



On an acoustic criterion for cultural connections¹

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“Nothing is more useless than a debate about ‘loan or folk idea’. Such a debate – I have said it a hundred times – does not exist.” Today, this statement by Adolf Bastian, quoted by K. von den Steinen in his memorial speech to the doyen (March 11, 1905),² must be understood in a slightly different way than it was probably meant originally. Nobody will deny that an ethnologist encounters similar phenomena which independently have common psychological, physiological or psychophysical roots; that there are other cultural elements which have traveled long distances with or without their carriers or have outlived long periods and several cultural changes. The debate, which is today more lively than ever,³ is hardly about the either-or but rather about the methods according to which the different ethnographic parallels have to be judged and the corresponding elements be placed in cultural contexts. The discussion about the methods of ethnological work is not at all needless but rather an inevitable precondition for fruitful research and solid, applicable results. Without adequate and generally accepted methodical fundamentals, the same phenomena will be interpreted in different ways and placed in different contexts according to the leanings of the evaluator. Some will create hypothetical histories of development, others hypothetical cultural complexes. It is simple and unjustified to mutually shift the burden of proof onto each other because a hypothesis is neither disproved if another one seems more plausible a priori, nor proved if also the other one is only a presumption.

Thus, if we do not want to content ourselves with a simple registration of single facts but connect them and bring them into an order, we will have to find flawless criteria. Finding, evaluating and applying such criteria requires good acquaintance with the relevant field because the so-called cultural *elements* are also highly complex facts with various complex dependencies in most of the cases.

¹ “Talk at the Anthropological Society of Berlin”, June 17, 1911. *Zeitschrift für Ethnologie* 43 (1911).

² *Zeitschrift für Ethnologie* 37, 245.

³ For the following, cf. Graebner’s “*Methode der Ethnologie*” (Heidelberg: C. Winter, 1911) and the polemics between Haberlandt, Graebner and Fox in *Petermann’s Mitteilungen* 57, 1911, 113-118, 228-234.

Some parts or aspects of the compared phenomena can point to cultural connections, whereas others have to be explained from a psychological or physiological perspective. The latter will always be the case if we trace back to the general or even most general categories of a phenomenon, which are only characteristic for all humanity, for example, as an animal-psychological species (e.g., use of language, singing or weapons). A general - and thus necessarily undefined - claim is the claim for *sufficient determination* of the compared phenomena. It has to be decided from case to case according to the particular nature of the relevant phenomenon which degree of preciseness and which kind of determination are sufficient. Thus, a solely (or mainly) descending melody together with decreasing volume and slowing tempo would be a totally insufficient determination of a vocal style because all three aspects are functions of physiological processes (and furthermore not independent of each other). Most of such natural characteristics are even suspicious because of their wide distribution, but not all. Some are pushed back in the course of cultural developments and seem initially "exceptional", but later on they also turn out to be "natural" and universal like, for example, the use of intervals of "equal distance" instead of "consonant" ones.⁴ Others prove to be really primitive by being omnipresent or at least very common in early stages of traceable individual development (in children, ungifted and totally inexperienced people from different races and cultures), like singing in parallel fifths or descriptive drawing.⁵ Such characteristics can often be found as remnants even in highly developed cultures - for example, if we think of the pictorial representations by early American civilized people. These features can belong to the overall characteristic of a complex phenomenon and be transferred together with it. But the transfer *cannot* be understood from *these* characteristics. Thus, psychological experiments and observations are not at all useless to analyze and evaluate phenomena of the so-called intellectual culture. The results of child psychology deserve to be considered even if we cannot agree to an unconditional transfer of the biogenetic law to intellectual developments.

In objects of comparison from the field of material culture - which are in general easier to determine precisely and, therefore, used more often for comparative investigations - it is necessary to distinguish between *constitutive* and *accessory* characteristics, that is characteristics without which the object cannot fulfil its purpose and other ones which are irrelevant or at least secondary for the purpose. Again, we can generally say that the latter are better criteria for cultural connections than the former and that the probative value of a characteristic increases with its variability. On the contrary, we can only decide from case to case and based on precise knowledge of the technical details, the production method and the type of application of the object which characteristics are more or less

⁴ This also applies to the astonishing sensory performance of indigenous people, which is not, as it was assumed in the past, caused by their superior sensory organs but by a particular attitude the biological conditions require and by practice of attention. Therefore, it cannot be used as a racial characteristic.

