations to the Italian bibliography on tropical tunas (second part)

Annotations			Annotations		
Theme	No	%	Theme	No	%
IOTC	2	2.27	Turkey	3	3.41
FAO	1	1.14	United Kingdom	1	1.14
IUCN	16	18.18	Economy	7	7.95
Laws/rules	1	1.14	Economic problems	3	3.41
Regulations	4	4.55	Socio-economy	3	3.41
Tuna conservation	1	1.14	Markets	18	20.45
Conservation status	15	17.05	Costs	1	1.14
IUU	2	2.27	Price	3	3.41
Tropical oceans	4	4.55	Farming/Caging/Fattening/Rearing	5	5.68
Atlantic ocean	57	64.77	Captive/Artificial breeding	2	2.27
Eastern Atlantic ocean	1	1.14	Industry	19	21.59
Western Atlantic ocean	5	5.68	Processing plants	1	1.14
Gulf of Guinea	2	2.27	Canning/canned	15	17.05
Indian ocean	42	47.73	Salted products	4	4.55
Pacific ocean	47	53.41	Dried products	1	1.14
Mediterranean sea	42	47.73	Smoked products	1	1.14
Red Sea	3	3.41	Seafood mislabelling	1	1.14
Persian Gulf	2	2.27	Seafood	4	4.55
Canary Islands	1	1.14	Pet food	1	1.14
European union	2	2.27	Packaging	2	2.27
Ivory coast	2	2.27	Loins	2	2.27
Mauritania	3	3.41	Trade	19	21.59
Morocco	4	4.55	Import	14	15.91
Nigeria	2	2.27	Export	13	14.77
Senegal	3	3.41	Consumption/Consumers	3	3.41
United States of America	2	2.27	Traceability	2	2.27
Australia	3	3.41	Sustainability	3	3.41
Canada	1	1.14	Social problems	4	4.55
Chile	2	2.27	Social science	1	1.14
Croatia	5	5.68	Anthropology/Ethno-anthropology	2	2.27

(continued)



**Table 1b** (continued)

Annotations			Annotations		
Theme	No	%	Theme	No	%
Djibouti	1	1.14	Census	1	1.14
France	5	5.68	Fishermen	6	6.82
Germany	1	1.14	Fishermen villages	3	3.41
Indonesia	1	1.14	Traditions	4	4.55
Italy	23	26.14	Culture	3	3.41
Japan	5	5.68	History	9	10.23
Madagascar	2	2.27	Phoenicians	2	2.27
Malta	5	5.68	Greeks	2	2.27
Mexico	1	1.14	Romans	3	3.41
Mozambique	1	1.14	Arabs	1	1.14
Peru	1	1.14	Middle Ages	3	3.41
Somalia	1	1.14	Modern Age	31	35.23
Spain	6	6.82	Food habits	3	3.41
Tunisia	3	3.41	Recipes	2	2.27

The various countries concerned are also identified, with a majority of papers concerning Italy (23 papers, 26.14%), 6 papers related to Spain (6.82%), and then Croatia, France, Japan and Malta, with 5 papers each (5.68% each); other 21 countries are less mentioned. Among these species, the yellowfin tuna is included in 41 papers (46.59%), the skipjack tuna is mentioned in 26 papers (29.55%), the big-eye tuna and the albacore tuna are mentioned in 22 papers each (25% each), the southern bluefin tuna is mentioned in 15 papers (17.05%), the Pacific bluefin tuna is mentioned in 10 papers (11.36%), while the other species are less mentioned.

The fishing methods also have a clear relevance: the longline fishery is mentioned in 20 papers (22.73%), the purse-seine fishery is mentioned in 14 papers (15.91%), the traps are mentioned in 10 papers (11.36%) and the line fisheries (hand lines and troll lines) are mentioned in 9 papers (10.23%), while the other fisheries are less represented. Conflicts with other activities are mentioned in just 1 paper (1.14%), while the various impacts caused by the gears are mentioned in 6 papers (6.82%); by-catch is reported in 7 papers (7.95%).

