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Vietnam's Middle and Late Neolithic marine cultures

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Abstract:

This article presents the basic content of the prehistoric marine cultures in Vietnam in the Middle Neolithic including Cai Beo culture, Trang An relic complex, Da But culture, and Quynh Van culture as well as Late Neolithic marine cultures including Ha Long, Hoa Loc, Bau Tro, and Xom Con. This study clarifies human adaptation to changes in the ecological environment in each region, the cultural achievements of inhabitant groups in these localities, and the position of communities in the coastal plains during the formulation and development of Vietnam's prehistoric marine culture. Today, Vietnam's marine region has been under the influence of rising sea levels. Rising sea levels would lead to the disappearance of archaeological sites as it did in the late Pleistocene. In the future, the sea will extend, while mountains are being destroyed, hills are being levelled and the sea being filled, all of which will result in the permanent destruction of a number of sites. Each individual archaeological site not only serves as an annal, but also an identity card of the country in an integrated world. Evidently, the prehistoric sites of the marine cultures of Vietnam have been playing a particularly important role in the socio-economic development of Vietnam and it needs to be studied, protected, and brought into play.

Keywords: **East Sea, marine culture, Neolithic, Prehistoric cultures, sea level fluctuation.**

Classification number: **8.2**

1. Introduction

Vietnam is located in Southeast Asia between 23°22'-8°30'N and 102°-109°24'E (mainland) or 117°E (islands). The mainland covers an area of 331,688 km^2 and its continental shelf connected to Southwest Pacific Ocean extends more than 1 million km^2. With such a location, Vietnam demonstrates an apparent advantage as a bridge that links its mainland to islands in Southeast Asia. The coastline of Vietnam is 3,260 km long with every 100 km^2 of land owning 1 km of coast (the world average is every 600 km^2 of land has 1 km of coast). In Vietnamese waters, there are thousands of islands and archipelagos connected to the mainland via an extensive continental shelf.

The East Sea extends over an area of 3,537,000 km^2, is 1,400 m in average depth, and pertaining to the tropical and equatorial climate pattern. The Vietnam sea accounts for almost one-third of the East Sea's area. An outstanding characteristic of the East Sea is that it is a closed sea; it is enclosed by the Asian continent and archipelagos of the Philippines and Indonesia, and only such narrow marine straits as the Taiwanese, the Luzon, the Malay and the Palawan are open to the Pacific Ocean. The nature of a closed sea influences the features of sea currents, tides, and creatures.

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The East Sea is of a particularly important position in Asia based on three categories: natural position, geo-economy, and geo-politics. It possesses a great deal of resources for surrounding countries, a life-line nautical route for a number of countries around the world, a place of contact of multiple cultures, and a geo-military position on the global scale. At present, Vietnam has 26 coastal provinces and cities that make up over 42% of the area and over 45% of the total population of the country. About 15.5 million people are living on the shoreline and 160,000 people on the islands. This is a human force that directly protects and sustainably exploits resources in the country's marine sovereignty, which includes marine cultural resources.

2. Paleoclimatology and environment from Late Pleistocene to Early Holocene

2.1. Geological divergence and prehistoric cultures in Vietnam

During the times of geological divergence, the Late Pleistocene is dated from 40,000 to 12,000 BP, while the Holocene is from 12,000 BP to present. Holocene consists of 3 periods: Early Holocene (from 12,000 to 7,000 BP), Middle Pleistocene (7,000 to 4,000 BP), and Late Pleistocene from 4,000 BP to present [1].

The beginning is the presence of An Khe Palaeolithic, dating from the Middle Pleistocene, with a Kalium-Argon (K^{38}/A^{40}) radioactive isotope age between 782,000±20,000 BP and 800,000±22,000 BP [2], and a Homo erectus fossil from Tham Khuyen cave, which was dated by Electron Spin Resonance to be from 401,000±51,000 BP to 534,000±87,000 BP [3]. The end of the primitive period and the beginning of the Protohistoric period occurs when the State of Van Lang appeared dated at 2,700 BP [4].

Basically, the dates of geological periods correspond to the existing time frame of prehistoric archaeological cultures in Vietnam[1]. During the Late Pleistocene, there existed two archaeological cultures belonging to the Late Palaeolithic period, namely, the Nguom culture (or Nguom industry) (from 41,000 and 34,000 BP to 23,100±300 BP) [5, 6], Son Vi culture (32,100±150 BP and 28,139±200 BP to 11,500±120 and 11,330±150BP) [7].

Early Neolithic Vietnam has identified two Archaeological cultures named Hoa Binh culture (or Hoabinhian) and Bac Son culture (or Bacsonian), which date from the Early Holocene and both ending together in 7,000 years BP [8, 9]. The Bacsonian date is 11,000±200 BP (Doi cave), 10,295±100 BP (Bo Lum cave), while the Hoabinhian lies across from the end of Pleistocene to the beginning of Holocene, from 21,560±220 BP, 21,300±300 BP, 20,170±160 BP to 13,980±200 BP and 10,430±180 BP (Cho cave). The inhabitants of the Hoa Binh and Bac Son cultures resided in the karst valleys where they hunted and gathered animals and plants from the continent. These two cultures belong to the continental culture, but did know the gifts of the sea by exchanging items such as jewellery made of sea shells with other inhabitants living by the sea.

