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## MESSINIAN MARINE FISH COMMUNITIES OF THE MEDITERRANEAN SEA (\*\*)

**Summary** — A synthesis of the marine ichthyofauna of the Lower Messinian «Tripoli» in the Mediterranean Basin from the most famous Italian and Algerian fish-bed localities is provided.

The most important data are the following:

1) The known ichthyofauna is represented by 77 genera of which 70 are still living; the recorded species are 106 of which 14 are still living, representing the 13,21%. It is worth of note that this percentage could increase; in fact it is possible that several species founded on the base of fossil material (material not yet revised) are synonyms of living species.

2) In the Mediterranean Basin the ichthyofauna was distributed uniformly during the Lower Messinian; the differences between some associations are due simply to different depths of the corresponding environments.

3) During the Lower Messinian, a Mediterranean-Eastern Atlantic ichthyofaunal Region was already recognizable. In this Region a modest residual number of species with indo-pacific affinities were still present. Therefore, the marine fish communities during the Lower Messinian were similar to the actual ones. Nevertheless, we believe that the actual communities do not derive from the Messinian communities, but probably they represent the consequence of a faunal renewal of atlantic origin during the Lower Pliocene.

**Riassunto** — *Ittiofaune marine del Messiniano inferiore del Bacino Mediterraneo.* Viene qui fatta una sintesi delle ittiofaune francamente marine provenienti dal «Tripoli» (Messiniano inferiore) delle principali località fossilifere dell'Italia e dell'Algeria. I dati principali che emergono sono:

1) L'ittiofauna conosciuta è costituita da 77 generi di cui 70 ancora rappresentati; le specie segnalate sono 106 di cui 14 ancora viventi, pari al 13,21%. A questo proposito viene fatto notare che questa percentuale potrebbe aumentare dato che numerose spe-

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cie istituite su materiale fossile, materiale non ancora revisionato, probabilmente sono sinonime di specie attuali.

2) Durante il Messiniano inferiore nel Bacino mediterraneo il popolamento ittico era uniformemente distribuito; le differenze che si riscontrano fra ittiofaune di provenienza diversa sono la conseguenza di differenze di profondità dei rispettivi bacini di sedimentazione.

3) Nel Messiniano inferiore esisteva già una regione ittiofaunistica mediterranea-atlantica orientale simile a quella attuale, in cui tuttavia sopravviveva un numero limitato di specie ad affinità indo-pacifica. Riteniamo però che le comunità ittiche attuali non derivino da quelle messiniane, ma rappresentino la conseguenza di un rinnovamento ittiofaunistico di origine atlantica successivo alla crisi di salinità del Miocene superiore.

**Key words** — Vertebrata (Osteichthyes, Teleostei) - Lower Messinian - Mediterranean Basin - Paleobiogeography.

The purpose of this work is the complete analysis of the principal marine ichthyofauna of the Lower Messinian of the Mediterranean Basin. These represent the last fish population, of an obviously marine form, so far known in the Upper Miocene of this basin.

The provenances of the various ichthic associations taken into consideration are the following:

- (P) - Pecetto di Valenza (Alessandria, Piedmont)
- (M) - Mondaino (Forlì, Emilia-Romagna)
- (S) - Senigallia (Ancona, The Marches)
- (B) - Bessima (Enna, Sicily)
- (L) - Licata (Girgenti, Sicily)
- (R) - Racalmuto (Girgenti, Sicily)
- (G<sub>1</sub>) - Gabbro<sub>1</sub> (Leghorn, Tuscany)
- (G<sub>2</sub>) - Gabbro<sub>2</sub> (Leghorn, Tuscany)
- (O<sub>1</sub>) - Oran<sub>1</sub> - (Raz el Ain, Planteurs, Gambetta)
- (O<sub>2</sub>) - Oran<sub>2</sub> - (Saint Denis du Sig)
- (O<sub>3</sub>) - Oran<sub>3</sub> (Sidi-Brahim)

Tab. 1 shows the list of the species present in at least two localities; the letter are indicated with the letter corresponding to their own initials. Then follows the list of the species indicated in a single locality. In brackets the known distribution.

