



---

## Taiwanese Emigrated About 6,000 Years Ago after the Catastrophes to Form a Vast Domain of Austronesian

Hsien-Jung Ho

Host / Newidea Research Center

Address: 10 Floor, No. 110-6, Jie-Shou N. Road, Changhua City, Taiwan.

email: [newidea.ufoho@msa.hinet.net](mailto:newidea.ufoho@msa.hinet.net); [newidea@newidea.org.tw](mailto:newidea@newidea.org.tw)

---

**Abstract** According to the scientific research results of modern scholars, it was found that the volcano of Turtle Island in northeast Taiwan erupted about seven thousand years ago, and the volcano of Seven-Star Mountain in Taipei City erupted about six thousand years ago. After the eruption of the volcano, there are some remains, such as: 3 tsunami boulders from more than 5,000 years ago in Jiupeng, Pingtung County, 4 tsunami boulders from 5,000 to 7,000 years ago on the north shore of Lanyu Island, and there is a layer of sea sand about 1 meter thick and about 6,000 years ago in Fanashan, Gongliao District, Xinbei City. Besides, archaeologists had discovered the Neolithic Hemudu cultural site in Yuyao City, China, and later excavated the Tianluoshan Site in Hemudu cultural site area and found that the Hemudu Culture was destroyed by the tsunami about 6,000 years ago and interrupted. Combined with the above circumstances, it can be found that about 6,000 years ago, the people of Taiwan were struck by natural catastrophes and had to flee from Taiwan in large numbers. They took Hamlet Type Catamaran — “Keilang”, as the marine transportation and used specific maritime and navigational skills to emigrated to uninhabited islands in the Pacific and Indian Oceans and then formed a vast domain of today's Austronesian.

**Keywords** Hemudu Site, Tsunami boulder, Seven-Star Mountain, Volcanic eruption, Austronesian

---

### 1. Introduction

In the recent 50 years, the Austronesian domain, which covers one-third of the Earth's sea surface, has attracted the attention of scholars, and this larger language family about 400 million people speak 1,262 Austronesian languages today, making it the most diverse and geographically distributed language in the world. According to statistics, before the time of Columbus, the most spoken language in the world was not Indo-European, but Austronesian. Over the years, the results of the study explored by scholars from linguistics [1-5], archaeology [6-11], genetics [12-18] and culture [19-21] etc., showed that the vast majority of scholars believed that the Austronesian language family is consistent with the "out of Taiwan hypothesis" [22]. Particularly, in recent years, the study of the spread of Taiwan Paper Mulberry and Bark-Cloth Culture [23] as well as the spread of Taiwan Jade [24] have proved that the homeland of Austronesian is Taiwan. However, what prompted the ancestors of Austronesian from Taiwan emigrated to islands in the Pacific and Indian Oceans beginning at 4,000 BCE to form the vast domain of the Austronesian? So far, no conclusion has been reached yet. Therefore, we cite the scientific research of some modern scholars and try to find out the reason, which need to explore paleo-



geographical analyses as well as paleo-environmental change around Taiwan, and then find something happened about “Tsunami” and volcanic eruptions that may answer the question.

**2. Materials and Methods**

**2.1 There are three tsunami boulders on Jiupeng coast from more than 5,000 years ago**

The tsunami boulders are giant coral boulders that refers to the coral reef, which was originally in shallow waters, and were pushed to land by strong tsunamis. Geologists of Taiwan and Japan have found three tsunami boulders of giant coral gravel about five meters high on the Neolithic coral terrace of Jiupeng coast, Pingtung County in southeastern Taiwan (Figure 1). Three exotic corals on the outer part of the boulders are dated from more than 5,000 yr BP, two among those at the earliest one after <sup>14</sup>C dating is for 5,490-5,250 yr BP [25]. It shows that the age is close to the Holocene coast terrace under the original coral reef, so that three tsunami boulders may have washed away by the waves below the reef and pushed up by the tsunami’s huge waves.

