KONINKLIJKE VEREENIGING INDISCH INSTITUUT
(ROYAL INSTITUTE FOR THE INDIES)
AMSTERDAM

Mededeling No. LXXVI
Afd. Volkenkunde No. 27

AROUND VON HORNBOSTEL'S THEORY OF THE CYCLE OF BLOWN FIFTHS

BY

J. KUNST

CURATOR OF THE ETHNOLOGICAL SECTION
OF THE ROYAL INSTITUTE FOR THE INDIES

UITGAVE VAN HET INDISCH INSTITUUT

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A. The hypothesis. When, on the 25th of November 1935, ERICH MARIA VON HORNBOSTEL died, his brilliantly-conceived theory concerning the structure of a large number of exotic scales, commonly called the „theory of blown fifths", seemed to have found pretty general agreement. It was expounded in various stages of its development, now concisely, now in greater detail, by its author in **Anthropos** 1919/'20 (p. 569 **et seq.)** and in Vol. 8 of GEIGER and SCHEEL's **Handbuch der Physik** (1927), and further by ROBERT LACHMANN in his **Musik des Orients** (1929); by CURT SACHS in his **Vergleichende Musikwissenschaft** (1930); by FRITZ BOSE in the **Atlantisbuch der Musik** (1934) p. 960 **et seq.**; by MARIUS SCHNEIDER in his article **Ethnologische Musikforschung** (in PREUSS, **Lehrbuch der Völkerkunde** p. 135 **et seq.),** 1937; by GEORG SCHÜNEMANN (**„Archiv für Musikforschung"** Vol. I fasc. 3 and 4), 1936; by HEINRICH HUSMANN in his article **Marimba und Sansa der Sambesikultur** (in the **Zeitschrift für Ethnologie,** Vol. 68, p. 197 **et seq.),** 1936, and by the present writer in **De Toonkunst van Bali,** Vol. II (1925), in the article **De l'origine des échelles musicales javano-balinaises (Journal of the Siam Society** XXIII) (1929) p. 111 **et seq.,** in **De Toonkunst van Java,** Vol. I (1934) p. 19—31, and in **A musicological argument for cultural relationship between Indonesia — probably the isle of Java — and Central Africa (Proceedings of the Musical Association,** Session LXII) (1936).

The broad outline of this theory of blown fifths may be stated as follows:

From somewhere in Central Asia — probably from the territory called today Chinese Turkestan — the legendary Chinese musician LING LUN, by the order of the mythical emperor HUANG TI, imported a tone-sequence which may be obtained — starting from a fundamental tone of 366 v.d. (the so-called **huang chong,** yellow bell), produced on a bamboo tube closed at the bottom end by a node, about 230 mm long and 8.12 mm in diameter - by taking the twelfth of this fundamental tone (produced by overblowing), transposed an octave lower, as the second tone in the sequence; the twelfth of this second tone, again transposed an octave lower, as third tone, etc., etc.

Now according to VON HORNBOSTEL, these twelfths obtained by overblowing (and, therefore, also the corresponding fifths, called by him „blown fifths" (Blasquinten)) are on the average (within the register in question here) just over one-tenth of a tone (i.e. **24 cents**) [1]) smaller than the natural intervals of that name, with the result that the series of fifths obtained thereby does not — like the cycle produced from the pure fifths of **702** C. — after twelve jumps of a fifth each, finish up approximately (allowing for octave-difference) on the same tone from which it started, but does not reach this point until after 23 jumps; then, however, with greater exactitude, as the following figures show:

12 pure fifths of **702** C = **8424** C
7 octaves of **1200** C = **8400** C

Difference: **24** C = the „comma" of PYTHAGORAS;

23 blown fifths of **678** C = **15594** C
13 octaves of **1200** C = **15600** C

Difference: **6** C = ¼ „comma" of PYTHAGORAS.

Now by „condensing" the entire series of 23 blown fifths within one and the same octave, we obtain, starting from the **huang chong** of 366 v. d. (O = XXIII), the following sequence of tones[2]):

O	I	II	III	IV	V	VI	VII	VIII	IX	X
366	541	400½	593	438	648½	480½	710	525	387½	574

XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
425	628½	465	688	509	376½	557	412	609	450½	667

XXII	XXIII = O
493½	366

Granting that VON HORNBOSTEL correctly interpreted the above-mentioned legend, the conclusion must be that, before ancient China began to base its scales — as is still the custom today — on „Pythagorean" tonal sequences obtained from string-measurement and constructed on the principle of pure fifths, it must have known another type of scales, derived from the cycle of blown fifths described above.

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1) The „cent" as metrical unit for the measurement of musical intervals was suggested by the English musicologist A. J. ELLIS, and first applied by him in his foundational treatise **Tonometrical Observations on some existing non-harmonic scales (Proceedings of the Royal Society** 1884). The **cent** is equal to one-hundredth part of the tempered European semitone. This method accordingly permits of the immediate comparison of the intervals of exotic scales with those familiar to us from childhood.

2) Some of the vibration figures given here deviate a little from those originally taken by VON HORNBOSTEL. The values computed by the present writer with the aid of the cents-table published later by VON HORNBOSTEL **(Zeitschrift für Physik,** Vol. 6, 1921) doubtless approximate the pure cycle of blown fifths slightly more accurately still. Only the last blown fifth has been taken greater by **6 cents** in order to round off the cycle as a whole.

Now as far as I am aware, no instruments producing this latter type of scale have yet come into our possession or to our knowledge from prehistoric China itself; indirectly, however, their existence at some time or other may be inferred from the fact that, as von Hornbostel discovered, a large number of exotic scales found in use among peoples widely separated both historically and geographically, as well ethnologically, may be derived **in some regular manner** from that cycle of blown fifths. As investigations by von Hornbostel and a few other musico-ethnologists have shown, this is the case, for example, with the tunings of pan-pipes originating from Oceania, pre-Colombian Peru, modern Ecuador, Columbia and N. W. Brazil, and with xylophone tunings from Siam, Birma, Java, Bali and Central Africa. Now it is a matter of general agreement among musicologists that scales with definitely fixed, as it were „objectivated", intervals **must** be products of a high culture level; there are various indications pointing to the probability that the cultural influence manifested in the tunings here referred to originally emanated from China. [1]).

To elucidate the above argument it may be useful to give a number of examples of scales examined by the writer in the course of many years. The Roman figures indicate the steps of the cycle of fifths; the encircled Arabic numerals, the degrees of the scale measured; those underneath either the Roman or the encircled numerals, the vibrations figures (v.d.), and the Arabic numerals in heavy type, the intervals expressed in **cents.**

It will be seen that the scales compared are identical not only relatively (i.e. with regards to the intervals), but also in the absolute sence (i.e. with regard to pitch).

It appears that the scale-types, called, in Java, **pélog**, make use of two different selections of blown fifths:

(a) one type is formed by 7 consecutive cycle steps, resulting — when arranged in scale-sequence — in a series of intervals which, expressed in **cents,** presents the following aspect:

156 156 156 210 156 156 210,

or, in certain cases, some inversion of this sequence.

Here follow a few examples of this type, from Bali, Java and the Congo territory, respectively:

[1]) About the reason why scales of this type have been handed down unchanged from generation to generation for so many centuries, **vide** von Hornbostel, **Die Maassnorm als kulturgeschichtliches Forschungsmittel (Pater Wilhelm Schmidt-Festschrift** 1928), p. 305; Maurice Courant, **Essai historique sur la Musique classique en Chine** (in Lavignac, **Histoire de la Musique,** Vol. I, p. 77 **et seq.)** (1912), p. 80; J. Combarieu, **La Musique et la Magie** (1909), and **Histoire de la Musique,** Vol. I (1913), first two chapters; J. Kunst, **De Toonkunst van Java** (1934), Vol. I, p. 30, and **De Inheemsche Muziek en de Zending** (1948), p. 6—8.

Blown fifths	XII	XIV	XVI	XI	XIII	XV	X	XII
X-XVI incl.	314½	344	376½	425	465	509	574	628½
Gam. Saih pitu from	①	②	③	④	⑤	⑥	⑦	①'
Ksatria,	312½	341½	375	430	470	510	576	625
Dén Pasar (South Bali)		**153**	**162**	**237**	**154**	**142**	**210**	**142**
Deviations in cents:	**—9**	**—13**	**—7**	**+20**	**+18**	**+4**	**+6**	**—9**

Blown fifths	XII	XIV	XVI	XVIII	XIII	XV	XVII	XII
XII-XVIII incl.	314¼	344	376½	412	465	509	557	628½
Bamboo gambang from	①	②	③	④	⑤	⑥	⑦	①'
	315	343½	378	415½	465	508	556	(630)
Batu bulan (South Bali)		**150**	**171**	**162**	**202**	**153**	**165**	**197**
Deviations in cents:	**+4**	**—3**	**+7**	**+14**	**0**	**—3**	**—3**	**+4**

Blown fifths	XVII	XIX	XXI	XVIII	XX	XVII
XVII-XXI incl.	557	609	667	824	901	1114
Gam. Gong from	①	②	③	⑤	⑥	①'
Padangtegal,	555	606	670	828	894	1110
distr. Ubud, (South Bali)		**152**	**174**	**366**	**133**	**375**
Deviations in cents:	**—6**	**—8**	**+8**	**+8**	**—14**	**—6**

