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Notes on Jumbo flying squid distribution in Peruvian national waters during 2018-2019

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NOTES ON JUMBO FLYING SQUID DISTRIBUTION IN PERUVIAN NATIONAL WATERS DURING 2018-2019

by

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SUMMARY

In the hydroacoustic assessment surveys of pelagic resources carried out by IMARPE between 2018 and 2019, it was determined that the jumbo flying squid has a wide distribution throughout the Peruvian national waters, generally beyond 20 nm distance from the coast, where it was found in scattered small isolated areas of higher abundance, mainly concentrated in oceanic Surface Subtropical Waters (SSW) and along the fronts where mixed SSW and Cold Coastal Waters (CCW) occur. Habitat preferences of Jumbo flying squid appears to be highly flexible, as reflected by the wide range of temperatures and salinities typical of their horizontal and vertical distribution, from the surface to 400 meters of depth, following the concentration of mesopelagic organisms it feeds on. Confirming that this species has highly flexible habitat requirements and adapts easily to changing environmental conditions through its vertical migrations and constant search for food.

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1. Introduction

This paper presents the partial results of the analyses of the spatial-temporal distribution of the jumbo flying squid (*Dosidicus gigas*) recorded during the following four acoustic research surveys carried out by the Instituto del Mar del Peru (IMARPE) during 2018 and 2019:

(a) Pelagic resources hydroacoustic assessment survey, Cruise 1802-04, from 22 February to 6 April 2018 (IMARPE 2018);

(b) Pelagic resources hydroacoustic assessment survey, Cruise 1809-11, from 27 September to 18 November 2018 (IMARPE 2018a);

(c) Jumbo flying squid research survey, Cruise 1812-1901, from 1 December 2018 to 27 January 2019 (IMARPE 2019); and,

(d) Pelagic resources hydroacoustic assessment survey, Cruise 1902-03, from 12 February to 27 March 2019 (IMARPE 2019a).

The main objective of the pelagic resources hydroacoustic assessment surveys is to assess the biomass of anchoveta (*Engraulis ringens*). Therefore, the surveyed area covered with a series of parallel transects 10 nm apart, perpendicular to the coastline, from 3-5 nm to at most 100 nm distance from the coast, although some profiles may be extended beyond that distance from the coast in special circumstances. While during the jumbo flying squid research survey the maximum distance from the coast was 198 nm, with distances of 30 to 40 nm between transects.

The surveys were carried out with IMARPE's scientific research vessels: R/V José Olaya Balandra, R/V Humboldt and/or R/V Flores Portugal, which are equipped with scientific echosounders Simrad EK80, oceanographic rosettes, fishing nets, and other relevant research equipment. The sampling design was systematic (parallel transects perpendicular to the coast) as described by Simmonds and MacLennan (2005).

2. Horizontal and vertical distribution of jumbo flying squid

Jumbo flying squid horizontal distribution was generally "very dispersed", along the whole Peruvian coast, usually beyond the 20 nm from the coast (Figure 1). During the pelagic surveys it was detected in various areas or isolated nuclei, and during the jumbo flying squid survey it had an increased presence, mainly in the central and south-central zone. In general, the tendency of its distribution according to the centers of gravity is the central zone. Meanwhile, the inertia of the distribution was

