Radiocarbon Analysis (^{14}C) To Determine the Chronology of Bangka-Bangka Culture in Mamasa, West Sulawesi Province, Indonesia

Rosmawati[1], Akin Duli[2], Muhammad Nur[3], Yusriana[4], Erwin Mansyur U. Saraka[5], Hasanuddin[6], Stephen Chia[7], Yunus Sauman Sabin[8], Zuliskandar Ramli[9], Francis David Bulbeck[10], Adam Brumm[11]

[1,2,3,4,5]Department of Archaeology, Faculty of Cultural Sciences, Hasanuddin University – Makassar, Indonesia
[6]Institute for Archaeological Research Makassar, Indonesia
[7]Centre for Global Archaeological Research, Universiti Sains Malaysia
[8]Department of History Universiti Pendidikan Sultan Idris (UPSI)
[9]Institute of the Malay World and Civilization Universiti Kebangsaan Malaysia
[10]Department of Archaeology and Natural History, The Australian National University
[11]Australian Research Centre for Human Evolution, Environmental Futures Research Institute, Griffith University, Brisbane, QLD, Australia 4111.

E.mail: akinduli@unhas.ac.id,

Abstrak. Research on the *Bangka-bangka* culture in Mamasa as a grave cultural heritage made from Uru wood, still leaves various questions that need to be answered. Cultural chronology is one of the most crucial issues to be explained, when its time began to be known, how long the development period, and when it will begin to be abandoned by its supporting communities. This research was conducted using a systematic survey method and sampling for radiocarbon dating from five *Bangka-bangka* cultural sites that were considered representative; Buntu Balla, Orobua, Paladan, Balla 'Kalua, and Salulo Site. At the site, hundreds of wooden tombs were found in a certain shape consisting of boat (*bangka-bangka*), buffalo (*tedong-tedong*), horse (*narang*), round (*talukun*) and house-shaped tomb *(batutu*). As the results of the dating analysis using the radiocarbon (^{14}C) method show that the wooden tomb of *Bangka-bangka* culture has been used since 730 ± 50 BP or around 1200 M and continued until the 1970s.

1. Introduction

The ethnic of Toraja Mamasa is one of the indigenous groups living in Mamasa Regency, West Sulawesi Province, Indonesia. They have inhabited in Mamasa region from the past to the present and have various unique and interesting cultural forms to study. Burial system is a hallmark of their culture by placing graves on limestone hills using wooden crates (*bangka-bangka*). To date, only a few archaeologists have examined the burial of wooden crates in the area. In effect, the distribution of sites, forms, layout, dating, and cultural significance has not been widely known scientifically. Therefore, archeologically it needs to be studied in order to understand various aspects of the culture before the wooden coffin graves are damaged and extinct due to natural processes such as weathering and being destroyed by treasure seekers.

Preliminary research on the same burial culture has been carried out by Akin Duli [1-4], *erong* in Tana Toraja, *mandu*/*duni* in Enrekang [5], and Bangka-bangka burial in Mamasa [6]. Furthermore, in Sulawesi region has been analyzed with radiocarbon dating in Luwu (the Origins of Complex Society project in South Sulawesi or OXIS project) with

the date of 450 + 60 BP AD 1400 -1635 [7]. In Takalar, pre-Islamic tombs were found with a development period between the 14th-17th century [8], which culturally imitated under the Bajau Tribe from Kalimantan or Philippines [9-10]. The same cultural distribution was also found in Kalimantan, Irian (Key Islands and Aru), Sulawesi (Selayar, Bira, Luwu, Kalumpang, Seko, Rongkong, Kumila', Kolaka and several sites in Central Sulawesi) whose development period is unknown [2].

In Southeast Asia, the study was conducted at several sites, such as in Thailand at the Spirit Cave site, Pang Ma Pha (Ban Rai and Bo Krai), and Kanchanaburi developed during the period of 2100 BP to 1200 BP [11-12]. Research by Grave *et al* [13] on the Pang site in Nan Province, Northern Thailand, there was a coffin (teak wood) of 1000 BP (teakeastasianarchaeology.com). An analysis of several wooden gravesites in Thailand using the dendrochronological method. The results can be seen that the teak used between 80 and 100 years old. The difference between simple and complex shape was influenced by the factors of belief, social status, and the creativity of the maker [14]. Exploration by Schoocongdej [15-16] in Northern Thailand concluded that adherents of coffin culture in the region originated from South China, while by Coates [12] said that the teeth found in the tomb were similar to the teeth of residents in Malaysia, Borneo and another Southeast Asia.

