THE ROLE OF THE DARDANELLES OUTFLOW ON THE AEGEAN ECOSYSTEM

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Abstract
The Dardanelles outflow of Black Sea-originated waters plays a major role not only in the thermohaline functioning of the North Aegean Sea, but also with regard to its ecological character. The buoyancy input from the Dardanelles significantly influences the North Aegean buoyancy budget, while the input of organic matter determines its ecological functioning. The variability of the Dardanelles outflow induces shifts of the North Aegean ecosystem from a state driven by the microbial food web (during periods of estuarine functioning) to another driven by the new production of organic matter (after periods of dense-water formation) The implications of such shifts can be traced up to the higher trophic levels.
Keywords : Aegean Sea, Dardanelles, Water Convection, Primary Production.

The North Aegean thermohaline functioning is greatly influenced by the buoyancy input from the Dardanelles [1], which in turn is controlled by the volume exchange through the Turkish Straits [2] and the density of the outflowing Black Sea waters. During periods of high buoyancy inflow (which is the norm), the North Aegean behaves as a dilution basin. Anomalously low buoyancy inflow from the Dardanelles combined with winter cooling result in episodic, massive dense water formation. Two such incidents have been recorded, in 1987 and 1992-1993 [1].
The Dardanelles outflow also plays a critical role in determining the characteristics of the Aegean Sea ecosystem. During the "normal"periods of estuarine functioning, the Black-Sea originated waters enrich the North Aegean with organic carbon and nitrogen [4], thus maintaining a microbial-loop based production in the region, in contrast to a multivorous food-web of the South Aegean [5, 6]. This enrichment of Northeastern waters entails a gradient in the oligotrophic character of the ecosystem in the Aegean Sea, which is also reflected in the fisheries and the distribution of the Greek fishing fleet [7]. During the long periods of estuarine functioning, the decomposing organic matter results in a gradual depletion of dissolved oxygen and accumulation of inorganic nutrients in the deep basins of the North Aegean. Thus, during estuarine periods, the deep basins progressively become nutrient reservoirs for the Aegean Sea.
When the estuarine periods are interrupted by episodes of massive dense water formation, the ecosystem functioning of the North Aegean may exhibit similar shifts. These incidents are aided by a reduction of the buoyancy exchange between the Aegean and the Black Sea, which may also be accompanied by a reduction in the inflow of organic matter to the Aegean. Furthermore, the upwelling of the inorganic nutrients stored in the deep basins throughout the estuarine periods may provide the basis for extensive new production in the North Aegean. Thus, a transition from a microbial loop-based to a new production-based ecosystem could be taking place.

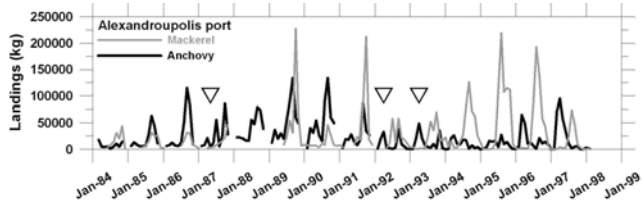

Fig. 1. Time series of mackerel (gray) and anchovy (black) landings at the port of Alexandroupoli, North Aegean. The triangles denote times of massive dense water formation in the North Aegean Sea.

The ecosystem response to the dense-water formation events of 1987 and 1992 has not been studied in detail, mostly due to lack of data from that period. While the response of the primary producers has not been witnessed, a strong influence on the pelagic zooplankton [8] and benthic community [9] in the Cretan and Levantine Seas has been recorded. The magnitude of these findings cannot be explained by the nutrient upwelling in the euphotic zone in these regions [10]. However, the overturning of the water column of the Aegean (and the consequent nutrient upwelling) was much more intense in the regions north of the Cyclades than the South Aegean Sea [1]. In this work we assess the amount of nutrient upwelling in the North Aegean during the dense-water formation period, and estimate the organic carbon production that such an infusion could support. Due to the unfortunate lack of chl-α-monitoring space-borne sensor at that time, we attempt to indirectly assess chl-α concentrations through the monitoring of ocean colour, exploiting NOAA-AVHRR images. The response of the pelagic zooplankton community cannot be studied, as there are no measurements from the Aegean at that time; however, the response of the higher levels of the food chain can be indirectly assessed through the North Aegean fishery landings records. Analysis of the pelagic small fishes (known to be most sensitive to changes in environmental conditions), sardine and anchovy, as well as the anchovy predator mackerel, reveal that the fishery landings increased significantly over the 1-3-year period which followed the major dense-water formation events of 1987, 1992 and 1993 (Fig.1).
These findings suggest that the North Aegean food-chain, which under mild conditions is based on a regenerated-production cycle fed by the infusion of organic matter through the Dardanelles, may shift to a new-production based regime through the upwelling of inorganic nutrients, when the exchange with the Black Sea weakens in conjunction to severe winter conditions.

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