

A NOTE ON THE METALLURGY OF SOUTHEAST ASIAN KETTLE-DRUMS: PROPORTIONS OF LEAD AND TIN AND IMPLICATIONS FOR CHRONOLOGY.

*Dieter Hollmann
Johann Wolfgang Goethe University
Frankfurt am Main
and
Dirk H.R. Spennemann
Department of Prehistory,
Australian National University*

The huge bronze kettle-drums of the Southeast Asian Bronze Age have aroused a never-ending interest among scholars of Southeast Asian as well as other fields of archaeology. Early this century Franz Heger analysed and described all drums accessible to him in his meticulous monograph 'Alte Metalltrommeln aus Südostasien' (Heger 1902). Herein he provided a useful typology which to some extent is still quite valid. This typology has been successfully revised by Li Weiqing (1979; with further additions by Spennemann, in press a), who has supplied in addition a chronological outline based on Chinese data. Many drums, especially with Heger's profile type 'I', have been found in datable tombs of the southern Chinese Dian culture (Yunnan Sheng Bowuguan 1959; Pirazzoli-t'Serstevens 1974; von Dewall 1979) and the Dong Son culture of northern Vietnam (Goloubew 1929; Janse 1958).

Currently, drums of the type termed 'pre-Ia', as found in Yunnan at Dabona in Xianyun district (Yunnan Sheng Bowuguan 1964) and at Wanjiaba in Chuxiong district (Yunnan Sheng Bowuguan 1983), are typologically the oldest ones known. The drums from Wanjiaba date to the Warring States Period (481-222 BC). The chrono-typological evolution of drum profiles is outlined in Figure 1. The majority (11 specimens) of the drums found in the major Dian cemeteries of Shizhaishan, Taijishan and Lijiashan, all in Yunnan Province (Yunnan Sheng Bowuguan 1959, 1965; Zenqi and Dadao 1975; von Dewall 1979), belong to types Ib and Ib/c (transitional), and only 3 specimens are of the earlier type Ia/b (transitional). Through the occurrence of well-dated finds, such as mirrors of the Western Han Period (206 BC - AD 8), the major Dian cemeteries have been dated approximately from 175 BC to the end of the Western Han.

The drums found in northern Vietnam belong entirely to the types with Ib and Ib/c profiles and are, in terms of dated associations (Han Period coins, mirrors etc.), contemporary with those found in the major Dian cemeteries. Radiocarbon dates, however, suggest that the type Ib and Ib/c (transitional) drums found in northern Vietnam may be as old as 450 BC (calibrated dates; cited after Solheim 1983, calibrated after Klein *et al.* 1982), and a similar radiocarbon age may also apply to the Heger type Ib/c (transitional) drums excavated in Kampong Sungai Lang in Selangor (Peacock 1979). The issue of absolute chronology, however, is not settled satisfactorily as yet, and will not be discussed further within this article.