- 1) Pecetto di Valenza: *Merluccius merluccius* (LINNEO) (Mioc. - Act.).
- 2) Mondaino: no sole species.
- 3) Senigallia: *Zeus primaevus* COCCI (Mioc.).

4) Bessima: no sole species.

5) Licata: *Photichthys larteti* (SAUV.) (Mioc.); *Belone acutirostris* SAUV. (Mioc.); *Fistularia licatae* (SAUV.) (Mioc.); *Bathygadus incertus* (SAUV.) (Mioc.); *Caranx albyi* (SAUV.) (Mioc.); *C. scillae* (SAUV.) (Mioc.); *Pseudovomer minutus* SAUV. (Mioc.); *Hemithyrsites* (= *Promethichthys* GILL, 1893) *armatus* SAUV. (Mioc.); *Orcynus proximus* (SAUV.) (Mioc.); *Trigla licatae* SAUV. (Mioc.).

6) Racalmuto: no sole species.

7) Gabbro<sub>1</sub>: no sole species.

8) Gabbro<sub>2</sub>: *Gadiculus jonas* (D'ERASMO) (Mioc.); *Boops gortanii* (D'ERASMO) (Mioc.); *Callionymus pusillus* DELAROCHE (Mioc. - Act.); *Monochirurus hispidus* RAFINESQUE (Mioc. - Act.).

9) Oran<sub>1</sub>: *Muraena saheliensis* ARAM. (Mioc.); *Brosme murdjadjensis* ARAM. (Mioc.); *Zeus faber* LINNEO (Mioc. - Act.); *Microcentrum melitense* (WOODWARD) (Mioc.); *Epinephelus casotti* (COSTA) (Mioc.); *E. longispinis* ARAM. (Mioc.); *E. progigas* ARAM. (Mioc.); *Serranus cabrilla* LINNEO (Mioc., Act.); *S. scriba* CUVIER et VALENCIENNES (Mioc., Act.); *Apogonoides cottreaui* ARAM. (Mioc.); *Cepola cuneata* ARAM. (Mioc.); *Caranx prorusselli* ARAM. (Mioc.); *Seriola dallonii* ARAM. (Mioc.); *Pomadasys proronchus* (ARAM.) (Mioc.); *Dentex barbarus* ARAM. (Mioc.); *Diplodus jomnitanus* VALENCIENNES (Mioc., Act.); *D. oranensis* (WOODWARD) (Mioc.); *Pagellus leptosomus* ARAM. (Mioc.); *Sparus cinctus* (AGASSIZ) (Mioc.-Plioc.); *S. compactus* ARAM. (Mioc.); *S. neogenus* ARAM. (Mioc.-Plioc.); *Branchiostegus mesogeus* (ARAM.) (Mioc.); *Crenidens intermedius* ARAM. (Mioc.); *Chromis savornini* ARAM. (Mioc.); *Syphodus pellegrini* (ARAM.) (Mioc.); *S. woodwardi* (KRAMBERGER) (Mioc.); *Sarda roulei* ARAM. (Mioc.); *Xiphiorhynchus courcellei* ARAM. (Mioc.); *Gobius aidouri* ARAM. (Mioc.); *G. anthoni* ARAM. (Mioc.); *G. briversi* ARAM. (Mioc.); *G. razelaini* ARAM. (Mioc.); *Labrisomus pronuchipinnis* (ARAM.) (Mioc.); *Tripterygion pronasus* ARAM. (Mioc.); *Neopercis mesogeia* ARAM. (Mioc.); *Mugil ornatus* ARAM. (Mioc.); *Scorpaena boulei* ARAM. (Mioc.); *S. jeanneli* ARAM. (Mioc.); *Trigla macroptera* ARAM. (Mioc.); *Syacium oranensis* (ARAM.) (Mioc.); *Achirus mediterraneus* ARAM. (Mioc.); *Microchirus abroptericus* (SAUV. (Mioc.); *Trigonodon oweni* SISMONDA (Mioc.-Plioc.); *Halobatrachus didactylus* (BLOCH-SCHNEIDER) (Mioc., Act.).

