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China Annual Report (Squid)

China

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Annual Report of China to the 2020 SPRFMO Scientific Committee
Part II: The Squid Jigging Fishery

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Summary

A total of 503 Chinese squid jigging vessels were recorded to operate in the Convention Area and caught 306 thousand tons of jumbo flying squid in 2019, but the actual number of the active fishing vessels varied from 193 (January) to 459 (December). The number of operated fishing vessels and fishing days increased in 2019, compared with 2018, but the annual catch and nominal CPUE decreased. Three observers and three studying vessels were designated to implement the observer program in 2019. A total of 726 fishing days were observed and 29,574 squids were measured in the 2019 observer mission.

1 *Description of Chinese Squid Jigging Fishery*

The Chinese distant-water squid jigging fleet have targeted jumbo flying squid (*Dosidicus gigas*) since 2001 (Chen et al., 2008). The Chinese squid jigging vessels operate in the high seas of the South East Pacific. In general, small vessels with hand jiggers catch jumbo flying squid all year round, while the big vessels move to the South East Pacific from the southwestern Atlantic to catch jumbo flying in a few months of the year. In recently, more squid-jigging vessels moved to the equator waters from the traditional fishing ground, high seas off Peru.

Twenty-two fishing vessels arrived at the international waters of the Southeast Pacific in 2001. The number of vessels increased to 119 in 2004 and then declined continuously in the flowing three years. In recent several years, the number of squid jigging vessels is increasing and reached to 503 in 2019 (Table 1).

The number of active fishing vessels tends to change from time to time (even on a fine scale of weekly) in a calendar year. During 2014-2015, the number of monthly operational vessels fluctuated between 105 and 220. In 2016, the maximum number

was 242, which occurred in December. 356 jigging vessels were reported to operate in the Convention Area in 2017, and the monthly maximum number varied from 180 (April) to 327 (November), however, in 2018, it changed from 192 in March to 373 in November. In 2019 the maximum occurred in the third week of December while the minimum number was 193, which occurred in the first week of January.

Table 1 Number of vessels and annual catch of the Chinese squid jigging fisheries in the Southeast Pacific during 2012-2017

Year	Number of vessels	Catch in tons
2015	252	323,600
2016	276	223,300
2017	356	296,100
2018	435	346,200
2019	503	305,700

Annual total catches of the Chinese squid jigging fishery fluctuated widely in the first few years in the Southeast Pacific, but maintained at a higher level during the last five years. In 2019, 306 thousand tons of squid were caught.

2 Catch, Effort and CPUE Summaries

Annual catch continued to grow and reached a higher level in 2014 and 2015, about 320 thousand tons, however, it fell to 223 thousand tons in 2016. Later it grew over the next two years and peaked in 2018. In 2019 annual catch was 306 thousand tons, declined by 11.7%.

Fishing effort and CPUE during 2015-2019 are presented in Table 2. The estimated fishing days continued to grow with the increase of fishing vessels. Fishing days were 85,862 in 2018, up 13% compared to 2017, and it rose to 111 thousand days. CPUE was relatively stable and fluctuated between 3.9 and 5.5 tons/day-vessel during 2014-2018, however it was only 2.8 tons/day-vessel, the lowest in during the past 5 years.

The monthly catches and CPUEs over the period 2015-2019 are presented in Figures 2 and 3, respectively. Monthly catches curves in 2016 and 2017 showed a similar

trend that they decreased in the first half-year and increased in the second half of the year. In 2018, monthly catch continued to grow basically and peaked in September, and then it started to decline month by month. In 2019 the monthly catch fluctuated more sharply than it in the last three years and showed two rise phases decline phases. Contrary to 2018, the monthly catch started growing from September, and peak 44.9 thousand tons in November. The minimum value was 11.3 thousand tons, which occurred in April.

Monthly CPUEs in the previous five years showed a U-shape curve and dropped to the lowest value in May, June, or July, and then recovered month by month, however, in 2018, the CPUE peaked in February, and had not started moving upward since September, but continued to fall with the catch. In 2019 monthly CPUE was highest in December, and it appeared a small peak in July. In general, monthly CPUE in 2019 was at the lowest level over the last five years.

Table 2 Catch, effort and CPUE of the Chinese squid jigging fleet in the past five years

Year	Catch in tons	Fishing days	CPUE (tons/day-vessel)
2015	323,600	60,116	5.4
2016	223,300	62,258	3.6
2017	296,100	75,655	3.9
2018	346,200	85,862	4.0
2019	305,700	111,343	2.8

