Production Specialization of Liaoning- and Korean-type Bronze Daggers during the Korean Bronze Age

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Introduction

During the Bronze Age in the Korean Peninsula, a key transition from household-based production to craft specialization is believed to have occurred in the manufacture of such artifacts as red burnished pottery, ground stone daggers, and jade ornaments. This transition in the nature of craft production was accompanied by the introduction of a new class of objects made from bronze. Of these bronze objects, Liaoning-type bronze daggers and Korean-type bronze daggers are regarded as representative artifact types of the Korean Bronze Age (~1500 - 400 BCE), and thus are the central focus of this article.

Bronze objects in general, and bronze daggers in particular, appear in the Korean archaeological record around the same time that significant transformations were taking place in the production of crafts. The nature of the production of bronze objects during the Korean Bronze Age has not yet been systematically researched, however, likely due to the limited number of extant bronze artifacts and the complete lack of known production sites on the Korean Peninsula. Due to the comparative lack of archaeological data, previous studies have primarily focused either on establishing typologies and schemes of classification or on interpreting the cultural meanings of the bronze objects based on the archaeological contexts from which they were recovered. More recently, researchers have begun to utilize metallurgical analysis to investigate the casting technology and the source of the bronze used on the Korean Peninsula (Choi Ju 1992; Choi Ju *et al.* 1996). The reconstruction of the bronze artifacts through experimental archaeology has also been attempted, albeit on a limited scale.

These new research trends have sparked interest in the production and distribution of bronze objects in the ancient times, which in turn has led to discussions on the possibility that such bronze objects were manufactured by specialized craftspeople (Lee Youngmoon 1998; Cho Jinseon 2004). However, little has yet been done in terms of investigating the actual nature of bronze production in this period. Given that bronze daggers are the most common bronze artifacts from the period, this paper examines the characteristic features of bronze dagger production during the Korean Bronze Age. Specifically, Liaoning-type and Korean-type bronze daggers discovered in southern Korea are analyzed, focusing on the morphological attributes that are related to specialized production. Based on this analysis, the organization of the system of bronze production of this period is considered.

Research Aims and Methodology

Archaeological evidence of bronze production in the Korean Bronze Age is sparse, to say the least. The mining and smelting of copper ores, for example, are essential aspects of bronze production, but no archaeological evidence of such activities has yet been found in the Korean Peninsula. To date, the only evidence of bronze production comes from the numerous talc and sandstone molds that have been found (Cho Jinseon 2005). But the presence of such molds allows us to deduce that the entire process of bronze casting—finding the stone with which to make the molds, carving the stone molds, and using the molds to cast the bronze objects—indeed took place on the peninsula during the Bronze Age. In order to explicate further details about bronze production, the issue of production specialization is very important. By identifying how bronze production was organized (i.e., whether or not specialization had emerged), we can better understand the system for producing prestige goods, the relationship between craftspeople and elite members of society, and the overall nature of social complexity at the time.

This paper examines and compares the degree of production specialization of Liaoning-type and Korean-type bronze daggers. Do the Korean-type bronze daggers evince a higher degree of production specialization? What is the nature and scale of the respective systems for producing Liaoning- and Korean-type bronze daggers? The morphological attributes of Liaoning- and Korean-type bronze daggers excavated from southern Korea are quantified and analyzed in order to determine if the degree of production specialization changed over time. This analysis allows us to consider the overall level of manufacturing of the bronze daggers and to examine the nature and development of the system for producing bronze daggers.

Before we can consider the issue of craft specialization through an analysis of bronze daggers, we must first define "craft specialization," and discuss how it can be identified in the archaeological record. Craft specialization generally is understood as a supra-household phenomenon, in which a specialist or part-time specialist produces more goods than he or she needs and then distributes the surplus in order to procure other desired goods or services. In other words, it entails a division of labor, which is why production specialization is regarded as a useful tool for identifying the degree of complexity of social and political organizations. Ideally, specialization in craft production should be confirmed through direct evidence of production obtained through the excava-