10) Oran<sub>2</sub>: *Capros steindachneri* (KRAMBERGER) (Mioc.); *Spicara dionysii* (ARAM.) (Mioc.); *Balistes procapriscus* ARAM. (Mioc.).

11) Oran<sub>3</sub>: *Argyropelecus logearti* ARAM. (Mioc.).

TABLE 1

TABLE 1 (continued)

## STRATIGRAPHIC OBSERVATIONS

In the marine ichthyofauna of the Lower Messinian of the Mediterranean Basin 77 genera are present; of these 7 are extinct: *Parascopelus*, *Microcentrum*, *Apogonoides*, *Paracalamus*, *Pseudovomer*, *Xiphiorhynchus* and *Trigonodon*.

Genera still living: 90,91%

Genera extinct: 9,09%

The species present are 106; of these 14 are still living: *Sardina pilchardus*, *Maurolicus muelleri*, *Merluccius merluccius*, *Zeus faber*, *Capros aper*, *Serranus cabrilla*, *S. scriba*, *Trachurus trachurus*, *Scomber colias*, *Callionymus pusillus*, *Monochirrus hispidus*, *Solea vulgaris*, *Halobatrachus didactylus* and *Lophius budegassa*.

Species still living: 13,21%

Species extinct: 86,79%

It is noteworthy that the percentages relative to the species could undergo significant variations; in fact, the material studied by ARAMBourg not having been seen yet, it may be that some of the species established by him on the Algerian fossil ichthyofauna and some of those established by SAUVAGE on the fossil ichthyofauna of Licata are synonymous with present species, as ARAMBOURG himself (1925, 1927) suggests on the basis of affinities found by him.

Among the extinct species 5 (equivalent to 4,72% of the entire ichthyofauna) are indicated (as ichthiolites and/or ichthyodontolites and/or otolites) also in the mediterranean Pliocene: *Bregmaceros albyi*, *Pagrus mauritanicus*, *Sparus cinctus*, *S. neogenus* and *Trigonodon oweni*.

Finally only 1 species, *Bregmaceros albyi*, (equivalent to 0,94% of the entire ichthyofauna) is also indicated in the Oligocene of Central Europe.

## PALEOENVIRONMENTAL OBSERVATIONS

The complete examination of the mediterranean marine ichthyofauna of the Lower Messinian allows one to individualize quantitative differences, sometimes remarkable, in the material coming from different deposits.

Aboveall we can distinguish a neritic component from a pelagic component and within the sphere of the latter we can apply a further subdivision based on the bathymetry. Here we consider species:

1) essentially neritic those which spend most of their life in the mass of water above the continental shelf;

2) essentially epipelagic those which spend most of their life in the superficial mass of the pelagic environment (0-200 m);

3) essentially meso-bathypelagic those that spend most of their life in the pelagic environment below 200 m.

Depending on the affinities and/or differences in the fauna it is possible to arrange the 11 areas of origin of the Messinian ichthyofauna in the following way (fig. 1) (they are indicated thus: A - essentially

