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## Case report

## Trade ornaments as indicators of social changes resulting from indirect effects of colonialism in northeastern Taiwan

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## A B S T R A C T

Long-lasting indirect impacts on Indigenous peoples in the periphery of colonial control are poorly understood, especially in East Asia. Trade ornaments from Kiwulan (1350–1850 CE) in northeastern Taiwan show indirect impacts of European colonial activities on local societies. The diversity of ornaments was greater during the period of European presence compared to previous periods, and their spatial distribution was more clustered in the residential area. The change reflects an increased use of ornaments and an uneven distribution of ornaments in a pericolonial context. This may hint at increased social inequality resulting from European colonial influence. Trade ornaments give insights into the increased social inequality stimulated by a European colonial presence, and show the agency of Indigenous people to incorporate ornaments into their social system.

## 1. Introduction

The direct impacts of European colonialism on Indigenous communities in East Asia were much less conspicuous than in island Southeast Asia and Oceania. Direct European colonial rule throughout East Asia was rare and limited, and the question of long-lasting indirect impacts on local Indigenous communities remains largely unanswered. Understanding these indirect effects is important for detecting colonial impacts on Indigenous peoples in the periphery of colonial control (Acabado, 2017; Trabert, 2017). In many parts of the world, the introduction of foreign trade goods by colonial traders into local Indigenous societies caused substantial transformations of Indigenous economic, cultural, and socio-political systems (Dietler, 2005; Dietler, 1997; Junker, 1993; Silliman, 2005). Consumption patterns of foreign goods can give insights into negotiations between colonized and colonizer, and the resistance and accommodations of Indigenous people through their daily cultural practices (Dietler, 2015; Given, 2004; Mullins, 2011; Scaramelli and De Scaramelli, 2005; Silliman, 2001; Torrence and Clarke, 2000; Voss, 2005). Northeastern Taiwan is an ideal context to study pericolonial influence because although there was a prominent Spanish and Dutch colonial presence in parts of Taiwan, the northeastern region was isolated from intensive direct contact by the Xueshan Mountains.

This article describes personal ornaments excavated from the upper component of Kiwulan (1350 CE–1850 CE), the largest Iron Age settlement on the Yilan plain in northeastern Taiwan. Ornaments are found at many Iron Age sites in Yilan, but only Kiwulan shows clear stratigraphic contexts from pre-European period to modern time. The first recorded European presence in Yilan was a Spanish revenge attack on Indigenous villages in 1632 (Borao, 2001: 163). In 1647 the Dutch

attacked villages and forced them to accept colonial rule and pay an annual tribute without strict enforcement of colonial power that allowed flexibility for Indigenous people in Yilan (Andrade, 2007; Kang, 2016). According to Dutch census reports in 1650, Kiwulan was the largest Indigenous settlement in the plain, with a population of 840 adults (Nakamura, 1938: 12). Following defeat of Dutch by the Chinese general Koxinga in 1661–1662, the Dutch abandoned northern Taiwan. Direct contact with Han Chinese is indicated by Qing dynasty census reports mentioning Yilan villages in 1821 (Yao, 1996).

One of the most commonly traded types of object in this region were ornaments such as glass and stone beads (Chen, 2007; Li and Chiu, 2014; National Museum of Taiwan History, 2005). Personal adornments in the archaeological record are useful as signal of an individual's status (Joyce, 2005; Scaramelli and De Scaramelli, 2005). The consumption of stone beads in Southeast Asia during Iron Age is often associated with increasing social inequality or socio-political complexity (Bellina, 2014; Carter, 2016; Francis, 2002; Theunissen et al., 2000; Kenoyer, 2000). In this paper, we explore archaeological ornaments from Kiwulan spanning the pre-European contact period, period after the Spanish and Dutch presence, and the following period after the Chinese presence. We address the question of whether indirect colonial influences on the local Indigenous populations can be detected through the ornament assemblages.

## 2. Ornaments in exchange networks during the late Iron Age and early historical period

The island of Taiwan lies at the junction of mainland China, Southeast Asia, and Northeast Asia in the Pacific Ocean. The prehistory

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of Taiwan can be roughly divided into three major periods, Palaeolithic (c. 27,000–5000 BP), Neolithic (c. 6500–2000 BP), and Iron age (c. 2000–400 BP) with slight regional differences in the onset of each period and variations in style of artifacts and assemblages (Chen, 2017; Liu, 2011). It is generally accepted that Taiwan entered the historical period in the early 17th century due to the colonial activities of the Spanish and the Dutch who played an important role in keeping written records about Taiwan. The European colonial presence in Taiwan ended in 1662 when the Dutch were defeated by the kingdom of Tungning, founded by Koxinga from China. Later in 1683, Taiwan was incorporated into the Qing dynasty in China and a large wave of Han Chinese migrated to Taiwan during the late 18th century. Because of natural safe harbors, northeastern Taiwan was involved in a regional trade network through cross-culture interactions with Chinese merchants since the 14th century, and later global trade networks with Europeans in the 17th century brought more trade goods circulating in Southeast Asia into Taiwan (Chen, 2005; Liu and Wang, 2017). Although located on the periphery of regional trade centers, Yilan was connected by sea to trade networks via visits of other Indigenous groups, Chinese merchants, and Europeans.

The European presence in northern Taiwan started with the Spanish who founded Fort San Salvador in 1626 at Heping Dao, Keelung (cf. Berrocal et al., 2020), and Fort San Domingo in 1629 at Tamsui (Fig. 1). They sent missionaries to local Indigenous settlements in this region (Blussé and Everts, 2000: 343) and kept records about their observations of Indigenous communities. A Dominican priest in 1632 reported that the Taparri, an Indigenous tribe from northern Taiwan, exchanged carnelian beads with other Indigenous groups. This form of exchange was widespread and even the Spanish soldiers used carnelian beads as bargaining chips for gambling (Li and Wu, 2006: 132–49). The use of beads as prestige goods is further indicated by their role in bride price payments, and compensation to resolve disputes (Li and Wu, 2006: 132–49). Other records mention that the women shamans in the tribe would use carnelian beads as magical items in ritual healing practices (Borao, 2009: 122–51). Records of an Indigenous funeral describe the use of carnelian beads in ritual contexts, with more carnelian beads, pottery, and cloth placed into the graves of more influential people to indicate their family's higher status (Li and Wu, 2006: 153). While a full critical analysis of these historical accounts remains to be produced, we take them to minimally indicate that carnelian beads were already treated as prestige goods in Yilan before the arrival of Europeans. In 1642, the Dutch Vereenigde Oostindische Compagnie (VOC) defeated the Spanish and took over their forts in northern Taiwan. They introduced a feudal system in an attempt to control the Indigenous communities by asking Indigenous leaders to attend an annual ceremony for demonstrating their loyalty and

paying tribute (Andrade, 2007, ch. 9; Kang, 2016, ch. 4). The Dutch provided beads and other goods based on negotiations with Indigenous communities to secure alliances in the annual ceremony or during their travels (Kang, 2016, ch. 6). We might predict that the activities of the Dutch feudal system to build and maintain alliances resulted in an increase in the amount and diversity of ornaments in northeastern Indigenous communities during this period.

Chinese historical records from 1829, 1837, and 1852 during the Qing dynasty (1616–1911) contain some notes on the purposes of ornaments from Yilan (Chen, 1963: 228, 308; Ke, 1993: 11, 126; Yao, 1996: 77). According to those records, Indigenous people in Yilan wore ornaments in ceremonial contexts to display their wealth and status. Among those ornaments, fish-shaped necklaces made of metal threads had high value due to their delicacy and the exotic materials used in production. These were usually possessed by wealthy people. Other people wore carnelian beads or glass beads on their head or neck to participate in ceremonies. In 1895, at the beginning of the Japanese colonization of Taiwan, an academic field survey for Indigenous groups reported that fish-shaped metal necklaces were not used in Yilan at that time, but elderly people still used beads (Ino, 1996: 227–32). Although these historical records are fragmentary and may contain some biases (Galloway, 2006) that have not yet been studied in detail, we find consistency among multiple sources in their descriptions of how ornaments represent high status or specialized social roles in Indigenous communities in Yilan. Compared to the European period, there are fewer documentary mentions of beads in the Chinese period and the descriptions are limited to clothing, but these generally confirm the role of beads as status markers.