The biology is included in 12 papers (13.64%), but the generic analyses (16 papers, 18.18%) and genetic studies (14 papers, 15.91%) are more relevant; food safety or security is the subject of 10 papers (11.36%), heavy metals and mercury are mentioned in 9 papers each (10.23% each) and bioaccumulation or contaminants are mentioned in 7 papers (7.95%); all these issues are very important for the tuna canning industry.

The management is included in 10 papers (11.36%), generic RFMOs are mentioned in 6 papers (6.82%), stock structure is mentioned in 4 papers (4.55%), while the conservation status concerns 15 papers (17.05%) and IUCN is mentioned in 16 papers (18.18%).

The tuna trade and the tuna industry are reported in 19 papers each (21.59% each), the markets are reported in 18 papers (20.45%), the canning industry is reported in 15 papers (17.05%), while several aspects of the tuna economy are also mentioned in various papers. The social problems are mentioned in 4 papers (4.55%), while social sciences, traditions, history, fishermen, food habits, culture and many other themes are also included in other papers.

Table 2 shows the ranking of the main authors included in the Italian annotated bibliography on tropical tunas, over a total of 146 authors. Based on the institutional workplace of each author, it is very clear that the most of the authors are

**Table 2** List and ranking of the main authors included in the Italian annotated bibliography on tropical tunas

Ranking	Author	Number of TRO papers
1	Di Natale Antonio	25
2	Pecoraro Carlo	11
3	Tinti Fausto	5
4	Cariani Alessia	4
4	Valsecchi Adolfo	4
5	Bini Giorgio	3
5	Catanese Gaetano	3
5	Del Caro Alessandra	3
5	De Metrio Gregorio	3
5	Franco Mario Andrea	3
5	Menghini Vittorio	3
5	Sferlazzo Gianvito	3
5	Valetti Bruna	3
6	Anastasio Aniello	2
6	Arena Pasquale	2
6	Babucci Massimiliano	2
6	Bargelloni Luca	2
6	Bernardi Christian	2
6	Cattaneo Patrizia	2
6	Corriero Aldo	2
6	Deflorio Michele	2
6	Franch Raffaella	2
6	Ottolenghi Francesca	2
6	Papetti Chiara	2
6	Piccinetti Corrado	2
6	Serra Antonio	2
6	Tirioni Enrica	2
Anonymous author(s)		
1		

belonging to the four main research centres targeting the large pelagics in Italy: Messina, Bologna-Fano, Genova and Bari, where Universities and other research institutes were historically located. Among the authors, there are most of the Italian national research coordinators for the large pelagics over the years (Arena, De Metrio, Piccinetti and Di Natale). Just one paper is by an anonymous author(s).

Due to the number of references, the Italian annotated bibliography on tropical tunas is provided in Annex 1 to this paper.

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## 4 Conclusion

This work was able to find also the several scientific expeditions carried out by Italian scientists on tropical oceans, such as those by Bini in the Atlantic Ocean (1931 and 1936) and in the Pacific Ocean (1952), by Ninni in the Red Sea (1931) and by Arena in West African waters (1964 and 1967), papers that are usually never mentioned by foreign scientists working on tropical tunas. Therefore, listing them in this annotated bibliography is somehow important.

Even if it is evident that the tropical tunas have been not the main scientific interest of Italian scientists, it is clear that several research activities have been conducted on many species, mostly in the last century. The list of scientific papers on tropical tunas here provided is still certainly incomplete but the aim of this work is also to further stimulate scientists to provide additional titles, with the purpose to create a very complete reference list to be used by all the researchers working on these species or on related subjects, for helping them in their work.

It is sure that additional documents are certainly existing, but it was not possible to find them during this bibliographic research. Indeed, this is a never-ending work and possibly this work will be never completed.

