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Prospect of distribution and fishing of jumbo squid off the Chilean coast in the 2019 season versus 2017-2018

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Prospect of distribution and fishing of jumbo squid off the Chilean coast in the 2019 season versus 2017-2018

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Abstract

Related to the studies available from 2011-2019, in the coast of central and south-central Chile, the jumbo squid was presented in the fishery between the years 2011-2016 by specimens which belong to two incoming generations from open sea parallel to the coast, with fattening distribution throughout the year.

During the years 2017-2019 there are changes in the behavior of the resource, such as spatial distribution, permanence in the fishery and the size structure of captured specimens. In these years the fishing season is reduced to only 7-8 first months of the year. Jumbo squid fishing in 2017 is concentrated in incoming specimens above 50-55 cm ML, during the second half of 2016 without abundants new pulses from the open sea in the first months of 2017.

During 2018, similar sizes of squid concentrations of 2017 enter to the coast with a single pulse for 37ºS approximately, to subsequently disperse along the coast. To the south (smaller quantity) and to the north (larger quantity). As during 2017 the entire jumbo squid mass present in 2018 at an age close to two years (as in 2011-2016) migrates northward to its spawning area in front of the southern coasts of Peru from July-August. During 2019 season the entrance to the fishery also occurs with a single pulse but not from the open sea, if not from the north through the areas which are very close to the coast, starting from 27ºS in February to concentrate in April-July in 35-36º40'S

This year, for the first time in the Chilean fishery development period, the incoming jumbo squid is represented by very small specimens, 25-30 cm ML in February-March and a mode close to the 50 cm ML in August, also in a very short size range, not exceeding 20 cm between minimum and maximum size. Probably, the generation of jumbo squid (smaller size) that entered to the Chilean coast from February 2019 is a spawning product from October-November 2018 in front of the coast of southern Peru. This generation is also predominant in the coastal fishery of southern Peru between May-August of the current year, according to preliminary data which indicates the similarity of sizes in both regions in the same period.

1. Background

As is known in jumbo squid fishery of the Southeast Pacific (in front of the coast of Peru and Chile) it is possible to observe the presence of up to three groups of specimens of different sizes (ages). According to the classification of Nigmatullin et al. (1991, 1999 and 2001), these groups correspond to: a) small sizes (males (M) 13-26 cm ML, females (F) 16-34 cm ML), b) medium sizes (M-F: 24-42 cm ML and 28-60 cm ML), c) large sizes (M-F:> 40-50 cm ML and from 55-65 to> 100 cm ML) (group “S”, “M” and “L”, respectively) (Figure 1).

It is also recognized that spawning occurs at each of these groups with different levels of intensity, mainly between November and January, as well as in July-August (Yamashiro et al., 1998; Tafur et al., 2001). It is also recognized, on the basis of fishing operations of different fleets in the Southeast Pacific during the last decade, the spatial preference of different groups of jumbo squid (in food) to different habitat´s conditions, for example, types of water bodies: “S” group - towards the equatorial-tropical waters; group "M" - towards subtropical waters; group "L" - towards subantarctic (Humboldt Current). However, jumbo squid spawning occurs preferably in tropical or tropical and subtropical mixing waters, with surface temperatures between 18-25ºC (mainly>21ºC) (Tafur et al. 2018; Csirke et al., 2018; IMARPE 2015).

Studies based on jumbo squid´s biological information conducted by INPESCA, collected and analyzed between 2011 and 2018, mainly from the industrial fleet of central-south Chile, it was possible to conclude the following (Gretchina & Zúñiga, 2018):

a) In Chilean fishery, jumbo squid presents a group with a life cycle of two years.

b) This group is formed by migrant specimens in age close to one year (50-60 cm ML) from subtropical ocean waters to the Chilean coasts between months May-June to October of each year.

c) Jumbo squid´s preferential coastal habitat in Chile is cold waters and high biological productivity from Humboldt Current and / or frontal areas at the edges of the coastal upwellings.

d) In these waters, jumbo squid additions are being fattened from the entrance to Chilean coasts from May-October of year 1 to September-November of year 2, mainly in the high concentrations of mesopelagics fishes and/or euphausiids.

e) Practically, there is not reproductive activity of jumbo squid in the area during this period; there are not found specimens; maturing process and spawning.

f) The emigration of jumbo squid from Chilean coast (supposes towards oceanic spawning area in warm tropical waters in front of the coast of Peru and northern Chile) occurs in October-December when the specimens reach their mantle´s greatest dorsal length and weight at the age close to 2 years. In those months there is a total biomass renovation of D. gigas in front of south-central Chile.

