

Iron materials from Shipwrecks—the iron as traded goods of Song-Yuan period in China

ISHIGURO Hisako 石黒 ひさ子

Visiting Researcher for Research Institute of Ancient Japanese Studies, Meiji Univ.

(明治大学日本古代学研究所客員研究員)

ABSTRACT

Iron is present in the traded goods of Song-Yuan period in China. In the shipwreck survey in China and Southeast Asia, iron bars and iron pots have been discovered as cargo on trade vessels. There are also iron bars in the Middle Ages of Japan. There are also iron bars being used during the Middle Ages of Japan, with some of these iron bars preserved in some archaeological sites. There is a view that these iron bars found in Japan are locally produced. But some researchers suggest it may have been imported from other places, such as China. Iron Bars also were discovered in Nanhai I shipwreck (Chinese: 南海 I 号), Huaguang Reef 1 shipwreck (Chinese: 華光礁一号) and several other ones around the South China Sea. These iron bars found on the aforementioned shipwrecks are very similar to the Iron Bar found in Japan.

The ironware found on the shipwreck (10th-13th Century) in Southeast Asia, especially in the Java region, was mainly iron bars as raw material and iron pots. Historical documents include descriptions of iron products exported from China. According to the description, there are two types of concrete shapes of iron products: "bar-shaped" and "pot-shaped". In Chunxi Sanshan-zhi (Chinese: 淳熙三山志), the local gazetteer of Southern Song Fuzhou (Chinese: 福州), there is a decree restricting the export of iron in the third year of Qingli (Chinese: 慶曆三年, 1043). This decree prohibited the export of ironware other than agricultural tools, pots and pans. Conversely, it can be interpreted that export is possible as long as it is in the shape of agricultural tools or pots and pans. Iron Bars are similar in shape to the "harrow teeth" of agricultural tools. This is the reason why the iron products from shipwrecks have "Iron Bars" and "Iron pots".

In this paper, the iron materials of Nanhai I and the iron material of shipwrecks in Southeast Asia such as Cirebon Wreck, Intan Wreck, Pulau Buaya Wreck, Java Sea Wreck, are compared and examined. The purpose of such comparison is to recognize the significance in their similarities and differences, and to propose issues related to the sourcing and usage of iron materials found from the shipwrecks.

KEYWORDS: Iron bars, Traded goods of Song-Yuan period, Iron, "Harrow teeth"

LIST OF FIGURES AND TABLES

Table 1. The iron artifacts from Nanhai I.

Table 2. Iron artifacts of select shipwrecks

Figure 1. The iron bars from Nanhai I

Figure 2. Iron bars of Saida Site

1. INTRODUCTION

Iron was traded in the South China Sea during the Song and Yuan dynasties. It was referred to in literature as "鐵" (iron), "鐵器" (ironware), "鐵塊" (iron ingots), as well as "鐵鼎" (iron cauldrons), "鐵鍋" (iron pots), "鐵針" (iron needles), "鐵條" (iron bars), and "鐵線" (iron wires) in Chinese. From these references, it is understood that there were two types of iron traded in the South China Sea: ironware in the shape of pots, and ironware in the form of bars. In recent years, iron pots and bar-shaped iron have been found among the cargoes of sunken ships in China and Southeast Asia.

Bar-shaped iron artifacts have also been found in medieval Japan. These are believed to be the form of iron collected as taxes in Japan during the 10th to 11th centuries (T.Fukuda 1983, 163-189). However, the similarity between these bar-shaped iron artifacts and those found in sunken ships suggests that there may have been imports of iron materials from China as well (Y. Momosaki 2008, 1-53).

Details of ironware have been revealed through the report on the sunken ship Nanhai I, which dates back to the Southern Song Dynasty. The bar-shaped iron artifacts found there are about 20 centimeters in length and bear a striking resemblance to the "bar shaped ironware" found in Japan.

During the Song Dynasty, there were laws prohibiting the export of iron, and the local gazetteer of Fuzhou, "Chunxi Sanshan Zhi"(Chinese: 淳熙三山志) , records a law that restricted iron exports in the third year of Qingli (Chinese: 慶曆三年, in year1043). The existence of such laws suggests that there were restrictions on the outflow of iron due to the high volume of iron exports. This law prohibited the export of ironware other than agricultural tools and pots. In other words, it can be interpreted that exports of iron in the form of agricultural tools or pots were allowed. The bar-shaped iron products found in sunken ships resemble the shape of the "teeth of a horse plow," which can be considered as an agricultural tool. This means that they can be considered as "agricultural tools." The presence of both bar-shaped iron and pots in the cargoes of sunken ships indicates that iron pots and bar-shaped iron were exported as materials, rather than finished products, which was in compliance with the law of the time.