In recent years many scientists and particularly (but not only) young researchers are adopting a sort of selective attitude when they prepare their papers, avoiding even to mention papers that were not published in peer-review journals or by scientists who are competing with them. This attitude is clearly causing a serious scientific problem because there are several very recent papers that are not at all using the knowledge available so far, which sometimes means forgetting an important part of the scientific knowledge and culture we already have.

Clearly, this paper can improve the knowledge on available Italian studies on tropical tunas and this annotated bibliography was made exactly for providing a helping hand to all the colleagues working on these species.

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## Annex 1: Annotated Italian Bibliography on Tropical Tunas (TRO)

1. Anonymous, 1927. La produzione di pesci in iscatola negli Stati Uniti durante l'anno 1926. Boll. Pesca Piscic. Idrobiol., 3 (5): 17–18.
  - i. Tuna industry, canned tuna, production, export, tropical tunas, *Thunnus* spp., United States, Atlantic Ocean, Pacific Ocean.

2. Arena P., 1964. Missione di studio sulla pesca in Africa Occidentale. Rapporto al Centro Sperimentale della Pesca, Messina: 1–85.
  - i. Experimental fishery, exploratory fishery, fishery research, bottom trawl fishery, coastal fishery, pelagic fishery, longline fishery, skipjack tuna, *Katsuwonus pelamis*, Atlantic little tunny, *Euthynnus alletteratus*, albacora, yellowfin tuna, *Thunnus albacares*, bigeye, *Thunnus obesus*, Morocco, Mauritania, Senegal, Nigeria, West Africa, Gulf of Guinea, western Atlantic Ocean.
3. Arena P., 1967. La pesca del tonno nell'Atlantico intertropicale. Rivista della Pesca, Luglio-Settembre, 3: 536–590.
  - i. Longline fishery, purse-seine fishery, bluefin tuna, *Thunnus thynnus*, skipjack tuna, *Katsuwonus pelamis*, little tunny, *Euthynnus alletteratus*, albacora, yellowfin tuna, *Thunnus albacares*, bigeye, *Thunnus obesus*, Morocco, Mauritania, Senegal, Nigeria, West Africa, Gulf of Guinea, Tropical seas, western Atlantic Ocean.
4. Baiocchi C., Medana C., Dal Bello F., Giancotti R., Aigotti R., Gastaldi D., 2015. Analysis of regioisomers of polyunsaturated triacylglycerols in marine matrices by HPLC/HRMS. Food Chemistry, 166: 551–560. <https://www.sciencedirect.com/science/article/pii/S0308814614009534> <https://doi.org/10.1016/j.foodchem.2014.06.067>.
  - i. Fish oil, tuna oil, algae oil, analyses, mass spectrometry, thermal induced fragmentation, CID MS/MS tag fragmentation, HPLC/HRMS methodology, Omega-3 fatty acids, intestine absorption, polyunsaturated triacylglycerols composition, yellowfin tuna, *Thunnus albacares*.
5. Barbujani F., 1980. I problemi della conservazione e trasformazione dei prodotti ittici. In: Contributo della Pesca alla soluzione del problema alimentare. Atti Conf. Naz. Pesca, CNEL, Roma: 169–190.
  - i. Industry, preserves, canning, import, export, market, distribution, marketing, fish consumption, nutritional value, energy inputs, food safety, frozen products, refrigerated products, vacuum products, dried products, cod, *Gadus morhua*, tropical tunas, bluefin tuna, *Thunnus thynnus*, Italy, Mediterranean Sea, Atlantic Ocean.
6. Bayona-Vásquez N.J., Glenn T.C., Uribe-Alcocer M., Pecoraro C., Díaz-Jaimes P., 2018. Complete mitochondrial genome of the yellowfin tuna (*Thunnus albacares*) and the blackfin tuna (*Thunnus atlanticus*): notes on mtDNA introgression and parafly on tunas. Conservation Genetics Resources, 10 (4): 697–699.
  - i. Genetic analyses, mitochondrial genome, DNA, nuclear loci, parafly, phylogenetic relationship, introgression, genus *Thunnus*, yellowfin tuna, *Thunnus albacares*, blackfin tuna, *Thunnus atlanticus*, Atlantic Ocean.
7. Bernardi C., Tirloni E., Cattaneo P., 2015. Content of methylmercury in swordfish (*Xiphias gladius*), tuna (*Thunnus thynnus* and *Thunnus albacares*) and sharks (*Prionace glauca*, *Mustelus mustelus* and *Isurus oxyrinchus*): Estimation of the exposure on the Italian consumer. Industrie Alimentari, 54: 5–12.