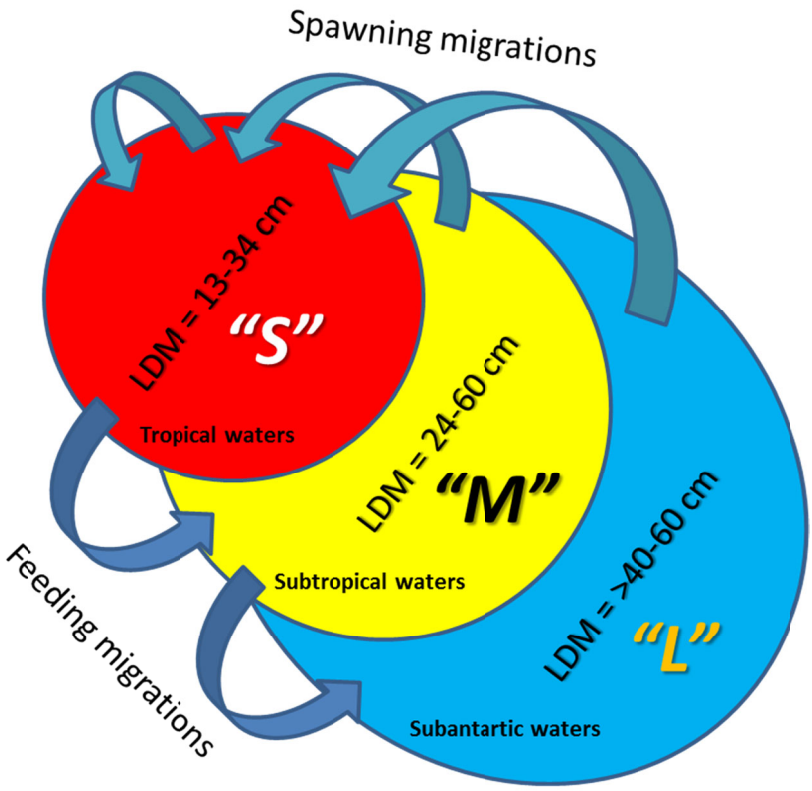


Figure 1. Conceptual scheme of structural composition of jumbo squid size groups in the population structure in the Southeast Pacific (Gretchina & Zúñiga, 2018).

2. The jumbo squid fishery in Chile in 2017-2019

Jumbo squid fishing in Chile is carried out by the industrial fleet (with half-water trawls) and the artisanal fleet (jigging and sporadically with purse seines). The main fishing areas of the industrial fleet are located in front of the coast between 36º-38º30'S and the artisanal fleet, in 30ºS, 32-34ºS, 35ºS and 36º30-37º30'S

The most stable fishing areas are where the industrial fleet operates, that is, with a few variations on a monthly and interannual scale, its fishing operations are restricted only with volume of the fishing quota, 40,000 tons per year and / or 5,000 tons per month during the first 8 months of the year (Gretchina & Zúñiga, 2018). This is not the case for the artisanal fleet when the fishing intensity in the indicated areas depends on the availability of the resource at certain times of the year and the adverse, unfavorable and frequent weather conditions in the region.

During the last three years (2017-2019) the industrial fleet operates practically in the same region as 2011-2016 (Gretchina & Zúñiga, 2018) (Figure 2). However, unlike the years 2011-2016 and considering the fishing information coming from the artisanal fleet, the last three years there have been important changes in distribution, resource availability and

fishing season lenght throughout Chilean coasts. Before 2017 jumbo squid was present all year for the industrial fishery. In 2017, only present for the first 8 months (January-August) between 36º-38º20'S, in 2018 only the first 7 months (January-July) between 35º50'-38º40'S and, in 2019, the fishing season starts only at the end of March-April and it has a significantly decrease towards the end of August. Fishing areas are located only towards the north of Talcahuano, between 35º50'-36º40'S (Figure 2).