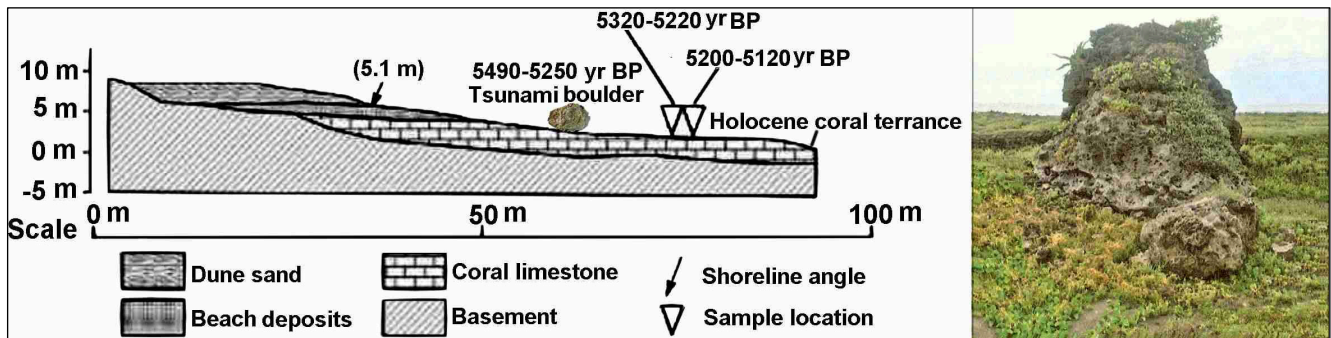


Figure 1: The location of the tsunami boulder in Jiupeng, Pingtung from more than 5,000 years ago and its photo

**2.2 There are 4 tsunami boulders on the Shore of Lanyu Island from more than 5,000 years ago**

There are 9 coral boulders at six sites on the north shore along the coast of the Lanyu Island, and on the uplifted coral reef terraces (Figure 2). The giant boulders of these six sites are all likely moved by extremely strong waves, and four sites have better constraints to suggest that the boulders may indeed be transported during a paleo-tsunami event, which is a strong display of tsunami boulders that were hit by extremely strong waves in ancient times. Through <sup>14</sup>C and Uranium-thorium dating methods, the results were similar in age, from more than 5,000 years ago, and even older about 7,000 years ago. One of the earlier tsunami boulders was 2.4 meters high, 7.5 meters long and 5.0 meters wide, which determined by the dating method to have the data for 7,533-7,637 years ago [26].

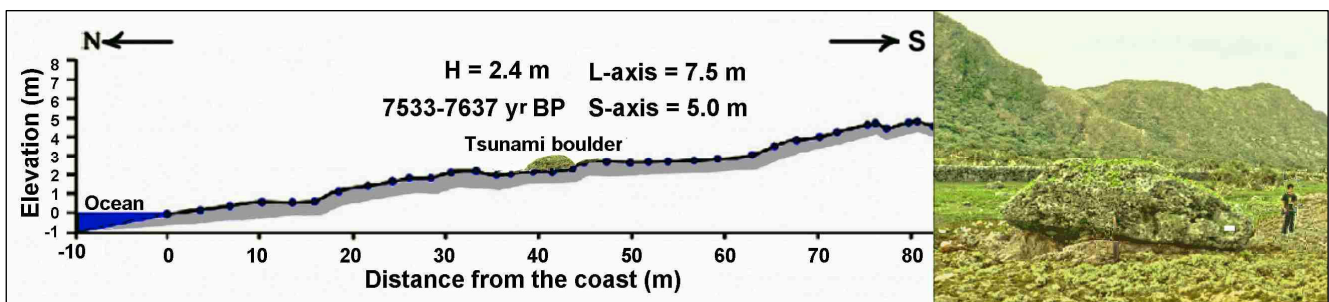


Figure 2: The location of Tsunami boulder from more than 5,000 years ago on the north shore of Lanyu Island and its photo.

### 2.3 A sea sand layer at Fanashan of Gongliao happened about 6,000 years ago.

According to geological data, sea levels near Taiwan rose by several decade meters at several thousand years ago, and the traces of remains can still find in the stratum of hills near the seashore in the northeast corner of Taiwan. A sea sand layer was found up to one-meter-thick at Fanashan, Gongliao District, Xinbei City, a possible tsunami sedimentary layer, according to the Law of Superposition, it happened about 6,000 years ago [27].

### 2.4 A tsunami destroyed China's Hemudu Culture about 6000 years ago

The Hemudu Site is a Neolithic culture site in China located at Kingo Temple Village, Hemudu Town, Yuyao City of Zhejiang Province, and on the north bank of the Yuyao River. In 1973, the Hemudu Site was first discovered, and after two excavations, it was found that the site stacked on four cultural layers with obvious soil distinctions, and the thickness was about four meters, and the distribution area reaches 40,000 square meters. The architecture and burial system of the four cultural layers are similar, the types of excavated artifacts are basically the same and there are complete signs of evolution, so it is considered to belong to the same archaeological culture, called the Hemudu Culture.

