

Fish Guests of the Stone Fish Weirs and Traps- Two Case Studies in Jibei and Qimei Islands, Penghu Archipelago, Taiwan

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ABSTRACT

The Penghu Archipelago, Taiwan, has the highest concentration of stone fish weirs in the world. Most built several hundred years ago, some of which are in use by local people today. This paper describes the longstanding traditional knowledge and systems of management of stone fish weirs by local peoples including catching, keeping, and consuming the fish and shellfish from stone weirs in Jibei Island. The island lies north of the Penghu, with 92 stone weirs covering 3.1 square kilometres around its coastline.

The paper also details the record catch of Rainbow Runner (*Elagatis bipinnulatus*) in July, 2019 in the twin-heart basalt stone fish weir of the Qimei Island, the southernmost island in the Penghu archipelago. This paper plans to shed light on how the local community utilize stone fish weirs in a sustainable manner to decipher the long practiced ancient wisdom of Tienrengonghao 天人共好 in Chinese, meaning “The universe and human in harmony”.

Key words: Basalt stone fish weirs, Jibei Island, Qimei Island, Penghu Archipelago, *Tienrengonghao*

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INTRODUCTION

The Penghu archipelago, with around 600 estimated stone fish weirs, is well known as having one of the highest concentration of stone fish weirs in the world (Li & Chen 2013:3). This study aims to outline the fish species associated with stone fish weirs and traps in the Penghu archipelago, with special focus on Jibei and Qimei Islands. The Twin-heart Stone Fish Weir in Qimei has been listed as the Cultural Landscape of Penghu County in 2006, while the Cluster of Stone Fish Weirs in Jibei Island was listed in 2008 (National Cultural Heritage Database Management System website). In 2009, the “Penghu Stone Fish Weirs” were listed as one of Taiwan’s 18 Potential World Heritage Sites by the Bureau of Cultural Heritage (2009). Due to the rapid decline in stone fish weirs, the “Heritage Preservationists Jibei Stone Fish Weirs Team” was established in 2007; their objective is to restore these stone fish weirs (Ministry of Culture website).

The Penghu archipelago, also known as the Pescadores (Portuguese word for “fishermen”) comprise a group of nearly ninety islands and islets lying in the middle of the Taiwan Strait, about 45 kilometers west of Taiwan and 140 kilometers east of mainland China. Jibei and Qimei are two

islands of the Penghu Archipelago (Penhu County); Jibei located in the north and Qimei represents the southernmost in the archipelago (Fig. 1).



Figure 1: Map of Jibei and Qimei islands in the Penghu archipelago (revised from Google Map by Chen Mei-Fang).

Most Penghu archipelago islands, apart from Huayu, are formed mainly by flows of basaltic lavas in association with seafloor spreading in the South China Sea dating from 17.5 to 8.2 MYA (Chen and Chang 2009:73). Therefore abundant basalt stones are available for constructing stone fish weirs. Large tidal areas (some of them stretching outward for more than 10 km) with fringing coral reefs are available as materials for building stone fish weirs and traps as well. Additionally, there are two currents that meet at the Taiwan strait, one is the Kuroshio Branch current flowing northward along the southwest coast of Taiwan and east of the Penghu archipelago while the fresh and cold China Coastal water current flows southward along the west side of Penghu and southeast coast of China. Both currents are modulated by the annual cycle of monsoon winds. The northeast monsoon begins in mid-September and peaks from October to March. In November and December we see its windiest period of the year. Strong northeast monsoons in winter often bring a large amount of fish into the stone fish weirs.

GEOLOGY OF JIBEI AND QIMEI ISLANDS

Jibei island, 23°44'40"- 23°47'44"; 119°35'58"-119°37'04"E, covers 3.1 square kilometers, belonging to the Baisha Township, Penghu County. Jibei Island, known as the "Home of the Stone Fish Weirs", gains its name because of the highest concentration of stone fish weirs; over 92 stone fish weirs along a 13km coastline (Lee & Chen 2013). These stone fish weirs are no longer the

major method in catching fish from an economic standpoint, both due to modern fishing gear and a mechanization of inshore fishing. But still visiting fish weirs and traps remain very much a part of every-day life by locals at the receding tide and the fish caught still form the main source of their diet.

Qimei Island is located in the southernmost point of the Penghu Archipelago and on the southern side of the Tropic of Cancer, at 23°09'40"- 23°11'44"; 119°23'58"-119°26'04"E. It covers 6.99 square kilometers when measured at high tide whereas 7.54 square kilometers at low tide (Juang W.S. 1999:243). Belonging to the Qimei Township, Penghu County. Various magnificent basaltic columns are found along the southeastern, eastern to northern shores of the Qimei Island. The Twin-heart stone fish weir is located in the northeast of Qimei Island.

THE DEFINITION OF FISH WEIRS AND TRAPS

Although Rowland and Ulm (2011:3) noted that the terms ‘weirs’ and ‘traps’ were used interchangeably, they cited Connaway’s definition of weir and trap, whereby a ‘weir’ was an obstruction placed in a stream or tideway or along a shoreline to funnel fish into a procurement area, while a ‘trap’ is a device placed in the procurement area to capture and impound fish for collection. In this paper, the author refers those stationary structures, such as stone walled as a fish “weir” (known as *shihu* in Mandarin Romanization; tsio₁₁ ho³³ in Taiwanese Hokkien with International Phonetic Alphabet), while a movable one, such as piled-rock are a “trap”(known as tun⁵⁵). The materials used for construction are all locally available with a combination of basalt stones forming the base, the foundation stone, and top of the weirs with coral limestone blocks laying in between providing hiding places for fishes as well as for a further reinforcement to the wall of a stone fish weir. It is more apparent as seen in the case of traditional stone fish weirs in Jibei Island as the island is surrounded by large areas of fringing reefs in the intertidal zone.