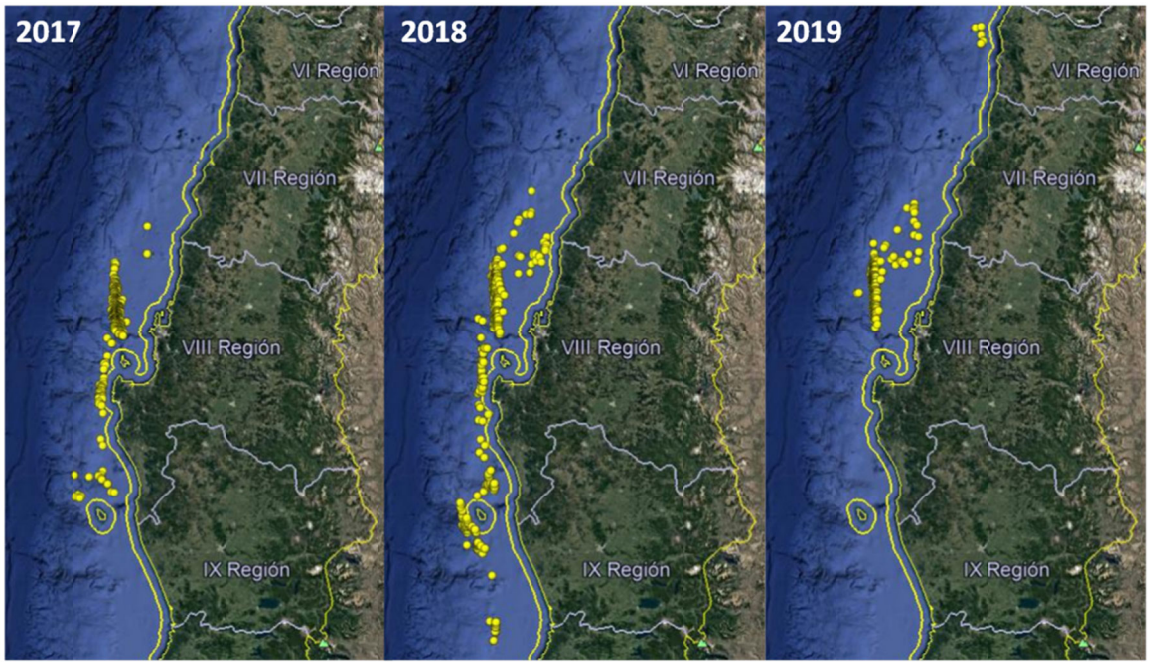


Figure 2. Monthly distribution of jumbo squid fishing tows of the industrial fleet of central-south Chile, the years 2017-2019. Source: INPESCA.

Despite this, as the statistics of jumbo squid landings in Chile for period 2012-2019 shows, the period when by law the fishery of this resource is declared only for human consumption (Table 1), during the years 2017 and 2018 the annual catches of industrial and artisanal fleet remain practically similar to each other respectively, totaling around 145 thousand tons per year. During the year 2019 the industrial fleet fulfills its fishing quota in 5 months (the catch of April-August reaches 40,660 tons), however, artisanal fleet catches decrease drastically, they reach until August only 9,393 tons (against about 110 thousand tons in 2017 and 2018). The latter is related to the almost total absence of squid in some traditional fishing areas (such as south of 36º30'-37ºS) and the only presence of small squid specimens in other areas that determines low yields (profitability) of artisanal jigging fleet.

Analyzing the inter-monthly dynamics of industrial and artisanal fleet between 2016-2019 (Figure 3), it is possible to see a significant difference in 2019 monthly catch compared to 2016-2018: a) the industrial fleet in 2019 concentrates its operations between May and July, while in 2016-2018 its catching was quite similar (small variations in 2018) between January-August, with monthly landings around 5,000 tons; b) the artisanal fleet in 2019 between January and August 2019 presents very low monthly catches, while in 2016-2018

the inter-monthly dynamics within each fishing season showed very clear similarities between the years, reaching the maximum monthly catch between March and June, only that in 2017 and 2018 the main fishing season ends in August and July. In 2016 with lower monthly catches lasts until the end of the year.

Table 1. Catches (tons) of jumbo squid in Chilean waters between 2012-2019 (2019 until August 26) artisanal and industrial fleet (SERNAPESCA Statistics).

Year	Artisanal	Industrial	Total
2012	114.271	29.489	143.760
2013	96.867	9.050	105.917
2014	124.076	51.203	175.179
2015	104.179	39.403	143.582
2016	120.021	39.329	159.350
2017	103.340	39.130	142.470
2018	110.656	33.390	144.046
2019	9.393	40.660	50.053

