

Variable Longline Fishing: The History and Sustainable Innovation of a Traditional Marine Ecological Knowledge

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ABSTRACT

Amoy variable longline fishing is an efficient, accurate and controllable traditional fishing technique created by Amoy fisherman, which has been popular in the Taiwan Strait and Zhoushan fisheries for hundreds of years. It was replaced by seine and trawl since the 1970s but continues to exist with inshore small-scale fisheries. It is a fishing method based on traditional marine ecological knowledge such as seabed topography, water current and fish migration. It evolves with environmental conditions, and is a living marine cultural heritage.

In the past ten years, we have conducted a series of experimental archaeology studies on traditional shipbuilding, traditional navigation and traditional longline fishing. The studies expanded the boundary of marine ecological knowledge. This introduces a special perspective on the effects of climate change towards marine ecology and other external conditions. We aim to explore feasible coexistence with underwater cultural heritage and maritime cultural heritage by exploring the role of Amoy's longline fishing as an innovative precision fishing technology. We work to teach local communities to use traditional methods to carry out non-destructive, accurate and efficient productive fishing in the complex environment of underwater cultural heritage (UCH). We promote the variable longline fishing for nomination on the List of Intangible Cultural Heritage in Need of Urgent Safeguarding, developed from the UNESCO 2003 Convention for the Safeguarding of the Intangible Cultural Heritage.

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Figure 1: Detected Seabed Topography and Sediment Using a Sounding Lead

INTRODUCTION

In the past twenty years, we have conducted a series of experimental archaeology studies on traditional shipbuilding and navigation, and have also come into contact with traditional fishing techniques closely related to them. Among them, we conducted a special study on the local history of Amoy longline fishing (Xu 2018) and successfully included it in the local intangible cultural heritage list. However, it is precisely because of being in the East Asian cultural zones where Chinese characters or even certain dialects are used, it is difficult for mainstream academia to understand the field research-based technological history or intangible cultural heritage.

As the issue of UCH is increasingly receiving attention to address major global threats, such as climate change, we urgently hope to introduce and promote Amoy variable longline fishing to the world. Its 'variable' is an understanding and technical logic that is adjusted to respond to changes in the marine environment and other external conditions. As an easy to learn and localized marine knowledge system, the variable longline fishing can coexist sustainably with underwater cultural heritage in various regions of the world.

CASE STUDIES

Longline fishing may first appear in the Iron Age after the prehistoric stone tidal weirs and tidal zones gathered. The longline fishing operation is called 'Banggun' in Hokkien dialect, which

‘Gun’ refers to a specialized fishing line.

The variable longline fishing is based on the data of seabed topography and sediment morphology of the target fisheries detected by iron sounding lead. For fishermen engaged in longline fishing the bottom of the sea has its hills and valleys like the land, and they acquire an intimate acquaintance with its contours and the type of bottom to be expected in each locality. This knowledge is supplemented by the data of wind direction, wind force, tidal direction and velocity, the habits and rules of different water colors, upper, middle and lower water layers, and different fish habitat and migration,; so as to adjust the specifications of longline fishing gear and bait form according to the conditions of the operation site of target fish species. It can avoid catching young fish and non-targeted fish species by no selectivity.

This traditional fishing technique involves releasing a main line from a boat into the sea, with a certain number of branch lines tied at a certain distance to the main line, and each branch line ends with a fishing hook with bait attached. Each basket of longline is equipped with sinking stones and buoys at the head and tail, which are used to control the main and branch lines in specific depths of water. This traps adult fish in specific water layers. According to the different fishing layers and fish species, longline fishing can be divided into two types of operations: fixed fishing and floating fishing. According to the combination of fishing vessels, it can also be divided into single vessel operation and barge-carrier operation. Each basket of longline is equipped with more than 10 to 100 branch line fish hooks based on the size of the fish hooks. During operation, first release the first buoy and sinker, then place the longline, with a buoy mark attached between each basket longline, and a tail basket tube mark attached to the end of the last basket longline.

