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Changes of Balinese Gamelan in Indonesia -Pitch of Gamelan Gong Kebyar Relating to Educational Institutions-

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Abstract

Bali in Indonesia is known as an island of gods and entertainment. For the Balinese people, Gamelan music is a part of living and is indispensable to the everyday soundscape. In this study, changes of Balinese Gamelan in Indonesia are discussed and described with acoustical analysis. Approximately 90 sets of Gamelan, mainly Gamelan Gong Kebyar commonly used in Bali, Indonesia, were measured and analyzed in Japan and Bali. As a result, it has definitely been shown that their interference beat frequencies were tuned between 5 Hz and 10 Hz and their pitches and intervals were different depending on the regions and periods in Bali. Gamelan Gong Kebyar is a new Gamelan with a pentatonic scale created in the early 20th Century and is now the most popular Gamelan in Bali. In this paper, 11 sets of Gamelan Gong Kebyar were measured and their pitches calculated from frequency analysis of keyboard instruments (Jegogan, Jublag, Pemade and Kantilan) were compared and examined. Four sets were made by I Wayan Beratha and two sets of them are owned by Balinese educational institutions – KOKAR (Konservatori Karawitan Indonesia) and ASTI (Akademi Seni Tari Indonesia) . The other two older sets were made in the early 20th Century and one of the two was tuned by I Made Regog, Beratha's father. The remaining five sets were made by I Nyoman Sudarna and I Wayan Sukarta. For the 11 sets of Gamelan Gong Kebyar, the pitch of the lowest tone, pitch name 'ding', in a pentatonic scale was either C# or D of western pitch. Especially, all sets newer than ASTI's had C#.

Key Words: Bali in Indonesia, Soundscape, Gamelan Gong Kebyar, Pitch, Educational Institution

1. Introduction

Bali in Indonesia is known as an island of gods and entertainment. For the Balinese people, Gamelan music is a part of living and is indispensable to the everyday soundscape. Therefore, understanding its acoustic

structure and changes means to understand taste in sound of the Balinese people as well as its changes.

Overall Balinese entertainment including music and dance in Indonesia, have been gathering international attention since the early 20th Century, and were study subjects of ethnomusicology from early on¹⁾⁻⁵⁾, which

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essentially relates to ethnography of music and dance played or performed in each period of time, and acoustical engineering studies on Gamelan music or instruments have rarely been found. Only Colin McPhee expressed in *Music in Bali*³⁾ pitches and intervals of Jublag in several Gamelan in frequencies and cents in order to compare the temperaments. Thomas. D. Rossing, etc. also analyzed frequency characteristics of Jegogan, the keyboard instrument of Gamelan Angklung, as well as of tawa-tawa, small gong⁶⁾, which only include analysis of two types of instruments in one set of Gamelan Angklung, one of the many types of Gamelan composition. There is almost no acoustical engineering study that analyzed Gamelan in the West.

In Japan, Sugiyama⁷⁾ studied the temperament relating to Gamelan Semar Pegulingan to analyze frequencies of instruments. In Indonesia, there are several reports⁸⁾⁻¹⁰⁾ that analyzed fundamental frequencies of each instrument in Gamelan.

The ultimate purpose of this study is to clarify changes of Balinese Gamelan in Indonesia from the 18th to 21st Century with acoustic analysis of these instruments and through interviews with Gamelan performers and owners as well as with makers and tuners of instruments in Bali.

Various compositions and instruments exist in Balinese Gamelan according to types of ceremony and dance. The major characteristic is a pair of two instruments for any composition, which are tuned to create interference beats, unlike western music. Authors have conducted acoustic analysis by measuring nearly 90 sets of Gamelan mainly including Gamelan Gong Kebyar, the most common composition used in Bali in the past. It has been clarified according to the analysis that interference beat frequencies of Gamelan are generally tuned between 5 Hz and 10 Hz^{11), 12)} and their pitches and intervals were different depending on the regions and periods in Bali.

In this report, pitches in fundamental frequencies are analyzed to review the changes of Gamelan Gong Kebyar mainly in regards to Gamelan Gong Kebyar owned by educational institutions that influenced many Gamelan Gong Kebyar made in Bali in late 20th Century as well as to Gamelan Gong Kebyar made by famous Gamelan makers in Bali at present time and from the end of the 20th to 21st Century.