Blown fifths	XI	VI	VIII	X	XII	VII	IX	XI
VI-XII incl.	425	480½	525	574	628½	710	775	850
Hindu-Jav. demung, excavated in	①	②	③	④	⑤	⑥	⑦	①'
Banjarnegara	427	475	518	576	628½	710	768	(854)
(Mus. R. Bat. S. No. 1051a)		**184**	**150**	**184**	**151**	**211**	**136**	**184**
Deviations in cents:	**+8**	**—20**	**—24**	**+6**	**0**	**0**	**—16**	**+8**

Blown fifths	II	IV	VI	I	III	V	VII	II
I-VII incl.	200¼	219	240½	270½	296½	324¼	355	400½
Gam. Kyahi Munggang	①	②	③	④	⑤	⑥	⑦	①
(Paku Ala-	199½	217	237	273	298	326	357	399
man, Jogja)		**146**	**153**	**245**	**151**	**155**	**158**	**192**
Deviations in cents:	**—7**	**—16**	**—23**	**+16**	**+9**	**+9**	**+10**	**—7**

Blown fifths	XVI	XVIII	XX	XV	XVII	XIX	XIV	XVI
XIV-XX incl.					139¼	152¼	172	
	188¼	206	225¼	254½	278½	304½	344	
	376½	412	450½	509	557	609	688	753
Marimba of	①	②	③	④	⑤	⑥	⑦	①
the Bakwese					140½	152½	171½	
SW Belgian						**145**	**201**	**122**
Congo (Congo	189	205	227	252	276	302	338	
Mus. No.		**141**	**176**	**181**	**157**	**156**	**195**	**106**
15862)	368	411	456	510	572	604	692	(736)
		192	**180**	**194**	**198**	**94**	**236**	**106**
Deviations					**+15**	**+ 3**	**— 6**	
in	**+ 7**	**— 8**	**+ 8**	**—13**	**—16**	**—14**	**—31**	
cents:	**—40**	**— 4**	**+16**	**+ 4**	**+46**	**—14**	**+10**	**—40**

Blown fifths	XVI	XVIII	XX	XV	XVII	XIX	XIV	XVI
XIV-XX incl.					139¼	152¼	172	
	188¼	206	225¼	254½	278½	304½	344	
	376½	412	450½	509	557	609	688	753
Marimba of	①	②	③	④	⑤	⑥	⑦	①
the Bakubu					141½	151	172	
S. Belgian						**112**	**226**	**131**
Congo	185½	205½	228	248	281	309	332	
(Congo-Mus.		**177**	**180**	**146**	**215**	**165**	**124**	**215**
No. 15861)	376	412	458	516	568	620	688	(752)
		158	**184**	**206**	**166**	**152**	**180**	**154**
Deviations					**+28**	**—14**	**0**	
in	**—25**	**— 4**	**+21**	**—44**	**+ 9**	**+26**	**—62**	
cents:	**— 2**	**0**	**+29**	**+24**	**+34**	**+32**	**0**	**— 2**

(b) It is probable that another pélog sequence represents an older form than the preceding one; we might conveniently call it „primitive" pélog. It consists of 8 steps of the cycle at intervals of 12 fifths between each other; arranged according to height of pitch, these tones produce a series of intervals formed from steps of a blown semi-fourth (**261** C) [1]) and of the following sizes:

105 156 261 156 105 156 261.

In this, however, the second step — to be reached in the manner indicated (i.e. the 13th fifth including the starting point) — is always skipped, because, if it were gathered into the scale, it would split the seventh pélog-interval (of **261** C.) into two smaller intervals of **105** and **156** C. respectively, which would alter the scale from being a heptatonic one into an octotonic one:

Part of the cycle of blown fifths in semi-fourths arrangement	XII 314½	I 541	XIII 465	II 400½	XIV 344	III 296½	XV 509	IV 438
Gam. Kyahi Kanyut Mèsem pélog (Mangku Nagaran)	② 317	—	⑥ 465	④ 399	③ 345	① 295	⑦ 512	⑤ 439
Deviations in cents:	**+15**	—	**0**	**−7**	**+5**	**−8**	**+10**	**+4**

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[1]) i.e. 7 octaves of **1200** C each = **8400** C
12 blown fifths of **678** C each = **8136** C

Difference: **264** C.

We should bear in mind, however, that the cycle of blown fifths — which in fact, does not „round off" exactly, but with a minus discrepancy of **6** C — has to be run through nearly four times in order to obtain this type of scale; so that we have to reckon with an „error" of about 4 × **6** = **24** C., i.e. a reduction of about **3** C per step, as a result of which these degrees are, theoretically, only **261** C, or exactly a semi-fourth ($\frac{522}{2}$ C.)

Cf., in regard to semi-fourth scales (which have also been found elsewhere, notably in Melanesia, NW Brazil and ancient Peru): von Hornbostel in Geiger and Scheel **Handbuch der Physik** VIII, p. 431.

Part of the cycle of blown fifths in semi-fourths arrangment	XIX 304½	VIII 525	XX 450½	IX 387½	XXI 333½	X 287	XXII 493½	XI 425
Gam. Kyahi Bermara (kraton Jogja)	② 308	—	⑥ 450	④ 387½	③ 332½	① 290	⑦ 496	⑤ 425
Deviations in cents:	**20**	—	**—2**	**0**	**—6**	**+18**	**+9**	**0**
Gam. Kyahi Pengasih (kraton Solo)	② 308	—	⑥ 450	④ 392	③ 335½	① 286	⑦ 500	⑤ 421
Deviations in cents:	**20**	—	**—2**	**+20**	**+10**	**—6**	**+22**	**—17**

Arranged according to pitch, the tones of these three semi-fourths pélog scales form the following series of intervals:

	①		②		③		④		⑤		⑥		⑦		①^{1}
Kyahi Kanyut	295		317		345		399		439		465		512		590
Mèsem:		**125**		**146**		**252**		**165**		**100**		**167**		**245**	
Kyahi	290		308		332½		387½		425		450		496		580
Bermara:		**104**		**132**		**265**		**160**		**99**		**169**		**271**	
Kyahi	286		308		335½		392		421		450		500		572
Pengasih:		**128**		**148**		**270**		**123**		**116**		**182**		**233**	

Nothwithstanding the fact that scales of this **b**-type (or, at any rate, those unmistakably deriving from this type, i.e. those whose I-II and V-VI steps are considerably smaller than their II-III, IV-V and VI-VII steps, while their III-IV and VII-I^1 steps are about a semi-fourth) are at the present time more numerous than those of the previously described **a**-type, it is precisely the latter that have given us an insight into the structure of the entire pélog system; it is these scales which have supplied the answer to the question why pélog, in playing practice, possesses only three different patets.[1]).

* * *

[1]) Cf. **De Toonkunst van Java,** Vol. I, p. 33.

Of the scales classed in Java among the group of **sléndro**-scales, there are also a number of types, each of which can be derived from the cycle of blown fifths, each in its own way, **but always according to a fixed, regular principle.** On the ground of a large number of scale measurements, I am inclined to distinguish three phases of development, to which I propose to give the names of **primitive** (or **semi-fourths-**), **medium,** and **modern** sléndro, respectively.

(c) Primitive sléndro makes use of 5 cycle-steps which, again, lie at distances of 12 fifths from each other. Assuming this scale to close on the octave, we get in this way a series of intervals of the following type:

261 261 261 261 156

Some examples of this, from the Congo territory and from Java, respectively, are:

Part of the cycle	(O)				XXII				XXI		(O)
of blown fifths	183				246¼				333½		366
in semi-fourths	366				493½				667		732
arrangment [1])			XI				[X [2])]				
			212½				[287]				
			425				[574]				
							III				
							296½				
							593				
Marimba from the	①		②		③		④		⑤		①
Yakoma-tribe,	185½		210½		247		298		338		
Belgian Congo		**218**		**277**		**325**		**218**		**147**	
(Congo-Mus.	368		428		494		596		676		(736)
No. 34939)		**262**		**248**		**325**		**218**		**147**	
Deviations	**+24**		**—17**		**+ 1**		**+ 9**		**+23**		
in cents:	**+ 9**		**+12**		**+ 1**		**+ 9**		**+23**		**+ 9**

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[1]) To be read from right to left, because of the fact that the tones of this scale **go up** in the **descending** sequence of fifths.

[2]) Step X has been replaced by a step III which lies 7 fifths (one **saptaka**) higher in the cycle.

Part of the circle of blown fifths in semi-fourths arrangment	IV 438		XV 509		III 593		XIV 688		II 801		(IV) 876
Gam. miring of Musadikrama, désa Katur, Bajanegara	⑤ 434	**230**	① 510	**252**	② 590	**246**	③ 680	**259**	④ 791	**163**	⑤ 868
Deviations in cents:	**—16**		**+ 4**		**— 8**		**—20**		**—22**		**—16**

We see, therefore, that primitive pélog and primitive sléndro are closely akin: both they are semi-fourths scales and they differ only as regards the number of intervals within the octave: in the case of primitive pélog there are 7, and in the case of primitive sléndro, 5.