In the Wanli year of the Ming Dynasty, it was recorded that fishermen in southern Fujian had already mastered the migration patterns of hairtail fish in the East China Sea by late sixteenth century and pursued shoals of fish. They crossed provinces and transferred to the waters of southern Zhejiang for operation. According to a historical painting from the Himi City Museum collection dating back to 1785 in Japan, long line fishing was introduced to the coastal areas of northern Japan during the Edo period (1603-1615 CE), and was used to catch snapper and cod in offshore areas (Figure 1).



Figure 1: Detected Seabed Topography and Sediment Using a Sounding Lead

The earliest professional investigation into the fishing industry in Xiamen began in 1922. Investigators from the Water Obstetrics Department of Jimei School claimed there were 150 fishing boats engaged in longline fishing in Xiamen (Zhang 1922). According to statistical data from 1930 to 1931, Xiamen's fishing industry was particularly prosperous, with fishing boats and boats operating in Xiamen. The annual fishing output was approximately one million yuan silver dollar (Su 1931). Another data from the same period shows there are over 120 fishing boats of all sizes in Xiamen; with over 4000 fishermen, with an annual fishing output worth approximately one million yuan silver dollar (Huang 1933).

Amoy variable longline fishing can not only use low-cost simple fishing gear to make small scale producers quickly grasp and benefit, but also combine with modern large fishing boats, fish carriers, echometer, hydraulic and electric winches to achieve relatively high production efficiency.

Amoy's variable longline fishing tradition is also rare in the world where women and men work together at sea and get equal payment for equal work. Further, organizing the fishing gear can be carried out on land, providing job opportunities for unskilled laborers.

Amoy's variable longline fishing established a deity revered as the 'Diao Caowang (King of Longline Fishing Vessels)' during a period of uncertain times. It is enshrined in a specialized temple called the 'Long Zhu Dian (Dragon Ball Temple)', forming a unique folk religion. At this location we collected sounding hammers, navigation compasses, stone anchors, sinking stones, buoys and other ancient longline fishing tool remains.

In May 2015, the historic home port of Amoy's variable longline fishing, Shapowei, was permanently closed for redevelopment into a tourist spot. Its fishers were told to stay away (Liang 2018).

RESOURCES

The variable longline fishing technology mastered by fishermen in Xiamen is also a common technology that's heritage is based on thousands of years of practical human experience. This tool is simple, easy to learn, scalable, and transferable, which can quickly provide local sustainable blue food to local communities, making a significant contribution to economic benefits. But so far, there has been relatively limited historical research and technical observation, and there has been a lack of fishermen taking the lead and standing from the perspective of fishermen.

Since 2015, we established a community of interests with Xiamen longline fishermen who just lost their fishing work. We have systematically sorted out the eight series of methods for their longline fishing gear for the first time, extracted technical logic, and applied for inclusion in the local intangible cultural heritage list. We have organized a technology transfer team to inherit the variable longline fishing techniques of Fujian and Zhejiang from the offshore to the open sea, allowing fishermen to return to the ocean and use friendly fish resources for variable longline fishing instead of net fishing.

The veteran fishermen in Xiamen Port are an important component of this team, mainly responsible for technology transfer work, while members of our organization provide project assistance and management work. We hope that based on the success of the project, local fishermen who have made changes due to our help can also become members of our fishermen's technical team to help other regions. At the same time, we also assist them in forming their own teams and copying our solution model to promote variable longline fishing. This returns a common technological heritage of humanity to society. We hope to promote and teach variable longline fishing technology to the world, especially low-income coastal areas.

The co-author of this paper, Yu Longfa, is the most famous fisherman in Xiamen longline fishing industry. He has over 50 years of marine fishing experience in Fujian fishing grounds, Zhejiang, and Taiwan Strait, and is also a representative inheritor of Xiamen's intangible cultural heritage of longline fishing techniques.

FRAMEWORK

The crisis of global marine fish resources is mainly caused by the large-scale and undifferentiated centralized net fishing of recent decades. A 20-year retrospective review of global aquaculture issued at 6th Workshop on Lipid Nutrition and Metabolism in Aquatic Animals of China, aqua feeds are reliant on fish meal and fish oil sourced from wild-captured forage fish. Increasing use of forage fish is unsustainable. About 70% fishmeal and fish oil are used in aquaculture. Currently we do not have exact data on the cost of dozens to hundreds of wild captured forage fish needed to feed an adult cultured fish. Variable longline fishing does allow for accurate numbers of captured adult wild fish. This is undoubtedly better for ecosystem health than aquaculture and other methods of fishing.

