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Material, making and measurement : The development and functional changes of Tube zither in China

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Abstract:Bamboo tube zither is a very popular instrument in coastal countries and regions of Asia. As bamboo is used as the main material, it has a long history, but no physical material has been preserved, so that scholars still cannot predict the origin time. Despite this, Bamboo tube zither still plays an important role in the music of china, and due to population migration, ethnic and cultural influences, the instruments are made and shaped differently. To understand the distribution and development of Musical Instruments, I have utilized theories from the field of ethnomusicology and organology. At the same time, based on the research of previous scholars and my own field work, I finally sorted out and analyzed the current distribution, shifts and development of this kind of musical instrument in china.

Keywords:tube zither; material; functional; measurement

Introduction

A instrument made of bamboo which has two(or more) strings made by lifting up thinstrips from the hard skin of the bamboo tube itself. Small individual wooden(or bamboo)bridges are inserted at both ends of each string(Lee,2019:72-91).

The instrument is found in various Asian countries, such as China, Philippines, Indonesia, Java, Vietnam, and even Madagascar. From the way of playing, the instrument can be played by striking the strings with wooden sticks, plucking the strings with fingers, directly hitting the instrument against the ground to make a sound, and even drawing with a bow. According to the H-S (Hornbostel-Sachs) instrument classification, these instruments can be divided into Percussion tubes(111.231), Idiochord tube zithers(312.11), Heterochord tube zithers(312.12)and Idiochord half-tube zithers(312.21).

Literature review

Bamboo tube zither is a musical instrument from the southeastern coastal areas of China (Lu & Yang, 1993). It is used by many ethnic minorities in China. The tube zither of the Yao people has a simple structure and rough production, and even retains more of its natural state and originality. Style (Qin, 2001). Regarding the evolution of the tube zither, Wang Qi of the Ming Dynasty of China once described this instrument in a monograph, including its shape, size and production principles. He also believed that the traditional Chinese musical instrument "Zhu" evolved from this instrument. It is also the earliest one discovered in China. Introduce tube zither ancient literature. At the same time, Japanese scholars believe that ancient Chinese string instruments such as zither, zither, and zhu all evolved from semi-tubular zither and round tubular zither (i.e., tube zither) (Kenzo , 2013). Of course, some scholars in China have proposed that this instrument is the origin of other stringed instruments in China. The instrument progresses from simple to complex and from rough to perfect (Yang, 1987). This instrument is currently found in the mountainous areas of western Guangxi and southern Yunnan, China. There are still remains (Xiang, 1992).

Regarding the production process of tube zither, it mainly includes the four steps of making strings, cutting out strings, installing piano keys and opening sound holes. It is also believed that the bamboo zither in Nandan can achieve similar sound effects to bronze drums through different playing methods (Yang et al. , 1984). Although there are big differences in the shapes of tube zither and bronze drum, the two instruments are similar in playing methods and occasions due to the same environment, language family and culture (He, 1994). Of course, there are also many scholars who want to improve this instrument, including the volume, timbre and melody of the instrument.

Regarding the function of the musical instrument, although the music played by this instrument generally has a relatively simple melody, it has a lively rhythm, rich sense of movement, and has the simple characteristics of primitive music (Qiu, 1994). At the same time, the tube zither has a close relationship with the Guangxi bronze drum, both of which are important instruments in the folk activities of the Baiku Yao nationality (Guo, 2011). In addition, the tube zithers of Nandan and Tianlin counties in Guangxi, China vary according to folk activities. Among them, the Nandan area is mostly used in ensembles with bronze drums for funerals and sacrificial activities, which has a strong ritual and various playing methods (Jia, 2016).

Methods

This article is a qualitative study. The author will introduce the tube zither of some ethnic minorities in Guangxi and Yunnan, China, including the production and shape of the instrument, and then explore the functions of tube zither in different regions. In addition to playing, this instrument is

also used in China What role does it play among ethnic minorities? In addition, some scholars in the literature review believe that this instrument has similar playing methods, occasions and sound effects to Guangxi's bronze drums. The author will use vocal music measurement to verify whether it is true.

Results

Types and Evolution

Although the history of the Chinese tube zither cannot be traced back, we cannot know who first made this instrument. However, this type of instrument still exists in Guangxi, Yunnan, and Taiwan, China, and is widely used in various entertainment, worship, or ritual activities, indicating that the instrument still has an important position in different folk cultures. In order to further study the Chinese tube zither, the author will describe the acoustic characteristics of this type of instrument, select the most common type as a case for acoustic analysis, and provide a detailed introduction to the shape and evolution of various tube zithers.