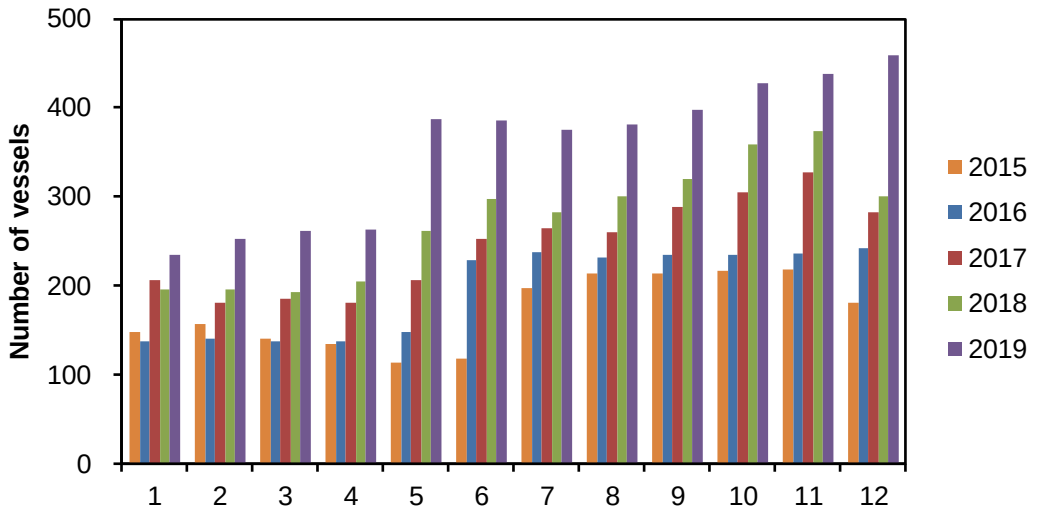

Figure 1 The number of monthly maximum active fishing vessels during 2014-2018

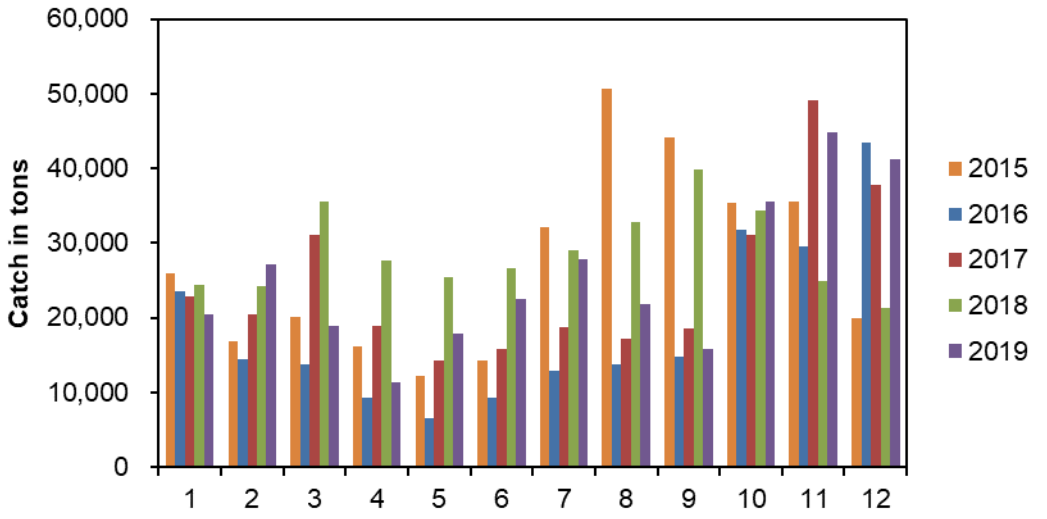

Figure 2 Monthly catches of the Chinese squid jigging vessels during 2015-2019

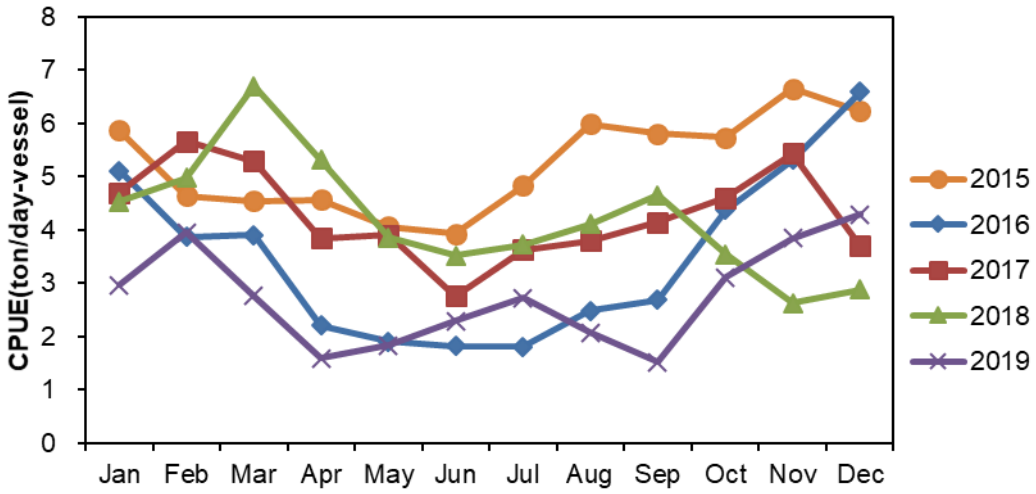

Figure 3 Monthly CPUE of the Chinese squid jigging vessels during 2015-2019

Monthly catch or CPUE distributions in recent years are shown in Figures 4, 5, 6, and 7. The monthly geographical distributions showed that these fishing vessels operated in the high seas and moved back and forth between high seas off Peru and equator waters. The former was the main fishing grounds for the Chinese squid jigging fleet but been replaced by the latter since 2017. Furthermore, only a few vessels operated in the high seas off northern Chile. In 2019, the fishing vessels distributed in the high seas off Peru have moved northwards since January and almost all of them constricted in the equatorial waters in February and March (120-110 degrees west). From April to December, the fishing vessels operated both in the equatorial waters and in the southern area, however they disappeared in the far west waters around the equator and distributed in high seas east of 90 degrees longitude west.