In this paper, we will start with analysing the iron artifacts found on Nanhai No.1 shipwreck. Then, we will proceed to comparing the iron artifacts with those found in other South East Asian shipwrecks such as Cirebon Wreck, Intan Wreck, Pulau Buaya Wreck and Java Sea Wreck. Several arguments will be proposed as the paper compare the similarities and differences of these iron materials. The paper will arrive at some tentative conclusion which deems further studies.

2. NANHAI I AND ITS IRON ARTIFACTS

Nanhai I is a sunken ship from the Southern Song Dynasty that was discovered in the waters near the border of Taishan City (台山市) and Yangjiang City(陽江市) in Guangdong Province, China, in 1987. This ship was a trading vessel from the late 12th century. The remaining length of the ship's hull is 22.1 meters, with a width of 9.35 meters. It is categorized as a junk ship with 15 cargo holds confirmed vertically, and is deemed typical of Chinese trade ships (National Center of Underwater Cultural Heritage 2018, 110-159).

Nanhai I was loaded with a large amount of iron artifacts. It has been reported that as of December 2017, 80 tons of iron artifacts have been confirmed through excavations, and it is estimated that there may have been over 100 tons of iron artifacts on board, including the previously excavated concretions (T.Li 2018, 66-71). This is consistent with historical records of iron being an export commodity from China during the Song and Yuan dynasties. However, the quantity of iron artifacts, exceeding 100 tons per trading ship, requires a re-evaluation of the influence of Chinese iron trade on foreign trade, as it is even greater than previously imagined. Several data have already been reported on the iron artifacts from Nanhai I . According to reports from 2014 to 2015, iron artifacts were found throughout the entire ship, and it has been confirmed that the iron artifacts were placed on top of ceramic artifacts (National Center of Underwater Cultural Heritage 2018, 496-502). The quantities of iron artifacts reported are as follows (Table 1).

Table 1. The iron artifacts (iron bar and iron pot) from Nanhai I .

*Created with reference to (National Center of Underwater Cultural Heritage 2018, 157- 420).

Iron Bar	NO.	weight (g/kg)	length	Thick (max)	Thick(min)
Iron bar-A					
Sample 1	N28	402.87 g	30.6 cm	1.4 cm	1.1 cm
Sample 2	N15—43	281.1 g	20 cm	1.9 cm	1.5 cm
Iron bar-B					
type-B-a					
Sample 1	N28	309.91 g	33.2 cm	2.5cm (top)	
Sample 2	N28	153.071 g	22.87cm	1.7 cm	
type-B-b					
Sample 1	N15—35	306.86 g	25.9 cm	3.8 cm (upper middle)	
Sample 2	N15-35	453.15 g	26.5 cm	3.3 cm (upper middle)	
Iron Bar-C					
Sample 1	N44	456.81 g	24.8 cm		
Sample 2	N44	660.76 g	23 cm		

Iron pot	NO.	weight	caliber	height	thick
Iron pot-A	N28	3.56 kg (Total of 2 pots)	22 cm	7.3 cm	0.2 cm
Iron pot-C	N39	13.36 kg (Total of 14 pots)	28.5 cm	7.7 cm	0.2 cm
Iron pot-B	N58-29	71.86 kg (Total of 20 pots)	40 cm	14.3 cm	0.4 cm



Figure 1. The iron bars from Nanhai I shipwreck.

*image source: plate7-55 (p.498), plate7-58 (p.499), plate7-62 (p.500)
from (National Center of Underwater Cultural Heritage 2018).

The iron artifacts include "iron bars" and "iron pots". The iron bars from Nanhai I is generally bundled with ropes made of bamboo or rattan, with 35 to 45 bars being the basic configuration, and some of them are wrapped in mat-like materials. The forms are classified into three categories: A-shaped bars, B-shaped curved bards, and C-shaped wedge-shaped bars (Figure 1). In addition, knife-shaped iron

artifacts have also been confirmed. The iron pots are classified into three categories: A-handled pots, B handleless flat pots, and C-handleless deep pots.