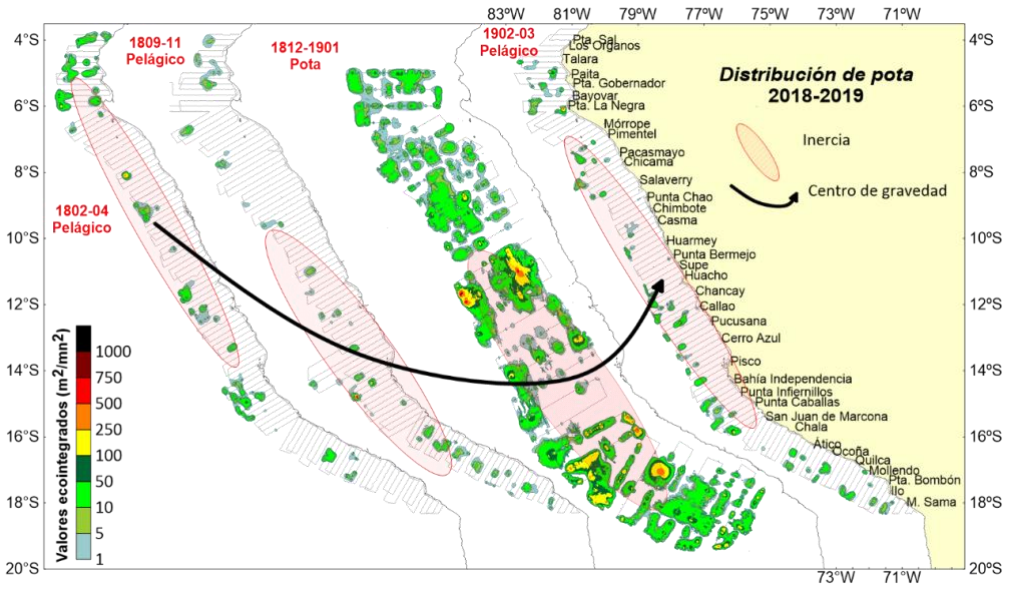

Figure 1.- Observed horizontal distribution of jumbo flying squid (*Dosidicus gigas*) during four IMARPE acoustic surveys in 2018 and 2019. Inertia ellipses are indicated in shaded red and the trend of the centers of gravity by the black arrow

broader during Cruise 1812-1901 (December 2018 – January 2019), due to the greater distribution areas or presence of jumbo flying squid in most of the scheduled transects. In this research survey the area covered was wider, extending to as far as 198 nm from the coast, while the pelagic surveys only reached the 100 nm distance from the coast.

The nictemeral behavior of jumbo flying squid during its vertical distribution is observed though the acoustic registries obtained during these four surveys (Figure 2). Ii is noted that during daytime jumbo flying squid tended to descend to depths of 350 m, and down to 450 m in December 2018-January 2019; while at nighttime they ascend towards the surface layer, within 100 m from the surface. However, it was observed that in some areas these aggregations tend to remain close to the surface layer also during daytime, probably due to the higher availability of food. It is clear that during Cruise 1812-1901, there was a higher abundance of jumbo flying squid, which is reflected by the nictemeral behavior and vertical distribution in Figure 2, as well as by horizontal distribution in Figure 1. It was