⁵ "Primitive" is certainly to be understood as "relatively initial": An early stage of a development series can, together with this series, represent a later stage of a more comprehensive development. Thus, parallel fifths are a primitive form of polyphony, but they themselves, at least as an art form, are a very late form of joint music performance.

variable according to their nature and which are freer or more bound regarding the usefulness of the whole. Even the fundamental question about constitutive and accessory characteristics often cannot be answered easily. The finger holes of flutes or pipes, for example, might have been arranged mainly (or only) because of optical pleasantness – equal distances, symmetric distribution.⁶ Thus, the tone sequence formed on the instrument becomes accessory. What we would a priori consider the main issue becomes accidental. Outwardly identical forms can serve very different purposes: The second hole of a Chinese flute is covered with a thin membrane in order to modify the timbre. A cord to hang it up is threaded through the two lowest holes, whereas the top hole serves as the mouth hole and the others as finger holes.⁷

The variability of the characteristics and, thus, their probative value to indicate relatedness is reduced and perhaps even annulled due to mutual dependencies. The range of possible forms can be limited by the technique (e.g., in plait ornaments) or the material (e.g., in wind instruments made of animal horns).⁸

The general requirements a characteristic has to meet in order to be suitable as a connective criterion are the following three: *precise determination, purposelessness, variability*. Corresponding practical advantages would be easy and precise determinability, and transparency of the causal and functional relations.⁹ –

The characteristic I want to recommend as a criterion for cultural connections is a *physical-acoustic* one. One physical method has been used for a long time in comparative musicology – the measurement of pitches. Initially, the only aim was to identify intervals and scales, which were of particular interest for musicologists and psychologists as specific musical factors. The wide-spread conviction that “natural” scales are universal proved invalid, in particular when the peculiar Siamese and Javanese tonal systems were discovered.¹⁰ In principle, this made it also possible to use the results of pitch measurements as ethnological material, besides the melodic and rhythmical forms, similar to the grammatical structures of languages. But musicological data can also be compared with linguistic ones because

⁶ Cf. Ch. K. Wead, *Contributions to the History of Musical Scales*. Smithsonian Institution Reports 1900 (Washington 1902).

⁷ This is why it is confusing if only the absolute number of holes and the outer length (which is not equal to the acoustically effective length) are stated when describing an instrument. It is, however, still rather common in collection catalogues and museum leaflets.

⁸ If they are variable enough, also the technique – weaving – and the material – strings made of plant fibers, gut, horsehair, metal, silk – can be used as criteria.

⁹ The intended brief summary of the main methodological aspects may be sufficient at this point. They are partly in accordance with Graebner’s comments on the “Formkriterium” (formal criterion), although formulated in a slightly different way (*Methode der Ethnologie*, in particular IV, 2 B, § 5; IV, 3 A, § 3, 9). But it seemed necessary to me to emphasize more clearly that the characteristics are not equivalent. The fewer phenomena are used to argue a cultural connection, the higher the requirements for the probative value of every single parallel. But this should be considered in any case. The “quality criterion” could perhaps be handled more precisely if correlation calculation was introduced, which has also proved useful in somatic anthropology (Czekanowski).

¹⁰ Cf. C. Stumpf, “Tonsysteme und Musik der Siamesen”, *diese Beiträge* 3, 1901; A. J. Ellis, “On the musical scales of various nations”, *The Journal of the Society of Arts* 33, 1885.

their interpretation requires certain knowledge and is not entirely transparent for all people.

On the contrary, the *absolute pitch* is a simple, purely physical piece of information which is easy to determine. Its characteristics can be seen even without musical talent and theoretical knowledge. We gain the absolute pitch – stated in frequencies – in a direct comparison of the tones to be determined and the tones of a calibrated measuring instrument.¹¹ Theoretically, the frequency clearly determines every tone (regarding its pitch). In practice, full accuracy is limited by measurement errors,¹² which should, however, not exceed 0.5% at the maximum for careful work.¹³ Thus, we can say that the absolute pitch as a criterion meets very strict requirements regarding precision and determination.

