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Generation-To-Generation Transmitted Tsunami-Like Wave Sightings Along the East Coast of Taiwan

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ABSTRACT

Oral tradition indicates that a tsunami-like wave occurred along the east coast of Taiwan during the middle of the 19th century. However, evidence of the event is limited. Based on interviews with local residents we obtained evidence of a tsunami-like wave from a local resident who watched the sea wave strike the coast. His account was passed down to his great granddaughter. The total number of generations between them spanned one and a half centuries. From our interviews with local residents, we observed the difficulty that people experience in retaining original memories for more than two generations. For this reason, this account of the tsunami-like wave is a valuable and rare case for the study of tsunamis along the east coast of Taiwan.

Key words: Tsunami, Eyewitness, Oral story, 19th Century, East coast of Taiwan

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1. INTRODUCTION

In the 18th century a tsunami struck southern Taiwan near Kaohsiung in 1781. Another tsunami struck northern Taiwan near Keelung in 1867 (Yu 1994; Hsu and Lee 1996; Mak and Chan 2007) (Fig. 1a). The 1781 event was possibly caused by Manila trench subduction (e.g., Wu and Huang 2009). The 18 December 1867 tsunami is the first event to be documented in terms of its date and the damage to land. Conversely, no large tsunami has struck the eastern coast of Taiwan due to the steep seafloor gradient, which has a depth of approximately 500 m, 5 - 10 km from the coast (Fig. 1b).

The Amis, which is a Taiwanese aboriginal tribe, has legends that include an account describing "a large sea wave that struck an area, and then, all of the plants and trees perished". This area was subsequently named "Malaulou", which means "withered" in the Amis language. The area is located at the center of Chenggong, which is situated 80 km south of Hualian along the east coast of Taiwan. The name "Malaulou" was first reported by Abe (1938), who interviewed local residents to investigate the origin of locality names in Taiwan. Abe (1938) described that wave as a tsunami that occurred 80 - 90 years prior to the publication of his book, which suggests that the Malaulou event occurred during the 19th century.

Because the Malaulou site is 18 m above mean sea level and 400 m inland from the coast, the run-up height should have been significantly high. If the sea wave was a tsunami generated by an offshore fault, it should have struck the entire eastern coast of Taiwan. The strong motions of an earthquake should also have been experienced and documented in the western half of Taiwan, which was already populated at that time. Ando et al. (2013) performed numerical tsunami simulations to explain the Malaulou wave. However, none of the sources fit the observations and historical data. Consequently, the reliability of the Malaulou story remains uncertain because it is only documented in Chenggong.

During our study of the Malaulou event, we interviewed a lady who resided southwest of Hualian and clearly remembered her great grandfather's account of a large sea wave. This account may be possibly related to the Malaulou event based on its time and location. The investigation described in this paper focuses on the reliability and importance of this account and our interviews with other local residents along the east coast of Taiwan.

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2. AN ACCOUNT OF A LARGE WAVE

In 2010 and 2013 we interviewed Mrs. Feng-Ting Lin at Guangfu, who has roots in the Amis tribe. Mrs. Lin was born in 1969 at Fengbin, which is located 50 km SSW of Hualian (Fig. 1b), but left the town in 1984. Currently, she is the owner of an Amis ethnic restaurant at Guangfu, which is located 20 km northwest of Fengbin.

One day her great grandfather observed a large wave that struck his community. The wave washed out removing the majority of the village's possessions. The great grandfather mentioned that only one large wave struck the village. These descriptions were passed down to Mrs. Lin. Mrs. Lin stated that her great grandfather had told his daughter about the strike of a large wave at Fengbin and that she had heard the story from her grandmother many times. Considering the strike of one large wave, we determined that the large wave was caused by a tsunami instead of storms generated by a typhoon. However, the exact time at which the great grandfather watched the large wave and the height of the large wave remains unknown. We attempt to estimate an approximate time and height for the large wave.

3. TIMING OF THE LARGE WAVE

Mrs. Lin's grandmother was probably born in 1896 and died at the age of 106 in 2002. Her great grandfather died at the age of approximately 90 before 1945, which marked the end of World War II. The birthdate of her great grandfather is unknown.

Figure 2 shows a family photo that may have been taken in 1900 when her grandmother was 5 years old. The photo depicts her great grandfather, great grandmother, grandmother, grandmother's elder brother and grandmother's elder sister. At that time taking a family photo was an expensive and rare occurrence. Her elder brother, who is wearing Japanese-style clothes in the photo, appears to be approximately 15 years old. We infer the age of her great grandfather to be 60 years old or younger based on his appearance in the photo and the ages of his children at the time the photo was taken.