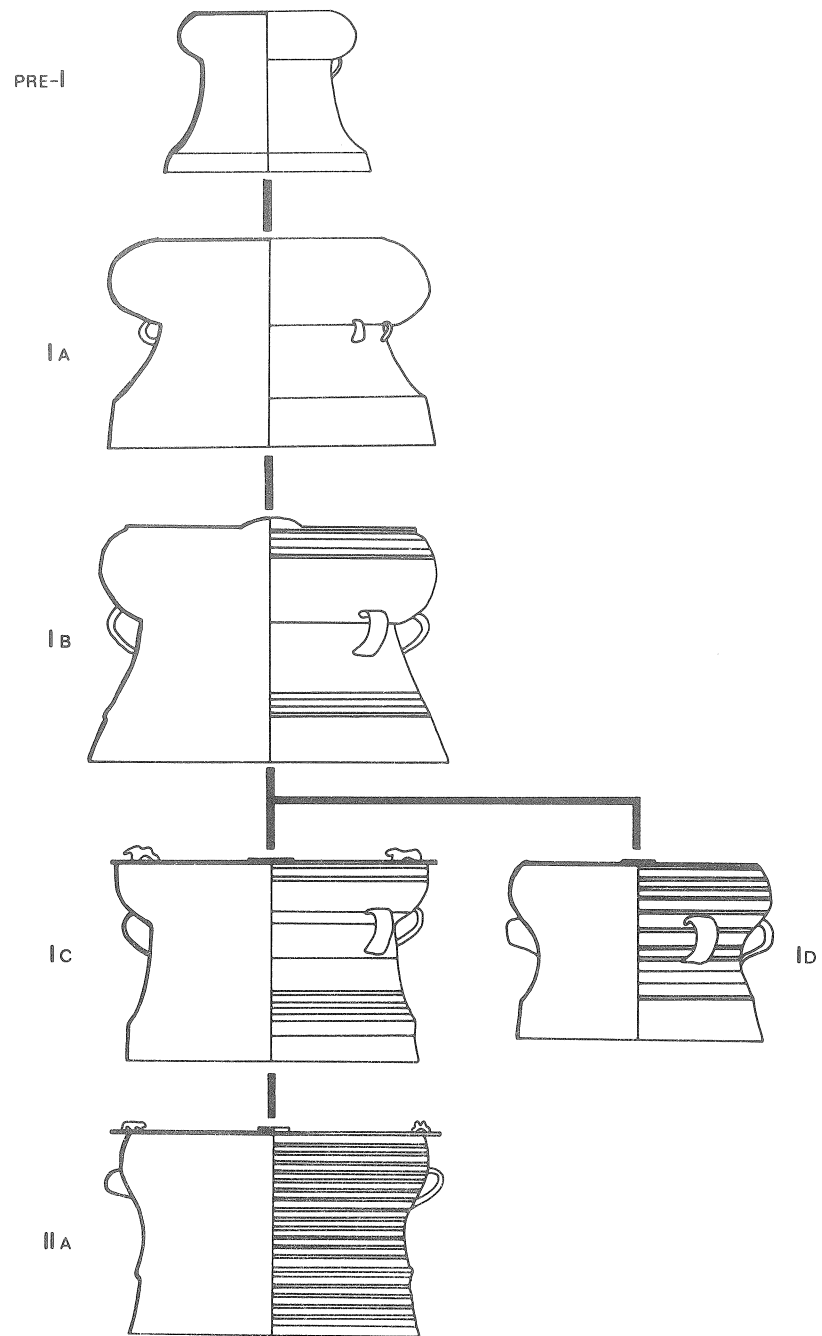


Figure 1. The typology of early Southeast Asian bronze kettledrums.

Although the maximum distribution of these drums covers the whole of Southeast Asia, from the southern provinces of China through Burma, Thailand, Indochina (with a certain lack of finds in southern Vietnam), and the Indonesian Archipelago to as far east as New Guinea (see Figure 2), most specimens have been found in southern China and northern Vietnam. Most recent studies on these drums have concentrated on problems of chronology, typology and stylistic analysis (Bunker 1972; Sheng 1974; Smith 1979; Weiqing 1979; Spennemann in press a). The remainder of this current contribution, however, will not focus on these issues but solely on the metal composition and implications for chronology.

The composition of the bronze alloy - especially the proportion of tin and/or lead added to the copper - is partially a reflection of the intended use of the object to be cast. In general, the bronze artisan has to deal with three basic use categories for bronze alloys:

- 1) Alloys for weapons and tools
- 2) Alloys for personal ornaments
- 3) Alloys for vessels and outsized objects

For example, hardness and malleability are crucial attributes for the production of weapons. Once useful recipes for alloys have been developed and established they tend to be stable over long periods of time.

Alloys entirely different from those used for weapons, however, are required for casting personal ornaments, and an increased runniness of the alloy is very useful for casting intricately decorated ornamental objects. This characteristic may be obtained to a certain extent by adding the well known and widely used tin. The most useful metal to be added, however, is lead, since it both lowers the melting-point significantly and increases the ability of the alloy to fill a mould without flaws.

Increased percentages of tin affect mainly the colour of the bronze - a characteristic employed in Indonesia for decorative purposes (Huyser 1939):

- 10% tin gives a red to yellow-red bronze;
- 10-15% tin gives an orange-yellow to yellow bronze;
- ca. 24% tin gives a blue-red bronze;
- 30-50% tin gives a grayish or whitish bronze.

For the casting of huge and comparatively thin bronzes such as drums the artisan needs considerable skill. A major potential problem is that the bronze might cool too early, thus producing an imperfect cast. Addition of a considerable proportion of lead is one major solution to this problem, and the pre-heating of the mould in a kiln-like construction of bricks piled around the mould is another. In fact, the latter is the method usually employed in the Southeast Asian region for casting large bronze Buddha statues (Grisvold 1952).