STONE FISH WEIRS AND TRAPS IN JIBEI AND QIMEI

The earliest literature mentioning stone fish weirs in Jibei was *Penghu Jilue* (The Local Gazetteers of Penghu) compiled by Hu Jianwei in 1771 A.D (during the 36th year of the Qianlong reign) (1958:209-230). At that time, there were one large and four small stone fish weirs recorded whereas there was only two large and sixty-nine small fish weirs in the whole of Penghu. Jibei, a small island, already consisted of 7% of the total number of stone fish weirs. During the Japanese colonization period (1895-1945), stone fish weirs numbers were booming. The recorded number of stone fish weirs in Jibei Island was 70 according the the Collection of Taiwan Sotokufu Documents in 1913, among them, 57 were arc-shaped (81.43%) and were the most common ones followed by single-chambered (13 or 18.57%)(Lin 2006:8; Lee *et.al.* 2018:158). The Twin-heart Stone Fish Weir located in the northeast Qimei is a two chambered fish weir owned by Yan Gong and finished around 1937. After Yan’s death, the Twin-heart stone fish weir gradually degraded for a period of time until Qimei County started to employ a skilled team from Jibei Island to repair and maintain it regularly since 1995. Because of the maintenance by government institutions as well as the

generosity of Yan's descendants, all islanders living in Qimei could access and catch fish freely. In addition, the Twin-heart stone fish weir has become one of the most attractive tourism destinations among the Penghu archipelago, especially with lovers or newly-wed couples that want to have their romantic memories captured with the Twin-heart. The Weir consists of two chambers and a fish well (a deep hole for storing fish for short periods). The dimensions of Twin-heart Stone Fish Weir is as such: the outer chamber is 46m in length, 2m in width and 2m in maximum height, while the inner chamber is with 71 m in length, 1.8 m in width and 1.8m in height. The fish well is 0.85 m in diameter, 0.96 m in depth (Hong 1999:215).

On the 8th of July 2019, after 4 o'clock in the afternoon when the tide was starting to ebb, local people saw, "a pot of gold in the end of the rainbow" - schools of over 300 Rainbow Runner (known as *la₃₃ lun⁵⁵*) caught inside the inner chamber of the twin-heart stone fish weir of the Qimei Island. Eleven people worked together to gather them up. Two of them pulled a net in the gate of the inner chamber to block the escape of fish and the others caught them by hand. The abundance of fish took 4 hours to harvest. (Fig. 2).



Figure 2: Over 300 Rainbow runners were harvested in the Twin-heart Stone Fish Weir, Qimei, on the 8th of July, 2019 (Photo courtesy of T.SIX).

Over 300 Rainbow Runners were harvested and shared by the people who made the effort to gather this catch. The weight of them each ranged from 4-5tw catty to about 7-8tw catty (one Taiwan (tw) catty weight equal to 0.6 kg). Most of them are large sized, weighing 7-8 tw catty each. Some of them sold them at 120 Taiwan dollars per catty and got a high profit with this harvest (T.SIX 2019 *pers. comm.*) (Xu Y.J. 2019 *pers. comm.*) (Shao 2020, in press).

Compared to other islanders of the Penghu archipelago, Jibei islanders have the longest engagement with reef fisheries and fish harvested from these stone fish weirs and traps are still a major source of their diets and source of income. Among the varied species of reef fish, rabbitfish and grouper are of particular significance for island communities due to their productivity and the ease of catching. A lists of names of different stages as well as the specific timing or seasons of rabbitfish caught is provided in the Appendix (Special Terms of Rabbitfish) of this paper compiled by 75 year-old Chang Ching-Hai who has gathered and written about their use in Jibei for over 20 years and with English translation by the author.

FISHES RELATED WITH STONE FISH WEIRS AND TRAPS IN JIBEI AND QIMEI

In general, the peak time of catching fish inside the stone fish weirs is when the northeast monsoon starts, usually from late autumn to early spring (the eighth month to second month next year in lunar calendar). Lin Wen-Zhen (2006: 33-34) in his book *Jibei shihu jiyi tuxiang* (Memory and Images of the Jibei Shihu) listed the fish species related to stone fish weirs in different seasons in Jibei including Porcupine and Bigfin reef squid all year round; most other species make their appearances after ninth month until first month next year in lunar calendar including Parrotfish, young striped cat-fish eel, Black-barred Halfbeak, Yellowtail Barracuda, Silver Croaker (Japanese meagre), Largehead Hairtail, Greater Amberjack, Buccaneer Anchovy, Chicken Grunt, Rabbitfish and Pharaoh Cuttlefish. Zebra Shark and Silver-stripe round Herring can also be seen all year round but peak in the ninth to tenth month of the lunar calendar. From the second to eighth month in lunar calendar catches are low, however several fish species can still be seen, such as Bower's Parrotfish, Indian Anchovy, Oceanic Bonito, Flat Needlefish and Butterfly Rays. Chang Ching-Hai's (2020) account of the fish species caught in the weirs of Jibei in previous seasons are the same with the peak in winter. When the weather was extremely windy and cold, there is an increased chance to see fish. During the winter, fish species liked the Silver-stripe round Herring, Buccaneer Anchovy, Silver Croaker, Greater Amberjack, Rabbitfish, Black-barred Halfbeak, Rough Flutemouth, Young Striped cat-fish Eel, Whiptail Silver-biddy, Largehead Hairtail, Yellowtail Barracuda are all often seen. If the fish are typically small, such as Silver-stripe round Herring and Buccaneer Anchovy when appear in winter, then it is possible there were sharks following in and got caught; In Spring, after *Lichun* (Beginning of Spring in Chinese solar term, usually around early February), fish are caught less inside the weirs apart from those "vegetarian rabbitfish" (see Appendix), Bigfin reef Squid and Pharaoh Cuttlefish; In summer, Silver-stripe round Herring and Oceanic Bonito are among common fish as well as Flat Needlefish. When typhoons arrive along with the time of spring tide, various fish, called wind-hit fish, would be caught.