After determining these ages, we estimated that her great grandfather was born in 1840 or a previous year. Because he died prior to 1945 at the estimated age of 90 according to Mrs. Lin, he was probably born before 1855. Because he built a new house for his family after the tsunami occurred, he was likely older than 15 years old at that time. These age estimations indicate that her great grandfather probably observed the large sea wave strike Fengbin village no earlier than 1855.

From 1867 - 1874, Charles W. LeGendre, who was a consular from the U.S.A., remained in Taiwan and recorded international incidents in Taiwan. His document implies that the Qing dynasty did not have power over the southern and eastern region of Taiwan, which was primarily inhabited by the aborigines (LeGendre 2012). Likewise, W. A. Pickering, who was an English sailor and adventurer, remained in Taiwan from 1863 - 1870. During this period he visited some aboriginal villages in southern Taiwan and recorded his experiences. However, he had no chance to enter eastern Taiwan (Pickering 2010). These accounts suggest that no events were documented along the eastern coast of Taiwan prior to 1870.

In 1878 a confrontation in which some Amis clan groups resisted the Qing dynasty's military garrison, occurred in Dagangkou along the east coast of Taiwan (e.g., Li 2005; Lin 2008). If the tsunami occurred after 1878, the Qing dynasty garrison would probably have documented the event. Consequently, we estimated that the large wave that

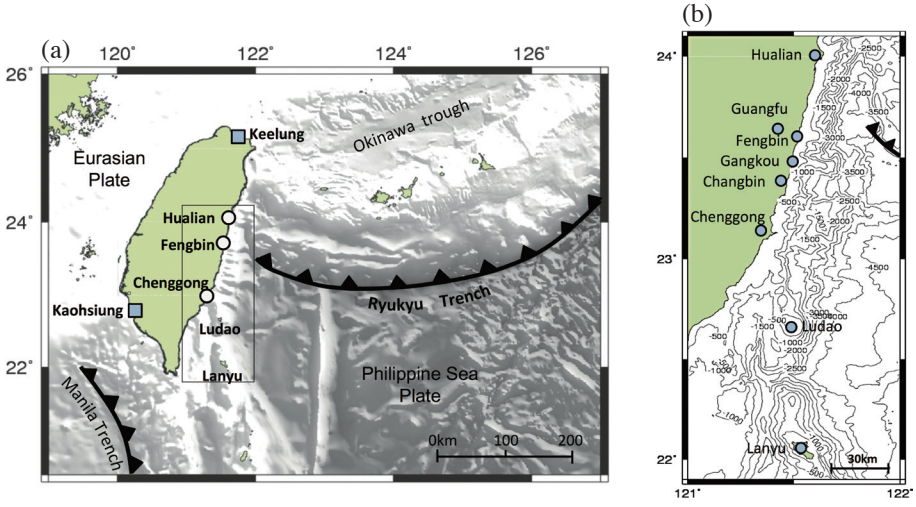

Fig. 1. (a) Map showing the bathymetry around Taiwan. The rectangle depicts the survey area of this study. It also shows Keelung and Koushing, where the 1867 tsunami and 1781 tsunami were observed, respectively, according to historical documents. (b) Locality map of the interview sites of this study.

Fig. 2. A family photo taken near 1900. In the front row (from the left), the grandmother, the grandmother's elder sister and great grandfather; in the second row, the great grandmother and the grandmother's elder brother. The grandmother's elder brother, standing in the last row, is wearing traditional Japanese clothing. The grandmother was five years old when this photo was taken. The great grandfather told his daughter (the grandmother) that the large wave struck his community, and the grandmother repeatedly told her grandchild (Mrs. Feng-Ting Lin, born in 1969) about this large wave. These situations sustained the family's memory of the large wave that the great grandfather experienced possibly between 1855 and 1878. Until recently, family photos including this photo were displayed on the wall of Mrs. Lin's restaurant.

affected Fengbin and Chenggong occurred between 1855 and 1878 (Fig. 3).

