A Bowed Bamboo Tube Zither from Southeast Asia

C. Koehn
University of Hamburg, Neue Rabenstraße 13, 20354 Hamburg, Germany
c.d.koehn@web.de

The musical instruments of ethnic minorities receive, with few exceptions, little attention outside the ethnomusicology community. This article presents a synoptic overview of the basic sound generation principles of the *kating ga-un*, a simple duo-heterochordic bowed tube zither from Southeast Asia. Its constructional simplicity locates this instrument among the most elementary representatives within the class of bowed chordophones. The instrument's morphology as well as the materials and methods of construction are briefly summarized. Characteristic features of the instrument's timbre are illustrated by the results of high-speed camera measurements of the string's transversal deflection. The Influence of the instrument's bamboo body on sound generation and propagation are discussed. Supplementary, an actual scale is shown in the form of a pitch-class histogramm.

1 Introduction

The group of musical instruments generally classified as bamboo tube zithers can be considered typical for the Western-Malayo-Polynesian linguistic area, frequently to be found, often with ethnic minorities, over a vast geographical space, extending from Mindanao in the East to Madagascar in the West. Tube zithers are commonly believed to represent a very early stage in the developmental history of the chordophone family [1].

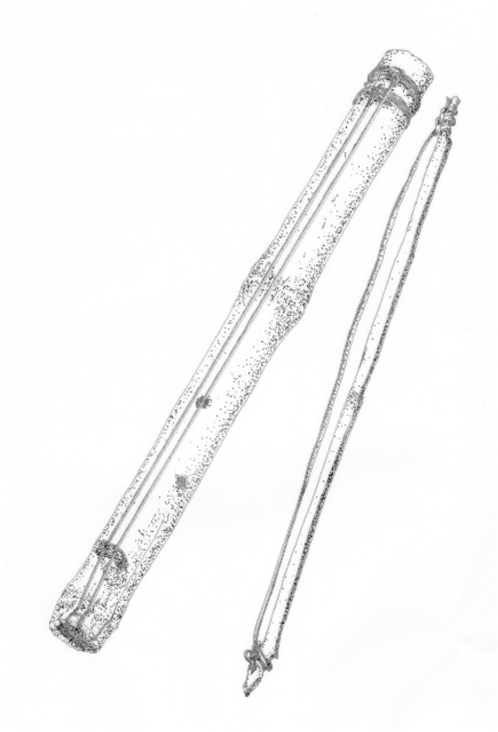

Figure 1: The Moken *kating ga-un*; bamboo body and bow stick with rattan 'hair', fishing line strings, hardwood bridge

The *kating ga-un* is the only continuous pitch instrument in use with the *Moken*, a people of maritime nomad hunter-gatherers living, until comparatively recently in relative isolation, within the Mergui archipelago off the western coasts of Burma (Myanmar) and Thailand. The *kating* is of particular significance in the context of the spiritual worldview of the Moken, the instrument's two heterochordic strings representing archetypal ancestral couples, a dyad central to Moken mythology, belief, and ethnic identity. While from the standpoint of ethnomusicology, it is this religio-cultural meaning that makes this particular instrument especially valuable as an explanatory tool, the *kating* moreover exhibits traits that render it noteworthy also from the perspective of instrumental acoustics. Most notably, while virtually all known tube zithers are either plucked or beaten with sticks or mallets, the Moken *kating* is played using a bow. It is thus an example of the rare category of *bowed tube zithers* (Hornbostel-Sachs classification: 312.121-71 [2]), none of which has as yet received attention in literature. As the author's area of competence is in ethnomusicology, this article deals with the more general aspects of the acoustics of the instrument as a whole, rather than with complex models of specific details of sound production.