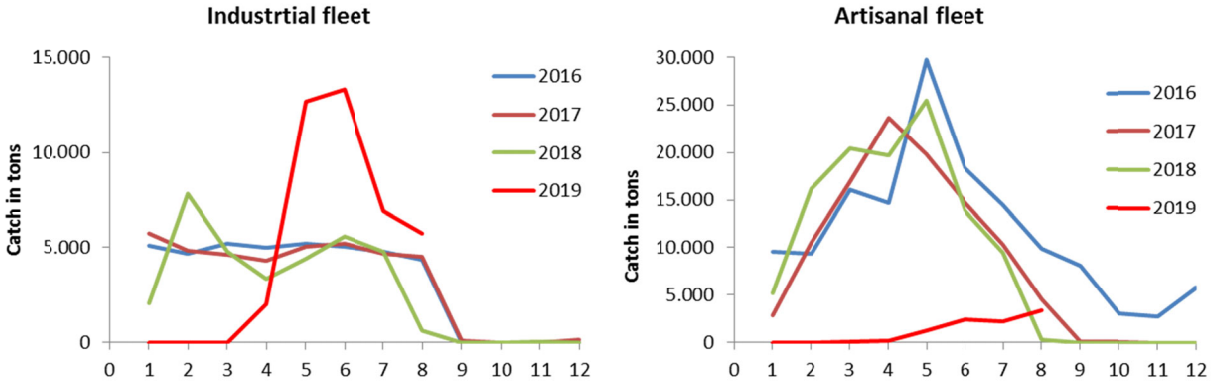


Figure 3. Dynamic of monthly jumbo squid catches of the Chile, of industrial and artisanal fleets between 2016-2019.

2. Space-time distribution and size dynamic in 2017-2019

In general, jumbo squid fishery in front of the Chilean coast before 2017 was always based, at least, on two generations of this mollusk: one from current year and another that stayed in the area of the last year. For this reason is registered a wide range of sizes catched in an annual scale (Figure 4).

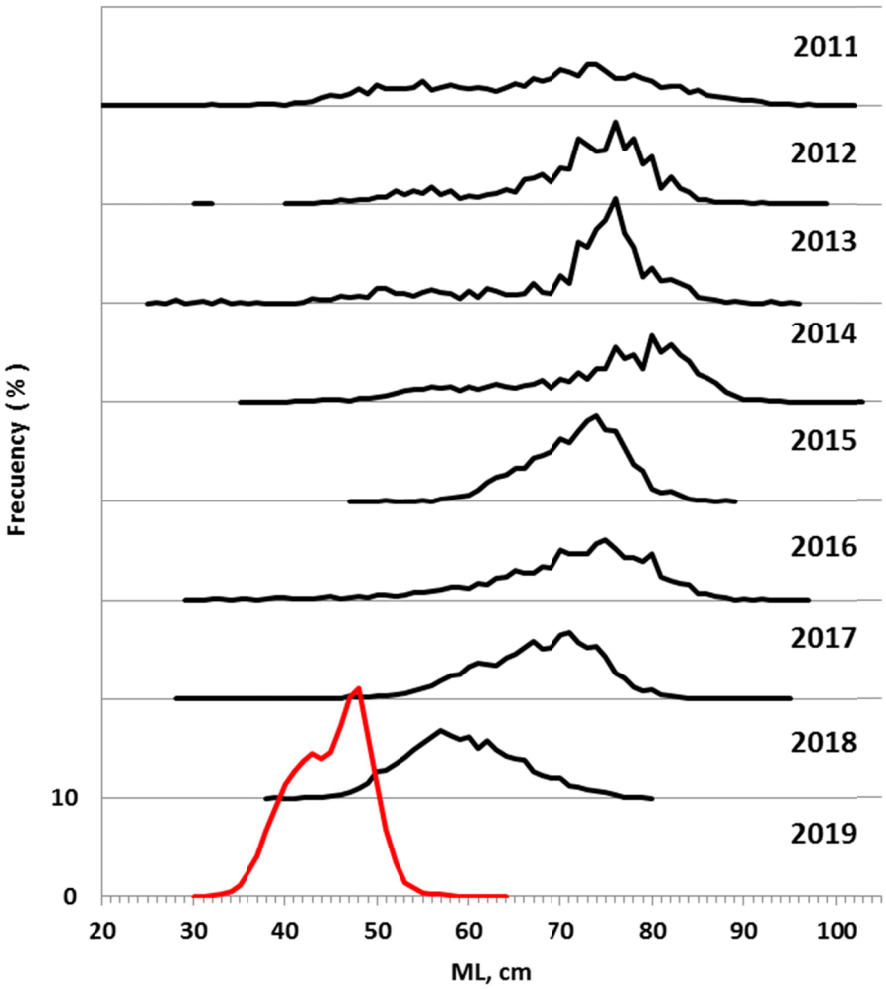


Figure 4. Size structure of jumbo squid in captures of Chile´s industrial fleet, period 2011-2019. Source: INPESCA

However, since the end of 2017, important changes in the squid size structure and its spatial distribution have been noted (Figure 5, a). In 2017, practically all the concentrations of squid leave the coastal areas of central-south Chile. The squid migrates in mass to the north from August. This was a determining factor for breaking, since August 2017, the clear rule of the previous years (2011-2017) about the occurrence of jumbo squid concentrations in front of the coast of Chile during all months of the year.