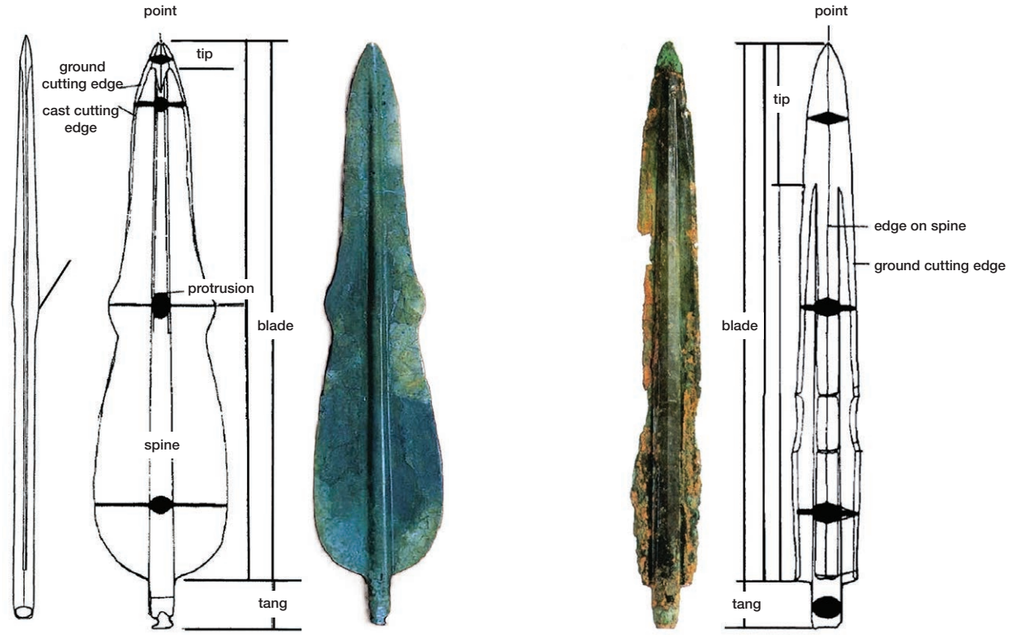

Fig. 1. Liaoning-type (left) and Korean-type bronze dagger parts (revised from Cho Jinseon 1999, 84)

tion of production sites. However, as such evidence is generally difficult to acquire, most studies, including this one, utilize indirect evidence of production (i.e. archaeological features and artifacts pertaining to production) to identify and examine craft specialization.

It has been demonstrated that craft specialization can indeed be observed from secondary evidence (e.g. the nature of the exchange of products, standards of production technology, labor conditions, etc.), and not just from production facilities (Blackman *et al*. 1993; Costin and Hagstrum 1995). Relative to this, the "standardization hypothesis" has been proposed, positing that standardization—or at least a high degree of similarity in the use of raw materials, manufacturing techniques, and artifact form or decoration—can be regarded as an index of craft specialization (Costin 1991). The basic assumption of this hypothesis is that variability is reduced and products become more standardized as production becomes more specialized (Arnold 1993). At present, the standardization hypothesis has been used to analyze a wide range of archaeological materials, frequently in conjunction with ethnographic studies.

The standardization hypothesis has not often been applied to the study of bronze artifacts, largely because, in metal casting, multiple items can be cast from a single mold, thereby distorting the actual degree of production standardization. However, the majority of bronze artifacts—and all of the bronze daggers—excavated from the Korean Peninsula appear to have been cast with different molds. Therefore, it is possible to use the standardization hypothesis to study the production specialization of Korean bronze daggers. Moreover, in this case, analysis of bronze daggers can also illustrate how the degree of production specialization changed over time. The earlier Liaoning-type bronze daggers and the later Korean-type bronze daggers differ only in terms of morphology, and thus share a common production process, which makes it valid to compare the degree of specialization in the production of the two dagger types.

In order to apply the standardization hypothesis, a means for measuring the degree of standardization of a production group is required. Many archaeologists use the coefficient of variation (CV) as this tool. CV can be defined as the sample standard deviation divided by the sample mean, multiplied by 100 and expressed as a percentage. It allows comparisons between groups of different sizes or units, and therefore can be useful in pointing out the "relative" degree of variation in certain attributes of different products.

Recently, various studies have demonstrated how CV can be used as an effective tool for measuring the degree of production standardization. For example, in ethnographic studies undertaken in Spain, Delhi, and Andhra Pradesh, Roux (2003) has suggested that ceramic assemblages presenting CV values below 3% may belong to high-scale (specialized) production, while ceramic assemblages presenting CV values from 6% to 9% indicate small- or very small-scale production. In addition, a CV value of 10% has been proposed as an arbitrary cut-off point between specialized and non-specialized production (e.g., VanPool and Leonard 2002), but such an empirical generalization is highly problematic. Therefore, this study compares the CV values of Liaoning-type and Korean-type bronze daggers in order to identify the "relative" degrees of standardization for these functionally equivalent types. This analysis then serves as the foundation for a discussion on production specialization in the Korean Bronze Age.

Overview of the Data Set

It has been suggested that comparative analyses to identify different degrees of standardization are most effective when they a limit the temporal or regional scope of the artifacts under study (Blackman *et al*. 1993). Therefore, in examining and comparing the degree of standardization evidenced in the bronze daggers of southern Korea, the data set must first be carefully chosen and defined. This requires a review of the previous studies undertaken on these bronze daggers, particularly those pertaining to chronology and typology, in order to select which Liaoning- and Korean-type bronze daggers are most appropriate for a comparative analysis in order to explore their differing degrees of production standardization.

Liaoning-type bronze daggers have been found in almost every region of the Korean Peninsula, in archaeological contexts dating from the ninth to the eighth century BCE. Korean-type bronze daggers appear in the archaeological record at a later date, from the fifth to the fourth century BCE. Therefore, the Liaoning-type bronze dagger and Korean-type bronze dagger are considered to be the representative artifact types of the Middle and Late Bronze Age, respectively (Korean Archaeological Society 2012).