Data from chemical analysis of the iron indicate that the iron bars is wrought iron based on its carbon content, while the iron pots are cast iron based on their sulfur content, which indicates the possibility of iron smelting using coal (W.Liu 2011, 145- 146; J.Wan 2016, 46-51; T.Li 2018, 66-71). Some of the iron pots from Nanhai I have sulfur contents exceeding 0.4%, indicating iron smelting using coal. On the other hand, some pots have sulfur contents of around 0.2% or less, and some have sulfur contents of less than 0.1%. The sulfur content of the iron bars is less than 0.1%. From this, it can be inferred that the iron artifacts on board Nanhai I consist of both cast iron produced using coal and cast iron produced using wood charcoal. As for the ceramic artifacts, it is clear that the ceramic artifacts on board Nanhai I were collected from multiple production sites of kilns such as Jingdezhen (Chinese:景德镇), Longquan (Chinese:龍泉), Dehua (Chinese:德化), Cizao (Chinese:磁灶), Minqing-yiyao (Chinese:閩清義窯), etc, (National Center of Underwater Cultural Heritage 2018, 157-420). It is also likely that the iron artifacts were collected from multiple sources, similar to the ceramic artifacts.

In addition to Nanhai I, ironware has also been unearthed from South East Asian wrecks such as the Cirebon Wreck, Intan Wreck, Pulau Buaya Wreck, and Java Sea Wreck. We will consider these next.

3. SHIPWRECKS AND THEIR IRON ARTIFACTS

There is no evidence of iron as a commodity from shipwrecks such as the Takashima (Japanese: 鷹島) Underwater Site in Japan or the Sinan (in Chinese Characters: 新安) Shipwreck in Korea (M.Osawa 1996, 97-103; J. Kimura 2010, 50-55). However, there are several instances of ships carrying large quantities of iron as cargo in the Southeast Asian region, particularly in the Java Sea area. According to Derek Heng's list, shipwrecks such as the Cirebon Wreck (late 10th century), Intan Wreck (late 10th century), Pulau Buaya Wreck (12-13th century), Java Sea Wreck (early 13th century), Brunei Wreck (15th-16th century), Vung Tau Wreck (1690s), and Ca Mau Wreck (1730s) are known to have contained iron items (Table.2, D.Heng 2018, 1-29). Although Derek Heng's list does not mention iron items as cargo, iron pots have been identified on the Tanjong Simpang Mangayau Wreck, a shipwreck dating to the Northern Song period (960-1127) (Y.Meng 2018, 11-26).

Table 2. Iron Artifacts found on selected shipwrecks. Information retrieved from D. Heng, 2018.

***Created with reference to (D.Heng 2018.1-29)**

Name of shipwreck	Time	Type of vessel	Iron artifacts in freight
Cirebon Wreck	Late 10th century	Southeast Asian (dowel and peg fasteners)	Iron bars and iron pots
Intan Wreck	Late 11th century	Southeast Asian (lashed-lug hull)	Chinese iron rods and blades
Pulau Buaya Wreck	12th-13th century	Unknown	iron bars and woks
Java Sea Wreck	early 13th century	Southeast Asian (Bornean ironwood dowels; lashed-lug hull)	200 tons of Chinese iron
Brunei Wreck	15th-early 16th century	Southeast Asian Hybrid	iron bars
Vung Tau Wreck	1690s	Chinese Lorcha (Chinese-European hybrid; built in China)	cast iron pans and cauldrons
Ca Mau Wreck	1730s	possibly Southeast Asian Hybrid (hull constructed of Dipterocarpus timber)	iron pans

The age of the ships from the Cirebon Wreck, Intan Wreck, Pulau Buaya Wreck, and Java Sea Wreck is from the Song-Yuan period in China. Iron bars and iron pots were found in the Cirebon Wreck. The Cirebon Wreck contained iron bars that were packaged in a manner similar to the iron bars found on the South China Sea Shipwreck, with about 50 bars bundled together with plant fibers. The iron items were mostly located in the lower part of the ship, with Chinese ceramics placed on top of them (H.H. Liebner 2014, 203-206). The iron items from the Intan Wreck were believed to be of Chinese origin, and they included conical-shaped iron bars (about 30 cm long) that were packaged, as well as cylindrical-shaped iron bars and cast iron items such as a 21 cm diameter iron pot (F. Michael 2002, 85-86). The shape and packaging method of these iron items were similar to those found on the Nanhai I.