Jumbo squid (industrial and artisanal) fishery in Chile in 2018 is based on single-generation specimens that began to enter the coast in December 2017-January 2018 at the age of one year. Its size structure during the fishing season (February-July) was presented by specimens of 45 and 80 cm ML (Figure 5, b), all fattening and without active maturation process. Since July 2018, the entire mass of jumbo squid has migrated northward, as is supposed, to the oceanic spawning area in front of the coast of southern and central Peru. In the fishing season of the year 2018 the entire fraction of jumbo squid was considered as the adult, belonging to the group of sizes “L” (Figure 1), that is, a life cycle of two years.

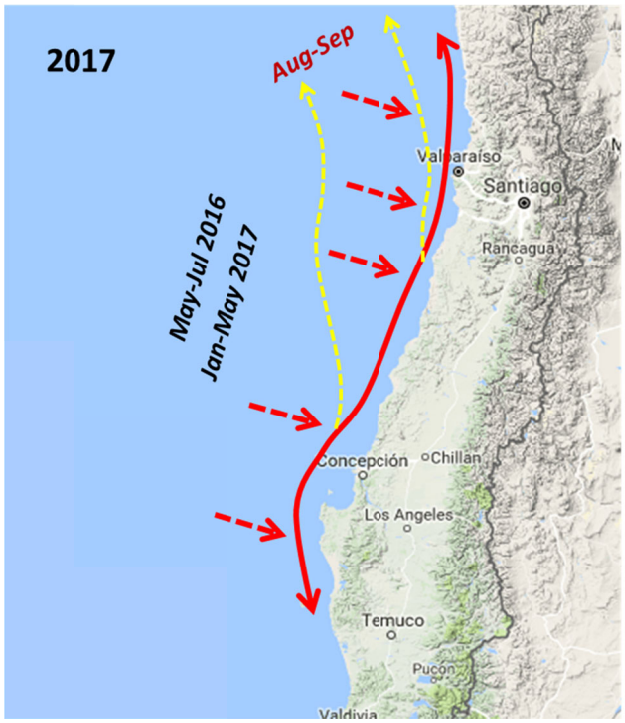
However, at the beginning of the 2019 fishing season from March-April, appear very small specimens (25-30 cm ML) (at the beginning of March), in a very narrow range (15-30 cm ML), It is also assumed of a single generation, probably from the birth of November-December 2018. That means, still of the first year of life. This is very likely in the following months, when the size range remains narrow and the progressive displacement of modal sizes is seen (fast somatic growth process) (Figure 5, c). Despite this, as the generation presented in 2018, the jumbo squid generation in 2019 carry out an active fattening in front of the Chilean coast and also presents the first signs of its sexual maturation in the specimens of "small" sizes (the size group" M ") compared to previous years. The average maturity (SMS – sexual maturity stade) of males between April and August increases from 1.2 to 1.8 and females, from 1.1 to 1.5 (Table 2).

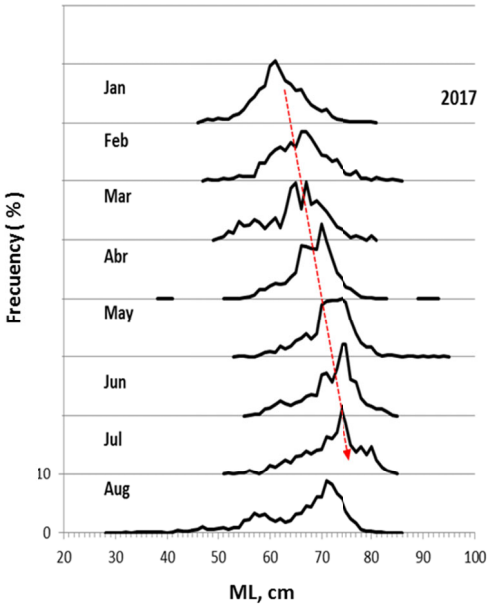
Thus, it is very clear that the size structure of jumbo squid in April-August 2019 is totally different from the same period in 2017 and 2018 (Figure 5). It is also different on annual scale respect to the years 2011-2018 (Figure 4), as well as the monthly average values of the dorsal lenght mantle of the specimens analyzed in 2019 compared to the previous years (2014-2018) are significantly lower, below 50 cm ML (in 2014-2018 these fluctuated between 58 and 78 cm ML) (Figure 6).

Table 2. Average values of sizes, total weight, sexual maturity stage (SMS) and Gonadosomatic Index (GI) for males and females in jumbo squid samples during April-August 2019. Source: INPESCA.