The prehistoric marine culture of Vietnam is known to the inhabitants of the Middle Neolithic period as people lived in the marine

[1]Archaeological culture is a term to refer to archaeological sites that have stable and unified characteristics of relics and artifacts, and distinguish it from other archeological cultures of the same line.

environment, exploited marine resources, had extensive relations with the surrounding area, and created a new culture imbued with elements of the sea [10, 11]. These cultures are the Cai Beo culture (dating from 6,475±170 BP from the Cai Beo site to 4,100±40BP from the Ba Vung site after adjusting 4,520 BP); the Da But culture (from 8.7040±85 BP at the Hang Sao cave to 6,430±60BP at the Da But site and 4,790±50BP at the Go Trung site), and finally the Quynh Van culture (4,785±100 BP or 2,835 BC to 3,450±70BC) (Fig. 1).

The marine cultures of the Later Neolithic period include archaeological cultures such as Ha Long (Quang Ninh province - Hai Phong city), Hoa Loc (Thanh Hoa province), Bau Tro culture (Nghe An, Ha Tinh, and Quang Binh provinces), Xom Con (Khanh Hoa and Phu

a. Pointed tools

b. Discoid tools

c. Fully sharpened axes

d. Fully sharpened axes

e. Stone with round holes

f. Pottery pot

Fig. 1. Stone artifacts of Cai Beo Culture. Source: Nguyen Khac Su (2009), *Cai Beo Prehistoric Site, Cat Ba Island,* Social Sciences Publishing House, Hanoi, p.308, 313, 326.

Yen provinces), group of relics of Long Thanh - Binh Chau (coastal of South Central Vietnam), and a group of relics of An Son - Giong Ca Vo (coastal of Southern Vietnam). These cultures are dated ranging from 4,500 to 3,000 BP.

2.2. Paleo-environment in Vietnam's sea area

The study of Vietnam's prehistoric marine culture cannot be separated from the study of the paleo-environment, especially the fluctuations in ocean levels since the Late Pleistocene to Holocene and their impacts on the waters of Vietnam. In Earth's history, there were at least 20 glacial and interglacial cycles representing the same number of phases of marine transgression and regression, but excluding the negligible fluctuations of sea level between phases or those caused by neo-tectonic movements varying from region to region. According to G. Kukla, the Pacific level had various fluctuant phases between 300,000 and 20,000 BP. It lowered to -140 m from 150,000 to 20,000 BP [12]. Several recent studies have also confirmed that Southeast Asian sea levels lowered to -130 m and -120 m bringing about floating bridges that humans and animals used to migrate across the region between most islands and the mainland [13].

According to recent geological and geomorphological research, the East Sea's water level fluctuates from -120 m to water levels of -100, -30, -20 and -5 m, respectively. These stages of transgression are approximately dated to c 15,000; 10,000; 9,000; and 8,000 BP, respectively. Sea levels reached its current position c 7,000 BP, while from c 6,000-4,000 BP, it was approximately 2-3 m higher than today's levels, but dropped relatively rapidly after c 4,000 BP [14]. According to Boyd and Doan Dinh Lam's analysis of sediment core data from Tam Coc, sea level from c 5,500-2,600 BP was approximately 5.4-40 m higher than current national standards [10, 15]. This means that around c 5,500 BP, it was 3.25 m higher than the current average sea level.

3. Late Pleistocene - Early Holocene cultures

3.1. Late Paleolithic cultures

The Late Pleistocene marine transgression is still evidenced through a presence of a water notch on Hang Dinh at 7.05-7.85 m high dated from 32,960±689 to 41,000 BP. The sea at that time inundated the present coastal zone and encroached deeply onto the mainland fully covering most of the area of the current plain of Red river. During this time, the northern part of Vietnam was represented by the Nguom Industry (Thai Nguyen province) and the Son Vi culture (Phu Tho province). The Nguom Industry is between 41,000 and 34,000 BP to 23,100±300 BP [5, 6], while the Son Vi culture is from 32,100±150 BP and 28,139±200 to 11,500±120 BP and 11,330±150 BP) [7]. The pollen composition found in sediment from this period includes species prone to hot temperature such as *Polypodiaceae, Palmae, Quercus,* and so on, while some species prone to cold climate like *Juglams, Pinus,* and so on, which are characteristic of primarily broad-leaved forest vegetation, some coniferous trees, and altogether being year-round evergreen forests; monsoon tropical climate with a humid hot summer, elevated rainfall and a cold dry winter, low precipitation [16].

Regarding climate and environmental changes at the end of Pleistocene, Ha Van Tan said that there was a cold dry period of about 30,000 BP over the entire Southeast Asian continent. Corresponding to this period is the appearance of fine industries and small stripping. After that, the climate gradually warmed up, which can be divided into two periods: a hot but relatively dry period and a hot and humid period. This period of warming is marked by the emergence of Son Vi and Hoa Binh Cobblestone Industries [17].

3.2. Early Neolithic cultures

The prehistoric residents who resided in limestone caves inland like the Hoabinhian (20,000-7,000 BP) or the Bac Son people (11,000-7,000 BP) were still ignorant of sea products. Only some pierced cowries serving as ornaments or grave goods were found to be resulting from exchanges. It seems that traditional cave colonization, pebble tool manufacture, and freshwater mollusc exploitation kept these people away from marine contacts and integration.