In Vietnam, boat coffins were found in the Dong Xa and Yen Bac sites, aged 2140 ± 70BP [17]. In the Philippines, there were coffin burial sites such as in Sagada and Luzon Island (Lumiang, Sugong, Matangba, Sumawan, Bohol, Cebu, and Rombron site) between 2000 BP - 500 BP [18] [14]. Investigation on coffin sites in the Sarawak and Sabah regions done by Harrisson [19], Bellwood [20], Yunus [21-22], Chia and Koon [23], Chia and Molijol, P. [24], and Chia [25-26] was between 700 BP - 1000 BP. In southern China, several coffin sites are found in Sichuan, Hubei, Jiangxi, Fujian and Yunnan Provinces. At Gongxian coffin, from 3000 BP to 400 BP (Http: //www.china.org.en). In the area of "Three Georges" coffin is 2500 BP to 1000 BP (http://www.chinatravel.com).On the Yangtze River (Hubei), 475 BC to 221 BC (http://www.hiyangtze.com); the Fujian Wuyi site dates from 1027 BC to 777 BC and the Longhushan and Jiangxi sites are 2500 BP (http://www.thesupernaturalworld.com).

This article describes the results of coffin studies in Mamasa that were accomplished in 2012 and 2018. In that study, a systematic survey has been done with inventory, documentation, and sampling for dating. It aims to determine the age and development of wooden coffin tombs in the area chronologically using the ^{14}C radiocarbon analysis method. Specifically, the purpose of this study was to determine the period of cultural development chronologically, through radiocarbon analysis (^{14}C).

List of Carbon Dating (^{14}C) results of several coffin sites in Southeast Asia (Duli, [5])

Site	Laboratory code Source	Determination	Calibrated date (a)
Niah West Mouth coffin Sarawak, Malaysia	GrN-1907 Harrisson 1958	2695±65 BP	780–1003 BC
Niah Painted Cave canoe Sarawak, Malaysia	GX0307 Szabó and others 2008	2330±+80 BP	166–750 BC
Niah Gua Samti canoe Sarawak, Malaysia	GX0213 Szabó and others 2008	2115±125 BP	411 BC–AD 207

Niah Painted Cave canoe Sarawak, Malaysia	GX0212 Szabó and others 2008	1780±150 BP	101 BC–AD 584
Niah Painted Cave canoe Sarawak, Malaysia	GX0214 Szabó and others 2008	1450±125 BP	AD 266–870
Niah Painted Cave canoe Sarawak, Malaysia	Not stated Harrisson 1970	1180±70 BP	AD 685–987
Niah Painted Cave canoe Sarawak, Malaysia	GX0309 Szabó and others 2008	1045±80 BP	AD 779–1163
Agop Atas coffin Sabah, Malaysia	ANU-2944 Bellwood 1988	960±70 BP	AD 899–1221
Melanta Tutup coffin Sabah, Malaysia	Not stated Chia 2008	Not stated	AD 880–1110(b)
Sanrabone, Bayoa coffin South Sulawesi	ANU-5564 Bulbeck 1992	780±80 BP	AD 1040–1388
Arateng 1 coffin	ANU-11109 Bulbeck and Caldwell 2000	450±60 BP	AD 1324–1634
Lamuru coffin South Sulawesi	ANU-5922 Bulbeck 1992	340±70 BP	AD 1437–1794
Bayoa 1 coffin South Sulawesi	ANU-5927 Bulbeck 1992	270±120 BP	AD 1442–1953

2. Radiocarbon Methods in Archaeological Research

Laboratory analysis for archeology is essential [27-28] as an example, XRD and XRF analysis to find out the material [29]. One method used to determine the age of coffin is radiocarbon dating. Fagan [30] describes that radiocarbon dating is the most useful dating method for archeologists. This method was introduced by Libby and Arnold in 1949, to determine the age of organic samples from their radiocarbon content. The basis of radiocarbon dating depends on determining the relative concentrations of radioactive isotopes carbon-14 (^{14}C) and isotope carbon-12 (^{12}C). Carbon isotope is unstable and shrinks to produce nitrogen-14 (^{14}N) by releasing beta particles. The time used for half of the ^{14}C to shrink in a sample is 5730 years (also known as half life). However, this isotope is produced continuously by nitrogen in the Earth's atmosphere with cosmic emission from loose space.