But what about variability? Of all audible tones in a frequency range from 16 to 20,000 oscillations, only the tones of a narrower range between 30 and 3,000 are musically useful. If we take six oscillations¹⁴ as the average margin of error (error in the production of the instrument regarding tuning + measurement error), about 500 (practically different) pitches are possible. This number is significantly limited in cases in which the octave is not considered – if we equate tones with a distance of one or more octaves or frequencies at a ratio of 1: n. 2. This is justified because the similarity of the octaves is a universal psychological phenomenon: Male, female and children's voices in a choir run (unknowingly) in octaves; the same is true for singing and instrumental accompaniment. On instruments with a larger ambitus, entire tone sequences or at least single tones are almost always "repeated" in several octaves.¹⁵ If we bring all frequencies into the same octave between around 400 and 800 by multiplying them with or dividing them by two, there are 400/6 or around 70 possible values (assuming the same margin of error as in the example above). Hence, the variability is rather high also in this case. It is an advantage that it can at least be defined numerically. –

Absolute pitch as a criterion will hardly be the only one applied but rather together with identical *scales*. Their probative value for cultural connections is

¹¹ Most suitable are continuously changing flue pipes or reeds. The tones to be compared should be played one after the other; simultaneously only if beats are to be used for extremely precise tuning. (For details, cf. Abraham and v. Hornbostel, "Vorschläge für die Transkription exotischer Melodien", *Sammelbände der Internationalen Musikgesellschaft*. XI, 1910, 18.)

¹² Possible sources of error are as follows: 1. Wrong or inaccurate calibration of the measuring instrument; 2. Inaccurate settings (in particular for big differences in timbre or volume or different octaves of the experimental tone and the measured one); 3. Inaccurate reading. All three can be reduced to a minimum by close monitoring. For error calculations, the sources of error mentioned in 2 would have to be considered.

¹³ This means about three oscillations in a middle pitch of about 600 oscillations. Consequently, half oscillations are still significant for practice, whereas the second decimal of the frequency is, if anything, only arithmetically relevant.

¹⁴ This value is arbitrary in the first place, but it is probably rather too high than too low. If sufficient material is available, it should be possible to empirically calculate it (for specific cases).

¹⁵ The entire tone sequence is often spread on several bigger (bass) and smaller (treble) instruments, for example, on Javanese metallophones.

then significantly¹⁶ increased and established. The two criteria are not at all equivalent. They are very contrasting regarding one of the three standards defined above – with purposelessness maybe being most important.

Absolute pitch is only secondary in music and totally irrelevant for the naïve musical consciousness. For musical impression, it does not make a difference if a melody starts with a *C* or an *F#*. Even few European music experts would notice. Unexperienced singers often interrupt a song they have started because the pitch range of the melody exceeds their vocal range and they start again from another tone. A random initial or main tone is often maintained for a long sequence of songs. Sometimes the singers follow a random tone they have just heard.¹⁷ We can observe something of the kind in everyday life and everywhere. The “ability to transpose” is a general and, as Stumpf¹⁸ has shown, one of the most essential fundamentals of music. This means that the *absolute pitch is (almost¹⁹) irrelevant for music*.

The *intervals*, on the contrary, are relevant for the impression of a melody. Arithmetically, they are defined by the *ratios* of frequencies. Changes of these ratios appear as changes of the melodic shape as soon as they go beyond a limit which is usually not very high. In general, *intervals* – and *scales*, as they are nothing but clearly arranged interval systems – must be regarded as *constitutive* factors.

In detail, however, the situation is not as easy as for absolute pitches. Starting from entirely different initial points, we can come to very similar and maybe even equivalent scales. Only very skilled musicians experienced in all three tonal systems can identify if a (monophonic) piece of music is performed in just intonation, tempered or with Pythagorean tuning; the average listener would not notice any difference. As scales are often typical examples of convergence phenomena, it is necessary to go beyond the simple physical findings and perhaps back to their formative principles. These principles can sometimes be deduced from the measured data with a high degree of reliability, but as long as they have not been confirmed in direct observation of the calibration of the instruments, they remain a hypothesis. Furthermore, we have to consider that even well-characterized tonal systems in their development depend on psychological and mechanical conditions, which can repeatedly lead to very similar results. The Chinese, for example, found

¹⁶ According to the assumptions above, it is increased by 500 or 70 times.

¹⁷ Many vocal recordings of the Berlin phonogram archive start with an *a*, the tone of the pitch pipe, which should also be phonographed to determine the original tempo.