Ornaments found in northeastern Taiwan in the early historical period, including glass beads, stone beads, and metal ornaments, are considered to have been imported from other regions. This is because of a lack of archaeological evidence of beadmaking waste, metalworking, or accessible local raw materials. The chemical composition of glass beads from this region shows a high content of lead and, together with the winding/folding technique, these details suggest a Chinese beadmaking tradition (Cheng, 2008; Gan et al., 2006; Wang, 2018). Although there is a wide variety of metal ornaments such as bells, bracelets, rings, and pendants, the common components of metal ornaments are brass and copper, with a small number made from lead and tin that indicates multiple origins that include Southeast Asia (Chen, 2011). There is no direct evidence showing European delivery of beads, however, a large amount of the glass beads containing gold foil (hereafter, gold-foil beads) at Kiwulan might have been introduced by the Spanish through economic activities because similar beads were found at Luzon, northern Philippines, as part of the trading route of the Spanish between 16–19th century (Wang and Liu, 2007). Both archaeological evidence and

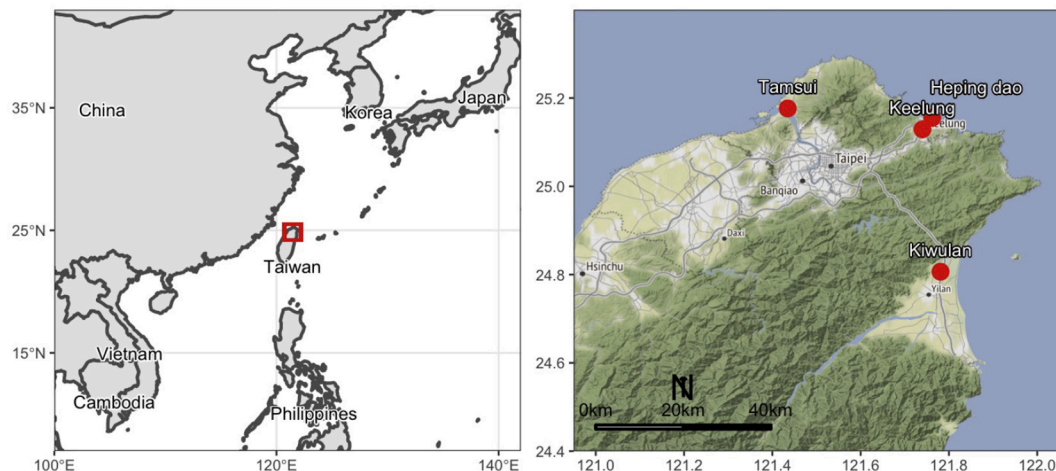


Fig. 1. Map (from Wang and Marwick, 2020) showing the location of Kiwulan, and other places in northern Taiwan named in the text. Map data from [naturalearthdata.com](https://www.naturalearthdata.com).

historical records indicate northeastern Taiwan was involved in regional networks with East and Southeast Asia in the late Iron age. These included Chinese merchants trading metal items, clothes, and beads with local Indigenous people in Taiwan in exchange for local resources. The foreign-made large dark brown glazed stoneware jars frequently found in European shipwrecks were also commonly found from many sites in Taiwan, suggesting direct or indirect interactions. Despite the Chinese origin of some ornaments at Kiwulan, there is compelling evidence that a large amount of ornaments found at 17th century sites resulted from European colonial and economic activities in the region.

### 3. Excavations at Kiwulan in northeastern Taiwan

Archaeological ornaments from Kiwulan (Fig. 1) come from a rescue archaeology project that was conducted between 2001 and 2004 in advance of a water diversion project and road bridge construction. The excavations used 2 mm and 1.5 mm mesh screens and covered eight open area sections in total of 262 squares (4 m by 4 m) reaching 3814 m<sup>2</sup> (Chen, 2007). The nearly 2 m thick archaeological deposits reveal a large amount of artifacts, burials, middens, post-holes, wooden pillars, and stone structures, all of which indicate it was a long-term settlement. Artefact locations were mostly recorded to the 2 × 2 m sub-square they were recovered in. Except for a handful of finds, artefacts lack individual point provenance information. Based on the continuity of deposition and the frequency of artifacts, the center of the site is the open area consisting of the A and D sections, which is also the study area where our samples come from (Fig. 2). In the AD area, post-holes were found aligned in a north-south direction in intervals with construction marks, which have been interpreted as the remains of still house structures. At the north margin of the dwelling place were burials that are mostly oriented in an east-west direction.

#### 3.1. Chronology

Studying change over time at a site like Kiwulan has some distinct challenges. First, the archaeological deposits are relatively thin. This makes it difficult for excavators to clearly identify distinct chronological phase boundaries. In thin deposits, site formation processes can

quickly blur the boundaries or completely mix deposits from different time periods. Second, the time periods we aim to compare are relatively short, just a few human generations. This limits the usefulness of common chronometric methods such as radiocarbon dating, where the age errors are relatively large compared to the periods we are studying. Most of the previously obtained radiocarbon ages from Kiwulan do not span the time period we are investigating here (Fig. 3 and Table 1). Third, pericolonial contexts such as Kiwulan can involve non-Western notions and experiences of time. For example, a Western concept of time seeks clear temporal divides, and may create material signature of this, but Indigenous experiences of time may prioritize continuity and continuums of gradual change, and their material culture traces may reflect that intentional experience of time (Trabert, 2018; Scheiber and Finley, 2012). Despite the relatively short period of the European colonization in Taiwan (38-years-long Dutch occupation and 16-years-long Spanish occupation), the indirect impacts of the Europeans through trade networks could go beyond these temporal boundaries and last longer. This is because the use of foreign goods in many Indigenous societies often goes through processes of negotiations, resistance, and transformation. A static time frame may not capture the processes well (Scheiber and Finley, 2012). Fourth, the circulation of foreign goods that we use as chronological indicators might start earlier than the historically documented European presence in Taiwan. Similarly, the use of the foreign goods in Indigenous societies could continue after the end of the European colonization (Mitchell and Scheiber, 2010). This limits the usefulness of specific artefact types as chronological markers, and implies they have an error range similar to radiocarbon ages. Unfortunately, we do not have a way to accurately estimate these errors at Kiwulan. Ideally, we would divide the deposits at Kiwulan into many time slices to investigate the possibility of a gradual versus sudden change, and assess errors in the accuracy of artifacts as temporal markers. However, this would result in many analytical units with no finds, so we have grouped excavation units together to create minimum sample sizes suitable for addressing our research questions. The details about the distribution of the temporal indicators, accompanied with stratigraphy data, radiocarbon dates, and archaeological contexts for each sampled excavation unit are provided in Supplementary Online Materials.

