Environmental variability on the distribution, abundances and growth rates of the larvae of bullet tuna.

Pérez-Torres A , Alemany F, and Reglero P.

Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Baleares. Muelle de Poniente s/n, Apdo. 291, Palma de Mallorca, Spain.

Abstract

Small tunas, as bullet tuna (*Auxis rochei*) play a key role in coastal marine ecosystems since they can have a major impact in small pelagic fish stocks. At their larval stages they can interact, as competitors or prey/predators, with other tuna larvae, as those of *Thunnus thynnus* or *T. alalunga*. It is a well known fact that environmentally driven variations in larval survivorship rates, potentially induced by climate changes, can result in large fluctuations in population abundances. Therefore, studies providing information on the ecology of small tuna species larvae are useful to assess both the impact of climate changes on the dynamics of small pelagic fishes and other tuna stocks. Here we provide a review on the information available up to now of this species overall ICES areas, focusing on the distribution, abundances and growth rates of the larvae of bullet tuna. Since water temperature may be of crucial importance in larval stage dynamics we assess/explore the relationship between temperature and distribution patterns and growth of bullet tuna larvae using data obtained within the framework of ichthyoplankton surveys directed to tuna larvae sampling carried out during the last decade off the Balearic islands, recognized as one of the main spawning grounds of tuna species in the Mediterranean. These relationships are compared to other tuna species and other ICES areas where information is available. Our findings highlight the role that temperature plays at these early stages of development and the impact that increasing temperature may have on the distribution and growth of these species, and hence in recruitment success.

Keywords: tuna, coastal ecosystem, bullet tuna, distribution, growth, larvae

Methodology

Auxis rochei, is distributed worldwide in tropical and subtropical waters (1), including ICES areas as atlantic coast of Iberian Peninsula, isolated records from the British Islands and coasts of Belgium and Scandinavia (2). *Auxis rochei* larvae were captured off Balearic Islands (Western Mediterranean) within the framework of an ichthyoplankton survey carried out between 29th July and 11th August 2008, by means of double oblique tows from the thermocline to surface realized with Bongo 90 nets fitted with 500 microns meshes. CTD (Seabird-911) casts were performed at each station to characterize hydrographic scenario. Plankton samples, after sieving, were preserved in 96% ethanol. In the lab, fish larvae were picked up and identified at species level. Standard lengths (SL) of the target species were measured to the nearest 0.1 mm with an Image Analysis System (Image-Pro). Shrinkage, on average, may be as 7 %, based on estimates for others genders of fish larvae preserved in ethanol (3) but since all samples were preserved following the same methodology, it was assumed that the shrinkage would not influence the comparison of growth rates among analyzed specimens. Sagittae and lapilli otoliths were teased out with tungsten needles down stereostopic microscope, being the larvae placed on a cover glass submerged in distilled water. The otoliths were dried and sealed with resin "Eukitt". Then, the sagitta otoliths were analyzed under a light microscope at 1000 magnifications. Daily rings were counted, measuring their widths and distance to otolith center, using an Image Analysis System based on the software Image-Pro. Once agreed the lecture criteria, each otolith was read independently by two different readers.

Image 1. *Auxis rochei* larvae with 5.09 mm SL and 9 days of life

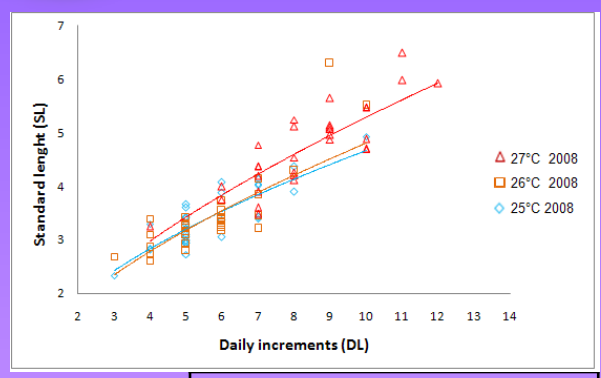

Fig. 1 and Table 1. Temperature effect in Bullet tuna larvae growth rates

Year	Tº C	Potential	p-value	R^2
2008	27	$SL = 1{,}240DL^{0{,}629}$	0,001	0,71
2008	26	$SL = 1{,}220DL^{0{,}594}$	0,001	0,68
2008	25	$SL = 1{,}327DL^{0{,}547}$	0,001	0,71