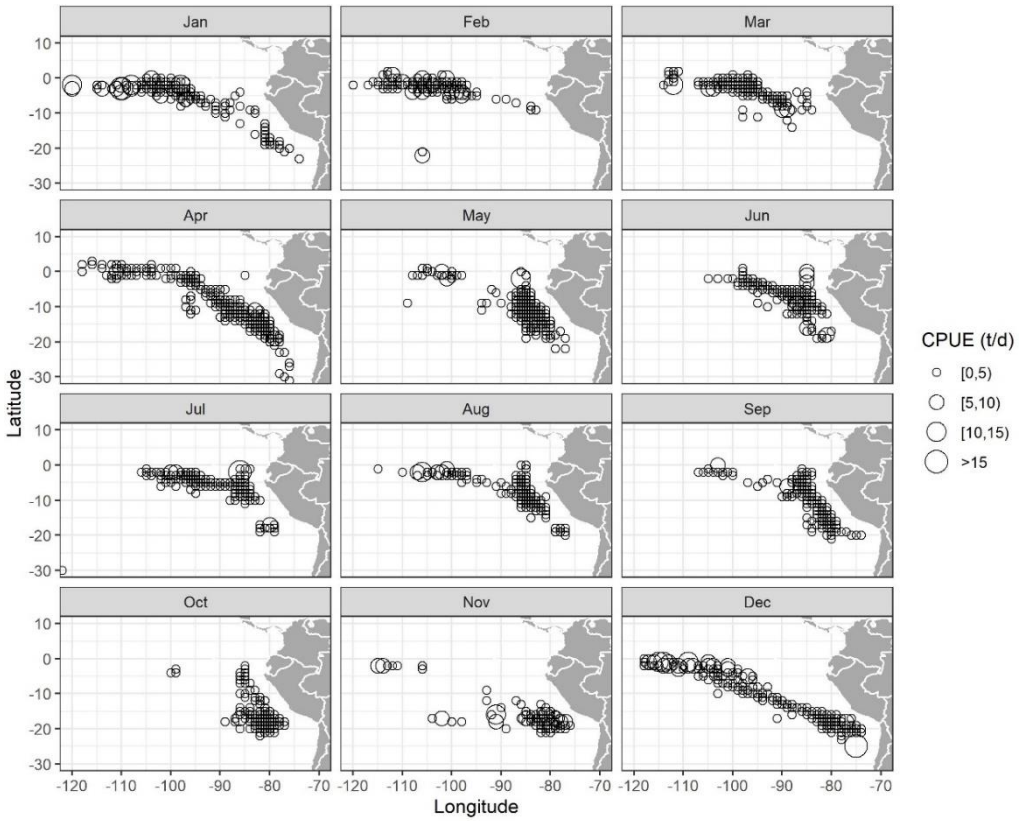

Figure 4 Monthly catch rate distribution of the Chinese squid jigging fishery in 2019

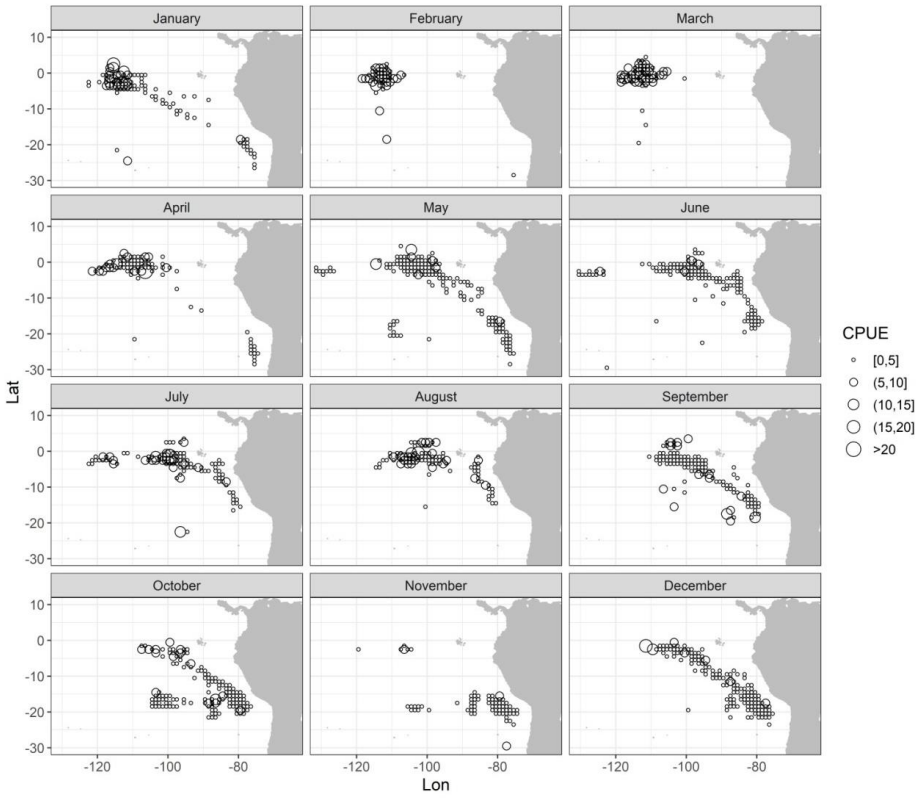

Figure 5 Monthly catch rate distribution of the Chinese squid jigging fishery in 2018