The Hemudu Culture mainly distributed from the Ningshao Plain area on the southern shore of Hangzhou Bay to the Zhoushan Islands. According to the data measured by  $^{14}\text{C}$  dating method, the cultural layer dates from 7,000 yr BP to 5,000 yr BP. In 1979, the Zhejiang Provincial Institute of Cultural Relics and Archaeology and other institutions conducted several surveys in Ningbo, Shaoxing and Zhoushan Islands and inspected many contemporaneous sites in the region, and found that these sites all had the same cultural connotation as the Hemudu Site (Figure 3), therefore, they were all classified as the sites of Hemudu Culture [28].

The Tianluoshan Site was discovered in 2001 and is located at the Xiang'ao Village of Sanqishi Town, Yuyao City, Zhejiang Province. It lies to the north side of the Yuyao River Valley Basin, and to its southwest, the Hemudu Site is about seven kilometers away. The site covers an area of about 30,000 square meters, stacked on 6 cultural layers, and has a depth of 2 to 3 meters. Because of its good preservation, continuous stratigraphic relationship, and a large number of excavated cultural relics, the Tianluoshan Site can answer many controversial questions at the Hemudu Site [29].

Large-scale excavations from February to June 2004 confirmed that the artifacts excavated from the Tianluoshan Site are almost identical to the Hemudu Site. Based on the expert research of Zhejiang Provincial Institute of Cultural Relics and Archaeology and Hemudu Site Museum, according to the calculation of  $^{14}\text{C}$  dating method, the Tianluoshan Site was initially determined to be more than 6500 years ago, which is the same age as the Hemudu Site. The study of the Tianluoshan Site can largely reflect the information of the disappearance of the Hemudu Culture, so the Tianluoshan Site also belongs to the Hemudu Culture.



Figure 3: Map of the sites of Hemudu and Tianluoshan and the nearby areas



After the excavation of the Tianluoshan Site, archaeologists were surprised to find that the Tianluoshan Site not only had a small number of sporopollen fossils, ferns remains and other terrestrial biological remains in the soil of the cultural layer, but also there are a large number of seaweed sporopollen and marine life fossils, and even underground rocks had traces of saltwater erosion.

After the systematic sampling of the profile of Tianluoshan Site, on the basis of the research already studied, the research method of stratigraphy was adopted, through stratigraphic correlation, paleomagnetism, micropaleontology and palynological study and  $^{14}\text{C}$  dating, the scientists considered that the Hemudu Culture probably had been interrupted by a large amount of seawater intrusions, which should be the result of tsunami or storm tide calamities [30].

In research into the relationship between cultural disruption and rice domestication, scientists reported high-resolution records of pollen, phytolith, and diatom, and accurately measured the elevation from the modern coastlines. Based on these collected data, scientists suggested that the Hemudu Culture was developed in the context of regression and was interrupted by two transgressions that occurred during 6,300-5,600 yr BP and 5,000-4,500 yr BP [31].

Researchers have also done a three-year survey of the geographical environment around Hemudu and found that there are traces of major floods at all the bends of the Yuyao River near the Hemudu Site. In addition, scientists have increased the content of seawater species through abundant sponge spicule and brackish marine diatoms, indicating that after about 6,000 yr BP, the Tianluoshan area obviously implied a seawater progression [32].

During the Quaternary Middle Pleistocene to the Late Pleistocene the Yuyao River originally flowed northeast into Hangzhou Bay, however, about 6,000 years ago, a huge flood occurred, and the river channel was greatly impacted and drastically changed its course and even turned to the east into the sea, flowing into the Pacific Ocean through the Yong River, becoming the current landform [33].

The flood, which flooded the seawater along the river estuary, flooding the homes of inhabitants and salinizing the paddy field, so it ended the Hemudu Culture with a mass emigration. In view of this, archaeologists have concluded that the interruption of the Hemudu Culture is most likely due to the invasion of the ocean torrent. It is the infusion of a large amount of saltwater that causes the environment in the Hemudu area to become extremely harsh in an instant. Since then, it is no longer suitable for human life, so that the development of Hemudu Culture ends overnight [34]. Archaeologists claim that the disruption of the Hemudu Culture was caused by the intrusion of seawater, which should have been caused by the massive Tsunami in the Pacific Ocean.

## 2.5 Volcanic eruptions of Taiwan's northeast corner and its waters triggered massive tsunami

Hemudu Culture Site is on the Pacific coast and at the north of Taiwan, when its culture disappeared about 6,000 years ago, at the same time as the tsunami boulders of Jiupeng and Lanyu Island in Taiwan have appeared, and a tsunami sedimentary layer has formed at Fanashan, so, Hemudu Culture was destroyed by the flood and disappeared that can be used as a conclusive evidence to the tsunami. A tsunami is a natural phenomenon that is a series of waves in a water body caused by the displacement of a large volume of water, generally in an ocean. It should be caused by a violent earthquake, due to the power of the seismic wave, which can form powerful tall waves, submerging the coastal zone. Earthquake can be caused by volcanic activity. Volcanic eruption usually accompanies a earthquake, therefore, regardless of above or below water it all has the potential to generate a tsunami.