Juvenile rabbitfish were also seen during the summer; After *Liqiu*, (Beginning of Autumn, usually begins around early August), Dorab wolf Herring, Greater Amberjack and Young Striped cat-fish Eel can be found. As for the catch of Twin-heart Stone Fish Weir, Hong G.X (1999:215) recorded that during summer, the deeper outer chamber of the Twin-heart Stone Fish Weir catches more fish than winter time with species such as Bigfin reef Squid, East Asian fourfinger Threadfin, Buccaneer Anchovy, Silver-stripe round Herring and Round Herring, whereas the shallower inner chamber

tends to catch more fish during winter. Apart from Rainbow Runner, Ray, Rabbitfish, Big scale Liza and Green Sea Turtle were all commonly seen in the Twin-heart Stone Fish Weir, as reported by Xu Y.J. He heard that sharks are also among the quests of the twin-heart stone fish weir in the past but he did not see one (Xu 2019). Table 1 is a list of fish family and species (in alphabetical order) caught inside the stone fish weirs and traps in Penghua compiled by the author according to personal interviews as well as books written by Lin Wen-Zhen (2006:33-34) and Hong Guo-Xiong (1999:39-45; 215). Both the fish family and species are provided as the identification of the archaeological fish assemblages has been made mostly to the family level. The fish references of Penghu local, common names, species, and families are according to the Fish Database of Taiwan (Shao K.T. 2020 retrieved).

Family	Scientific name	Common name	Weir & Trap	References
Atherinidae	<i>Atherinomorus lacunosus</i>	Silverside, sandsmelt	W	Hong, G.X(1999:39-46)
Belonidae	<i>Ablennes hians</i>	Flat Needlefish	W	Hong, G.X(1999:39-46); Lin, W.Z(2006); Chang, C.H(2020)
Caesionidae	<i>Pterocaesio digramma</i>	Double-lined fusilier	W	Hong, G.X(1999:39-46)
Carangidae	<i>Caranx ignobilis</i>	White ulua, Yellowfin jack, Yellowfin trevally	W	Chen, Y.P(2019)
	<i>Decapterus macarellus</i>	Mackerel Scad, Scad, Robin or Mackerel	W	Hong, G.X(1999:39-46)

	<i>Decapterus maruadsi</i>	White-tipped mackerel, Japanese scad	W	Hong,G.X(1999:39-46)
	<i>Elagatis bipinnulata</i>	Rainbow runner	W	Xu.Y.J(2019); T.SIX(2019);Chen,Y.P(2019)
	<i>Seriola dumerili</i>	Greater amberjack	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020);Zhu,H.B(2020)
Chirocentridae	<i>Chirocentrus dorab</i>	Dorab wolf-herring	W	Chang, C.H.(2020)
Clupeidae	<i>Spratelloides gracilis</i>	Silver-striped round herring	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020); Xu,Y.J(2019); Chen, Y.P(2019)
	<i>Etrumeus teres</i>	Round herring	W	Hong,G.X(1999:39-46);Chang,C.H(2019)
	<i>Sardinella melanura</i>	Blacktipped sardine	W	Hong,G.X(1999:39-46)
Diodontidae	<i>Diodon holocanthus</i>	Porcupine	W	Hong,G.X(1999:39-46);Lin,W.Z(2006)
Engraulidae	<i>Encrasicholina punctifer</i>	Buccaneer anchovy	W	Li,K.T(2020); Chang,C.H(2020);Hong,G.X(1999); Lin,W.Z(2006)
	<i>Stolephorus indicus</i>	Indian anchovy	W	Hong,G.X(1999:39-46);Lin,W.Z(2006)
Fistulariidae	<i>Fistularia petimba</i>	Rough flutemouth	W	Chang,C.H.(2020)