	Type*	Cu	Sn	Pb	Reference
CHINA					
Wanjiaba (M23:158)	pre-Ia/Ia	95.63	0.00	0.00	Yunnan 1983
Wanjiaba (M1:1)	pre-Ia	97.52	0.16	0.60	Yunnan 1983
Shizhaishan	I	82.95	15.07	0.55	Pirazzoli 1974
Dabona	pre-Ia/Ia	87.96	6.87	3.46	Pirazzoli 1974
VIETNAM					
Binh Phu, Thu-Dau-Mot /1	I	50.80	12.34	11.88	Malleret 1958
Binh Phu, Thu-Dau-Mot /2	I	61.0	12.1	13.8	Malleret 1958
Dak Glao, Kontum /1	I	57.91	23.02	5.22	Malleret 1958
Dak Glao, Kontum /2	I	54.4	19.1	12.0	Malleret 1958
Quang Xuong, Thanh Hoa /1	I	45.8	13.3	20.7	Malleret 1958
Quang Xuong, Thanh Hoa /2	I	64.0	17.7	Trace	Malleret 1958
Thanh Hoa I /1	I	73.7	5.9	5.8	Malleret 1958
Thanh Hoa I /2	I	74.5	9.9	4.43	Malleret 1958
Thanh Hoa II /1	I	69.85	12.96	2.39	Malleret 1958
Thanh Hoa II /2	I	65.1	12.0	1.5	Malleret 1958
Dong Van, Cao Bang /1	I	68.6	19.1	1.5	Malleret 1958
Dong Van, Cao Bang /2	I	61.91	26.09	1.22	Malleret 1958
Giao Tat, Bac Ninh	I	66.2	9.9	19.5	Malleret 1958
Co Loa I	I	85.42	6.54	6.18	Huyen 1984
Co Loa II	I	54.18	1.84	1.59	Huyen 1984
Dong Dau	I	53.79	0.75	1.59	Huyen 1984
My Loc	I	61.6	0.4	18.5	Huyen 1984
Dinh Cong I	I	47.41	2.77	8.3	Huyen 1984
Dinh Cong II	I	52.63	0.44	16.65	Huyen 1984
Dinh Cong III	I	44.35	2.35	25.65	Huyen 1984
Thanh Hoa Museum	I	62.63	0.46	20.0	Huyen 1984
Hoang Ly	I	71.72	0.27	4.35	Huyen 1984
MALAYSIA					
Kampung Sungai Lang A/1	Ib/c	69.9	9.9	18.5	Treloar 1976
Kampung Sungai Lang A/2	Ib/c	70.2	10.5	15.2	Treloar 1976
Kampung Sungai Lang B/1	Ib/c	79.8	11.5	7.8	Treloar 1976
Kampung Sungai Lang B/2	Ib/c	75.3	10.5	11.3	Treloar 1976
Klang, Fragment 1	I	67.8	9.4	21.0	Malleret 1958
Klang, Fragment 2	I	68.2	9.3	20.4	Malleret 1958
Tembeling, Fragment 1	I	65.1	7.5	18.3	Malleret 1958
Tembeling, Fragment 2	I	68.9	6.5	21.8	Malleret 1958
INDONESIA					
Lake Kerinci, Sumatra	I	84.04	11.55	3.94	Pirazzoli 1974
Kur, Kai Islands	I	71.3	12.7	15.82	Steinmann 1942
Majbrate, New Guinea	Id(?)	78.9	6.35	13.8	Elmberg 1959

* Many drums analysed for their metal compositions are insufficiently published or not published at all, so detailed typological assignments to subtypes cannot be undertaken. These drums are simply classed as Type I.

Table 1: Bronze alloys of Southeast Asian kettledrums with Heger I profiles.

		Cu	Sn	Pb	Reference
WANJIABA					
Socketed axe	(M1:50)	98.37	0.00	0.00	Yunnan 1983
Hoe/spade	(M1:82)	99.5	<0.01	0.02	Yunnan 1983
Arrowhead	(M1:8)	96.04	2.2	0.2	Yunnan 1983
Hoe/spade	(M1:76)	97.4	<0.01	0.19	Yunnan 1983
Spearhead	(M3:410)	99.5	0.01	0.02	Yunnan 1983
Spearhead	(M23:266)	97.95	0.00	0.00	Yunnan 1983
Arrowhead	(M23:426)	97.55	1.85	0.02	Yunnan 1983
Socketed axe	(M23:24)	99.78	<0.01	0.058	Yunnan 1983
Arrowhead	(M65:5)	95.65	0.00	0.00	Yunnan 1983
Socketed axe	(M23:13)	98.01	1.4	0.59	Yunnan 1983
Socketed chisel	(M23:213)	92.95	6.5	0.00	Yunnan 1983
DABONA					
Spearhead		93.75	2.35	0.62	Pirazzoli 1974
Hoe		92.77	0.19	0.00	Pirazzoli 1974
Socketed axe		94.20	3.71	0.00	Pirazzoli 1974

Table 2: Bronze alloys of tools and weapons from southern China.