(d) Medium sléndro employs 5 cycle-steps which lies at distances of 6 fifths from one another, which produces, when arranged according to pitch, a sequence of intervals of the following type:

264 204 264 204 264

Here are a few examples of this type of scale:

Series of blown fifths	XIX $304\frac{1}{2}$	II $400\frac{1}{2}$	VIII $262\frac{1}{2}$	XIV 344	XX $450\frac{1}{2}$
Gam. miring from Bajanegara	② 308	④ 399	① 262	③ 347	⑤ 450
Deviations in C:	**+20**	**— 7**	**— 4**	**+15**	**— 2**
Gam. miring from Ngumpak, Bajanegara	② 310	④ 405	① 266	③ 348	⑤ 455
Deviations in C:	**+32**	**+19**	**+22**	**+20**	**+17**

It will be seen that the latter of these two gamelans is pitched, in its entirety, about **20** C higher than the absolute norm; relatively, however, it is purer than the former, since its intervals hardly deviate at all from the theoretical ones (in playing practice the discrepancy would not be noticeable):

Gam. miring	①		②		③		④		⑤		①'
from Bajanegara	262		308		347		399		450		524
		280		**207**		**241**		**209**		**263**	
but											
Gam. miring	①		②		③		④		⑤		①'
from Ngumpak	266		310		348		405		455		532
		266		**200**		**262**		**202**		**270**	
Theoretical scale:		**264**		**204**		**264**		**204**		**264**	
Deviations in cents:		**+2**		**—4**		**—2**		**—2**		**+6**	

In regard to these medium sléndro scales I should remark that its tones, when arranged in the position which they occupy in the cycle, are known in Bali by names whose vowels form a „spectral" sequence from light to dark:

①	③	⑤	②	④
ding	**dèng**	**dang**	**dong**	**doong**

This is a significant point, in a race like the Balinese, which is so fond of relating the pitch of a tone, the size of an instrument or part of an instrument (key, sound-kettle), on the one hand, and the tone-colour of the instrument's name, on the other hand.

(e) Modern sléndro, the third type, employs, for the two even, or the three uneven tones of its scale, cycle-steps again lying at distances of 6 fifths from each other; for the three (or two) remaining intermediary tones, however, tones are used which lie half-way between the third and fifth of the cycle-steps missed; together they constitute a sequence presenting f.i. the following picture:

I III/V VII IX/XI XIII I',

which, when expressed in cents, results in the following scale:

234 234 234 234 264

There are plenty examples of this; I content myself with a few of the most striking instances:

Scale derived	XVII/XIX		XXI		O/II		IV		VI/VIII		XVII/XIX
from the cycle of blown fifths	291		333½		383		438		502		582
Kyahi Kanyut	①		②		③		④		⑤		①'
mèsem sléndro	291		331		383		439		500		582
(Mangku Nagaran Solo)		**223**		**253**		**236**		**225**		**263**	
Deviations in C:	**0**		**—13**		**0**		**+ 4**		**— 7**		**0**

Scale derived from the cycle of blown fifths	III 296½		V/VII 339		IX 387½		XI/XIII 444½		XV 509		III 593
Kyahi Pengawé sari (Paku Alaman, Jogja)	① 295	**251**	② 341	**233**	③ 390	**234**	④ 446	**233**	⑤ 511	**249**	①̇ 590
Deviations in C:	— **8**		+ **10**		+ **11**		+ **5**		+ **7**		— **8**

Scale derived from the cycle of blown fifths	XIII 232½		XV/XVII 266½		XIX 304½		XXI/O 349¼		II 400½		XIII 465
Gam. sléndro of R. M. Jayadipura, Jogja	⑤ 231	**245**	① 266	**231**	② 304	**239**	③ 349½	**231**	④ 399	**254**	⑤̇ 462
Deviations in C:	—**12**		— **2**		— **2**		+ **2**		— **7**		—**12**

Scale derived from the cycle of blown fifths	I/III 283		V 324¼		VII/IX 371		XI 425		XIII/XV 486½		I/III 566
Gam. sléndro, Rancha iyuh, Tanggerang, res. Batavia	① 282½	**232**	② 323	**241**	③ 371	**245**	④ 427½	**222**	⑤ 486	**260**	①̇ 564½
Deviations in C:	— **5**		— **7**		**0**		+ **10**		— **2**		— **5**

Scale derived from the cycle of blown fifths	XIX 304½ 609		XXI/O 349¼ 698½		II 400½ 801		IV/VI 458 916		VIII 525 1050		XIX 609 1218
Gendèr wayang from Pliatan, South Bali	① 611	**236**	② 350 700	**218**	③ 397 794	**251**	④ 459 918	**223**	⑤ 522 1044	**272**	①̇ 611 1222
Deviations in C:	+ **6**		+ **4**		—**15**		+ **3**		—**10**		+ **6**

This modern sléndro-scale often seems to be tempered to form an equi-grade tone-sequence with the structural formula:

240 240 240 240 240

This equigradity, however, is never reached perfectly, but the remaining imperfections have no **functional** significance anymore, with the result that one and the same nuclear melody, when played on one gamelan, may sometimes produce a totally different (tonal) effect on the western ear than when it is played on another gamelan.

(f) Finally, we come across scales employing 7 consecutive **even** („feminine", or **yin)** or **uneven** („masculine", or **yang)** cycle-steps, i.e., for example, the steps:

I III V VII IX XI XIII

or, for instance,

VI VIII X XII XIV XVI XVIII

which sequences, when expressed in **cents,** give the following theoretical scale:

156 156 156 156 156 156

and which, therefore, assuming them to have seven steps, and to finish on the octave, must contain one larger interval, of **1200** — (6 × **156)** = **1200** — **936** = **264** C, unless — as VON HORNBOSTEL appears to have found in NW Brazilian scales — they just ignore the octave altogether.

VON HORNBOSTEL inclined to the supposition that, of these „Umschicht-reihen" („alternating series"), as he called them (each of which missed the interval of approximately a fifth, so important for melody-building: blown fifth = 678 C; pure fifth = 702 C; tempered fifth = 700 C; whereas 4 × 156 = 624, and 5 × 156 = 780 C), a „masculine" and a „feminine" sequence were played each time on two complementary instruments, in order to provide for this missing fifth-interval; further, that in view of the difficulty of this roundabout method, some tones (ultimately three) from each set of seven were changed over [1]), as a result of which tone-sequences were obtained by means of which the desired fifths could be produced, i.e. scales which are nothing more or less than the modern pélog-scales described above sub (a). For with the aid of these it is possible to play all sorts of fifths, since (3 × **156**) plus **210** = **678** C, which represents the blown fifth.

[1]) These substitute-tones are those which have their place 7 steps (a **saptaka)** earlier or further in the cycle, which amounts to a tone either 52 C higher or 52 C lower, respectively, than the tone to be replaced.

It appears, however, that many of the modern pélog-scales have got stuck in a kind of transition-stage between a real pure pélog- and an „alternating" scale.

First an example from South-America, an Andean pan-pipe. It is a double-instrument with one series of 8 stopped tubes, extending over two octaves, and an other series of 8 open tubes, intended (at least as far as they could be made to sound, which was no easy matter) to produce exactly the same scale, one octave higher. The complete instrument, therefore, covers three octaves.

The series of stopped tubes gave the following sequence of tones. They form, as we shall see, a „feminine" alternating series, of which one tone is replaced by another, one **saptaka** further in the cycle — the first of the three steps that lead to real pélog:

Blown fifths	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
VI-XVIII	240¼	360	262½	387½	287	212½	314½	232½	172	254½	376	278½	206
	480½	720	525	775	574	425	628½	465	344 688	509	752	557	412
Pan-pipe from La Paz, Bolivia (Mus, de l'Homme, no. 30.44.32).	⊙		③ 262½		⑦ 578		④ 313	⑥ 467	① 171 ①' 683		⑤ 380		② 206½
Deviations in C:			**0**		**+12**		**—7**	**+5**	**—10** **—13**		**+16**		**+4**

When arranged according to pitch, the tones of this scale form the following sequence of intervals:

①		②		③		④		⑤		⑥		⑦		①'
171		206½		262½		313		380		467		578		683
	326		**416**		**304**		**336**		**357**		**369**		**286**	

The next scale, this time one from the isle of Bali, has already set two of the three steps in the direction of real pélog:

Blown fifths	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
VI-XVIII incl.	480½	710	525	387½	574	425	628½	465	688	509	367½	557	412
Gam. Semar pegulingan, — Ubud (S. Bali)	⑦	④ 714	① 527	⑤ 389	② 568		③ 636		⊙		⊙		⑥ 416
Deviations in C:		**+10**	**+6**	**+6**	**—18**		**+23**						**+17**

This originally a „feminine" scale, too, has replaced the „alternating" cycle-steps XIV and XVI by the steps VII and IX, both one saptaka earlier in the cycle, but not yet the step XVIII by the step XI, which would give this scale a pure pélog-structure.

