Micro-Structure, Macro-Structure, and Genre in ’Are’are Solo Polyphonic Raft Panpipe Music

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First, my thanks to Shay Loya and Lawrence Shuster for organizing this session. As well, I am grateful to Hugo Zemp whose publications precipitated this study, and who kindly gave me access to his field recordings at CREM, the Centre de Recherche en Ethnomusicologie. I am also indebted to the staff at CREM, especially Josephine Simonnot, who provided wav files of Professor Zemp’s field recordings. In all, these recordings comprise 26 pieces performed in 66 versions on 9 solo polyphonic raft panpipes by musicians of the ’Are’are language group on Malaita Island in the Solomon Islands.

These instruments are certainly unusual, and as far as is known, unique in world music. They are termed ‘raft panpipes’ because their pipes are arranged in a row, rather than in a circle. In contrast to other raft panpipes, the pipes are ***not*** arranged uniformly between the highest and lowest pitches. Moreover, as **Figure 1** shows, there is much variety in the way that long and short pipes are arranged within a row.

A consequence of the non-consecutive ordering of long and short pipes is that a single performer can simultaneously play, and realize slurs on,

Figure 1. Four of the 32 solo polyphonic raft panpipes collected by Hugo Zemp on Malaita Island, Solomon Islands, displayed at http://collections.quaibranly.fr (respectively, catalogue nos. 27, 29, 33, and 36).

adjacent pipes that are not adjacent in pitch. Accordingly, I focus presently on such resources of this kind of instrument before observing how such details of microstructure are related to an entire version of a whole piece.

Serving as my central illustration is the first recorded version of the piece ‘Mera ka nara’ (A child is crying) played by Komua of Ta’aruamanu village,

who played a 5-pipe instrument he himself made and whose arrangement of long and short pipes is diagrammed in Figure 2.

Figure 2. Arrangement of pipes on solo polyphonic raft panpipe for 'Mera Ka Nana,' based on simultaneous tones and slurred tones and corroborated by information in Zemp (1981: Fig. 1, p. 387; Fig. 2, p. 390; Fig. 3, p. 391; n. 3, p. 417).

C5 ----------
D5 ----------
E5 ----------
G4 ----------
G5 ----------

In ***Example 1***, the tones notated as G, E, D, and C on the lower staff are the most prominent in the sense that they are longer and louder than the high Ds and low Gs on the upper staff.

Usual among the 26 pieces is an introductory passage that contrasts with the rest of the piece. For 'Mera Ka Nana,' this introduction is designated by the lower-case i's above the upper staff.

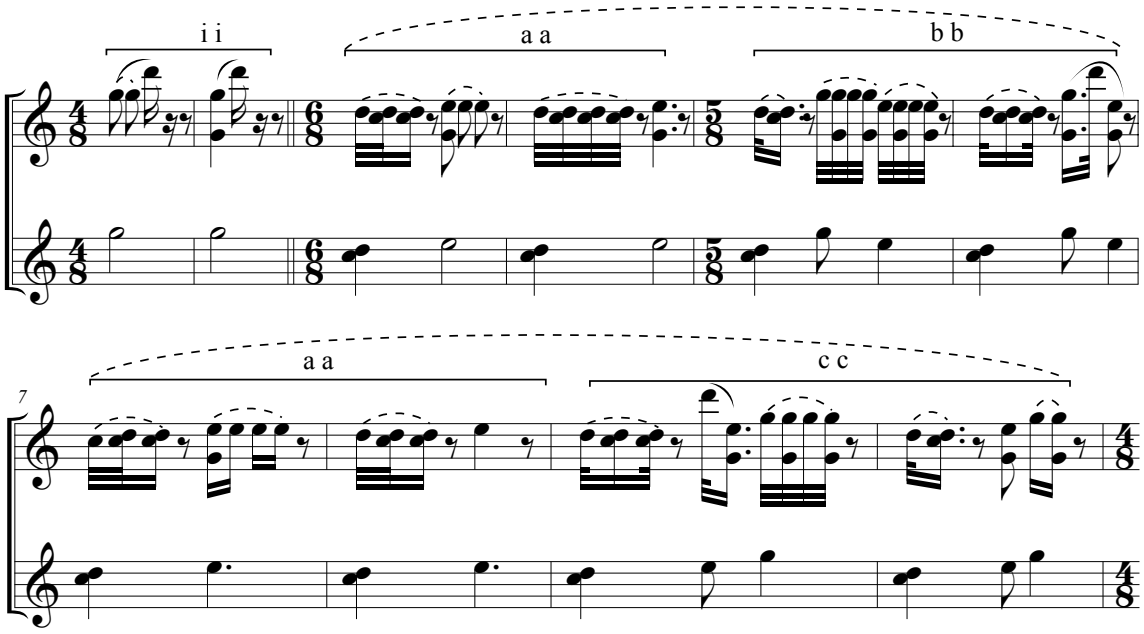
As shown by the other lower-case letters above the upper staff, one-measure passages (indicated by 'a,' 'b,' and 'c') are immediately repeated during measures 3 to 10, resulting in segments of two measures, indicated by solid braces. Moreover, the parallelism of measures 3 and 4 and measures 7 and 8 corresponds to larger segments of 4 measures, indicated by broken slurs above measures 3 to 6 and measures 7 to 10.

