

Doctoral Thesis

Genetic population structure in the highly commercial Humboldt squid

Dosidicus gigas

(Summary)

Sanchez Silva Luis Gustavo

Department of Bioresource Science

Graduate School of Biosphere Science

Hiroshima University

March 2019

Ommastrephid cephalopods represent an important percentage of the global fisheries of squids all over the world. As in any cephalopod, environmental changes might affect the global catch of these resources which are important in the human diet due to the low-fat content and high-quality protein. The Humboldt squid *Dosidicus gigas* is the largest squid fishery in the world and the total landings of this species has been high compared with the rest of the ommastrephid squids. Landings of this resources is high in upwelling regions such as in the Humboldt current in which is caught by local artisanal fisheries within the exclusive economic zone (EEZ) of Peru as well as by industrial fleets at international waters outside the EEZ of Peru. The lifespan of this squid ranges from 1 – 2 years which makes it susceptible to the year-to-year environmental change that happened in its distribution, particularly in the El Niño 1+2 region. In addition, three different sizes at maturation can be observed throughout its ranges of distribution with different sizes overlapping in the same regions. This dissertation addresses the population dynamics of this important economic resource using genetics tools from maternal and paternal inheritance such as the nuclear microsatellite DNA markers and the mitochondrial DNA NADH dehydrogenase II (ND2).

Chapter 2 is focused on DNA barcoding from several cephalopods distributed in the Japanese market including the Humboldt squid and other highly commercial species sold fresh, frozen and in cans. The Humboldt squid importation to the Japanese market is high and will likely increase in the following years thanks to the Japan-Peru Free Trade Agreement. Thus, traceability based on DNA of this resource is very important. A novel DNA marker is proposed, the 5' end of the mitochondrial 16S rRNA, as a complement to the universal DNA barcode. The high between-species polymorphism of this marker was able to identify correctly different cephalopod species

as also indicate a potential cryptic species in other two commercial cephalopods from diverse distribution.

In Chapter 3, I develop ten novel nuclear microsatellite loci for this species in a small population within Peru. Then, I used these microsatellite loci together with a short region of the mitochondrial ND2 in 120 individuals from Peru to explore the population genetics of this species based on abundances (geographical locations: North and Central – South populations) and different size at maturation (small, medium and large population). Although a small genetic differentiation was found between the small and large population based on mtDNA ND2, nuclear markers indicated a single genetic unit, giving the first hint into a contrasting pattern of genetic structure based on the inheritance of the DNA markers. To confirm this pattern, in the Chapter 4 more individuals were included in the analysis ($n = 451$) from different regions that includes the southern hemisphere (Peru), the northern hemisphere (Costa Rica Dome) and populations surrounding the north-south hemisphere break (one within the South Equatorial Current and the other from Ecuador). This analysis also yielded in a contrasting pattern from the nuclear mitochondrial DNA. Mitochondrial DNA markers indicate a low but significant population genetic structure at both hemispheres while microsatellite loci indicated a population structure only between the Costa Rican Dome and the Peruvian populations. As the region of this squid distribution is under constant changes (observed as differences in temperature every year), the results of this thesis suggest an overall elevated gene flow and possibly sex-biased dispersion as observed from the contrasting pattern on both DNA markers used.

To sum up, the results of the present dissertation provide a very important information for the fisheries management of the Humboldt squid *Dosidicus gigas* in the upwelling waters of Peru and other regions. Also, traceability of this squid (and other cephalopod species) is addressed in this

dissertation within the Japanese market, principally due to the difficulty of species identification of cephalopods from small muscle tissues sold as fresh, frozen or in cans.