（1）Acoustic Characteristics

According to the acoustic characteristics of music, a complete instrument consists of four parts: the vibrating body (such as strings or reeds), the exciter (bow or drum), the resonator (soundboard or resonant box), and the tuning device (the keys of a trumpet). Even simple instruments have vibrators and exciters, otherwise they cannot produce sound (Han 2016:112). In addition, some instruments also have transmission devices, such as the frets of various stringed instruments.

In order to have a more detailed understanding of the tube zither, which is a type of Chinese instrument, Figure 1 is selected for analysis, although it is very primitive among similar instruments in Southeast Asia.

The vibrating body usually refers to the strings of a stringed instrument or the reeds of a wind instrument. The vibrating body of the tube zither is composed of bamboo strings at both ends of the instrument. The causative body is the hammer of a piano or the bow of a violin, while the exciter of the tube zither is a bamboo (or wooden) stick. The resonator refers to the soundbox of a violin or the soundboard of a piano, while the resonator of the tube zither is a closed bamboo tube (with bamboo nodes at both ends). If the tube zither is regarded as a stringed instrument, the frets below the ends of the strings can be seen as bridges connecting the strings and the bamboo tube, allowing the vibration of the strings to be transmitted to the entire instrument and amplifying the energy of the sound (a). Some tube zithers in certain regions of China also have a device to control the sound

and performance of the instrument. A circular hole is opened directly below two strings, and different sound effects can be produced by pressing or releasing the hole with the thumb while playing the instrument (b).

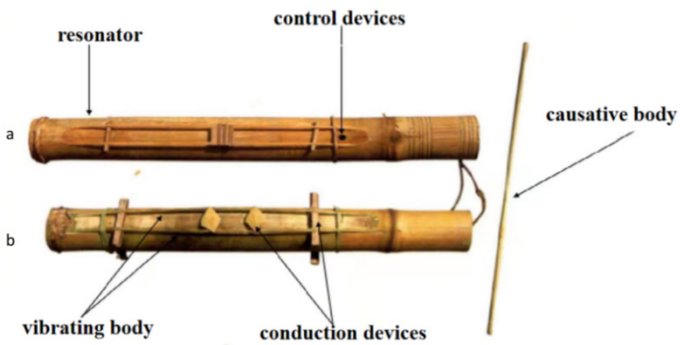

Fig.1 The tube zihter consists of a vibrating body, resonator, regulating device, conduction and control devices. Photo:Yuan Shouyu,2019.

（2）Initial Shape

The production process of the tube zither, which was first created, may have been simple. According to the earliest Chinese literature on the tube zither, the Ming Dynasty (1638-1644 AD) tube zither was made of bamboo that was three to four feet (96-128 cm) long, with the bamboo skin serving as the strings. During performance, the strings needed to be supported and tightened with a code (Wangqi, 1607:27). Another viewpoint suggests that the Chinese tube zither belongs to the primitive idiochord family, from which traditional Chinese instruments such as the qin and zheng have evolved (Kenzo Hayashi, 2013:142). Currently, there are still similar instruments in Taiwan, which are in their most primitive form. The Saisiyat people in Taiwan call it kango 'ngo. The kango 'ngo' an slit drum is made of a bamboo tube that is around 6 to 10 cm wide and 45 to 65 cm long. The lip of the kango 'ngo' an has been thinned by shaving off one side of the bamboo outer layer. The thin outer layer of the bamboo tube has been cut with two parallel slits, and two bamboo slips have been inserted under the thin outer layer at the two ends of the bamboo slit for good resonance(Lancini and Jenhao Cheng,2015:106-107).

（3）Changes in Shape I

Similar to other Southeast Asian countries, the strings of the Chinese tube zither were originally made of bamboo skin, which seems to have some kind of origin or connection. After observing similar instruments in Asia, the author found that people in the past had made improvements to these instruments in order to produce a louder sound. The tube zither in China also underwent some

changes in its initial shape.

1)Addition of a new device: Based on the initial shape, two bamboo strings were connected with a bamboo strip, which is called a bridge. The production of the bridge for the tube zither is very simple, and it is still used in some areas of Guangxi, China. People use a knife or axe to make a rectangular bamboo strip (approximately 5mm wide, 2mm thick, and the length is about 2mm between the two strings). The ends of the bamboo strip have gaps and are wedged onto the strings (Yuan Shouyu, 2020:54-55).