As described in Ando et al. (2013), Mr. He-Sheng Wang (http://bedrock.ccl.ttct.edu.tw/ResourceShow.aspx?CID=1555, accessed on 12 January 2015), was a former vice mayor of Chenggong and a local historian with Chinese roots who inhabited Chenggong 55 km SSW of Fengbin since the 1930s. He reported hearing about the Malaulou event as a child (an unpublished memo 2008). He frequently visited his friends and listened to stories from the elder Amis, who passed down their legends to younger generations. Because the Amis tribes did not have written text, legends were passed orally from generation to generation. Mr. Wang estimated that the Malaulou event occurred in the middle of the 18th century. This estimation is consistent with our estimation of the large wave timing.

4. HEIGHT OF THE LARGE WAVE

The great grandfather's account provides minimal information about the height of the large wave. Consequently, we attempt to assess the wave height based on the location of his new home. Before the strike of the large wave, the great grandfather lived near the shore on the northern side of the Fengbin River. After the event he decided to move further inland from the coast. We assume that the great grandfather moved to a place where the large wave did not reach or that was only slightly inundated. However, Mrs. Lin mentioned that his new home was eroded by sea waves after she moved from the area in 1984. She grew up in the new home that her great grandfather had rebuilt. Based on these conditions we estimate that the new home was established on a coastal terrace at a height of 6 m at site B in Fig. 4. This site was eroded by sea waves or river flows and is currently located near the shoreline. We infer that the original home was located 100 - 200 m oceanward at site A in Fig. 4, which implies that the height of the wave may be less than 6 m.

If the estimation of the house location is correct, the coastal retreat rate must be very high at this location, that is, a retreat rate of one to two hundred meters over approximately 100 years. This rate is similar to the geomorphological investigation results of Hsu et al. (1998), who obtained a 20 - 50 m coastal retreat over 30 - 40 years at several locations along the east coast of Taiwan. This rate is highly dependent on the coastal rock properties and geomorphological features. Additional evidence for the high coastal retreat rate is shown in Fig. 4. The existing coastline receded approximately 100 - 200 m from the coastline that existed in 1904 (the Center for GIS, RHCSS, Academia Sinica, http://gissrv5.sinica.edu.tw/GoogleApp/JM20K1904_1.php, accessed on 10 July 2014).

5. INTERVIEWS IN SIX TOWNS

Accounts of a large sea wave were obtained in Chenggong and Fengbin, which were separated by 55 km along the eastern coast of Taiwan. This suggests the occurrence of regional tsunami event. If the tsunami struck neighboring areas, it might have been preserved in oral stories or legends. To obtain more evidence of the tsunami, we interviewed a total of 73 persons in five towns (Table 1 and Fig. 1b) to determine whether their families or neighbors mentioned a tsunami-like wave or large wave that struck their communities in the past. We attempted to question people who were at least 60 years of age. The oldest interviewee was 90 years old. The majority of interviewees replied that they had never heard about these waves.

However, two interviewees in Fengbin replied that they had heard that a large wave struck their town and that a boat on the shore was carried by the wave to the top of "Chiragasan" mountain (Mt. Maokon, 23.581°N and 121.519°E), which has a height of 150 m and is located 5 km inland. This story originated from one of the local Amis mythoi. For this reason we omitted these interviews from the accounts of the most recent tsunami experience.

We learned that four interviewees on Ludao remembered an evacuation after a tsunami warning approximately 50 years ago during their childhood. They followed adults running toward the mountains without knowing the reason. The adults subsequently informed them that a tsunami

warning had been communicated from foreign countries. Based on news from Hawaii and Okinawa, the newspapers described an evacuation from the 1960 Chilean tsunami, which occurred in Hualian and other cities along the east coast of Taiwan. No official tsunami warning was issued in Taiwan. Despite the experience of this tsunami evacuation, they never heard about a previous tsunami occurrence from their parents or grandparents.

Some of the interviewees mentioned legends of floods or large sea waves, which are possibly related to previous events or mythoi. A number of similar legends or folklore from Taiwanese aboriginal tribes, such as the Amis, Tao and Puyuma, describe large sea waves that struck the land (Sayama and Onishi 1923). A number of similar stories were also discovered in New Zealand by King et al. (2007), who indicated that the aborigines may have experienced previous hazards.

6. DISCUSSIONS AND SUMMARY

We interviewed 73 persons in six towns along the east coast to confirm the tsunami event. However, none of these persons had heard about a tsunami-like wave or large wave that had occurred approximately one and a half centuries ago from their parents, grandparents or neighbors. We learned that family-transmitted eyewitness accounts are difficult to sustain over three generations.