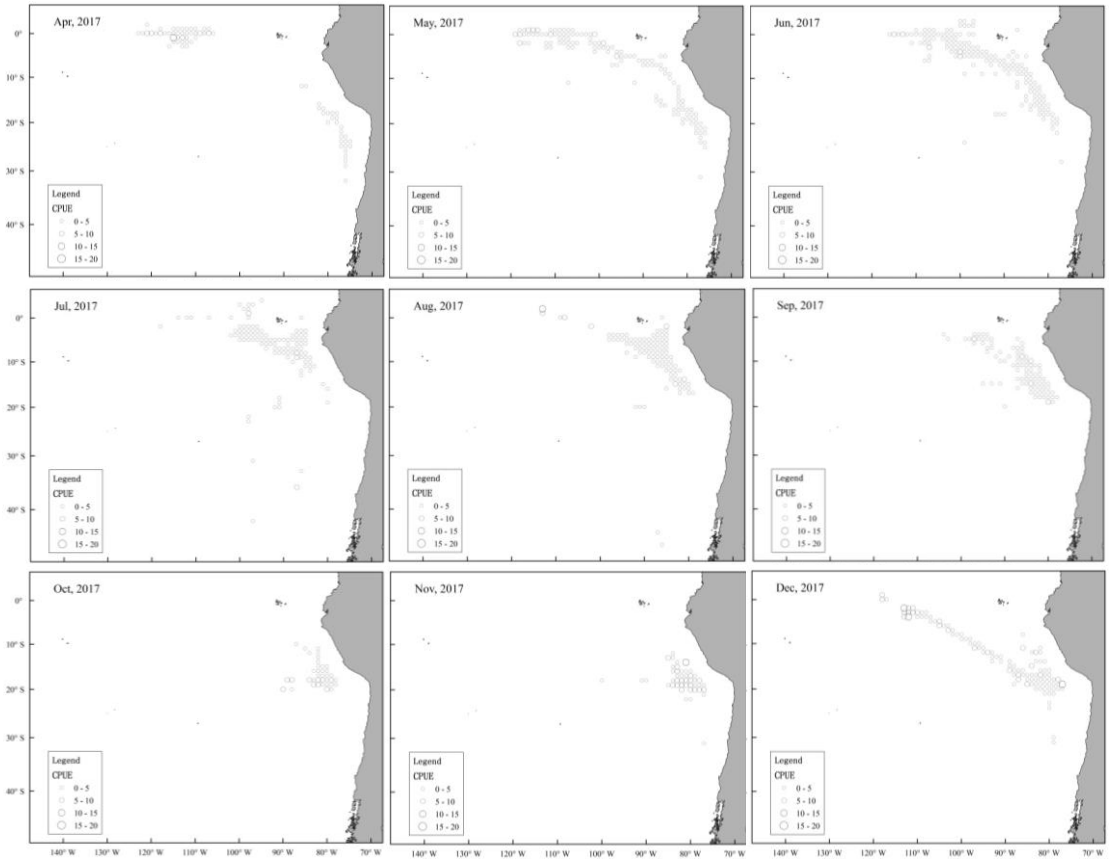

Figure 6 Monthly catch rate distribution of the Chinese squid jigging fishery during 2017