Until now, the ^{14}C to ^{12}C ratio has been found to be rather constant at 1.30×10^{-12}. All living plants absorb carbon dioxide from the air to form organic material through photosynthesis. Radiocarbon content which is thought to be the same as in the atmosphere. However, if an organism dies, ^{14}C is no longer replaced. Therefore, the ratio of ^{14}C to ^{12}C in organisms that die will decrease due to ^{14}C depreciation. Measurement of ^{14}C levels allows us to determine the date of death of the organism. Measurement of ^{14}C levels is now controlled by Jisim Spectrometry. Preliminary studies usually use beta-ray validation to measure 14C levels [31-33].

Coffin Sampling for radiocarbon dating was used to determine the date and development of coffin culture in Mamasa. There are several criteria that are used as a basis for taking samples, are: (1) local community information about the oldest coffin at each site, (2) Coffin that is still good and has not suffered much damage due to human activities, (3) it is not exposed to direct sunlight and rain and (4) Samples are taken when the weather is conducive.

The sampling process deal with several problems. Coffin's findings, for instance, are numerous that may not necessarily be proportionally represented of the sample. Another problem, some sites are prohibited by the local community from being sampled. Moreover, the research location is far-reaching, thus requires a long time and expensive cost. Therefore, only five sites and seven samples were selected that were considered representative. The issue of financing for radiocarbon dating which costly is also one of the limitations of this study. Coffin samples taken, sent to the Beta Analytic Inc. Laboratory. 4985 S.W. 74 Court Miami, Florida, United States.

3. Coffin Sites Distribution in Mamasa

After determining five coffin sites in Mamasa that were considered representative, a systematic survey was then conducted. These sites were chosen with consideration that they could represent five large indigenous community groups in Mamasa; Buntu Balla Site, the Orobua Site, the Paladan Site, the Kalua Balla Site, and the Salulo Site.