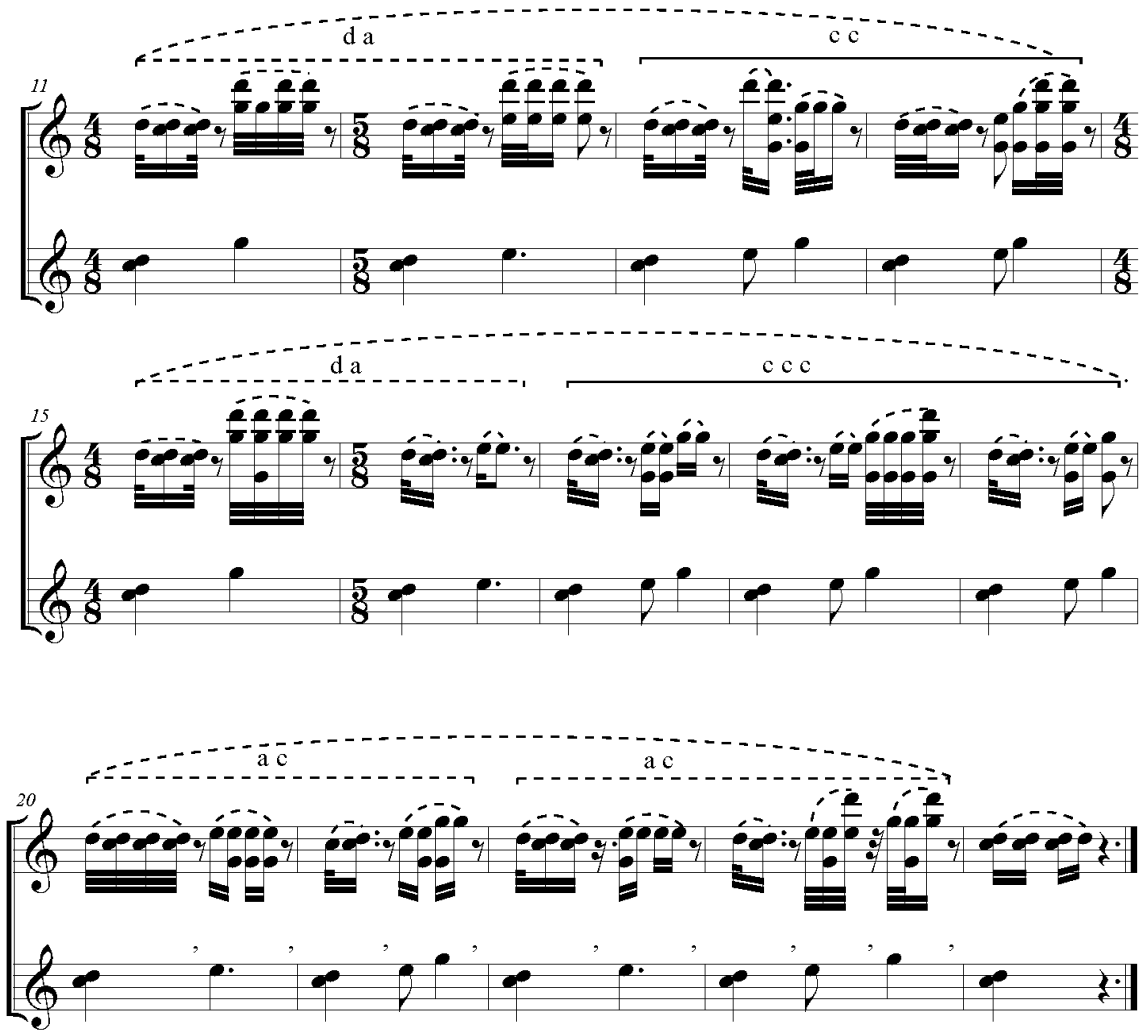
Whereas pairs of a's precede pairs of b's and pairs of c's in measures 3 to 10, a 'd' replaces the first of two a's in measures 11 and 12, and in these measures' parallel counterpart in measures 15 and 16. Nonetheless, the immediate repetitions of 'c' in measures 13 and 14 and measures 17 and 18