2 Construction

The examined instrument's body consists of a lenght of woody bamboo culm (presumably either *Bambusa burmanica* or *B. membranacea*), 622mm long, spanning two internodes, with a diameter of 48mm in the middle of an internode and about 52mm at the nodes. The wall thickness varies between six and 7mm at the tube's ends. The internal diaphragm of the node dividing the two segments of the body has been removed; the one on the lower end is left intact. The basic shape of the instrument's body can, in good approximation, be described as a one-end-closed elongated right circular cylinder. Three small holes of approximately eight to 9mm in diameter have been burned with a red-hot iron spike through the bamboo tube's wall at irregular intervals around the internode that holds the bridge (see Fig. 1).

The strings were traditionally prepared, according to the author's Moken informants, from several types of plant fibres or alternatively from dog or shark intestines. For two generations however, plastic monofilament fishing line (i.e. mixed polymers more or less equivalent to DuPont's *Nylon*), waste from industrial fisheries found in clews as jetsam on the islands' shores, is being used exclusively. The smallest gauge of fishing line thus obtained is 0.8mm. Dunung, the most accomplished instrument maker of the Moken group the author conducted fieldwork with, regards this as being "too thick" for use as string material. According to him, in his youth (I estimated him to be in his fifties in 2010) the diameter of line found had generally been much smaller and therefore better suited for instrument making. There seems to be a causal connection to the continual increase of fishery yields in the eastern Andaman Sea over the past decades and the corresponding need for ever more resilient equipment

A single length of line is divided in half to give two playable strings by forming a bight at half-length and catching it into two slits cut into the end of the bamboo tube. The resulting two loose ends are tied to the body as illustrated in (Fig. 2). A small hardwood bridge (most likely *Zanthoxylum limonella*, family *Rutaceae*) with two guiding notches elevates the strings from the body.

The bow assembly is comprised of a narrow batten of split bamboo of the same length as the body (so it can be

Figure 2: String termination: Attachment by several tight round turns and half hitches; individual tuning of strings is achieved by twisting and sliding each knot assembly along the body, after which it is held in place by friction

stored within the body's cavity when not in use), to which a ribbon of rattan skin is fastened at both ends with knots. The player's index and middle fingers are tucked between bow stick and 'hair' to apply the neccessary tension, as can be seen in (Fig. 6). Stingless bee's wax is used to rosin the rattan ribbon before playing.

3 Sound Generation

Bamboo (*Bambuseae* with its many subtribes) has been used as a building material for many kinds of musical instruments; the bamboo culm's tubular shape almost makes it a ready-made staple for use as a resonator. As there is a large variety of individual species within the *Bambuseae* tribe, figures given for the mechanical properties of bamboo vary accordingly (for a detailed treatment see [3]). Values of around 1 g/cm^3 for density ρ and a Young's modulus E along the fibres of about 20-30 GPa can be assumed to be realistic averages. Bamboo exhibits a large sound radiation coefficient and a high characteristic impedance compared to woods commonly used as soundboard materials (i.e. spruce, pine, or fir) [4]. The contrbution of the body's surface to sound radiation is relatively minor; sound is radiated mostly from the open end of the bamboo tube, pointing towards the performer's head (see, again, Fig. 6).

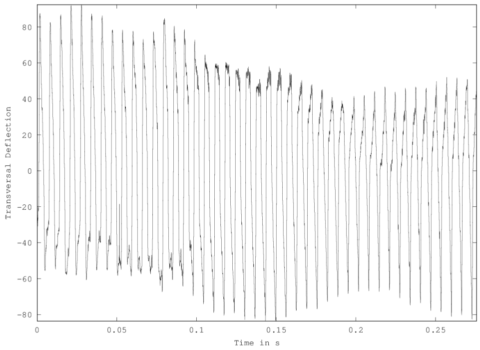

Figure 3: Transient state transversal string displacement

The purpose of the three small holes in the lower segment of the Body remains uncertain, as no significant contribution to sound radiation could be observed in the measurements.