¹⁸ *Die Anfänge der Musik* (Leipzig: J. A. Barth, 1911), 10ff.

¹⁹ I have two facts in mind regarding this limitation: Even naïve listeners can notice rough differences of the absolute pitch (the *pitch range*) as different *timbres*, particularly in singing. But our criterion refers to subtler differences. – Secondly, people with so-called absolute tone consciousness not only notice transpositions but may also feel them as modifications of the musical impression. Absolute tone consciousness, however, can only develop if a certain standard tuning has been determined for an instrument. Thus, it can only be a consequence of the use of absolute pitches which serve as a criterion. But if we can prove one day that absolute tone consciousness in a nation is not limited to some individuals and the absolute pitch in music is more relevant, this fact would not reduce the probative value of our criterion.

a tempered twelve-tone scale more than a century before us.²⁰ It is almost the same artificial tonal system without which the development of our music since Bach would have been unthinkable.

It can be concluded that scales (or intervals) can be used as a criterion for cultural connections only very cautiously and never as the only criterion.²¹

One more aspect has to be considered when combining this criterion and absolute pitches: Accordance of *all* homologous tones of two instruments regarding their absolute pitch certainly implies that the two tonal systems are identical. In this case, the scale would not add a new argument. But the probability would obviously strongly increase due to the multiplication of coincidences. However, this would be a totally biased perspective on the facts. All single absolute pitches would have to be overtaken regardless of the tonal system. As opposed to all experience, the absolute pitches would be the constitutive characteristics, and the tonal system an accessory one. But complete identity of two scales is also constituted if the tonal system and the absolute pitch of a single tone homologous in both scales regarding the system are identical, for example, the initial tone of the scale. To be correct, we have to assume only two aspects of evidence: identity of the tonal system and the absolute pitch of the scale en bloc.²²

(For example: If both scales correspond to our tempered major scale - $C D E F G A B C'$ - and the initial tone of both is $C = 256$ v.d.*, also both D, E, F , etc. are identical.)

If *not all but only several tones* (or maybe only *one*) of two instrumental scales correspond, we can often decide based on the tonal system if there is a connection. If the tonal system is identical, but the position of the tones with the same absolute pitch in the system differs, this is either a scale with its transposition or two different sections of a larger scale (of the overall system).²³

For example:

C	D	E	F	G	A	B	C'			} both: tempered scales; F and C' of both are identical
	D^b	E^b	F	G^b	A^b	B^b	C'	D^b		

or:

²⁰ Cf. L. Laloy, *La musique chinoise*, Paris s. d. (1910), 48ff.

²¹ Therefore, I cannot agree with Haberlandt who (loc.cit. 115) regards identical *scales* as proof of cultural historical dependencies. (However, only "in an area of distribution"! But like Graebner, I do not see why apparent obstructions should annul ^{the} probative value of a criterion.) I have also clearly emphasized the essential difference between absolute pitch and ratios in the place mentioned by H. (in: Stephan and Graebner, Neumecklenburg, 134f.) and elsewhere (in: Hagen: *Die Orang-Kubu auf Sumatra*, 249 and in Koch-Grünberg: *Zwei Jahre unter den Indianern*, II, 390) so that there should not be any misunderstanding.

²² In cases in which the constructive principle of the scale requires more than one initial point, where in fact several independent systems seem to be combined, we can assume the same number of absolute pitches as aspects of evidence.

* [*vibrations doubles*, i.e., c.p.s. (or Hz). Eds.]

²³ In scales where the frequency ratios between adjacent tones are constant, the two options concur.

$$\begin{array}{cccccc} C & D & E & \mathbf{F} & \mathbf{G} & \\ & & & \mathbf{F} & \mathbf{G} & A & B & C' \end{array} \left. \vphantom{\begin{array}{cccccc} C & D & E & \mathbf{F} & \mathbf{G} & \\ & & & \mathbf{F} & \mathbf{G} & A & B & C' \end{array}} \right\} \begin{array}{l} \text{both: parts of the tempered diatonic scale; } F \text{ and} \\ G \text{ of both are identical, } C \text{ and } C' \text{ are octaves} \end{array}$$

If the tonal systems are not identical but similar, some homologous tones can nevertheless be identical, also regarding their absolute pitch.