- i. Heavy metals contamination, bioaccumulation, methylmercury, provisional tolerable weekly intake, PTWI, health problems, consumers, swordfish, *Xiphias gladius*, bluefin tuna, *Thunnus thynnus*, yellowfin tuna, *Thunnus albacares*, blue shark, *Prionace glauca*, smooth-hound, *Mustelus mustelus*, shortfin mako, *Isurus oxyrinchus*, Italy, Mediterranean Sea, Atlantic Ocean, Indian Ocean, Pacific Ocean.
8. Bernardi C., Tirloni E., Stella S., Anastasio A., Cattaneo P., Colombo F., 2019.  $\beta$ -hydroxyacyl-CoA-dehydrogenase activity differentiates unfrozen from frozen-thawed Yellowfin tuna (*Thunnus albacares*). Italian Journal of Food Safety, 8 (3): 6971. <https://doi.org/10.4081/ijfs.2019.6971>.
- i. Frozen-thawed tuna, HADH,  $\beta$ -hydroxyacyl-CoA-dehydrogenase activity, fresh-frozen differentiation, formaldehyde, dimethylamine, trimethylamine oxide, import, export, yellowfin tuna, *Thunnus albacares*, Italy, Maldives, Indian Ocean.
9. Bini G., 1931. Rapporto sulla crociera di pesca del tonno compiuta a bordo del piropeschereccio "Orata" nell'Atlantico. Boll. Pesca, Piscic. Idrobiol., 7(I): 57–90.
- i. Experimental fishery, fishing gear, gear technology, longlines, size measurements, yellowfin tuna, *Neothunnus albacora*, *Thunnus albacares*, bigeye tuna, *Parathunnus obesus*, *Thunnus obesus*, Canary Islands, Atlantic Ocean.
10. Bini G., 1936. La pesca oceanica e l'industria del pesce congelato. Boll. Pesca, Piscic. Idrobiol., 12(IV).
- i. Oceanic fishery, trawl fishery, longline fishery, demersal species, fishing industry, frozen fish, yellowfin tuna, *Neothunnus albacora*, *Thunnus albacares*, bigeye tuna, *Parathunnus obesus*, *Thunnus obesus*, Atlantic Ocean.
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- Thunnus thynnus*, albacore, *Thunnus alalunga*, yellowfin tuna, *Thunnus albacares*, blackfin tuna, *Thunnus atlanticus*, southern bluefin tuna, *Thunnus maccoyi*, bigeye tuna, *Thunnus obesus*, Pacific bluefin tuna, *Thunnus orientalis*, long tailed tuna, *Thunnus tonggol*, skipjack tuna, *Katsuwonus pelamis*, Atlantic Ocean, Pacific Ocean, Indian Ocean, Mediterranean Sea.
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- rochei*, Atlantic bonito, *Sarda sarda*, Atlantic little tunny, *Euthynnus alletteratus*, skipjack tuna, *Katsuwonus pelamis*, yellowfin tuna, *Thunnus albacares*, bigeye tuna, *Thunnus obesus*, swordfish, *Xiphias gladius*, Mediterranean spearfish, *Tetrapturus belone*, Italy, Ligurian Sea, Tyrrhenian Sea, Sardinian Sea, Strait of Sicily, Strait of Messina, Ionian Sea, Adriatic Sea, Mediterranean Sea, tropical Oceans.
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