Dynamics of the Confluence of Malvinas and Brazil currents, and a Southern Patagonian spawning ground, explain recruitment fluctuations of the main stock of *Illex Argentinus*

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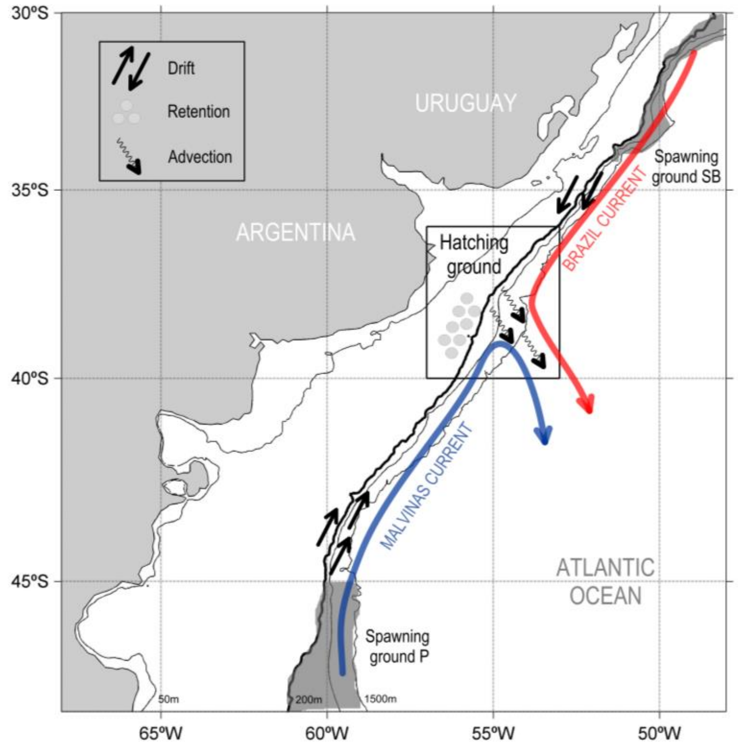
The Argentine shortfin squid (*Illex argentinus*) sustains one of the world's largest squid fisheries. This squid presents strong interannual fluctuations in abundance, attributed to its semelparous life strategy coupled with environmental influences on recruitment. Several stocks have been identified, but the south patagonic stock (SPS) is the most abundant and the main support (ca. 80%) of the Argentine fishery. SPS spawns in autumn-winter, but there are controversies regarding the spawning ground location. We studied the relationship between the recruitment variability and oceanographic conditions to which eggs and paralarvae are exposed, considering two possible spawning ground locations: Patagonia (P) and Southern Brazil (SB). We tested the hypothesis that the SPS recruitment variability could be controlled by oceanographic fluctuations related to the transport of the egg masses spawned on each of the two grounds, to their retention on the continental shelf and to the attainment of the thermal habitat required for eggs hatching.
To accomplish our objectives we used a 24 years long time series (1993–2017) of catch per unit effort of the squid fishery, a stock-assessment time series as recruitment proxy; geostrophic velocities derived from maps of sea level obtained from satellite altimetry and maps of satellite sea surface temperature (SST). All this information was employed to model the advection of the squid egg masses along the external shelf and slope and to estimate the annual recruitment success. Geostrophic currents were used to compute the advection of the egg masses. Results show that if spawning occurs in Patagonia, 52% of the recruitment variability could be explained. On the other hand, if spawning occurs in southern Brazil, it does not result in successful recruitments for the SPS.