The Pulau Buaya Wreck also contains iron objects believed to be of Indian origin, such as iron lamps, as well as cast iron pots with a diameter of 29 cm and iron bars packaged in bundles, which are also similar to the iron bars from the Nanhai I (R.Abu 1998, 84-87).

In the Java Sea Wreck, iron bars and iron pots were also found, believed to be of Chinese origin. The iron objects were mostly located in the lower part of the ship. The iron bars were packaged in woven materials such as rattan strings and hemp cloth, as well as in cone-shaped bundles about 40 centimeters long, which have the characteristic of being coated with white lime compound. The iron pots from the Java Sea Wreck come in three sizes with diameters of about 32 centimeters, 51 centimeters, and 70 centimeters.

The iron pot is made of cast iron, and since China excels in the production of cast iron, these iron pots are considered to be Chinese products. In the cargo arrangement of the Java Sea Wreck, it was confirmed that the iron pots and iron bars were located below the ceramics (M.W.Matters 1997, 77-80, 95-102).

Iron bars packaged in a conical shape have been found in common at both the Intan Wreck and Java Sea Wreck. Additionally, iron bars packaged in the same conical shape have also been found in the waters of the Paracel Islands at the Huaguang Reef 1 shipwreck. The Huaguang Reef 1 shipwreck is estimated to be from the early Southern Song Dynasty (first half of the 12th century) and is considered to be the earliest Chinese trade ship in the South China Sea (Y.Meng 2018, 11-26).

What would have been the mounting position of the iron artifacts found on the sunken ship? In the case of the Nanhai I, the iron artifacts were located in the middle layer of the ship's cargo. Beneath the iron artifacts were ceramics. On the other hand, in the Cirebon Wreck and Java Sea Wreck, the iron artifacts were located in the lowest part of the ship. Chinese ceramics were placed above the iron artifacts. The Nanhai I was a type of Chinese junk ship, while the Cirebon Wreck and Java Sea Wreck were of Southeast Asian style. The positions of iron artifacts and ceramics differed between the Nanhai I and the Cirebon Wreck and Java Sea Wreck. This suggests the possibility that Chinese trade goods originating from China were transferred from Chinese ships to Southeast Asian-style ships in the Java Sea region.

Nanhai I iron artifacts are exports from China. Chinese ironware has also been found in shipwrecks in Southeast Asia. Their form is iron bar or iron pot. Of these, rod-shaped iron will be examined next.

4. APPROACHES TO THE PROBLEM OF "IRON BARS"

It can be confirmed in historical documents that iron products were included in exports from China during the Song and Yuan dynasties. Using the descriptions from "Zhufan zhi" (Chinese : 諸蕃志)

written around 1225, "Zhenla-fengtuji" (Chinese: 真臘風土記) written around 1296, and "Daoyi-zhilüe" (Chinese: 島夷誌略) written during the Yuan Dynasty (1341-1370), Shigemitsu Sasamoto (Japanese: 笹本重己) confirms that China during the Song-Yuan period was exporting ironware (S. Shigemitsu 1952, 131-144). Based on records by the Arabian scholar Edrisi from the 12th century and Dimashki from the 14th century, which stated that Chinese iron was being imported to the Arabian Peninsula, Ichisada Miyazaki (Japanese: 宮崎市定) inferred that iron had become an important export product in China. Using "Daoyi zhilüe," Miyazaki compiled a list of country and place names that imported iron products (I. Miyazaki 1957, 441-454).

The list compiled by Miyazaki shows that the specific shapes of iron products for export mentioned in the literature were iron bars and iron pots. Iron objects found in sunken ships such as Nanhai I and those in Southeast Asia were produced in China and were in the form of iron bars and iron pots, which supports the descriptions in the literature. These physical objects serve as evidence supporting the written records.

Iron products excavated from medieval Japanese ruins have a shape similar to "Iron bars," and Yoshiro Momozaki (Japanese: 桃崎祐輔) suggests that these items were imported from China or Korea (Y. Momozaki 2008, 1-53). For example, at the Saida (Japanese: 才田) site in Asakura (Japanese: 朝倉) City, Fukuoka (Japanese: 福岡) Prefecture, a total of 12 iron products were discovered, including a well-preserved 20cm iron bar (Figure 2), which is similar to the iron bars found in the Nanhai I and Huaguang Reef 1 (Y. Momozaki 2023, 1-24).