Example 1. Transcriptions of the first version of 'Mera Ka Nana' (A Child Is Crying). Performed by Komua in Ta'aruamanu village, Malaita Island, Solomon Islands, June, 1969, recorded by Hugo Zemp, archived by the Centre de Recherche en Ethnomusicologie (CREM), Université Paris X, streamed at http://archives.crem-cnrs.fr/archives/items/CNRSMH_I_1972_016_053_07/, based on wav file provided by Joséphine Simmonot, Ingénieur de recherche at CNRS (Centre National de Recherche Scientifique), CREM.

Lower staves convey the most prominent tones, i.e., loudest and longest; IOIs (i.e., inter-onset intervals) of all quavers are shorter than IOIs of all crotchets, which are shorter than all IOIs of all dotted crotchets, as identified by ear and measured by Transcribe! and Audacity software; commas indicate silences during which there is an audible inhalation; lower-case letters, braces, and slurs above upper staves indicate repetitions of prominent tones transcribed in the lower staves; Figure 2 specifies ranges of prominent tones' fundamental frequencies as identified by ear and measured by Melodyne and Transcribe! software; original recording is ca. 1 semitone lower; M.M. crotchet = 88.2.

Upper staves convey G4 (i.e., an 'octave' below G5) and 3rd harmonic of G4 (i.e., D6) as well as tremolos within, and prefixes and suffixes before and after, the prominent tones notated in the lower staves; solid slurs indicate legato; broken slurs indicate respiratory articulation within tones; Figure 2 specifies ranges of G4 and D6, as identified by ear at 33% of the original tempo and measured by Melodyne and Transcribe! software.





parallel their prior counterpart in measures 9 and 10, and measure 19 extends the immediate repetition of ‘c’ in measures 17 and 18.

Finally, in measures 20 and 21, ‘a’ precedes ‘c,’ as before, and, as the broken braces indicate, measures 22 and 23 immediately repeat this succession.

In sum, within the piece’s overall binary segmentation, one can regard the pairs of ‘a’ measures as initial and the similarly paired ‘b’ and ‘c’ measures

as terminal in measures 3 to 10; thereupon, ‘a’ measures are the second of two, and finally ‘a’ and ‘c’ are, respectively, the first and second of two.

Sustained throughout the piece is an oscillation between the simultaneous dyad D-C that initiates each measure, and the conclusion of each measure on E and/or G. In this regard, it should be emphasized that the durations of these tones (i.e., their inter-onset intervals) are relative rather than perceptually precise.

Notationally, each quaver corresponds to a duration that is heard as shorter than each crotchet and each crotchet’s duration is heard as shorter than each dotted crotchet’s duration. However, each quaver duration is ***not*** necessarily heard as the same in duration as every other quaver. Similarly for each crotchet and dotted crotchet. Instead, the quavers constitute what could be called a ‘duration class,’ insofar as each is shorter than any of the crotchets, and similarly for the relationship between the crotchet class and the dotted-crotchet class.

Moreover, whereas the audible duration of the initial D-C dyad in a measure is generally shorter than the duration of the rest of the measure, measures 11 and 14, which are notated in 4/8, constitute a surface exception that can be regarded as generalizing this regularity even further. For, rather than the initial portion of each measure being regarded as shorter than the terminal portion, it can be considered ‘at least as’ short.

Finally, before listening to the piece you should note also that each comma above the lower staff corresponds not only to a rest in the upper staff but also to an audible inhalation. Until the end of the piece, these audible

inhalations occur just before and after the initial D-C dyads. That is, each tonal oscillation between the D-C dyad and the contrasting Es and/or Gs coincides with two respiratory oscillations of inhalation and exhalation.

The only exceptions to this regularity occur in the introductory passage, where there is only one audible inhalation between the first and second measures, and at the end, where there are two audible inhalations within the second last measure. Just as a contrasting passage is usual as an introduction among the 26 pieces, a contrasting, 'non-sequitur' passage is also usual as a conclusion. In 'Mera Ka Nana,' not only is the D-C oscillation interrupted at the very end, but also the preceding measure comprises an additional inhalation in contrast to every measure since the introduction.