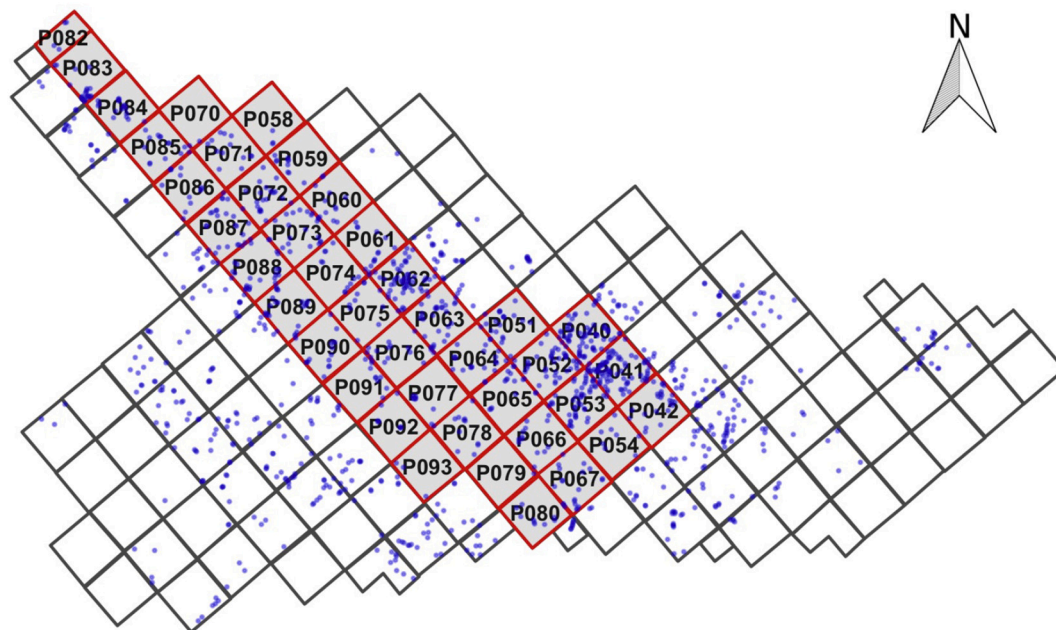
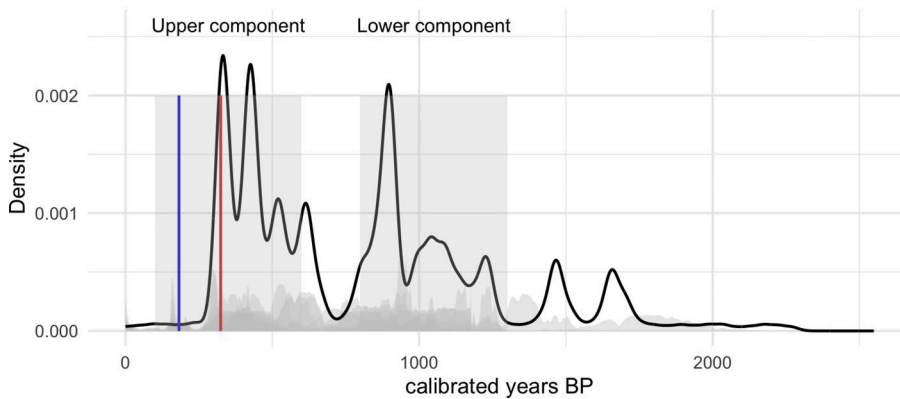


Fig. 2. Map (from Wang and Marwick, 2020) showing the largest section of excavation areas at Kiwulan, and the distribution of forty squares sampled in this paper presented in red with square ID numbers. Small dots represent the locations of post-holes. Each square is 4 × 4 m. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



**Fig. 3.** Summed probability distributions for dates from Kiwulan. The dark line represents the summed probabilities of all radiocarbon ages, and the grey lines in the background are the probabilities of individual ages. Grey rectangles indicate the approximate chronology of the major archaeological components of the deposit. For the upper component, the red line indicates the start of European presence, while the blue line is the Chinese presence. Ages calibrated with the Bchron package (Parnell et al., 2008). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**Table 1**

Radiocarbon ages from charcoal samples excavated from Kiwulan (Chen, 2007), calibrated using IntCal20 Atmospheric curve. All depth is recorded in centimeters above mean sea level. The codes in the context column refer to the excavator's feature labels, cf. Chen, 2007.

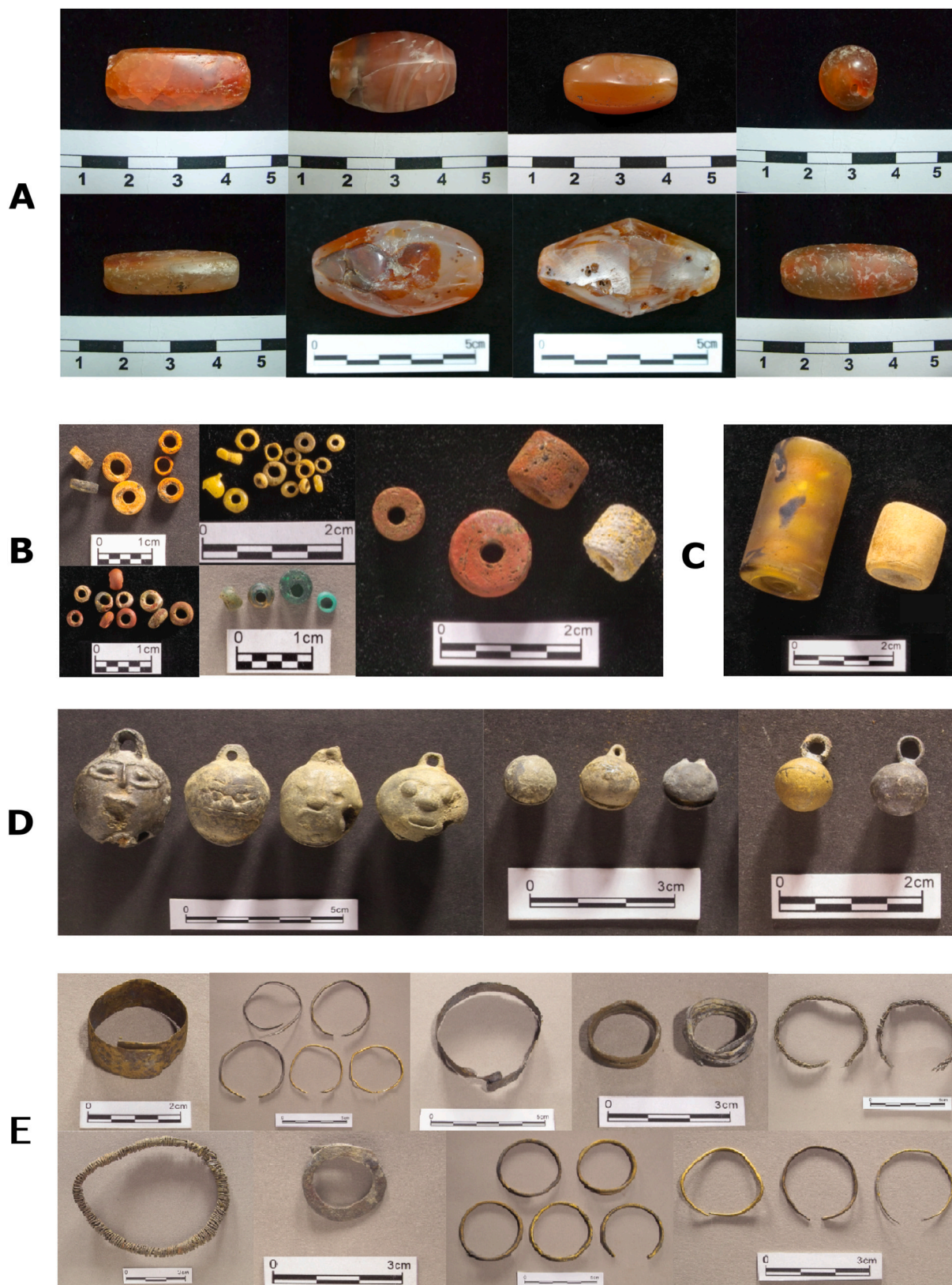
Lab code	Pit-Layer	Depth (cm)	Uncalibrated Age BP	Calibrated Age BP (95% credible interval)	Context
NTU-3803	P052-L7	0 to -10	< 200		artefact-bearing deposit
NTU-3925	P051-L17	-36 to -56	< 200		sterile deposit
NTU-3943	P051-L19	-70 to -90	< 200		sterile deposit
NTU-4283	P063-L12	-30 to -70	< 200		midden H044
NTU-4293	P089-L11	-50 to -70	< 200		artefact-bearing deposit
NTU-4305	P089-L7	-20 to -30	< 200		artefact-bearing deposit
NTU-4322	P051-L11	0 to -40	< 200		midden H026
NTU-4323	P070-L3	20 to -57	< 200		burial M095
NTU-3993	P041-L7	-25 to -45	250 ± 40	4–429	artefact-bearing deposit
NTU-4419	P162-L3	-10 to -110	280 ± 70	11–483	midden H172
NTU-4311	P052-L16	-110 to -130	310 ± 100	15–508	artefact-bearing deposit
NTU-4320	P168-L1	6 to -51	340 ± 100	26–527	midden H193
NTU-4016	P028-L9	-44 to -80	270 ± 40	76–448	burial M020
NTU-4310	P018-L2	-28 to -70	360 ± 100	55–545	burial M039
NTU-3791	P049-L11	-20 to -30	340 ± 30	316–479	artefact-bearing deposit
NTU-4292	P052-L6	4 to -56	510 ± 75	342–644	burial M009
NTU-4304	P066-L11	-40 to -60	600 ± 75	512–670	artefact-bearing deposit
NTU-4423	P144-L5	-10 to -30	610 ± 90	494–700	artefact-bearing deposit
NTU-4315	P248-L5	-100 to -120	800 ± 120	561–946	artefact-bearing deposit
NTU-3926	P041-L9	-70 to -90	900 ± 50	705–914	sterile deposit
NTU-4421	P162-L11	-160 to -180	920 ± 70	698–950	artefact-bearing deposit
NTU-4319	P154-L3	10 to -10	920 ± 105	678–1047	artefact-bearing deposit
NTU-4430	P238-L10	-130 to -150	1020 ± 60	786–1055	sterile deposit
NTU-3788	P028-L15	-130 to -150	1050 ± 40	832–1053	artefact-bearing deposit
NTU-4422	P237-L4	-70 to -90	1030 ± 80	755–1141	artefact-bearing deposit
NTU-4428	P154-L13	-170 to -180	1080 ± 90	794–1229	artefact-bearing deposit
NTU-4427	P246-L8	-160 to -180	1170 ± 70	945–1260	artefact-bearing deposit
NTU-4316	P019-L5	-100 to -120	1190 ± 70	962–1267	burial M066
NTU-3792	P041-L13	-150 to -170	1240 ± 30	1074–1267	artefact-bearing deposit
NTU-4434	P144-L11	-130 to -150	1480 ± 70	1287–1518	artefact-bearing deposit
NTU-4321	P154-L14	-180 to -190	1870 ± 110	1541–2068	artefact-bearing deposit