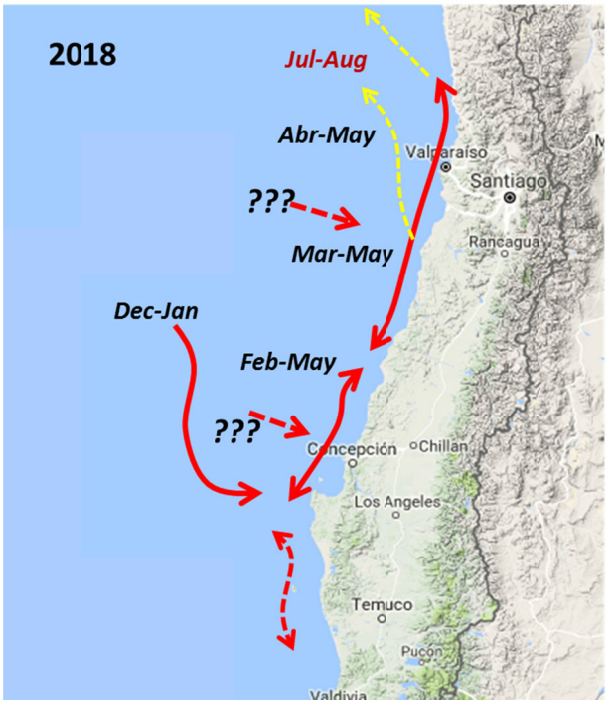
		Males		
Month		Average		
	ML	P.Total	SMS	GI
Abr	38	1665	1,2	0,3
May	42	2253	1,6	0,5
Jun	47	3001	1,6	0,6
Jul	49	3407	1,5	1
Aug	50	3837	1,8	1,2

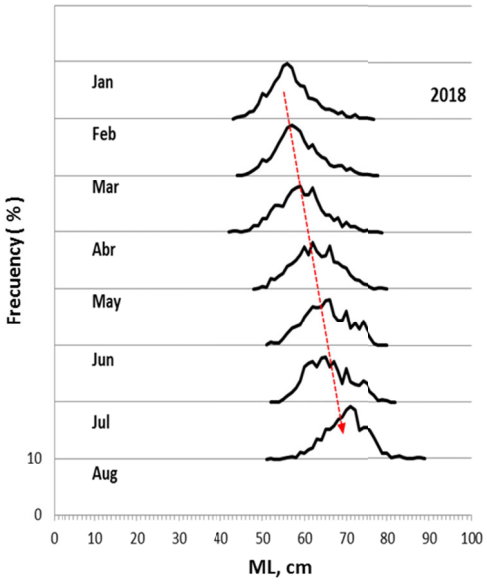
		Females		
Month		Average		
	ML	P.Total	SMS	GI
Abr	38	1660	1,1	0,3
May	42	2192	1,1	0,4
Jun	47	3001	1,1	0,4
Jul	49	3402	1,2	0,4
Aug	50	3911	1,6	0,9





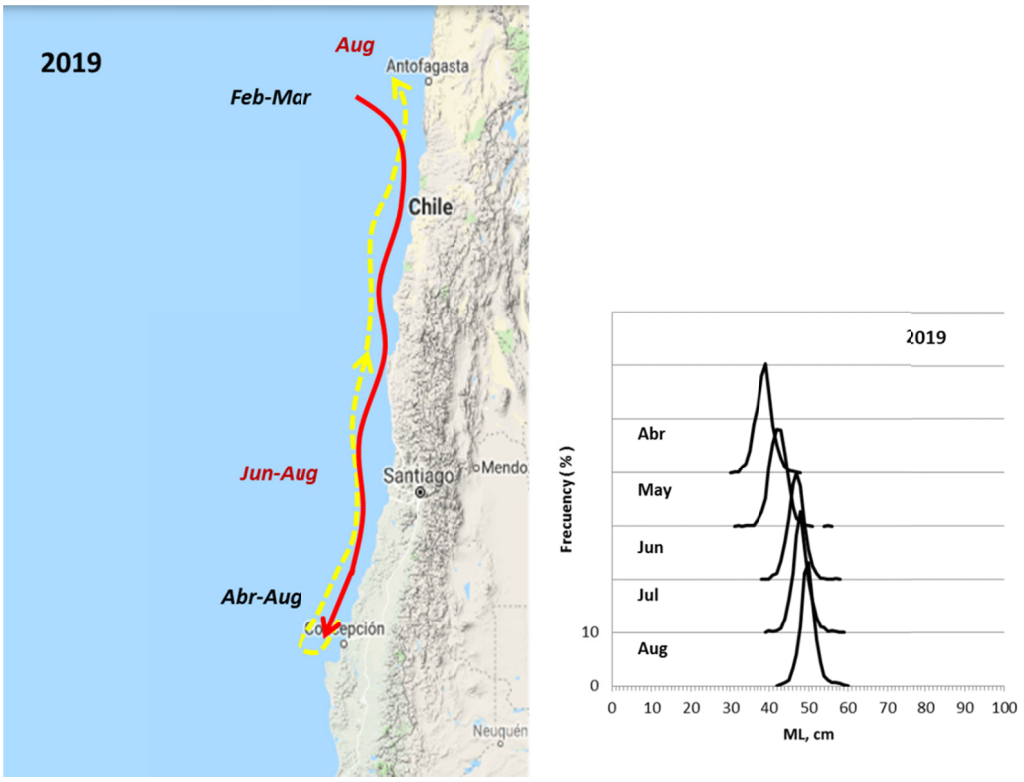
a)