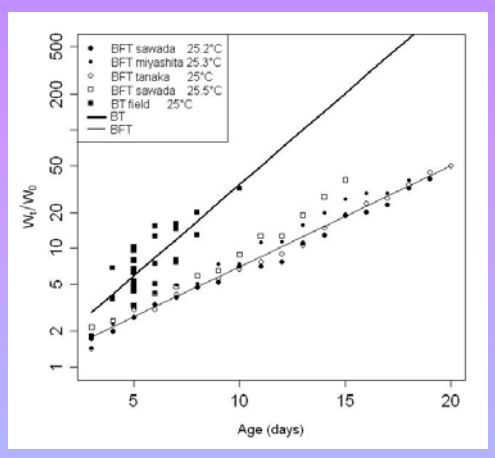

Fig. 2. The weight at age relative to the estimated initial weight. The symbols are the estimated data from different laboratory experiments with Bluefin tuna (*T thynnus*) larvae (4). The black squares are our observations for BT at 25 °C from otolith data. The continuous lines represent the fits for bullet and bluefin tuna.

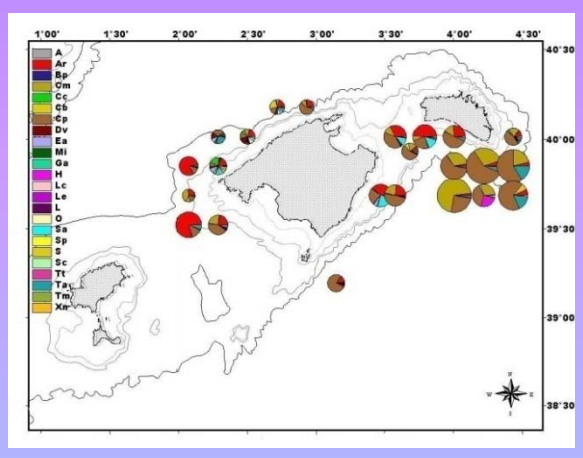

Image 2. Map of spatial distribution bullet tuna larvae within the community during summer 2008 in Balearic Islands. Bullet tuna print in red

Environmental variable	Yolk-sac and pre-flexion larvae		Flexion and post-flexion larvae	
	Dev. %	UBRE	Dev. %	UBRE
Temperature	6.12	0.31 *	4.16	0.11*
Zooplankton biomass	11	**	2.79	0.11*
Salinity	6.94	0.31 *	1.01	0.14ns

Table 2. Based on GAM models the estimated significance relationship between the presence/absence of two ontogenetic stages, yolk-sac and pre-flexion larvae and flexion and post-flexion larvae with respect to the temperature, zooplankton biomass, and salinity. ns: no significant; *: significant (<0.05); **glm instead of gam

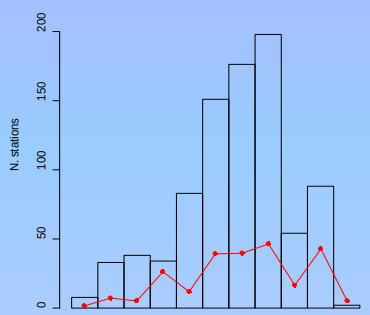

Fig. 2. Results of Single Parameter Quotient analysis considering all the data about average temperature in the upper mixing layer, above the thermocline, and *Auxis rochei* larval abundances calculated from Bongo 60 standard oblique tows, available from Tunibal surveys carried out annually from 2001 to 2005.

Results & Conclusions

Bullet tuna is the tuna species among Bluefin tuna and albacore whose larval stages are more ubiquitous and show the highest abundances. Results from previous studies (5) indicate that bullet tuna larvae can be found in a wider range of temperatures than other tuna larvae, from 18.5 to 28.5, but showing preference for temperatures over 23.5ºC. The larvae analyzed in this study showed SL vs age potential relationships and the temperature had a clear positive influence on the growth rates, as have been widely reported (6). The GAMs show how the presence of yolk-sac and pre-flexion larvae have a positive relationship with temperature, salinity and highest with zooplankton biomass, although the flexion and post-flexion larvae only have it with temperature and zooplankton biomass. Bullet tuna had higher growth rates compared to laboratory estimates from the literature for Bluefin tuna.

Since recruitment variability has been related to early larval and juvenile growth (7), higher temperatures in the surface layers where tuna larva inhabits could result in higher growth rates if food is not limiting and hence in higher recruitment success.

Bibliography

1. Field Manual ICCAT. Chapter 2.1.11.2 Bullet tuna
2. Fishes of the North-eastern Atlantic and the Mediterranean. Unesco
3. Fowler and Smith, 1983; Kruse and Dalley, 1990; Jennings, 1991
4. Tanaka et al 2008, Sawada et al. 2005 Miyashita et al 2001
5. Alemany et. al 2008 (Acceptet)
6. Chambers and Legget, 1987
7. Houde, 1987, 19889

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