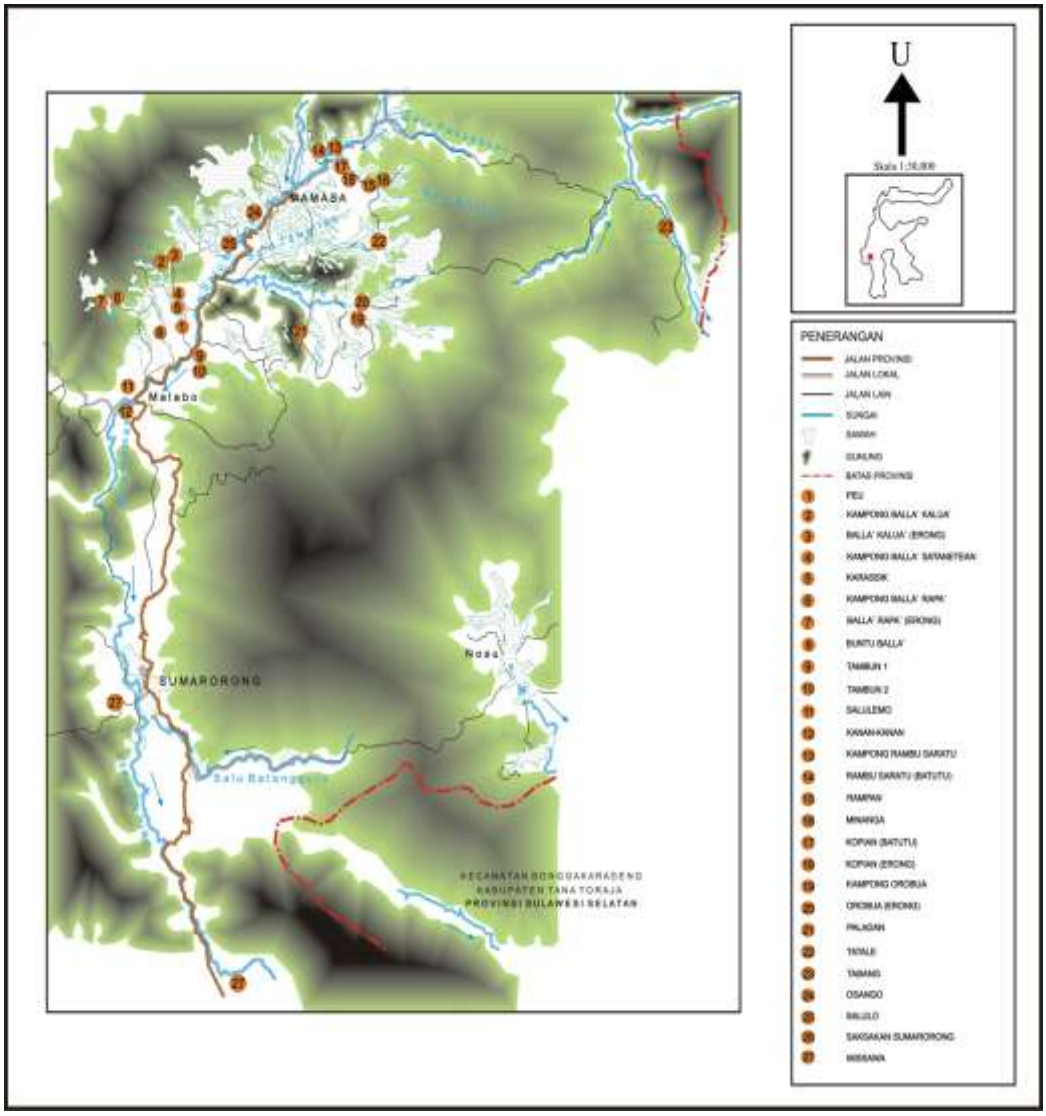

Figure 1: Research location

3.1. Buntu Balla Site (Tedongtedong Minanga)

The Buntu Balla site is in Balla Village, Balla District, Mamasa. Located at the coordinate point S 03º 00' 01.7 ", E 119º 19' 137", height of 1097 m above sea level. There are two figures buried at the site; Nenek Patompo' and Nenek Ami who are said to be the last two traditional leaders who were buried in buffalo-shaped coffin. There are 11 coffins on the site, two samples taken from two coffins of different shapes and are fragile. The results of the ^{14}C radiocarbon analysis in the laboratory were 280 ± 40 BP and 380 ± 40 BP, around the 17-18th century AD.

Figure 2: Boat-shaped (*bangka-bangka*) and Buffalo-shaped coffin (*tedong-tedong*) at the Buntu Balla site

3.2. Orobua Site

The Orobua site located in Orobua Village, Sesena Padang, Mamasa. Location coordinates are S 02º 59' 25.5 " and E 119º 24' 03.9", with a height of 1,223 m above sea level. There arw three pieces wooden coffin, each one in the shape of a boat (*bangka-bangka*), buffalo (*tedong-tedong*) and round (*talukun*) and a house-shaped tomb (*batutu*). Samples were taken from buffalo shaped which partially decayed body. As the results of analysis were 730 ± 50 BP around the 13th century AD. According to information from the local community said that the first person to be buried in the coffin was Parengnge' (the leader) who first founded Orobua Village; Nenek Puang Bongga in the period of around 600 years ago.

Figure 3: Buffalo shaped coffin sampled for ^{14}C analysis at the Orobua site

3.3. Paladan Site

Paladan site is in Paladan Village, Sesena Padang, Mamasa. Located S 02º 59 '53.0 ", E 119 º 22' 56.2", with a height of 1,324 m above sea level. There were four coffins include boat (*bangka-bangka*), buffalo and horse-shaped (*tedong-tedong* and *narang),* and tomb Batutu. Samples were taken from coffin boat-shaped, analysis ^{14}C shows 390 ± 50 BP or around the 17th century AD. Based on information, the person who was first buried on the site was the first traditional leader named Nek Lento and his wife Nek Tasi 'Langi'. Both were buried in a boat-shaped wooden coffin around 1650 AD as a Paladan hero who fought the Dutch invaders named Demmatande who was last buried in coffin in the form of buffalo and horse.When the Dutch came in Mamasa around 1890, the habit of burying dead bodies in coffin had begun to diminish because the Dutch government forbade it.