For example:

perfect: $C \mathbf{D} E \mathbf{F} \mathbf{G} A B C'$
 Pythagorean: $C \mathbf{D} E^+ \mathbf{F} \mathbf{G} A^+ B^+ C'$ } both: diatonic (major) scales;
 C, D, F, G, C' are identical

It is only a borderline case of what has been described above if the tonal systems are totally different, but the scale has been construed starting from the same absolute pitch. In this case, a single tone would be enough to make a connection likely. But this tone would have to prove to be the pivotal point of both systems or the initial tone of both scales.²⁴

It is not very likely in this case that only the reference tone has been adopted from another system. It is more likely that a system which had originally been adopted with its absolute pitches has been more and more modified or replaced by a new system.

But also tonal systems should hardly ever move without their carriers, i.e., the instruments.²⁵ We will rather appreciate a musical instrument initially and for a long time after because of its sonority and timbre, its easy playing technique and comfortable production method. Further, we will copy the model even more painstakingly and preserve it in all its aspect the less we know the true reasons for the first two characteristics. Thus, we unintentionally overtake and continue the tonal system,²⁶ the absolute pitches and presumably also some technical details. With gradually relaxing traditions and increasing temporal and spatial distance from the original models, the correspondences will be less and less exact. As a consequence, also the material in our collections is very inhomogeneous. We cannot expect to find a well-defined tonal system or standard tuning accepted in an entire cultural field if we randomly pick out an object. Only the scales of the best²⁷ examples can initially serve to find a hypothesis and focal points the other ones can maybe build on later. As the scales increasingly diverge from the norm, and due to their spatial distribution, we could hence achieve a relative chronology and reconstruct the propagation paths.²⁸ The claim to prove the precise correspondence of

²⁴ In large scales, single tones can also stand out because they are represented in several octaves.

²⁵ In principle, however, simple constructive systems such as the Pythagorean circle of fifths may also be transferred without specific models.

²⁶ In this limited sense, also instrumental scales can be regarded as accessory characteristics.

²⁷ The "good" objects mostly stand out already due to careful facture and visible traces of long-term use; in particular, however, due to the inner regularities of the scales themselves: constant interval sizes, perfect octaves, precise match of pairs of instruments, etc. These are objective quality criteria which are not based on hypotheses.

²⁸ Cf. Graebner, "Kriterium des Verwandtschaftsgrades". (*Methode* IV, 3 A, § 13).

all types belonging to a group, however, is unjustified and cannot be fulfilled even for a limited area of distribution.

Another obvious objection against our criterion must be rejected: The absolute pitch depends on the size of the resonating body. This dependency, one could say, limits the variability of the characteristic – according to the above-defined principle (see p. 40). We would choose dimensions that are most comfortable for the production and handling of the instrument and, thus, consistently obtain approximately the same sizes (and pitches). Apart from the fact that there is still a large scope for the dimensions within the comfort zone, this perspective can be disproved even because the majority of instruments exist in several sizes – panpipes tall as a man or only one inch long. If we defined and copied the *dimensions* instead of the absolute pitches, we would get an equally good criterion for relatedness. The dimensions can also be defined precisely (numerically); they are variable almost without limitations and independent of the purpose of the instrument. If we furthermore know the functional relationship between the frequencies and the dimensions of the resonating body, we can trace the one back to the other and have only two expressions for *one* thing.²⁹ We can sometimes make also use of this fact, for example, to determine the pitch of a broken pipe.

Likewise (and better), we can use measures that have nothing to do with the pitch as criteria for relatedness, as well as other *ergological characteristics*. The latter are always taken into account; in many cases we depend on them only. But it has to be emphasized once again that they are in general more obvious but not at all more conclusive than the acoustic criterion.

Among the instruments with standardized tuning, which are the only ones that come into question for tone measurements, *xylophones* and *panpipes* are to be preferred because their tones are hardly influenced by the style of playing (kind of touch and velocity, kind and strength of the blow) and climatic factors (temperature, humidity). Furthermore, these instruments are particularly easy to tune and will, consequently, represent the intonation of the constructor very precisely.³⁰

The following two *examples*, which belong to the above-mentioned types, will further explain how the absolute pitch is *used as a criterion*:

1. The question of whether the *African xylophone* is autochthonous or imported from Southeast Asia has been widely discussed but not yet decided. It has

²⁹ For pipes, the pitch is approximately a linear function of the length. In fact, as reported by Prof. Aug. Krämer and Dr. Thurnwald, the (inner) lengths of carved panpipes in Melanesia are initially determined by sounding with a little stick. The fine tuning, however, is done by ear. On the contrary, the Chinese deduce their entire measuring system of pipes from a certain pitch, also considering the cross-section besides the length (Laloy, *La musique chinoise*, 51). Also indigenous people tune instruments with complicated dependencies (mallets, bells) only by ear. (cf. Stumpf, *Anfänge der Musik*, 94f.)