When arranged according to pitch, the tones of this scale form the following sequence of intervals:

①		②		③		④		⑤		⑥		⑦		①'
263½		284		318		357		389		416		—		517
	130		**196**		**200**		**149**		**117**			**376**		

Such transitional forms do exist also between (d) medium and (e) modern sléndro. The following scale is an example of this. As will be seen, only the tone ④ occupies a fresh position; tone ② through whose displacement from cycle step IX or II to XVI/XVIII this scale would have been completely converted into modern sléndro, is still in the medium-sléndro position:

Scale derived from the cycle of blown fifths	VIII	X/XII	XIV	XVI/XVIII	XX	XXII/I	III	V/VII	IX	XI/XIII	XV
		574/628½		376½/412		493½/541		648½/710		425/465	
	525	600½	344	394	450½	516½	593	678½	387½	444½	510
Gendèr wavang from Ubud (S. Bali)	⊙		① 347		③ 452	④ 516	⑤ 590		② 388		⊙
Deviations in C:			**+15**		**+5**	**—1**	**—8**		**+2**		

When arranged according to pitch, the tones of this scale form the following sequence of intervals:

①		②		③		④		⑤		①'
347		388		452		516		590		694
	193		**264**		**230**		**232**		**281**	

It might just be possible that the „coupling" of two instruments, which is still found today in the musical practice of different peoples, is reminiscent of the primitive stage, i.e. the simultaneous playing of a **yang-** and a **yin-**instrument. One example of this might be the Sundanese pan-pipes **(hatong),** which are always blown in duplicate during harvest festivals, and called **indung** (= mother) and **anak** (= child). The double-row pan-pipes used by some South American Indian tribes might perhaps be explained in the same way.

In the case of African marimba's too, „male" and „female" tone-sequences are also occasionally combined in one and the same instrument. Such a combination of a masculine and a feminine scale of the type referred to here is shown, for example, by a marimba from the Bayanzi-tribe (Belgian Congo):

Male series	XIV	XVI	XVIII		VI		VIII	X			XII
of blown fifths								143½			
VI-XVIII	172	188¼	206								
	344	376½	412		480½		525	574			628½
Female series				XIII		XV			XVII	XIX	
of blown fifths						127½				152½	
XIII-XIX				232½		254½			278½	304½	
Marimba of the	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
Bayanzi (Congo-						127		143½		151	
Museum no.	171½	191	210	233		255			282½	306	
31354)	346	381½	420		472		526	570			624
Deviations						**—3**		**0**		**—14**	
in cents:	**—5**	**+25**	**+33**	**+4**		**+4**			**+24**	**+9**	
	+10	**+20**	**+33**		**—29**		**+3**	**—12**			**—12**

And the same combination we find realized on a marimba from the Kasai district:

Alternating	XVIII		XX		XXII		(I)		III		V		VII		
series of	206		225¼		246		270½		296½		648½		355		
bl. fifths		XIX		XXI		(O)		II		IV		VI		VIII	X
		1218		333½		366		400½		438		480½		525	1148
Marimba	①	⑭	②	⑤	③	—	—	⑦	④	⑧	⑪	⑨	⑥	⑩	⑬
Kasai distr.	205	1232	226	330	246			397	302	440	652	473	360	526	1160
(Mus. du Cons.															
Brussels								⑫							
no. Prov. 128)								808							
Deviations	**—8**	**+20**	**+5**	**—18**	**0**	—	—	**—15**	**+32**	**+8**	**+9**	**—27**	**+24**	**+3**	**+18**
in cents:								**+15**							

This remarkable correspondence and kinship between scales, both as regards their structure and as regards their absolute pitch, is not an isolated phenomenon; it appears that there also exists — if we are to accept VON HORNBOSTEL's argument on the subject in his above-mentioned paper **Die Maassnorm als kulturgeschichtliches Forschungsmittel** — a similar connexion in the field of metrical standards. For in this treatise the author brings forward a plausible argument to the effect that the length of the bamboo tube on which the basic tone of the cycle of blown fifths, the **huang-chong,** is sounded — i.e. 230 ± 3 mm [1]) — was adopted as sacred norm and served, as such, as basis for the length-measurements valid not only in ancient China, but also, it seems, in the territory of the Sumerian priest-prince Gudea (2600 B.C.), as well as in pre-Columbian South America. In other words, it would appear that we are here confronted with two inseparably connected phenomena — one metrical, the other musical — which constitute irrefutable evidence of the existence of an early contact between cultures covering an astonishingly extensive, in fact, almost world-wide area. It will be admitted that this would be a discovery of the very first importance; indeed, a discovery almost too grand to be accepted without scepticism or criticism. In effect, objections were duly raised to the theory; it is to be regretted that they were not put forward until after the death of him to whom we owe this hypothesis.

B. Objections to Von Hornbostel's theory.

Criticism of the theory of the cycle of blown fifths, partly amounting to complete rejection, has been published chiefly by two musicologists, Miss KATHLEEN SCHLESINGER and Dr. MANFRED BUKOFZER; while CURT SACHS, in his more recent writings, also gives the impression of discountenancing it. [2])

Now it had already been remarked on previous occasions that one could hardly credit the assumption that such an extremely complicated structural form as that embodied in a cycle of blown fifths of 23 steps could possibly have been conceived and realized as early as the third millennium B.C.; nay, it was affirmed that it was utterly impossible to arrive at construing a cycle of this kind by purily experimental means.

But are we sure that this view is correct? One feels inclined to doubt it, in view of the existence of structures such as those of the scales reproduced above (p. 6, 8, 9, 12 and 13), and still more strongly, in view of that of a pan-pipe from Ecuador in possession of the Musée de l'Homme, Paris, under No. 41.39.1. The tonal sequence of this latter instrument — which counts as many as 26 tubes — uses no less than 16 out of the 23 steps of the cycle — they are, moreover, 16 **consecutive** steps — covering the latter with truly remarkable accuracy, as the following table shows:

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[1]) This norm has not remained precisely the same through the centuries; it has fluctuated somewhat, around 230 mm as a central value, but with a deviation of a few millimetres at most. About the magical significance of this norm for the dynasties and the empire of China I may refer the reader to VON HORNBOSTEL, **op. cit.**; MAURICE COURANT, **Essai historique sur la musique classique en Chine,** p. 80, and CURT SACHS, **The Rise of Music in the Ancient World, East and West** (1943), p. 11.

[2]) Cf. also W. APEL, **Harvard Dictionary of Music** (1944, 3rd ed. 1945), p. 374a.

No. of tube	Vibration-figure	Interval in cents	Step of the cycle of blown fifths		Deviations in cents
1.	682		XIV	688	**—16**
		708			
2.	453		XX	450½	**+ 9**
		311			
3.	542		I	541	**+ 4**
		287			
4.	461		XIII	465	**—19**
		469			
5.	604		XIX	609	**—14**
		323			
6.	728		O	732	**—10**
		231			
7.	832		XVIII	824	**+17**
		324			
8.	690		XIV	688	**+ 4**
		521			
9.	932		XIII	930	**+ 4**
		391			
10.	746		XVI	753	**—16**
		704			
11.	1120		XVII	1114	**+ 9**
		303			
12.	940		XIII	930	**+18**
		491 (709)			
13.	1248 (624)		XII	1257 (628½)	**—12**
		326			
14.	1034 (517)		XV	1018 (509)	**+27**
		657 (1857)			
15.	1512		XVI	1506	**+ 6**
		298			
16.	1272		XII	1257	**+21**
		502			
17.	1700		XI	1700	**0**
		250			
18.	1472		O	1464	**+ 9**
		524			
19.	1992		XXII	1974	**+15**
		397			
20.	1584		II	1602	**—22**
		697			
21.	2368		III	2372	**— 2**
		300			

No. of tube	Vibration-figure	Interval in cents	Step of the cycle of blown fifths		Deviations in cents
22.	1992		XXII	1974	+15
		508			
23.	2672		XXI	2668	+ 2
		508			
24.	1992		XXII	1974	+15
		686			
25.	2760		XIV	2752	+ 4
		489			
26.	2232		XVII	2228	+ 3

This pan-pipe uses, therefore, the following steps of the cycle:

XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	O	I	II	III
17	16	4	1	14	10	11	7	5	2	23	19	6	3	20	21
	13	9	8		15	26					22	18			
		12	25								24				

On examining sequences of tones such as the above, we must indeed be led to wonder whether it was so impossible, after all, even in those remote times, to attain to the construction of a cycle such as we are dealing with, for the construction of the proto-type of a pan-pipe like this Andean one is hardly feasible without the preliminary knowledge of the complete cycle of fifths.

For that matter: even if there had been unsurmountable difficulties of a practical nature in the way of tuning the tones by way of overblowing and then lowering them each time by one or two octaves — seeing that there were such a large number of steps to run through — then there was still a second method to arrive at an equivalent result: we possesss data which show that, in addition to the acoustical method discussed, there existed another, metrical method, which consisted of giving each subsequent tube either 3/4 or 4/3 of the preceding one's length. In this way, too, a chain of fifths was obtained each slightly smaller than a pure fifth.