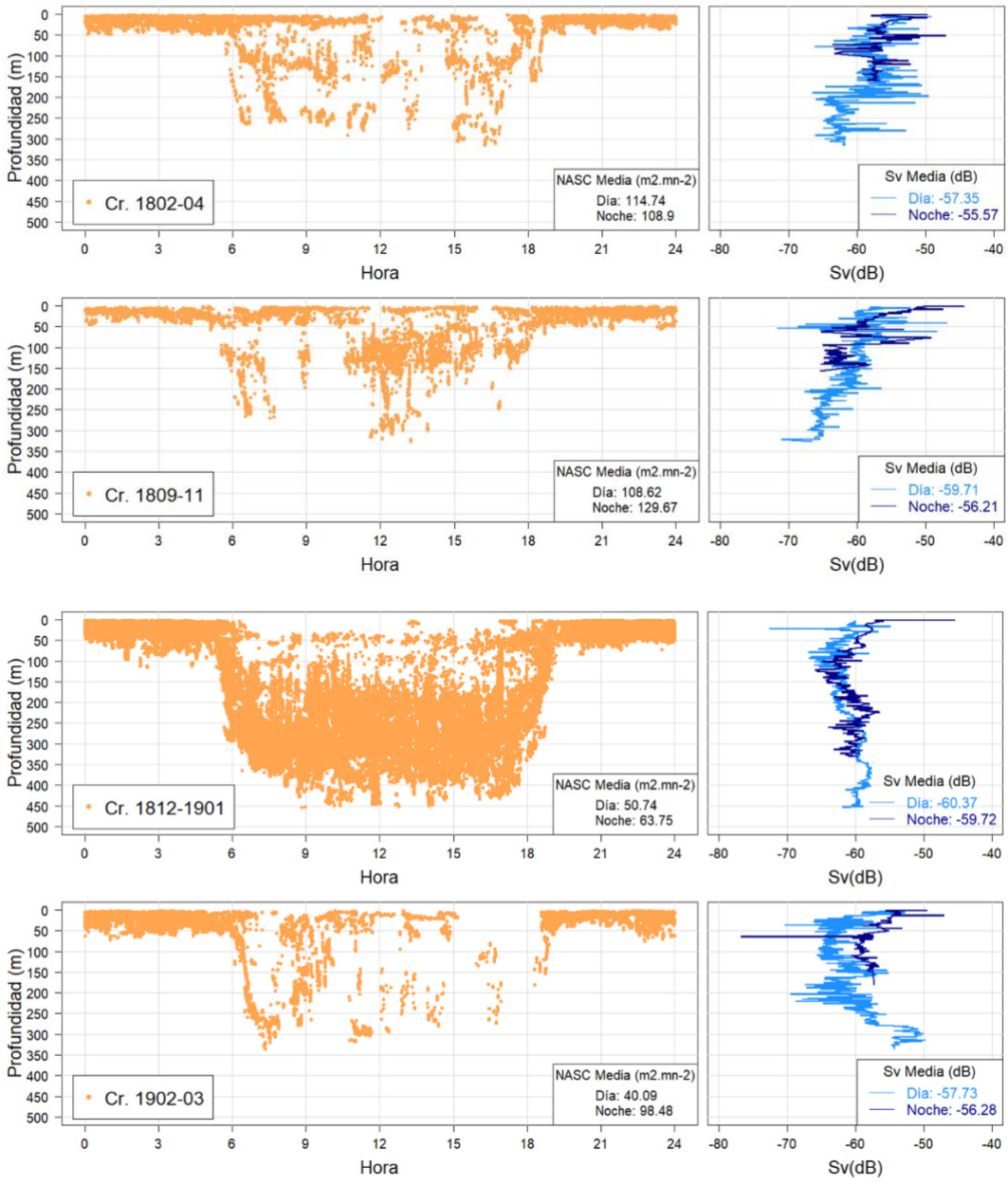

Figure 2.- Changes in the vertical distribution of jumbo flying squid (*Dosidicus gigas*) concentrations during a 24-hour cycle (left panels, orange dots), and in the mean vertical acoustic volume backscattering strength Sv(dB) (right panels) during day-time (light-blue lines) and night-time (dark-blue lines), observed during four acoustic surveys conducted by IMARPE between February 2018 and March 2019

noted that in all the cruises, the jumbo flying squid abundance was higher during the night hours than during daytime, due to the increased availability of food in the surface layer. On some occasions, when jumbo flying squid was small or medium-sized, the acoustic traces were tenuous, and was found deeper during the day (up to 450 m depth, during Cruise 1812-1901, Figure 2), making their identification difficult if there was no fishing at those depths, requiring a more experienced eye for proper identification.

3. Environmental conditions and jumbo flying squid distribution

At the surface level, the spatial-temporal distribution of jumbo flying squid was generally associated with surface temperatures between 18.5° and 26.0°C, and surface salinities between 35.05 and 35.40 ups, corresponding to the SSW (oceanic) and CCW and SSW mixed waters (Figure 3).