Figure 2. tube zihter in different regions of China, Hani in Yunnan (a), Yao in Hechi City in Guangxi (b), and Yao in Jinxiu County (c). (photos:Han baoqiang,Yuan Shouyu)

At the same time, different regions (or ethnic groups) in China use different numbers of bridges when making instruments. The Hani people in Xishuangbanna, Yunnan Province, often install only one bridge when making a tube zither (Figure 2a). The Yao people in Hechi City, Guangxi Province, have two or three bridges (Figure 2b). The Yao people in Jinxiu County, Guangxi Province, even have five (or more) bridges (Figure 2c). Generally, the purpose of the bridge is to make the two strings sound simultaneously and to produce a louder sound. If these two conditions cannot be met simultaneously, the number of bridges needs to be increased continuously.

2)Adding an enlarged sound hole: Use a knife or other tool to create a hole on the instrument that can amplify the sound.

We believe that when the sound produced by the two strings of the Chinese tube zither cannot meet people's needs, the instrument will be improved again, as similar phenomena have occurred in many Southeast Asian regions. In Karangjati and Banjarnegara Regency in Central Java there is an instrument called the gumbeng, when you hit one of the joined strings, this bridge freely vibrates,

a small hole below it sending the sound to reverberate throughout the instrument. In Curug Cibareubeuy, West Java, a similar instrument called celempung is usually cut with a knife at the top (or end) of the instrument to obtain a louder sound.

This method of making the instrument louder has been discovered in various parts of Asia by cutting a hole (sometimes two) on the instrument. The Chinese tube zither will have two holes to increase the volume. People will use heated iron tongs to burn a circular hole on the bamboo tube, which is located directly below the bridge. If the sound produced is still not satisfactory, the maker will need to chisel a hole on the top of the instrument with a knife (size or shape is not required).

3)Adding a hole to change the sound effect: Usually, another circular hole will be added to the instrument, which can be controlled by the fingers. This special circular hole currently only appears in the tube zither used by the Yao people in Nandan County, Guangxi, China, and they call this instrument Zarong or Zawentong. This special circular hole is located at the position of the thumb (when the player holds the instrument, the thumb can just cover the circular hole). When people play, they will use bamboo (or wooden) sticks to strike the strings, and the other hand will hold the instrument while using the thumb to press the circular hole. From the sound effect, when the strings vibrate, they produce sound, and the thumb controls the circular hole on the bamboo tube to change the airflow inside the bamboo tube, thereby producing another sound effect.

(4) Changes in Shape II

There is no doubt that the manufacture and improvement of musical instruments is aimed at achieving better performance or more convenient playing. If the instrument frequently breaks down or has problems during performance, the maker will make improvements. The Chinese tube zither is no exception. It is certain that the appearance of the bridge did indeed make the tube zither produce a louder sound during performance, but the bridge made up of several bamboo skins often deviated or fell off during performance (according to oral accounts from the Yao makers in Guangxi, China). In order to solve this problem, makers began to try using other materials, and similar methods have also appeared in other countries. The Sundanese people in West Java play a tube zither called Celempungan. Although it is not known who first improved it (or whether it has ever been improved), the bridge is made of thick bamboo pieces tightly clamped between two strings. In addition, the Celempung instrument in the Curug Cibareubeuy area of West Java also places a thick bamboo piece between two strings, but it is usually hexagonal in shape, which is more artistic.

Similar changes have also occurred in the Chinese tube zither (although there is no literature to verify it). At some point in history, the makers made the bridge into a regular hexagon shape, similar to the Celempungan in West Java. According to the author's field investigation, the Yao tube zither

in some areas of Tianlin County and Nandan County in Guangxi uses regular hexagonal wooden or bamboo blocks to make the bridge. The locals believe that this shape can be more stable (less likely to fall off) and can better transmit sound (Yuan Shouyu, 2020:16).