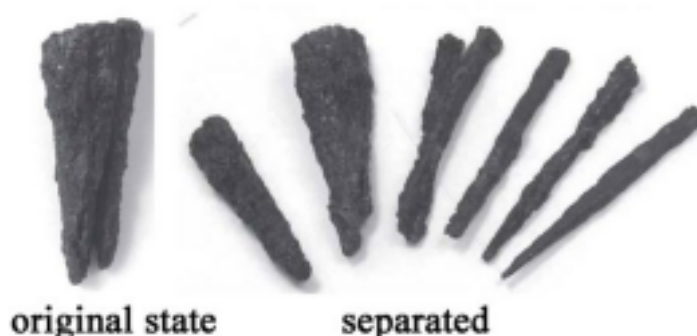


Figure 2. Iron bars of Saida Site *image source: plates from (Y. Momozaki 2023, 1-24).

However, there is debate over how these "Iron bars" were used in Japan. Kazuyuki Matsui (Japanese: 松井和幸) argues that these iron bars could be the teeth of a "harrow" and that some harrow had iron teeth attached to wooden frames. In this discussion, viewing the iron bars as teeth of a horse plow is a very suggestive perspective (K. Matsui 2004, 76-93).

There is information in the "Chunxi Sanshan-zhi," which is a local gazetteer of Southern Song Fuzhou (Chinese: 福州), about the specific iron production situation in the Southern Song Dynasty. Sanshan is another name for Fuzhou, and "Chunxi Sanshan Zhi" is compiled during the Chunxi (Chinese: 淳熙) years of the Southern Song Dynasty (1174-1189). The following description can be found in Volume 41, "Local Products and Iron":

「慶曆三年、發運使楊告乞下福建嚴行禁法。除民間打造農器、鍋釜等外、不許私販下海。」

In the third year of Qingli, the envoy Yang Gao proposed strict enforcement of iron prohibition in Fujian, prohibiting private sales and exportation of iron goods, except for agricultural implements,

pots, and kettles made by the common people.

This Qingli Third Year (1043) decree prohibits the circulation of iron goods, except for agricultural implements and cooking pots, which are daily necessities. The large number of "iron pots" confirmed in the iron products found in shipwrecks is consistent with this decree.

Regarding "iron bars," as mentioned above, there is a debate that the iron bars excavated from Japan during the medieval period are the "teeth of a harrow." Iron bars found in Japan have a similar shape to those found in Nanhai I and Huaguang Reef 1. The decree of Qingli Third Year stated that ironware, including agricultural tools, could be traded. "The teeth of a harrow" refers to agricultural tools, meaning that iron bars were iron intended for circulation and export using the shape of harrow teeth. However, it is highly likely that they were actually made from raw materials of iron. In the decree of Qingli Third Year, the exclusion of agricultural tools and cooking utensils was actually important. The shape of the iron artifacts found in shipwrecks from the Song and Yuan dynasties, such as iron bars or iron pots, can be attributed to this decree. The large quantities of iron bars or iron pots found in sunken ships were in the shape intended to circumvent regulations that restricted the circulation and export of iron. These iron bars or iron pots were export products and were likely made from iron as raw material.

5. CONCLUSION

Artifacts from shipwrecks related to the South China Sea trade, including Nanhai I, contain a large quantity of iron products. This indicates that iron production in China during the Song and Yuan dynasties had a wide export market through maritime trade. The forms of iron artifacts in wrecks are iron bars or iron pots. Its form is related to Chinese law. This was because the iron that could be exported from China was limited by law to pots and farm tools. Iron bars have the potential to be raw iron for export using the shape of agricultural tools. Similarities can also be observed between the iron artifacts found in Japan from the same period, such as iron bars, and those discovered in shipwrecks in the Java Sea region. These shipwrecks in the Java Sea are geographically linked to trade involving Java Island, which, like Japan, had limited iron ore resources but was known for its abundant sulfur production. It is believed that the Nanhai I alone contains around 100 tons of iron artifacts, although only a small portion of the findings has been publicly released. The data on iron bars in Japan and shipwrecks in Southeast Asia is still not sufficient. However, they make it possible to demonstrate that a large amount of iron was being produced in China for export purposes. To achieve this, more information will be added in the future and comparisons between regions will be conducted.