The analytic results using the method of magnetic susceptibility on cave sediments extracted from Con Moong cave (Thanh Hoa province), Cho cave (Hoa Binh province), and Lan Mo (Son La province) have indicated that between 20,000 and 7,000 BP in North Vietnam, there were humid and hot cycles intervening with cooler or cold ones. Cave sedimentation was 10 times faster in the period of 11,400-8,800 BP than that of 11,400-20,500 BP. That is, the precipitation of the later period was 10 times more elevated than that of the previous one [18]. There was a cold period evident in North Vietnam from 11,400 to 8,800 BP, which was also accompanied with a high rainfall giving rise to a reduction of mountain snail species *(Cyclophorus)* in the case of Mai Da Dieu (Thanh Hoa) and an extremely prosperous expansion of stream snails *(Antimelania costula)* seen in all Hoabinhian cave sites. These research results are proven to be partly in line with Bellwood's comments that from 18,000 to 6,000 BP, the increased rainfall and expanded rainforest fundamentally changed the paleo-geography and profoundly affected the humane ecosystem of Southeast Asia [19]. Not until 7,000 BP did almost all prehistoric cave inhabitants move out to the open air for settlement and systematic exploitation of resources in the coastal plains. From that point, the prehistoric marine cultures were officially formed.

4. The prehistoric marine cultures

4.1. Marine cultures of the Middle Neolithic

Residents of Cai Beo culture: the group of Hoabinhian inhabitants who resided in the northeastern coastal region of Vietnam currently encompasses 12 sites of the Soi Nhu site group with Soi Nhu cave being the most well-known [11]. In the Early Neolithic era, this inhabitant group dates back 25,000 to 12,000 years corresponding to the pre-Hoabinhian period. Typically, inhabitants in Soi Nhu cave dated back to 12,460±60 BP to 15,560±180 BP; those in Ong Bay Rockshelter dated back to 16,630±120 BP, and inhabitants of Ang Ma cave dated back to 25,510±220 BP. All the cultural findings in these caves were the remains of terrestrial animals and stone tools that mostly stemmed from the Hoabinhian including blade-sharpened axes and tools

made of limestone. In the period from 12,000 to 7,000 BP, the living area of the Soi Nhu inhabitants had expanded but remained along the edge of the mainland despite the increasing proximity of the rise in the sea level called Flandrian elevation [20].

After 7,000 BP, the sea began to rise submerging some low-lying northeastern coastal areas. The inhabitants at this time extended their residential space, but some remained living in caves such as the Eo Bua, Ba Thom, Ha Giat, Dong Dang, Dong Cau (or Ha Long cave) and Tien Ong (or Duc cave) caves, while others occupied coastal plains such as Thoi Gieng (lower layer), shelf seas such as Cai Beo (lower layer), and Ao Coi, or tidal flats, such as Hon Ngo-Nui Hua. These sites formed an archaeological culture named the Cai Beo culture, which dates from 7,000 to 4,000 BP in the Middle Neolithic period. Notably, Ha Long cave dates from 6,480±40 BP and Cai Beo (lower layer) from 6,475±170 BP [21].

In order to adapt to their new surroundings, the Cai Beo people made and used tools such as points, triangular axes, oval axes, discoidal implements, shouldered axe for edge-ground polishing, squid shell-shaped completely polished axes, along with percussion stones, anvil stones, pestles, grinding tables, and pebbles with round holes like Hoabinhian artefacts. In particular, clay, sand-mixed, thick-walled, and hand-shaped pottery items were also evident during this period. After 5,000 BP, thin-walled pottery made of a sand-clay mixture bearing different decorations such as knitted patterns, coarse cord-marked patterns, crushed patterns, and printed patterns began to appear.

The Cai Beo people developed ways to exploit marine resources. Over 90% of the animal bones found here belonged to marine animals such as dolphins, catfish, pomadasys hasta, arias leiotetocepkalus, stingrays, sharks, a number of unidentified species of fish, crabs, squid, sea turtles, mussels, scallops, and sea oysters. Over 200 kg of fish bones were found in the Cai Beo site and the vertebrae of one fish unearthed even measured up to 10 cm in diameter [21]. In addition, the bones of some terrestrial animals such as deer, elk, goat, and wild boar were excavated. The Cai Beo cultural sites show that the Cai Beo people quickly adapted to changes in the marine environment, mastered marine exploitation activities, and established the prehistoric marine culture in the country's Northeast.

Some skeletal remains of the Cai Beo people show characteristics of the *Australo-Melanisien* ethnic. Such elements were unearthed in this region such as *Australo-Melanesien* in Ang Giua cave and *Australo-Negritoid* in Soi Nhu cave [22]. The above anthropological and archaeological documentations suggest that inhabitants of the Cai Beo culture descended from inhabitants of the Hoabinhian. Many archaeological papers testify to the development path from the Cai Beo to the Ha Long cultures [11]. In short, the existence of a prehistoric coastal plain exploration route from the Hoabinhian through the Cai Beo to the Ha Long cultures along the north-eastern coast is beyond dispute.