Gerreidae	<i>Gerres filamentosus</i>	Whiptail silver-biddy	W	Chang,C.H.(2020)
	<i>Gerres oyena</i>	Common silver biddy	W	Hong,G.X(1911)
Gymnuridae		Butterfly rays	W	Lin,W.Z(2006)
Haemulidae	<i>Parapristipoma trilineatum</i>	Chicken grunt	W	Hong,G.X(1999:39-46);Lin,W.Z(2006)
Hemiramphidae	<i>Hemirampus far</i>	Black-bar red halfbeak	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H.(2020)
Kyphosidae	<i>Kyphosus lembus</i>	Blue sea chub, Bass seachub	W	Hong,G.X(1999:39-46);Chang,C.H(2020)
Leiognathidae	<i>Leiognathus bindus</i>	Silver belly, Splendid ponyfish	W	Hong,G.X(1999:39-46)
Lethrinidae	<i>Lethrinus nebulosus</i>	Sand sapper, parrot fish	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020)
Mugilidae	<i>Liza macrolepis</i>	Big scale liza, Borneo mullet	W	Hong,G.X(1999:39-46);Xu,Y.J(2019)
Muraenidae	<i>Gymnothorax buroensis</i>	Vagrant moray	W	Hong,G.X(1999:39-46)

	<i>Gymnothorax favagineus</i>	Laced moray	W	Hong,G.X(1999:39-46);Chang,C.H(2020)
	<i>Gymnothorax fimbriatus</i>	Spot-face moray, Darkspotted moray	W	Hong,G.X(1996:117)
	<i>Gymnothorax reevesii</i>	Reeves's moray	W	Hong,G.X(1996:117)
Plotosidae	<i>Plotosus lineatus</i>	Young Striped cat-fish eel	W&T	Hong,G.X(1999:39-46);Lin,W.Z(2006); Xie,F.Y.(2020) ;Chang,C.H(2020)
Polynemidae	<i>Eleutheronema rhadinum</i>	East Asian fourfinger threadfin		Hong,G.X(1999:39-46)
Pomacentridae	<i>Abudefduf coelestinus</i>	Sergeants, six-barred sergeant	W	Hong,G.X(1999:39-46)
	<i>Chromis notata</i>	Pearl-spot chromis, Damselfish	W	Hong,G.X(1999:39-46)
Scaridae	<i>Chlorurus bowersi</i>	Bower's parrotfish	W&T	Lin,W.Z(2006)
Sciaenidae	<i>Argyrosomus japonica</i>	Japanese meagre, Silver croaker,	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020)
		Silver jewfish,		

Scombridae	<i>Euthynnus affinis</i>	Oceanic bonito, kawakawa ; Black skipjack	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020)
	<i>Scomberomorus sinensis</i>	Chinese seerfish	W	Hong,G.X(1999:39-46)
Scorpaenidae	<i>Sebastiscus marmoratus</i>	False kelpfish	T	Xie F.Y.(2020)
Serranidae	<i>Epinephelus quoyanus</i>	Rockfish grouper	W&T	Hong,G.X(1999:39-46);Lin,W,Z(2006:41);Chang,C.H 2020);Xie,F.Y(2020)
Siganidae	<i>Siganus fuscescens</i>	Rabbitfish , Streamlined spinefoot	W&T	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020);Xie,F.Y(2020);Xu,Y.J (2019)
Sphyraenidae	<i>Sphyraena flavicauda</i>	Yellowtail barracuda	W	Lin,W.Z(2006); Chang,C.H(2020)
Stegostomatidae	<i>Stegostoma fasciatum</i>	Zebra shark	W	Lin,W.Z(2006)
Terapontidae	<i>Pelates quadrilineatus</i>	Fourlined terapon	W	Hong,G.X(1999:39-46)
	<i>Terapon jarbua</i>	Thornfish	W	Hong,G.X(1999:39-46)
Trichiuridae	<i>Trichiurus lepturus</i>	Largehead hairtail	W	Hong,G.X(1999:39-46);Lin,W.Z(2006); Chang,C.H(2020)

TABLE 1: Lists of common fish species (in alphabetical order) caught inside the stone fish weirs and traps in Penghu compiled by Shao, Meihua

Several fish species are of particular importance seen in Jibei and Qimei islands which provide further informative insight of the practice and tradition of fishing related to stone fish weirs and traps and summarized below.

PELAGIC FISHES AND STONE FISH WEIRS

“pa₃₃ laN⁵⁵ is too delicious to share with husband; la₃₃ lun⁵⁵ is too delicious to share with grandchildren” are idioms in Penghu to describe how the White-tipped Mackerel Scad (known as pa₃₃ laN⁵⁵) and Rainbow Runner (known as la₃₃ lun⁵⁵) is so delicious that people are reluctant to share it with their families.

According to Chen You-Po (2019 *pers. comm.*), the carangidae family, such as Rainbow Runner (*Elagatis bipinnulata*) and White Ulua (*Caranx ignobilis*) all can be found in the twin-heart stone fish weir in Qimei. In the summer of 2018, groups of White Ulua were caught in the fish weir. These pelagic fish all have a strong tendency to form schools and prey upon small fish entering and got caught inside the stone fish weir; hundreds were caught in just one catch. 65 year-old Xu You-Jin (2019) noted that just a week ago before the big catch of Rainbow Runners on the 8th of July, 2019 he heard the sound then saw huge amount of Silver-stripe round Herrings darting in and out just ‘like silver waves’ and left the next morning. Most likely those Rainbow Runners were chasing after smaller fish and got caught.