So where and how is any solution currently being applied?

The innovative approach of Amoy variable longline fishing solution is reflected in the following aspects:

1. Technological innovation: a set of strict technical logic. Sort out the key factors and

important links, helping fishermen to develop sustainable longline fishing programs based on local geographical conditions and current status of fishery resources,. This provides innovative paths for the future implementation of the control of total amount in fishery resources.

2. Innovation of promotion methods: the fishermen who master the variable longline technology get better benefits than any other fishing methods as soon as possible. This promotes the replacement of net fishing and other fishing methods.
3. Community friendly Innovation: let local fishermen increase their income. Encourage women and disabled people to participate in learning and production, and support teenager experience.
4. Overall solution Innovation: through the collection and analysis of the first-hand data of the operation site, transformed previous static fishing data into real-time dynamic guidance. The project provides data and technical support for the future fishing traceability, origin certification, format planning, and quota management.
5. Sustainable innovation: studying the sea conditions and fish conditions from local fishermen, setting fishing gear for trial operation, adjusting fishing gear for trial operation again, formulating local operation methods and compiling operation guidelines, teaching local fishermen operation techniques, replacing existing fishing methods with variable longline fishing for offshore production operations to measure the solution impact, write reports and put forward suggestions on utilization and protection of local marine fishery resources. Then the living standard of fishermen in the project implementation area can significantly improve, and the marine fish resources are significantly protected. This is measured annually, and can be expanded to more areas.

The operation tradition and future promotion of Amoy variable longline fishing technology adheres to the most restrained environmental footprint, are the first local fishermen to use a small single fishing boat with a length of less than 10 meters for nearshore operation. In contrast, the fishery harvest is family operated, with surplus sold in local markets. Where conditions are sufficient, it is considered to develop into a consortium of fishermen. This uses vessels of 20 meters length, adopts the mode of sub mother-ship operation, takes the location as the center for offshore operation and the catch enters the market circulation system and the online direct-to-consumers sales system.

Sailing fishing vessels can be used for the single vessel operation and the production operation of sub and mother-vessels of Amoy variable longline fishing technology. Even if the diesel engine is used as the power engine, it consumes little petroleum fuel. Small fishing boats are usually equipped with two 8 HP engines, with a speed of 5-6 knots and an average fuel consumption of 6 litres per hour. Coastal operations usually consume 6-12 litres of diesel per voyage. For fishing operations up to 20 nautical miles offshore, 60-70 litres of diesel oil are usually consumed per voyage.

Take the example of the Amoy variable longline replacement demonstration project of Zhoushan Zhongjieshan islands in 2020-2021 funded by World Wildlife Fund (WWF). We first coached the local government to establish a specialized NGO organization as the specific implementer of the project. Through their collaboration with local marine fishery administrative authorities and marine nature reserve management authorities, we mobilize local fishermen, and

then send a technical team of Amoy old fishermen for technology transfer work.

CONCLUSIONS

This paper focuses on Amoy variable longline fishing, exploring the history and technical logic of this unique local traditional marine ecological knowledge system. Here, we point out the value of its intangible cultural heritage and physical remains. Based on this, we explore the possibility of continuous innovation as a solution for non-destructive, accurate, and efficient production fishing in complex water bodies. We also seek a solution for sustainable development of marine fish resources and low energy consumption production fishing. We aim to replace other fishing methods that may cause damage to seabed sediments in various water areas including UCH, and support a vital fishing industry for local fishermen including those in the site protection areas.

We are concerned about marine cultural heritage in the face of climate change and global economic recession. We also care for marine life and marine livelihoods. Humans need food, and with limited land resources, they naturally turn to huge ocean resources. Human wisdom should be used to develop marine resources in a sustainable manner. Amoy old fishermen said that in the history of longline fishing, there have been more and more fish in the sea.

Longline fishing seems to be negotiating with the Dragon King. I'll catch your son and I'll keep your grandson. The young fish won't take the bait. The catch of the hooked fish is far less than the breeding quantity, so the fish will naturally be able to reproduce.'

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