（5）Changes in Shape III

Japanese scholar Kenzo Hayashi once proposed that the Chinese qin and zheng evolved from the tube zither. Chinese scholar Xiang Yang agrees with this view and proposes that makers may have changed the resonator of the instrument from bamboo to wood due to climate, materials, different regions, and aesthetics (Xiang Yang, 1993:58-64). Although there is no literature to record it, it can be confirmed that at some point in Chinese history, the material of the tube zither changed from bamboo to wood, and the bamboo skins of the strings were replaced with other materials (silk, iron wire, copper wire, etc.). The tube zither also changed from idiochord to heterochord. However, in the process of forming a revolutionary change, we believe that the tube zither also underwent another change. Although it cannot be proven by literature or artifacts, it can be certain that the tube zither formed independent strings during its development. Makers changed the way the instrument was made, increased the thickness of the strings, and made the strings more sturdy (less likely to break), and each string could produce a fixed pitch and meet people's needs. Perhaps this new shape and playing method is a step or link in the process of the tube zither changing from idiochord to heterochord, or perhaps it is a new instrument formed in the development of the tube zither (belonging to the same sequence as the traditional Chinese instruments zheng and qin), but it cannot be denied that this shape is common in China and Southeast Asia.

1)Each string can produce a fixed pitch: this type of instrument is more common among the Zhuang people in Tian'e County, Guangxi, China, and is called Tongdeng. This instrument usually has four strings, and each string is carved out by the maker with a sharp tool (such as a hammer hitting a knife into the surface of a bamboo tube). The thickness of the string is about 0.3-0.5cm, and the ends of the string are installed with tuning pegs to make the string more tense, and the pitch of the string can be adjusted through the tuning pegs.

2)Other changes in manufacturing techniques: because each string can produce a fixed pitch, there is no longer a need for a bridge (and a circular hole located under the bridge). Tongdeng only has a hole carved out at the top of the instrument, which is approximately half the diameter of the instrument (Table 1).

Tongdeng		No.1	No.2	No.3
Bamboo tube				
	Length	66	72	67
	Diameter	8.1	8.9	8.5
String				
	Length	62.5	67.2	64.6
	Width	0.29	0.26	0.27
	Thickness	0.18	0.2	0.19
Code				
	Length	0.5	0.51	0.52
	Width	0.24	0.22	0.28
	Thickness	0.31	0.33	0.29
Irregular hole				
	Maximum diameter	4.3	4.6	4.2
	Minimum diameter	3.5	3.4	3.7

Table 1 Measurement data of three Tongdeng in Tiane County, Guangxi

After analyzing the evolution of the shape of the Chinese tube zither, the author found that the original tube zither was only played by striking its own bamboo skin on the bamboo tube, and as the demands of music increased, people continuously improved the instrument. Through the author's field research, it was found that: 1) currently, the tube zither is only used in Taiwan, Guangxi, and Yunnan provinces of China. 2) The kango 'ngo in Taiwan is the closest to the original shape and is similar to the description in the Ming Dynasty literature. 3) The tube zithers in Guangxi and Yunnan mainly have variations in shape I and II, with only differences in the shape of the bridge. The Yao people in Jinxiu County and Nandan County of Guangxi and the Hani people in Yunnan use bamboo pieces (one or more) as bridges, while the Zhuang people in Tianlin County and Nandan County of Guangxi use hexagonal bridges. 4) Currently, only the Tongdeng in Tian'e County, Guangxi, has four bamboo skin strings, and each string can play music individually.

Function

The tube zither, as a traditional and important instrument in China's ethnic minority areas, has been closely linked to the culture of its ethnic group since its inception. According to the author's field research and analysis, the functions of this instrument mainly include educational and instructional functions, ritual and ceremonial functions, and social and entertainment functions.

（1）Entertainment Function

In China, the tube zither is sometimes used as a toy for children, so there are no specific requirements for pitch or volume. It is also used as a social tool, with young men and women accompanying each other by tapping the bamboo tube zither and singing together to express their feelings. In addition, the bamboo tube zither also plays an important role in some festivals and occasions. In some areas, it is also used in dance performances, with the performers moving or jumping according to the changes in the instrument's sound effects and rhythm. The Zhuang people in Tianlin County, Guangxi, play the tube zither solo during the New Year period to celebrate the festival.

(2) Mobilization Function

People in different regions use the tube zither to call or warn nearby people, similar to modern broadcasting or whistling. For example, the tube zither in the Dayao Mountains of Guangxi and the Wa ethnic group in Yunnan are often used as tools to mobilize the masses, and the tube zither in the early days of the Wa ethnic group in Yunnan was also used as a tool to mobilize the masses.