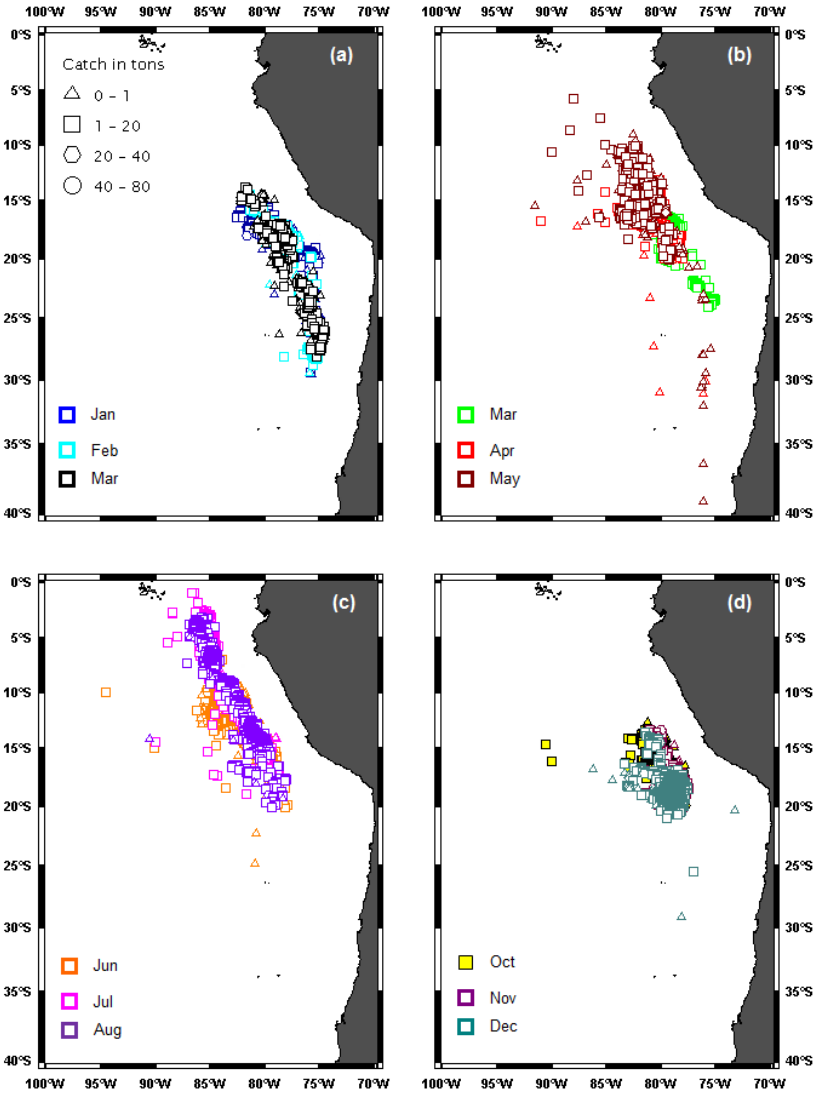

Figure 7 Monthly catch rate distribution of the Chinese squid jigging fishery during in 2016

3 *Fisheries Data Collection and Research Activities*

Two types of fishery data were collected for the squid jigging fishery, the catch data, and biological data. The logbook was designed and made by China Distant Water Fisheries Association (CDWFA). Some key information such as the fishing vessel (name, engine power, total light power, etc.) and fishing activities (start and end locations and time, catch and by-catch species of marine mammals, birds and turtles) are all list in the logbook. Moreover, the fishing companies were requested to report

the estimated catch and number of fishing vessels with their status (operating, being repaired, returning or shifting) every week. Since 2015, data collection work has been in the charge of the National Data Center for Distant-water Fisheries of China (NDCDF).

106,907 recorders of daily fishing activity data have been collected by NDCDF in 2019, and 99,420 of them were derived from 463 Chinese squid jigging vessels that operated in the high seas of Southeast Pacific in 2019. The rate of logbook submission continued to increase and 92.1 percent of the fishing vessels submitted their 2019 logbook by June this year.

Biological data and samples were also collected in 2019 by the scientific observer and studying fleet. Observers are requested to record catch data and collect length, sex, maturity, and by-catch information, and monitor transshipment on the sea. The caught jumbo flying squid were sampled randomly for length measurement each time, in which some individuals were weighed and determined sex and maturity. 22,861 squid were measured by the observer on the sea, and the other 2,147samples were frozen and transported to the laboratory of Shanghai Ocean University for biological examination and genetic research. The task of the studying vessels is to collect length data and a total of 4,309 squids were measured length on board by fishermen.

Research activities of the squid research team of SHOU focused on genetic diversity and feeding ecology of the jumbo flying squid. Genetic studying was continued based on last year. 42 matured medium size squid (79°32′- 86°04 ′W, 03°33′S -20°31′S; Jun - Oct. 2019) and 10 matured large size squid (76° 28′ W-81° 19′ W, 17° 52′ S-20° 31′ S; October 2018) were added for DNA analysis and the total of sample size increased to 90 which covered the small (sample size 30), medium (sample size 42) and large (sample size 18) phenotype.

Gong et al. (2020) used a novel combination of stable isotope (SI) and fatty acid (FA) analyses of muscle tissues and morphometric measurements of feeding apparatuses to evaluate spatial patterns of habitat. Results showed that the δ13C and δ15N values

were different among samples from a different area, possibly because of site-specific dietary sources and isotopic baseline values. Spatial variabilities in FA profiles/biomarkers, combined with SI results, suggest two foraging patterns: utilization of resources mainly from oceanic food webs or from both neritic and oceanic food webs. This behavior likely promotes the site-specific trophic niche width, increases adaptation to inhabiting oceanographic conditions, and could be driven by differences in feeding apparatuses morphology, body size, and trophic position.

Liu et al. (2020) investigate ontogenetic shifts in the trophic geography of jumbo flying squid by analysis of sequential stable isotopic values of δ13C and δ15N in eye lenses. The result showed significantly increased isotopes across the eye lens which significantly differed between years and sexes. Significant ontogenetic differences were present in δ13C but not in δ15N at different growth stages. These ontogenetic isotopic changes cannot be explained solely by trophic growth and may also be due to geographic movement. The corrected standard ellipse area was different at different life span suggests larva and juvenile squid live in wide areas with different isotopic baseline values, but adult squid forage in the same habitat and become more specialized in particular prey. There were high and medium isotopic overlaps between the two consecutive stages before juvenile and after juvenile, respectively, which reflect the squid nursery and foraging strategy. The lack of isotopic overlap between the embryo and adult squid suggests that maternal squid have different trophic and spatial ecology compared with their offspring.