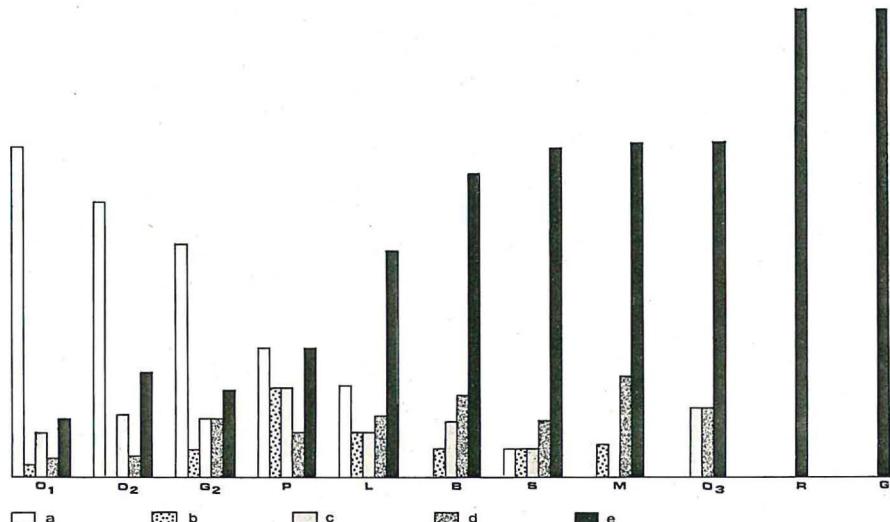


FIG. 1

neritic species; B - essentially neritic and epipelagic species; C - essentially epipelagic species; D - essentially epipelagic and meso-bathypelagic species; E - essentially meso-bathypelagic species).

1) **Oran<sub>1</sub>** - species present: 72

A	-	51 sp.	=	70,83%
B	-	2 sp.	=	2,77%
C	-	7 sp.	=	9,72%
D	-	3 sp.	=	4,16%
E	-	9 sp.	=	12,52%

2) **Oran<sub>2</sub>** - species present: 22

A	-	13 sp.	=	59,09%
B	-	0 sp.	=	0,00%
C	-	3 sp.	=	13,64%
D	-	1 sp.	=	4,54%
E	-	5 sp.	=	22,73%

3) **Gabbro<sub>2</sub>** - species present: 16

A -	8 sp.	=	50,00%
B -	1 sp.	=	6,25%
C -	2 sp.	=	12,50%
D -	2 sp.	=	12,50%
E -	3 sp.	=	18,75%

4) **Pecetto di Valenza** - species present: 11

A -	3 sp.	=	27,273%
B -	2 sp.	=	18,182%
C -	2 sp.	=	18,182%
D -	1 sp.	=	9,090%
E -	3 sp.	=	27,273%

5) **Licata** - species present: 31

A -	6 sp.	=	19,35%
B -	3 sp.	=	9,68%
C -	3 sp.	=	9,68%
D -	4 sp.	=	12,90%
E -	15 sp.	=	48,39%

6) **Bessima** - species present: 17

A -	0 sp.	=	0,00%
B -	1 sp.	=	5,88%
C -	2 sp.	=	11,76%
D -	3 sp.	=	17,65%
E -	11 sp.	=	64,71%

7) **Senigallia** - species present: 17

A -	1 sp.	=	5,882%
B -	1 sp.	=	5,882%
C -	1 sp.	=	5,882%
D -	2 sp.	=	11,764%
E -	12 sp.	=	70,590%

8) **Mondaino** - species present: 14

A -	0 sp.	=	0,00%
B -	1 sp.	=	7,14%
C -	0 sp.	=	0,00%
D -	3 sp.	=	21,43%
E -	10 sp.	=	71,43%

9) **Oran<sub>3</sub>** - species present: 7

A -	0 sp.	=	0,00 %
B -	0 sp.	=	0,00 %
C -	1 sp.	=	14,285%
D -	1 sp.	=	14,285%
E -	5 sp.	=	71,430%

10) **Racalmuto** - species present: 7

A -	0 sp.	=	0,00%
B -	0 sp.	=	0,00%
C -	0 sp.	=	0,00%
D -	0 sp.	=	0,00%
E -	7 sp.	=	100,00%

11) **Gabbro<sub>1</sub>** - Species present: 6

A -	0 sp.	=	0,00%
B -	0 sp.	=	0,00%
C -	0 sp.	=	0,00%
D -	0 sp.	=	0,00%
E -	6 sp.	=	100,00%

In the 11 fossil locations thus arranged one can note, starting from Oran<sub>1</sub> towards Gabbro<sub>1</sub>, an evident progressive decrease in the essentially neritic forms until they vanish completely; one notes a progressive increase in the number of meso-bathypelagic forms, which at Racalmuto and Gabbro<sub>1</sub> represent the only components of the ichthyofauna represented here.

If we now analyse the pelagic (taken in its complete form) and neritic components, we can note the following.