Trang An inhabitants: another direction of coastal plain occupation and exploration taken by post-Hoabinhian inhabitants was to the southwest of the Red river delta to the region of the Trang An landscape complex, Ninh

Binh province. This is home to 25 prehistoric archaeological sites of which nine have been excavated, namely, Trong, Boi, Moi, Thung Binh 1, Thung Binh 3, and Thung Binh 4 caves, and the Ong Hay, Vang, and Oc rockshelters. The sites are scattered over an area covering 6,000 ha in the core zone of the Trang An heritage site, which is a lowland and swampy region with an average elevation of 2 m above sea level.

The prehistoric inhabitants here, dating from 30,000 to 4,000 BP, witnessed fluctuations in the natural environment shifting from the continental environment (30,000 to 7,000 BP) to a marine one (7,000 to 4,000 BP). They then returned to the mainland after 4,000 years due to the impact of the rise and fall of sea levels in the Middle Holocene period. Cultural sites before the rising waters are the Ong Hay rockshelter 27,750±100 BP, 9,535±30 BP; Trong cave 24,438±93 BP, Boi cave 12,447±72 BP, 10,620±64, Moi cave (lower layer) 12,640±35 BP, 9,555±30 BP, and Thung Binh 1: 12,880±420 BP to 12,980±390 BP [23].

The inhabitants of this period made tools mainly from dolomite limestone, which they used to hunt terrestrial animals such as buffalo, gaur, deer, roe deer, pigs, badgers, bears, leopards, monkeys, porcupines, birds, tortoises, and freshwater fish. They also caught mountain and stream snails, Lanceolaria fruhstorferis, clams, and freshwater mussels. Cultural remains, which are mainly mollusc shells compacted into layers ranging from 2 m to over 3 m thick in the caves, indicate that man's temporary and seasonal habitation at the time was linked to the mollusc breeding season.

The inhabitants of this period had not yet exploited the marine resources although, through their trading activities, they were aware of the seawater products. In the layers dating back to 9,000 BP in the Boi and the Trong caves, small, thick, and bright white shells of the Netrita undata species were found perforated with a bead-like thread, as well as round clam shells pierced with strap holes. At a later stage, jewellery was made from the shells of *Neritina pulligera* and *Cypraea* with beautifully-shaped mouths, punctured at the back and dyed with ochre to make jewellery beads.

During the rise in sea level, the ancient inhabitants of Trang An landscape complex continued to live typically in the Moi cave (upper layer) dating from 8,550±30 to 4,705±25 BP, Oc rockshelter from 8,790±210 BP to 5,120±315 BP, and the Vang rockshelter from 8,720±235 to 5,130±310 BP. Inhabitants of this period began to exploit what the sea had to offer. They collected molluscs such as *Geloina coaxans*, estuarine oysters, undata sp snails, black-spotted tritons, yellow-rimmed snails, apple snails, blood cockles, *Cyclina sinensis*, asiatic hard clams, and caught sea fish. However, they continued, as normal, hunting terrestrial animals such as deer, boar, monkeys, hedgehogs, and turtles.

Due to the marine environment, the Trang An complex no longer had a source of pebbles from rivers and streams. Therefore, it was important to produce tools made from limestone, which the people exchanged with traders for andesite to make blade-sharpened axes and sandstone-ground tables. They made use of large-sized oyster shells and Geloina

coaxan shells to make knives, scrapers, and pickaxes, and they used Asiatic hard clam and cowrie shells to create jewellery, and, in particular, they produced pottery. The earliest pottery remains found in layer 6A of the Moi cave dates from 7,381 to 7,186 years BC; the pottery recovered from the Vang rockshelter dates from 8,720±235 BP, and that found in the Oc rockshelter from 8,410±295 BP. The pottery is a clay type, unrefined, and filled with gravel. The pottery was handmade and fired at low temperatures to shape it into products such as the brown or greyish brown round-bottomed vase with a vertical, flat mouth lip, an 8 to 12-mm thick edge, and the outer surface marked with deep fault grooves 5 to 8 mm in width. The creation of pottery in this area may have been associated with the need for freshwater storage and microbiological processing of marine products [24].

Five thousand years after the sea level fell, the continental characteristics of the Trang An complex gradually returned. It took 4,000 years for this region to basically revert to a continental environment. During this period, people were less interested in living in caves and moved to occupy outside spaces, and they practised fixed agricultural activities in the low plains of today's Nho Quan and Gia Vien districts. In exploring the marine environment, the ancient inhabitants of the Trang An complex gradually adapted to the changed environment from the mainland to the sea and back to the mainland, and they made new types of tools. They soon developed grinding techniques and pottery, and deployed mixed economic activities to exploit the resources of the limestone forests surrounded by the sea and picturesque areas, thereby creating a unique cultural nuance of the Trang An landscape.

Residents of Da But culture: the inhabitants of this region are proud to have 10 sites belonging to the Da But culture of which five are located in Vinh Loc district (Thanh Hoa province). Specifically, the ages of the following sites are 6,430±60 BP at the Da But site, and 6,390±60 BP, 6,095±60 BP, and 5,710±60 BP; the Ban Thuy site 5,860±95 BP; the Con Co Ngua site 5,520±95 BP, 5,140±95 BP and 5,560±95 BP; and the Lang Cong and Con Trung sites 4,790±50 BP [25]. They also inherited five sites located in Tam Diep city and Yen Mo district (Ninh Binh province), which are the Sao cave dating back to 9,170±105 BP and 8,740±85 BP, Co cave, Mo cave, Oc cave, and Dong Vuon over 4,000 BP [26].

