SCI. MAR., 59(3-4): 399-403 SCIENTIA MARINA 1995

INTERNATIONAL SYMPOSIUM ON MIDDLE-SIZED PELAGIC FISH. *C. BAS, J.J. CASTRO and J.Mª. LORENZO (eds.).*

Distribution model and association in three pelagic congeneric species (*Trachurus* spp.) present in the Iberic Mediterranean Sea*

D. LLORIS[1] and T. MORENO[2]

[1]Instituto de Ciencias del Mar, (C.S.I.C.), Passeig Joan de Borbó, s/n. 08039, Barcelona, Spain.
[2]Universidad de Las Palmas de Gran Canaria, Facultad de Ciencias del Mar, Apdo. 550, 35017 Las Palmas de G. C. Spain.

SUMMARY: The total number of fish species catalogued for the Iberic Mediterranean Sea (Balearic and Alboran Sea), consists of 519 which are found throughout the year or are seasonal in the water column and at the bottom ranging between 0 and 1050 meters deep. The above mentioned depth range is where the three congeneric species belonging to the family Carangidae (*Trachurus mediterraneus, Trachurus picturatus* and *Trachurus trachurus*), considered as middle-sized pelagic fishes, develop their respective life cycles. These species may overlap in an interval of the water column. This overlapping contributes to obscure their habits in such a way that, from the statistical and fishery point of view, they are usually considered as a single unit (*Trachurus* spp.), thus ignoring their true distributional pattern. In fact, each of the *Trachurus* species is very precisely related with a group of fish acting as indicators of a particular niche. This diversity makes the differentiation among habitats a way to distinguish the different *Trachurus* species, and thus attenuates any kind of intercongeneric competition or rivalry.

Key words: Trachurus, distribution, interspecific association, competition, Mediterranean Sea.

RESUMEN: MODELO DE DISTRIBUCIÓN Y ASOCIACIÓN DE TRES ESPECIES PELÁGICAS CONGENÉRICAS (*Trachurus* spp.) PRESENTES EN EL MEDITERRÁNEO IBÉRICO. – Del total de especies de peces inventariadas en el Mediterráneo occidental ibérico (mares de Alborán y Balear), 519 se encuentran a lo largo del año o estacionalmente en la columna de agua y fondos comprendidos entre 0 y 1050 metros de profundidad. El rango de profundidad antes mencionado es aquél en el que las tres especies congenéricas pertenecientes a la familia Carangidae (*Trachurus mediterraneus, Trachurus picturatus* y *Trachurus trachurus*) desarrollan sus respectivos ciclos vitales. Estas especies pueden solaparse, y de hecho lo hacen, en un intervalo de la columna de agua, lo cual contribuye a enmascarar sus hábitos, en el sentido de que, desde los puntos de vista estadístico y pesquero, se consideran generalmente como una sola unidad (*Trachurus* spp.) ignorando, además, su verdadero patrón de distribución. De hecho, cada una de las especies de *Trachurus* se relaciona, con precisión, con un grupo de especies de peces que actúan como indicadores de su nicho particular. Esta diversidad hace de la diferenciación entre hábitats una manera de distinguir las distintas especies de *Trachurus*, atenuando cualquier clase de competencia intercongenérica.

Palabras clave: Trachurus, distribución, asociación interespecífica, competencia, Mar Mediterráneo.

INTRODUCTION

The aim of the present study is to raise attention to certain aspects related to the patterns of distribution and association observed in three congeneric species of the Carangidae family (*Trachurus mediterraneus, Trachurus picturatus* and *Trachurus trachurus*), that are present in the Iberic Mediterranean Sea and are caught by the commercial fishing fleet.

Their special fishing characteristics, abundance and similarities of specific traits and obvious overlapping of their respective habitats in the water

*Received April 15, 1994. Accepted November 15, 1994.

column contribute to the confusion over identification. This is evident when landings are evaluated either at the harbours where the fishery industry is important or through statistics encountered in annual reports. The three congeneric forms are designated by a generic name (*Trachurus* spp.) or a common name (horse mackerel). Therefore, there is no way to analyse the historic data from an individual species approach.

Different studies where sampling is monospecific consider abundance indices, fecundity and growth, but rarely diversity. Most of the studies indicate nothing about their etology and disregard biotic and abiotic relationships with their environment. Furthermore, the completely different diversity spectrums are ignored.

The absence of multispecific ecological studies makes it difficult to know the role that each population plays within the community, despite overall exploitation of the family.

The present study reports new data on the depth distribution of *Trachurus trachurus* and develops a different treatment of interspecific competition as an indicator of the success or equilibrium in the spatial and temporal distribution. A final model of distribution patterns is proposed.