This possibility, has been taken in consideration also by VON HORNBOSTEL, towards the end of his life. In a letter dated May 12, 1935, we read:

„Ich glaube jetzt eigentlich, dass es im alten China den in der Litteratur ausschliesslich beschriebenen **metrischen** Quintenzirkel auch in der Praxis gegeben hat. Wenn man nämlich Röhren (von konstantem Durchmesser) nach dem Rezept 1, × 3/4, × 4/3 usw. schneidet, so werden die Quinten ebenfalls zu eng und zwar (wie ich einmal durch einen flüchtigen Versuch überzeugt habe) etwa im gleichen Verhältnis wie beim überblasen. Für das Verhältnis des metrischen zum Blasquintenzirkel (BZQ) sind verschiedene Annahmen möglich: 1°. der BZQ ist älter, der metrische Zirkel erst von den Theoretikern eingeführt und dann neben oder statt den BQZ verwendet; 2°. der metrische Quintenzirkel ist älter, und erst in der Praxis durch den bequemeren BZQ ersetzt worden (dies könnte sogar erst ausserhalb Chinas bei Völkern geschehen sein, die keinen Maassstab und keine Längenmessung kannten); 3°. = 1°. plus 2°., d.h., der BQZ hat zu allen Zeiten bei den Praktikern vorgeherrscht, ist nur zeitweise in den gelehrten Kreisen durch den metr. QZ. ersetzt worden, ganz analog wie es mit den bequemen Körpermaassen (Fuss, Fingerbreite, Spanne usw.) und den normierten Maassen der Fall war. Diese letzte Hypothese ist mir persönlich die wahrscheinlichtste." [1])

However this may be, Father P. Rozing S.V.D. came forward, in 1946, with a rather plausible argument in support of the theory that it would be quite possible to construe at least the majority of the scale-structures referred to above, without having a complete cycle of blown fifths at one's disposal at all.

Father Rozing's reasoning is as follows:

We may regard the existence of the octave-interval as a primary fact, since it arises in a natural way from the simultaneous singing by men and women, whose voices usually move at an octave's distance:

I	I'
0	**1200** C.

By overblowing a stopped flute one obtains the — too flat — twelfth of the tonic (**1878** C), which, when brought back into the octave, yields the blown fifth of **678** C. We then obtain the following tone-sequence:

I		II	I'	
0		**678**	**1200** C.	
	678	**522**		=**1200** C.

[1]) „As a matter of fact, I now believe that, in ancient China, the **metrical** cycle of fifths which alone is described in the literature, must also have existed in musical practice. For, if we cut down tubes (of constant diameter) according to the recipe 1, × 3/4, × 4/3, etc. etc., the fifths also become too small, and, in effect — as I discovered one day by a more or less superficial experiment — in approximately the same proportion as by overblowing. Different assumptions are possible in regard to the relation between the metrical cycle and the cycle of blown fifths (CBF): (a) the CBF is older, and the metrical one was introduced only by theorists, when it was used either in the place of, or side by side with, the CBF; (b) the metrical cycle is older, and was replaced only in practice because the CBF was easier (this, indeed, might well first have been the case with peoples outside China, who lacked standards by which to measure lengths); (c) = (a) plus (b), i.e. the CBF has prevailed at all times amongst practical musicians, being replaced only as time went on, in learned circles, by the metrical CF in a way quite analogous to the simpler measurements based on the body (foot, span, finger-width, etc.) relatively to normalized ones. This latter hypothesis appears the most probable to me personally."

When applying the same process again, but starting, this time, from tone II, we get the blown fifth of the first blown fifth, and this, within the scale-compass, will be placed between tones I and II, at a distance of **156** C from tone No. I (for, **678** + **678** — **1200** = **156** C)::

I		II		III		I'	
0		**156**		**678**		**1200** C.	
	156		**522**		**522**		=**1200** C.

So long as these tones were used only for the purpose of giving signals, or to accentuate dance-steps, they were quite adequate as such. For the purpose of melody-forming, however, the two distances of a blown fourth (**522** C.) are rather too great. There was every reason, therefore, to fill up these fourths by means of an intermediate tone. This filling up of structural intervals may still be observed to this day among primitive peoples, **e.g.** the North Papua tribes. [1])

The smaller intervals aimed at may be obtained in two ways, **i.e.** either on the ,,consonance-principle" (the intervals already obtained came into being in this way) or on the ,,distance-principle" — in this case, by halving both fourths. Instances of the halving of fourths have also been found — as we saw above (p. 8, footnote) — among primitive peoples in our own time.

When halving the two fourths in question we obtain the following scale:

I		II		III		IV		V		I'	
0		**156**		**412**		**678**		**939**		**1200** C.	
	156		**261**		**261**		**261**		**261**		=**1200** C.

which is the very scale referred to above (p. 10) under the name of **primitive slendro,** and which, as we have seen, is still found on certain **gamelans miring** in Bajanegara and in Central Africa.

The heptatonic scale may also be explained by means of the course of development described above. We begin at the stage where the following tone-distances were available:

I		II		III		I'	
0		**156**		**678**		**1200** C	
	156		**522**		**522**		=**1200** C.

Now instead of following, from this point, the ,,distance-principle", as we did in the case of sléndro, we adhere to the ,,consonance-principle". On overblowing a stopped tube with a pitch equal to tone No. II, we obtain

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[1]) Cf. Kunst, **A Study on Papuan Music** (1930).

a tone which, when lowered by an octave, yields a blown fifth lying **156** C above step No. III **(678)**. In the same way, another blown fifth may be derived from this newly-obtained tone **(834** C. above step No. I), whose position will be **312** C **(i.e. 834** + **678** — **1200** C) above tone I. From the latter, in its turn, a blown fifth may be derived, which will take its place in the sequence at **990** C. above step No. I (for **312**+**678** =**990** C); and finally, from the last-named blown fifth, a step whose position will be at a distance of **468** (=**990**+**678**—**1200** C) from step No. I. In other words, in order to obtain this new tone-sequence we simply apply the overblowing process another four times, **i.e.** six times in all. The result, then, will be the following scale:

I		II		III		IV		V		VI		VII		I'	
0		**156**		**312**		**468**		**678**		**834**		**990**		**1200** C	
	156		**156**		**156**		**210**		**156**		**156**		**210**		= **1200** C.

i.e. the pélog-scale which, as we have seen, is constructed out of seven succeeding fifths of the cycle of blown fifths.

It is, of course, possible to carry on with this method of generating fifths, as has been done here six times, still further. The result will then be a series of intervals of **156** C. If we hold on to the principle of „limitation to the octave" — which was the initial idea in this line of thought — we shall get a series of seven steps of **156** C, followed by one of **108** C. And this is the „Umschichtreihe" (alternating series of tones) in the purest form which, therefore, in this line of reasoning, is a **younger** scaleform than either real pélog or sléndro (miring).

Modern sléndro may also be derived in a similarly simple manner, namely, from the „Umschichtreihe" just mentioned:

$$\underbrace{\underbrace{156 \quad 156 \quad 156}_{468}}_{234 \quad 234} \qquad \underbrace{\underbrace{156 \quad 156 \quad 156}_{468}}_{234 \quad 234} \qquad \underbrace{156 \quad 108}_{\substack{264 \\ 264}}$$

which amounts, after all, to a halving of two intervals which are too large for melodic construction (distance-principle), in the same way as we supposed it to be the case in the construction of the **sléndro miring** scale.

The generation theory expounded above has the following advantages as compared to that given previously:

(1) it is simpler, more feasible psychologically, and substantiated by examples from present-day musical practice;

(II) both the fifth-interval and the octave are present from the start, and are not obtained, as in the case of the pélog-fifths, only afterwards by means of the interchange of male and female tones. Father ROZING is of opinion that one may well conceive the existence, in higher forms of culture, of tone-sequences constructed without the aid of these two fundamental intervals; but in the case of more or less primitive peoples this is less probable, and still less in this particular case in which the fifth-interval, according to our supposition, constitutes the foundation of the entire tonal system;

(III) finally there is the most important point that this presentation of the evolution of the scale does not require any previous acqaintance with a complete cycle of blown fifths, which is too complicated a structure to assume it to have been present when these tonal systems were first generated. It is, however, quite possible that, later on, when all these different tonal sequences were available, the construction of such a cycle was proceeded to, just as the Chinese, and the Greeks, came to the construction and calculation of the Pythagorean cycle.

At the same time, however, we should remark that no explanation is given in Father ROZING's line of thought for the structure of medium sléndro, with the following steps:

264 204 264 204 264,

which, in our exposition of the matter, is the result of bringing together into a single octave five tones lying at distances of six blown fifths each time (**vide** above, p. 11).

We may draw attention to the fact that, both in the course of development described by Father ROZING and in our explanation, sléndro and pélog were correlated in the beginning, i.e. before they became individualized into the sequences indicated by their respective names. Sléndro — both in one of its pre-stages and its modern form — assumes its typical structure by transferring at a given moment from the consonance- to the distance-principle, whereas pélog (as well as the „Umschichtreihe") is typified by the fact that it remains true to the consonance-principle.

Now what are the objections raised during the last few years against VON HORNBOSTEL's theory?

Dr. BUKOFZER's criticism [1]) may be summarized as follows:

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[1]) a) **Präzisonsmessungen an primitiven Musikinstrumenten** („Zeitschrift für Physik" Vol. 99, p. 643 **et seq.**), 1936;

b) **Kann die „Blasquintentheorie" zur Erklärung exotischer Tonsysteme beitragen?"** („Anthropos" Vol. 32, p. 241 **et seq.**), 1937.

(I) the blown fifth is a variable magnitude and does not always measure **678** C. It is now a pure fifth, now too large or too small. This depends on the length of the tube and its diameter. The manner of blowing may also make difference.

(II) The **huang chong,** says Dr. B., produces a tone of about 357 v. d., and **not** one of 366 v. d.

(III) It is not possible to realize a cycle of blown fifths in the manner indicated.

(IV) The course of development of sléndro is much too complicated.