A first step to outlining chronology of Kiwulan is indicated by the stratigraphy. There is an upper component (1350–1850 CE, 600–100 BP) and a lower component (650–1150 CE, 1200–800 BP) based on 32 radiocarbon ages, previously published by Chen (2007), and shown here in Fig. 3 and Table 1. There is a sterile deposit between these two components spanning c. 150 years that may be related to dry weather, according to pollen analysis, leading to site abandonment (Chen, 2007; Lin, 2015). These component divisions present the differences in the colours and textures of the deposit, and the content of artifacts such as pottery types. Whether these two stratigraphic components suggest a continuity of culture from the same people is still under debate (Chiu, 2004; Chen, 2007). We focus on the upper component because this component spans the periods when local residents interacted with the Europeans and the Chinese. In our study area, all excavation squares demonstrate signs of continuous human occupation throughout the upper component. Previous work divided the upper component into six analytical units, spanning from the 14th century to the 19th century, according to the types of chronologically diagnostic ceramics, excavation depth, consistency of contexts,

and radiocarbon dates (Hsieh, 2009; Wang, 2011). However, to achieve sample sizes suitable for exploring changes in ornament assemblages over time associated with foreign impacts, we assigned the original excavation levels into three phases: before the European contact, after the European presence, and the presence of large Chinese immigrants.

### 3.2. Chronological markers in the artefact assemblages

We made refinements of the original chronology to assign contexts into the pre-European, European, and Chinese periods by following six steps of assigning and evaluating contexts using copies of original excavation records and fieldwork notes. First, for each excavation unit, we assigned the arbitrary excavation layer (mostly 10 cm) to a period based on frequencies of indicators of the European and the Chinese periods. Second, we identified the archaeological context (normally 2–3 layers) that the layer belongs to based on the description of soil colour, texture, and density of potsherds and charcoal. We assumed that a larger population would be reflected by denser distributions of potsherds and charcoal. Third, we



**Fig. 4.** Subtypes of ornament in each major class. A: carnelian beads, B: glass beads, C: gold-foil beads, D: bells, E: metal rings. Photographs are presented in the same order as in Table 2. The photographs of B, C, D, E classes are from the original excavation report (Chen, 2007). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

checked if there are radiocarbon ages associated with the context as a cross-validation. Since most radiocarbon ages represent long time ranges, we did not consider the ages could determine a period by themselves, but

only as a cross-validation. Fourth, we explored any post-depositional issues that might affect the deposition of time indicators to ensure an appropriate assignment based on the fieldwork notes and excavation report. Fifth, we

cross-evaluated all adjacent squares to confirm a consistent and continuous context between them. Sixth, we compared our chronology with the six analytic units classified by previous studies to make a final decision (Hsieh, 2009; Wang, 2011). More detailed data information is provided in our Supplementary Online Materials. After assigning the contexts into three analytical units, pre-European contact, European presence, and Chinese presence, we assigned ornaments to one of these units according to their find context. We did not use the ornaments themselves as temporal markers because many of the ornaments have been found throughout long time periods in Taiwan. Through these six assigning steps and validation rules, we believe our chronology is reasonable and suitable for discussing the indirect colonial impacts led by trade networks.

The primary archaeological indicators of indirect impacts of Europeans at Kiwulan are the high frequencies of light grey glazed jars, known as "An-ping" "安平" jars in China and Taiwan, and large dark brown glazed stoneware jars that were introduced to Taiwan during the early 17th century. Large dark brown glazed stoneware jars may have been made in Southeast Asia, but are frequently found in European shipwrecks from this period as vessels for transporting water, wine or other liquids on long voyages (Cort, 2017; Ketel, 2011). The earliest evidence of light grey glazed jars in this region has been found among the cargo of the Spanish shipwreck *San Diego*, which sunk in 1600 CE (Dizon, 2016; Hsieh, 1995). Southeast China is assumed to be the origin of the light grey glazed jars, however these are commonly found at sites in Taiwan that were associated with European activities, especially at Anping in Tainan, where the Zeelandia fort site is located (Wang and Liu, 2007). The jar shapes found at Kiwulan are typical of those found elsewhere in VOC sites occupied during the 17th century (Berrocal et al., 2018: 917; Cort, 2017: 282; Grave and Mcniven, 2013; Ketel, 2011; Klose and Schrire, 2018: 131). We cannot be sure of the exact process that brought them to Kiwulan: they might have been directly imported by Europeans, by Chinese merchants, or by Indigenous groups via regional networks in northern Taiwan. In any case, the high volume of ceramics transported by Europeans, and their high mobility in the shipping trade played an important role in introducing foreign jars to Taiwan.

Those jars were widely distributed across the site and can serve as indicators, together with the radiocarbon dates, to identify the excavation units associated with the pre-European period and the start of European influence at Kiwulan. In addition to stoneware jars as indicators of European presence, around 300 pieces of locally made clay pipes and a few imported pipes were found at Kiwulan. Smoking is likely to have been introduced by Europeans. This custom was widely adopted in many European countries in the 16th century and spread to other regions (Uçar, 2019). We found that the presence of pipe bowls in the archaeological record here is consistent with distributions of glazed jar fragments, which are far more numerous and widespread across the site ( $n = 1685$ ). It should be noted that these temporal indicators might have been introduced before direct European contact by Chinese traders, and this could result in some uncertainty in identifying the start of European phase. However, the archaeological evidence shows that the layers with abundant trade ceramics match the 17th century according to the excavation report and previous studies (Hsieh, 2009; Wang, 2011). Thus, we focus on identifying the contexts with high frequencies of those ceramics as indicators of the early 17th century.

The archaeological signature of the Chinese period at Kiwulan is the large amount and diversity of Chinese porcelains in many styles and forms such as bowls, plates, and cups. Other indicators include opium pipe-bowls and distinctive architectural bricks and tiles used by Chinese (Hsieh, 2009). Chinese migrations to Yilan were also recorded in official Chinese documents written in the early 19th century, recording the first immigrants in 1768 (Chen, 1963; Ke, 1993).