Many researchers have attempted a type classification of Liaoning-type bronze daggers (Lee Youngmoon 1991; Kang Inuk. 2005; Miyamoto Kazuo 2002; Miyazato Osamu 2001). Of these, the framework for this study is provided by the chronological schemes established by Y.M. Lee and Kang Inuk, which are relatively detailed in nature. In order to identify the degree of standardization for Liaoning-type bronze daggers, the current analysis requires a single classificatory dagger type that was produced within a clearly defined period of time. Therefore, this study focuses on the 21 daggers belonging to the "Typical Ib type" of Lee's chronological scheme, a data set that roughly corresponds to the "Yejeon-dong" type of Kang's chronological scheme. These daggers date to the eighth century BCE and represent the majority of Liaoning-type bronze daggers that have been found in southern Korea (Fig. 2).

Various studies have also attempted a type classification of Korean-type bronze daggers (Yoon Mubyeong 1966; Kim Jeonghak 1978; Lee Chongkyu 1982; Yi Kunmoo 2003; Cho Jinseon 2004). In most studies, the most important attribute for classifying daggers into different types is the length of the "edge on spine." However, it has been argued that such attempts at classification fail to consider that some morphological attributes that were present at the time of casting (and are therefore indicative of the production process) may have been altered by the subsequent use of the dagger (Cho Jinseon 2004). Thus, to trace the development of Korean-type bronze daggers effectively, it is necessary to differentiate between those morphological attributes that represent the original casting process and those that may have been affected by usage (Fig. 3). As such, this study adopts the chronological scheme set forth by Cho Jinseon (2004). Specifically, the current analysis focuses on the 44 daggers belonging to the "Establishment phase" (around 300 BCE) and "De-

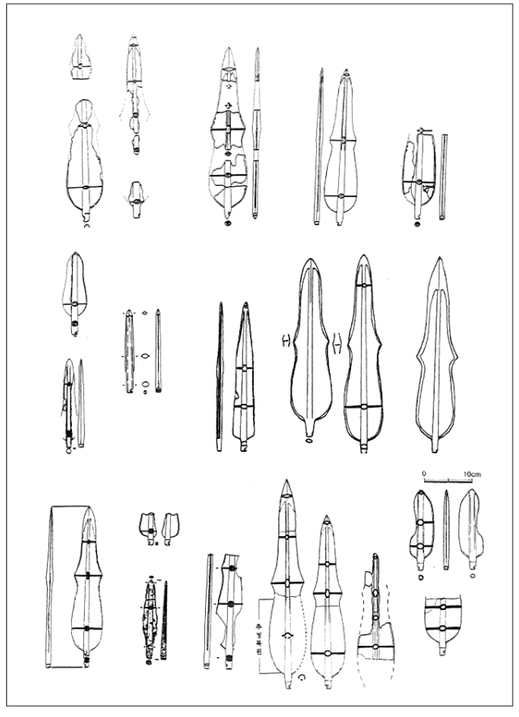

Fig. 2. 'Typical Ib' Liaoning-type bronze daggers of southern Korea.

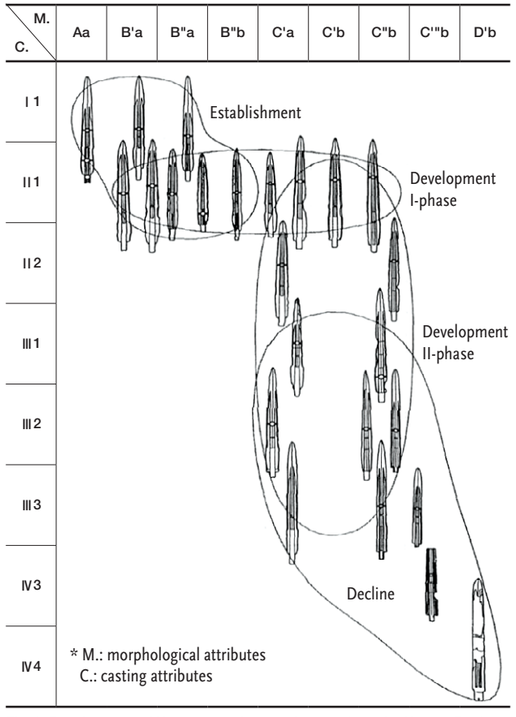

Fig. 3. Development of Korean-type bronze daggers from the Korean Peninsula (from Cho Jinseon 2004, 96).

velopment I phase" (late third - early second century BCE) of Cho's classificatory scheme. These Korean-type bronze daggers were found in most regions of southern Korea, so the data set is appropriate for a comparative analysis with the Liaoning-type bronze daggers (Fig. 4).

Comparative Analysis of Liaoning-type and Korean-type Bronze Daggers

Before undertaking the comparative analysis of Liaoning-type and Korean-type bronze daggers, we must first identify the morphological attributes common to both types that can be used to measure the standardization in the production process. For the purposes of this study, it is crucial to differentiate between those morphological attributes that are associated with spatial and diachronic variation, and those that reflect production standardization. At present, the morphological attributes of Korean-type bronze daggers have been examined in more detail than those of Liaoning-type bronze daggers; thus, we will first consider the former to identify attributes that may be of most use in our analysis of production standardization. Those same morphological attributes will then be used to examine the degree of standardization evidenced in both Liaoning- and Korean-type bronze daggers.