Zhu Huang-Bao (2020 *pers. comm.*) noted that actually Greater Amberjack, also the Carangidae family, was more often seen and caught in the Twin-heart stone fish weir in the past and the appearance of Rainbow Runner was much less. Hong G.X. (1999:39-46)’s account also indicates three species of the *Carangidae* family are often seen in the stone fish weirs in the Penghu Archipelago. These are the Greater Amberjack (*Seriola dumerili*), White-tipped Mackerel Scad (Japanese scad) (*Decapterus maruadsi*) and Mackerel Scad (*Decapterus macarellus*) as well as two *Scombridae* family such as Oceanic Bonito (kawakawa) (*Euthynnus affinis*) and Chinese Seerfishh (*Scomberomorus sinensis*). Recorded by Lin W.Z (2006:77) recorded a huge amount of Oceanic bonito (*Euthynnus affinis*) in the *Scombridae* family were found in the sai₃₃ pHiã₃₃ k^{hau}⁵¹ Weir in the Mudou islet, 7 kilometers north of Jibei, around sunset. In average they weight 7-8 tw catty (4.2 to 4.8 kg) each, some as heavy as 10 tw catty (6 kg) were caught. Seven people cleaned and prepped all the fish, working until 4 in the morning. Once, hundreds of Oceanic bonito were just caught in the fish weir during the ebb tide, and soon after the tide turned and flowed in, hundreds more came in with the tide flow again.

Chang C.H (2020) stated that when it was nearly the Winter Solstice, Oceanic Bonito start to make appearance in many stone fish weirs. Sometimes, Oceanic Bonito still can be seen until early spring (first month of lunar calender) which is very fatty and delicious. It is interesting that according to Zhu H.B. (2020), he has never heard Oceanic Bonito caught in the Twin-heart Stone Fish Weir in Qimei.

SMALL FISHES AND STONE FISH WEIRS

The Silver-stripe round Herring (*Spratelloides gracilis*), Round Herring (*Etrumeus teres*) and Blacktipped Sardine (*Sardinella melanura*) as well as the Indian anchovy (*Stolephorus indicus*) are often seen in the stone fish weirs in Penghu in years past. Hong Guo-Xiong (1999:39) recorded that the Silver-stripe round Herring is one of the most important fish caught in stone fish weirs in Penghu. In the past, one catch of over ten thousand two catties in a stone fish weir were frequently heard of. As with Round Herring, the high peak time is from April to September while the peak time of Blacktipped sardine is from July to December.

Chen You-Po recalled that when he was a child, there were abundant fish along the coastal areas of Qimei such as Silver-stripe round Herring, Round Herring, Buccaneer Anchovy and Rabbitfish, especially from late spring to early summer. People usually catch them at night. Li Ko-Tek photoed a harvest of Buccaneer anchovy in the kua₅₁ lua³³ Weir at Jibei after 5 o'clock in the morning on the 9th of Nov, 2014 (Figs. 3-4). However, small fish seen inside stone fish weirs have declined rapidly.



Figure 3: Huge amount of Buccaneer Anchovy got caught inside the kua₅₁ lua³³ weir in Jibei (Photo courtesy of Li Ko-Tek).



Figure 4: People harvesting Buccaneer Anchovy in Nov, 2014 (Photo courtesy of Li Ko-Tek).

RABBITFISH AND PILED-ROCK TRAPS BUILT INSIDE STONE FISH WEIRS

Rabbitfish (known as $\text{ŋu}_{11} \text{e}_{51} \cdot \text{a}_{11}$ in Qimei and $\text{lo}_{33} \text{ue}_{55} \text{a}^{51}$ in Jibei) are an important and much appreciated food throughout the Jiabei and Qimei islands. And the piled-rock traps built inside stone fish weirs are the main device for catching them (Chang C.H 2020; Xie F.Y.2020). *Siganus argenteus* is the species of rabbitfish often seen in Jibei and Qimei islands. The kind of piled-rock trap for catching rabbitfish is built inside a stone fish weir is also known as $\text{lo}_{33} \text{ue}_{55} \text{tun}^{55}$ (literally rabbitfish mound). $\text{lo}_{33} \text{ue}_{55} \text{tun}^{55}$ are built with three large corals to form the base and start to pile them in layers with flat coral stones. It could be two to three layers covering an average about 1.5 to 2 meters in diameters. Normally, there are two to three $\text{lo}_{33} \text{ue}_{55} \text{tun}^{55}$ inside the fish weir; their locations inside the weir are with one near the gate and the other two along an existing wall of the stone fish weir. Several illustrations of the tun^{55} were provided by Lin in this book (2006:43-44; Figure 69-72). Only the one who piles the rock traps in the morning has the fishing right of the stone fish weir that day. They collect them in the evening by encircling a net (Chang C.H 2020).

The $\text{ts}^{\text{h}}\text{o}_{33} \text{tsio}/3$ Weir in Jibei is the one weir that has caught the most rabbitfish. According to Lin Wen-lai, there were around 3000 rabbitfish caught during the evening in the 5th day of the twelfth lunar month about 20 years ago. The weir was packed with rabbitfish. No one dared to stand inside as the extremely painful sting of rabbitfish is well known by every fishermen, instead, people stood on the top of the weir wall piercing. Another fish weir nearby also caught c. 700 rabbitfish that same day (Lin 2006:78). Rabbitfish are widespread in the Penghu water however Jibei seems to be their main spawning grounds as seen from the Appendix that abundant juvenile rabbitfishes ($\text{ka}_{33} \text{taN}_{33} \text{a}_{55} \text{ke}^{13}$) made their appearance during summer.