(V) When, as is the case in modern sléndro, the distance between the theoretically possible steps is taken so small, that the octave is made to contain no fewer than 46 tones (i.e. the 23 blown fifths-degrees and the same number of intermediary tones — see above p. 12), while a deviation of circa **13** C., in both directions is allowed for, not only all the tones of a sléndro-, but of **any** scale whatsoever are bound to find their equivalent in such a theoretical sequence of tones. For, in this case, the distance between the respective theoretical tones would then be no more than **1200** : 46 = **26** C = **2** × **13** C.

Against this reasoning I would submit the following arguments.

Ad (I). Although the blown fifth is admittedly variable, and, broadly speaking, decreases in range according as the fundamental tone is a higher one, I have recently found, when measuring those of several pan-pipes, that the majority of the blown fifths produced on stopped tubes of average length (i.e. between 20 and 30 cm) were definitely smaller than the pure fifth **(702** C), and generally ranged roundabout **670**—**690** C; in other words, that VON HORNBOSTEL, in fixing the blown fifth of these tubes, in the middle register, at an average of **678** C, perfectly well knew what he was doing.

Ad (II). My own experiments showed further that the **huang chong** (366 v.d.), produced **by oral blowing** into a stopped tube with a wall-thickness of 1 mm and **with an inside diameter of 8.12 mm, as indicated by prince Chai Yü,** [1]) requires an air-column length of exactly the Chinese metrical norm of 230 mm (while its blown fifth turned out to be **689** C). Until, therefore, my own measurements are proved to have been incorrect, I feel compelled to adhere to my conviction that VON HORNBOSTEL was right, and that some error must have crept into Dr. B.'s experiments and calculations, however seemingly accurate they may have been.

And, indeed, there **are** mistakes to be found in his treatise **„Präzisionsmessungen** etc.". First and foremost: the experimental tubes measured by him to test the relation between the metrical norm and the fundamental tone, have a too large diameter, i.e. of 11—19 mm (mostly

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[1]) **Vide** MAURICE COURANT, **Essai historique sur la musique classique des Chinois** (in LAVIGNAC, Encyclopédie de la Musique, Vol. I), p. 91.

12 mm) instead of 8.12 mm. No wonder, therefore, that the results obtained do not coincide with VON HORNBOSTEL's theory and my own experiments.

[Apart from this cardinal error, I noted one more small inaccuracy — such as slip through now and then in everybody's work — viz. on p. 661 of his treatise, where Dr. B., in the second column of the table erroneously mentions the vibrationnumbers obtained **by calculation,** instead of the intended numbers obtained **by means of blowing with the mouth** (cf. p. 649 op. cit.)].

Ad (III) and (IV). It should be clear that the objections raised under these numbers are for the most part satisfactorily dealt with by Father ROZING's approach to the problem, while, for the rest, the existence of pan-pipes of the type which we have described on p. 19/20 shows that the said objections are not perhaps so unsurmountable as Dr. B. appears to believe.

Ad (V). Finally, as regards the argument under this number, Dr. B.'s remark is admittedly quite justified, but he forgets an other, in this connection far more important, element, which to my mind invalidates his argument, viz. **the regularity** with which the tones of the sléndro-scale fit into the theoretical sequences. By this I mean that, in a large number of cases, the tones of the scales compared do **not** coincide **at random** with certain tones here or there in the theoretical sequence, but, as we have seen, invariably with such tones as are placed **at equal mutual distances from each other** (for primitive sléndro **vide** p. 10; for medium sléndro p. 11, and for modern sléndro p. 12, above).

The same applies **ceteris paribus** to the pélog-scales (cf. p. 5—9).

With this I believe that also this objection, so weighty at first blush, has been set at nought.

I may add in this connection that (a) although it is doubtless possible, theoretically and in a laboratory, to get tubes such as are described here to produce musical sounds by different methods, in actual playing practice a tube was made to sound exclusively **by the mouth,** while there was **only one particular position of the lips** that allowed of the sound being produced well on any particular tube; (b) that the tones obtained in this manner are susceptible only between extremely narrow limits to being driven up by means of increased pressure of breath before jumping up to the twelfth, and (c) that, once the fundamental tone of a tube has been blown, it is **not** necessary (as Dr. B. pretends it is) to alter the position of the mouth in order to produce this twelfth.

* * *

Whereas, therefore, BUKOFZER's criticism in both his articles mentioned was purily negative — for he merely contends that the theory of blown fifths can never have been the foundation of the scales in the respect of which VON HORNBOSTEL imagined to be able to show it to be — Miss SCHLESINGER goes further.

In her stout volume [1]) she gives a wealth of material from which she concludes that a large number of exotic scales are identical with different ancient Grecian **auloi**-tunings **(harmoniai).** Miss SCHLESINGER's argument — although rightly criticized on some points by the Dutch physicists Prof. Dr. A. D. FOKKER and Dr. E. J. DIJKSTERHUIS — gives the impression of being very thorough and learned, and — it must be admitted — the parallelism between the Greek **harmoniai,** as reconstructed by her and the exotic scales measured, is apparently quite as convincing as that between the same tonal sequences and the hypothetical cycle of blown fifths. But when, after this, she comes to the conclusion that the Grecian scales are **foundational** to the other ones [2]), one is inclined to wonder why the relation between the different musical systems should necessarily be of this nature. Is it not more feasible to assume, as VON HORNBOSTEL does, that both the Greek and those other scales have their common origin in a primitive system whose genesis lies hidden in ages long past? For, is this not also the explanation of the correlation between other ancient Grecian and f.i. ancient Hindu-,,Aryan" cultural phenomena, such as religious and philosophic notions, the structure of the language, etc.? [3])

This, however, is to say that, also after Miss SCHLESINGER's discovery, we have not got much further as regards finding an other explanation of the correspondence (both relative and as regards absolute pitch) between the scales of races and peoples so different and living so far apart.

* * *

In another treatise, however, which, owing to war conditions, did not come to my notice until quite recently, Dr. BUKOFZER attempts to give, indeed, such another explanation of the genesis and development of Javanese tonal systems. [4])

He summarizes his argument in the following six points:

(1) The fourth has been shown to be the structural interval in the Pélog and Munggang systems. Thus, the older stratum of Javanese music has something in common with ancient Greek, Japanese, and (to some extend) even American music.

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[1]) **The Greek aulos** (London 1939).

[2]) Ibid. p. 291: ,,the harmoniai of ancient Greece, as a survival or a rebirth, in the music of the folk of many nations";

p. 334: ,,the harmoniai as origin of the musical system of Java and also of Indonesia generally".

[3]) Cf., amongst others, H. G. RAWLINSON, **India and Greece** in ,,Indian Art and Letters", Vol. X, p. 57; CURT SACHS, **The Rise of Music in the Ancient World East and West,** p. 209.

[4]) **The evolution of Javanese tone-systems** (in ,,Papers read at the Intern. Congress of Musicology, held at New-York Sept. 11th to 16th, 1939", p. 241 **et seq.)** (1944).

(II) If we explain the Sléndro system as being derived from the Pélog scale we must conclude that some of the tone names were transferred from the older system to the younger. This is confirmed by the fingering of the **suling.**

(III) The size of the steps selected from Pélog fits in with a regular sléndro scale.

(IV) The tones in Pélog and Sléndro often coincide even in pitch.

(V) This coincidence is partly known to the Javanese under the term of **tumbuk.**

(VI) The etymology of the word Sléndro enables us to determine the age and the chronology of the Sléndro system.

I must confess that Dr. B.'s argument has failed to convince me.

In the first place I cannot agree with Dr. B. in his derivation of pélog from the three-tone munggang scale. He argues that these munggang scales vary in range between a fourth and a major third, and that, providing one leaves out of consideration the lowest tone of the present pélog scales, one may represent those scales as consisting of the doubling of a munggang tonal sequence, i.e. by two conjoint munggang-,,tetrachords". which would then represent, from high to low, the two sets of three tones **bem-nem-lima** and **lima-ḍaḍa-gulu,** respectively.

Dr. B. bases his argument on the measurements, as known to him, of the interval-sequences of munggang-scales, of which he asserts that there are **thirteen** in all. I wonder by what road Dr. B. arrives at this number. I believe I am acquainted with the whole of the existing literature dealing with Javanese music; Dr. B. was never in Java; and in the fifteen years during which I had the privilege of investigating Javanese music on the spot I never came across more than **six** three-toned munggang-scales, either optically, or auditively. Neither do I believe that there are any more; but there do exist a number of other three-toned orchestras, viz. **six** gamelans Koḍok ngorèk, and **one** so called gamelan Patalon. Only by including these can we bring the number up to thirteen. The scale-intervals of ten of these gamelans may be found in Table XVI of my ,,Toonkunst van Bali", Vol. II, and in ,,De Toonkunst van Java", Vol. I, pp. 197, 199 and 200.

