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An Acoustical and Historical Study of the Taiwanese Horned Fiddle: Exaptation of Musical Instruments

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ABSTRACT

The Taiwanese horned fiddle is a new member of the huqin (bowed-string instrument) family. Several components of this instrument are taken from the gramophone, such as the P-shaped tube and the horn (bell). The invention of this instrument may be related to Japanses colonial rules. Later, the development of the Taiwanese horned fiddle was related to the characteristic timbre. The horn not only results in directional effects of sound radiation, but also emphasizes a formant at 1.8 kHz. Due to this formant, the timbre of the Taiwanese horned fiddle hardly fuses with other musical instruments. Through historical and acoustical investigations of this musical instrument, the present study provides an application of the biological notion “exaptation” (preadaptation) in the field of organology.

INTRODUCTION

Organology, the science of musical instruments, has been developing in different countries and cultures with diverse topics. In China, for example, ancient musical instruments have been explored over the past decades using the methodologies of archeology and acoustics. The technical aspects of how instruments produce sound are combined with the approaches of ethnomusicology or material culture, which focus on the functions and uses of these instruments and their sounds.

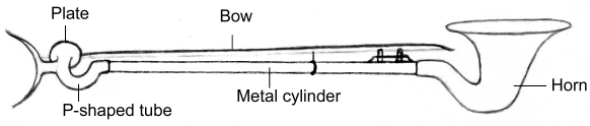
The aim of the present paper was to investigate a bowed-instrument invented in Taiwan in 1930s. Its Taiwanese name is *ko-tsue-hen*, literally “horned string”. Invention of this Taiwanese horned fiddle dates back to the Japanese colonial period (1895-1945) and may be related to the banning of Han music. After the Japanese colonial period, the development of the Taiwanese horned fiddle was related to the characteristic timbre. It has become the principal instrument in several musical genres and is associated with alien, lonely, even melancholic characters.

Through historical and acoustical investigations of this musical instrument, the present study provides an application of the biological notion "exaptation" (preadaptation) in the field of organology, i.e., a (structural) feature that fortuitously serves a new function during the evolution of this musical instrument.

CONSTRUCTION AND ORIGINS OF THE TAIWANESE HORNED FIDDLE

Looking into the construction of the Taiwanese horned fiddle gives an impression that this instrument can be regarded as a variation of the gramophone, because three of its components are taken from the gramophone. For constructing this instrument, a horn (of the gramophone) is put on the top of a hollow metal cylinder, and the P-shaped tube of the gramophone is attached to the bottom of this cylinder. On the opening of the P-shaped tube is a plate that received vibration of the string via a bridge (Fig. 1).

Invention of the Taiwanese horned fiddle dates back to the Japanese colonial period and may be related to the banning of Han music. To Japanese colonialists, the Taiwanese horned fiddle looked like a novel instrument and had nothing to do with Han music. Taiwanese musicians were allowed to use the Taiwanese horned fiddle during the final rigid years of the Japanese colonial period.



Source: (Authors, 2009)

Figure 1. Construction of the Taiwanese horned fiddle. The length of the metal cylinder is approximately 45 cm; the radius of the plate is approximately 2 cm.

Source: (http://www.digitalviolin.com/images/stroh-player.gif)

Figure 2. Stroh violin.

The idea to put a horn on the the huqin (Chinese traditional-bowed-string instrument) may be related to the Stroh violin (Fig. 2), which is

> A type of violin developed for early gramophone recordings by (John Matthias) Augustus Stroh in London between 1899 and 1901; it was manufactured in London by his son Charles Stroh from 1901 to 1924 and then by George Evans until 1942. Augustus settled in Britain in 1851 and worked as an engineer and inventor in the fields of electrical telegraphy and acoustics; he was Charles Wheatstone's assistant from the mid-1850s until the latter's death in 1875. From 1878 he experimented with gramophone recording. Until the advent of electrical recording techniques in the early 1920s the sounds made by the performers usually had to be directed at a single large horn; those of a normal body of strings were neither sufficiently loud nor sufficiently directional to record well, so Stroh devised an appropriate instrument which incorporated elements of the gramophone. [1]

It is possible that the Stroh violin has been imported to Taiwan via Japan, inspiring Taiwanese musicians to make substantial changes in the construction of the traditional huqin, which radiates sound via a plate or a membrane and does not have any tube or horn.

EXAPTATION CAUSED BY SPECIAL TIMBRE

There were several novel musical instruments invented by Taiwanese musicians in 1930s. Only the horned fiddle survives. It is of interest to think about the success of this instrument from the perspectives of evolutionary biology. Like domestic animals, the construction of a musical instrument has been determined by artificial selection. In this sense, the notion of "instrument's adaptation" is the evolutionary process whereby an instrument becomes better suited to its users.

We hypothesized that the inventors of the Taiwanese horned fiddle did not intend to produce a novel timbre, which has significant impact on the survival and development of this instrument. Similarly, the inventors of the Stroh violin may not consider that this instrument is characterized by its special timbre, which played a key role in the popularization of this instrument in European folk music. We argued that the adaptation of the Stroh violin and the Taiwanese horned fiddle can be regarded as examples of "exaptation". *Wikipedia* provides the definitaion of exaptation.

> Exaptation, cooption, and preadaptation are related terms referring to shifts in the function of a trait during evolution. For example, a trait can evolve because it served one particular function, but subsequently it may come to serve another. Exaptations are common in both anatomy and behavior. Bird feathers are a classic example: initially these evolved for temperature regulation, but later were adapted for flight. Interest in exaptation relates to both the process and product of evolution: the process that creates complex traits and the product that may be imperfectly designed. [2]

Shifts of the functions of the horned bowed-string instruments can be found in Europe and Taiwan. The Stroh violin incorporated elements of the gramophone for sound recording. But later, this instrument has been used in folk music because of its interesting timbre. The Taiwanese horned fiddle was invented in the Japanese colonial period under the policy of banning Han music. But later, this instrument has been widely used because of its interesting timbre.