When the Thanh Hoa plains were first occupied, and when the sea had not yet encroached upon this region, the inhabitants of the Da But culture hunted animals, collected river clams and made clam dunes from their shells, as well as carried out cultivation and domestication. In the period of 5,500 to 5,000 BP, most of the Vinh Loc plain lowlands were under water. The inhabitants of Lang Thuy and Con Co Ngua at this time exploited the sea, collected marine molluscs, and dumped waste into high mounds. Some people ventured further afield to explore the coastal plains and settled in Con Trung (Hau Loc district, Thanh Hoa province), or the Sao, Co, Oc, and Mo caves (Tam Diep city, Ninh Binh province).

While the Da But inhabitants were exploring the coastal plains, they quickly developed tool-making techniques from crudely flaked

pebble tools to edge-polished ones, and completely polished implements such as oval and quadrangular axes. They also invented new tools such as hoes, chisels, saws, awls, centre-perforated stones, and weights added to fishing nets with stones bearing grooves for stringing, and they used animal bones, horns, and mollusc shells to make chisels, awls, sewing needles, and cutters.

Through this process, Da But became one of the earliest pottery centres in Vietnam. Da But pottery culture has remained mostly unchanged for thousands of years. The Da But people would still hunt animals such as deer, buffalo, pigs, dogs, chevrotains, cats, mink, and porcupines, and they collected animals from rivers, streams, swamps, and freshwater such as clams, mussels, snails, venus clams, lanceolaria fruhstorferi, crabs, fish, *trionychid* turtles, and tortoises. When the sea level was rising, the local people exploited coastal seafood resources such as sea urchins, scallops, veneridae, and they went fishing, although not as much as during the Cai Beo period.

Pollen spores found in some sites dating from the Da But culture indicate the existence of a significant amount of legumes, coconuts, and herbaceous pollen suggesting the possibility that the Da But people cultivated and tended certain species of vegetables, tubers, fruit, and seeds. The stone axes and hoes accounted for a high proportion of tools. The fertile Ma river delta had favourable conditions for growing and cultivating fruit and vegetables such as tubers, gourd, squash, water potatoes, taro, and cypress. The Da But inhabitants raised various animals such as buffaloes, cows, and pigs as well as possibly dogs and elephants [27, 28].

The Da But people maintained their custom of burying the dead at their homes in a squatting position or lying on their sides according to their burial rites. Moreover, if a number of individuals passed away at the same time, they would be buried collectively in one grave. They also unanimously agreed on arrangements for the deceased. Specifically, corpses were placed in circular acupoints of 0.6 to 0.7 m in diameter and 0.5 to 0.8 m in depth. Burials were one-off affairs with no re-burial rituals performed [29].

The anthropological composition of skulls of the Da But people was predominantly *Melanesien (Australoid)* or *Indonesian (Southern Mongoloid),* which existed long before the Hoabinhian [30]. According to Marc, cranio-metric and dental non-metric analyses of the 1979-1980 in Con Co Ngua site season human material are consistent with observations of the 2013 assemblage. The people are phenotypically aligned with both Late Pleistocene Southeast Asians and modern Melanesians and Australian Aboriginal populations. They contrast with the majority of Neolithic, Metal period and modern peoples of Mainland Southeast Asia [31]. Pottery and full-body-ground axes of the Da But culture were found in the surface layer of Con Moong cave, Dang cave, Lai cave, and Doi cave (Ba Thuoc district), suggesting the migration path taken to explore the coastal plain was from the area of Cuc Phuong National Park.

However, during the late stages of the marine culture sites such as Hoa Loc (Hau Loc district) and Man Bac (Ninh Binh province), and the Le and Ho mountains (Nam Ha), new elements appeared that differed from those of the Da

But culture. There is a high likelihood that this population group arose from exposure between the native Mon-Khmer language speakers and migrants who arrived by sea. In this regard, it is important to take Peter Bellwood's point of view into consideration when he argued that there was a group of Malayo-Polynesian-speaking inhabitants in Chinese Taipei around 5,500 to 5,000 BP who migrated down to the islands in Southeast Asia through Batanes province to the islands of the Philippines, then to Borneo and the Palawan islands, and into Vietnam. During this time, the majority of people in Vietnam spoke the Mon-Khmer language. Cultural and anthropological vestiges have been found at the Man Bac site (Ninh Binh province) [32] and the An Son site (Long An province) [33].

Residents of Quynh Van culture: the 24 sites revealing scallop dunes or piles of kitchen deposits situated along the coastal plains of Quynh Luu district (Nghe An province) and Phai Nam district (Ha Tinh province) belonged to the Quynh Van culture dating from 6,000 to 3,500 BP. This period had three development stages: (i) early stage (6,000 to 5,000 BP) with a prime example being the Quynh Van sites, (ii) middle stage (5,000 to 4,500 BP) with the Quynh Hoa and Go Lap sites, and (iii) the late stage (4,500 to 3,500 BP) illustrated by Con Dat and Phai Nam sites [34].

