OCEAN PLANKTON

Environmental characteristics of Agulhas rings affect interocean plankton transport

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Agulhas rings provide the principal route for ocean waters to circulate from the Indo-Pacific to the Atlantic basin. Their influence on global ocean circulation is well known, but their role in plankton transport is largely unexplored. We show that, although the coarse taxonomic structure of plankton communities is continuous across the Agulhas choke point, South Atlantic plankton diversity is altered compared with Indian Ocean source populations. Modeling and in situ sampling of a young Agulhas ring indicate that strong vertical mixing drives complex nitrogen cycling, shaping community metabolism and biogeochemical signatures as the ring and associated plankton transit westward. The peculiar local environment inside Agulhas rings may provide a selective mechanism contributing to the limited dispersal of Indian Ocean plankton populations into the Atlantic.

The Agulhas Current, which flows down the east coast of Africa, leaks from the Indo-Pacific Ocean into the Atlantic Ocean (*1*). This leakage, a choke point to heat and salt distribution across the world's oceans, has been increasing over the last decades (*2*). The influence of the Agulhas leakage on global oceanic circulation makes this area a sensitive lever in climate change scenarios (*3*). Agulhas leakage has been a gateway for planetary-scale water transport since the early Pleistocene (*4*), but diatom fossil records suggest that it is not a barrier to plankton dispersal (*5*). Most of the Agulhas leakage occurs through huge anticyclonic eddies known as Agulhas rings. These 100- to 400-km-diameter rings bud from Indian Ocean subtropical waters at the Agulhas Retroflection (*1*). Each year, up to half a dozen Agulhas rings escape the Indian Ocean, enter Cape Basin, and drift northwesterly across the South Atlantic, reaching the South American continent over the course of several years (*1*, *6*). During the transit of Agulhas rings, strong westerly "roaring forties" winds prevalent in the southern 40s and 50s latitudes cause intense internal cooling and mixing (*7*).

We studied the effect of Agulhas rings and the environmental changes they sustain on plankton dispersal. Plankton such as microalgae, which produce half of the atmospheric oxygen derived from photosynthesis each year, are at the base of open-ocean ecosystem food chains, thus playing an essential role in the functioning of the biosphere. Their dispersal is critical for marine ecosystem resilience in the face of environmental change (*8*). As part of the *Tara* Oceans expedition (*9*), we describe taxonomic and functional plankton assemblages inside Agulhas rings and across the three oceanic systems that converge at the Agulhas choke point: the western Indian Ocean subtropical gyre, the South Atlantic Ocean gyre, and the Southern Ocean below the Antarctic Circumpolar Current (Fig. 1).

Physical and biological oceanography of the sampling sites

The Indian, South Atlantic, and Southern Oceans were each represented by three sites sampled between May 2010 and January 2011 (Fig. 1 and table S1). A wide range of environmental conditions were encountered (*10*). We first sampled the two large contiguous Indian and South Atlantic subtropical gyres and the Agulhas ring structures that maintain the physical connection between them. On the western side of the Indian Ocean, station TARA_052 was characterized by tropical, oligotrophic conditions. Station TARA_064 was located within an anticyclonic eddy representing the Agulhas Current recirculation. Station TARA_065 was located at the inner edge of the Agulhas Current on the South African slope that feeds the Agulhas retroflection and Agulhas ring formation (*3*). In the South Atlantic Ocean, station TARA_070, sampled in late winter, was located in the eastern subtropical Atlantic basin. Station TARA_072 was located within the tropical circulation of the South Atlantic Ocean, and Station TARA_076 was at the northwest extreme of the South Atlantic subtropical gyre. Two stations (TARA_068 and TARA_078) from the west and east South Atlantic Ocean sampled Agulhas rings. Three stations (TARA_082, TARA_084, and TARA_085) in the Southern Ocean were selected to sample the Antarctic Circumpolar Current frontal system. Station TARA_082 sampled sub-Antarctic waters flowing northward along the Argentinian slope, waters that flow along the Antarctic Circumpolar Current (*11*) with characteristics typical

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