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COMPARISON BETWEEN THE ESTIMATED REPRODUCTIVE STOCKS OF BLUEFIN TUNA (I. THYNNUS) OF THE GULF OF MEXICO AND WESTERN MEDITERRANEAN

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SUMMARY

This study shows a comparison of data, obtained in the evaluation of reproductive populations of bluefin tuna (T. thynnus L.) in the Gulf of Mexico and in the western Mediterranean, after five ichthyoplankton cruises made by several researchers. (See bibliography)

The equipment for taking samples, the methodology used on the different vessels, as well as the number of seasons and area covered by each cruise are similar in all aspects, making their comparision possible as well as interesting.

The results are presented in Table 1.

It is not believed that the mortality rates considered (0.90, 0.99, 0.999), between the egg and the larva of 5 mm in length--which is the average size--are at all exaggerated, especially if the quantity of eggs that can be spawned by the tuna and the sensitivity of the first stages of development are taken into account and if it is assumed, also, that the population remains balanced.

From this comparison, it results that the reproductive stock of the Gulf of Mexico is larger than that of the Mediterranean and is less variable. The two spawning areas are very important and can support the hypothesis of two separate stocks in the Atlantic.

RESUME

Le travail recueille une comparaison de données obtenues dans l'évaluation des populations reproductrices du thon *T. thynnus L.*) dans le golfe du Mexique et de la Méditerranée occidentale, au cours de cinq campagnes réalisées par des chercheurs en ichtyoplancton (voir bibliographie).

Le matériel employé dans la prise d'échantillons, la méthodologie suivie dans les différentes croisières, ainsi que le numéro de stations et la zone couverte lors de chaque campagne, est similaire dans tous les travaux, ce qui nous semble intéressant et fait possible sa comparaison.

Les résultats sont présentés dans le tableau 1.

Nous ne croyons pas que les mortalités considérées entre l'oeuf et la larve de 5 mm de long -qui est la taille moyenne des capturées- de 0.90, 0.99 et 0.999 soient absolument exagérées, surtout si nous n'oublions pas la quantité d'oeufs dérivés de la ponte du thon, la faiblesse des premiers stades du développement, et nous considérons en outre que la population conserve l'équilibre.

De cette comparaison se dégage que le stock reproducteur du golfe du Mexique est plus grand et moins variable que celui de la Méditerranée.

RESUMEN

En este trabajo se expone una comparación de datos, obtenidos en la evaluación de las poblaciones reproductoras de atún (T. thynnus L.), en el Golfo de Méjico y en el Mediterráneo occidental, a través de 5 campañas de ictioplancton de varios investigadores. (Ver bibliografía).

El material utilizado en la toma de muestras, la metodología seguida en los distintos cruceros, así como el número de estaciones y área cubierta en cada campaña, es similar a todos los trabajos, por lo que nos ha parecido interesante y posible su comparación.

Los resultados se presentan en la tabla 1.

No creemos que las mortalidades consideradas, entre el huevo y la larva de 5mm de longitud- que es la talla media de las capturas- de 0.90, 0.99 y 0.999, sean en absoluto exageradas, sobre todo, si tenemos en cuenta la cantidad de huevos que puede llegar a desovar el atún, lo delicado que son estos primeros estudios del desarrollo y asumimos además, que la población se mantiene en equilibrio.

De esta comparación se desprende que el stock reproductor del Golfo de Méjico es mayor que el del Mediterráneo y menos variable. Las dos zonas de puesta son importantes y podrían apoyar la hipótesis de dos stocks separados para el Atlántico.

INTRODUCTION

During the past few years, we have seen published a number of documents dealing with the spawning areas and spawning intensity of the bluefin (Thunnus thynnus L.) in the Gulf of Mexico and the Western Mediterranean Sea. Most of them have appeared as Collected Scientific Papers of the SCRS (ICCAT).

In all of them the main objective is to assess the reproductive stock of bluefin tuna, based on data collected at sea from larval abundance.

There is also the problem of whether there is one or two stocks of bluefin in the Atlantic. Althought we have seen documents which show some degree of inter-mixing, from the East and West stocks, by tagging experiments, the problem is not as yet solved. On the other hand there are two spawning areas known for the Atlantic and Mediterranean, one in the Gulf of Mexico and the other in the Western Mediterranean, that could suport the idea of two separated stocks. There may also be a third spawning area in the Gulf of Guinea (see Richards 1975), or in the Ibero-Marroqui Bay, but none of those are well known yet.

We thought it will be most interesting to gather in one document those evaluations and to compare them .

All authors agreed that such a comparison could be most interesting.