The Quynh Van inhabitants mainly fashioned tools from bedrock. More than 95% were grinding and dressing tools made from amorphous stones. These implements include choppers, chopping tools, discoid scrapers, turtle-shell-shaped scrapers, short axes, and triangular and iron-shaped picks. The following two artefacts are representative of the Quynh Van culture. Some cobble tools such as pestles, striking stones, and grinding tables were also excavated. Generally speaking, in the Quynh Van culture, the tool-sharpening technique developed slowly whereas the pottery-creating technique and types of pottery developed rapidly. In the early and middle stages (6,000 to 4,500 BP), the main pottery items produced were large-sized conical ceramic vases with pointed bottoms, slightly flared mouths, and patterns brushed on the inside and outside surfaces.

In the late stage (4,500 to 4,300 BP), a new small round-bottom ceramic type of pot appeared with thin sides, an average mouth diameter of 20 to 30 cm, and body height of 15 to 30 cm. This item was often decorated with check and coarse cord patterns on the outside surface and with brushed patterns on the inside surface. The Quynh Van people mainly collected marine molluscs such as scallops, sea urchins, smooth scallops, screw snails, iron snails, meretrix, veneridae, oysters, clams, mussels, and lanceolaria fruhstorferis, as well as crab, trionychid turtle, and tortoises.

These sea creatures usually lived in coastal zones, estuaries, and enclosed bays. Species of marine fish in this area were rare as each site yielded only a few small head bones or vertebrae of such fish. The early inhabitants still hunted some terrestrial animals such as rhinoceros, wild buffalo, gaur, sambar deer, roe deer, deer, and elephants. There are no signs of cultivation and domestication practice during this period.

The Quynh Van people laid burial tombs at their own residences. Thirty-one tombs were discovered in a 100 m^2 excavation area at the Quynh Van site. The graves had round mouths and were 60 to 70 cm in diameter and were dug into the scallop shell layer. The corpse was placed directly into the grave in a squatting posture with two hands holding the knees. There are few cases where the corpse is found lying on its side. The remains of bones are often broken, fragmented, and incomplete. Burial items include pestles, stones, chopping tools, bone-made tools, jewellery made of marine mollusc shell, and ivory fragments. The excavated skulls bear anthropological characteristics of the *Australo-Melanesian* group with some traits of the *Mongoloid* group [35].

The scallop dune sites of the Quynh Van culture are large with a layer that is 7-m thick that includes intermingled layers of scallops discarded by inhabitants at the time and scallops that had died naturally. This indicates that the people here lived a nomadic existence rather than in a permanent manner and caught seafood according to the seasons. Most archaeologists consider Middle Neolithic cultures to be derived from the Hoabinhian, even from the Dieu technique in Ba Thuoc district (Thanh Hoa province) as evidenced by the existence of iron-shaped tools, which were identical to tools typical of the Quynh Van culture [36]. The latter evolved into the Bau Tro culture through the Thach Lac culture. This development process reflected changes in population structure and ways of living, as well as the relocation of residences in order to adapt to environmental changes along the coastal plains of Nghe An and Ha Tinh provinces at that time. Historically, the Quynh Van culture represented the post-Hoabinhian Neolithic path in central Vietnam, an approach to the shallow bay in this region.

4.2. Marine cultures of the Late Neolithic

The culture of Ha Long: this culture ranges from 5,000 to 3,000 BP and is distributed predominantly in the Ha Long bay [37]. The stone tools are typified by shouldered axes, stepped adzes, grooved grinding stones with U-shaped cross section, and porous pottery. Twenty-eight of the thirty-one habitation sites of the Ha Long people are located on sand dunes and riverine tidal areas while only 3 caves were found. Each of the "fishing villages" here had an average area of 1,500 m^2, which is smaller than the "agricultural villages" situated in the Red river delta, however, the population density here was also likely lower. The Ha Long people showed a very high development of stone-working technology, building pottery, planting trees for fibres and as means of transport for exploiting the marine products, as well as exchanging and trading goods with the mainland and distant islands. Stepped adzes and Ha Long marks have been found not only in the mainland of North Vietnam, but also in the coastal provinces of Guangdong, Fujian, and Hong Kong indicating the overseas relationships made by Ha Long people in the past [11]. Radiocarbon dates determined from several Ha Long "fishing villages" are as follows: Ba Vung 4,100±40 BP (calibrated from 4,820 to 4,520 BP); Bai Ben 3,380±50 BP, 3,470±55 BP, 3,180±55 BP, 3,300±55 BP, 3,900±80 BP, 4,070±50 BP, 3,090±50 BP, 3,270±55 BP.

This is a stage of forming the typical marine cultures such as Ha Long, Trang Kenh (Quang Ninh province, Hai Phong city), Man Bac (Ninh Binh province), Hoa Loc (Thanh Hoa province), Bau Tro (Quang Binh), Long Thanh, Binh Chau (Quang Ngai province) and Xom Con (Khanh Hoa province). Among them, the Trang Kenh - Man Bac sites belong to Phung Nguyen culture and they are distributed in the sea dating from 4,000-3,500 BP.