Audio example

Absolute Values

Before turning to the much more detailed transcription in the upper staves of the systems in Example 1, two absolute values are worth noting.

Although the crotchet durations are only relative to the quaver and dotted-crotchet durations, their absolute values are not capricious. Among all 26 pieces, there is a dyad that corresponds directly to the D-C crotchets of 'Mera Ka Nana.' Throughout the recorded repertoire, this dyad's absolute duration is quite constant: very close to 667 milliseconds, i.e., approximately the metronome value crotchet = 90.

As well, the absolute frequencies of the D-C dyad are very uniform. Whereas the frequency produced by an individual pipe can vary considerably during a performance (e.g., much more than on such fixed-

frequency instruments as the xylophones, metallophones, free-reed instruments, and pipe organs of other musical traditions), the frequencies of all 26 pieces' counterparts to the D-C dyad occur within a very narrow range, namely, between approximately B and D in the treble-clef staff. As a consequence, the acoustical interference produced by the fundamental frequencies of these dyads is uniformly quite close to approximately 65 Hz, i.e., 65 cycles per second: see Table 1. That is, within the range between 5 and 80 Hz where perceived auditory roughness or beating is maximal.

Table 1. Magnitudes and interference among simultaneous intervals of the first version of 'Mera Ka Nana.' Corresponding values in European-derived theory are in quotation marks.

Dyads	**Magnitudes** (in cents, i.e., 1/100ths of a tempered semitone)			**Interference** (in Hz, i.e., cycles per second)	
	minimum	**maximum**		**minimum**	**maximum**
D5-C5	201	213	'M2'	62	66
G5-G4	1081	1120	'M7/p8'	36	54
E5-G4	761	801	'm6'	42	70
D6-G4	1858	1887	'p12'	10	31
D6-G5	755	795	'm6'	72	127
D6-E5	1075	1114	'M7/p8'	61	89

Turning now to the detailed transcription in the upper staves, a similar observation is pertinent to the simultaneous dyads notated there by the low Gs. As measured by the widely available commercial software Melodyne and Transcribe!, the magnitudes of these simultaneous intervals range from 1081 to 1120 cents, i.e., close to a tempered major 7th. Among all 26 pieces, these values are not exceptional, for their counterparts are between approximately 1100 and 1300 cents, i.e., between a major 7th and minor

ninth. Moreover, such a range of values holds for fixed-frequency instruments of musical traditions in Southeast Asia and East Africa.

Whereas a Eurocentric approach might regard such dyads as ‘out of tune,’ or one of their tones as a ‘wrong note,’ one can formulate them quite differently. In the case of the 26 pieces, the interaction of the upper tones of these dyads with the second, so-called ‘subjective’ or ‘aural’ harmonics of their lower tones produces acoustical interference that ranges from approximately 40 to 80 Hz, and as observed for the D-C dyads, such interference maximizes audible roughness. Accordingly, the spectra of such intervals and the timbres they produce can be understood as perceptually privileged, and the so-called ‘octave phenomenon’ can be re-cast in terms of concrete spectral interaction rather than the abstract mathematical ratio 2:1, which is not only clearly falsified by measurements of actual intervals in oral traditions but also unverifiable in principle.

Another audible aspect of intervals is their relative magnitude. Just as the prominent tones’ durations constitute three classes, namely, small medium, and large, the simultaneous dyads notated by D-C, E-G, and G-G in the upper staves comprise small, medium, and large intervals, as shown also in Table 1.

Table 1 shows that within ‘Mera Ka Nana,’ the simultaneous D-C dyads range from 201 to 213 cents. A among all 26 pieces, they range between approximately 100 and 300 cents, i.e., a minor 2^{nd} to minor 3^{rd}. The simultaneous E-Gs of the piece are between 761 and 801 cents, and in the entire archived repertoire, approximately between 600 and 900 cents, i.e., a diminished 5^{th} to a major 6^{th}; and, as already noted, the G-G dyads of ‘Mera

Ka Nana' range from 1081 to 1120 cents, and among all 26 pieces from a major 7th to a minor ninth.

Within the most prominent tones are several tremolos during which the pitches of prominent Gs, Es, and D-C dyads are sustained. Notated by means of broken slurs in the upper staves of Example 1, these tremolos are products of respiration and/or changes from one pipe or pair of adjacent pipes to another. Presumably Komua semi-articulated the brief durations one can hear within prominent tones by varying the pressure with which he blew by means of his diaphragm, tongue or glottis, and/or by changing the pipe or pipes into which he blew.