2. Gamelan Gong Kebyar

2.1 Instruments used for analysis

Bronze percussion instruments in Gamelan Gong Kebyar can be divided into keyboard instruments and gongs as indicated in **Fig.1**.



Fig.1 Gamelan Gong Kebyar

The target of analysis at this time includes the keyboard instruments with a range of four octaves. For Gamelan Gong Kebyar, keyboard instruments have five keys of one octave or 10 keys of two octaves, and a pelog scale with one octave consists of five tones. There are four types of keyboards: Jegogan with the lowest octave (**Fig.2**), Jublag with the second lowest octave (**Fig.3**), Pemade with two octaves beginning from the same pitch as the second lowest key of Jublag (**Fig.4**) and Kantilan with two octaves with an overlapping octave with the higher octave of Pemade (**Fig.4**). One set of Gamelan Gong Kebyar has two each of Jegogan and Jublag that are tuned by slightly shifting the pitch of the corresponding five keys, creating interference beats. There are four instruments of both Pemade and Kantilan with 10 keys of two octaves, respectively. Two of them create a pair and are tuned by slightly shifting the pitch of the corresponding 10 keys, creating interference beats. A key with a higher pitch (Pengisep) is made first, and then one with a lower pitch (Pengumbang) is adjusted and made by hearing the interference beats with the first key as the reference. Therefore, the Pengisep key that becomes a reference is analyzed to compare the pitches of each set.



Fig.2 Jegogan (five keyboards)



Fig.3 Jublag (five keyboards)

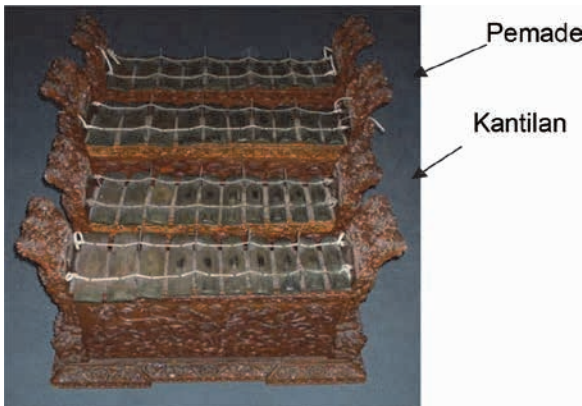


Fig.4 Pemade and Kantilan (10 keyboards)

The 5-tone pelog scale of Gamelan used in Bali is indicated in **Fig.5**. The characters in the middle line are letter notations traditionally used in Bali and their pronunciation is indicated on the top in English. The numbers on the bottom are numerical notations used at

Scale	ding dong deng dung dang				
Balinese Character	ꦢꦶꦁ	ꦢꦺꦴꦁ	ꦢꦺꦁ	ꦢꦸꦁ	ꦢꦁ
Numeral	1	2	3	5	6
	← low	Pitch			high →

Fig.5 Pitch name for Gamelan

a college of music, etc., indicating the pelog scale of Gamelan Gong Kebyar has five tones including the 1st, 2nd, 3rd, 5th and 6th of seven tones. The numerical notations in Fig.5 are used in this report.

2.2 Changes in literature research on Gamelan Gong Kebyar

Gamelan Gong Kebyar is an ensemble with many bronze percussion instruments, as Gamelan with the most common instrument composition in Bali at present time. Gamelan Gong Kebyar is new Gamelan created in the early 20th Century, and started in the Buleleng region in the northern Bali. There is a record of Gong Kebyar festival³⁾ in Jagaraga village in the Buleleng region in 1915, and it was passed onto the Tabanan region near the central western Bali and came to be performed in southern Bali in the 1920s^{13), 14)}. During the days when they were made in Buleleng region, Pemade, one of the important instruments used for Gamelan, had eight or nine keys which subsequently changed to the current 10 keys.^{14), 15)}

This new Gamelan Gong Kebyar was very popular, and it appears that a considerable number of old Gamelan including Gamelan Pelegongan and Gamelan Gong Gede (they have the pentatonic scale with the same five tones as Gamelan Gong Kebyar, while all of keyboard instruments have five keys) was modified to make Gamelan Gong Kebyar by the 1950s by melting the bronze part.