ROCKFISH GROUPEL AND PILED-ROCK TRAPS BUILT IN TIDAL AREAS

Rockfish grouper (*Epinephelus quoyanus*) (*Serranidae* family) are one of the favorite fishes of the Penghu people. The most efficient way of catching them, especially in the old days, is mainly associated with piled-rock traps constructed in tidal areas (Hong 1996:124; Chang, C.H 2020; Xie F.Y 2020). According to Xie Fu-Yuan (2020), "in this way, 70-80% of the catches are groupers with the rest of moray eels, False kelpfish, young striped cat-fish eel and other reef fishes. One of the suitable places for having piled-rock traps is in the marginal areas between sand and reef. Built on sand but located near reefs in order to attract those reef fishes coming in". Rockfish Grouper is called *kueh-a*, therefore to construct this kind of piled-rock trap is called p^ho₁₁ kue₅₅ a₅₅ tsHu¹¹ (literally grouper's holding house). The shape of it is usually rectangular and the materials used are mainly large coral stones (Chang, C.H. 2020; Lin 2006:41). Grouper is best cooked in soup with just a touch of salt and spring onions in order to taste the subtle sweetness of fresh fish according to local people.

According to Hong G.X (1996:121-124), when Sargassum seaweed arrives around January, it is the time that juvenile groupers make their appearance. Therefore the kue₅₅ a₅₅ tsHu¹¹ built near the shore would have good catches of juvenile grouper around January. When young grouper are getting bigger in June and July, the piled-rock trap build off the shore will catch more of these fish. After Mid-Autumn, Sargassum seaweed comes to the end and the grouper moves into deep water. Many fishermen simply leave the trap rocks in situ and come back to build again around March and April next year.

The procedure of constructing the p^ho₁₁ kue₅₅ a₅₅ tsHu¹¹ (literally grouper's holding house) is to start with clearing the coral stones and Sargassum seaweed around the "grouper's house". One man/woman or child takes a kind of Y shaped lave net with one hand to encircle the opening of the grouper's house while the other hand take off the "house corals" one by one until the "house" gets smaller and smaller. When the house can be covered by the net, one can just close and pull up the net to harvest them all. Those same house corals are put aside and used for the construction of a new house. When a new house is built, usually it takes half a month to gather enough fish therefore one will comeback to harvest around 15 days later. However, the catches (mainly groupers) declined rapidly from tens of tw catty a day per person to 6-7tw catty a day three years ago to this year (1996) down to only 2tw catty a day.

MORAY EELS AND STONE FISH WEIR

Approximately nine species of moray eel (*Muraenidae* family) inhabit Penghu water; all called tsĩ₃₃ muã¹³ (literally money eels). Among them, laced moray (*Gymnothorax favagineus*) is the most common one in stone fish weirs. They are often seen concealing themselves in the hollows of coral stones and between basalt rocks of the walls of stone fish weirs. However, it is difficult to get them out of their crevices therefore a set of five to six specific tools are needed to catch moray eels. Another tactic is to lay pieces of certain fish (those with a particularly strong fishy smell, such as rabbitfish) into the fish well of the stone fish weir. The fishy smell will attract lots moray eels

gathered in the fish well. The bulk of moray eels can be caught in this way (Chang C.H 2020). According to Hong's informant (1996:117), laced morays dwell mostly in corals whereas Reeve's morays (*G.reevesii*) prefer to shelter under rocks of the walls of the fish weir. As for the taste and ease-of-eating, Spot-face morays (*G.fimbriatus*) have less bones while Vagrant morays (*G.buroensis*) have fine and delicate meat.

SILVER CROAKER (JAPANESE MEAGRE) AND STONE FISH WEIR

“One catch of the Silver croaker made one man a house built”, is a story widely told in Penghu. The story goes that in the 28th of September 1946 (the 4th day of the eighth month in lunar calendar), when the tsun₃₃ nã₅₅ tHau¹³ Weir already had a big catch of Silver croakers, Yang Shun-Hu started to worry about his turn in the 7 days after. It came out that there were over nine hundreds of Silver croakers during the dawn of the 7th about 10.000 tw catty (6000 kg) in total weight. Ten people helped him out that day. On the same day, during the evening, over 6000 tw catty (3600 kg) of Silver-stripe round herring come in. He dried and sold them to Tainan. That month was very windy and nearly every day people saw Silver croakers and Silver-stripe round herring visiting the weir. The money raised from the sale of this fish enabled Yang Shun-Hu to rebuild his house which was badly damaged by US bombing on the 28th of July in 1945 (Lin W.Z. 2006:76-77;108).

DISCUSSION

In the archaeological literature, numerous studies in many Pacific islands draw a relationship between types of fish hooks and fish-bone remains as an interpretation of the fishing techniques applied by different groups of people in the past. For instance, when the family *Carangidae*, fast swimming pelagic carnivores such as Rainbow runner, made their appearance in archaeological sites on Kapingamarangi and Nukuoro (two atolls in Micronesia), it is discussed and suggested that a likely catching method was by angling with baited hooks or trolling with a lure (Leach and Davidson 1988:2;11).

Two types of fast swimming predators, the *Carangidae* and *Thunnidae*, are also seen in the archaeological fish remains from the Viraria stie, Rurutu, Austral Islands (Leach and Intoh 1984). Rainbow Runner, known as *te kina*, is held in great esteem in both Kapingamarangi and Nukuoroo islands and is thought after by the Polynesian fishermen. Although, pelagic fish such as Rainbow runner are easily taken by a lure but one must be close to it (Leach and Davidson 1988:2;11).