The two strings are tuned approximately a fourth apart

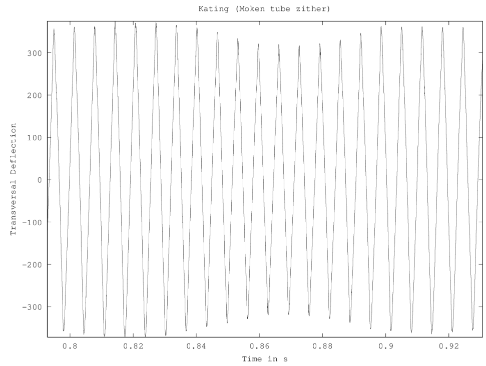

Figure 4: Steady state transversal string displacement

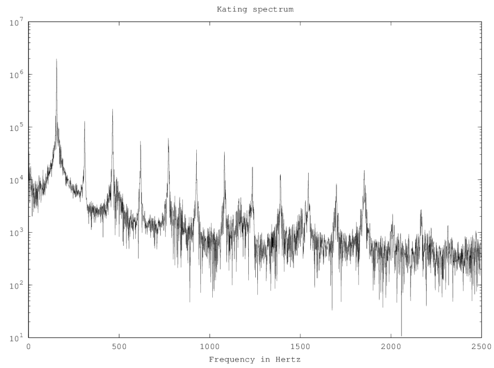

Figure 5: Spectrum shows harmonic overtone series as well as high levels of inharmonic partials, responsible for the instrument's characteristic 'rough' timbre

(342Hz and 477Hz, roughly F_4 and A#$_4$, respectively, on the actual instrument). Accuracy of the relative pitches is not considered critical by the Moken. String tension is, due to the method of attachement, comparatively low. This is most probably also the main reason for the very symmetric slopes of the steady state deflection waveform as shown in (Fig. 4), rather uncommon for bow exitation [5, 6]. Only minor traces of double-slip or fly-back motion can be observed in transient state string deflection, despite relatively low bow pressure during measurements (Fig. 3). A more detailed observation of bow-string interaction had to be postponed to a later date.

The hardwood bridge transmits the vibratory motion of the strings to the bamboo body, exiting resonances of the air column within the tube. The transfer is, however, not very efficient and the resulting sound is very quiet, yet rather rough and scratchy, as can be seen in (Fig. 5).

4 The Instrument in Use

The *kating ga-un* is commonly played to accompany song in both sacred and profane contexts. It is only the higher pitched string on which melodies are played; the lower string acts as a kind of drone, bowed every once in a while to add a certain degree of heterophony.

The *kating* is of particular significance in the accompaniment of recitations of ancestral myths [7]. The two strings are symbolic representations of ancestral couples, referred to as *luuy* and *biay*. Due to their role in a series of fateful and formative events, these mythical ancients bring forth fundamental aspects of the Moken's *Lebenswelt* and thereby lay down the ontological foundations of maritime nomadism.

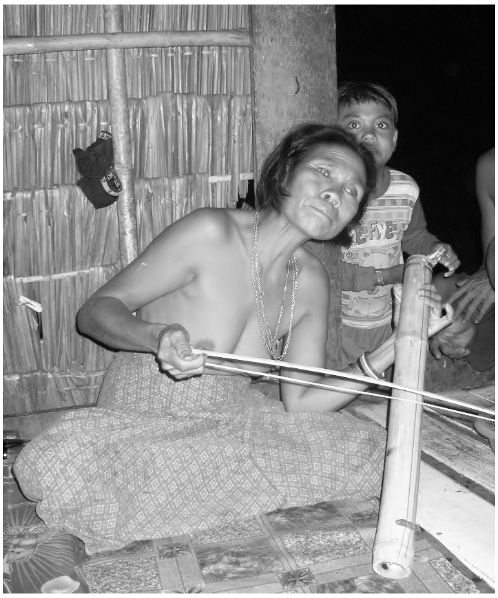

Figure 6: Moken women playing the kating at a nightly gathering; note left hand fingers placed underneath the strings to modulate tension (photo by the author, 2007)

An especially popular tune among the Moken is *djiné tichum putíak* ('song bird white'), a song about two lovers' yearning for each other. This melody is also often used as a basis for spontaneously improvised songs. The pitch contour of the song's melodical motif is shown in (Fig. 7). The pitches of the underlying four-tone scale are shown in (Fig. 8). The results of the statistical analysis of nineteen individual recordings of this particular song gave average intervals of 537cents between the drone string and the first degree, followed by steps of 162c, 174c, and 132c. This amounts to a cumulative interval between the first and fourth degree of 468c, 2,78 cents short of the narrow fourth, 21:16.