Gamelan is mainly made in Sawan village in the northern Bali and the villages of Tihingan and Blahbatuh in the south-east of Bali at present. Gamelan Gong Keybar is believed to have different intervals and pitches depending on the village where it is owned³⁾. According to the results of pitches in the fundamental frequency of each instrument of Gamelan Gong Kebyar in each region analyzed by authors, the lowest pitch in the pentatonic scale with five tones varies from B^b to D of western pitch¹⁶⁾.

KOKAR (afterward SMKI: Sekolah Menengah Karawitan Indonesia) was established in Denpasar in 1961. I Nyoman Sumandhi, the former principal of SMKI, states that the creative drama Sendratari played by using the Gamelan Gong Kebyar was aired on radio in the whole area of Bali in those days, becoming the craze. With the desire to perform Sendratari created by SMKI, Gamelan Gong Kebyar with the same pitch as

one owned by SMKI was made.

ASTI (current ISI: Institute Seni Indonesia Denpasar) was established in Denpasar in 1969. Around this time, cassette tapes began to be circulated in Bali, and new pieces of Gamelan composed at ASTI came to be recorded on cassette tapes for publication. To perform these new pieces at each village, Gamelan Gong Kebyar with the same pitch as one owned by ASTI was also made.

3. Gamelan Gong Kebyar as the subject of measurement

There are 11 sets of Gamelan Gong Kebyar as the subject of measurement, as detailed in the following.

3.1 Set A

Set A of Gamelan Gong Kebyar is owned by SMKI in Bali, and was made in 1962, the year following establishment of the school. It was made and tuned by I Wayan Beratha who was a performer as well as a maker of Gamelan. Jublag in this set has six keys (generally five keys) (**Fig.6**). Measurement was conducted in 2008.



Fig.6 Jublag for SMKI (six keyboards)

3.2 Set B

Set B of Gamelan Gong Kebyar is owned by Abian Kapas village in Denpasar, and was also made by Beratha in 1963. Measurement was conducted in 2010.

3.3 Set C

Set C of Gamelan Gong Kebyar is owned by ASTI (current ISI) in Bali and was made in 1969. The maker is Beratha, the same as Set A and B. Jublag in this set

has also six keys (**Fig.7**). Measurement was conducted in 2011.



Fig.7 Jublag for ASTI (six keyboards)

3.7 Set D

Set D of Gamelan Gong Kebyar was purchased by Osaka College of Music in February 1985. It is currently owned by Shizuoka University in Japan. The maker is Beratha, similar to Sets A to C. It was re-tuned by Beratha in 1990. Jublag in this set also has six keys, similar to SMKI's and ASTI's (**Fig.8**). Measurement was conducted in October 2014.



Fig.8 Jublag for Shizuoka University (six keyboards)

3.5 Set E

Set E of Gamelan Gong Kebyar originally belonged to Bulaluan village that was probably the first owner of Gamelan Gong Keybar in Denpasar, and was made in 1929. It is currently placed in Gerenceng village in Denpasar. The bronze part of these instruments was made by Pande in Tihingan village, while Beratha's father I Made Regog probably tuned them^{17), 18)}. Jublag in this set has also six keys, similar to SMKI's and ASTI's (**Fig.9**).



Fig.9 Jublag (forward, six keyboards) and Jegogan (backward, five keyboards) for Bulaluan

The group in Bulaluan village had a relationship with that of Ringdikit village in Buleleng region in the early 1920s^{(17), (18)}. Since Jublag has many keys in the northern Bali, Gamelan Gong Kebyar in Ringdikit village might have been referenced to make Gamelan Gong Kebyar in 1929. Measurement was conducted in 2011.

3.6 Set F

Set F of Gamelan Gong Kebyar is owned by Ringdikit village in Buleleng region, and seems to have been made in 1912 according to the interview conducted in the village. Jublag in this set has eight keys, and Jegogan has six keys (generally five keys) (**Fig.10**). As mentioned earlier, the group in this village might have



Fig.10 Jublag (backward center and left side, eight keyboards) and Jegogan (backward right side, six keyboards) for Ringdikit

had a relationship with that of Bulaluan village in Denpasar. Measurement was conducted in 2009.