Another fast swimming pelagic family *Scombridae* mentioned by Allen (2002:753) is especially apparent in ancient times along a north to far-southeast arc (Societies-Marquesas-Rapa Nui) hence it is suggested that the early fishermen regularly worked the productive outer reef. By the fifteenth to sixteenth century AD both carnivorous fish and fish-hooks are on the decline. It is worth noticing that certain fish in the *Carangidae* and *Scombridae* families are among the most common fish types caught in stone fish weirs in Penghu seen from the Table 1 of this paper with a big catch of over 300 Rainbow runners just happening in the Qimei Twin-heart stone fish weir in 2019.

The family *Serranidae*, such as grouper, are highly represented as reported by archaeologists studying prehistoric fish remains in the Pacific. Leach and Davidson (1988:2;11) are aware that high percentages of fish from families *Serranidae* (Epinephelinae) and *Carangidae* in Kapingamarangi however very few related artefacts such as fish hooks were found. Contrarily, excavations on Nukuoro revealed a large quantity of fish hooks made from pearl oyster shell and the debris of their manufacture is present but the fish assemblage is mainly caught by netting. Allen (2002: 753) pointed out that in most cases three families (*Serranidae*, *Scaridae*, and *Scombridae*) comprised the bulk of any given assemblage ($\geq 60\%$). Family *Serranidae*, such as groupers, tend to inhabit inshore silty reefs and rocky bottoms of intertidal waters, therefore archaeologists assumed those groupers most likely have been caught with baited hooks based on the experiences of modern fishermen. In New Zealand a lure trolled deep in the water may sometimes catch a grouper (Leach and Davidson 1988:2,11). It is worth noticing that the groupers are the main and targeted fish caught by piled-rock traps in the intertidal areas therefore it is named after grouper (kue₅₅ a₅₅ tsHu¹¹, literally grouper's holding house) which have been practiced by generations of Penghu people. One possibility that this phenomenon is not recognized may be because the use of piled-rock trap is very rare in the Pacific nowadays. Hunter-Anderson (1981:86-87) recorded that the prehistoric use of piled-rock traps (*ulung*) in the northeastern lagoon in Map Island, Yap, was reportedly extensive, however, contemporary use of *ulung* is rare and no clear forms can be discerned. This may also explain that why contemporary informants do not know what species of fish would have been caught by piled-rock traps.

Archaeological assemblages of the Kapingamarangi fish remains actually show an intriguing pattern with families of *Serranidae* (bottom feeding fishes, such as groupers), Anguilliformes: *Muraenidae* (Moray eel) and *Carangidae* (fast swimming pelagic fishes) (Rainbow runner) been the top five species among twenty four fish families (Leach & Davidson 1988:5, Table 1) . This may be an indication of the practice of stone fish weirs and traps which need further research in archaeological fish remains.

CONCLUSION

In conclusion, the targeted fish of the piled-rock trap (kue₅₅ a₅₅ tsHu¹¹) in the intertidal areas is grouper (*Epinephelus quoyanus*)(*Serranidae* family) whereas rabbitfish (*Siganus fuscescens*)(*Siganidae* family) is the targeted fish by piled-rock trap (lo₃₃ ue₅₅ tun⁵⁵) inside the stone fish weir. Furthermore, species of fast swimming pelagic fishes could be caught in weirs as well. Species including those in the *Carangidae* family, such as White-tipped mackerel scad (*Decapterus maruadsi*), Greater amberjack (*Seriola dumerili*), Macherel scad (*Decapterus macarellus*) are seen often whereas Rainbow runners are caught occasionally. Members of the *Scombridae* family, such as the Oceanic bonito (*Euthynnus affinis*) are often seen as well. However, it appears some regional variations exist. For instance, Rainbow runners are not recorded catches in the weirs in Jibei while the Oceanic bonito has been caught in the Twin-heart stone fish weir in Qimei.

Comparing to the cultural factors of human societies, the nature of fish behavior is quite straightforward. Certain fish species often caught in stone fish weirs or traps would have formed a pattern of fish assemblages and shall be reflected in the archaeological fish remains. If the type of fish taxa found in the remains resemble cultural practices observed by groups of people then it can only be seen in the archaeological context left by people who had the knowledge and skills to construct those facilities to invite certain fish in and harvest them with a minimum of human interference. This is also an intrinsic link between cultural identity and material archaeology. Specific contexts of fish remains served as codes of practice with stone fish weirs and traps by specific social or cultural groups, peoples, or tribes.

An issue associated with the practice of stone fish weirs is the expansion of the Austronesian raised by Lee Ming-ju (2009:112-113), he pointed out that the distribution and configurations of stone fish weirs seem highly correlated with the route of Austronesian expansion which would be one of the traces to look at for the future studies. From archaeological and linguistic points of views, Taiwan could have been one of the Austronesian language families presumably originated has been suggested (Bellwood 1991; Diamond 2000: 709-710, Diamond and Bellwood 2003:59-60; Blust 2009). Although archaeological sites of the Kuoyeh period of the late Tapenkeng Culture (c. 4800-4200 BP) to the Sokang period of the early Niuchoutzu Culture (c. 4200-3800 BP) are widely seen in the Penghu archipelago (including Jibei and Qimei islands) (Tsang 1992). It is too early to draw any connection between them however it surely is one potential in capture technology used by people and can be tested to some extent by studying archaeological fish remains. Reef fish are significant and most accessible food sources for the people, especially islanders of small islands in prehistoric time, where only limited sources of food were available. The practice of stone fish weirs and traps would have enabled islanders and early colonizers in the Pacific with a relatively stable supply of animal protein which must had played a vital role in past societies. The author would like to propose that when certain types of fish assemblage occur in an archaeological context, archaeologists need to look for the remains of stone fish weirs and concentration of rock piles and coral stones on the reef or lagoons along the coastal area in the vicinity of the excavated sites and take them into consideration. They should also view them (fish taxa) as a whole when making an interpretation of the fishing strategies used by the people in the past societies in the Pacific.