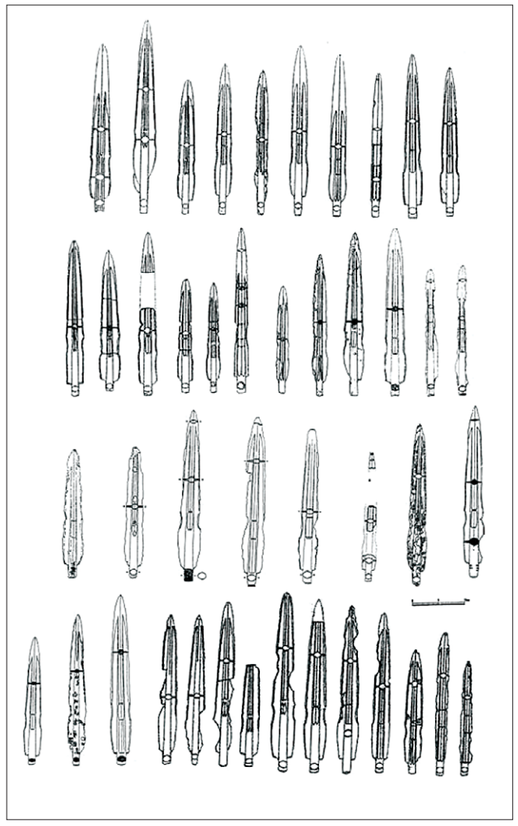

Fig. 4. 'Establishment-' and 'Development I-phase' Korean-type bronze daggers of southern Korea.

The following morphological attributes have been used to establish typologies of the Korean-type bronze dagger: blade form, blade length, spine height, cutting edge form, and tip thickness. Of these attributes, blade length can be seen to reflect the original casting process, since the length of a dagger's blade does not change much, even after extended use. The blade form, on the other hand, might change drastically over time, as the blade is continuously ground in order to sharpen the cutting edge. Similarly, the height of the spine, the shape of the cutting edge, and the thickness of the tip also experience significant wear during use, and are thus considered to be attributes subject to alteration after casting (Cho Jinseon 2004). Hence, this study uses the length of the blade to measure production standardization. The other morphological attributes, which experience change during use, cannot be used to accurately evaluate the degree of production standardization. Some studies implementing the standardization hypothesis have also identified the entire length of the artifact as one of the most valid attributes of standardization (Blackman *et al.* 1993; Clark 1995). Therefore, this study will also examine the length of the dagger body (i.e., the blade and tang) as a morphological attribute that reflects standardization. Finally, the length of the tang—the area where the dagger body joins the handle—will also be considered. The tang is important because it represents a functional element, rather than a spatial or temporal element. To summarize, this study utilizes the length of the entire dagger body, the length of the dagger blade, and the length of the dagger tang as morphological attributes indicative of the degree of standardization for Korean-type bronze daggers.

Typological studies of Liaoning-type bronze daggers have considered the following morphological attributes: cross-section shape of the dagger spine

(i.e. flat or semi-circular); shape and position of the protrusion on the spine; shape of the lower section of the cutting edge; shape of the base of the blade; and length of the tip. However, this study compares Liaoning- and Korean-type bronze daggers, so morphological attributes common to both dagger types must be used as measures of standardization. Fortunately, the attributes previously identified as being indicative of standardization in the Korean-type bronze daggers—length of the entire body, length of the blade, and length of the tang—are equally relevant to the casting process of the Liaoning-type bronze dagger. Therefore, these three morphological attributes will allow us to compare the degree of standardization between Liaoning- and Korean-type bronze daggers. In addition, the length ratio of the body to the tang will also be examined, as it is deemed to be an important feature of standardization.

In accordance with this approach, measurements were compiled of the length of the entire body, the blade, and the tang of the "Typical Ib type" Liaoning-type bronze daggers and the "Establishment-" and "Development I-phase" Korean-type bronze daggers. The resulting data are presented in the following three tables.[1]

Analysis of the Liaoning-type bronze daggers yielded the following results: the CV values are 0.11% for dagger body length, 0.12% for blade length, and 0.18% for tang length. The CV value for the body-to-tang length ratio is 0.16%, which is close to the CV value of the tang length. As for the Korean-type bronze daggers of the Establishment phase, the CV values are 0.15% for body length, 0.16% for blade length, 0.18% for tang length, and 0.17% for the ratio of the body-to-tang. Thus, the CV values for the Establishment-phase Korean-type bronze daggers are higher for the body length and blade length, and slightly higher for the ratio of the body-to-tang. The CV value of the tang length, on the other hand, is similar for the two dagger types. Finally, in the case of the Korean-type bronze daggers of the Development I phase, the CV values are 0.10% for body length, 0.10% for blade length, 0.12% for tang length, and 0.08% for the body-to-tang length ratio. Hence, all of the CV values for the Korean-type bronze daggers of the Development I phase are considerably lower than those of the other dagger types (Table 4).