3.9 Set G

Set G of Gamelan Gong Kebyar is owned by Gita Kuncana, the Gamelan group active in Osaka. This Gamelan was ordered to I Nyoman Sudarna, a musical instrument merchant in Denpasar, and purchased in 1992. Sudarna is also a Gamelan performer and has the experience to teach Gamelan at SMKI after graduating from ASTI. Measurement was conducted in January 2015.

3.1 Set H

Set H of Gamelan Gong Kebyar is owned by Okinawa Prefectural University of Arts in Japan. Similar to Set G, this Gamelan was also ordered to I Nyoman Sudarna, and made to have the standard pitch used in Bali around 1999. Measurement was conducted in 2006.

3.8 Set I

Set I of Gamelan Gong Kebyar is owned by Osaka College of Music in Japan. Similar to Set G and H, it was ordered to I Nyoman Sudarna, and purchased in 2007. Measurement was conducted in January 2015.

3.10 Set J

Set J of Gamelan Gong Kebyar is owned by Taman village in Sanur, Denpasar, and made by I Wayan Sukarta, a maker of Gamelan in Blahbatuh, around 1970. Sukarta was a pupil of Beratha. Measurement was conducted in 2013.

3.11 Set K

Set K of Gamelan Gong Kebyar is owned by I Ketut Suanda, a performer residing in Batubulan, and made by I Wayan Sukarta, in 1990. Measurement was conducted in 2014.

4. Measurement method and analysis

DAT or Wave Recorder (sampling frequency 44.1 kHz or 48 kHz; quantization 16-bit) was used for recording. Since it was basically measurement of frequency only, keys of each instrument were hit one by one in the quiet surroundings and by paying attention

Table 1 Pitch of Gamelan Gong Kebyar for Okinawa Prefectural University of Arts

Pitch Name	Frequency (Hz)	Pitch (cent)	3-1	565.0	C#5 +33
1-1	139.5	C#3 +11	3-2	597.0	D5 +28
1-2	151.0	D3 +48	3-3	662.0	E5 +7
1-3	168.5	E3 +38	3-5	826.5	G#5 -9
1-5	210.0	G#3 +19	3-6	884.0	A5 +8
1-6	224.0	A3 +31	4-1	1129.5	C#6 +32
2-1	277.0	C#4 -1	4-2	1212.5	D#6 -45
2-2	300.0	D4 +37	4-3	1344.5	E6 +34
2-3	329.5	E4 -1	4-5	1664.0	G#6 +3
2-5	417.0	G#4 +7	4-6	1790.0	A6 +29
2-6	449.0	A4 +35	5-1	2236.5	C#7 +15

to background noise and adjusting the level to prevent overloading. Digital data recorded was stored on a computer hard disk in the WAV file format, and frequency was analyzed with FFT software made by B&K to obtain the fundamental frequency of each key. Resolution performance of frequency can be randomly set, while 0.5Hz was used at this time.

With the A4 pitch at 440 Hz, the frequency of each key, f Hz, is converted into the cent unit to indicate each pitch with equal temperament of 12 degrees in western music. The pitch of Gamelan Gong Kebyar owned by Okinawa Prefectural University of Arts is indicated in **Table 1** as an example. The interval has four octaves, and because of the pentatonic scale, the last pitch name in the first octave is indicated as 1-6. As explained in the above, the pitch is indicated with the pitch name in equal temperament of 12 degrees, and \pm represents the cent difference. For example, the pitch of the pitch name 1-1 is C#3; however is 11 cents higher. The pitch of each pentatonic scale for four octaves is eventually averaged for comparison purposes.

5. Measurement results and discussion

Pitches of Sets A to K of Gamelan Gong Kebyar are indicated in **Table 2**.

Both Set A of Gamelan Gong Kebyar made in 1962 and owned by SMKI and Set E of Gamelan Gong Kebyar made in 1929 and owned by Bulaluan village have pitches of five tones arranged from the low pitch: D, E^b, F, A and B^b. Set A was made and tuned by Be-

ratha. Set E was tuned by Beratha's father Regog. For Both Gamelan Gong Kebyar, Jublag that plays melodies has six keys (generally five keys); therefore Beratha might have referenced Set E that was tuned by his father when Set A was made.