According to data from Taiwan and Japan that the volcanic groups in the area of Taiwan have had the records of volcanic eruptions in the Quaternary from more than three million to six thousand years ago.

About 12,000 years ago, the northern Snow Mountain in northeastern Taiwan was once a stratovolcano. This volcano abruptly erupted and triggered a big landslide, and then generated a mega-tsunami. Its waves are hundreds of meters high, and caused a worldwide catastrophe [35]. In recent years, scholars have pointed out that the Taiwan's northeastern corner and its waters are the origin zone of tsunami.



Many of the volcanos in the northeast corner of Taiwan and its waters were formed by new volcanic eruptions at the junction of the Ryukyu volcanic arc and the Luzon volcanic arc, with a total of three volcanic groups, including: Tatun Volcanos, Keelung Volcanos and Northeast Volcanic Islands (Figure 4), these are typical ancient volcanos that have erupted before [36]. In there still have two active volcanos today, including Turtle Island and Seven-Star Mountain.

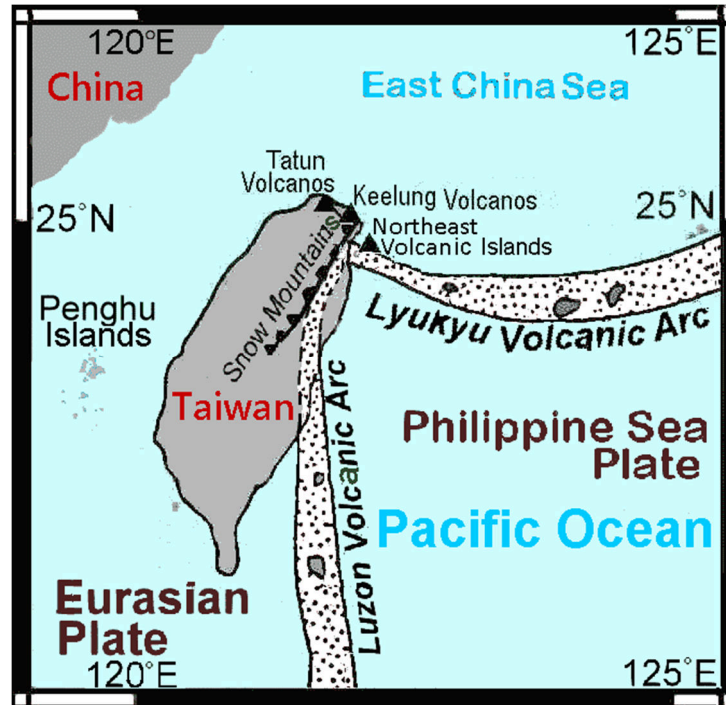


Figure 4: Map of volcanic arcs and volcanos in Taiwan

## 2.6 A volcanic eruption on Turtle Island about 7,000 years ago

Turtle Island is a volcanic island, and its highest point is 401 meters above sea level (Figure 5). After much year's research, scientists confirmed that beneath the deep waters of the local sea around Turtle Island, there is a large number of volcanic groups hidden, including 60-70 submarine volcanos of erupting type, of which 11 are active volcanos [37].

The Central Geological Survey has learned that Turtle Island has recorded at least four or more eruptions in the past, based on the three kinds of analysis: the sedimentary rock age, phenomenon of geothermal hot springs and helium isotope of volcanic gases, combined with the geothermal hot springs around the waters of Turtle Island, helium isotope analysis also has signs of magma activity, and many cone-shaped underwater volcanic features have found, along with many hot spring vents. Turtle Island conforms to the current definition of "active volcano" by the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI). In 2001, Yue-Gau Chen and colleagues used radiometric dating methods to analyze siltstone xenolith in Turtle Island and obtained the most recent eruption date about 7,000 years ago [38].