MATERIAL AND METHODS

The information used has been taken from samplings conducted during different projects and cruises (MEDITERRÁNEO II, MAIRE, TRANSFER, BATIMAR, PROA, ZONAP, MERSEL 0392, MERSEL 0992, MERSEL 0693), and from data collected on board commercial fishing boats in the Iberic Mediterranean Sea from Algeciras to Creus Cape. The whole study period covers 17 years (from 1977 to 1993).

Scientific nomenclature is used to the specific level, but the species considered correspond to the subspecies: *Trachurus mediterraneus mediterraneus* (Steindachner, 1868), *Trachurus picturatus picturatus* (Bowdich, 1825) and *Trachurus trachurus trachurus* (Linnaeus, 1758) as established by SHABONEYEV (1981).

The influence of parameters such as salinity, temperature and light are not taken into account because these factors are homogenous during the life cycle and only show a seasonal incidence. Similarly, trophic aspects are not included because of the absence of individual species data.

Statistical analyses are based on a 524 x 71 matrix. Rows are composed of all the species catalogued for the Iberic Mediterranean Sea (LLORIS, 1991-1994). The following variables consstitute the columns: Depth from 0 to 2550 m, in 10 m intervals during the first 100 m and 50 m intervals from 100 m onwards; domains (pelagic, mesopelagic and benthic) and eight bottom types (sand, mud, gravel, stones, detritus, coralligenous,...) where all of the species are present.

Depth distributions from samplings of the three species considered were contrasted with information from the literature. Cluster analysis was used to group the different *Trachurus* species. Similarity analysis based on the Jaccard coefficient (NTSYS program, version pc-1.70; ROHLF, 1992) was calculated to find out which species show some affinity with each of the three *Trachurus* species being considered.

RESULTS

According to SHABONEYEV (1981), *Trachurus mediterraneus* is the most thermophylic and neritic of the three congeneric species. The results from cruise samples show that this species was not present beyond 200 or 250 m, although the literature cited it at depths of 500-600 m (HUREAU and TORTONESE, 1973; SMITH-VANIZ, 1986; BAUCHOT, 1987). *T. picturatus* keeps its depth distribution interval from 0 to 370 m. *T. trachurus* is generally considered pelagic and often in the surface waters, common at 100-200 m depth on sandy bottoms, although in some cases it has appeared at 500 m (SMITH-VANIZ, 1986; BAUCHOT, 1987). We have found the latter species in the whole interval comprised between 0 and 1050 m (LLORIS *in* ZONAP project *op. cit.*).

These species have been located on different bottom types. *Trachurus mediterraneus* is generally found over sand and muddy bottoms and in the water column. *T. picturatus*, shows a pelagic and oceanic character that is endorsed by their absence or scarcity in bottom trawls. *T. trachurus* is the most versatile species and is located on coastal bottoms (sand, muddy, stone, coral, detritus), muddy bottoms offshore, and in the water column.

The spawning season of *Trachurus mediterraneus* lasts from July to October and shows a maximum fecundity of 206,000 eggs (CASAPONSA, 1993). *T. picturatus* spawns between June and August with a lower maximum fecundity close to 73,000 eggs (CASAPONSA, 1993). Spawning season of *T. trachu-*

rus spans from April to August and its maximum fecundity is the highest with 585,000 eggs (CASAPONSA, 1993).

The influence of the different combinations of parameters considered for each species determines two types of association (Fig. 1): the first one (Dominion and Bottom) does not differentiate between the species because of similar characters with a redundant significance, since they have been only considered to be swimmer and pelagic species; the second one (Depth; Bottom; Depth and Bottom; Dominion, Depth and Bottom) separates the species indicating habitat diferentiation. Based on the later type of association, two groups of species were found, one of them clustering together *Trachurus mediterraneus* and *T. picturatus* and the other one containing only *T. trachurus* (Fig. 1). Factors such as partial coincidence of spawning season, occupation of the same domain and sharing a near depth interval seem to be the cause that motivates the appearance of *Trachurus mediterraneus* and *T. picturatus* in the first group. This situation could be interpreted as an overlapping between both populations. However, as seen, those factors are due to different diversity spectra that have to be evaluated correctly.

In relation to *T. trachurus*, it maintains some affinities with the other two species, further suggesting overlapping.

Finally, it has been detected that 519 species from the total catalogued for the Iberic Mediterranean Sea are, at certain times of their life cycle, in the same depth interval as any *Trachurus* spp. (from 0 to 1050 m of depth). Only those species with a similarity index up to 0.64 were considered.

The interspecific association index sets *Trachurus picturatus* in the highest rank level; *T. mediterraneus* comes next and then *T. trachurus* is in the lower level (Table 1).