1) The pelagic component, present even if with a different frequency in all the deposits, aboveall comprises various species with a wide geographical distribution as directly shown by their presence in many

localities. We refer particularly to: *Alosa elongata*, *Maurolicus muelleri*, *Lampanyctus edwardsi*, *L. larteti*, *L. licatae*, *L. microsomus*, *Myctophum columnae*, *M. dorsale*, *Lestidiops sphekodes*, *Bregmaceros albyi*, *Trachurus trachurus* and *Benthodesma albyi*.

But a wide geographical distribution is also indirectly shown by species found only in two, a maximum of three, deposits, given the location of the latter. For example: *Sardina pilchardus* (P; G<sub>2</sub>), *Synodus avus* (O<sub>1</sub>; G<sub>2</sub>), *Lampanyctus vexillifer* (M; S; L), *Myctophum dainelli* (M; S; B) and *M. probenoiti* (S; O<sub>1</sub>; O<sub>3</sub>).

Finally, the species found in a single locality are present, even if in a limited number, only in deposits which have produced a very varied fauna; more precisely:

Oran<sub>1</sub> - 72 species (pelagic species found here only: 4)

Licata - 31 species (pelagic species found here only: 4)

Gabbro<sub>2</sub> - 16 species (pelagic species found here only: 1)

2) The distribution of the neritic component is more directly influenced by the nature of the basin; this justifies the main differences that are found among the various deposits and the possible heightened heterogeneity of fauna in each one. Nevertheless also among the neritic forms there are various species which have their own wide geographical distribution either directly in that they are present in many deposits (e.g. *Syngnathus albyi*), or indirectly given the geographical location of the provenance. In particular we refer to: *Capros aper* (P; O<sub>1</sub>; G<sub>2</sub>), *Gobius ehrmanni* (O<sub>1</sub>; G<sub>2</sub>), *G. xiphurus* (O<sub>2</sub>; G<sub>2</sub>), *Arnoglossus sauvagei* (P; L; G<sub>2</sub>), *Solea procellata* (O<sub>1</sub>; G<sub>2</sub>) and *S. vulgaris* (P; O<sub>1</sub>).

Everything mentioned so far leads one to retain that during the Lower Messinian in the Mediterranean Basin, at least regarding the portion including the deposits under examination here, the ichthyofauna presented, essentially, a homogenous character.

The differences that exist among the various deposits, partly shown in fig. 1, are essentially the consequence of different sedimentation environments.

The ichthyofauna of Oran<sub>1</sub>, Oran<sub>2</sub> and Gabbro<sub>2</sub> indicate strictly coastal environments, as shown by the high percentage of essentially neritic forms; the presence of essentially meso-bathypelagic forms does not contrast with the general characteristics of these populations, in that one is dealing with species with migratory habits of a nictomeral type.

The ichthyofauna of Licata, Bessima, Senigallia, Mondaino, Oran, Racalmuto and Gabbro, indicate relatively deep environments (even if not necessarily far from the coast), as shown by the high percentage, or even exclusiveness, of the essentially meso-bathypelagic forms and low percentage, or absence, of the essentially neritic forms.

The ichthyofauna of Pecetto di Valenza presents characteristics of transition between the two groups listed above; in fact no component is predominant. Nevertheless it is worth pointing out that the lower number of species indicated here can limit considerations of a statistical nature.

#### BIOGEOGRAPHIC OBSERVATIONS

In the marine ichthyofauna of the Lower Messinian of the Mediterranean Basin 70 presently living genera are represented; among these 17 are not at present represented by any species in the Mediterranean Sea: *Etrumeus*, *Spratelloides*, *Photichthys*, *Fistularia*, *Bathygadus*, *Brosme*, *Bregmaceros*, *Crenidens*, *Branchiostegus*, *Chaetodon*, *Promethichthys*, *Benthodesmus*, *Labrisomus*, *Neopercis*, *Syacium*, *Achirus* and *Chilomycterus*.

The above-listed genera are however present in the ichthyofauna of the Eastern Atlantic, with the exception of *Etrumeus* (Red Sea, Indian Ocean, Pacific and Western Atlantic), *Spratelloides* (Indian Ocean and Pacific) and *Crenidens* (Red Sea and Indian Ocean).