Both Set C of Gamelan Gong Kebyar made in 1969 and owned by ASTI and Set B of Gamelan Gong Kebyar made in 1963 and owned by Abian Kapas village have pitches of five tones arranged from the low pitch: C#, D#, E, G# and A. Five tones are approximately 50-cent to semitone lower than those of Set A owned by SMKI. Both were also made by Beratha, while it seems that Set B was made in 1963 with the pitch lower than that of Set A by approximately 50-cent to semitone. Set D of Gamelan Gong Kebyar made in 1985 by Beretha and owned by Shizuoka University also has pitches of five tones arranged from the low pitch: C#, D, E, G# and A, and its pitch name 3 is 34-cent different at maximum from that for Set C of Gamelan Gong Kebyar made in 1969 and owned by ASTI; therefore it is almost equal to Set C.

In the case of the pitch for Set F of Gamelan Gong Kebyar in Ringdikit village made in the oldest age, the pitch name 1 is close to Set A of SMKI or Set E of Bulaluan village, while pitch names 2 to 6 are close to Set C of ASTI or Set B of Abian Kapas village. Since there was Gamelan used by Bulaluan village until 1928, it is not necessarily appropriate but is possible to say that Regog referred to Gamelan Gong Kebyar of Ringdikit village made in 1912 when he tuned the pitch for new Gamelan Gong Kebyar in 1929 as they maintained

Table 2 The Pitches for 11 sets of Gamelan Gong Kebyar

Set	Owner	Year	Tuner	1 (cent)	2 (cent)	3 (cent)	5 (cent)	6 (cent)
A	KOKAR(SMKI)	1962	Beratha	D-14	E \flat +16	F-41	A-36	B \flat -23
B	Abiankapas	1963	Beratha	C#+50	D#-33	E+25	G#-1	A+23
C	ASTI(ISI)	1969	Beratha	C#+43	D#-30	E+26	G#-20	A+12
D	Shizuoka Univ.	1985	Beratha	C#+11	D+48	E-8	G#-8	A+12
E	Belaluan	1929	Regog	D-18	E \flat +21	F+7	A-11	B \flat +8
F	Ringdikit	1912	—	D-19	E \flat -16	E+25	G#+31	A+33
G	Gita kencana	1992	Sudarna	C#+36	D#-34	E+35	G#+14	A+32
H	Okinawa Univ.	1999	Sudarna	C#+18	D+42	E+20	G#+5	A+26
I	Osaka College	2007	Sudarna	C#+27	D+49	E+16	G#+2	A+19
J	Taman	1970	Sukarta	C#+4	D+42	E-13	G#-13	A-11
K	Suanda	1990	Sukarta	C#+32	D#-25	E+31	G#+30	A+41

close relations.

Set G of Gamelan Gong Kebyar made by Sudarna in 1992 and owned by Gita Kuncana, the group in Osaka, has pitches of five tones arranged from the low pitch: C#, D#, E, G# and A, and its pitch name 5 is 34-cent different at maximum from that for Set C owned by ASTI; therefore it is almost equal to Set C.

Both set H of Gamelan Gong Kebyar owned by Okinawa Prefectural University of Arts that was ordered to make a standard pitch used in Bali at the time of 1999 and Set I owned by Osaka College of Music made in 2007 have pitches of five tones arranged from the low pitch: C#, D, E, G# and A, and their pitch name 2 is 28-cent different at maximum from that for Set C owned by ASTI; therefore it is almost equal to Set C. In particular, Sets H and I have the maximum difference of nine cents in the pitch name 1, i.e., their pitch is almost equal. Both were made and tuned by Sudarna.

Since Sudarna who made Sets G, H, and I and was also a performer graduated from ASTI, the pitch for the standard Gamelan Gong Kebyar he used from 1992 to 2007 might have referenced the pitch mainly used after Beratha made ASTI's Gamelan Gong Kebyar.

