NORTHWESTERN MEDITERRANEAN ANCHOVY SPAWNING GROUNDS OFF THE CATALAN SEA, GULF OF LIONS AND LIGURIAN SEA DURING 1992 AND 1993

I. PALOMERA[1], A. GARCÌA[2] and O. GIOVANARDI[3]

[1] Instituto de Ciencias del Mar, Paseo Joan de Borbó s/n, 08039 Barcelona, Spain.
[2] IEO - Centro Oceanográfico de Málaga, P.O. Box 285, Fuengirola, Málaga, Spain.
[3] Istituto Centrale Per La Ricerca Scientifica e Tecnologica applicata al Mare, Roma, Italy

Under the framework of UE financed FAR project on the NW Mediterranean anchovy stock (*Engraulis encrasicolus*) off the Catalán Sea, Gulf of Lions and Ligurian Sea, two fish egg and larval surveys were carried during the peak spawning period (June-July) with the main objective delimitating the spatial distribution of the spawning areas in 1992 in order estimate Daily Egg Production spawning biomass in 1993. The present paper describes the results obtained from the surveys "MAD-0792" and "MPH-MED 93" carried out on board the R/V Garcia del Cid.

MAD-0792. A total of 195 Bongo-40 plankton oblique hauls (200µ mesh) were carried out in stations 10 nautical miles apart within near to perpendicular to the coastline transects, distanced 10 or 12 miles apart, depending on the anchovy spawning intensities expected in different surveyed sectors. In order to assure the maximum limit of anchovy egg vertical distribution (PALOMERA, 1991), tows were carried out to the desired depth of 100 mt depth, whenever possible. Vertical CTD profiles (Seabird Model) were also done at each station providing information on temperature, salinity and relative fluorescence distribution complemented with Doppler profiling of currents (GARCÌA, 1994). The main anchovy spawning grounds are located along a mid cross-section of the Gulf of Lions, whose edges coincide with the shelf break, which practically form a continuation with the more litoral spawning areas off Cape of Creus and the northern Catalonian coasts. At the southernmost sector, the traditional anchovy spawning ground (PALOMERA, 1992) opposite the Ebro river delta outflow is clearly defined, with southwestern extensions. The Liguro-Provençal basin has anchovy spawning grounds located mainly along the Tuscan shelf, limited seaward by the shelf margin; but in comparison to the previously described spawning grounds, the scale of abundances decrease six fold, approximately. Anchovy larvae offer a more spread out distribution due to their longer presence in the planktonic phase. Highest abundances occur in the mid section of the Gulf of Lions, and subsequently following a similar distributional pattern to the egg distribution.The inner litoral sector of the Gulf of Lions register practically insignificant or null presence of larvae. In general, higher larval abundances are recorded in more offshore stations (normally in the second or third station of the transect), rather than the strictly litoral ones. In comparison, anchovy larval abundances decrease greatly in the Ligurian basin, where these have not practically exceeded values over 10 larvae/m^2. These abundances are mostly located in the last transects, near the island of Elba, across Corsica and the Italian coasts, coinciding with the widening of the continental margins. The most productive spawning ground is located in the region comprehended between the northern Catalonian coasts and the Gulf of Lions, where the main bulk of the target species is located, in agreement with the echo-acoustic evaluations carried out in recent years (ABAD *et al.*, 1991). Several common features can be pointed out in relation with anchovy spawning grounds distribution:1) they are associated to river runoffs (e.g., Rhône, Ebro); 2) are influenced by the strong Liguro-Provençal-Catalán current, producing associated cyclonic or anticyclonic eddies that can either disperse or retain larvae in nursery grounds favourable to growth or inversely; 3) hydrological phenomena associated to bottom topography (e.g., submarine canyons).

MPH-MED-0793. During July 1-30, 1993 another anchovy egg survey was carried out aboard the R/V Garcia del Cid with the main objective of estimating spawning biomass through the Daily Egg Production Method. This evaluation technique implies an intensive plankton vertical tow sampling. The basic scheme of egg sampling stations was based on a 5 by 5 nautical mile track (stations and transects), with transects near perpendicular to the coastline, modified in some of the covered regions to 2.5 miles between stations and 10 miles between transects. A total of 602 CalVET net (150µ mesh) vertical tows of 100 m depth were done, representing a coverage of 59,981 km^2 of sea surface. Catalán Sea accounted for 292 plankton hauls, whereas the Gulf of Lions and Ligurian Sea accounted for 138 and 172, respectively. Temperature-salinity with depth from CTD (Seabird 25) profiles were obtained in 278 of the stations sampled (GARCÌA., 1994; Annex V). No spawning activity was observed in the southernmost area of the sampled area from Cape San Antonio to Castellón (Gulf of Valencia). Thereon northward, spawning was detected continously until the Gulf of Lions. The spawning ground associated to the Ebro river delta showed high egg concentrations in the inmediate zone of influence of it's outflow spreading high concentrations seaward, but mainly concentrated along the shelf break where the continental shelf is widest. The influence of the Ebro river discharge on salinity is observed up to 25 miles offshore. Along the coast of the northern sector of the Catalan Sea, the continental shelf is much narrower, thereby limiting spawning to the litoral zone, until the region of the Gulf of Lions. In this area, practically no spawning occurs in its inner coastal section, and once more higher egg densities occur along the margin of the shelf. Two main spawning areas are observed in this region, a western one that forms continuity with the northernmost Catalan sector, and an eastern spawning ground influenced by the Rhône river runoff. In comparison to the southern region, surface temperatures are significantly lower (~19°-20°C) in the Gulf of Lions sector with a gradual increasing trend southward (~20°-22°C).