The culture of Hoa Loc: this culture was named after a site located in Lien Loc commune, Hau Loc district (Thanh Hoa), with a date of 4,050±53 and 3,913±84 BP [38]. The Hoa Loc inhabitant possessed a sedentary settlement pattern, a farming that used hoes, and a high growth of stone tool and pottery production. The large-sized stone hoes, large and crude quadrangular axes, stone artifacts with engraved marks in horizontal, earthen seals with geometric motifs, "leech"-shaped earrings, polygonal-rim pots, and ink-slab-shaped boxes are typical of the Hoa Loc culture. People of this culture had relationships, exchanges, and contacts with those who lived inland such as Con Chan Tien (Thanh Hoa), Ghe Da (Phu Tho), Ban Giem (Son La), and notably in the marine habitats like Ha Long (Quang Ninh), Thach Lac (Ha Tinh), Bau Tro (Quang Binh), and even in Taiwan, Fujian (China) [39].

The culture of Bau Tro: this culture was named after the site of Bau Tro excavated by E. Patte in 1923 [40], which consisted of over 20 sites distributed on the coastal plain from Nghe An to Quang Binh dated between 4,500 and 3,000 BP. The distinctive characteristics are recognized through the manufacture and use of axes, adze, hoes, chisels, knives, saws, drills, polishing stones, pestles, saddle querns, and hammerstones. Pottery includes vessels with knobs attached to rim walls, and everted-rim pots with worm-shaped rim edges impressed by such decorative motifs as tortoise-shell shape, stave shape on the cord ground, and pigmented with red and black. The Bau Tro people practiced hunting, gathering, fishing, farming and reached a high level of stone manufacture [40]. They colonized the coastal plain and mastered the freshwater pools, had an open relationship with other contemporary tribes, and contributed to the formation of the pre-Sa Huynh and Sa Huynh in Central Vietnam as well as the pre-Dong Son and Dong Son cultures in Ca river basin.

Along with the cultures of Ha Long and Bau Tro, there are some synchronic marine ones like Hoa Loc (Thanh Hoa), Binh Chau - Long Thanh (Quang Ngai), and Xom Con (Khanh Hoa) that fundamentally belong to the Bronze Age dated between 4,000 BP and 3,000 BP.

The culture of Long Thanh - Binh Chau: this culture is represented by two stages of the early and late Bronze Age in the marine area of Quang Ngai. The site of Long Thanh, situated in Duc Pho, showed similarity to the lower layer of Xom Oc, Bai Ong, and Vuon Dinh - Khue Bac through the introduction of egg-shaped and globular burial jars accompanied with earthen and stone artifacts in residential areas with no signs of bronze artifacts dated to the early Bronze Age. The site of Binh Chau, located in Binh Son, has had similar findings to the upper layer of Xom Oc, Bau Tram with such features as: graveyards located separate from the living area, earth

burials accompanied with grave goods like spear head, arrow head, chisel, fishing hook, folded-shoulder vessel, high-footed bowl, and "leach"-shaped earrings. Of which, the pots with folded shoulders and pointed bases, as well as the bowls with cylindrical feet, are the most represented artefacts of this culture. This is a marine culture developing into the Sa Huynh culture in central Vietnam [41].

The culture of Xom Con: this culture was named after the site of Xom Con, Cam Ranh (Khanh Hoa) and is dated to 4,000-3,000 BP and comprises the coastal sites such as Xom Con, Cu Hin, or island sites like Hon Tre, Hon Mun, and Hon Tam. Stone tools are characterized by stone quadrangular axes, ornaments made from snail shells with species *Tridacnan and Tubo*, high-footed bowls built by a paddle technique, and had incised and pigmented decorations. Sea products gathered by Xom Con people were exported to other regions like Bien Ho (Gia Lai), Hoa Loc (Thanh Hoa), and even Japan or the Pacific islands [42].

A place belonging to the Xom Con culture is the site of Van Tu Dong. It is situated on the sea bay of Cam Ranh, Khanh Hoa, which is the farthest residential point on the south among the people living in the marine transgression habitat at about 4,000 BP. This site was excavated in 2006. The meal waste of the ancient residents here includes mainly shells of arca, scallop, barnacle, and snail that were piled up into mound called a shell-midden site. A shell examination indicated that there were 7 species of snails, 3 species of barnacles, and a few marine species of arca, scallop, oyster and mussel, which inhabited the alluvial ground, estuary, swamp, lagoon, tidal areas, and even off-shore at a depth of a few tens of metres below the surface. They reflected a very dynamic mode of marine exploitation and had various ways of processing mollusc species suggesting a diversity of cuisines that local people had. The ancient people of Van Tu Dong were those who settled in the coastal area with primary economic activities of exploiting the marine products in the coastal zone.