#### 4. The personal ornaments

Ornaments (Fig. 4) were found in a variety of archaeological contexts including post-holes area, burials, and middens. For the ornament categories, we follow the well-established topology based on raw materials

and shapes for the region of northeastern Taiwan (Chen, 2007; National Museum of Taiwan History, 2005). This study focuses on 406 ornaments from 40 sampling squares located at the main habitation areas of Kiwulan, indicated by aligned post-holes with in-situ posts (Fig. 2). Occupation floors were roughly identified according to the position and depth of posts during excavation. We choose these units because they were stratigraphically intact and undisturbed by modern construction activity, compared to excavation squares on the periphery of the site. There are 35 burials in the sampling area, one third of the total number of burials at Kiwulan. Intact ornaments are commonly found in burials used as personal adornment, indicating the property of ornaments as prestige goods (Wang, 2011). The majority burials from the sampling area date to the European period ( $n = 21$ ), limiting the usefulness of comparisons between the periods. In general, there are large differences in the number of gold-foil beads, carnelian beads, and glass beads across burials. For example, over a thousand beads are found in a few burials, but none are found in some burials. This is also because of the presence of bead strands or patterned bands of beads, which sometimes contain thousands of beads in an individual burial (Chen, 2007). The uneven distribution of beads likely indicates some social differentiation. However, the complexity of the taphonomy and chronology of the burial features at Kiwulan mean that a full discussion of these is beyond the scope of this paper.

We focus on ornaments from the habitation contexts (Fig. 5, Table 2) because these give us the greatest spatial and temporal representation across the three time periods, and so are most informative of social inequality as indicated by uneven distributions of ornaments. A possible limitation to our chronological resolution is that ornaments could be heirlooms inherited over multiple generations and well-preserved for a long time. This is difficult to rule out completely, but we consider that because there is no continuous increase in ornament frequency over time, we conclude that accumulation and discard of ornaments is not constant, but was affected by contemporary conditions. Thus, we assume that changes in the abundance of ornaments reflect changes to otherwise relatively continuous discard behaviors rather than accumulations due to collecting of heirlooms.

#### 5. Reproducibility and open source materials

The entire R code (R Core Team, 2019) used for all the analysis and visualizations contained in this paper is included in the Supplementary Online Materials at <http://doi.org/10.17605/OSF.IO/R8YGA> to enable re-use of materials and improve reproducibility and transparency (Marwick, 2017). Also in this version-controlled compendium (Marwick et al., 2018) are the raw data for all the visualizations and tests reported here. All of the figures, tables, and statistical test results presented here can be independently reproduced with the code and data in this repository. The code is released under the MIT license, the data as CC-0, and figures as CC-BY, to enable maximum re-use.

#### 6. Results

##### 6.1. Changes in the frequencies of ornament types over time

Fig. 6 shows the comparison of frequencies of the major classes of ornaments for different time periods at Kiwulan. The difference in frequencies between the three time periods reflect significant differences in the use of ornaments (chi-square = 71.82,  $df = 8$ ,  $p$ -value =  $2.14 \times 10^{-12}$ ). Most ornament types were present before European contact. Ornament frequencies reached a peak during the European period and then dropped during the Chinese period, especially gold-foil beads. This trend can be also seen on other ornaments including carnelian beads, metal rings, and bells. However, glass beads show a different pattern that indicates a higher frequency in the pre-European contact, and then a decrease in the European period and a further decrease in the Chinese period. To model the number of ornaments as a function of the mass of ceramics in each period, we used a Poisson GLM with a log link

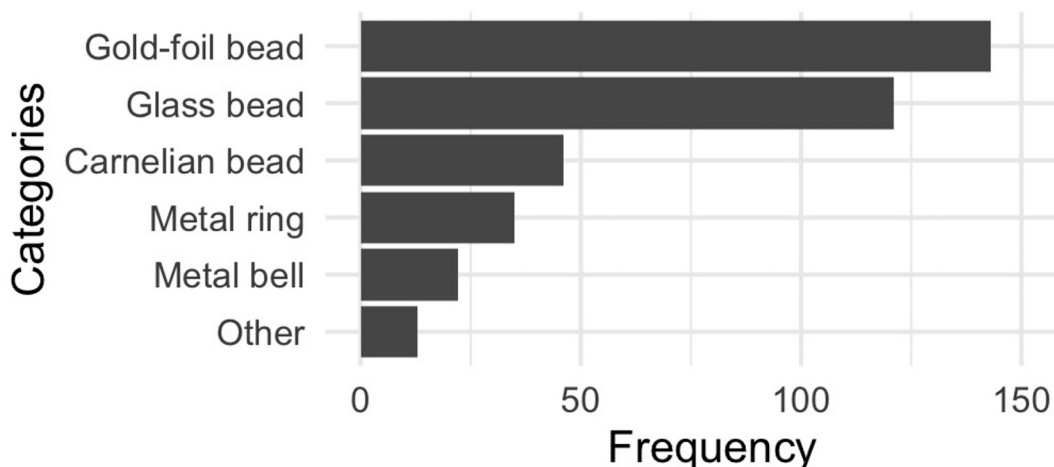


Fig. 5. Frequency of the major class of ornaments at Kiwulan. Frequency represents artefact counts for all three periods.

Table 2

Frequencies of ornaments by subtype at Kiwulan. Frequency represents artefact counts.

Categories	Type	Before European Contact	European Presence	Chinese Presence
Carnelian bead	hexagonal	6	17	5
Carnelian bead	waxy oval	0	4	0
Carnelian bead	small oval	3	3	0
Carnelian bead	globular	0	1	0
Carnelian bead	pentagonal	0	1	0
Carnelian bead	big oval	0	0	1
Carnelian bead	long bicone	0	0	1
Carnelian bead	octagonal	0	0	1
Glass bead	small (0.5–1 cm)	60	37	1
Glass bead	medium (1–2 cm)	8	15	0
Gold-foil bead	NA	48	93	2
Metal bell	large	3	8	3
Metal bell	plain small	0	4	1
Metal bell	thin small	0	1	1
Metal ring	wide small	1	9	1
Metal ring	thin large	4	5	2
Metal ring	wide large	0	5	0
Metal ring	overlapped	0	2	0
Metal ring	braid	0	1	0
Metal ring	entwined	1	1	0
Metal ring	flat	0	1	0
Metal ring	large thick string	0	1	0
Metal ring	small thin string	0	1	0

function. The model reveals that ceramic abundance strongly predicts the number of ornaments ( $\beta = 1.94 \times 10^{-5}$ ,  $p = 4.225 \times 10^{-29}$ ). If ceramic abundance is a suitable proxy for population at Kiwulan due to its basic role as cooking vessels, then ornament quantities per period may be influenced by the number of people living at the site.

Fig. 7 shows the distribution of frequencies for subtypes in each major class. Spearman's correlation test shows that there is a significant relationship between diversity of subtypes and sample size ( $S = 1660.07$ ,  $\rho = 0.59$ ,  $p = 7.3 \times 10^{-4}$ ). This indicates that the increases in diversity can be explained by a combination of the effects of culture interaction and the effects of sample size. Carnelian beads and metal rings have greater quantity and variety of shapes compared to copper bells and glass beads during the European period. The greater varieties for carnelian beads and metal rings might indicate multiple origins due to participation in large scale trade networks stimulated by the European presence. In contrast, copper bells have less variety, typically > 2 cm long with a wide variety of human faces as a motif. Although glass beads have less variety in size, presenting as small

(0.5–1 cm) or medium (1–2 cm), they have a wide variety of colours or patterns mostly made by a winding technique and with high lead content indicating possibly from China (Cheng, 2008).

Although we are not certain of the specific origin of the kinds of beads found at Kiwulan, the glass beads and metal ornaments have similar production techniques and composition to those found in China, while gold-foil beads may relate to the economic activities of the Spanish in the South China Sea region (Chen, 2011; Wang, 2018). There seem to be no obvious changes in the sources of glass beads or metal ornaments at different phases in the upper component of Kiwulan (1350–1850 CE). However, the glass beads from the lower component (650–1150 CE) demonstrate the composition of m-Na-Al glass and soda plant ash glass that are subtypes of the Indo-Pacific beads, frequently seen in Southeast Asia (Carter, 2016; Francis, 2002; Wang and Jackson, 2014). A transition in the origin of glass beads from mainly Southeast Asia to multiple regions including China might indicate different trading networks. A regional network in the South China Sea in the earlier period and later involved in a larger scale trading network stimulated by the Europeans and the Chinese (Hung and Chao, 2016; Wang and Liu, 2007).