Although rather spatially restricted, the freshwater river discharge from the Rhône river was observed in the eastern coast of the Gulf of Lions (minimum salinity values 32.750/00). Relative fluorescence intensities increase considerably in the stations close to the river mouth, attaining maximum levels registered during the survey. Coastal upwelling in the interior part of the Gulf was clearly observed which is also reflected on the maximum levels of relative fluorescence intensities. Finally, the anchovy egg distribution off the Ligurian and N Tyrrhenian Sea was concentrated along the continental shelf of the Tuscan region. High egg densities were observed opposite the two river outflows (Arno and Magra) and the northern part of the island of Elba. In this latter zone, rather low sub-superficial temperatures and high salinities were observed indicating an upwelling process which does not reach surface layers. South of this island, isolated and dispersed anchovy egg concentrations were observed.

In conclusion, anchovy spawning grounds distribution is related to the complex hydrology which represents the linking factor of the studied regions, in such a way that the resource has an inter-relationship which should be considered for its assesment.

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A STUDY OF THE POPULATION DYNAMICS OF THE NORTHWESTERN MEDITERRANEAN ANCHOVY (*ENGRAULIS ENCRASICOLUS*) USING LCA (LENGTH COHORT ANALYSIS)

J.P. PERTIERRA and J. LLEONART

Institut de Ciències del Mar. Plaça del Mar. 08039 Barcelona, España

The use of population dynamics in the evaluation of small pelagics is a controversial topic. The small pelagics have a short life, most of the biomass is presumed to belong to a single year class making them highly dependent of uncertain recruitments, and a highly variable natural mortalities. Hence small pelagics gather the wrong features for the proper operation of the population dynamics methodology, while the acoustic techniques and the egg production method have demonstrate to be efficient estimators of actual biomass. Nevertheless, population dynamics can contribute with a sinchronic view to the more precise, but punctual, direct estimations mentioned above. In this paper a Length Cohort Analysis (LCA) of anchovy is presented. LCA has severe limitations, being the steady state the most restrictive, involving constant recruitment and constant mortalities. For this reason this method has received some criticism (HILBORN and WALTERS, 1992). Nevertheless LCA has at least two useful features: first it gives a wide view of the population status, and second, it can take the data arranged into many classes, hence the scale of study is much more precise than those based on anual classes. This last feature is significant in short lived organisms.

In the framework of a FAR project (GARCIA, 1994) 347 samples of anchovy length frequencies of the commercial landings were taken from Castelló (northern part of spanish coast of the Mediterranean) to Savona (septentrional Tirrhenian), incluiding France. In this paper the preliminary results of the analysis of these data are presented.

Data were grouped according to annual seasons starting on July 1st, as the birthday of the year class. Only the season July-92 to June-93 was complete. The samples were grouped in several ways, ranging various levels of agregation (i.e. harbour, country, gulf of Lion, etc.). Samples taken from Catalonian landings from 1987 to 1993 were also included. The length frequencies were smoothed in order to avoid sampling artefacts.

The resulting length frequencies were analyzed by means of the LCA using VIT software (LLEONART and SALAT, 1992).

The biological parameters employed were, for the von Bertalanffy growth equation: L (infinity) = 20.6 cm, K = 0.38, t0 = -0.937 year. Length-weight relationship: a = 0.0022 gr/vol, b = 3.41 (PERTIERRA, 1987), and Natural mortality (PERTIERRA, 1992): M = 0.81. As a general remark on the data, it must be pointed out that the lower standard length limit was 5.5 cm and the upper one was 19 cm.

In table 1, the main general results are presented. Some particularly significant parameters have been choosed in order to synthetize the great ammount of information from each analysis.

Some general conclusions can be stated. The stocks are kept at levels slightly lower than 50% of the virgin biomass. The turnover rates are, in all cases, higher than 100%. The recruitment represents around 50% of biomass when it reaches its maximum biomass. The values of biomass are absolute and refer to different surfaces, so they are hardly comparable between areas. The great differences between the global fishing mortalities are the most surprising results; sensitivity analysis showed, as it was expected, that these values are not affected (at a significant level) by the terminal F. Taking into account the cautions necessary in the interpretation of such analyses, it appears to be an increase in the biomass of catalan stock in the most recent years.

Yield per Recruit Analysis carried out on the fishing mortality vectors reveal an average subexploitation pattern for most (all except Barcelona) of the studied areas with maximun sustainable yields above the current fishing effort.

Table 1. Results of LCAs carried out on different sets of anchovy data.

F : global fishing mortality weighted by numbers of individuals. **B** : Mean anual biomass in tonnes. **%BV** : B expressed ad percentage of estimated mean anual virgin biomass. **%T** : Turnover (production/biomass) expressed as percentage. **%R** : Percentage of the mean annual biomass represented by one year recruitment at the critical (maximum biomass) point.

1992-1993	**F**	**B**	**%BV**	**%T**	**%R**
Castelló	0.334	4748	48	137	65
Barcelona	0.533	2698	26	165	55
Port de la Selva	0.132	2166	60	116	44
Sète	0.200	8464	56	123	51
Savona	0.307	2076	49	131	59
Sestri Levante	0.412	375	42	142	64
Catalonia	**F**	**B**	**%BV**	**%T**	**%R**
1987-1988	0.353	15638	33	154	59
1988-1989	0.344	23321	39	141	53
1989-1990	0.368	20402	32	155	54
1990-1991	0.338	16529	38	144	53
1991-1992	0.188	19091	47	130	49
1992-1993	0.189	28697	52	121	43
1987-93 (6 seasons)	0.254	21264	41	137	49
Gulf of Lions 92-93	0.145	10548	56	121	47

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