Now, if we examine the steps of the ten three-tone sequences, of which I noted the vibration-numbers — the same from which Dr. B. derives his argument — we shall see that there are only **two,** or, if we stretch a point, **three,** of them which may be said to supply more or less the interval distances which Dr. B. needs for substantiating his explanation of the pélog scale. For it is only in the case of the gamelan Koḍok ngorèk in the Jogja kraton, in that of the Munggang in the Solo kraton, and, at a pinch, in that of the gamelan Koḍok ngorèk in the Jogja kepatihan, that a conjoint doubling as referred to by Dr. B. leaves room for a lower tone **bem** lying at the right distance; i.e. the tone with which the pélog octave — looked at from low to high — begins, and without which the pélog sequence would not be a pélog sequence at all; which amounts to saying that only in the three cases named above does this tone **bem** form, with the next higher tone **gulu,** an interval of about normal size (**110**—**120** C). In these three cases we get the following pélog octave structure:

	bem[1]	gulu	bem
Munggang, kraton Solo,	2×**558** C	+**124** C	=**1200** C
Koḍok ngorèk, kraton Jogja	2×**532**	+**136**	,,
Koḍok ngorèk, kepatihan Jogja	2×**520**	+**160**	,,

In three other cases the ,,residue''-interval **gulu-bem** turns out much too great:

	bem[1]	gulu	bem
Patalon, kraton Solo	2×**510**	+**180**	=**1200** C
Munggang, kraton Jogja	2×**494**	+**212**	,,
Munggang Sèngkang turunan from the Mangku Nagaran, Solo	2×**490**	+**220**	,,

whilst in the remaining four there is not even any question of a residue-interval; nay, in three of these four cases the doubling of the three-tone scale **itself** already reaches above the close of the octave!:

	bem[1]	gulu	bem
Koḍok ngorèk II, kraton Solo	2×**600** C	**0** C	=**1200** C
Munggang Segara windu, Mangku Nagaran, Solo	2×**608**	—**16**	
Munggang, Madiun	2×**613**	—**26**	
Koḍok ngorèk, kraton Solo	2×**621**	—**42**	

The structure of the three-tone scales which have thus far become known, therefore, does not justify any attempt to base upon it, in the way Dr. B. has indicated, the genesis of the pélog scale.

But even if the measurements of the interval-sequences of the three-tone ensembles mentioned should have yielded a majority of intervals of the size required to support Dr. B.'s presentation of the case — **quod non** — even then his theory would not, in my opinion, hold water. For, what are the facts?

In order to make acceptable the genesis of the pélog scale from two conjoint munggang-,,tetrachords'', the lowest tone of the pélog scale (the **bem),** as we have already mentioned, is represented as having been added later, and this notion is supported by the contention that, in many pélog tone-sequences, the (second) tone **gulu,** and not the **bem** ,,actually dilimits the scale''. I am at a loss to understand how Dr. B. arrives at this pronouncement. The tone **bem** is quite as essential to the pélog scale as all the other tones, more especially the **gulu, ḍaḍa, lima** and **nem.** It should also not be forgotten that the other name for **bem** is **penunggul,** i.e. „head". This is not a name for a tone that has been added, as it were, on second thought! Moreover, I have never, as far as I can remember, come across any pélog-instruments or -scales delimited by the tone **gulu** in all the fifteen years of my sojourn in Java.

On the single-octave pélog instruments, on the other hand, the tone **bem¹,** finishing the octave at the „top" (and indispensable if the pélog sequence should actually have arisen from two conjoint munggang-tetrachords), hardly ever occurs; only a single case of this is known to me, namely in the Madurese gamelan, whose tuning I was able to measure at the time at Kedawung in East-Java. [1]

To say the least it gives one to think, before accepting Dr. B.'s theory as correct, that, for the sake of his argumentation, he disavows as it were the tone **bem** as a pélog scale-tone, but is evidently, at the same time, unable to do without it for the construction of his tetrachords, which, according to him, are foundational to the pélog-scale.

Ad (III) and (IV). Without any doubt there exists a certain interrelation between pélog and sléndro, namely, as may have become clear from the above, between their respective semi-fourths phases (cf. p. 8 **sub** (b) and p. 10 **sub** (c)). We shall find that it is the 6th and 7th step which the semi-fourths pélog **does** and the semi-fourths sléndro **does not** use, that actually take the position of **gulu** and **lima,** respectively, when put in their proper places in the pélog tone-sequence.

As long as this semi-fourths sléndro — now become so rare, and, it appears, confined to a few „islands" in East-Java [2] — was the generally used form, the playing of a suling pélog whose 2nd and 5th stop was kept closed, would result in a perfectly satisfying sléndro scale. This is, of course, no longer to today, because another form of sléndro has taken the place of the semi-fourths form, which latter, having consequently been degraded to sléndro **miring,** „deviating" sléndro, has fallen in decline.

The result if this is that, when — at any rate in the Principalities — a sléndro tone-sequence is imitated today on a suling pélog in the manner indicated, this is only done for the purpose of obtaining a comical effect.

In the Sunda districts — where the people are not unduly particular, at any rate instrumentally speaking, and where ancient forms and customs are blessed with a longer life than elsewhere in Java, notably in Central Java with its much greater cultural creativeness — this type of sléndro scale, played on a suling pélog is taken more seriously today; nevertheless it is admitted there too, that only an **approximation** to the now customary sléndro scale is thereby obtained.

But **tumbuk,** mentioned in point (v), in my opinion cannot be adduced

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[1] Cf. **De Toonkunst van Java,** Vol. I, p. 208, scale No. 1.
[2] **Ibid.** Vol. I, p. 18 and 19.

in support of the theory that sléndro must have been derived from pélog, better: that there is a genetic connexion between both systems. For **tumbuk** is favoured nearly exclusively [1]) for the sake of the considerable saving of bronze resulting from it. It occurs, besides, comparatively rarely, and then, moreover, far more frequently in the form of tumbuk **lima** (this effecting a still greater saving of bronze) than of tumbuk **nem** — the only form Dr. B. mentions — (or, for that matter, tumbuk **jongga).** [2])
Moreover: in the case of tumbuk no more than one single tone is ever involved; and surely it is plain that the common possession of **one** tone is in itself no evidence whatsoever of any relationship existing between two scales!

The author's argument on p. 242 of his paper is not quite clear to me. He there speaks of **three** sorogan, although he states just before that there exist only **two**; the tone **pélog** as a substitute for **ḍaḍa,** and the tone **barang** for **bem.** (In reality there are **two** sorogan **in each paṭet,** namely in P. 6 the tones **pélog** and **barang**; in P. barang the tones **bem** and **pélog**; in P. 5 (originally) the tones **ḍaḍa** and **barang).** As third sorogan, however, Dr. B. adds the tone **bem,** and then he states that the relative position of these three sorogan have been interpreted by me as tonic, dominant and subdominant, respectively. I am unable to find any place in my writings where I could have represented the relation between those sorogan-tones and, for that matter, between any sorogan-tones, in a way justifying such an interpretation. It may be that Dr. B. had in mind the schematic representation of the pélogscales, given on p. 32 of „De Toonkunst van Java"; but in that case it is not the tones **pélog, barang,** and **bem,** which would seem to play the role of tonic, but the tones **pélog (a+), bem (e)** and **lima (b),** respectively.

Neither is Dr. B.'s representation of the three principal pélog paṭet-scales (p. 242) quite accurate.

When we reproduce them, in the usual European way, from low to high, [3]) we do not obtain the sequences named by Dr. B., but the following (and with the sorogan-tones placed in brackets):

in paṭet barang:	b	c	d−	(e)	f+	g	(a+)
in paṭet nem:	e	f+	g	(a+)	b	c	(d−)
in paṭet lima:	a+	b	c	(d−)	e	f+	(g).

And these scales definitely lie — irrespective of Dr. B.'s view — at distances of a (pélog-)**fifth** from each other:

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[1]) Perhaps, in some rare cases, also for „modulation" from sléndro to pélog, or **vice versa.** Cf. **De Toonkunst van Java,** Vol. I, p. 66 sub C.

[2]) Ibid. Vol. I p. 113, footnote. The three forms of **tumbuk** which I have mentioned, i.e. **nem, lima** and **jongga** are the only existing ones.

[3]) They ought really to be given, in the proper Javanese manner, from high to low, and starting with the most important tone, the **dasar** (the „pivotal" tone), being the tone **ḍaḍa (g)** in P. barang, the **nem (c)** in P. nem and the **gulu (f+)** in P. lima.

P. barang: b c d⁻ (e) f⁺ g (a⁺)
P. nem: e f⁺ g (a⁺) b c (d⁻)
P. lima: a⁺ b c (d⁻) e f⁺ (g)

The same applies, **ceteris paribus,** to the three sléndro-paṭet's.

It therefore appears to me that the construction which Dr. B. puts on the matter is far from being supported by the facts which the study of Javanese music has revealed.

Having regard to all this, I believe I am justified in affirming that we are not allowed to speak of any structure of **fourths** as being the basis of the Javanese tonal systems, and that we may well adhere to a presentation of the facts in which the **fifth** is regarded as the generative element **par excellence** [1]. This is also in complete accordance with the view of Javanese musicians themselves, as is evident, for example, from the writings of Radèn MACHYAR ANGGA KUSUMADINATA [2].

