ミナミマグロの生態関連種である大型浮魚類のガストロ *Gasterochisma melampus* に関する分布、生活史及び CPUE

Distribution, life history and CPUE of butterfly kingfish *Gasterochisma melampus*, a large pelagic ecologically related species of southern bluefin tuna

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要約

ミナミマグロ延縄漁業で混獲されるガストロについて、産卵場、分布、生活史及び CPUE を明らかにした。産卵場は南東太平洋の温帯域に存在した。成長に応じて分布域を変え、産卵場から未成魚の摂餌場でありミナミマグロの摂餌場でもある南半球温帯域の大西洋からインド洋、南西太平洋に回遊した後、成熟（オスで約 110 ㎝ FL、メスで約 140 ㎝ FL）してから南東太平洋へ回遊し、その後はその海域に滞在する。CPUE は 1993 年から 2016 年まで、または 1970 年からほぼ一定であり、ガストロ資源は抑圧されていないと考えらえた。ガストロ研究は CCSBT において、SBT 漁業が他種に与える影響の評価及びミナミマグロの生態を明らかにするうえで有益である。

Summary

Distribution, life history and CPUE were investigated for butterfly kingfish, by catch species of southern bluefin tuna longline fishery. The spawning area locates in the south-eastern temperate Pacific Ocean. Butterfly kingfish migrate ontogenetically that they migrate to the feeding grounds in the area that extends from the Atlantic Ocean to the south-west Pacific Ocean in the temperate waters of Southern Hemisphere, before moving to the south-east Pacific Ocean after reaching maturity (about 100 cmFL in male and about 140 cmFL in female), and then do not return to the Atlantic Ocean or the Indian Ocean. The data indicated that CPUE has been stable from 1993 to 2016 and similar to that in 1970, which suggests that the stock is currently not likely to be depleted. Studying butterfly kingfish is valuable for CCSBT in the point of understanding stock status of each of ecologically related species to SBT, and in the point of reveal the not-well-understood biological aspects of SBT by comparing to other species.

Introduction

In the circumpolar temperate waters of the Southern Hemisphere at latitudes between 30S and 50S extending across the Atlantic, Indian and Pacific oceans where southern bluefin tuna (*Thunnus maccoyii*; SBT) fishing operated, there have been few studies of the ecosystems. Representative large pelagic fish species distributed in this area are SBT, albacore (*Thunnus alalunga*), butterfly kingfish (*Gasterochisma melampus*), slender tuna (*Allothunnus fallai*), opah (*Lampris guttatus*), blue shark (*Prionace glauca*) and the porbeagle (*Lamna nasus*). Although commercially important species such as tunas have been studied well, there have been few studies of other species, such as the butterfly kingfish (but see Semba et al. (2013) for the porbeagle).

The butterfly kingfish (Fig. 1) is a large Scombridae species that reaches a fork length (FL) of 190 cm; the genus *Gasterochisma* has only this single species. The fish's silver body is covered with large cycloid scales and has many distinctive morphological characteristics that differentiate it from other Scombridae (Collette et al. 2001). The fish's physiology is interesting in that it has a brain heater (Carey 1982). The taxonomic position of the species, in terms of the evolution of endothermy, has been somewhat controversial (Block et al. 1993; Collette et al. 2001). The general distribution of the species was reported by Warashina and Hisada (1972) and its sporadic occurrence off Argentina, Brazil and Hawaii has been reported (Ito et al. 1994 Rotundo et al. 2015). I investigated several aspects of butterfly kingfish, including spawning ecology, distribution, life history and migration, and also investigated CPUE to assess the influence of SBT fishery on stock status of other ecologically related species.

Study of spawning ecology

A research project was run for 10 years from 1987 by the Japan Marine Fishery Resources Research Center (JAMARC; now the Marine Fisheries Research and Development Center of the Fisheries and Education Research Agency) and found the spawning area of the species located through an analysis of captured fish with ripe ovaries. Because the results have not been published, although they have been reported in domestic documents, we published it recently in an international peer-reviewed scientific journal (Itoh and Sawadaishi 2018). See detail CCSBT-ERS/1905/Info2 which including the paper Itoh and Sawadaishi 2018. The study revealed that the spawning area was between longitude 85W and 130W and latitude 28S and 41S in the south-east Pacific Ocean, off the coast of Chili, and that the spawning season was from mid-April to mid-July. Females mature at about 140 cmFL and males at about 110 cmFL. The diameter of ripe egg was 1.6 mm in mean, which was quite larger (4.1 times in volume) than those of most Scombridae species, including *Thunnus* and *Scomber*, the diameter of hydrated eggs is 1.0 mm.