The data of this paper provides an overview of important fish species associated with practice of stone fish weirs and traps which not just sheds new light on the interpretations of fishing techniques seen in archaeological fish fauna but also highlights this as a tool in sustainable fish management. Coral reefs are essential spawning, nursery, breeding, and feeding grounds for various fish species and are among the most biological diverse. It is true especially in the case with the stone fish weirs constructed in reef flats and reef edges. The best and effective way to maintain and protect stone fish weirs is to use them. Places such as Yap, and the Federated States of Micronesia has started to work on surveying their fish weirs (*aech*) and to restore and reinvigorate their cultural practices (Jeffery and Pitmag 2011, Jeffery 2013). The traditional uses, value, and management of stone fish weirs and traps in the Penghu Archipelago therefore is essential for further understanding the science of ancient wisdom as they all require specific knowledge and experience. The study of cultural patterns, sustainable reef fisheries and management involve various specific areas of study which are

all intangible heritages associated with tangible heritages -the stone fish weirs and traps which need research undertaken by experts in different fields in cooperation including osteo-fish and underwater archaeologists, anthropologists, fishery scientists and marine biologists.

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Appendix

Special Terms of Rabbitfish (*Siganus argenteus*) written by Chang, Ching-Hai, translated by Shao, Meihua and Taiwanese Hokkien with International Phonetic Alphabet by Chang, Ping-Sheng

Rabbitfish (lo₃₃ ue³)

There are various special terms related to rabbitfish including names for different stages of sizes: if the length of the fish over the width of three fingers (c. 4cm) is called lo₃₃ ue³, and juveniles are called lo₃₃ ue₅₅ a⁵¹, lo₃₃ ue₅₅ tsī¹³, lo₃₃ ue₅₅ tsī₃₃ ā⁵¹, to the smallest reddish brown in colour ones called ka₃₃ taN₃₃ a₅₅ ke¹³.

ka₃₃ taN₃₃ a₅₅ ke¹³

In those days, when summer comes, abundant ka₃₃ taN₃₃ a₅₅ ke¹³ will gathered around the meadows of sea grasses and seaweeds on rocky shores along the coastal area. During daytime, schools of ka₃₃ taN₃₃ a₅₅ ke¹³ packed together. If schools of them enter the stone fish weirs, fishermen shall catch (“ka”) by netting. If gather inside the meadows, fishermen harvesting by lave netting. Local people prefer to salted them for one to two weeks and served by itself, or with minced ginger.

tsa₅₅ lau¹³ lo₃₃ ue/5 (literally morning-tide rabbitfish)

When rabbitfish are too much to harvest in the night, people shall leave them inside the stone fish weirs. Fishes tend to gather near the gate or inside the hollows of corals or between rocks of the fish weir walls and get out next morning.

Fishes caught in the morning is called tsa₅₅ lau¹³ lo₃₃ ue/5 . **tsua₅₅ lau₃₃ lo₃₃ ue/5 (literally staying rabbitfish)**

Those rabbitfishes did not get into the “rabbitfish trap” and stayed near the gate of the stone fish weirs or inside the crevices of the wall in the night are called tsua₅₅ lau₃₃ lo₃₃ ue/5. tsua₅₅ lau₃₃ lo₃₃ ue/5 had nothing to eat for a whole night therefore their stomach are empty, clean and yellowish. The best way of cooking is to stew them in the medium heat. People often describe a man who is skinny with empty stomach a “tsua₅₅ lau₃₃ “.

tsia₁₁ ts^hai₅₅ a₅₅ lo₃₃ ue/5 (literally vegetarian rabbitfish)

During spring time, rock flat will grow seaweeds and sea grasses. The rabbitfish come along with the high tide grazing on seaweeds therefore called vegetarian rabbitfish. Those fishes are fat.

hoN33 pHa₅₅ lo₃₃ ue/5 (literally wind-hit rabbitfish)

During summer and autumn, the morning after typhoon will see large numbers of different types of fishes washed into stone fish weirs, among them are rabbitfish. The sizes of these type of rabbitfish are much larger, even larger than the rabbitfish seen inside the weirs during the winter.

iam₃₃ kuā₃₃ lo₃₃ ue/5 (literally freezing cold rabbitfish)

In winter, when the temperature are extremely low, the rabbitfish caught inside the stone fish weirs are called iam₃₃ kuā₃₃ lo₃₃ ue/5 . This period of rabbitfish is very lean therefore people prefer to dry them. Cut them in half and dry in the northeast wind is considered the best quality of dried rabbitfish. On the contrary, during summer and autumn, south wind and high temperature caused the dried rabbitfish become oily, the taste is not as good as winter ones. Therefore people hardly dry rabbitfish during summer and autumn.