Figure 4: Buffalo-shaped coffin on the Paladan site

3.4. Balla' Kalua' Site

At the same region, the 'Kalua' Balla Site is in the Sangtanetean Balla Village, In the coordinates S 02º 58'07.4 ", E 119º 19'23.0", with a height of 1,291m above sea level. There are two round coffins that have been found on this site. Some samples were taken from coffin which has been weathered, the results of the analysis give the results of 580 ± 40 BP or around the 15th century AD. According to local resident, the buried on the site was the traditional leader of the 'Kalua Balla Village', but they no longer knew the names.

3.5. Situs Salulo

The Salulo, is in Dusun Bambasola, Lembang Salulo Village, Mamasa. Coordinates points at S 02º 057 '43.5 ", E 119º 20 '52.4", with a height of 1,145 m above sea level. The site is located on the top of a sandstone hill, around 400m to the north from the old village, some rice fields and people's gardens, and in south there is the Mamasa River. There were two pieces of wood estimated to have come from shards of a wooden boat-shaped (*bangka-bangka*), located on the west side of the Batutu tomb with a length of 183 cm, a width of 50 cm and a thickness of 3-5 cm. The tomb is taken as a sample for the date, the result is around 470 ± 50 BP. Besides, Around the site were found pottery fragments, human bones and pig jaws.

4. A Radiocarbon Analysis ^{14}C as a Determination of the Development Period and the Role of Bangka-bangka Culture in Mamasa Region

The distribution of *bangka-bangka* grave sites in Mamasa region is in the valley along the Mamasa River, which extends north to south and empties into the Makassar Strait. The valley is located at an altitude between 800 m - 1400 m above sea level, which is a very fertile area and suitable for agriculture.

The cultural form of wooden tombs found in Mamasa was shaped by boat (*bangka-bangka*), buffalo (*tedong-tedong*), horse (*narang*), round *(talukun*) and batutu. These differences were strongly influenced by belief, social stratification and developmental period factors. Belief was based on respect for ancestral spirits and cosmological understandings, especially must be done by the aristocratic social class symbolized using tombs of different shape. Wooden coffins were only used by high social classes especially the aristocrats and their relatives. However, the status of each noble also differs according to their role while still alive, such as as chief and servants of the customary government or as a part of the family. All these roles were symbolized using different wooden tombs. Batutu grave was used by high social class, boat-shaped wooden coffin graves (*bangka-bangka*) are used by medium class, buffalo-shaped coffin graves and horses (*tedongtedong and narang*) for rich and brave class, while round shaped caskets (*talukun*) for low nobility and royal warriors or servants. Whereas ordinary people or slaves were only buried in stone pits (*liang lo'ko'*) without using wooden tombs.

Wooden-coffin-tombs culture in Mamasa is one of the distinctive features of Toraja Mamasa ethnic which has developed from the beginning along with Tongkonan and various religious rituals as reflected in the *Rambu Tukak* or *Rambu Solo*. According to the local community (Demmatayan and Bongga Tiboyong, personal communication, 2018), it was explained that differences in social status were buried at the wooden coffin tomb sites in Mamasa, determined by the type of grave and the shape of the wooden coffin used. High noble class (*tana 'bulaan*) buried in Batutu, high noble class and also hero or brave person (*tana' bulaan*) in the grave of buffalo-shaped (*tedong-tedong*) and horses *(narang*). Furthermore, middle class nobility (*tana 'bassi*) who were economically capable are buried in the tombs of wooden boat (*bangka-bangka*). Low aristocratic class (*bassi or karurung tanak*) who were able to be economically buried in the tomb of round wood type (talukun). Then, Low social class was buried in the ground made holes in the cliffs of the hill (*liang lo'kok*).