But perhaps we must distinguish here, in some cases at least, [3] between pélog as a mere tone-sequence, and pélog as it is used melodically. Prof. Dr. J. HANDSCHIN, the Basle musicologist, who read my objections against the theory of Dr. BUKOFZER, wrote to me in this connexion:

„Ich glaube, ich würde hier mehr unterscheiden zwischen Pélog als Material-Tonleiter and Pélog als musikalischer Tonleiter. In letzterer Hinsicht ist es doch oft so, dass der Ton **f** (entschuldigen Sie, wenn ich **gulu** so vereinfacht bezeichne) die untere Grenze der Melodie bildet und dass die Melodie quartenmässig aufgebaut ist...... Darum akzeptiere ich aber doch auch die konkrete Ableitung von BUKOFZER nicht, oder vielmehr: ich brauche es nicht zu tun. Es ist durchaus nicht nötig, dass die Pélog Material-Leiter durch Aneinanderfügung von zwei Munggang-Quarten entstanden ist, und doch kann musikalisch (musikalisch nicht nur vom europäischen sondern auch vom javanischen Standpunkt aus) die Quart hier grundlegend sein. Auch die Ableitung von Sléndro aus Pélog durch Weglassen von Tönen ist wahrscheinlich zu mechanisch, und doch tritt auch in Sléndro musikalisch ein Einfluss der Quarte entschieden in die Erscheinung" [4].

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[1] See, about fifth-relation, f.i. **De Toonkunst van Java,** Vol. I, p. 37, 47/8 (finales), 58/9 (paṭet's), 284 (melodic structure) and 327/8 („pivotal" tones).

[2] **Djadjar mamaos** (rakitan pèlog), Vol. I (1929), II (1930); (rakitan slèndro), Vol. I (1930); **Sarining Gentra Murangkalih** (pèlog sarèng salèndro) 1935).

[3] For, without doubt, the melodic structure is based far more often on the fifth-relation. Cf., f.i., **De Toonkunst van Java,** Vol. II, Appendix 53.

[4] „I think I would prefer, in this case, to distinguish between pélog as „tone-material", and pélog as a name for a musical scale. For, if one looks at it from the latter angle, one often finds that the tone **f** (excuse my using this simplified designation of the tone **gulu**) forms the lower limit of the melody, and that the melody is constructed on the basis of fourths.... For this reason I do not accept, however, BUKOFZER's too direct deduction, or rather, I do not need to accept it. There is absolutely no need for the pélog scalar material to have originated from the joining together of two munggang fourths; musically speaking (not only from the European, but also from the Javanese standpoint), the fourth can just the same be the fundamental structural principle. Moreover, the derivation of sléndro from pélog by omitting certain tones is probably also too mechanical a procedure; nevertheless, in sléndro melodics, too, the influence of the fourth is quite apparent".

Ad (VI). Now granting that both pélog and sléndro are based on the cycle of blown fifths, and granting, further, that the word **sléndro** may actually be said, on etymologically incontestable grounds, to derive from **Çailéndra** (the name of the princely dynasty ruling in Central Java during the 8th century A.D.), then this **cannot** mean that sléndro only **came into being** in Java during the period, and at the instigation of these Çailéndras (as Dr. B. endeavours to demonstrate), but only that it was **imported** there by them, and subsequently — through their influence — attained musical hegemony. [1])

There are, however, still other possibilities to be examined in this connexion.

There is first of all Dr. STUTTERHEIM'S suggestion that sléndro might possibly be the specifically **Javanese** tonal system, and pélog that of the **Sundanese,** who very probably arrived in Java at an earlier period (and of the Balinese and different other archipelago peoples). In that case the derivation of the name sléndro from Çailéndra, which Dr. STUTTERHEIM also considers probable, would have its origin in the circumstance that the central sléndro territory was one and the same as that over which the Javanese Çailéndras ruled during the period of its greatest prosperity and influence. It would then be only the **name** sléndro that arose in the eighth century.

In the third place I must also make mention here of the view of Dr. NYESSEN concerning the racial composition of the population of Java, which, according to this anthropologist, differs in the mountain districts from that in the plains. Dr. NYESSEN comes to the conclusion, based on an examination of more than 10.000 men, that the population of Java consists of:

I. earlier arrivals: a mesophalic, low browed, Proto-Malay mountain population, also characterized by shorter stature, broader nose and light brown eyes, and

II. later arrivals: a brachycephalic, Deutero-Malay lowland population, characterized by taller stature, higher brow, thinner nose and dark brown eyes.

The above division cuts across the other, usual division of the Javanese population into a Sundanese group, a Javanese proper, and a Madurese.

It would seem to me, then, that pélog (which, today, is chiefly limited

[1]) And in that case the other (and, in my view, genetically younger) sléndro forms — distinguished in the above as „medium" and „modern", respectively — must also have been known in Java as early as the 8th century A.D., side-by-side with the semi-fourths form. For the structure of these forms, too, presupposes a knowledge either of the cycle of blown fifths or of the corresponding **metrical** cycle of fifths (cf. above, p. 20/21); and it is hardly safe to assume that this ancient Java, only the merest superficies of which had been touched by Hindu culture by that time, could have been familiar with these typical forms of high culture.

to the mountain districts [1]), having been pressed back by the invaders), belonged originally to group I, and sléndro to group II.

(According to this notion too, the priority of pélog in Java is not affected).

Finally there are some minor points:

1°. Dr. B.'s remark that sléndro contains no minór seconds (p. 243) applies exclusively to the sléndro system as played on the majority of Javanese gamelans. The two other sléndro modes — chiefly used vocally— **madenda** and **degung,** quite definitely do make use of such semi-tone steps. [2])

2°. **Pélog bem** is not identical with **pélog nem**; by the former name the paṭet's **nem and lima** are denoted collectively, in contradistinction to paṭet **barang.** The reason for this distinction is, that Central-Javanese gamelans use to-day, both in the paṭet's nem and lima, as principal scale, the same tonal sequence, which deviates from the principal scale, as used in paṭet barang.

3°. Why does not Dr. B. give the correct vibration values (bottom of p. 247) for the tuning of the gendèr Kyahi Udan riris in the Mangku Nagaran, namely 340, 394, 448, 513 and 587, respectively? If he had done this, then the correspondence between this sléndro sequence and five tones of the scale of the Kyahi Kadok manis pélog of the Solonese kraton, which he compares with it, would have looked even more convincing. [3])

4°. The statement that the term **paṭet** is derived from the Sanskrit word **pat** (more correctly, **path)** definitely must be refuted.

Our linguistic co-worker, Drs. R. MELLEMA, whom I consulted in regard to this question, informed me as follows:

The word **paṭet** makes the **prima facie** impression of being of purily Javanese origin, which impression is further strengthened by the fact that it occurs as a verb in the form of **maṭet (dipaṭet),** meaning:

(I) holding on (tightly) to a rope;

(II) (colloquially): to stand taut, to pull at a rope;

(III) (obsolete): to restrain, to contain (also figurative);

(IV) (in certain districts only): to shorten, cut down. [4])

The word would not seem to occur in ancient Javanese; at any rate neither JUYNBOLL, **Oud-Javaansch Woordenboek,** nor VAN DER TUUK, **Kawi-Balineesch Woordenboek,** mentions it.

Sanskrit knows the following:

(I) the root **paṭ (paṭati)** = to split, to burst open;

(II) the root **pat (patati)** = to fall, to drop down, to collapse;

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[1]) Cf. **De Toonkunst van Java,** Vol. II, Appendices 58A and B.

[2]) **Vide De Toonkunst van Java,** Vol. I, p. 41 and 42.

[3]) The source of those tone-sequences is not **De Toonkunst van Java,** but **De Toonkunst van Bali.**

[4]) Cf. PIGEAUD, **Javaans-Nederlands Handwoordenboek,** p. 264.

(III) the root **path,** with the substantives **pathi** and **patha** =path, road, method, manner.

Of these three roots, the first two are obviously ineligible for our purpose. The root **path,** which Dr. B. has in mind, does not exist in ancient Javanese. But even if it did, it would not bring us any further, because it is phonetically impossible for an aspirated **tenuis (th)** to be converted into a lingual **ṭ** (indicated, in our system of transcription, for convenience sake and from lack of suitable symbols, by **ṭ,** but in reality a totally different sound from **th).**

Moreover, the first syllabe of the Javanese **paṭet** can never function as root, since it would be impossible to explain the rest of the word. The only part of the word which, as Javanese root, could possibly represent the most ancient part, is **ṭet**; and it is obvious that this cannot have anything in common with the Sanskrit **path.**

Thus far Mr. MELLEMA.

As the reader must no doubt have concluded by this time, I am, however regrettably, compelled to disagree with almost every argument on the above subject that my friend and colleague BUKOFZER advances in his three treatises (and in the article on this subject, written by him in APEL's Harvard Dictionary of Music). My only excuse is: **amicus Plato, magis amica veritas.**

For the rest, far be it from me to contend that all the mysteries surrounding the scales at issue and their interrelation are to my mind swept away by VON HORNBOSTEL's theory, nay, it is, indeed, not entirely to be excluded that really this theory is founded on an error, be it a brilliant and fascinating one. But this, however, will then need to be demonstrated with other and stronger arguments than those, stated above.

And further, this cannot be gainsaid: **if** VON HORNBOSTEL's theory one day should turn out to be untenable, it will nevertheless have the great merit of having clarified certain very thorny problems relative to the structure and the correlation of the instrumental scales of various peoples living far apart in time and space. The fate of this theory will then be similar to that of the famous epicycle-theory of PTOLEMY, which gave an adequate explanation of the apparent movements of the heavenly bodies, and which was nevertheless shown later on to be completely false. Sometimes, indeed, scientific knowledge is increased more by means of the error committed by a genius, than by irrefutable truths.

Amsterdam, February 3rd., 1948.

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