Set K of Gamelan Gong Kebyar made in 1990 and owned by Suanda has pitches of five tones arranged from the low pitch: C#, D#, E, G# and A. While there is a 50-cent difference in the pitch name 5, the arrangement of five tones is the same as the Set C of Gamelan

Gong Kebyar made in 1969 and owned by ASTI. Set J of Gamelan Gong Kebyar made in 1970 and owned by Taman village in Sanur has pitches of five tones arranged from the low pitch: C#, D, E, G# and A with a 52-cent difference from Set K in the pitch name 6, while the arrangement of five tones is almost equal. Both were made by Sukarta. Therefore, the pitch for Gamelan Gong Kebyar by Sukarta might have referenced the pitch mainly used after Beratha made ASTI's Gamelan Gong Kebyar. Also, Sets J and K are 20-year apart in terms of the years when they were made. Sukarta studied the basic of Gamelan tuning under the instruction of Beratha from 1982, and since then, he might have tuned approximately 30- to 50-cent higher overall than his previous tuning, in order to make it closer to ASTI's. However, the pitch name 5 of Set K made in 1990 is 50-cent higher than that of ASTI. The five sounds of Set G made in 1992 by Sudarna are approximately equal to ASTI's, while only the sound name 5 is 34-cent higher. Therefore, tuning of Gamelan Gong Kebyar around 1990 was probably preferred to be slightly higher than that of ASTI in terms of the pitch name 5.

Based on the above, Gamelan Gong Kebyar was made with various pitches until around 1960; however since ASTI's Gamelan Gong Kebyar was made in 1969, it seems that instrument makers and tuners conformed to it and tuned the lowest tone, pitch name 'ding' (1), in a pentatonic scale to C# of western pitch.

They certainly made it accordingly, when production or tuning was requested at a lower or higher pitch by an ordering village.

6. Conclusion

Pitches for Gamelan Gong Kebyar owned by educational institutions, SMKI and ASTI, as well as nine sets of Gamelan Gong Kebyar relating to them were reviewed in this study.

As a result, it was confirmed that the lowest tone, pitch name 'ding', in a pentatonic scale was tuned at C# or D in all cases. In particular, since ASTI's Gamelan Gong Kebyar was made in 1969, it seems that instrument makers and tuners conformed to it and tuned the lowest tone, pitch name 'ding', at C# of western pitch and somewhat added their own arrangement to make Gamelan Gong Kebyar.

Gamelan Pelegongan and Gamelan Gong Gede that are older than but with the same pelog scale as Gamelan Gong Kebyar will be analyzed in the future, and changes in pitches of Gamelan Gong Kebyar depending on regions and periods will also be studied.

Notes

Analysis results of six sets of Gamelan Gong Kebyar conducted in the literature 19) along with an additional five sets were reexamined in this paper.

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Owners of Gamelan Gong Kebyar analyzed in this paper included Okinawa Prefectural University of Arts, Shizuoka University, Osaka College of Music, Gita Kencana, SMKI, ASTI, Abian Kapas and Gerenceng village in Denpasar, Taman village in Sanur, Ringdik village in Buleleng region, and I Ketut Suanda, and

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References

- 1) Jaap Kunst, *De Toonkunst van Bali*, 1925
- 2) Walter Spies, *Dance and Drama in Bali*, 1937
- 3) Colin McPhee, *Music in Bali*, Yale Univ. Press, New Haven and London, 1966
- 4) Michael Tenzer, *Balinese Music*, Periplus Editions, Berkeley and Singapore, 1991
- 5) Michael Tenzer, *Gamelan Gong Kebyar*, The University of Chicago Press, Chicago and London, 2000
- 6) Thomas. D. Rossing and Robert B. Shepherd, *Acoustics of Gamelan Instruments*, 1982
- 7) Masako Sugiyama, Change in the Tuning System of Semar Pegulingan, *MOUSA (Journal of Musicology Okinawa Prefectural University of Art)*, vol.7, pp.37-53, 2006 (Japanese)
- 8) I Wayan Rai, *Balinese Gamelan Semar Pagulingan Saih Pitu, Modal System*, 1996
- 9) BADAN PERENCANAAN PEMBANGUNAN DAERAH TINGKAT I BALI DENGAN UNIVERSITAS UDAYANA, *Penelitian Tata Nada Gambelan Gong di Propinsi Daerah Tingkat I Bali*, Universitas UDAYANA, JULI 1986
- 10) I Wayan Rai, *KERAGAMAN LARAS (TUNING SYSTEM) GAMELAN GONG KEBYAR, SEKOLAH TINGGI SENI INDONESIA DENPASAR*, 1999.3
- 11) Hiro Yoshi Shio kawa, Interference Beat of Balinese Gamelan Gong Kebyar in Indonesia, *The Journal of the INCE of Japan*, Vol.35 No.1, pp.89-96, 2011.2 (Japanese)
- 12) Hiro Yoshi Shio kawa, Interference Beat of Balinese Gamelan in Indonesia –Part 2 Gamelan Gender Wayang and Gamelan Angklung-, *The Journal of the INCE of Japan*, Vol.36 No.2, pp.195-200, 2012.4 (Japanese)
- 13) Team Survey ASTI Denpasar, *Sejarah Perkembangan Gong Kebyar*, 1980
- 14) I Pande Made Sukerta, *FENOMENA DIBALIK KEJAYAAN GONG KEBYAR: KHUSUSNYA*