(3) Training Function

As a musical instrument, Zarong is currently only used by the Yao people in Nandan County, Guangxi, China to replace the bronze drum for daily performances. The bronze drum is an important musical instrument for ethnic minorities in southern China and is often used as a sacred object for worship. The Yao people in Nandan County, Guangxi believe that playing the bronze drum during funerals is a way to express mourning for the deceased and to help them enter another world peacefully (Liang Fulin, 2005). As a result, the utilization and gathering of bronze drums are subject to stringent requirements, necessitating rituals before and after each use. Additionally, each bronze drum is clandestinely collected by an individual of the highest status. To accommodate daily practice, locals must resort to alternative instruments resembling the brass drum. Consequently, a regulation has been established in this region mandating that individuals must first learn to play Zarong before attempting to master the bronze drum.

(4) Ritual function

Through field investigations and data collection, it has been found that the tube zither is still used in various ceremonies in Guangxi and Yunnan provinces of China. The Dai and Jingpo people in Dehong, Yunnan use the tube zither as a tool to drive away evil spirits. The local people call the shaman of the Jingpo's primitive religion "Dongsa". They often play the tube zither by plucking or striking the strings with bamboo pieces, while reciting prayers to complete the ceremony. The Zhuang people in Tian'e(Parts of Nandan) County, Guangxi regard the frog as a messenger of the gods and hold a ceremony for the frog every spring (the time of the ceremony varies in different

regions). The ceremony usually lasts for two days, during which people pray for a good harvest by striking the bronze drum. However, since the bronze drum is expensive and intricate to make, not everyone can afford it. Therefore, a musical instrument called Tongdeng has gradually emerged in the Tian'e area to replace the bronze drum in the performance. Compared with the bronze drum, the playing method of Tongdeng is basically the same, and the locals believe that the sound effect is similar and only one person is needed to play it. In the past, there were often scenes of rich people playing the bronze drum while poor people played the copper clapper in the frog festival ceremony. The bronze drum was often at the front of the procession, followed closely by Tongdeng.

Discussion

After discussing the distribution, evolution, and function of the Chinese tube zither, it was found that most tube zithers in different regions have similar shapes and functions to those in Southeast Asia. For example, the kereb (tube zither) of the Orang Asli tribe in Malaysia is mainly played by women for entertainment, and a similar entertainment function can also be found in the Cordillera region of northern Philippines. In the Simalungun region of Sumatra, people play a tube zither called jatja'ulul, which is mainly used in ancient religious ceremonies. Perhaps the tube zithers in Asia have a common origin, although there is no literature to support this. However, due to cultural differences, tube zithers have different functions in different countries and regions, which also leads to some differences in their production. Through field research, the author found that there are two types of tube zithers in China that are similar to those in other Asian regions in terms of culture and function: 1) Zarong of the Yao ethnic group in Nandan County, Guangxi, has a special round hole that is different from other similar instruments, and 2) Tongdeng of the Zhuang ethnic group in Tian'e County, Guangxi, has improved the instrument to produce a fixed pitch for each string, which may create a sound similar to that of bronze drums. The author will also provide a detailed analysis and discussion of these two issues.

In order to train

The Yao people in Lihu Township, Nandan County, Guangxi, China to play a musical instrument called Zarong, which is different from all the tube zithers in China. In the process of making the instrument, the maker not only selects bamboo tubes, makes strings, bridges, and holes, but also needs to make a circular hole at the position of the thumb (when the player holds the instrument), which can be opened or closed by the thumb when striking the strings, changing the airflow inside the bamboo tube and creating a special sound.

After field investigations in the area, the author found that this method of making the instrument is not accidental. As mentioned in Chapter 3, local people love to play bronze drums, but bronze

drums are extremely precious instruments that people cannot touch in their daily lives. Therefore, they have to use other instruments as substitutes for practice, and the two instruments are basically the same in playing style. When the Yao people in Lihu Township, Nandan County, Guangxi play bronze drums, in addition to one person using a wooden hammer to strike the bronze drum, another person holds a wooden barrel to deliver airflow into the bronze drum to make the sound more mellow and beautiful (Yu Shijie, 1989). This special playing method was popular among ethnic minorities in Guizhou and Guangxi, China, but now only the Yao people in Lihu Township, Nandan County, Guangxi, have retained this playing method.