Examining the results in more detail, we can see that, in the case of the Liaoning-type bronze daggers, the CV values of the body and blade are similar to the other dagger types, but the CV value of the tang is much higher. This is because the data set included eight "complete" daggers and nine "incomplete"

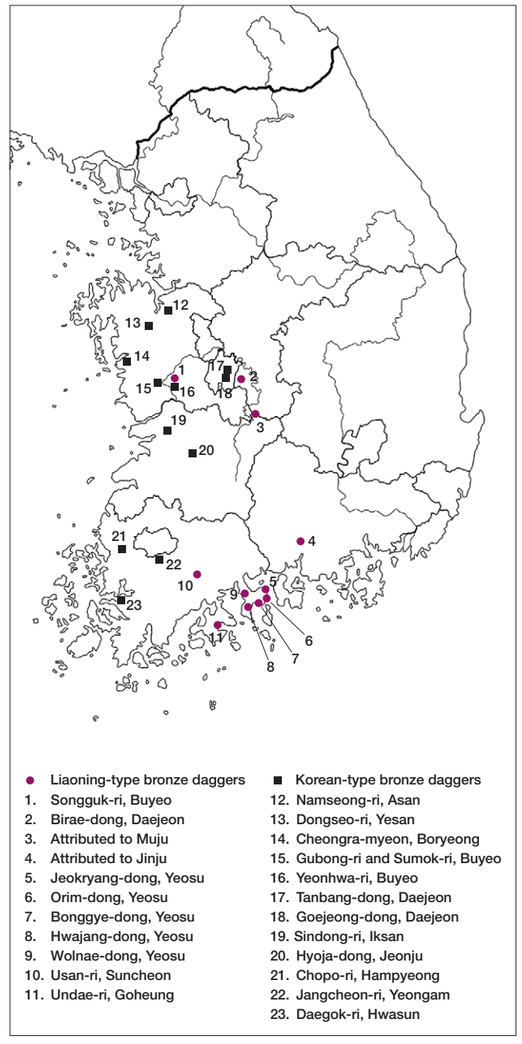

Fig. 5. Distribution of bronze daggers analyzed in this study.

1 The measurements of the morphological attributes of the Liaoning-type and Korean-type bronze daggers presented in the tables come from artifact descriptions and illustrations from published sources.

No.	Site	Dagger body	Dagger blade	Dagger tang	No.	Site	Dagger body	Dagger blade	Dagger tang
Fig. 2-1	Jeokryang-dong	·		2.5	**Fig. 2-12**	Songguk-ri	33.4	30.1	3.3
Fig. 2-2	Jeokryang-dong	·		2.8	**Fig. 2-13**	Orim-dong	·		1.6
Fig. 2-3	Jeokryang-dong	35	32.5	2.5	**Fig. 2-14**	Birae-dong	·		2.65
Fig. 2-4	Jeokryang-dong	33	30	3.0	**Fig. 2-15**	Hwajang-dong	·		4.1
Fi)g. 2-5	Jeokryang-dong	·		2.8	**Fig. 2-16**	Undae-ri	·		(4.2)
Fig. 2-6	Usan-ri	·		(4.0)	**Fig. 2-17**	Wolnae-dong	35.7	33.05	2.65
Fig. 2-7	Usan-ri	·		(1.4)	**Fig. 2-18**	Wolnae-dong	43.4	40.4	3
Fig. 2-8	Jindong-ri	·		2.7	**Fig. 2-19**	Wolnae-dong	(21.6)		
Fig. 2-9	Attributed to Muju	38.3	35	3.3	**Fig. 2-20**	Wolnae-dong	(16.8)	(14.4)	2.4
Fig. 2-10	Attributed to Muju	42	39.4	2.6	**Fig. 2-21**	Wolnae-dong	?	?	2.8
Fig. 2-11	Geumneung	40.8	38.1	2.7					

Table 1. Measurements (in cm) of morphological attributes of Typical Ib-type Liaoning-type bronze daggers.

No.	Site	Dagger body	Dagger blade	Dagger tang	No.	Site	Dagger body	Dagger blade	Dagger tang
Fig. 4-1	Dongseo-ri 1	31.8	29.3	2.5	**Fig. 4-12**	Namseong-ri d	26.2	24.5	1.7
Fig. 4-2	Dongseo-ri 2	36.8	33.5	3.3	**Fig. 4-13**	Namseong-ri e	[30.2]	[28.1]	[2.1]
Fig. 4-3	Dongseo-ri 3	25.1	22.5	2.6	**Fig. 4-14**	Namseong-ri f	21.2	18.9	2.3
Fig. 4-4	Dongseo-ri 4	28.1	24.7	3.4	**Fig. 4-15**	Namseong-ri g	20	17.7	2.3
Fig. 4-5	Dongseo-ri 5	26.9	24.6	2.3	**Fig. 4-16**	Namseong-ri h	29.5	26.5	3
Fig. 4-6	Dongseo-ri 6	31.8	28.3	3.5	**Fig. 4-17**	Yeonhwa-ri 1	20.4	18.4	2
Fig. 4-7	Dongseo-ri 7	31	28.5	2.5	**Fig. 4-18**	Yeonhwa-ri 3	26.8	24.3	2.5
Fig. 4-8	Dongseo-ri 8	27.5	24.8	2.7	**Fig. 4-19**	Yeonhwa-ri 4	30.8	27.9	2.9
Fig. 4-9	Namseong-ri a	31.5	28.9	2.6	**Fig. 4-20**	Goejeong-dong	32.4	29.9	2.5
Fig. 4-10	Namseong-ri b	28.5	25.7	2.8	**Fig. 4-21**	Cheongra	24	20.9	3.1
Fig. 4-11	Namseong-ri c	29.6	26.9	2.7	**Fig. 4-22**	Sumok-ri	24.3	22.5	1.8

Table 2. Measurements (in cm) of morphological attributes of Establishment-phase Korean-type bronze daggers.