The culture of Giong Phet (or the culture of Can Gio): this culture is most characterized by sites of Giong Phet, Giong Ca Vo, Long Buu, and Giong Am dated between 2,500 and 2,000 BP and located in the estuaries of Can Gio. This culture is composed of the habitation sites (in the early stage) and burial grounds (in the late stage). Giong Phet people exploited sea resources, building pottery, especially manufacturing ornaments made on semi-precious stones, glass, and sea shells. They buried the dead in big jars in a flexed position. Some of the graves were indicated as being reinterred or buried directly under the ground. The culture of Giong Phet was probably developed from the site group of Ben Do and Hoi An and transformed into the culture of Oc Eo. It had a close relationship with the Sa Huynh culture and the contemporary people in the Philippines, Cambodia, and Thailand. Radiocarbon dates were at 2,480±50 BP as determined from Trench 1 of the Giong Ca Vo site at 1.5 m deep, and 1,665±40 BP from Giong Am [43]. In history, it was possible that the Sa Huynh people used primitive seaports including Hoi An and Can Gio dated to the end of the first millennium BC, and that it was

those primitive seaports which witnessed a transformation from Sa Huynh to Champa and from Giong Ca Vo to Oc Eo.

5. Conclusions

The prehistoric marine cultures of Vietnam are sources of real historical material that illustrate a transitional step from the Stone Age to Bronze Age, from the prehistoric to historical time, and from the Primitive to Civilization through four generalized development stages below:

Stage of approach (10,000-7,000 BP): people of the Hoabinhian and Bac Son culture were the first ones approaching the sea as a predecessor of the prehistoric marine culture of Vietnam.

Stage of formation (7,000-4,000 BP): people of the middle Neolithic, represented by the cultures of Cai Beo, Da But, Quynh Van, and Bau Du, expanded their occupation to the coastal plains, exploiting the marine resources, and forming the centres of the prehistoric marine culture of Vietnam.

Stage of pervasion (4,000-3,000 BP): a series of late Neolithic and early Bronze Age cultures were formed and developed across the marine regions of the country including Ha Long (located in the northeastern marine region), Hoa Loc, Thach Lac, Bau Tro (in the coastal region of northern Central), Long Thanh - Binh Chau (in the middle Central), Xom Con (in Southern Central), and a number of other synchronic sites distributed on the coastal islands such as Con Co, Ly Son, Hon Do, Bau Hoe, Tho Chu, and Con Dao.

Stage of convergence (3,000-2,000 BP): the marine cultures of the late Neolithic and early Bronze Age were integrated with those living in mountainous areas and plateaus coming from the Pacific Ocean creating three Iron Age cultures of Vietnam: the Dong Son culture in the North, the Sa Huynh culture in the Central, and the Can Gio culture in the South.

The inhabitants of the Neolithic Middle Ages dominated and exploited the coastal plains of Vietnam such as the communities of Cai Beo, Trang An, Da But, and Quynh Van, which were the most crowded due to exploitation strength of copper from the sea and islands in their area. This created a difference in economic orientation between the sub-regions and opened the way for the formation of prehistoric marine cultures in Vietnam.

Within each of these occupational zones, the internal development from the Middle Neolithic to the Late Neolithic periods in each region was evident. For example, the transition from the Cai Beo to the Ha Long cultures along the Northeastern coast, from the Da But to Hoa Loc and Man Bac cultures, and from the Quynh Van to Bau Tro cultures. The historical process of Vietnam's prehistoric marine culture from 7,000 to 4,000 BP is diverse and multi-directional. However, all developments during this period had the same starting point - a background of the Hoa Binh - Bac Son culture, converging at the pre-Dong Son to Dong Son cultures in the North, and pre-Sa Huynh to Sa Huynh cultures in Central Vietnam.

Today, Vietnam's marine region has been under the influence of rising sea levels. On 17 April 2013, the Ministry of Natural Resources and Environment issued a scenario of changing climate and rising sea levels for Vietnam

from 2012 to the end of the 21st century that included three levels. In the lowest level, the annual average temperature of Vietnam would increase by 1.6 to 2.2 degrees Celsius and sea levels would be up by 49-64 cm accordingly. In the medium level, the average temperature would increase from 2 to 3 degree Celsius and sea levels would rise 57-73 cm. In the highest one, the average temperature increase would reach to 2.5-3.7 degree Celsius, causing a rising sea level to increase by 78-95 cm and up by 105 cm in the area of Ca Mau - Kien Giang.

With respect to a flooding threat, it is estimated that until 2100, sea levels would elevate by at least 1 m. As a consequence, approximately 39% of the area of Cuu Long river plain, over 10% of the area of Red river and Quang Ninh plains, more than 2.5% of the area of the coastal provinces, and more than 20% of the area of Ho Chi Minh city would be under the inundation threat. Roughly 35% of the population of provinces of Cuu Long river plain, over 9% of the population of Red river plain and Quang Ninh, nearly 9% of the population of the coastal provinces of the central region, and about 7% of the population of Ho Chi Minh city would be directly affected.

A lesson taken from the adaptation of the prehistoric inhabitants to the marine habitat during their cultural development would be certainly valuable. Rising sea levels would lead to the disappearance of archaeological sites as it did in the late Pleistocene. In the future, the sea will extend, while mountains are being destroyed, hills being levelled and the sea being filled, all of which will result in permanent destruction of a number of sites. Each individual archaeological site not only serves as an annal, but also an identity card of the country in an integrated world. Losing the relics can be viewed as losing one's direction in their lives and losing one's mind that is unable to come to success. Evidently, the prehistoric sites of the marine cultures of Vietnam have been playing a particularly important role in the socio-economic development of Vietnam and it needs to be studied, protected, and brought into play.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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