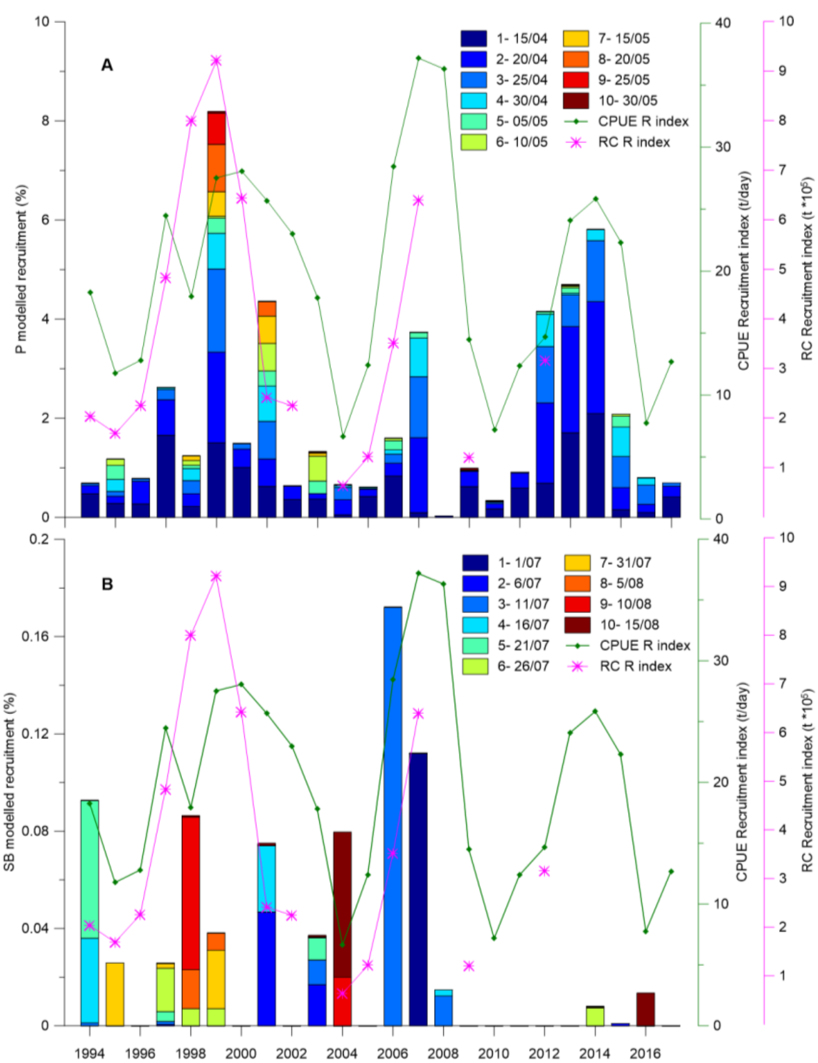
Study area and model summary. The two spawning ground of the SPS and the inferred hatching ground. The arrows represent the currents and the different processes that affect the particles. Black lines are isobaths 50 m, 200 m (bold line), 800 m and 1,500 m.

Particles (egg masses) were released sequentially (every five days for two months) at the surface in the two spawning grounds and their drift was tracked.

For each year of the 1993-2017 time series, we estimated the percentage of successful particles, which accomplish three conditions:

1. To reach the hatching ground (HG) and remain there for at least ten days;
2. To reach waters with SST higher than 11ºC for at least 10 days (11ºC is the thermal hatching threshold); and
3. To end the trip over the continental shelf (i.e. in waters shallower than 200 m) after departing from the P (SB) spawning ground.

Those particles having a final position in waters deeper than 200 m would be exported to the oceanic domain, and will be lost for the squid population. The number of successful particles (future recruits) for each year was compared with the squid CPUE and research cruises (RC) of the following year (recruitment indexes).



Principal results. Recruitment index versus modelled recruitment for the P (A) and SB (B) spawning grounds. Colour bars represent the percentage of successful particles (modelled recruitment) (left axis), and green and magenta line the recruitment indexes, respectively (right axis). Legend indicates the releasing period represented by each colour bar. Tests show significant correlation between the P modelled recruitment and the recruitment indexes and no correlation with the SB.

Conclusion

The Brazil Malvinas Confluence (BMC) region is the main conduit for the surface shelf waters to the deep ocean, and suggest that the exportation could be driven by the dynamics of the western boundary currents and local winds.

We conclude that part of the squid recruitment is explain by the three processes together:

1. the transport of egg masses to the HG;
2. the availability of an adequate thermal habitat for paralarvae hatching and survival; and
3. the retention of early paralarvae in the shelf ecosystem.

The three processes are dictated firstly by the dynamics of the MC and then by dynamics of the MC and BC in the BMC.

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