No.	Site	Dagger body	Dagger blade	Dagger tang	No.	Site	Dagger body	Dagger blade	Dagger tang
Fig. 4-23	Sindong-ri	(25.1)	·	2.3	**Fig. 4-34**	Gubong-ri	28.5	26.4	2.1
Fig. 4-24	Chopo-ri	(25.8)	·	2.1	**Fig. 4-35**	Gubong-ri	(28.5)	·	2.0
Fig. 4-25	Chopo-ri	32.7	30.3	2.4	**Fig. 4-36**	Gubong-ri	31.1	28.9	2.2
Fig. 4-26	Chopo-ri	31.3	29.2	2.1	**Fig. 4-37**	Gubong-ri	·	·	2.0
Fig. 4-27	Chopo-ri	28.5	26.1	2.4	**Fig. 4-38**	Gubong-ri	33.8	31.3	2.5
Fig. 4-28	Jangcheon-ri	·	·	2.2	**Fig. 4-39**	Gubong-ri	·	·	2.5
Fig. 4-29	Hyoja 4	31.8	29.2	2.6	**Fig. 4-40**	Gubong-ri	31.8	29.3	2.5
Fig. 4-30	Daegok-ri	24.7	23	1.7	**Fig. 4-41**	Gubong-ri	30.3	27.9	2.4
Fig. 4-31	Daegok-ri	29.5	27.3	2.2	**Fig. 4-42**	Gubong-ri	23.5	21.7	1.8
Fig. 4-32	Daegok-ri	32.8	30.7	2.1	**Fig. 4-43**	Gubong-ri	(27)	·	2.7
Fig. 4-33	Tanbang-dong	32.5	30	2.5	**Fig. 4-44**	Gubong-ri	(21.3)	·	2.0

Table 3. Measurements (in cm) of morphological attributes of Development I-phase Korean-type bronze daggers.

daggers, which were either fragmented or had been recycled into smaller daggers or even arrowheads (see Fig. 3, No. 6, 7, 8, 9, 14, 15, 20). The tang length of the incomplete samples varied significantly (1.4 - 4.2cm), resulting in the high CV values for the tang length of the Liaoning-type bronze daggers. Consequently, it was confirmed that the selected CV values were valid measures of the degree of standardization only in the case of complete Liaoning-type bronze daggers.

Additional analysis was therefore carried out on the eight complete samples, and a much lower CV value of 0.11% was obtained for the tang length. In contrast, a separate analysis of the nine incomplete daggers yielded a much higher CV value of 0.24% (Table 5). This indicates that, when the data were not skewed by the incomplete samples, the CV values of the body, blade, and tang lengths of Liaoning-type bronze daggers are indeed similar to those of the other dagger types.

It has been suggested that the Korean-type bronze daggers can be divided into three size categories according to blade length (Cho Jinseon 2004, 68-70): small (18-21 cm), medium (22-26 cm), and large (27-34 cm). Therefore, additional analysis was carried out to evaluate this proposition. Notably, however, this study categorizes daggers by the length of the entire body, rather than the blade alone, since the former has been shown to be a more useful morphological attribute for assessing standardization. The body measurements of the Korean-type bronze daggers are presented in the histogram in Figure 6, which shows that the daggers can be usefully divided into the following three groups: small (less than 21.0 cm), medium (23.0-27.5 cm), large (greater than 27.5 cm). The results demonstrate that size was indeed an important feature in the production of the Korean-type bronze daggers.

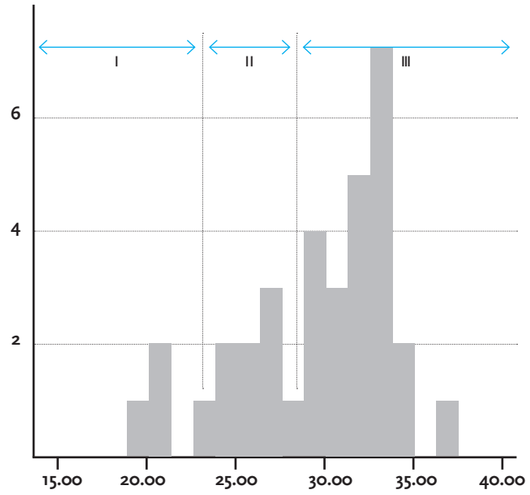

Fig. 6. Grouping of Korean-type bronze daggers according to the dagger length.