The wooden coffin was believed to be a vehicle used by their ancestors from across the island sailing to the Mamasa and believed as a symbol of the spirit boat that will be used by ancestors' soul to travel to the spirit realm (*puya*). The orientation is always placed facing south and west. This was closely related to belief and social status, because both directions were ancestral spirits. Nobles used to be believed to reside in *Puya* which was in the south, while noble people who come from the descendants of *Tomanurun*g (gods from the sky), will return to their origin in the sky, through the west as the way to heaven. Thus, the difference wooden shape was strongly influenced by the belief and social system that originates from the teachings of *aluk todolo* (customary rules from ancestors) that govern various aspects of the life of the Toraja Mamasa community in the past up to the present.

Laboratory analysis can provide information regarding the age of wooden coffin tombs found at several sites in the area. Although it is realized that there are still many

sites that have not been surveyed, mainly due to limited time, energy and cost. However, the sites surveyed are a very meaningful representation of the actual population, because the sites that were chosen historically are in the area that was the center of the cultural development of the Mamasa people, both in the past until today. The selection of sites in the Mamasa area, were in the Balla, Rambu Saratu, Orobua and Paladan areas. Five sites were selected from the total surveyed, then samples taken for radiocarbon dating (^{14}C) were analyzed in the laboratory by seven samples.

The results of the radiocarbon dating (^{14}C), obtained the oldest age is around 730 ± 50 BP or around 1200 AD (13th century AD). Thus, the initial development of wooden tombs in Mamasa was around 1200 AD and was still practiced by the local community until around the 1970s.

The dating result of wooden coffin tombs in Mamasa region

Lab. Number	Sample	Site	Determination (dating)	Shape
Beta-287176	MMS 01	Buntu Balla (Tedong-Tedong)	280±40 BP	Boat
Beta-287177	MMS 02		380±40 BP	Buffalo
Beta-287178	MMS 03	Orobua	730±50 BP	Buffalo
Beta-287179	MMS 04	Paladan	390±50 BP	Boat
Beta-287180	MMS 05		500±50 BP	*Batutu*
Beta-287181	MMS 06	Balla' Kalua'	580±40 BP	Roundes
Beta-287182	MMS 08	Salulo	470±50 BP	Boat

If referred to the initial use of wooden coffin tombs in Mamasa, the earliest coffin tombs used were buffalo-shaped tombs (*tedong-tedong*) found on the Orobua site. The other wooden coffin tombs such as boat (*bangka-bangka*), round (*talukun*) and batutu develop later. At first the high nobles were buried in the tombs of buffalo-shaped wooden crates and followed later by another form of tombs. This is also closely related to the mythology of people in Mamasa who assume that their first ancestor, Nenek Pongkapadang came from Tana Toraja (*Toraja Sa'dan*) with a buffalo and a dog [34-39]. Subsequent developments when the Mamasa community grew and became complex, then formed a traditional unity that was somewhat different from the area of origin in Tana Toraja.

5. Conclusion

The radiocarbon dating (^{14}C) method is one method that can help archeologists to determine the relative age of an object or archeological site. This method has been widely used by archeologists in various archeological studies in the world. In a study of Bangka-bangka culture in Mamasa, the radiocarbon dating results showed that the oldest age was 730 ± 50 BP or around 1200 AD. Therefore, the initial development of the Bangka-bangka culture in the Mamasa area was around 1200 AD or earlier and was still practiced by the local community until around the 1970s.

Ecologically and geography it can be identified that the distribution of Bangka-bangka cultural sites in Mamasa is in the valley area along the Mamasa River, with an altitude between 800 m-1,400 m above sea level. The culture forms are boat (*bangka-*

bangka), buffalo (*tedongtedong*), horse (*narang*), round (*talukun*) and traditional house shape (*batutu*), with various size variations and made from uru wood (*Elmerillia celebica dandy*). The cultural layout of the tomb found at each site, which is located at the foot or top of the limestone hill, which is located not far from the village and rice fields.

The difference in the shape, layout and orientation of the grave culture, is greatly influenced by factors of belief, social stratification and the period of development. Their belief which is still developing until now through respect for ancestral spirits and cosmological understandings, which must be carried out by aristocratic social classes symbolized using different forms of grave culture.