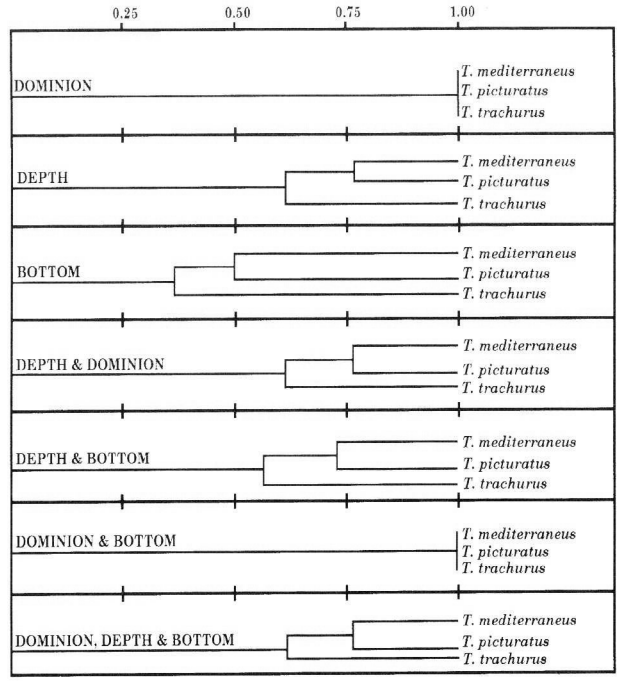

FIG. 1. – Phenograms from cluster analysis.

DISCUSSION

A new model of distribution of the three congeneric species is proposed as an alternative to the classical model based on the partial or total confluence of the spawning periods and the presence or absence of these species in a similar depth interval. Opposite to the overlapping idea, different degrees of organization are shown with independence between these species.

In this model, the interspecific association index is related to the diversity and stability level of the system (Ashby's law); that is, when a system has a high diversity it is less submitted to fluctuations, it leads to longer trophic chains and to a more strict specialitation; it exhibits a more efficient pathway with a tendency to a reduction in the number of offs-

TABLE 1. – Interspecific association index of *Trachurus mediterraneus, T. picturatus and T. trachurus* with species in the same depth interval (from 0 to 1050 m depth).

SPECIES	DOMINION	DEPTH	BOTTOM	DEPTH & DOMINION	DEPTH & BOTTOM	DOMINION & BOTTOM
T. mediterraneus	39	50	19	41	29	22
T. picturatus	39	94	52	85	67	10
T. trachurus	39	28	8	28	29	22

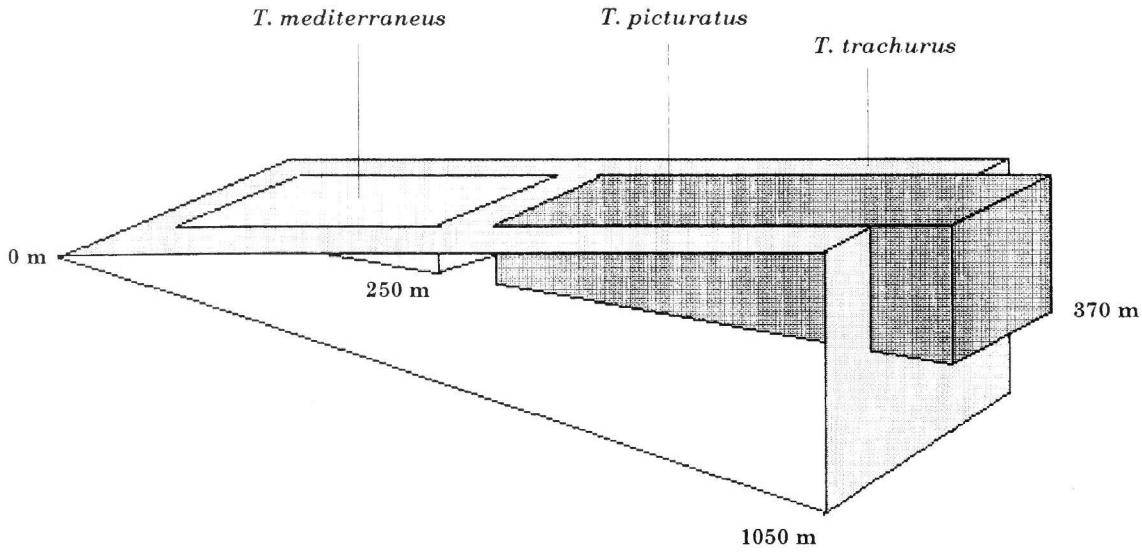

FIG. 2 – Spatial distribution model of the three *Trachurus* spp.

pring (ASHBY, 1954 and 1956 *in* MARGALEF, 1978).