## 6.2. Changes in patterns of the spatial distribution of ornament types

Fig. 8 presents the spatial distribution of all ornaments from the research area for each time period. For deposits predating European arrival, a greater amount of ornaments was found at the northern and middle parts of the research area. In European period deposits, ornaments were more widespread, with some clusters on the northern part. In units dating to the Chinese period the distribution is more even without clear clusters. Fig. 9 presents the distribution for the major ornament classes individually, some clusters across the area can be observed during the European period, such as gold-foil beads and carnelian beads. However, there seems to be no consistent pattern across those different ornaments. Each class shows its own pattern where the squares with higher numbers of ornaments are distributed separately and independently. For example, a cluster of gold-foil beads was found at the northern part, while a cluster of carnelian beads was found in the middle part. In contrast, there are multiple clusters of metal rings that are distributed separately across the research area. Copper bells were usually found individually and appear randomly distributed across the area. In the Chinese period, both the amount and density of different classes of ornaments decreased.

## 6.3. Point pattern analysis of ornament distribution

The distribution and density of prestige goods across the residential area can provide information on consumption, implying social structure based on the assumption that distribution patterns observed from spatial

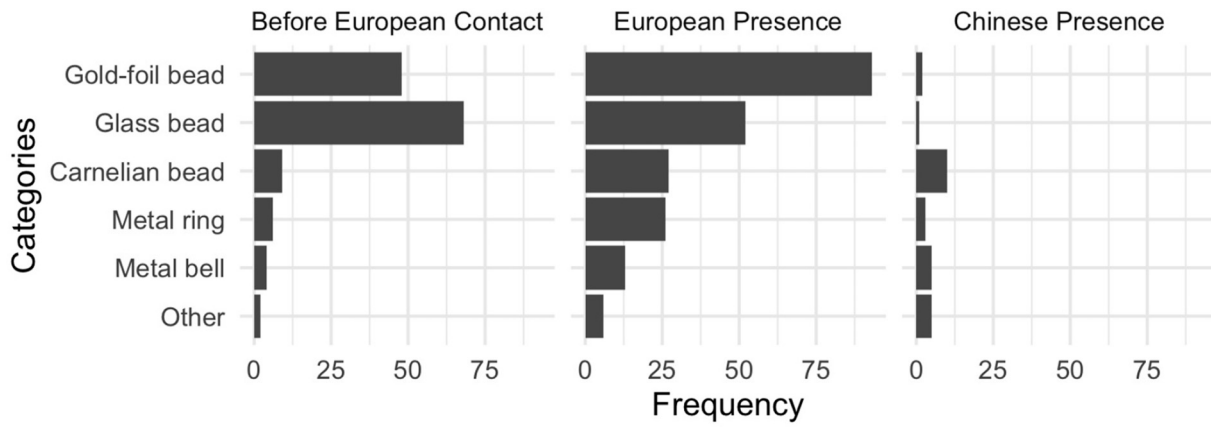


Fig. 6. Frequency of the major ornament types across different time periods.

data can reveal cultural processes (Kintigh and Ammerman, 1982). The differential accumulation of artifacts, especially high value goods, in many archaeological contexts can reflect social differentiation or hierarchy in a society (Halstead, 1993; Orser, 1988; Pearson, 1993; Trubitt, 2003; Wason, 2004). We used point pattern analysis to assess whether the distribution of artifacts represents hotspots produced by non-random processes (Bevan and Lake, 2016; Ducke, 2015), such as concentrations of ornaments in specific locations in the residential area that might result from social inequality stimulated by a colonial presence. To prepare the ornament location data for point pattern analysis, we assigned each ornament to a random coordinate pair in the square it was recovered from, because most artifacts from Kiwulan lack exact piece-provenance data. The next step was to divide the ornaments into three time periods. Finally we computed the density maps for each time period for comparison. Density values of artifacts per square meter were calculated for each

cell. Here we used kernel density estimation (KDE) for visualization and identification of spatial clusters (Baxter et al., 1997), in this case the core areas of ornaments and surrounding neighborhoods. KDE is a method of spatial analysis that computes the probability of the density of ornaments across space by creating a continuous, smooth density surface across space (Bonnier et al., 2019; Cortegoso et al., 2016).

Fig. 10 shows that there is one major core area during the pre-European period, multiple core areas during the European period, and a single core during the Chinese period. There are three consistent sub-regions with a core area that shifts over time. The distribution might indicate an increase and decrease in the number of social groups who possessed more ornaments. The multiple groups during the European period might reflect unequal consumption of ornaments across the site, relative to other periods, or random patterns resulting from a bigger sample size. In addition, the generation of core areas might be biased due to small sample sizes, for

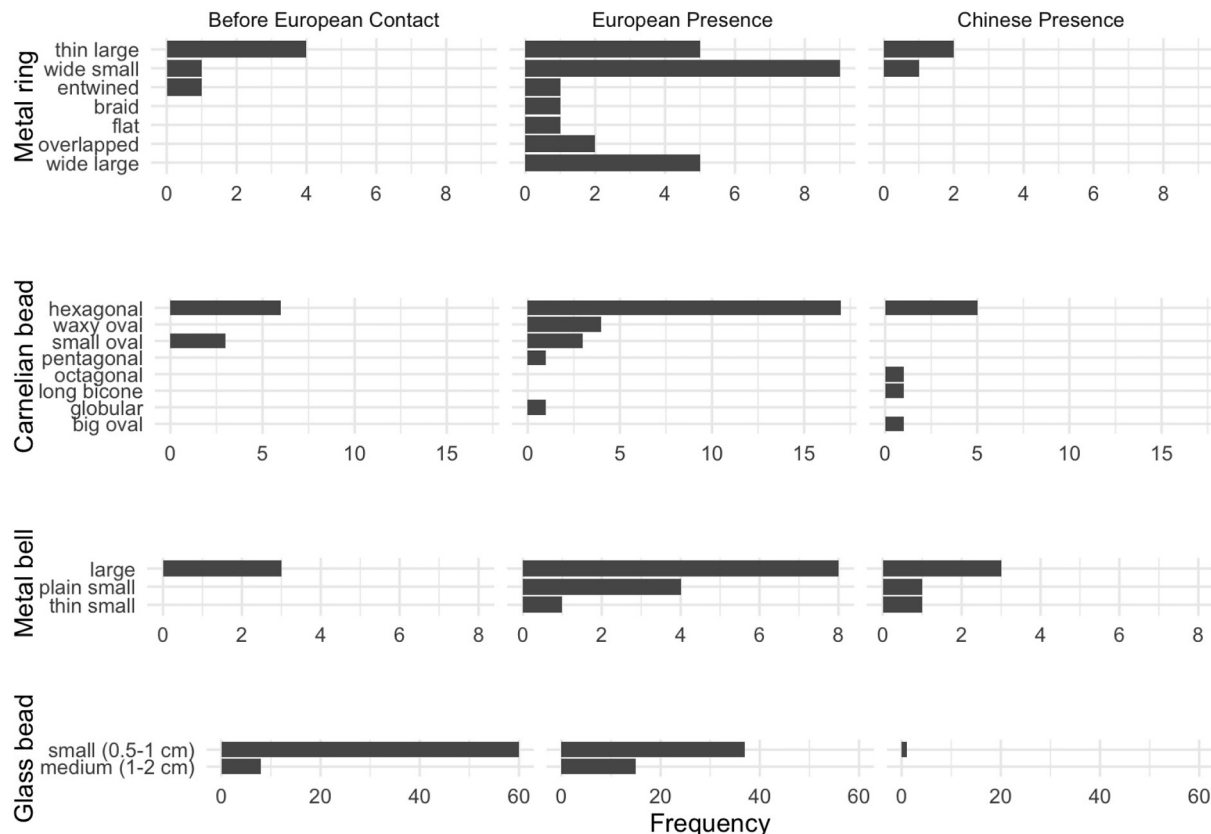


Fig. 7. Frequency of ornament subtypes showing the changes in frequency across time periods for metal rings, carnelian beads, bells, and glass beads.



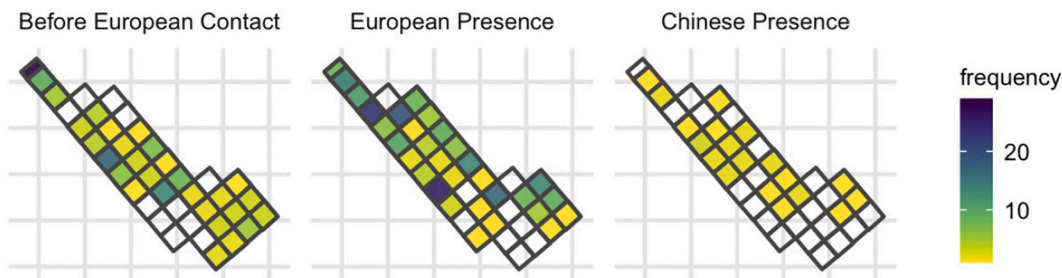


Fig. 8. Spatial densities of all class of ornament by time periods.