	Attribute	No. of analyzed samples	Mean (cm)	Standard Deviation	Coefficient of Variation (%)
Liaoning-type bronze daggers	Body length	8	37.7	4	0.11
	Blade length	8	34.8	4.08	0.12
	Tang length	17	2.79	0.51	0.18
	Body-Tang length ratio	8	13.24	2.12	0.16
Korean-type bronze daggers (Establishment phase)	Body length	21	27.82	4.31	0.15
	Blade length	21	25.2	4.07	0.16
	Tang length	21	2.62	0.48	0.18
	Body-Tang length ratio	21	10.82	1.89	0.17
Korean-type bronze daggers (Development I phase)	Body length	14	30.2	3.04	0.1
	Blade length	14	27.95	2.83	0.1
	Tang length	22	2.25	0.26	0.12
	Body-Tang length ratio	14	13.49	1.04	0.08

Table 4. Mean, SD, and CV of bronze daggers.

	Attribute	No. of analyzed samples	Mean (cm)	Standard Deviation	Coefficient of Variation (%)
Complete dagger	Tang length	8	2.88	0.31	0.11
Fragmentary/recycled daggerbronze daggers (Establishment phase)	Tang length	9	2.71	0.65	0.24

Table 5. Mean, SD, and CV of the tang length of Liaoning-type bronze daggers

	Attribute	No. of analyzed samples	Mean (cm)	Standard Deviation	Coefficient of Variation (%)
Establishment-phase daggers	Body length	12	30.78	2.48	0.08
	Blade length	12	27.91	2.46	0.09
	Tang length	12	2.87	0.36	0.13
	Body : Tang	12	10.87	1.47	0.14
Development I-phase daggers	Body length	12	31.22	1.71	0.05
	Blade length	12	28.88	1.66	0.06
	Tang length	12	2.34	0.18	0.08
	Body : Tang	12	13.44	1.07	0.08

Table 6. Mean, SD, and CV of large Korean-type bronze daggers.

Accordingly, the CV values of the Korean-type bronze daggers were re-calculated according to size group. In the case of the large dagger group (Table 6), the CV values of the Establishment-phase daggers were 0.08% for body length, 0.09% for blade length, 0.13% for tang length, and 0.14% for the body-to-tang length ratio. The CV values of the large Development I-phase daggers were 0.05% for body length, 0.06% for blade length, 0.08% for tang length, and 0.08% for the body- to-tang length ratio. These values are significantly lower than those obtained for the entire sample group of Korean-type bronze daggers (see Table 4), indicating that the CV values of middle- and large-size daggers were relatively higher. Therefore, it can be said that the large Korean-type bronze daggers exhibit a relatively high degree of morphological standardization. In fact, it appears that they were produced separately according to dagger size, and that the production process of the large Korean-type bronze daggers was relatively standardized.

The results of the foregoing analysis can be summarized in two graphs (Fig. 7). The graph on the left presents the CV values of all Liaoning-type and Korean-type bronze daggers, while the graph on the right features the CV values of the complete Liaoning-type bronze daggers andvv the large Korean-type bronze daggers. A number of observations can be made regarding the right graph. First, the CV value of the blade length decreases in the following order: Liaoning-type bronze dagger (0.12%) → Establishment-phase Korean-type bronze dagger (0.09%) → Development I-phase Korean-type bronze dagger (0.06%). This may reflect an increase in the degree of standardization over time. Second, all of the CV values of the Development I-phase daggers are noticeably less than the corresponding values for the Establishment-phase daggers. This can also be interpreted as a clear indication of an increase in the degree of standardization over time. Third, the CV value for tang length is noticeably higher for the Korean-type bronze daggers (particularly the Development I-phase daggers). It has been suggested that Liaoning- and Korean-type bronze daggers differed in terms of the means by which the handle was attached to the body (Oh Gangwon 2003, 12-13). This argument has yet to be confirmed, as no handle components of Liaoning-type bronze daggers have yet been found in southern Korea. However, if this indeed was the case, it might be regarded as a valid factor for explaining the pattern of CV values for tang length. Amongst Korean-type bronze daggers, the CV values for tang length are considerably