³⁰ Metallophones can be influenced regarding tuning by (significantly) changing temperatures; likewise bells which are also more difficult to tune. Flageolets are subject to contingencies already in the production process and changeable due to the strength of the blow; other wind instruments even more (flutes, clarinets, oboes). On string instruments with frets, the tension may influence the intervals. But with due caution, even these instruments are suitable for acoustic studies. For museum objects, the state of preservation certainly also has to be considered. Particularly in African lamellaphones (*sansas*) it is hardly ever trustworthy.

particularly been argued against this connection that the African examples have resonators made of pumpkins, which are missing in both the Farther Indian and the Javanese ones. It has further been argued that the instrument cannot be found in Madagascar.³¹ The first argument does not seem decisive to me because there are also many simple xylophones without resonance application in Africa. An imported instrument may easily be perfected later on. Some metallophones from Java – which are certainly a later variation of mallet instruments – have resonators made from bamboo, too. The fact that there are no xylophones in Madagascar can prove at the utmost that it does not belong to Indonesian cultural layers, which can still be found on this island. It could have been pushed back to the continent³² or have conquered the continent from another direction.

It is conspicuous that some African xylophone scales come very close to the system of seven equal degrees, which is characteristic for the music of Farther Indian civilized peoples. But as it has been explained above (p. 40f.), this would not yet prove a connection. The following table I (p. 49) comprises the *absolute pitches* (frequencies) found on some *Burmese* and two *African* xylophones. The first specimen was measured by A. J. Ellis in the South Kensington Museum in London,³³ the second one by me in the National Museum in Washington, the last one in the Museum of Ethology in Hamburg and all the other ones in the Ethnological Museum of Berlin.³⁴ The fact that the four Burmese *patalas* correspond so well makes it possible to take the mean values (horizontal column V), which almost perfectly correspond to the calculated (starting from 408) tempered scale of seven degrees (column VI). Consequently, we can regard the last row as *Burmese standard tuning*. If we have a look at the last two columns, this tuning can be found on the beautiful *Bavenda* xylophone of the Berlin collection and on the Mandingo specimen of the Hamburg collection. This tuning is hence confirmed for the utmost borders of the area of distribution. But this does certainly not mean that all African xylophones are copies of Burmese models. Siamese ones – which do not differ from the Burmese ones regarding the tonal system, but regarding the absolute pitches – and even Javanese ones could have got to Africa, too.

The range of the scales – only the “best” octave sections in the above-defined sense (p. 41) have been included in the table³⁵ – also indicates a connection. The second and the third *patala* (with 25 and 23 mallets) start (theoretically) with 606, and the first Burmese one (25 mallets) and the *Bavenda* instrument (22 mallets)

³¹ Cf. Ankermann, “Die afrikanischen Musikinstrumente”, *Ethnologisches Notizblatt*, Mus. f. Völkerkunde, Berlin, III (1901), 131f.

³² The xylophone came to Java probably also from Farther India, although it is missing on Sumatra. [Annotation at reprint: J. F. Snellman was so kind to draw my attention to two quotes from literature according to which the gap in the propagation path of the xylophone seems closed: Modigliani, *Un viaggio a Nias*, 565 and *Encyclopaedie van Nederlandsch West-Indië* II, 633 (Battakländer).]

³³ Loc. cit. 506.

³⁴ I am greatly indebted to the management of the mentioned museums for their kind support.

