

MASS MORTALITY OF GILT SARDINE, *SARDINELLA AURITA* (CLUPEIDAE), IN THE ADRIATIC AND IONIAN SEAS

by

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RÉSUMÉ. - Mortalité massive de la sardine dorée, *Sardinella aurita* (Clupeidae), en mers Adriatique et Ionienne.

Une mortalité massive de *Sardinella aurita* a été observée le long des côtes Sud-Est de l'Italie et de Croatie centrale en janvier 2002, de façon concomitante à une forte diminution de la température des eaux marines. Les observations rapportées dans cette étude et les informations disponibles suggèrent qu'un choc thermique pourrait être le mécanisme le plus probable pour expliquer le phénomène.

Key words - Clupeidae - *Sardinella aurita* - MED - Adriatic Sea - Ionian Sea - Mass mortalities - Climatic anomalies.

The consequences of climatic events on marine biota have long attracted the attention of marine biologists (see Astraldi *et al.*, 1995 and references therein). In the Mediterranean Sea, many authors have provided suggestive evidence of the effects of seawater warming on the northward expansion of a wide array of thermophilic marine organisms, from algae to fishes (Bianchi and Morri, 1994; Francour *et al.*, 1994; Bettoso and Dulcic, 1999; Dulcic and Grbec, 2000; Guidetti *et al.*, 2002). A short-term mass fish mortality (chiefly of *Sardinella aurita*) recorded in winter 1991 in Thessaloniki Bay (Greece) (Economidis and Vogiatzis, 1992) was attributed to an abrupt fall in seawater temperatures. Conversely, anomalous increases in seawater temperature have been invoked to explain catastrophic mass-mortality events of gorgonians, red coral (*Corallium rubrum*) and other benthic organisms from the Ligurian Sea to SE France (NW Mediterranean) during the summer of 1999 (Cerrano *et al.*, 2000; Pérez *et al.*, 2000; Garrabou *et al.*, 2001).

At the beginning of January 2002, the southern Apulian (SE Italy) and middle Croatian coasts (Dalmatia, from Makarska to Pag island) were struck by almost continuous and very cold northern winds for about a week. This caused a dramatic decrease in air temperature, which achieved unusually low values for those geographic areas ($< 0^{\circ}\text{C}$), and a noticeable surface seawater cooling. As an example of the atypical climate conditions in January 2002, figure 1 illustrates the trend of seawater temperature in the middle Adriatic from April 1999 to February 2002. Monthly averages of water temperature during this period were consistently higher than 11°C (usually sea water temperature during winter is around $11\text{--}12^{\circ}\text{C}$) until January 2002. Daily values (see the web site www.izor.hr) show a sudden decrease in temperature around January 1st-3rd, when water temperature achieved 9.6°C . Concomitant with this marked temperature fall and a severe sea storm, a mass fish stranding occurred along the southern Apulian coast (SE Italy; Fig. 2). Large amount of fish accumulated along both rocky shores and sand beaches from Villanova (Adriatic Sea) to San Gregorio (Ionian Sea), a stretch of coast more than one hundred kilometres

long (Fig. 2). Stranding events were firstly observed at Villanova and Torre Guaceto (6-7 January 2002), and subsequently (9-12 January) at San Cataldo, Otranto and San Gregorio, located southwards. Samples of organisms stranded along the coast have been collected, and the bulk of fish cast up belonged to the species *Sardinella aurita*. Taking into account the length of the coastline affected by the event and the densities of fish cast up, we roughly estimate that several millions of *S. aurita* specimens stranded along the Apulian coasts. Huge amounts of *S. aurita* were also observed, apparently moribund, swimming slowly near the surface and sunk to the bottom. Specimens of *S. aurita* stranded along the Apulian coast ranged from about 5 cm TL to the maximum size reported in the literature for the species (around 30 cm TL; Tortonese, 1970). A few days later (13 January), moribund fish were observed quivering in the sea along the eastern Adriatic coast, a few meters from the quay of peninsula Vranjic (small settlement Vranjic near town Split, Kastela Bay, near River Jadro Estuary; Fig. 2). The following morning (14 January) large quantities of dead fishes were cast up along the southern coast of peninsula Vranjic, and at two locations very close to the Croatian coast: northern coast of Ciovo Island (near settlement Okruk Donji-about 35 km from Vranjic peninsula) and in the Zadar channel (Mali Zdrelec, northern coast of Ugljan Island, at about 150 km from Vranjic peninsula; Fig. 2). All dead fish were again *S. aurita* with size ranging from about 5 to 29 cm TL, many of which had their mouths open.