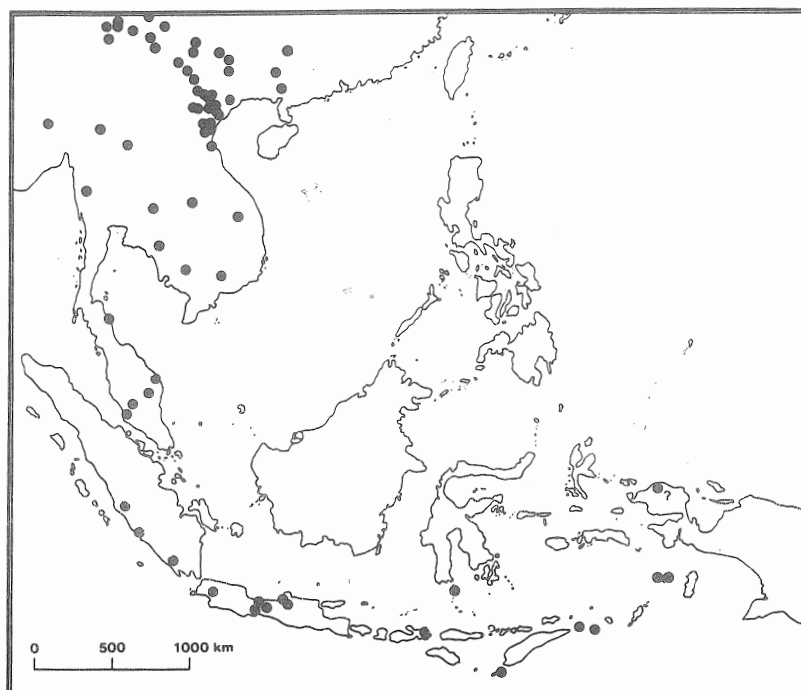


Figure 2. The distribution of Heger type I drums in Southeast Asia.

A compilation of all published analyses of the metal content of drums with Heger I profiles is given in Table 1. It can be observed that alloys with a high proportion of lead occur mainly in Vietnam, the Malay Peninsula and Island Southeast Asia, while the southern Chinese drums and some from Vietnam show alloys with almost no lead added at all, i.e. alloys comparable to those used for weapons and tools in the same period (see Table 2).

The chrono-typological evolution of drum profiles as proposed by Li Weiqing (1979) and the present author (Spennemann, in press a, b) is outlined in Figure 1. As may be seen in Figure 3 the regional distribution and relative frequency of the different drum types coincide with the assumed southward expansion of drums or the drum-manufacturing tradition into Island Southeast Asia¹. This expansion into the Malayan Peninsula and Indonesia must have happened during the period when drum profiles Ib, Ib/c (transitional) and Ic were in vogue. Not only the Indonesian drums, but also the typologically late Heger I drums from North Vietnam show a high proportion of lead.

It seems that the proportion of lead in the alloy may be used for the chronological assessment of drums. The tendency towards an increasing lead content over time is confirmed by the recently published find of drums from Wanjiaba (Yunnan Sheng Bowuguan 1983). Those with pre-Ia, pre-I/Ia (transitional), and Ia profiles are so far the oldest Heger type drums both chronologically and typologically². The bronze alloys found in the Wanjiaba cemetery have been analysed, and for drums, tools and weapons alike it has been shown that almost no lead was used at all (Table 2). For typological reasons it is very likely that the evolution of the Heger type drums may have started around the time this cemetery was used (Spennemann, in press b).

It is justifiable to assume that bronze artisans used the alloys already well known to them (i.e. those used for weapons and tools) when casting large drums and cauldrons for the first time. As time passed by, the alloys were improved and adapted to new needs. As far as can be judged from currently excavated drums, production started and slightly increased during the Warring States Period. It was boosted tremendously during the period of the Western Han, as documented by the numerous drums found in the major Dian cemeteries of Shizhaishan, Lijiashan and Taijishan.

- 1) Northern Vietnam has yielded some 130 drums of the Heger I type, but only a few have been published satisfactorily with drawings or photographs. Only these, however, have been used for classificatory purposes in Figure 3.
- 2) Only the drum of Dabona is typologically older than the ones from Wanjiaba, but it derives from a much younger context. It is very probable that some drums were in use for considerable periods of time, and burial contexts provide termini ante quem only.

Though the available series of analyses is small and insufficient, it cannot be overlooked that over time the proportion of lead steadily increased in alloys used for casting drums. A similar trend based on wider data has been observed for other bronzes in northern Thailand (pers. comm. N. Seeley and A. Bennett). Data currently available do not allow one to date single drum fragments too small to be classified otherwise. However, in view of the steadily increasing number of metal analyses undertaken on Southeast Asian artefacts it is likely that a better data base will be provided in the near future.

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	prae-I	Ia	Ia/b	Ib	Ib/c	N
CHINA						25
VIETNAM & THAILAND						17
MALAYA						5
INDONES.						10

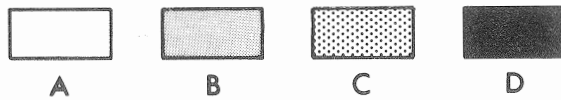


Figure 3. Distributions of the early sub-types of Heger I drums in Southeast Asia. The data base comprises only those drums which can be assigned to different sub-types by published illustrations. Shadings A to D represent increasing frequencies of occurrence for each sub-type.