The timbral characteristics of the Taiwanese horned fiddle are closely related to its three elements: the plate, the tube, and the horn. The plate is not optimal for low-frequency radiation because of its small size. In the following, we presented experimental results to show how the tube and the horn influence the spectral timbre of the Taiwanese horned fiddle.

The filtering effect of the tube and the horn can be noted by comparing the sound spectrum of the Taiwan horned fiddle recorded in the front of the plate (Fig. 3a) with that recorded at the horn (Fig. 3b). The harmonics around 1.8 kHz are enhanced by the tube and the horn. By contrast, the spectral components below 0.8 kHz and beyond 4 kHz are weakened.

To focus on the filtering effect of the horn, we measured its frequency response. The result is consistent with theoretical prediction that an exponential horn can be regarded as a high-pass filter, with the cut-off frequency determined by its shape. Fig. 3 shows that the cut-off frequency of the horn of this fiddle is approximately 350 Hz.

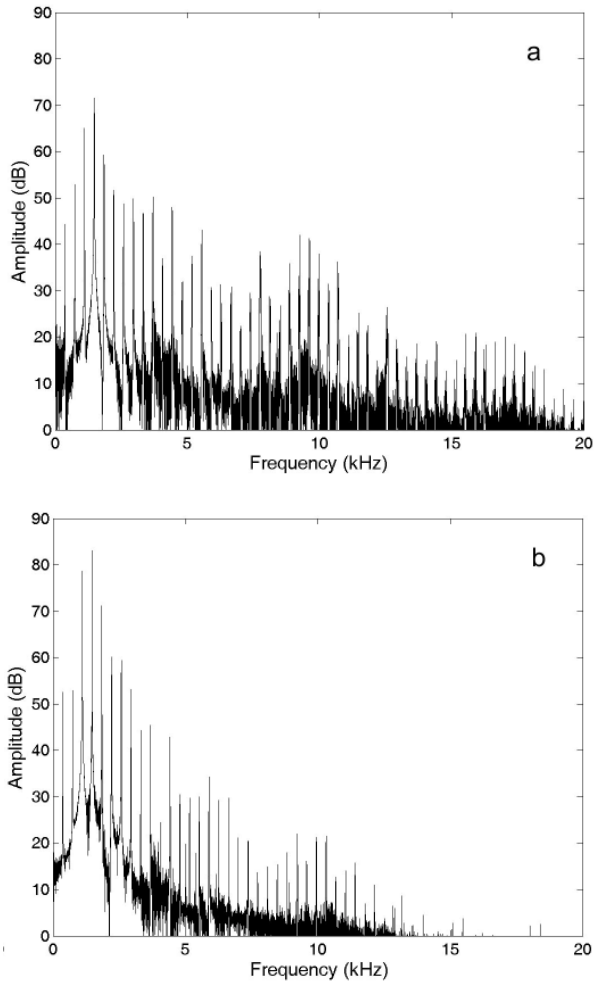
The filtering effect of the tube can be noted by comparing Fig. 4 with Figs. 3ab. The horn does not weaken the spectral components beyond 4 kHz. It may be the tube that weakens higher frequencies.

CONCLUSIONS

The timbre of the Taiwanese horned fiddle is characterized by a strong formant at 1.8 kHz. This format may cause lonely, melancholic expressions of this instrument, because it cannot fuse with the sounds produced by other instruments. Although this formant can be attributed to its tube and horn, the inventors of this instrument did not intend to produce this novel timbre. Through historical and acoustical investigations of the Taiwanese horned fiddle, the present study provides an application of the biological notion "exaptation", i.e., a (structural) feature that fortuitously serves a new function during the evolution of this musical instrument.

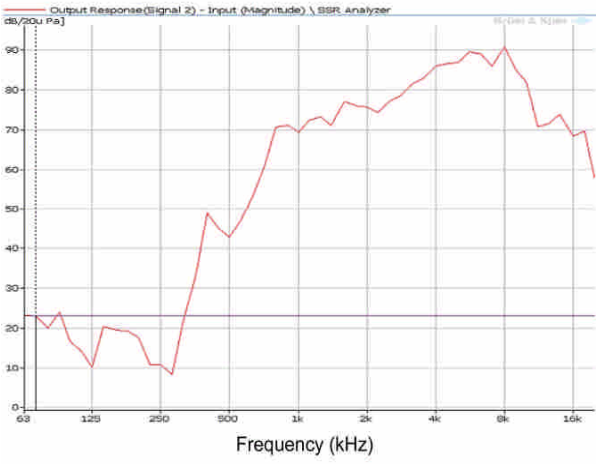
REFERENCES

1 H. Davies. "Stroh violin". In: *The New Grove Dictionary of Music and Musicians*, 2nd edition (New York: Oxford University Press, 2001), vol. 24, p.602.
2 http://en.wikipedia.org/wiki/Exaptation



Source: (Authors, 2010)

Figure 3. (a) The sound spectrum of the Taiwanese horn fiddle recorded in front of the plate. (b) The sound spectrum of the Taiwanese horn fiddle recorded at the horn.



Source: (Authors, 2009)

Figure 4. Frequency response of the horn of the Taiwanese horned fiddle.

Source: (http://edu.ocac.gov.tw/culture/chinese/cul_chculture/vod05html/images/vod05_12-6.gif; http://www.yunshun.com.tw/a/pic/GiZaSi/win/r010.jpg)

Figure 5. Photos of the Taiwanese horned fiddle.