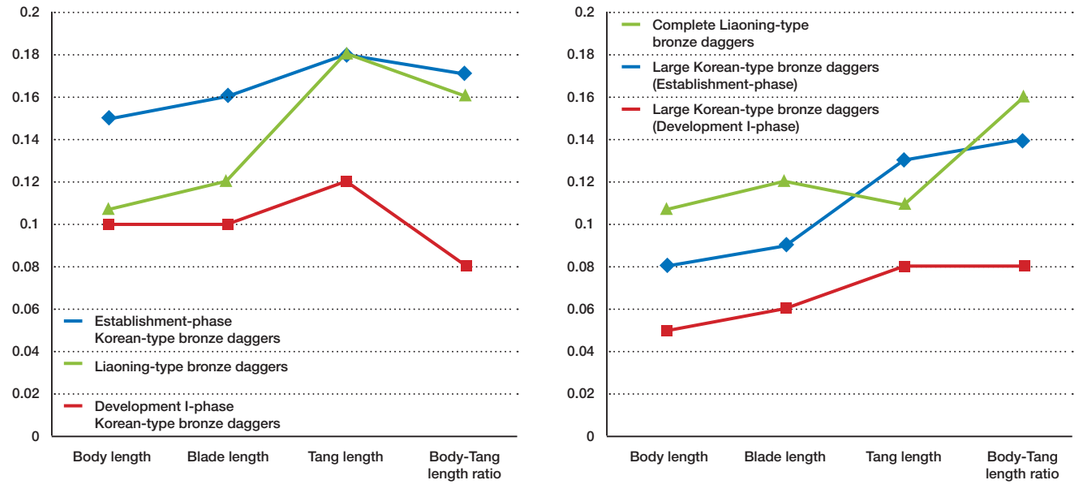

Fig. 7. Comparison of the CV values of Liaoning-type and Korean-type bronze daggers (left: CV values of all analyzed daggers, right: CV values of complete Liaoning-type daggers and large Korean-type bronze daggers).

lower with those from the later Development I-phase (0.08% as opposed to 0.13%). Again, this suggests increased standardization in the production of Korean-type bronze daggers on the Korean Peninsula. Finally, the CV values for the body-to-tang length ratio also demonstrate a similar pattern of decrease over time, further indicating an increase in the degree of production standardization.

Conclusion

This examination and comparative analysis of the CV values of the body length, blade length, tang length, and body-to-tang length ratio of Liaoning- and Korean-type bronze daggers from southern Korea has yielded meaningful results. Above all, the results indicate that the later Korean-type bronze daggers show a higher degree of standardization than the earlier Liaoning-type bronze daggers. Following other studies that have implemented the standardization hypothesis, the length of the body and blade (which best represent the entire dimensions of the artifact) were selected as key morphological attributes associated with production standardization. Notably, these two attributes also directly correlate with the total amount of molten bronze injected into the mold during the casting process. In other words, the standardization observed in these attributes is indicative of the standardization in the amount of bronze required to make a single dagger. In ancient times, bronze was an extremely valuable material that often had to be acquired over long distances, and standardization would have allowed craftspeople to make more precise estimates about the quantity of bronze required to manufacture the necessary number of daggers. The results also confirm that dagger size was taken into consideration from the earliest stages of production (i.e. when carving the mold).

Then is it possible to regard this increase in the degree of standardization as an indicator of production specialization? As previously mentioned, standardization does not necessarily indicate the specialization of production. But in the case of the bronze daggers examined in this study, it seems highly likely that the production system of the daggers indeed became more specialized over time. There is clear evidence that the demand for and production of bronze items increased significantly in the Late Bronze Age. Therefore, it is reasonable to assume that the production system of bronze items, including daggers, became more specialized, and such specialization would have naturally led to product standardization.

This specialization in the production system of bronze items would also have allowed for more diversity in the types of products being manufactured. The fact that the Korean-type bronze daggers examined in this study could be categorized into three different size groups might serve as evidence of such diversification,[2] along with the results of some previous studies (e.g. Cho Jinseon 2004). The fact that different-sized Korean-type bronze daggers were made through separate processes of production indicates that size was an important feature in the production of bronze daggers, which in turn suggests that different-sized Korean-type bronze daggers served different functions. In particular, the high degree of morphological standardization shown for large Korean-type bronze daggers might be attributed to their use as actual weapons. Of course, additional studies must be carried out to establish the viability of this claim. It can also be noted that the diversification of bronze items that took place in the Late Bronze Age led to the production of new types of bronze items, such as bronze mirrors with coarse and fine design, and ritual implements in the form of pole-top bells and eight-branched bells.

To summarize, the results of this study indicate that relative standardization was achieved in the production of Korean-type bronze daggers in the Late Bronze Age, and that the production system became more specialized around this time. This development can be attributed to the increase in the number, diversity, and technological standard of bronze objects produced in the Late Bronze Age in southern Korea. However, it must be stressed that this study simply aims to trace the general trend of diachronic change in the organization of production systems. Thus, rather than suggesting the existence of "specialized" bronze production in the Late Bronze Age, we interpret the results to indicate merely that bronze production in the Late Bronze Age, when the Korean-type bronze daggers were manufactured, was "relatively more specialized" than production in the Middle Bronze Age, when the Liaoning-type bronze daggers were manufactured,.

Discussions of production specialization must be further developed by examining the molds used to cast bronze items, as well as by undertaking a detailed comparative analysis of a wider range of bronze artifacts. In addition, such research must be supplemented by metallurgical studies that examine production technology, and provenance studies based on the analysis of rare earth elements. When such a holistic approach is adopted, then we may begin to reconstruct the entire process of bronze production—from the procurement of raw materials to the manufacture of the actual product—and thus gain a deeper understanding of the production, distribution, and consumption of bronze items in the Korean Bronze Age.

Translated by Ko Ilhong

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2 It has been suggested that Liaoning-type bronze daggers can also be divided into size categories (Kang Inuk 2005). However, as the data set is limited to southern Korea, there are not enough samples in the current study to confirm this possibility through quantitative analysis.

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