Also evident are tones one can consider ***'prefixes,' 'suffixes' and 'infixes'*** relative to individual prominent tones. Of particular interest are the tones notated in the upper staves as high Ds. Unlike the lower tones, these do not correspond to fundamental frequencies of any of the instrument's five pipes. Instead, by 'overblowing' (i.e., by blowing harder) and/or by changing the angle at which he blew into the low-G pipe, Komua appears to have produced the low-G pipe's 3rd harmonic—even in certain instances where the low-G pipe's fundamental is inaudible and does not show up in the displays produced by Melodyne and Transcribe! software.

Like other panpipes of world music, the tubes of Komua's instrument are closed at one end, resulting in odd-numbered harmonics of relatively great amplitude. As it turns out, the frequencies of the D6s are approximately a perfect 12th (more precisely, 1858 to 1887 cents) above the simultaneous low G4s.

In contrast, the high Ds are substantially ***more*** than a perfect 5th above the high Gs: from 755 to 795 cents, i.e., approximately a minor 6th higher, as are the Es relative to the low Gs—an observation that also corroborates the conclusion that the D6s originated in the low G pipes. Moreover, the simultaneous intervals that high Ds form with Es range from 1075 to 1114 cents. That is, their magnitudes are quite close to major 7ths, as are the G-G intervals. In sum, the small-medium-large interval categories hold not only for the panpipe's fundamental frequencies but also for simultaneous intervals that include the low-G pipe's 3rd harmonic.

In Figure 3, superscript 'h' before or after a prominent tone's letter-name conveys its position as a prefix or suffix, and the letter 'h' after a prominent tone's letter name indicates that it is an infix.

Underlining in Figure 1.a shows how such high D6s, or their absence, increase similarity between immediately repetitive measures, and italics show such increases for parallel measures.

In Figure 1.b, underlining shows how D6s introduce similarity between measures whose prominent tones otherwise contrast. In one instance, this involves d e g and d g e; in the other, d e and d g.

The italicized measures of Figure 1.c show how D6s are part of a segmentation of the final measures that differs from the lower-case letters of Example 1. Rather than the 3 immediately successive d e g measures, highlighted in **bold** typeface, being construed as an extension of 2 such measures, parallelism of the second d e g measure and its D6 suffix with a

Figure 3. D6s as parts of immediately repeated and parallel measures in 'Mera Ka Nana.' A superscript 'h' before or after a prominent tone's letter name corresponds, respectively, to a prefix or suffix. A letter 'h' after a prominent tone's letter name corresponds to an infix.

a) Underlining indicates immediately repeated measures; italics indicate parallel measures.

g^{h}	g^{h}			
d e	d e	d g e	d g ^{h}e	
d e	d e	d ^{h}e g	d e g	
d gh	d eh	d e ^{h}g	*d e g^{h}*	
d gh	d e	d e g	*d e g^{h}*	d e g
d e	d e g			
d e	d e^{h} g^{h}			

b) Underlining indicates immediately successive measures whose prominent tones, or ordering of prominent tones, differ.

g^{h}	g^{h}			
d e	d e	d g e	d g ^{h}e	
d e	d e	d ^{h}e g	d e g	reversal of order
d gh	d eh			replacement: e for g
d e ^{h}g	d e g^{h}			replacement: suffix for prefix
d gh	d e			
d e g	d e g^{h}	d e g		
d e	d e g			
d e	d e^{h} g^{h}			

c) **Bold** typeface indicates immediate succession of three d-e-g measures; *italics* indicate two-measure segments in which D6s are parallel.

g^{h}	g^{h}	introduction
d e	d e	
d g e	d g ^{h}e	
d e	d e	
d ^{h}e g	d e g	
d gh	d eh	
d ^{h}e g	*d e g^{h}*	
d gh	*d e*	
d e g	***d e g^{h}***	
d e g	*d e*	
d e g	*d e*	
d e^{h} g^{h}	d	conclusion

previous measure is part of parallels between two-measure segments that extend throughout the entire piece.

Finally, and unlike the D6s, the remaining details conveyed by the upper staves of Example 1 are remarkable in that they are continually varied. That is, specific configurations of tremolo and the low G are not immediately repeated nor are they employed in parallel measures. Instead, they contrast continually with the patterns produced by the D6s and the most prominent tones.