Acknowledgements

In particular, I extend my appreciation and thanks to all the archaeological colleagues who have collaborated in this research, especially to Prof. Dr. Stephen Chia (USM), Prof. Dr. Zuliskandar Ramli (UKM), Prof. Dr. Adam Brumm (Griffith University), Dr. Francis David Bulbeck (ANU), Dr. Yunus Sauman (UPSI), Dr. Hasanuddin (Institute for Archaeological Research Makassar), and young researchers from the Archeology Department of Hasanuddin University Dr. Rosmawati, Dr. Muhammad Nur, Yusriana, MA., dan Erwin Mansyur U. Saraka, M.Sc. and to all who have helped in this research, thank you.

Funding

This research is supported by funding from Hasanuddin University in collaboration with Universiti Sains Malaysia with Geran RU 1001/PARKEO/870002. Thank you for donating funds in this research.

References

[1] Duli, A. 1999, Bentuk-bentuk Kubur Dalam Sistem Penguburan Orang Toraja, Suatu Studi Etnoarkeologi. Presented in: *Kongres dan Pertemuan Ilmiah Arkeologi VIII*, di Yogyakarta, 15-18 Februari 1999.

[2] Duli, A. 2012 Budaya keranda *erong* di Toraja, Enrekang dan Mamasa, Sulawesi – Indonesia. Thesis Doctoral (Penang: Pusat Penyelidikan Arkeologi Global, Universiti Sains Malaysia)

[3] Duli, A. 2015 Typology and chronology of *erong* woodenn coffins in Tana Toraja, South Celebes *Time and Mind* **8** 3-10.

[4] Duli, A. et al 2019 The role of radiocarbon analysis in determining the chronology of erong culture in Tana Toraja *The 3rd International Conference on Science* In Journal of Physics: Conference Series. IOP Publishing.

[5] Duli, A. 2013 The mandu coffin: a boat syimbol of ancestral spirits among the Enrekang people of South Sulawesi *Journal RIMA* **47.**

[6] Duli, A. 2014 Shape and chronology of wooden coffins in Mamasa, West Sulawesi, Indonesia *Tawarikh* **5.**

[7] Bulbeck, F. D. and Prasetyo B. 2000 Two millennia of socio-cultural development in Luwu, South Sulawesi, Indonesia *World Archaeology* **32** 121-137.

[8] Bulbeck, F. D. 1992 A Tale of two Kingdoms: The Historical Archaeology of Gowa and Tallok, South Sulawesi, Indonesia, unpublished PhD thesis, The Australian National University, Canberra.
[9] Bulbeck, F.D. The bronze-iron age in south sulawesi: mortuary traditions, metallurgy and trade', in Bulbeck, F.D. and Barnard, N. (eds), Ancient Chinese and Southeast Asian Bronze Age cultures, vol. 2, Southern Materials Center Inc., Taipei, pp. 1007–76. 1996–7.
[10] Bougas, Wayne 2007 Gold looted and excavated from late (1300 AD–1600 AD) pre-Islamic Makasar graves *Archipel* **73** 111–66.
[11] Treerayapiwat C 2005 Pattern of the habitation and burial activity in the ban rai rockshelter, Northwest Thailand *Asian Perspectives* **44** 231-45.
[12] Coates, K.J. 2009 Mystery of the Log Coffin Culture. In: Archaeology. p 49-54. www.archaeology.org.
[13] Grave, P. J. S, Barrbetti, M. and Hotchkis M. 1994 Dating of log coffins of Northwestern Thailand *IPPA Conf.* 5-12.
[14] Wannasri, S., Pumijumnong, N. and Shoocongdej, R. 2007 Tek log coffin head styles in Northern Thailand: time sequencing with dendrochronology *Science Asia* **33** 47-56.
[15] Shooecongdej, R. 2001 *Progress Report I*. Presented in: Thailand Research Fund.
[16] Shooecongdej, R. 2003. *Progress Report III*. Presented in: Thailand Research Fund.
[17] Bellwood, P., Viet, N. V., and Liem, B. V. 2007 Ancient boats, boat timbers, and losked mortise-and-tenon joints from bronze/iron-age Northern Vietnam *The International Journal of Nautrical Archaeology* **36** 2-20.
[18] Tenazas, R. C. P 1973 The boat-coffin burial complex in the Philippines and its relation to practices in Southeast Asia *The Phillippine Quarterly of Culture and Society* **1.**
[19] Harrisson, T. 1975 Early dates for "scated" burial and burial matting at niah caves, Sarawak *Asian Perspective* **18** 161-165.
[20] Bellwood, P. 1988 Archaeological research in South-Eastern Sabah *Sabah Museum Monograph* **2** 111-253.
[21] Yunus, S. 2009 Ekskavasi arkeologi di gua Batu Tulug, Kinabatangan dan sumbangannya kepada zaman prasejarah di Sabah dan Sarawak *Jurnal Arkeologi Malaysia* **22** 21-34.
[22] Yunus, S. 2015 Tradisi pengebumian keranda kayu balak di Sabah dari perspektif etnoarkeologi (Malaysia: Universiti Pendidikan Sultan Idris).
[23] Chia, S., and Koon, P. 2003 Recent discovery of an ancient log coffin in Semporna, Sabah *Sabah Society Journal* **20** 35-43.
[24] Chia, S. and Molijol, P. 2010 Kajian keranda kayu balak di Kinabatangan, Sabah *Jurnal Arkeologi Malaysia* **23** 54-69.
[25] Chia, S. 2008 Prehistoric sites and research in Semporna *Bulletin of Society for East Asian Archaeology* **2** 1-7.
[26] Chia, S. 2012 Pengebumian keranda kayu balak di Kinabatangan, Sabah (Pulau Pinang: Universiti Sains Malaysia).