³⁵ Some xylophone tones, in particular the lowest ones, are also difficult to measure due to their noisy sound. They are probably also difficult to tune. Uncertain values in the table are in brackets. – The scales will be presented in greater detail in a broader context.

with 669. This means that the second type seems to be shorter to the lower end by one step compared to the first type. The highest tones of the second and fourth Burmese xylophone (20 mallets) and the Mandingo xylophone (16 mallets) are identical: All three are (theoretically) 408.³⁶ Accordingly, if we regard an instrument with 25 mallets with a range of 3 octaves + 1 fourth from 606 to 408 as the standard type – that is the Washington *patala* – we can easily understand the other ones as shortenings of this scale. Only the London specimen has one more mallet at the upper end instead of the missing one at the lower end.

2. If we have a look at the various forms of panpipes and their distribution in the world, we will not escape the fact that *double-row* types – instruments with an open pipe (of about the same length³⁷) next to each closed one, providing the higher octave – only occur in two defined areas which are, however, remote from one another: on the one hand on the Solomon Islands and in West Polynesia (Fiji, Samoa), on the other hand in Peru (also pre-Colombian) and Bolivia. The *ligature* typical for the Solomon panpipes – flat mallets with cross-wise placed threads³⁸ – can also be found in South America (Peru, Brazil).³⁹ The analysis of some *North-west Brazilian* panpipes showed a very strange *tonal system*, which is formed by a kind of circle of fourths and guided by the overblow tones.⁴⁰ The same characteristic row of intervals can be found in a series of panpipes which Dr. Thurnwald brought from *Bambatana* (on the west coast of *Choiseul* Island).⁴¹ Even if the formation of this tonal system is artificial, and its repeated invention very unlikely – we can also obtain different systems through overblown tones – the proof of this connection is only confirmed by identical *absolute pitches*.

In the first column, table II (p. 49) states the frequencies of two equally tuned panpipes of the *Uanána*, an Indan tribe at the Rio Caiary-Uaupés (V. B. 6322/23)^{**}, to the extent they are relevant at this point. The second column comprises the values calculated on the basis of the hypothesis of the circle of fourths (starting from 481.5). The last two columns state the pitches of the Solomon instruments. We notice that in particular the higher tones of the last columns are even more in

³⁶ The Roman numerals in the table indicate the ordinal numbers of the mallets. From these numerals and the overall number, we can easily deduce the arrangement.

³⁷ Only the panpipes of the Aymara have closed pipes of half the length as octave pipes.

³⁸ Buka Island seems to be a transition area: The panpipes still have two rows (not anymore on Nissan Island!), but they are bound by the “stepped ligature” which is typical for the Bismarck Archipelago. (cf. the illustrations in Schnee, *Bilder aus der Südsee*, 1904, as well as Meyer and Parkinson, *Album von Papuatypen I.*)

³⁹ But in a similar way also in the other direction, for example, in Upper Egypt.

⁴⁰ For details, see my notice in Koch-Grünberg, *Zwei Jahre unter den Indianern II.* (1910).

⁴¹ Now it is in the Ethnological Museum of Berlin (not yet inventoried). I have to restrict myself again to a preliminary discussion of two specimens (which I labelled as G and K) and postpone a detailed analysis regarding a third one to another notice to be published at a later date.

^{**} [This accession number refers to the holdings of the Ethnological Museum of Berlin. The item is accessible online at <http://www.smb-digital.de/eMuseumPlus?service=ExternalInterface&module=collection&objectId=155608&viewType=detailView>; retrieved on February 9, 2018. The editors would like to thank Susanne Ziegler for providing this information. Eds.]

accordance with the theory than the Brazilian scale it is deduced from.⁴² This is perhaps more than a confirmation of the hypothesis about the scale formation: It also indicates that the Bambatana pipes are closer to the original tradition than the Brazilian ones. For the latter, it seems plausible to me that they stem from *old Peruvian* models. Provided that the origin of both is identical, we have to also assume a long standing and cultivated tradition for the Choiseul tuning. Dr. Thurnwald has in fact observed such a tradition, at least in neighboring South Bougainville: The tuning of the old model instruments, which are in the hands of the *big chiefs*, is transferred to the newly produced instruments in a *ceremonial dance at special festive occasions*, in particular before a *big* induction ceremony to the vendetta association (*unu*).⁴³

Although the Brazilian panpipes do not have two rows, their arrangement is closely related to the one of the Melanesian panpipes. The circle of fifths is continued over twelve pipes; only the last five produce octaves of lower tones. Number VII-IX of the nine pipes of the Bambatana instruments produce the octaves of II-IV in both cases. V and VI on G are identical with II and III on K, combining the scales of both instruments. If a third, equally constructed panpipe was added in the same way, the twelve-step overall system like on the Brazilian specimens would be complete.⁴⁴ The strongest evidence for the connection is, however, the fact that the *lowest tone of the Solomon system*, G I, is not the lower octave of VI like the corresponding tone of the smaller panpipe (K I) but *identical with the lowest tone of the Brazilian system* (see above p. 40f.). Thus, the concurrence is more complete and precise than in any of the similar cases analyzed so far. It is to be hoped that the cultural connection detected here will be confirmed by other parallel phenomena to be observed.