Study of distribution, size and CPUE

Datasets including logbook data and scientific observer data of Japanese longline, as well as the research data mentioned above, over 20 years were examined in terms of distribution, size and CPUE of butterfly kingfish. The results were published in an international peer-reviewed scientific journal (Itoh 2019). See detail CCSBT-ERS/1905/Info3 which including the paper Itoh 2019. The data showed that butterfly kingfish were distributed in a continuous band around the circumpolar region between 35°S and 45°S. The southern limit of distribution corresponded with the sub-Antarctic front. The estimated global total annual catch for butterfly kingfish ranged from 613 to 3699 t (mean 1859 t) with Japan taking the largest proportion of the total catch. Large fish (120-190 cmFL) are distributed in the south-eastern Pacific, whereas smaller, immature fish (<140 cmFL) are distributed in feeding grounds in the area extending across the Atlantic and Indian Oceans to the south-western Pacific Ocean where is CCSBT statistical area of 4, 5, 6, 7, 8, and 9. Butterfly kingfish are well adapted to cold water and the sea-surface temperature of butterfly kingfish caught in the dataset, ranging from 6.2 to 20.6°C with a median of 10.6°C.

Only one spawning ground has been identified, off the coast of Chili, and fish with developed ovaries have not been reported from the Atlantic Ocean or the Indian Ocean. This suggests that butterfly kingfish comprise a single stock. The difference of size by area suggests that butterfly kingfish migrate ontogenetically within the distribution area. Butterfly kingfish migrate from the spawning ground to the feeding grounds that extends from the Atlantic Ocean to the south-west Pacific Ocean when < 90 cm L. Fish stay there for an unknown period (age and growth of butterfly kingfish is not understood), before moving back to the south-east Pacific Ocean after reaching maturity. The absence of large fish at the feeding ground suggests that fish do not return to the Atlantic Ocean or the Indian Ocean.

Catch per unit effort (catch number per 1000 hooks; CPUE) data for fish in the feeding grounds from 1993 to 2016 were compared with the CPUE value from 1970. These data indicate that the stock is currently not likely to be depleted. The CPUE and stock abundance of SBT estimated in CCSBT had been decreasing but recently started increasing (Anonymous 2017). Southern bluefin tuna and butterfly kingfish were distributed across similar regions. The CPUE values for butterfly kingfish did not increase in the 1990s and early 2000s, when SBT stock abundance was declining. This contrast suggests that competition for resources (prey or habitat) between SBT and butterfly kingfish was not sufficiently strong to be reflected in the CPUE values.

The reasons for this contrast are not clear, but there are several possibilities. First, butterfly kingfish are caught in their feeding grounds in their young period and the adult butterfly kingfish population has been protected from fishery. Second, SBT stocks have declined not only because of the longline fishery catch but also because of the surface fishery catch in Australian coastal waters, whereas butterfly kingfish have been caught only by offshore

longline fisheries. Third, because butterfly kingfish are mainly distributed in colder waters compared with SBT, and may also differ in vertical distribution patterns, the operational strategy of the longline fishery targeting SBT may not be optimised for catching butterfly kingfish.

Importance of ERS species study in CCSBT

Studying butterfly kingfish is valuable for CCSBT in two points. One is that the necessity to understand stock status of each of ecologically related species to SBT. The methodology which use the dataset combined with the logbook data, scientific observer data, historical records in literature, and independent research data, that our studies showed, would be applicable and allow evaluate stock status of other species.

The second point is that results of studies are expected to reveal the not-well-understood biological aspects of SBT by comparing life history and strategy of other species that utilize the same habitat. For example, butterfly kingfish has common feature with SBT that utilize water of wide area across the Atlantic, Indian and Pacific oceans. The spawning areas are different that in the eastern tropical Indian Ocean for SBT while in the south-eastern temperate Pacific Ocean for butterfly kingfish. Adult individuals are distributed in the same area of young fish for SBT, however, butterfly kingfish migrate to different area in their young stage and come back to the area of spawning ground. In the point of view that has habitat usage change along with life history, the migration pattern of butterfly kingfish is similar to that of Pacific bluefin tuna *Thunnus orientalis*, rather than SBT, that apart northwest Pacific and take trans-Pacific migration to the northeast Pacific Ocean in their young stage of age 1 to 4. In addition, butterfly kingfish has notably feature that they are also distributed in the south-eastern Pacific Ocean where SBT is scarce, 80% of individuals are females, and females are larger in size. These aspects are valuable when we consider the reason of SBT ecology.

Acknowledgement

This study was supported by a grant from the Japan Fisheries Agency. The Marine Fisheries Research and Development Center of the Japan Fisheries Research and Education Agency is appreciated that allowed us to use their data.

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Fig. 1. Butterfly kingfish caught by Japanese longline. Photo was taken by a scientific observer. Butterfly king fish was 92 cm in fork length and female caught on June 6, 2016 at 43S and 1W.