[27] Ramli, Z. et al 2011a Scientific analysis of ancient bricks at bukit Pendiat temple (site 17) and Pengkalan Bujang temple (site 23): a comparative study *Research Journal of Applied Sciences* **6, 7** 473-478
[28] Ramli, Z. et al 2011b X-ray diffraction and X-ray fluorescent analyses of prehistoric pottery shards from Ulu Kelantan *American Journal of Applied Sciences* **8, 12** 1337-1342.
[29] Ramli, Z. et al 2018 XRD and XRF Analysis of the ancient bricks from Candi Kampung Baru, Kedah *Planning Malaysia* **16** 314-323.
[30] Fagan, B. 1985 In The Beginning, an Introduction to Archaeology (California: Harper Collins College Publisher) 138-143.
[31] Faisal, W. et al 1991 Penerapan metode penanggalan radiocarbon dating dengan cara pembakaran kering Presented in: Pertemuan dan Presentasi Ilmiah Penelitian Dasar Pengetahuan Clan Teknologi Nuklir, PPNY-BATAN, Yogyakarta.
[32] Muneki, M. 1991 Radiocarbon meauserement and 14c ages of holocene deposits in the eastern margin of the West Osaka area, Southwest Japan *Journal of Geosciences, Osaka City University* **34** 75-84.
[33] Arnold, J. R. and Libby, W. F. 1949. Age Determinations by Radiocarbon Content: Checks with Samples of Known Age, *Science* 110, 678–680.
[34] Kruyt, A.C. 1923-24. De Toradja's van de Sa'dan, Massoeppoe en Mamasa. In: *Bijdragen tot de Taal – Land-en Volkenkunde van Nederlandsch Indie*. LXIII, hlm. 81- 259. (Amsterdam: 's Gravenhange).
[35] Nooy-Palm, H. 1979. The Sa'dan Toraja, A Study of Their Social Life and Religion. *Vol.1: Organisation, Syimbols and Beliefs*. KITLV, Verhandelingen, 87. (The Hague: Nijhoff).
[36] Koubi, J. 1982. *Rambu Solo', 'Lafume Descend': La Culte des Morts Ches Les Toraja du Sud*. Paris: Centre de Documentation et de Recherches sur l'Asie du Sud-est et le Monde Insulinden.
[37] Tangdilintin, L.T. 1980 *Toraja dan Kebudayaannya,* Cetakan IV. (Tana Toraja: Yayasan Lepongan Bulan).
[38] Duli, A. & Hasanuddin (ed) 2003 *Toraja Dulu dan Kini*. (Makassar: Pustaka Refleksi).
[39] Buijs, K. 2009 *Kuasa Berkat Dari Belantara dan Langit, Struktur dan Transformasi Agama Orang Toraja di Mamasa Sulawesi Barat*. (Makassar: Ininnawa).