Figure 5: The volcano of Turtle Island lastly erupted out above the sea from the seafloor about 7,000 years ago

### 2.7 Volcano of Seven-Star Mountain massively erupted about 6,000 years ago

Seven-Star Mountain of Tatun Mountain System about 1,020 meters height in the northern Taiwan locates at Taipei City (Figure 6). In 2010, geologists published an article that Seven-Star Mountain happened the last volcanic eruption about 6,000 years ago. This eruption of the group was dominated by long-term, voluminous extrusions of crystal-rich, very viscous lavas. These eruptions formed closely spaced monogenetic domes and lava flows (thicknesses 80~150 m, lengths up to 5.6 km, and volumes up to 0.6 km<sup>3</sup>), average rates of magma effusion ranged from 1 to 10 m<sup>3</sup>/s, eruption durations from 500 to 1800 days, and lava front speeds from 0.5 to 6 m/hr. Seven-Star Mountain was possibly an effusive eruption with gravitational collapses of volcano, which occurred on intersections with tectonic faults, and may have been triggered by seismic activity [39].

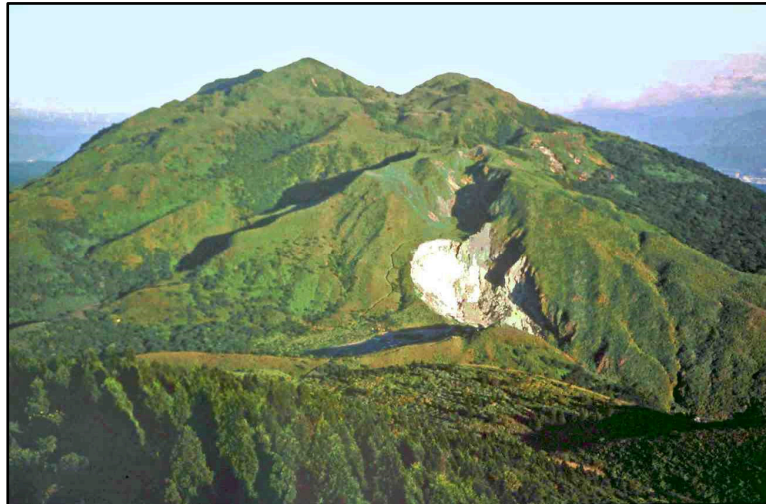


Figure 6: Taipei's Seven-Star Mountain is still an active volcano, with an eruption about 6,000 years ago, and the central white part is still spewing sulfur smoke

### 2.8 Frequent natural catastrophes caused Taiwanese emigration

The events, such as the destruction of the Hemudu culture, the productions of tsunami boulders at Lanyu and Jiupeng, and tsunami sedimentary layer at Gongliao, came from massive tsunami phenomenon (Figure 7), which occurred from 6,000 to 7,000 years ago. The time also happened to coincide with the same time of Seven-Star Mountain volcano erupted about 6,000 years ago and Turtle Island volcano erupted about 7,000 years ago, which should be triggered terrible earthquakes and the massive tsunamis.



According to the above description, volcano of Turtle Island has recorded at least four or more eruptions in the past, and the duration of volcanic eruptions of Seven-Star Mountain was about from 500 to 1,800 days, so, the volcanic eruptions happened frequently, and during a long time, which indicated these volcanic eruptions should accompany by the attacks of the terrible earthquake, and triggered the massive tsunamis that should cause the terrible natural catastrophes among the residents, who lives in Taiwan, therefore, they must flee from Taiwan and emigrate to a safe place to live.

Under the situations of terrible natural catastrophes, some people of Taiwan should carry their families, flocks, commensal species, and the Austronesian language and culture, taking vessels as the marine transportation to move by island and by sea, emigrating to uninhabited islands in the Pacific and Indian Ocean. They chose the islands with a climate of mild, fertile soil, excellent environment, and easy to live in, and then living a safe and happy life, finally, forming the today's vast domain of Austronesian (Figure 8).



Figure 7: Map of tsunami phenomenon sites



Figure 8: Map of Austronesian Domain

### 3. Discussion and Result

#### 3.1 what type of sailing vessels and sails were used to cross an open ocean at 6,000 years ago?

Austronesian has largest domain in the world, owning one-third of the Earth's oceans. However, how did the Austronesian people emigrate from Taiwan by vessel to reach the numerous and remote islands, and achieving such vast domain? The inhabitants of the Pacific islands had been voyaging across the vast expanse of ocean by sailing in double canoes and outriggers, but the two kind vessels seem too simple to convey these people to so vast domain of Austronesian. According to oral tradition of Plains Indigenous Peoples of Taiwan, they had a large vessel called “Keilang” that could sail around the world since several thousand years ago.