- GONG KEBYAR GAYA BULELENG, MUDRA, 23(2), pp.232-243, 2008.9
- 15) Tilman Seebass, Change in Balinese Musical Life: Kebyar in the 1920s and 1930s, Adrian Vickers (ed.) Being Modern in Bali: Image and Change, New Haven : Yale University Southeast Asian Studies, pp.71-91, 1996
 - 16) Hiroyoshi Shiokawa, Pitch of Balinese gamelan in Indonesia, 2013 Autumn Meeting Acoustical Society of Japan, CD-COM, 2-3-11, 2013.9 (Japanese)
 - 17) I Pande Made Sukerta, Gong Kebyar Buleleng: Perubahan dan Keberlanjutan Tradisi Gong Kebyar, Sukerta: Program Pascasarjana bekerja sama dengan ISI Press Surakarta. 2009
 - 18) I Wayan Senen, Wayan Beratha : Pembaharu Gamelan Kebyar, Yogyakarta Tarawang Press, 2002
 - 19) Hiroyoshi Shiokawa, Hideharu Umeda, Koichi Minagawa, Pitch of Gamelan Gong Kebyar Relative to Educational Institution in Bali of Indonesia, JOURNAL OF THE COLLEGE OF INDUSTRIAL TECHNOLOGY NIHON UNIVERSITY, Vol.47, pp.17-23, 2014.6 (Japanese)

インドネシア・バリ島のガムランの変遷 —教育機関に関係のあるガムラン・ゴング・クビャールの音高—

塩川 博義, 梅田 英春, 皆川 厚一, イ・マデ・カルタワン

概 要

インドネシアのバリ島は、神々と芸能の島として知られている。バリ島の人々にとって、ガムラン音楽は生活の一部であり、日常の音風景には欠かせないものである。本研究は、音響的解析によって、インドネシア・バリ島のガムランの変遷を考察して記述している。バリ島で一般的に使われているガムラン・ゴング・クビャールを中心に、日本とバリ島で、約90セットのガムランの測定解析を行ってきた。その結果、うなり周波数は5から10ヘルツの間で調律され、また、それらの音高と音程はバリ島における地域や時代によって異なることがわかってきた。ガムラン・ゴング・クビャールは、20世紀初頭に創作された新しいガムランであり、現在、バリ島で一番人気のあるガムランである。本論文では、11セットのガムラン・ゴング・クビャールが測定されて、それらの鍵盤楽器（ジェゴガン、ジュブラグ、プマデおよびカンティラン）の周波数解析から求められた音高が比較検討されている。4セットは、イ・ワヤン・プラタ氏によって作られ、そのうち2セットは、バリ島の教育機関KOKARとASTIが所有するものである。他の2つの20世紀初頭に作られ、そのうちの一つは、プラタ氏の父親であるイ・マデ・レゴッ氏によって調律された。残りの5セットは、イ・ニョマン・スダルナ氏とイ・ワヤン・スカクタ氏によって作られた。それらガムラン・ゴング・クビャール11セットの音名'ding'の音高は、C#かDであり、特にASTIより新しいそれらは、いずれもC#であることが明らかにされた。

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