b)

Figure 5. See the legend in the next page.



c)

Figure 5. Inter-monthly dynamic of structure of sizes and schemes of supposed migrations (entry to exit) of jumbo squid in front of the coast of central-south Chile during the fishing seasons of 2017-2019. Source: INPESCA.

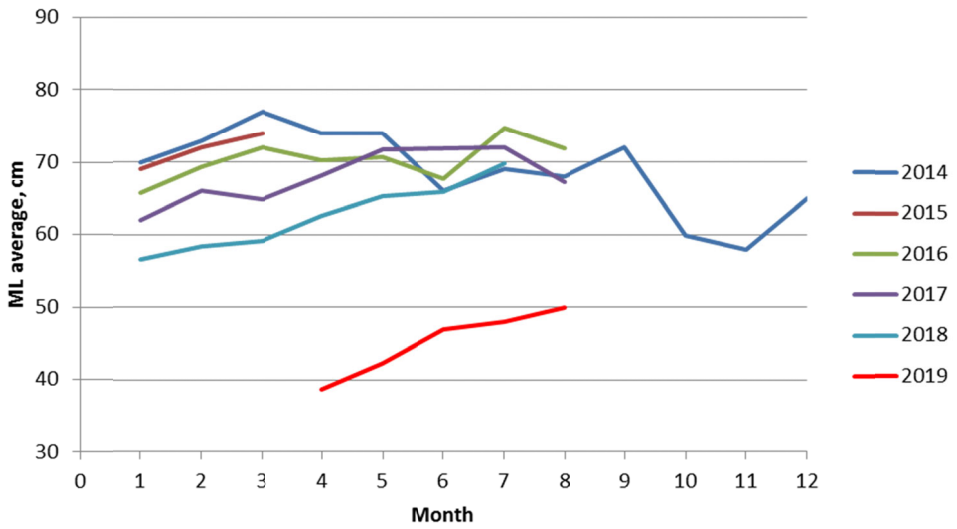


Figure 6. Monthly dynamic sizes (ML) averages of jumbo squid in the samples of the years 2014-2019. Source: INPESCA.

On the other hand, the constant monitoring of the industrial and artisanal fleet´s operations, as an indicator of the presence and availability of the resource in the fishing areas, it was possible to design conceptual schemes of distribution and migrations of jumbo squid for each fishing season for the years 2017, 2018 and 2019, since the squid appears in relative abundance in the fishery until it migrates northward, in the direction of possible spawning areas (Figure 5). In this case it is possible to see that for each year in question the schemes look different (Figures 5, a, b, c).

During 2017, the entrance to the jumbo squid fishery in front of the coast of central-south Chile, as in previous years (2011-2016), occurs from the open sea to the coasts with a wide front since the end of the 2016 - January 2017, entering from the north (30ºS); the center (33ºS) and the south (37ºS) approximately (Figure 5, a). For this reason, concentrations of jumbo squid are also captured practically at the same time in differents and distants fishing areas. In addition of incoming squid, the specimens from last year (from the first generation) are still present in the fishery. However, unlike previous years and for unknown reasons, all concentrations of jumbo squid begin active migrations (emigrations) of the Chilean coasts to the north-northwest from July and August. In September, these practically disappear from the fishery.