“Keilang” is a house ship, called Hamlet Type Catamaran, also known as floating village [40]. “Keilang” is a linked big ship, which can transport the people moving away from Taiwan to reach the islands of Pacific and Indian Ocean. “Keilang” is made from 10,000 to 15,000 pieces of large bamboo and fir lashing linked, and 100 to 200 meters in length, width of about 30 meters. The most bottom is made of firs, heavier after absorbing sea water as ballast, and the large bamboos blanket on it. On the upper layer, the bamboo joints of large bamboo are drilled for water storage. On large bamboos spread a layer of “tsang-sui” (Taiwan palm fiber), and cover with soil, then planting rice, vegetables, or other plants, which can produce the articles of living needs, and building houses on the ship all around, on it lives 100 to 150 persons. In central of the ship erects a net storey, and pulls the canvas as a navigation platform, then puts up sails to manage the course that can sail in the Pacific and Indian ocean. After reaching appropriate islands and all debarking, the large bamboos, and firs of the whole ship were taken off as the materials to build enormous quantities of housings in suitable place and then to form a village [41].

The conception of Wood Catamaran of Yangtse River in China may derive from the ancient village type vessel of “Keilang” [42] (Figure 9). Because Taiwan produces bamboo, fir, and "Tsang-Sui", but the other islands of Austronesian do not produce all the products, therefore, after the emigrant from Taiwan to settle down on the islands of Pacific and Indian Ocean, this kind of transportation “Keilang” was gradually lost.



Figure 9. Wood Catamaran of Yangtse River may derive from Taiwan Hamlet Type Catamaran — “Keilang”.

#### 3.2 What were the specific maritime and navigational skills of these ancient seafarers in the Pacific?

In recent years, according to the astronomy observing to accumulate down the prior years of data, the scientists have concluded that from ancient times until the time of Columbus, it was recognized that only Polynesian could travel to and from the islands of the vast Pacific Ocean. According to the results of the study explored by scholars, the ancestor of Polynesian, belonging to the Austronesian language family, came from Taiwan. The





Polynesian are a seafaring people that can manage a boat from their home in the vast Pacific Ocean, without relying on land landmarks and nor along coast sail. They can guide by Arcturus star [43] and Sirius star [44] and according to natural phenomena, such as the sun and moon, astral, currents, wind direction, birds, cloud changes, marine life, along the southward trade wind, and can determine the direction, two-way navigation, crossing the Pacific Ocean [45]. They can travel thousands of kilometers between Hawaii, Easter Island and New Zealand, and even reaches Madagascar in the east of Africa. It is said that the ancient world's only navigators can reach the ocean to the world to trade, so Polynesian should establish the common culture of the Pacific. However, their navigation techniques are not making out of nothing, but from oral tradition passed down from the homeland of Austronesian — Taiwan.

### 3.3 Early Taiwanese used specific navigational skills to sail “Keilang” across the vast ocean

About 6,000 years ago, happened the massive tsunamis, some people of Taiwan had to emigrate to a safe place to live. They built the Hamlet Type Catamaran of “Keilang”, carrying commensal species, used specific maritime and navigational skills to voyage across the vast ocean and then forming the vast domain of today's Austronesian.

## 4. Conclusion

About from 6,000 to 7,000 years ago, the volcanos of Turtle Island and Seven-Star Mountain in northern Taiwan took place massive volcanic eruptions repeatedly for a long period, longest nearly 5 years, accompanied by the attacks of the terrible earthquakes and the massive tsunamis, which caused big panic among the people of Taiwan. Therefore, some of them carried their families, flocks, commensal species, and the Austronesian language and culture, taking the floating village “Keilang” as the marine transportation to sail by island and by sea. They emigrated to uninhabited islands with excellent environment in the Pacific and Indian Ocean, and then established the vast domain of Austronesian language family.