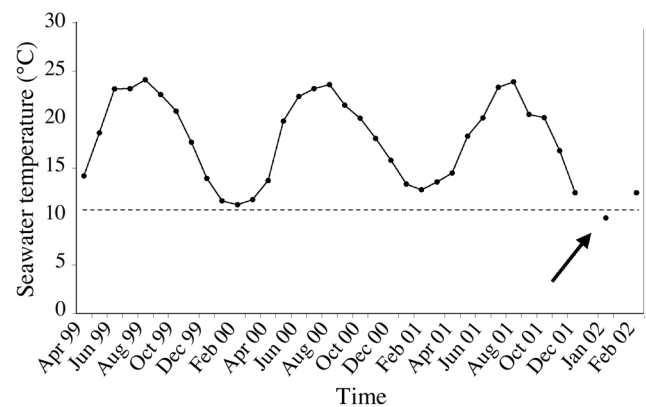


Figure 1. - Trend of monthly seawater surface temperatures from April 1999 to February 2002 in the middle Adriatic (Punta Jurana Station - Institute of Oceanography and Fisheries-Split, Croatia). The arrow indicates the anomalous value recorded in January 2002, while the dotted line refers to the reference temperature of 10°C .

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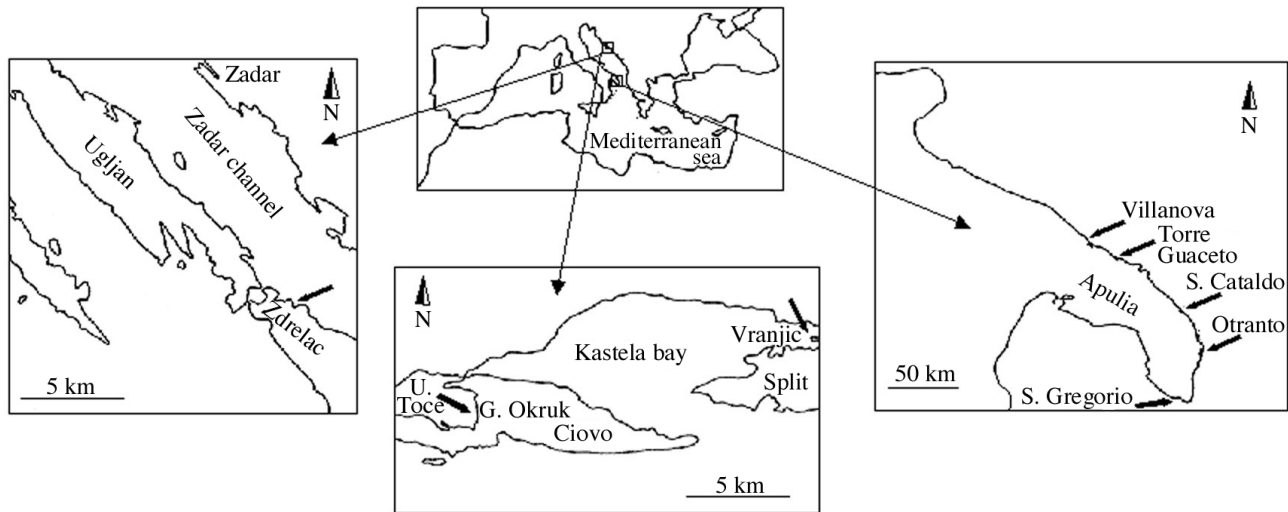


Figure 2. - Maps of the areas where mass fish mortalities were recorded.

A mass mortality of *S. aurita* similar to the one we have described was reported from Thessaloniki Bay (Greece) during winter 1991. This event also coincided with an abrupt temperature fall (Economidis and Vogiatzis, 1992). Furthermore, fishermen from Kastela Bay (pers. comm.) have reported that mass mortalities of *S. aurita* occurred during the winter of 1981, which (according to archive data in the Institute of Oceanography and Fisheries and Maritime Meteorological Centre in Split) was exceptionally cold (8.2°C at the surface and 9.0°C at 5 m depth). These observations thus support the hypothesis that mass fish mortalities could be related to sudden decreases in seawater temperature. It has to be considered, from this perspective, that *S. aurita* is a thermophilous species, having a tropical to temperate distribution between 37°N and 34°S (Whitehead, 1985). According to Kacic (1983-84), gilt sardine is present all year round in the middle Adriatic between 43°N and 44°N latitude, where it is able to complete the whole biological cycle, including spawning. Kacic (1993) also recorded *S. aurita* during summer in the northern Adriatic, off the western coast of peninsula Istra (45°20'N latitude), which is the northernmost occurrence of this species. The available literature shows some discrepancies with regard to the temperature tolerance range of *S. aurita* (see Ben-Tuvia, 1960; Postel, 1960; Bini, 1970). However, the various authors are consistent in stating that the species is very sensitive to temperature changes and that it is far more frequent in the southern sectors of the Mediterranean. Kacic (1983-84), pointed out that although gilt sardine occurs in the Adriatic over a wider temperature range (8.2°-24°C) than elsewhere, sea surface temperatures below 9-10°C may cause mass mortalities of this species.

In conclusion, the mass fish mortality and stranding of *S. aurita* we observed was probably the result of thermal shock and wind transport from open waters towards the middle and southern coasts of the Adriatic and Ionian Seas.

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