This law applied to the present study, confirms *Trachurus picturatus* as the species with the highest diversity and the lowest fecundity rate; this may indicate a great stability in the environment. *T. mediterraneus* has a fecundity rate three times higher and a lower number of related species due to the fluctuations that affect the coastal areas where it is located.

With respect to *Trachurus trachurus*, it occupies the widest depth interval from 0 to 1050 m and it has the highest fecundity rate of the three species. Both factors may be indicators of its environment. *T. trachurus* can make use of depth intervals that are not used by *T. mediterraneus* and *T. picturatus*. At the same time, its frequency in catches from bottom trawls and the variety of bottom types where it is present, endorse the hypothesis that its activity is developed close to the bottom. If we consider the high fecundity rate of *T. trachurus* and the number of species associated, it should be found in fluctuating systems as it happens with *T. mediterraneus*.

As a conclusion, we point out a graphical model of distribution (Fig. 2) where *Trachurus mediterraneus* is shaped as a neritic species in a coastal environment that it is probably not going to exceed a depth of 250 m. At the same level *T. picturatus* is located offshore between 0 and 370 m in a stable environment; this species is confirmed to be a pelagic species. *T. trachurus* occupies a wider depth interval and it shows a benthic behaviour, at least during day hours. It presence in shore waters is related to vertical migration and to the approach to coastal areas during spawning periods.

Finally, it was found that the relative frequency of appearance of *Trachurus mediterraneus* and of *T. picturatus* together with *T. trachurus* can be interpretated based on co-ocurrence with other shoaling species (*Scomber, Sardina, Engraulis*) that in general are individuals moved away from the spawning areas.

ACKNOWLEDGEMENTS

We want to thank all the colleagues and technicians that have contributed to the different samplings collected at the different cruises, but especially We want to acknowledge LUÍS GIL DE SOLA, biologist in the I.E.O. (Málaga Centre) who invited the first author to take part in his cruises in the Alboran Sea. This helped the author to gain experience as well as to confirm the methodology used to obtain the data. We also wish to thank MARÍA GUADALUPE VILLAGARCÍA ÚBEDA who helped us with the English version.

Finally, we want to emphasize the important contribution of the ZONAP project (Nº. PB90-0166) supported by DGICYT. The information obtained from it will contribute to widen considerably unknown aspects on the etology and distribution of the species present in the Iberic Mediterranean Sea.

REFERENCES

ASHBY, W.R. – 1954. *Design for a brain.* In: Chapman and Hall (eds.). 2nd. imp., London.

ASHBY, W. R. – 1956. *An introduction to cybernetics.* In: Chapman and Hall (eds.). London.

BAUCHOT, M.L. – 1987. Carangidae. In: W. FISCHER, M.L. BAUCHOT and M. SCHNEIDER (Réd.). –1987. *Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de pêche 37.* vol. II (Vertébrés): 1009-1030. FAO, Rome.

CASAPONSA, J. – 1993. *Contribución al estudio del género* Trachurus *(Pisces, Carangidae) en el mar Catalán.* Ph. D. thesis Univ. Barcelona. Facultat de Biología. 213 pp.

HUREAU, J.-C., E. TORTONESE. – 1973. Carangidae.In: J.C. HUREAU , TH. MONOD (eds./reds.): *Check-list of the fishes of the north-eastern Atlantic and of the Mediterranean. (CLOFNAM).*, vol. I: 373-384. Unesco, Paris.

LLORIS, D. – 1992-1994. Estudio de la zonación ictiológica en el Talud (entre 0-2500 m) del Mediterráneo Occidental. Project Nº PB90-0166 DGICYT.

MARGALEF, R. – 1978. *Perspectivas de la teoría ecológica* 1st. ed. (spanish version). Ed. Blume. Barcelona.

ROHLF, F.J. – 1992. *Numerical Taxonomy and multivariate analysis system* (NTSYS program, version pc-1.70). Exeter Publishing Ltd. New York.

SHABONEYEV, I. Ye. – 1981. Systematics, morphological characteristics and origin of Carangids of the Genus *Trachurus. Vopr. iktiol.*, 20 (6): 15-24.

SMITH-VANIZ, W. F. – 1986. Carangidae. In: P.J.P. WHITEHEAD, M.L. BAUCHOT, J.C. HUREAU, J. NIELSEN and E. TORTONESE (eds./reds.). *Fishes of the North-eastern Atlantic and the Mediterranean (FNAM).*vol. II: 815-844. Unesco, Paris.