To sum up, I would like to emphasize once again the difference between *tone ratios (intervals)* and *absolute pitches*. The relationship between them is the same as that between measuring system and unit of measurement. The same measuring system, for example, the decimal system - indicated by the number of fingers - or the duodecimal system - indicated by the lunar phases - may be found independently in different contexts. The units of measurement, however, centimeters or inches, are totally arbitrary and highly variable without defeating the purpose. Thus, the tonal system often depends on psychological or mechanical conditions. The intervals are indeed an essential factor in music. The absolute pitch, however, is irrelevant for the musician, as we can assume a priori and all experience so far has confirmed.

Hence, the criterion of the absolute pitch perfectly meets all the requirements one might have for a criterion for cultural connections. It is *independent of*

⁴² The differences between the instruments are so small - apart from II - that the listener, directly faced with them, has to be very attentive to notice them.

⁴³ Especially in the case of musical instruments one may assume that a religious, or at least ethical factor will have a positive effect on retaining them unchanged for a long time.

⁴⁴ The third *Bambatana* panpipe mentioned in footnote 40 [probably an error: read: 41? Eds.] approximately represents this addition, but at the same time it brings a complication into the system. Going into detail at this point would, however, go beyond the scope of this text. On the contrary, the missing link seems to be a specimen owned by the Chicago Field Museum (98547, "New Ireland" [??]).

the purpose of the object and its handling: It is non-musical as the unit is non-mathematical. Furthermore, the absolute pitch is *variable in such a large range that coincidences by chance are very unlikely*. Finally, we can *numerically state the degree of preciseness of the coincidence* and thus make the application of the criterion and the evaluation of its probative value less subjective and arbitrary.

Table I Burma – Africa (xylophones)

London 1630 . . . {	VIII. 604	IX. 794	X. 408	XI. 451	XII. 504	XIII. 551	VII. 600
		X. 786	XI. 407	XII. 447	XIII. 501	XIV. 555	XIV. 616
Washington 25,491 . {	XVI. (680)	XVII. (786)					XV. 617
Birma {	XI. 677	X. 744	XI. 405	XII. 455	XIII. 502	VII. 551	VIII. 609
					VI. 502		
Berlin 6462 . . . {						II. 551	III. 616
Berlin 140A . . . {	IV. 674	V. 740	VI. 411	VIII. 447	VIII. 490		
average . . .	672	738,5	408	450	500	552	611,6
theoretically .	669	739	408	450	497	549	606
Bavenda {	VIII. 675	IX. 785	X. (408)	XI. 453	XII. 492	XIII. 551	XIV. 609
	XV. 674	XVI. 744	XVIII. 405	XVIII. 449,5	XIX. 490	XX. 551	XXI. 617
Berlin III. D. 9802		I. 785	II. 405	III. 449,5	IV. 487,5	V. (543)	VI. 609
Afrika {	VII. 672	VIII. 785	IX. 405	X. 449,5	XI. 487,5	XII. 551	
Mandingo {							
Hamburg C. 2845							

Table II Solomon Islands – Brazil (panpipes)

Brazil {	I. 414,5	II. 481,5	III. 560,5	IV. 651,3	V. 374,5	VI. 439,5	VII. 516	VIII. 598,5	IX. 699
		XVII. 478,5						XIII. 595	XIV. 684
theoretically . . .	414,5	481,6	559,6	650,4	378	439,2	510,5	593,4	689,6
Bambatana G . . {	I. 415	II. 478	III. 557	IV. 651	V. 379,3	VI. 440			
		VII. 475	/III. 558,5	IX. 647					
Bambatana K . . {									I. 686
				II. 376,5	III. 489,5	IV. 510	V. 593	VI. 682	
			VII. 378	VIII. 435	IX. 507				