METHODOLOGY

The documents we have used for this comparison have been:

- Richards, W.J., 1976, "Spawning of bluefin tuna (Thunnus thynnus) in the Atlantic ocean and adjacent seas". SCRS/75/97, ICCAT Col. Vol. Sc. Pap., vol. V, p. 267.
- Montolio, M. and M. Juarez, 1977, "El desove de Thunnus thynnus en el Golfo de México, estimado preliminar de la magnitud de la población en desove a partir de la abundancia de sus larvas". SCRS 76/68, Coll. Vol. Sc. Pap., vol. VI (SCRS--1976), pp. 337.
- Richards, W.J., 1977, "Distribution and abundance of bluefin tuna larvae in the Gulf of Mexico". SCRS/77/47; ICCAT Working Document.
- Dicenta, A. 1977, "Zonas de puesta del atún (Thunnus thynnus L.) y otros túnidos del Mediterráneo occidental y primer intento de evaluación del "stock" de reproductores de atún". Bol. Ins. Espa. Oceanogr. t. II, nº 234, pp. 110.
- Dicenta, A. y C. Piccinetti, 1978, "Desove del atún (Thunnus thynnus L.) en el Mediterráneo occidental y evaluación directa del stock de reproductores, basado en la abundancia de sus larvas." SCRS/77/33, ICCAT Coll. Vol. Sc. Pap. vol.VII (SCRS-1977), pp. 389.

The basis for this comparison are:

a) all the surveys have used a similar methodology for the collection of ictioplankton samples at sea. The plankton nets for quantitative sampling were the FAO or Bongos 60, in doble oblique tows.

b) The area surveyed is also similar except for Richards document of 1975, based on data from a Cuban cruise that took place in April and May 1973, in which case the area was smaller.

c) The number of stations in each survey is also comparable ranging from 46 to 57 stations, and each satation has more or less a si

milar surface.

d) The spawning times for the two areas surveyed show some differences. In the Gulf of Mexico, spawning starts by the second half of April or the beginning of May and last untill the end of June, while in the Mediterranean it starts at mid June and last untill mid August. We have taken 60 days as the length of the spawning season in both areas, and we believe it is within this time that more than 90 % of the spawning for bluefin tune take place.

To evaluate the female adult population of bluefin tuna from a larval survey, (since we have no posibility to identify the eggs once they are fixed in formol), we use the following expression:

$$P = \frac{n \cdot t}{e \cdot f}$$

where n is the total number of larvae in the area surveyed, t is the spawning period, e is the estimated age of the average larvae captured, and f is the fecundity. P is expressed in weight (grams) and to account for the male part of the stock we have to multiply P by the sex ratio, to arrive at the total biomass of the reproductive stock.

To calculate n, we multiply the larval density per square meter per day times the area of the positive stations.

The estimated spawning time (t) is 60 days.

To estimate e, we take the average length of the larvae captured (around 5 mm TL) and we assumed an age of 10 days for those larvae. From rearing experiments we have seen that by the time they have finished their yolk sac absortion they reach a length of about 4 mm TL, 6 to 7 days after the eggs have been spawned.

We have calculated the fecundity f, on data based on Rodriguez-Roda (1967) paper. The fecundity given is in the order of 120 eggs per gram of body weight.

Finally we have assumed a sex ratio of 1: 1.

The final biomass calculated for the stock does not take into consideration the mortality that takes place between the egg stage and the 5 mm larvae.

RESULTS

The results are exposed on table 1.

Each of the parameters taken into consideration are on the first column of the table. On the top of each column appears the author and, in brackets, the year of the publication.

Some of the presented data do not agree with those of the document mentioned but it is due to the following reasons:

1.- The areas shown on table 1 include only the area covered by the positive stations.

2.- The area for each station on Richards (1975) paper is different in the sense that, the number of units of 100 m^2 per station is not 8.57×10^5 (see table 1, column 2 of his paper) but 8.57×10^7 by looking at the area surveyed (see fig. 2 of his paper).

3.- The area standard for each station in Montolio and Juarez (1977), has been also corrected, and it is not 11.32×10^7 (see column 2, table 1 of their paper) but 11.32×10^9 by looking at their fig. 1 of the same paper. From this viewpoint we are not able to know the total number of larvae in their paper.

