THE INFLUENCE OF THE GULF STREAM ON THE REGIONAL BIOGEOGRAPHY OF ZOOPLANKTON: EVIDENCE FROM TRENDS IN COPEPOD SPECIES ABUNDANCES ACROSS AND ALONG A GULF STREAM MEANDER

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THE GULF STREAM is the strong western boundary current of the North Atlantic Gyre, separating the Slope Water to the north from the Sargasso Sea to the south. The current has been considered an important boundary in both the biological and physical senses, separating two water masses with different environments and distinct biological characteristics. Recent work in physical oceanography introduced the concept that, in addition to being a boundary, the Gulf Stream may also enhance cross-stream transport (and inter-regional mixing) of water parcels and their intrinsic plankton between the Slope Water and the Sargasso Sea. These findings emphasized the need to understand the biological characteristics of the current itself to assess the potential of the cross-stream transport processes to influence the biological communities in the Slope Water and the Sargasso Sea and, in a broader sense, to influence the regional biogeography of zooplankton species.

In my dissertation I addressed the multiple roles of the Gulf Stream as 1) an agent of cross-stream transport/exchange of plankton populations, 2) a unique region with distinct patterns in plankton distributions, and 3) a biogeographical boundary between different plankton populations. In this article I present results from a study of zooplankton distributions in a Gulf Stream meander for which the special role of Gulf Stream meanders in promoting, or inhibiting, cross-stream transport and regional mixing of Slope Water and Sargasso Sea species was identified (Ashjian, 1992).

Abundances of zooplankton populations are hypothesized to change across and along Gulf Stream meanders in response to meander-associated physical processes (Olson, 1990). Upwelling and northward detrainment of Gulf Stream water to the Slope Water may occur up-

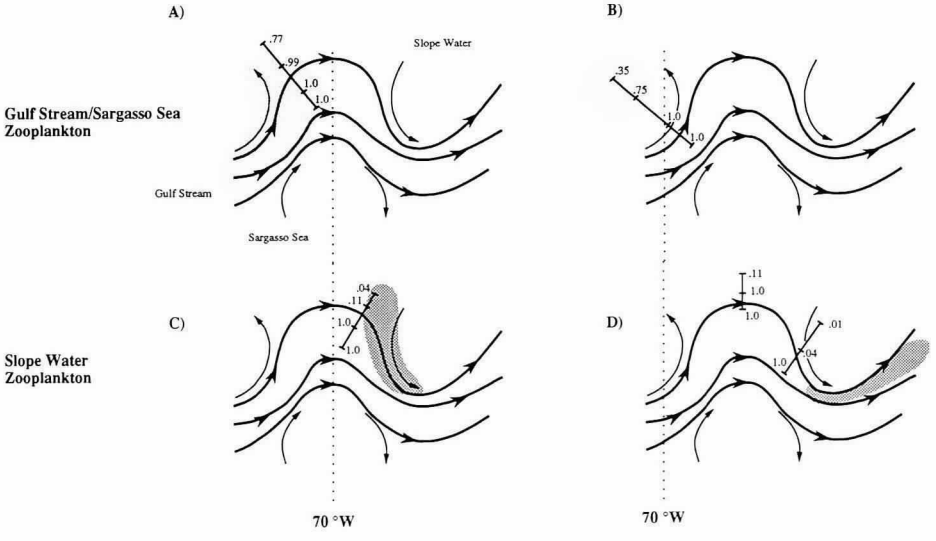

*Fig. 1. Schematic demonstrating cross-stream exchange mechanisms in Gulf Stream meanders, relative proportions of the Sargasso Sea species P. gracilis across 5 transects of the Gulf Stream meander, and the proposed transport processes for Gulf Stream/Sargasso Sea populations (**A** and **B**) and Slope Water populations (**C** and **D**). Stream lines and entrainment and detrainment of water from the current indicated by arrows. The relative proportions of P. gracilis were calculated from the integrated abundances (#/m$_2$) for each station according to the formula: Proportion = #P. gracilis ÷ (#P. gracilis + #P. borealis). All locations and distances for transects are approximate. The shading in the Figure depicts the hypothesized transport processes for plankton populations as a result of entrainment and detrainment (**A** and **C**) and following downstream (eastward) propagation of the meander (**B** and **D**).*

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stream of (before) the meander crest (upwelling flank), and downwelling and entrainment of Slope Water into the Gulf Stream is predicted for downstream of (after) the meander crest (downwelling flank) (Bower and Rossby, 1989; Olson, 1990). Five transects of a Gulf Stream meander were conducted in fall 1988 as part of the BIOSYNOP program. Zooplankton were enumerated from samples collected across the transects. The abundances and relative proportions of two congeneric copepod species, one characteristic of the Sargasso Sea/Gulf Stream (*Pleuromamma gracilis*) and one characteristic of the Slope Water (*P. borealis*), reflected the ongoing physical transport processes. In Figure 1, the proportion of the Sargasso Sea species, *P. gracilis,* out of the total abundance of the two species is indicated at appropriate cross-stream locations on the five transects. The Sargasso Sea species was relatively more abundant across transects of the upwelling flank and high proportions (0.35–1.0) were found to the north quite far away from the Gulf Stream along these transects (A and B). In contrast, the proportion of the Sargasso Sea species was very low (0.01–0.11), with high abundances of the Slope Water species, at all locations north of the Gulf Stream on the two transects conducted across the downwelling flank (C and D). A transect across the crest showed an intermediate pattern (D). These observations suggested that loss of Gulf Stream water, and intrinsic plankton, to the north was occurring in the upwelling region of the meander. Entrainment of Slope Water into the current was occurring in the downwelling flank, transporting high abundances of Slope Water species close to the Gulf Stream.

The high proportions of the Sargasso Sea species found to the north of the current (up to 102 km from the current) (B) suggested a past history of cross-stream exchange and a mechanism that would promote cross-stream transport for Gulf Stream/Sargasso Sea zooplankton populations (A and B). These species would be detrained from the Stream on the northern side of the upwelling flank and would remain in the Slope Water as the meander propagates to the east (B). In contrast, effective cross-stream transport of Slope Water populations across the Gulf Stream into the Sargasso Sea is not likely to occur by these processes. Although Slope Water populations may be entrained into the Gulf Stream in the downwelling flank of a meander (C), these animals will enter the high velocity region of the Gulf Stream and be advected downstream (D), rather than further across the current. The results of this study suggest that meander-associated cross-stream mixing, at least of Sargasso Sea species, may be a significant process in promoting the regional dispersal of zooplankton.

References

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