4 *Biological Sampling and Length Composition of Catches*

In 2019, biological sampling for jumbo flying squid was carried out by the scientific observer and studying vessel. Three observers worked onboard of five Chinese squid jigging vessels from January to November. A total of 22,861 individuals of jumbo flying squid were measured for length onboard by the observes, and some of the specimens were also determined sex maturity stage and stomach fullness. Moreover, the observer also sampled 2,147 squids, which were delivered to the lab of SHOU. NING TAI 62 and FU YUAN YU LENG 16 severed as studying vessels and measured 4,309

squids for length at sea and another studying vessel sampled 257 squids in January 2019, which were also sent to SHOU. Samples that were transported to the lab of SHOU had been measured for mantle length, weight, sex, maturity, and so on.

The hard structures of these samples including statolith, beak, gladius, and lenses of eyes were also extracted, and muscular tissue was applied to the genetic study. The length frequency of 2019 combined with the observer and studying vessel length measurements was presented in Figure 8. Mantle length ranged from 14 cm to 95 cm, and two models can be distinguished obviously. The dominant size class was 20-27 cm, followed by 54-63 cm. The small group squid in the length compassion was similar, compared with 2018, but the larger group was replaced by the medium group as the second modal. In general, the small squid derived from catch in the northern fishing area around the equatorial waters, and the medium and big squid were caught in the high seas off Peru. However, some immature squid with small size also found in the high seas off central Peru. Compared with the historic length composition, it can be seen that medium and larger size dominate the catch in the southern fishing area.

Gonad maturity stage measurements were divided into two groups according to sampling area, north and south of 8 degrees latitude south because the small type squid are caught in equatorial waters and the medium-large squid distributes in southern waters. The status of the maturity stage in 2019 is also compared with those of earlier years (Figure 9 and 10). For the small group, sex-specific sexual maturity was very similar, immature male and female squid were dominant, over 90 percent of females and 50 percent of males, their gonad maturity was at stage Ⅰ and II. In addition, male squid became sexually mature earlier than females. The ratio of immature and mature females (maturity stage I, II) was 98.6 percent and 1.4 percent respectively, however only 77.6 percent male squid were immature in 2019. Furthermore, the result of size at the maturity stage indicated that females are larger than males especially when they are mature. Another interesting thing was that country to the female, the male did not present significant growth in length with gonad developing. For the medium-large group that caught in the southern fishing ground, 32.6 percent female and 42.7 percent male were mature, among them the ratio of stage V was 0.22 percent and 0.07 percent respectively for the female and male. The mean size at the maturity stage of female and male squid both increased with the gonad developing, however, the females were smaller than the males when they were immature, vice versa, the females were larger than the males when matured.