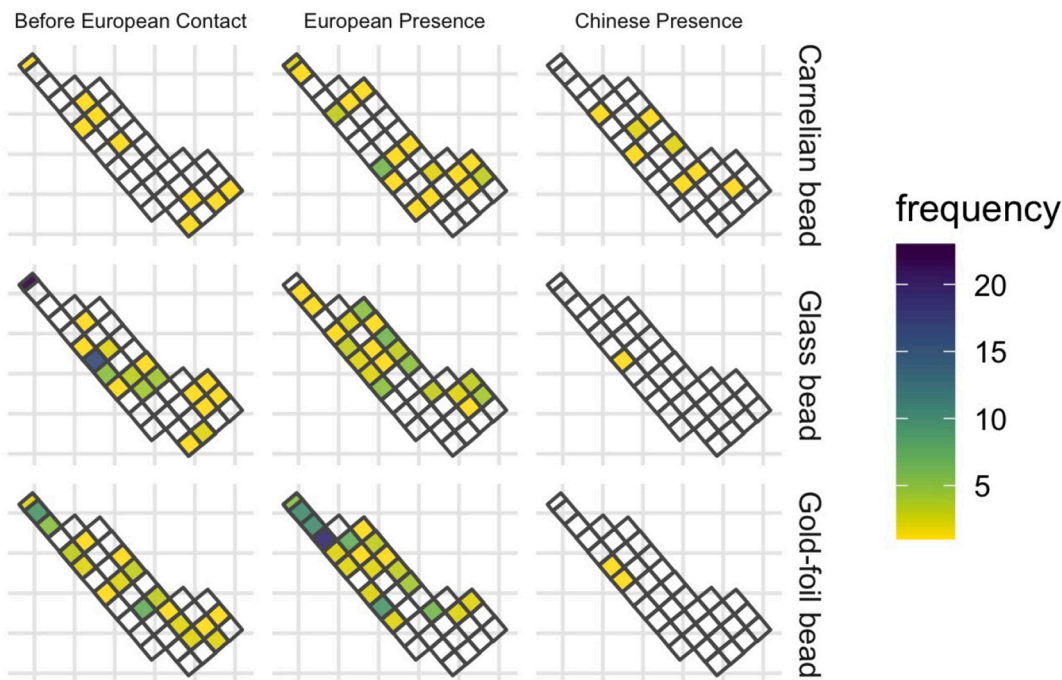


Fig. 9. Spatial densities for ornament class by time periods, only those types with more than 5 pieces are shown here.

example, a few ornaments found at one single square during the Chinese period could create an obvious hotspot. Whether the observed clustering is random or non-random is crucial for making reliable interpretations of intentional human activities at Kiwulan.

To test for randomness in spatial locations, we used a Monte Carlo method to simulate average nearest-neighbour distances (ANN). Fig. 11 shows the observed ANN distances with the distributions of the ANN distances calculated on 1000 simulations of random ornament locations. The results show that 100% of the simulated values are much greater than our observed ANN value during the European period, which means the ornaments have non-randomly clustered distributions. A similar, but less extreme, result is also observed during the pre-European period. The observed distribution of ornaments is more similar to the random distributions during the Chinese period, with about one third of the simulated values greater than our observed ANN value. The Chinese period has fewer artifacts in any category, likely reflecting a smaller population at Kiwulan at this time, making spatial patterns and hotspots difficult to discern with confidence. Our Monte Carlo testing reveals that clustering of ornaments during the European period is highly non-random, potentially indicating different degrees of access to foreign ornaments or an intention to accumulate ornaments at Kiwulan during this period.

## 7. Discussion

An indirect colonial influence may be indicated at Kiwulan by the greater diversity of ornament types and materials during the European

period. Yilan was involved in complex trading networks both on a regional scale with other Indigenous groups and Chinese merchants, and at a global scale with Europeans, including the Dutch and the Spanish. Those trade ornaments have multiple origins, including Southeast Asia and China, and were first introduced into northeastern Taiwan by Chinese merchants before the 17th century. Later, trade activities became more frequent and intense in the 17th century due to European activities. The greater diversity and quantity of ornaments likely resulted from participation in large scale exchange networks that stimulated the circulation of different ornament classes. The frequency of overall ornaments and each subtype declines significantly after European influence fades during the Chinese period in the early 19th century. This may be due to a smaller scale of trading networks, the overall decline of Indigenous populations in Yilan, or the adoption of Han Chinese practices. The decline of the population at Kiwulan may be related to the movement of many Indigenous people southwards to Hualien due to increasing numbers of Han Chinese immigrants who took over their lands at the end of the 18th century (Chen, 2007). Houses and burials may also be a useful source of evidence to understand population size but a proper treatment of those is beyond the scope of the paper.

Archaeological contexts at Kiwulan show that ornaments are especially abundant in burial contexts serving as grave goods (Chen, 2007). This supports the interpretation of ornaments as valuable objects functioning as status indicators. Spatial patterns of ornaments in dwelling contexts show that their distribution was clustered during the pre-European and European periods. These clusters are non-random,

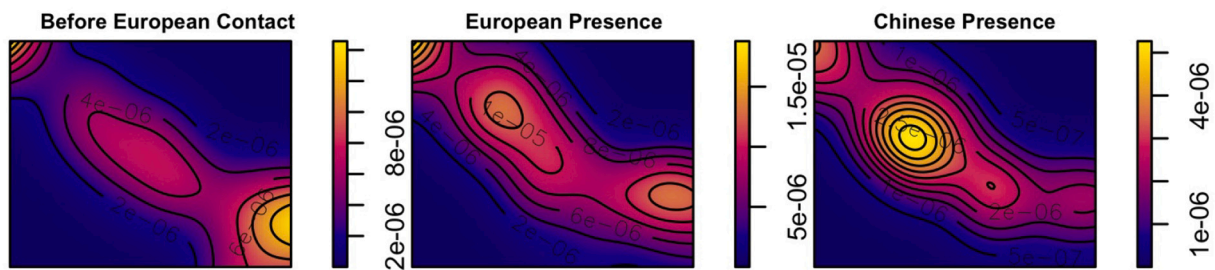


Fig. 10. Kernel density map showing hotspots for ornaments by periods, using a bandwidth based on Silverman (1986)'s rule of thumb.

and are most highly concentrated during the European period. This may indicate that a degree of social inequality based on the uneven distribution of ornaments was already present before European contact, and then it was reinforced and amplified during the European period. A further indicator of increased social inequality is a burial dated to the 17th century that included 60 gold-foil beads, well above the average of 2–3 pieces in the pre-European period (Chen, 2007; Cheng, 2008). Based on the finding of that burial, Cheng (2008) proposed a more hierarchical structure of Kiwulan. However, Hsieh (2012)'s research on burial data suggested a more egalitarian society since the few burials with rich goods are elders that indicate accumulated wealth over time instead of an inherited status. Although both Cheng and Hsieh use the same burial data, their inferences about Kiwulan social structure are the opposite. Our results provide an additional insight by focusing on the residential area which demonstrates an uneven distribution of ornaments during the European presence, indicating increasing social inequality, supporting Cheng's conclusions. Nevertheless, we still need to explore and compare with other archaeological evidence to make more robust inferences about the social structure of Kiwulan.

How might these results fit into a bigger picture of social change in a pericolonial context? We may get some insight into the general pathways that led to social inequality in northeastern Taiwan by considering how people have achieved and maintained power in a wide variety of societies (Ames, 2010; Bowles et al., 2010; Drennan et al., 2010; Feinman, 2000). Feinman's corporate/network model expands traditional hierarchical complexity to provide a comparative basis for distinct strategies for power (Feinman, 2000). In the network mode, inequality develops when individuals accumulate wealth through their individual networks and people use their wealth to attract factions, control resources, and monopolize trade networks. In contrast, the corporate mode stresses shared power across different groups and sectors, integrative ceremonies and rituals, and large cooperative labor tasks (Feinman, 2000; Siegel, 1999).

