

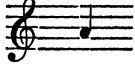
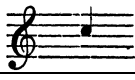


Modern Organ Tuning

Diatonic and Enharmonic.	COMPARATIVE TABLE OF THE VIBRATIONS THROUGHOUT THE EQUAL-TEMPERED SCALE AT THE THREE PITCHES				Corresponding Note on the staff.
	Greek.	A C	Standard Philosophical. Diapason Normal.	A 435·45 C 517·84 High English.	
213·33	A	215·54	217	227	
	A#	228·07	230·675	240·5	
240	B	241·631	244·39	254·86	
256	C	256	258·92	270	
c# 266·7	}	C#	271·222	286	
db 273			274·30		
288	D	287·350	290·62	303	
d# 300	}	D#	304·436	321·05	
eb 307			307·90		
320	E	322·540	326·22	340·11	
340·33	F	341·718	345·62	306·4	
f# 360	}	F#	362·038	382·76	
gb 358·8			366·17		
384	G	383·566	387·93	404·46	
g# 400	}	G#	406·375	428·5	
ab 409·6			411·00		
426·66	A	430·540	435·45	454	
a# 450	}	A#	456·141	481	
bb 461			461·35		
480	B	483·263	488·78	509·67	
512	C	512	517·84	540	

Until the investigations of Dr. A. J. Ellis and Dr. Koening the Diapason Normal was believed to be exactly 435 v. In May, 1880, Dr. K. especially determined it to be really 435·45. Hence all forks that are copies of it are nearly half a vibration sharper than marked, therefore, throughout the scale the ordinary calculations made upon the older basis are inaccurate.

"The Ear is the Umpire of Sound." — *Master Tansur.*



Modern Organ Tuning

THE HOW AND WHY?

CLEARLY EXPLAINING

THE NATURE OF THE ORGAN PIPE

AND THE SYSTEM OF

EQUAL TEMPERAMENT

TOGETHER WITH

AN HISTORIC RECORD OF THE EVOLUTION
OF THE DIATONIC SCALE FROM THE
GREEK TETRACHORD

BY

HERMAN SMITH



BARDON ENTERPRISES
PORTSMOUTH

First published by William Reeves, London.

Copyright this edition © 2003 by Bardon Enterprises.

This edition published in 2003 by Bardon Enterprises.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publishers.

ISBN : 1-902222-17-2

Typeset and printed in England

by Bardon Enterprises.

Bound in England by Ronarteuro.

Portsmouth, Hampshire, England.

<http://www.bardon-enterprises.co.uk>

TO THE READER.

I HAVE often been asked to write a book on Tuning intended specially for those who are engaged in organ work, whether in the building of organs, or in the playing of organs, professionally or otherwise. The demand for new editions of my former book "The Art of Tuning the Pianoforte" encourages the hope that my present task will be justified by a similar degree of usefulness.

In that Pianoforte treatise my aim was to enable the musician to tune his own pianoforte"; in the present case however I cannot start upon the same footing, with the advice that every Organist should tune his own organ, foreseeing that such an incitement, if it took effect, would certainly lead in most instances to disastrous results to the organ, palliated only by the gratitude to be won from organ builders for the additional amount of work thrown into their hands. The risk of damage to pianoforte strings was but little and such as might be measured by shillings, but the trouble in an organ by amateur intrusion would probably run the charges up to pounds for setting matters right again.

Modern Organ Tuning is carried out exclusively upon the principles of the system of Equal Temperament, since the old methods of the Mean Tone Temperament, and of the later Unequal Temperament, can only be occasionally found in benighted places, where life moves slowly. There were many engrossing problems in the old-time tuning, and they occupied the attention of some of the wisest mathematicians, but although these problems have possibly had their day, there yet remain in the same field of thought many diversions ready to engage intelligent enquiry ; wherefore I trust that Modern Organ Tuning will prove to be a desirable guide in the practice of the art, and that musicians likewise will find in its pages "a record," interesting in itself, one useful to have in a handy form concerning some matters in the history of the development of music.

HERMANN SMITH.

CONTENTS.

Plate 1, Comparative Table of Vibrations of the Scale under Different Pitches.	<i>To face the Title-page</i>
Plate 2, Table of the Progression of the Beats of the Tempered Concords, Thirds and Sixths.	<i>Page 90</i>
Plate 3, Table of the Progression of the Beats of Tempered Concords, Fourths and fifths.	<i>Page 91</i>
Plate 4, Table of the Sounds produced by the Manual and Pedal Stops from the low C key.	<i>Page 104</i>

SECTION I.

THE PURPOSE AND THE PLAN.

The Choice of Treatment	1
My audience.....	2
The Plan of the Work.....	3

SECTION II.

THE ORIGIN OF THE ORGAN.

In the Early Days	7
The most Ancient Organ	8
Pipes more Primitive than Strings in Music	9
The Voice the first Measurer	9
The Enquiry into the Origin of the Organ	11
Pythagoras Quite in the Dark	11
Step by Step the Diatonic Scale developed	13

SECTION III.

THE BASIS OF THE MUSICAL SCALE.