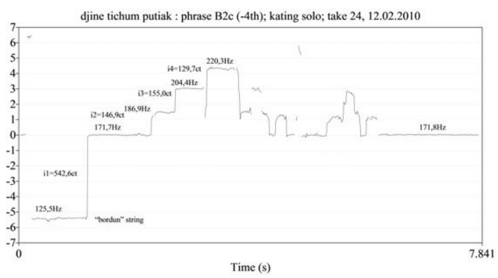

Figure 7: Pitch contour of the central motif of the melody *djiné tichum putíak*

5 Conclusion

This somewhat cursory treatment of of the elementary characteristics of the *kating ga-un* aimed at a contextualization of the instrument's acoustic and constructional properties with aspects of performance practice in relation to mythical symbolism and the religio-cultural worldview of the Moken. The radiation pattern, in addition to the overall quiet sound level, of the *kating* primarily benefits the performer rather than his audience. During the recital of ancestral myths it is he who, by means of his instrument, enters into a dialogue with the entities of the mythical past to reactualize and to validate the essential constants of maritime nomadism.

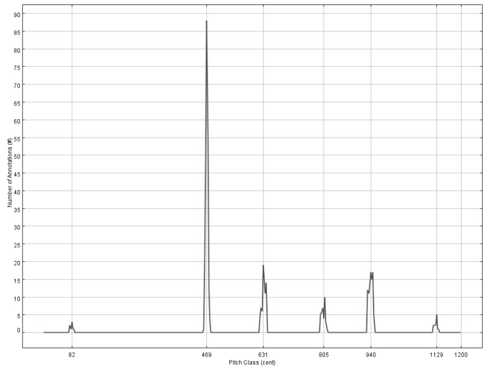

Figure 8: Histogram representation of the fundamental pitch classes of the melody *djiné tichum putíak*; filtered cumulative pitches from 1min 17sec audio recording

Acknowledgements

The author thanks Natiya Pisuthipornkul for the technical drawing of the *kating ga-un*. The pitch contour plot was made using *Praat* (Boersma and Weenink 2004-13 [8]); the pitch class histogram was created using *Tarsos* (Six *et al.* 2013-14 [9]).

References

[1] See e.g. T. Norlind, *Systematik der Saiteninstrumente, Bd.1*, Stockholm. Musikhistoriska Museet, 69-70 (1939)

[2] E. M. von Hornbostel, C. Sachs, "Systematik der Musikinstrumente: Ein Versuch.", *Zeitschrift für Ethnologie*, **46** (4/5), 553-590 (1914)

[3] J. Janssen, *Mechanical Properties of Bamboo*, Kluwer, Dordrecht (1991)

[4] U. G. K. Wegst, "Bamboo and Wood in Musical Instruments", *Annual Review of Materials Research*, **38**, 323-349 (2008)

[5] N. H. Fletcher, T. D. Rossing, *The Physics of Musical Instruments*, Second Edition, Springer, New York (1998)

[6] E. Jansson, *Acoustics for Violin and Guitar Makers*, KTH Dept of Speech, Music and Hearing, Stockholm (2002) *http://www.speech.kth.se/music/acviguit4/*, 2014-4-22

[7] J. Ivanoff, *Rings of Coral: Moken Folktales*, White Lotus Press, Bangkok (2001)

[8] *http://www.fon.hum.uva.nl/praat/*

[9] *https://github.com/JorenSix/TarsosDSP*