## References

- [1]. Shutler, R. & Marck, J. C. (1975). On the dispersal of the Austronesian horticulturalists, Wiley Online Library. *Archaeology and Physical Anthropology in Oceania*, 10(2): 81-113.
- [2]. Blust, Robert. (1999). Subgrouping, circularity, and extinction: Some issues in Austronesian comparative linguistics. In Elizabeth Zeitoun and Paul Jen-kuei Li, eds, Selected papers from the Eighth International Conference on Austronesian Linguistics, Symposium Series of the Institute of Linguistics (Preparatory Office), *Taipei: Academia Sinica*, 1: 31-94.
- [3]. Gray, R. D. & Jordan, F. M. (2000). Language Trees Support the Express-train Sequence of Austronesian Expansion. *Nature*, 405: 1052-1055.
- [4]. Li, Paul Jen-kuei. (2006). Numerals in Formosan languages. *Oceanic Linguistics* 45(1): 133-152.
- [5]. Gray, R. D., Drummond, A. J. & Greenhill, S. J. (2009). Language Phylogenies Reveal Expansion Pulses and Pauses in Pacific Settlement. *Science*, 323(5913): 479-483.
- [6]. Thiel, Barbara. (1988). Austronesian origins and expansion: The Philippine archaeological data. *Asian Perspectives*, 26(1): 120-129.
- [7]. Diamond, J. M. (2000). Taiwan's Gift to the World. *Nature*, 403: 709-710.
- [8]. Nunn, Patrick D., Kumar, R., Matararaba, S. et al. (2004). Early Lapita settlement site at Bourewa, southwest Viti Levu Island. Fiji, *Archaeology in Oceania* 39: 139-143.
- [9]. Elizabeth A. Matisoo-Smith. (2015). Tracking Austronesian expansion into the Pacific via the paper mulberry plant. *PNAS*, 112(44): 13432-13433.
- [10]. Spriggs, Matthew, Kendra Sirak, Pontus Skoglund. (2016). Genomic insights into the peopling of the Southwest Pacific. *Nature*, 538(7626): 510-513.
- [11]. Horsburgh, K. Ann & McCoy, Mark D. (2017). Dispersal, Isolation, and Interaction in the Islands of Polynesia: A Critical Review of Archaeological and Genetic Evidence. *MDPI. Diversity* 2017, 9(3): 37.



- [12]. Sykes, B., Leifoff A., Low-Beer, J., Tetzner S. & Richards, M. (1995). The origins of the Polynesians: an interpretation from mitochondrial lineage analysis. *Am. J. Hum. Genet.*, 57: 1463-1475.
- [13]. Melton, T., et al. (1998). Genetic Evidence for the Proto-Austronesian Homeland in Asia: mtDNA and Nuclear DNA Variation in Taiwanese Aboriginal Tribes. *Am. J. Hum. Genet.*, 63(6): 1807-1823.
- [14]. Redd, Alan J. & Mark Stoneking. (1999). Peopling of Sahul: mtDNA Variation in Aboriginal Australian and Papua New Guinean Populations. *Am. J. Hum. Genet.*, 65: 808-828.
- [15]. Chambers, Geoffrey K., et al. (2002). The Genetics of Alcoholism in Polynesians: Alcohol and Aldehyde Dehydrogenase Genotypes in Young Men. *Alcoholism: Clinical and Experimental Research*, 26(7): 949-955.
- [16]. Trejaut, J. A., Kivisild, T., Loo, J. H., et al. (2005). Traces of archaic mitochondrial lineages persist in Austronesian-speaking Formosan populations. *PLoS Biol.*, 3(10): e376.
- [17]. Storey, Alice, Daniel Quiroz, Nancy Beavan & Elizabeth Matisoo-Smith. (2007). Polynesian chickens in the New World: a detailed application of a commensal approach. *Archaeology in Oceania*, 48(2013): 101-119.
- [18]. Moodley, Yohan, et al. (2009). The Peopling of the Pacific from a Bacterial Perspective. *Science*, 323(5913): 527-530.
- [19]. Ferrell, Raleigh. (1966). The Formosan tribes: a preliminary linguistic, archaeological, and cultural Synthesis. *Bulletin of Institute of Ethnology*, 21: 97-130.
- [20]. Bellwood, Peter. (1991). The Austronesian Dispersal and the Origin of Languages. *Scientific American*, 265: 8-93.
- [21]. Stone, Richard. (2006). Graves of the Pacific's First Seafarers Revealed. *Science*, 312(5772): 360.
- [22]. Blust, Robert. (1985). The Austronesian Homeland: A Linguistic Perspective. *Asian Perspective* 26 (1): 45-67.
- [23]. Chang, C. S., Liu, H. L., Moncada, X., Seelenfreund, A., Seelenfreund, D. & Chung, K. F. (2015). A holistic picture of Austronesian migrations revealed by phylogeography of Pacific paper mulberry. *PNAS*, 112(44):13537-13542.
- [24]. Hung, Hsiao-Chun, Iizukac Y., Bellwood, P., et al. (2007). Ancient Jades Map 3,000 Years of Prehistoric Exchange in Southeast Asia. *PNAS* 104 (50): pp. 19745-19750.
- [25]. Matta, Nobuhisa, Ota, Y., Chen, W. S., Nishikawa, Y., Ando, M. & Chung, L. H. (2013). Finding of Probable Tsunami Boulders on Jiupeng Coast in Southeastern Taiwan. *Terrestrial Atmospheric and Oceanic Sciences*, 24(1): 159-163.
- [26]. Ota, Yoko J., Shyu, B. H., Wang, C. C. et al. (2015). Coral boulders along the coast of the Lanyu Island, offshore southeastern Taiwan, as potential paleo tsunami records. *Journal of Asian Earth Sciences*, 114: 588-600.
- [27]. Ho, Hsien-Jung. (2009). After ice age the people of Mu was subjected to natural catastrophes and emigrated south to form the domain of the Austronesian / The First Land of Civilization Was Taiwan (in Chinese). *Taiwan Paleocivilization Research Center*, 12: 412. ISBN 978-986-85792-0-0.
- [28]. Lin, H. T. (1992). A Preliminary Study of Hemudu Culture. *Zhejiang People's Press*, 27-51, ISBN 978-7-21300-793-4.
- [29]. Sun, G. P. Huang, W. J. & Zheng, Y. F. (2007). The Tianluoshan Neolithic Site at Yuyao, Zhejiang. *Cultural Relics*. 11:4-24.
- [30]. Zhou Z. Y., Yu G. C., Dong X. F. et al. (2012). New study of the reasons for the interruption of the earliest Hemudu Culture (in Chinese). *Geology In China*, 39(2):550-558.
- [31]. He, Keyang, et al. (2018). Middle-Holocene sea-level fluctuations interrupted the developing Hemudu culture in the lower Yangtze River, China. *Quaternary Science Reviews* 188: 90-103
- [32]. Wang, Shu-Yun, Mo D. W., Sun G. P. et al. (2010). Environmental context of ancient human activity in Tianluoshan Site, Yuyao City, Zhejiang Province: Fossil evidence of phytolith and diatom (in Chinese). *Quaternary Sciences*, 30(2): 326-334.