BIBLIOGRAPHY

R.Abu, and E. E. McKinnon. *The Pulau Buaya Wreck: Finds from the Song Period*. Jakarta: Ceramic Society of Indonesia, 1998.

D. Heng"Ships, Shipwrecks and Archaeological Recoveries as Sources of Southeast Asian History."In David Ludden .ed. *Oxford Research Encyclopedia of Asian History* New York: Oxford University Press,Online Publication Date: 2018.

H.Ishiguro(石 黒ひさ子) "Iron materials of Nanhai I Wreck"令和 2～4 年度科学研究費助成事業(基盤(C))「日中文明遺物の産地探索をめざす中近世沈船・船載遺物と自然科学の融合研究」,福岡大学人文学部考古学研究室 2023, 57-76.

J. Kimura / 木村淳"Iron nails recovered from the plank of the Shinan shipwreck." In J. Kimura.ed. *Shipwreck ASIA:Thematic Studies in East Asian Maritime Archaeology*, Maritime Archaeology Program Flinders University,2010: 50-55.

T.Li/林唐欧"「南海 I 号」船載鉄器初探."遺産与保護研究 3, no. 8 (2018):66-71.

T.Fukuda/福田豊彦"文献資料より見た古代の製鉄"古代日本の鉄と社会.東京鉱業大学製鉄史研究会,平凡社1982:163-189

H. H. Liebner "*The Siren of Cirebon A Tenth-Century Trading Vessel Lost in the Java Sea*" PhD dissertation, University of Leeds, 2014.W.Liu/劉薇,張治国,李秀輝,馬清林"中国南海三处 古代沉船 遗址出水 铁器 凝结 物分析."中国国家博物馆刊 91, No.2 (2011) :145-156.

M.W.Matters and M.Flecker.ed. *Archaeological Recoveryof the JAVA SEA WRECK*.Pacific Sea Resources.1997.

F. Michael. The Archaeological Excavation of the 10th Century: Intan Shipwreck. Vol. 1047. British Archaeological Reports, 2002.

K.Matsui/ 松井 和幸"馬鉄の起源と変遷"考古学研究 51, No.1 (2004).

K.Matsui/松井和幸.鉄の日本史.Tokyo:筑摩書房,2022 Y.Meng/孟原召"華光礁一号沈船与宋代南海貿易"博物院 (2018-No.2)

I.Miyazaki/ 宮崎 市定"支那の鉄について"史 林 40, No.6 (1957): 44-454.

Y.Momosaki/桃崎祐輔"中世棒状鉄素材に関する基礎的研究."七隈史学 No.10(2008): 1- 53.

Y.Mmosaki/桃 崎祐 輔"Study on bar-shaped iron materials excavated from medieval ruins",令和 2～4 年 度科学研究費助成事業(基盤(C))「日中文明遺物の産地探索をめざす中近世沈船・船載遺物と自然科学の融合研究」,福岡大学人文学部考古学研究室 2023,1－24.

National Center of Underwater Cultural Heritage, Guandong Provincial Institute of Cultural Relics and Archaeology Chinese Academy of Cultural Heritage ,Guandong Museum, Maritime Silk Road Museum of Guangdong.ed. *Archaeological Report on Nanhai I shipwreck Series II :Excavation of 2014- 2015*Beijing:Cultural Relics Press,2018.国家文物局水下文化遺産保護中心、広東省文物考古研究所、中国文化遺産研究院、広東省博物館、広東海上絲綢之路博物館編著『南海 I 号沈船考古報告之二—2014～2015 年発掘』文物出版社、2018

M.Osawa/大澤正己"鷹島海底遺跡出土木製碇使用円形頭釘の金属学的調査",鷹島町教育委員会 ed. 鷹島海底遺跡 III,1996:97-103.

M.Sasaki 佐々木稔"中世 鉄研究の現状と課題"七隈史学 No.9(2008):127-150.

S.Sasamoto/笹本重己"広東の鉄鍋について:明清代における内外販路"東洋史研究 12, No.2(1952):131- 144.

J.Wan/万 鑫,毛志平,張治国,李秀輝"「南海 I 号」沈船出水鉄鍋、鉄釘分析研究."中国文物科学研究 No.2 (2016):46-51.