Conversely, the account in Fengbin, as well as the Malaulou story from Chenggong, is a rare case that was transmitted and preserved in memory for more than 150 years. In the case of Fengbin, the grandmother lived to an age of 106 years and the grandmother's father lived to an age of 90 years. The great grandfather told his daughter that the wave struck his community, and the grandmother repeatedly told her grandchild about this large wave. These

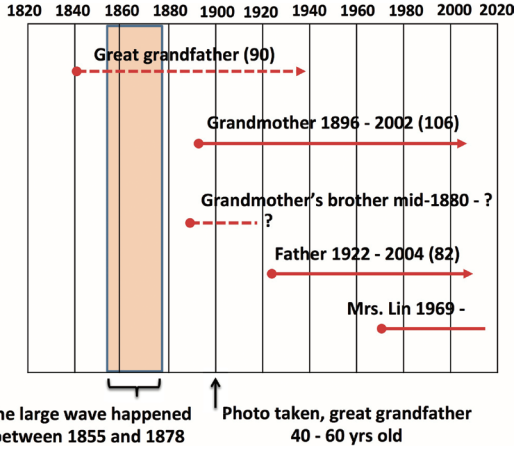

Fig. 3. Life spans of the family of Mrs. Lin: the great grandfather, the grandmother, the grandmother's brother, the father and Mrs. Lin. The birth year of the great grandfather is uncertain; we estimated that his birthdate fell between 1840 and 1860 based on the information of the family history. The shadow zone represents the possible range of the occurrence of the large wave that was observed by the great grandfather.

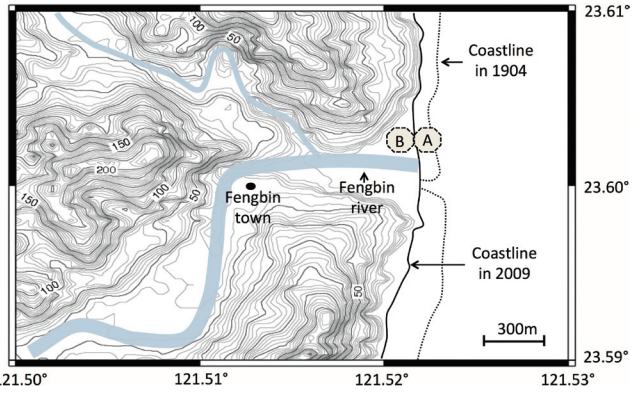

Fig. 4. Location map of Fengbin town and its vicinity. Site A denotes the possible home of the great grandfather prior to the occurrence of the large wave. The great grandfather moved to site B after the large wave struck. The dotted line denotes the coastline in 1904 (the dataset taken from the Center for GIS, RHCSS, Academia Sinica at http://gissrv5.sinica.edu.tw/GoogleApp/JM20K1904_1.php, accessed on 10 July 2014).

Table 1. Number of interviewees in eight cities along the west cost of Taiwan (refer to Fig. 1b).

Location	No. of interviewees	No. of "yes"*	Note
Guangufu	1	1	An account of a large wave in Fengbin
Fengbin	23	2	Chiragasan story in Ami's mythos
Guangou	25	0	
Chagpin	10	0	
Chenggong	1	1	Malaulou story
Ludao	7	0	Four persons evacuated during the 1960 Chile tsunami
Lanyu	8	0	
Total	75	4	

*Note: *: Number of interviewees who heard their families or neighbors talking about a tsunami or a tsunami-like wave that struck their communities.*

situations may have sustained the family's memory, which rarely occurred in ordinary families.

The wave height at Fengbin was not considered to be significant (< 6 m) based on the altitude of the place where the great grandfather rebuilt his home, whereas the height of the tsunami that struck the Malaulou site was 18 m above sea level and 400 m inland from the coast, which was considered to be significant (Ando et al. 2013). If these waves originated from the same source, the wave source should have been located near Chenngong. Ando et al. (2013) suggested the possibility of a local submarine slide off Chenggong, in which tsunami amplitudes should have struck a limited area. Nevertheless, no definite evidence is available to prove the two incidents were caused by the same source.

Based on the account that one large wave struck the great grandfather's home, we assumed the wave as a tsunami instead of storm waves generated by a typhoon. Nevertheless, we do not have any definite evidence to verify that the large wave was a tsunami and occurred between 1855 and 1878. Further studies of aboriginal tribes traditional stories are required to reliably investigate the Forgbin account. As historical documents and accounts were seldom recorded along the eastern coast of Taiwan in the 19th century, studies of geological deposits are important to investigating the source and size of a large wave. These studies will provide an assessment for the future tsunami risk on the eastern coast of Taiwan.

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