Regarding the above it is however necessary to remember that a specimen of *Etrumeus teres* (DEKAY) has been found, it having come from the Red Sea, in the Eastern Mediterranean near the Israeli coast (BEN TUVIA, 1966) and that specimens of *Crenidens crenidens* (FORSSKAL) are occasionally found in the Eastern Mediterranean, these also having come from the Red Sea (*fide* TORTONESE in CLOFMAN, 1973). Also worth remembering is that specimens of *Chaetodon hoefleri* STEIDACHNER, a species correctly considered to be of a non-Mediterranean habitat, are often regularly found in the Western Mediterranean (*fide* MONOD in CLOFMAN, 1973).

Among the 53 genera at present belonging to the Mediterranean ichthyofauna, 15 are found only in the Mediterranean-Eastern Atlantic area: *Alosa*, *Sardina*, *Paralepis* (only Mediterranean), *Gadiculus*, *Capros*, *Serranus*, *Cepola*, *Parapristipoma*, *Spicara*, *Chromis*, *Symphodus*, *Scorpaena*, *Trigla*, *Microchirus* and *Halobatrachus*.

In conclusion:

Among the genera still living (= 70 genera) 75,71% (= 53 genera) is at present represented in the Mediterranean Sea, among these 21,43% (= 15 genera) is exclusive to the Mediterranean-Eastern Atlantic ichthyofauna; 24,29% (= 17 genera) is not at present represented in the Mediterranean Sea, among these only 4,29% (= 3 genera) does not belong to the Eastern Atlantic ichthyofauna.

In the Messinian ichthyofauna considered here there are 14 species definitely known to be living (regarding this see previous paragraph above). Among these only two, *Maurolicus muelleri* (found almost everywhere) and *Trachurus trachurus* (Mediterranean, Eastern and Western Atlantic) have a widespread geographical distribution; the geographical distribution of the remaining 12 species is limited to the Mediterranean-Eastern Atlantic area. Species exclusive to the Mediterranean-Eastern Atlantic area: 85,71%; species with a more widespread distribution: 14,29%.

From the above it appears that in the Lower Messinian there was already a Mediterranean-Eastern Atlantic region of ichthyofauna, in which there still lived a limited residual component with an indo-pacific affinity. This is in accordance with the finding of ARAMBOURG (1927, 1965) regarding the presence in the Upper Miocene of a «paleo-mediterranean» fauna with biogeographical characteristics similar to those of the present mediterranean ichthyofauna.

ARAMBOURG (1965) also retains that: «La faune paléoméditerranéenne oligo-miocène correspond donc à la mise en place des éléments principaux de la faune actuelle». In our opinion, however, in agreement with SORBINI *et al.* TIRABELLE RANCAN (1979), the events of the end of the Miocene produced deep modifications within this fauna and the present population is almost certainly, in its general characteristics, the direct consequence of the renewal of the fauna originating in the Atlantic which happened in the Lower Pliocene. In the Mediterranean Basin, therefore, from the Miocene to today there has probably been the superimposition of two similar ichthic populations, but which, in their general characteristics, have not derived from each other.

REFERENCES

- ARAMBOURG C. (1925) - Révision des poissons fossiles de Licate (Sicile). *Ann. Pal.*, **14**, 39-132.  
ARAMBOURG C. (1927) - Les poissons fossiles d'Oran. *Mat. Car. Géol. Algérie*, S. 1 (6), 291 pp.

ARAMBOURG C. (1965) - Considerations nouvelles au sujet de la faune ichthyologique paléoméditerranéenne. *Senck. leth.*, **46** a, 13-17.

BEN-TUVIA A. (1966) - Red Sea Fishes recently found in the Mediterranean. *Copeia*, **2**, 254-275.

MONOD TH. (1973) - Chaetodontidae in CLOFNAM, 422-423, J.C. Hureau et Th. Monod Edit., UNESCO.

SORBINI L., TIRABELLE RANCAN R. (1979) - Messinian fossil Fish of the Mediterranean. *Palaeogeog., Paleoclim., Paleoecol.*, **29**, 143-154.

TORTONESE E. (1973) - Girellidae in CLOFNAM, p. 416, J.C. Hureau et Th. Monod Edit., UNESCO.

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