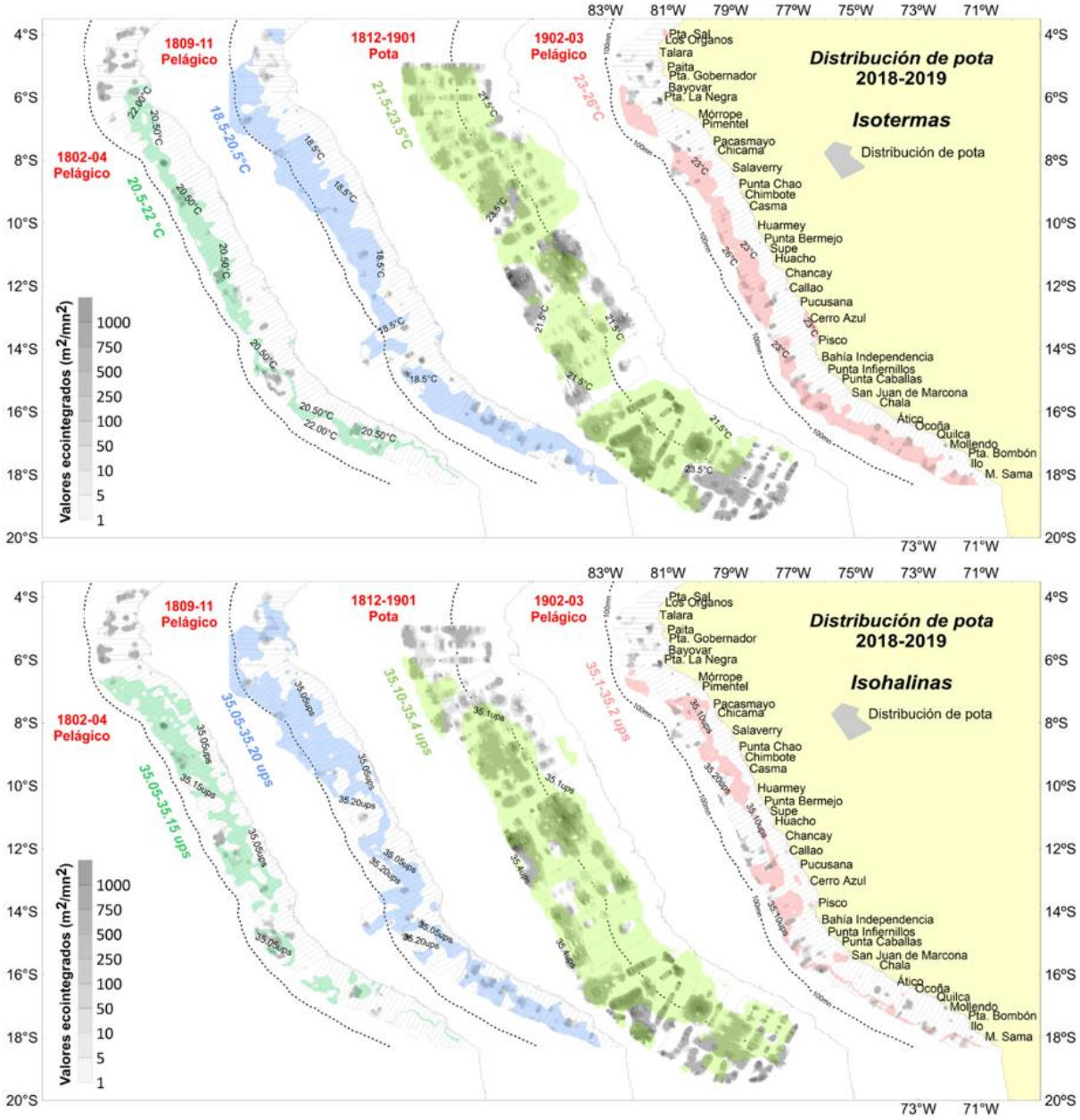

Figure 3.- Horizontal distribution of jumbo flying squid (*Dosidicus gigas*) in relation to surface isotherms and isohalines observed during four IMARPE acoustic surveys in 2018 and 2019. Dotted line parallel to coast corresponds to 100 nm distance from the coastline