- [33]. Underhill, Anne P. (2013). A Companion to Chinese Archaeology. Chichester: John Wiley & Sons, 38: 233-236.
- [34]. Zhejiang Provincial Institute of Cultural Relics and Archaeology. (2007). Brief report of the excavation on a Neolithic Site at Tianluoshan Hill in Yuyao City, Zhejiang (in Chinese). *Hemudu Site Museum: Culture Relics*, 11: 5-24.
- [35]. Ho, Hsien-Jung & Hsui, Haw-Ping. (2005). Mega-tsunami in Northeastern Taiwan at least 12,000 years ago / Sumatra Tsunami on 26 December 2004. *3rd International Conference on Asian and Pacific Coasts 2005*, 199-208. <http://newidea.org.tw/pdf/S4.pdf>.
- [36]. Yu, H. S. & Song, G. S. (1993). Submarine physiography around Taiwan and its relation to tectonic setting. *Journal of the Geological Society of China*. 36(2): 139-156.
- [37]. Lee, C. S., Chung, S. L. & SPOT Members. (1998). Southernmost part of the Okinawa Trough (SPOT): An active extension/ collision/ subduction area. *EOS, Trans. Am. Geophys. Union*, (79): W109.
- [38]. Chen, Y. G., Wu, W. S., Chen, C. H. & Liu, T. K. (2001). A date for volcanic eruption inferred from a siltstone xenolith. *Quart. Sci. Rev.*, 20: 869-873.
- [39]. Belousov A., Belousova M., Chen C. H. & Georg, F. Zellmer. (2010). Deposits, character and timing of recent eruption and gravitational collapses in Tatun Volcanic Group, northern Taiwan: hazard-related issues. *Journal of Volcanology and Geothermal Research*, 191(3-4): 205-221.
- [40]. Ling, Shun-Sheng. (1970). A Study of the Raft, Outrigger, Double, and Deck Canoes of Ancient China, the Pacific and India. *The institute of Ethnology Academia Sinica, bibliogroup*, 16: 41-42.
- [41]. Lin, Sheng-Yi & Ho, Hsien-Jung. (2001). "Keilang" was once a tool of transportation for Taiwanese ancestors to emigrate to the South Islands / Taiwan – the homeland of human civilization (in Chinese). *Taiwan Ufology Society*, 92-95. ISBN: 957-30188-0-2.
- [42]. Peng, De-Qing. (1988). The China ship manuals. *Hong Kong Economic Guide*.
- [43]. Makemson, Maud Worcester. (1941). The Morning Star Rises: an account of Polynesian astronomy. *Yale University Press: New Haven, Connecticut*, 199.
- [44]. Holberg, J. B. (2007). Sirius: Brightest Diamond in the Night Sky. Chichester, UK: Praxis Publishing. 25-26.
- [45]. Finney, B. (1993). Rediscovering Polynesian Navigation through Experimental Voyaging. *The Journal of Navigation*, 46(3): 383-394.