	Richards (75)	Montolio & Juarez (77)	Richards (77)	Dicenta (77)	Dicenta & Piccinetti (78)
Year of survey	1973	1974	1977	1975	1977
Number of stations	46	46	48	52	57
Number of positive stations	13	22	15	15	29
Area covered by positive st. (m^2)	111.48×10^9	249.04×10^9	226×10^9	227.17×10^9	333.32×10^9
Larval density/m^2	2.82		1.43	0.53	0.20
Total number of larvae	3.14×10^{11}		3.23×10^{11}	1.2×10^{11}	0.65×10^{11}
Total Biomass (Mortality=0) (in metric tons)	31,437		32,318	12,040	6,670
Total Biomass of the reproductive stock (in metric tons), considering:					
Mortality: 0.90	314,370		323,180	120,400	66,700
0.99	3,143,700		3,231,800	1,204,000	667,000
0.999	31,437,000		32,318,000	12,040,000	6,670,000

Table 1.- Evaluation of total biomass for the reproductive stock of bluefin tuna, considering different mortalities. Results of comparison of data from different papers. Those of Richards, Montolio & Juarez are from the Gulf of Mexico and those of Dicenta and Dicenta & Piccinetti from the Mediterranean.

The results of total biomass are expressed in metric tons and are obtained by the simple application of the above mention, expression P multiplied times two to account for the sex ratio of 1:1.

For example, taking Dicenta and Piccinettis 1978 data, we have:

$$P = \frac{0.20 \times 333,32 \times 10^9 \times 60}{10 \times 120} = 3,34 \times 10^9 \text{ grams}$$

which is the female reproductive stock. The total biomass will be:

$3,34 \times 10^9 \times 2 = 6,670$ metric tons

considering that there is no mortality between the egg spawned and the 5 mm larvae.

DISCUSSION

The most important parameters in assessing the biomass of the reproductive stock by means of larval surveys is, no doubt, the mortality produced between the eggs just spawned and the average length of the larvae captured.

We believe that this mortality has to be very high on several considerations:

1.- The fecundity of this species is enormous, in the order of 5 to 30 millions eggs spawned per female per year.

2.- The early stages of the life of any fish are the most delicate, suffering a high mortality at those stages and particularly those species with high fecundities.

3.- If the population we consider is in equilibrium, that means that only two of all the eggs spawn per female during her life span, will reach the stage of adult fish.

On those premises we believe that we have taken a very conservative approach by taking mortalities of 0.90 - 0.999.

If the fecundity of the bluefin tuna were to be reduced, because not all of the eggs of the ovary are spawned, or other reasons, then we are subestimating the stock.

On the contrary if the spawning time were to be reduced -to 30 days instead of 60, for instance- then we are over estimating such a population.

But nevertheless as I mention before, the main parameter to take into consideration is the mortality produced between the egg and larvae. In all documents that we have used for this comparison, this mortality is assumed but not known. The mortality for anchovy eggs, in the Adriatic sea, was in the order of 0.98 (Piccinetti). In the Gulf of Vizcay it was, for this same species, in the order of 0.98 June 1978. (Dicenta, in press). In rearing experiments with Thunnus albacares, in a one ton tanks (Mori et al., 1971) the mortality, after 8 to 9 days, was close to 0.99.

Finally, from table 1 we see that the bluefin tuna stock from the Gulf of Mexico seems to be rather fixed throughout the years, while that of the Mediterranean sea, appears more variable and subject to higher oscillations. Besides, the magnitude of the spawning population seems to be more important in the Gulf of Mexico than in the Western Mediterranean.

CONCLUSIONS

We present -on table 1- a comparison of some estimates of the reproductive stocks of bluefin tuna, for the Gulf of Mexico and the Western Mediterranean, based on ictioplankton surveys.

From that comparison it will seem that the adult stock is much higher in the Gulf of Mexico than in the Mediterranean, and less variable.

Both spawning areas seems to be important and could support the hypothesis of two separated stocks for the Atlantic.

BIBLIOGRAPHY

DICENTA, A., 1977, "Zonas de puesta del atún (Thunnus thynnus L.) y otros túnidos del Mediterráneo occidental y primer intento de evaluación del stock de reproductores de atún". Bol. Ins. Espa. Oceanogr. 2, (234) p. 110.

DICENTA, A. y C. PICCINETTI, 1978, "Desove del atún (Thunnus thynnus L.) en el Mediterráneo occidnetal y evaluación directa del stock de reproductores, basado en la abundancia de sus larvas". SCRS/77/33, ICCAT, Coll. Vol. Pap., vol. VII (SCRS-1977). p. 389.

MONTOLIO, M. and M. JUAREZ, 1977, "El desove de Thunnus thynnus thynnus -Estimado preliminar de la magnitud de la población en desove a partir de la abundancia de sus larvas". SCRS 76/68, Coll. Vol. Sc. Pap., Vol.VI (SCRS-1976), p. 337.

RICHARDS, W.J., 1976, "Spawning of bluefin tuna (Thunnus thynnus) in the Atlantic ocean and adjacent seas". SCRS/75/97, ICCAT Coll. Vol. Sc. Pap., vol. V, p. 267.

RICHARDS, W.J., 1977, "Distribution and abundance of bluefin tuna larvae in the Gulf of Mexico". SCRS/77/47, ICCAT Working Document.