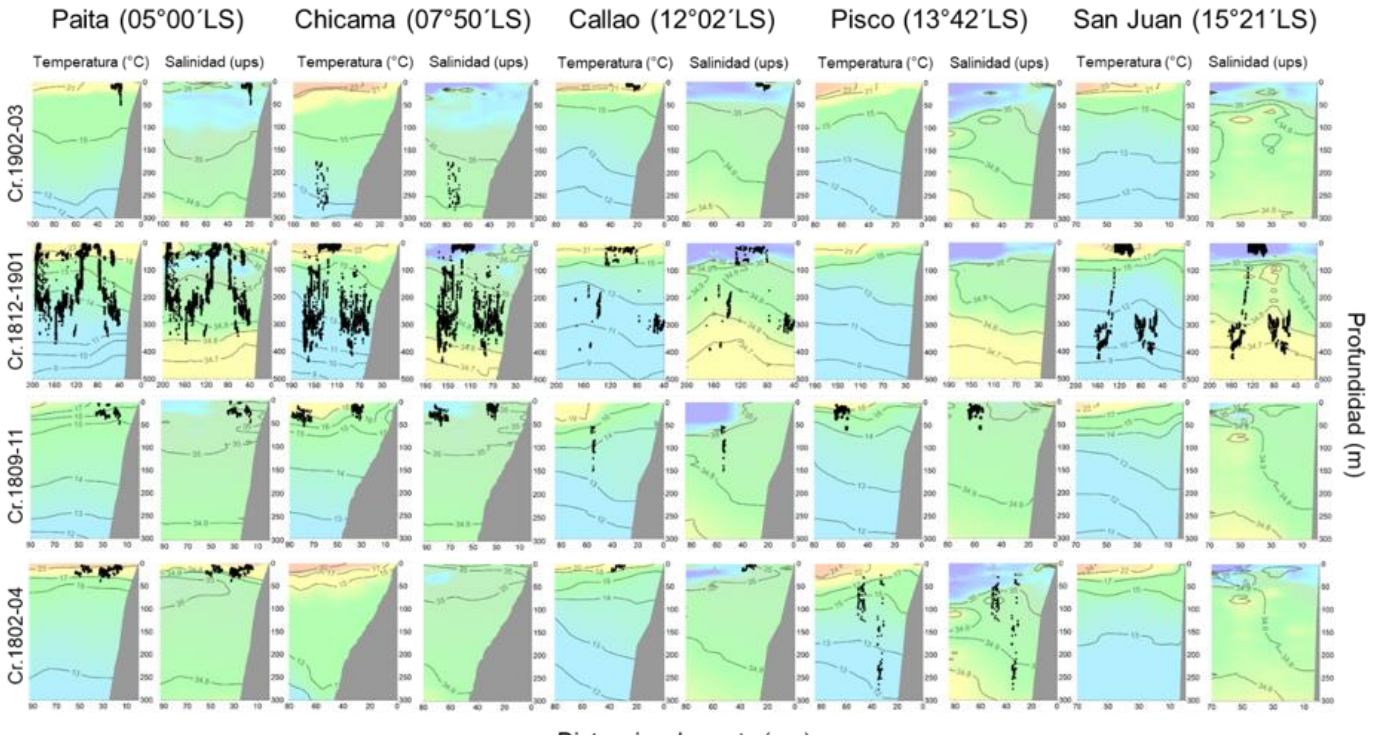

Figure 4.- Vertical distribution of jumbo flying squid (*Dosidicus gigas*) in relation to temperature and salinity by depth and distance from the coast observed along oceanographic profiles perpendicular to five selected sites along the Peruvian coast during four IMARPE acoustic surveys in 2018 and 2019

The observed distribution of vertical aggregations of jumbo flying squid in relation to temperature and salinity by depth and distance from the coast during oceanographic profiles perpendicular to five selected sites (Paita, Chicama, Callao, Pisco and San Juan) along the Peruvian coast made during the four IMARPE acoustic surveys in 2018 and 2019 is shown in Figure 4.

The widest range in the vertical distribution of jumbo flying squid in relation to observed environmental conditions was found during the squid Cruise 1812-1901. Where concentrations of jumbo flying squid were detected at the profiles off Paita (5°00'S), across the isotherms of 11 to 22°C and the isohalines of 34.8 to 35.1 ups, from the surface down to 300 m deep; off Chicama (7°50'S), across the isotherms of 10 to 22°C and the isohalines of 34.7 to 35.2 ups, from the surface down to 400 m deep; and, off Callao (12°02'S) and San Juan (15°21'S), across the isotherms of 9 to 23°C and the isohalines of 34.7 to 35.2 ups, from the surface down to 400 m deep.

During the pelagic Cruise 1802-04 the main jumbo flying squid concentrations were found off Pisco (13°42'S), across the isotherms of 12 to 22°C and the isohalines of 34.8 to 35.2 ups, from 20 to 300 m deep.

This wide range of environmental parameters observed for jumbo flying squid confirms that this species has highly flexible habitat requirements and adapts easily to changing environmental conditions through its vertical migrations and constant search for food.

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