After comparing the local bronze drums and Zarong, the author found that Zarong added a special circular hole for daily training. Since people cannot practice bronze drums every day, they use Zarong instead. However, when playing bronze drums, a wooden barrel is also needed to produce a special sound effect. Of course, not everyone can improvise and play with a wooden barrel. The player who strikes the bronze drum and the person who holds the wooden barrel need to have enough tacit understanding and practice. When playing Zarong, people not only need to practice the rhythm of striking the bronze drum, but also need to practice how to play the wooden barrel. Therefore, the maker improved Zarong by adding a special circular hole and using the thumb to imitate the airflow delivered by the wooden barrel. Although the history of Zarong is much longer than that of bronze drums, it may have undergone changes in the production process only when used as a tool for practicing bronze drums. Since there is no literature record, it cannot be determined which one came first, but Zarong with a special circular hole for training may not have been accidentally discovered, but was made through continuous attempts on a more primitive instrument, and finally improved the production process to obtain an instrument with a sound effect similar to that of bronze drums.

In order to imitate

The author's findings through historical literature sorting and field investigations, Tongdeng in Guangxi had the same status and function as local bronze drums in the early days. Poor people needed to play bronze drums to pray to the gods, but because they did not have enough money, they could only use Tongdeng instead. They believed that this instrument could produce a sound effect similar to that of bronze drums.

In order to explore the similarity between the two instruments, the author analyzed the acoustic performance of the instruments and compared their sounds using modern vocal measurement software. 1)The measurement tool:General Musical Analyse System (GMAS), which was developed by Professor Han Baoqiang of the China Conservatory of Music and only supports Windows platform. The equipment used in the experiment was the latest version of GMAS2.0. GMAS mainly consists

of three modules: audio signal acquisition, FFT (Fast Fourier Transform) and analysis. It converts analog signals (sound sample fragments) into digital signals through a sound card and a microphone, and uses Fourier transform analysis to obtain a frequency spectrum image. The measurement personnel select the harmonics in the spectrum, and the software automatically displays the peak frequency and the corresponding subjective pitch and sound intensity.

2)The measurement location:Intangible Cultural Heritage Protection and Inheritance Center in Teng County, Guangxi, China.

3)The instruments measured:Four Tongdeng and two bronze drums.

4)The measurement results: Table 2.

Table 2 Acoustic comparison between Tongdeng and bronze drum

Serial number	Pitch (Hz)			
	First string	Second string	Third string	Fourth string
TongdengI	A4-3 (441.45)	E4-11 (329.16)	#G4-38 (408.16)	B3+8 (249.19)
TongdengII	G4-42 (384.55)	#A4-3 (467.61)	G4+47 (404.84)	#C5-30 (547.60)
TongdengIII	#C4+15 (281.02)	B3-46 (241.48)	A3-6 (220.18)	F3-39 (171.50)
TongdengIV	D4-13 (292.91)	D4+2 (295.35)	#A4+20 (473.78)	B4+5 (497.71)

After acoustic measurement of 4 Tongdeng and 2 bronze drums, the author found that although the Tongdeng has four strings and four notes, and the pitch of each instrument is not fixed, there is always one note in the four strings that is close to the pitch of the bronze drum. Among them, TongdengI (B3+8) and III (#C4+15) differ from the bronze drum by one semitone. Although TongdengII (#C5-30) and IV (B4+5) are close to one octave higher than the sound produced by the bronze drum, or it can be understood that the sound produced by tongdeng II (#C5-30) and IV (B4+5) is different by one semitone after one octave higher, the auditory effect is still relatively similar. It can also be seen from the measurement of the instrument and the comparison of the sound that the producer wanted to obtain the similar sound effect as the brass drum in the process of making Tongdeng, which is indeed reflected in the pitch.

Conclusion

The Chinese tube zither is mainly distributed in Taiwan, Guangxi, and Yunnan. It has similar shapes, playing methods, and functions to musical instruments in other Asian countries. Manufacturers have begun to improve the instrument to amplify the sound for performance purposes. In addition to entertainment, calling, and sacrifice functions similar to those in Southeast Asia, the Zarong of the Yao people in Nandan County, Guangxi, also has a training function, which has led to changes in the production process. The Tongdeng in Tiane County, Guangxi, is the only tube zither in China that produces a fixed pitch through a single string. Producers aim to obtain a sound effect similar to that of the bronze drum, and the author finds that this is indeed the case after analyzing modern acoustic measurement software.

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