However, at the beginning of 2018 this typical scheme for the region is radically changed (Figure 5, b). After more than 4 months (September-December 2017) of squid absence in the region, in January 2018 massive entries concentrations of this mollusk are recorded towards the coasts of central-south Chile, but not as a wide and parallel to the coast from the open sea, rather as a single compact and abundant mass that reaches the coast between Punta Lavapie (37ºS) and Mocha Island (38º20'S), also formed by the specimens of narrow range sizes, between 50 and 65 cm ML, probably of a single generation, in the age close to 1 year life. During February-May the concentrations of jumbo squid of this mass begin to disperse along the coast to the north (mostly) and to the south (in smaller quantities). As it is calculated, the predominant vector in these migrations was always towards the north, in such a way that practically all the squid mass fattening and growing and, reaching the predominant sizes between 70-80 cm ML, already during the month of July-beginning August migrates from the fishing operations areas of both fleets.

The scheme of jumbo squid `s distribution and migration is very diffrent in 2019 (Figure 5, c). The first records of jumbo squid coincide with the squid stranding in 11-12 February in Bahía Inglesa (27º05'S), of very small sizes, less than 25 cm ML, that is, far away to the usual entrance areas. Later, since February 28, massive concentrations of this squid are found in a very large area (from 5-10 nm to 100 nm from the coast) along the 27ºS line, approximately 10 to 25-30 cm ML, visible in acoustic and surface equipment. From this date there is a rapid movement of squid along the coast to the south, to reach and concentrate since the beginning of April in the area between 36-36º40’S. As of April and until the beginning of August (until the end of the designated annual quota) its operations are carried out in this area, with high fishing yields, the industrial medium-water trawling fleet (Figure 2).

It is possible to assume that these concentrations of jumbo squid belong to an incoming mass from the N-NW with a single pulse, because the range of sizes is very narrow, mainly between 30 and 45 cm ML, with mode 35-36 cm at the beginning of the season and

growing between 40-60 cm ML, with a mode of 50 cm towards the end of the industrial fleet´s fishing season in the area (Figure 5, c).

On the other hand, several attempts to develop artisanal fishing when it appears of giant squid with jigging did not yield an expected result. The artisanal boats do not achieve fishing at night about 500-1000 kg. This catch (yield) is below that recorded in previous years when boats catched per night above 3000-5000 kg. This may be related to the specimens caught at the beginning of this year's season are the total weight that does not exceed 1,5-2 kg against 8-15 kg in previous years. For that, it is impossible the same fishing effort to achieve the yield from previous seasons.

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At the same time, the jumbo squid fishing experiments of the purse-seine artisanal boats brought a quite positive result: the catches per trip fluctuated between 20-80 tons. Here are recorded the same size specimens of the trawler fleet and practically from the same area, just a little more coastal. However, the success of the catching of this fleet depends strongly on weather conditions, they cannot operate with strong S-SW winds or bad weather frontal systems wich were quite frequents in the last months, as well as in full moon conditions when shoals deepen and/or disperse

Towards the end of June-beginning of July there is some fishing of the artisanal jigging fleet (accumulating several boats 10-80 t per night in some days) in the areas located in front of Duao-Constitución (35ºS) and in front of San Antonio (33º30'S), that when the specimens already approach in length mantle to 50-55 cm and of total weight of 3,6-4 kg. This benefit fishing yield increase. Towards the end of July-beginning of August are recorded jumbo squid catchs in Coquimbo (30ºS), including Caldera (27ºS) and Taltal (25º25’S). In this way it is possible to conclude that squid concentrations already began their emigration to the north of the country in August. These migrations occur one month later related to the year 2017 and two months later with respect to the year 2018, however they are still present in the southern areas of their registered distribution during this year.

4. Conclusions

1.- The resource of jumbo squid in front of the Chilean coast presents from 2017 clear changes in its distribution, migrations, permanence and size. The squid fishery in Chile depends on the entry concentrations from the north, from the region adjacent to the south of Peru. Since 2017, these are not gradual as years 2011- 2016; rather they appear in the form of isolated (unique) pulses and single-generation specimens.

2.- Incoming generations to the fishery in 2017-2018 were composed of specimens over 50-60 cm ML over one year old, unlike the year 2019 when the generation of small specimens enters to the fishery under 25-30 cm ML and <1 year of life at the beginning of the season.

3. - Also, unlike 2011-2016 periods, the presence of commercial concentrations of jumbo squid in Chilean waters is reduced throughout the year until the first 7-8 months of the year. These concentrations from July-August migrate massively to the north in direction of probable spawning zone located in the oceanic waters in front of southern Peru.

4.- More likely that the generation of jumbo squid (smaller in size) that entered to the Chilean coast from February 2019 is a spawning product from October-November 2018 off the coast of southern Peru. This generation is also predominant in the coastal fishery of southern Peru between May-August of the current year, according to preliminary data indicating the similarity of sizes in both regions in the same period.

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