The Kiwulan ornament data may be interpreted as indicating that Yilan social organization moved from a corporate mode, before European arrival, to a network mode during European presence. The changes from a less concentrated to a more concentrated distribution of ornaments before and after the presence of Europeans appears consistent with the shift from shared power and wealth to accumulated wealth and monopolization. One possible explanation for the shift could be the long-distance trade network introduced by Europeans. The rarity and the image of colonial power of foreign trade goods may have resulted in the emergence of competition among ambitious individuals for prestige, wealth, or power through collecting them (Boone, 1992; Brumfiel, 1994; Clark and Blake, 1994). Because of weak direct control from the European colonizers in northeastern Taiwan, local leaders may have had the flexibility to manipulate European colonial images, expand personal power, and monopolize the high-value trade goods (Kang, 2012).

That said, the evidence from Kiwulan may be consistent with a variety of scenarios of Indigenous-colonial relations. The increasing number and concentrated spatial patterns of ornaments may also suggest a practice of cultural resistance against the European intrusion. Resistance to European economic and political demands may be inferred if ornaments were used as a display of social identity and to emphasize the local customs that had existed before European contact (cf. Rubertone, 2000). We know of the use

of ornaments as a social signal from the custom of wearing ornaments for attending ceremonial events, as documented by Chinese historical records in the 19th century (Chen, 1963; Ke, 1993). Also, an ethnographic photo taken by Mackey (1895) presents a weaving practice by an Indigenous woman at Yilan, who wore beaded necklace and headpiece. This indicates that the ornaments commonly found in the residential area were part of their daily life and customary displays. This custom might have been reinforced during the foreign presence as a form of resistance. Analysis of pottery from Kiwulan shows subtle changes in shape, but not in standardization from the pre-European to European periods, this consistency may have been another way that people of Kiwulan demonstrated resistance to foreign influence (Wang and Marwick, 2020). However, more specific evidence from Kiwulan is necessary to prefer resistance, instead of colonial influence, as the primary mechanism behind the distribution of ornaments.

## 8. Conclusion

Analyses of the archaeological record at the peripheries of colonial activity offer an opportunity to understand pervasive, but not necessarily dominant, European colonial processes at remote Indigenous groups (Trabert, 2018). Kiwulan in northeastern Taiwan is an exceptional case study as an East Asian location that was relatively isolated and peripheral, and yet connected by regional and global trade networks. Kiwulan provides valuable insights into the discussion of pericolonial situations of local societies living beyond the reach of direct European colonial occupation. The frequency and spatial distribution of personal ornaments at Kiwulan present three distinct patterns during different dominant culture interaction periods. The greater amount and diversity of ornament types during the European period reflects an increased use of ornaments in a colonial context. Before European contact, ornaments were traded into local Indigenous societies via regional exchange networks with Chinese merchants, and viewed as prestige goods in the local Indigenous culture. After the arrival of the Europeans, the exotic and powerful image carried by those ornaments may have intensified, further signaling wealth and privileged trading connections among the inhabitants of Kiwulan. This may have stimulated more competition between aggrandizing individuals for prestige and wealth accumulation at Kiwulan, which might have resulted in an increase in social inequality. This might also indicate an act of intentional resistance to the intrusion of the Europeans by using more ornaments that are symbolic of the local cultural tradition, but additional evidence is required to confirm this.

By focusing on the distribution patterns in a settlement site, the Kiwulan ornaments suggest that foreign ornaments can be a proxy to detect indirect colonial influence on local Indigenous populations. Ornaments give insights into the amplification of social inequality stimulated by European colonization. They also show the agency of Indigenous people to incorporate ornaments into their social system and use them to display or intensify status differences. We are still far from understanding the full variety of colonial impacts on peripheral Indigenous communities. We have introduced here the corporate/network model for understanding the dynamics of social inequality at Kiwulan, and further provenance analysis of imported ceramics and ornaments such as X-ray fluorescence analysis may provide more information to construct a clearer picture of trade networks during these periods.

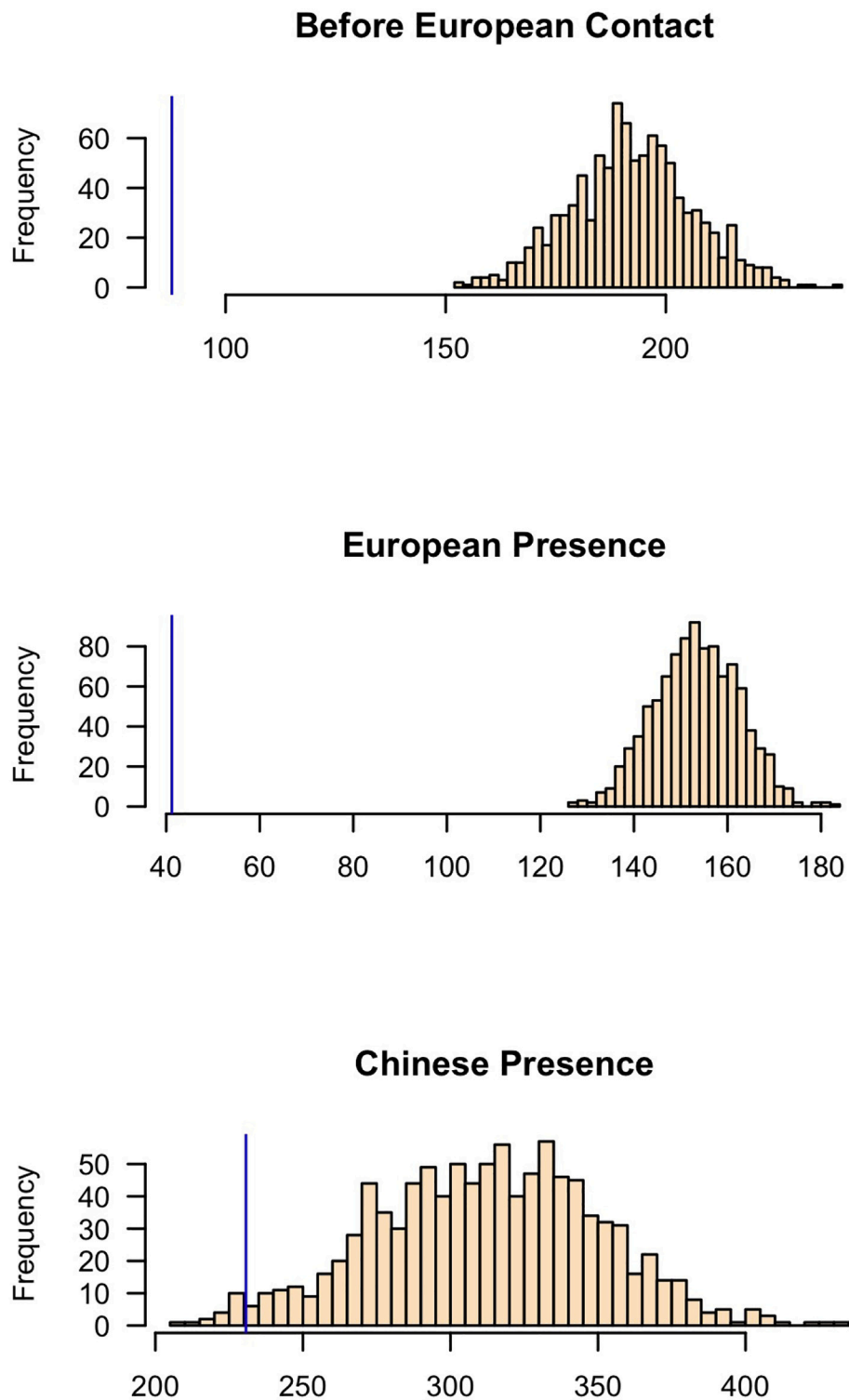


Fig. 11. Histograms of simulated ANN values from 1000 simulations for three time periods. X-axis values represent ANN expected values under a completely random process resulting from a simulated pattern. Each distribution presents the null hypothesis with the blue line indicating the observed ANN value for the sample from each period. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

#### Declaration of Competing Interest

None.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ara.2020.100226>.

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