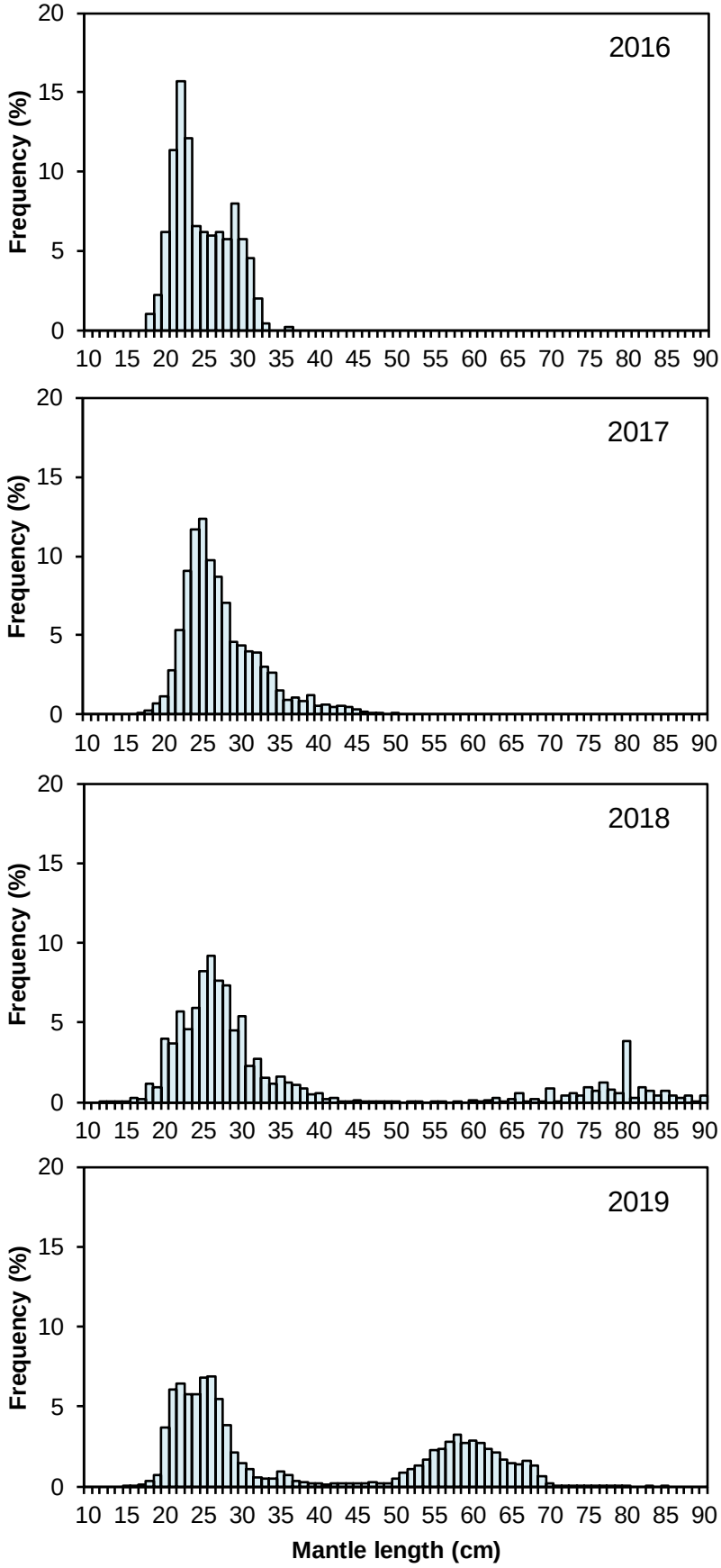

Figure 8 Size frequencies of the jumbo flying squid sampled in the high seas

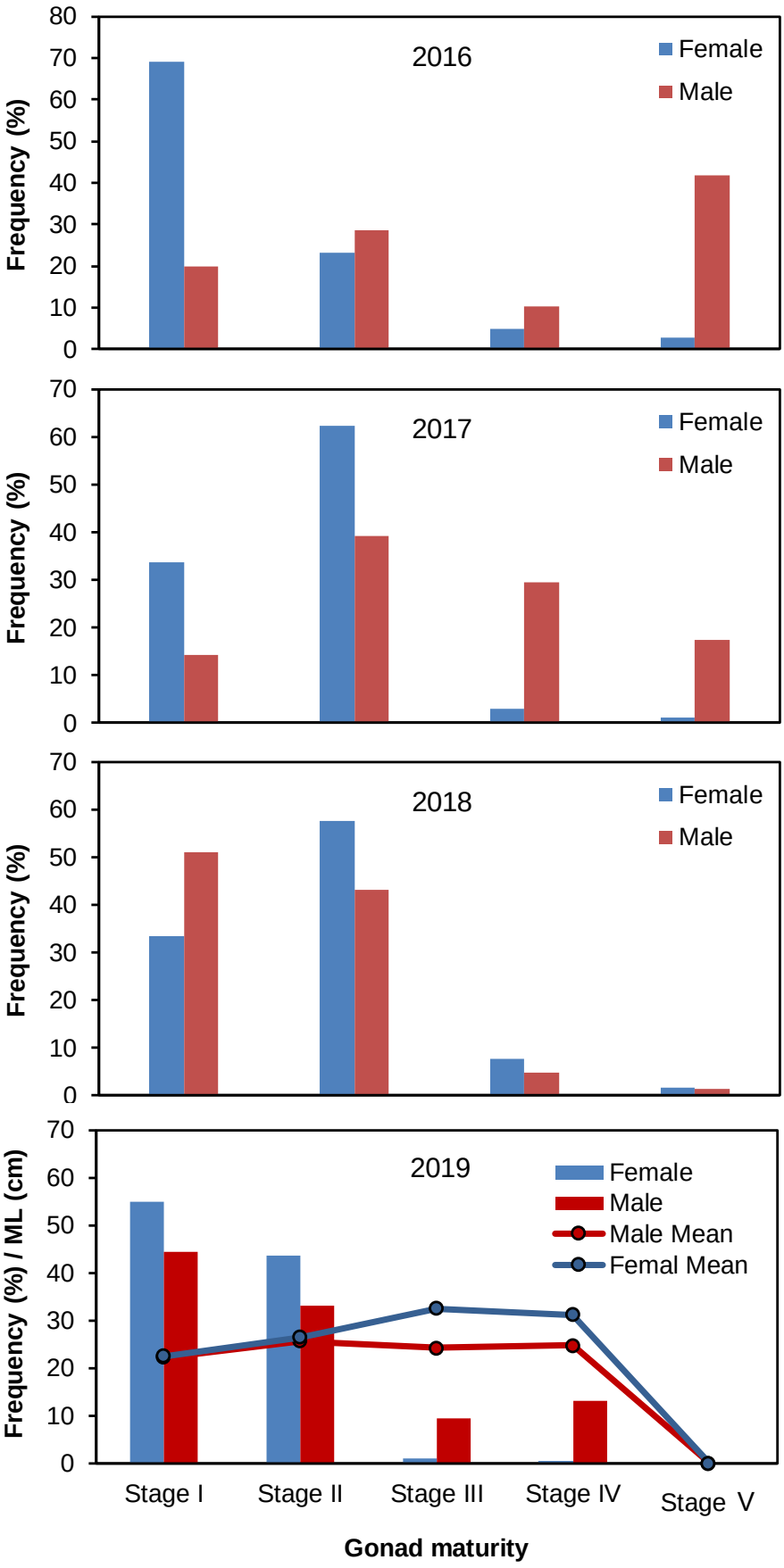

Figure 9 Sexual maturity stages of the small group jumbo flying squid

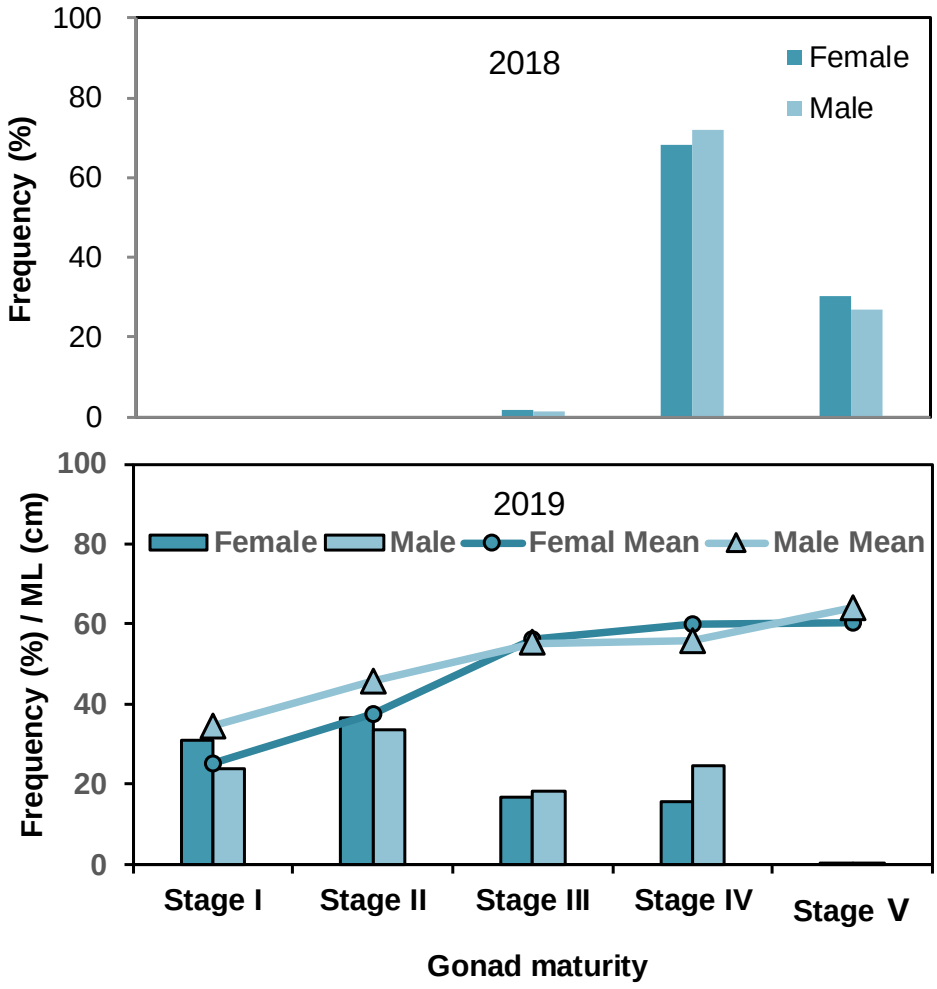

Figure 10 Sexual maturity stages of the big size jumbo flying squid

5 *Observer Implementation Report*

In 2019 the Chinese squid fishery performed the Observer Program. The observer program was designed to collect representative biological data for jumbo flying squid. Three observers and three studying vessels were designated to perform the observer program and a total of 726 fishing days were observed and 29,574 squids were measured. The observers also monitored transshipment and recorded sea birds around vessels. The details of the observer mission are reported in the observer program implementation report of China 2019 to the Science Committee (Gang Li. et al., 2020).

6 *Brief introductions of China's Fishing Closure and other measurements for protecting jumbo flying squid*

On 1st June 2020, the Ministry of Agriculture and Rural Affairs issued a notice on strengthening conservation of squid resources in the high seas and promoting the sustainable development of China's distant-water fisheries. This notice is the first Chinese official document that aimed at strengthening conservation and management specifically for squid resources in the international waters (Jumbo flying squid in the Eastern-central Pacific and northern shortfin squid in the Southern-western Atlantic).
The notice announces or requires to implement conservation and management measures for squid resources in the high seas including:

1) Implement seasonal closure of squid jigging fishery. From September 1 through November 30 each year, Chinese squid jigging vessels are banned form fishing in the area of East Pacific, which is bounded on the north by 5°N. lat.; on the south by 5°S. lat.; on the east by 95°W. long.; and on the west by 110°W. long.
2) Strengthen fishery monitoring and management, including implement electronic fishing logbook, electronic monitoring and observer program gradually, and combating IUU fishing through promoting multisectoral coordination and cooperation.
3) Strengthen squid resource monitoring and adjust the fishing closure management measurement dynamically in terms of timing and area.
4) Strengthen scientific research and carry out active international cooperation on conservation and management of squid resource in the high seas.

The purpose of the fishing closures is to protect squid populations including spawning stock biomass. Although the life history knowledge including spawning time and area for jumbo flying squid is not conclusive, the measurement is a good start to explore the feasibility of fishery closure in high seas and the measurement could be adjusted based on more sound scientific researches and computer simulation studies. Additionally, the fishery closure can improve the escapement rate of jumbo flying squid which is distributed in the East Pacific and categorized as small size group (Liu et al., 2013; Csirke et al., 2018; Li et al., 2018 and 2019). The effectiveness of the current fishery closure measurement will be evaluated timely.

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