The Beginning of the Scale	15
Evolution of Music as a System	16
The System of the Tetrachord	17
The Earliest Forms of the Tetrachord in Evolution	18
The Man's Voice the Guide in fixing Pitch	19
The Laws of the Tetrachord in Use.....	19

THE HISTORIC RECORD.

Foundation of Athens. The first Tetrachord	20
Terpander, Olympus, Anacreon, Pythagoras	21
Ion the Author of the Conjunct System	21
The Rise of the Aristoxeneans, and the Plan of the Greater or Disjunct System	22
Eratosthenes, Didymus, and Claudius Ptolemy	23
Review of the Scholastic Systems	23 to 33
Chance the good Genius of Science	34

SECTION IV.

THE OUT-OF-TUNENESS OF THE ORGAN.

What is the Use of Tuning it?	36
Weight of Air Particles in the Organ Pipe	37
The Original Voicing of the different Stops	38
Dust the Great Enemy	39

SECTION V.

THE NATURE OF THE ORGAN PIPE.

The Capture of a Column of Air	40
My Theory of the Speaking Process in an Organ Pipe	41
The Air-reed doing an Amount of Work	42
Velocity of Passage converted into Velocity of Vibration	43
All Organ Pipes are Stopped Pipes	44
Sounds made Musical by Pitch	46

SECTION VI.

THE PRACTICE OF TUNING THE ORGAN.

It takes Two Men and a Boy to Tune an Organ	48
The Real Work of the Tuning Man	49
Learnt by Experience in the Factory	49
Experimental Organ Tuning for Pitch and Temperament by Harmonium	50

SECTION VII.

THE SCIENTIFIC PRINCIPLES OF EQUAL TEMPERAMENT.

Temperament, What it denotes	53
Chief Requisites of the System	55
The Demonstrations of the Theory	56
The Tuning Fork in Science the Determinant of Pitch	57
The Problem before the Organ Tuner	57
Ancient Determination of Ratios	59
A little Stroke of Practice in figures	60

The Defect of the Diatonic Scale.....	61
Mean-Tone Temperament, and the Un-equal.....	62
Cardinal Points of Equal Temperament.....	63
Tuning is Rectification of Numbers.....	65
The Beats are the only Guide.....	67
How flat is a little flat ?	68
A Home-made Pendulum.....	69
How Rates of Beating are Calculated.....	70
Comparative Frequencies of Vibration.....	71
Table of the Philosophical Pitch for Four Octaves.....	72
To Temper is to Mistune by Rule.....	73
Tempered Minor Intervals Test the Truth of the Octaves.....	74
Proofs that the Beats have Two Relations only.....	75
The Fourth to be considered a Minor Interval.....	75
All Major Intervals beat half to Upper Minors.....	77
The Fourth is the Umpire of the Octave.....	79
The Time-Relation of the Beats	79
Beats of the Major and Minor Thirds proved.....	80
Selecting the Standard Fourth.....	83
Relation in Beats of a Fourth within a fifth.....	85
Phenomena of Beats described.....	86
Vibrations perceived by Time-distance only and not by Collective Numbers	87

SECTION VIII.

TUNING SCHEMES USED IN PRACTICAL WORK.

Laying the Beatings, and Learning the Methods.....	92
The Scheme of fifths with Octaves.....	93
Learn to Labour and to Wait.....	94
The Trial Tests by Chords.....	96
Tuning the Succession of Octaves.....	97
The Scheme by Fourths and fifths only	97
My New Scheme for a Learner by Octaves and Interposed Fourths.....	98
Specified Beats of each Fourth in the Chain.....	99
Progression through the Octave shewn by Table of Beats	101
Diagram of Time-distance of Beats.....	102
The Fourth the naturally selected Interval for Tuning.....	102

SECTION IX.

RE-INSTATEMENT—THE AIM.

The Completion of the Task.....	105
The Organ Tuner not a Free Agent.....	106
How to Proceed, by Routine.....	107
Why "The Principal" is Chosen to Rule the Tuning.....	108
How the flue Pipes are to be Identified	109
Similar Chords to Beat Differently in Different Stops.....	110
Beatings made only by Harmonics.....	111

The Growth of the Harmonic Series.....	111
Empiricism of the Mixtures and Compound Stops.....	112
Production of Harmonics due to Nature's Excess in Energy	113
The Law of Harmonic Progression	114
Table shewing how the Vibrations, Harmonic and Tempered, differ.....	115
The Octave Non-Existent in Music.....	116
The Unison the only Consonance.....	117
In Ultimate Analysis Sounds are Shocks	118
The Tuner is a Hot Iron Moving About	118
The Maxims of Ptah-hotep.....	118

MODERN ORGAN TUNING.

SECTION I.

The Purpose and the Plan.

The choice of Treatment.—The particular information upon Tuning given in Books on Organs is usually too brief in statement to satisfy the enquirer with a purpose, its conciseness gives him the impression of vagueness, and he wants to ask questions ; the directions are plain enough and complete as far as they go, yet he feels that he is left to follow them blindly, and is not sure how long such confidence as he yields will carry him onward to the end desired. Should his views be confined to trade utility then possibly the instructions he therein finds may, as book knowledge, suffice to put him in the way of practice, or to improve what he already knows, and his personal interest ends there.

Other seekers there are whose intellectual promptings lead them to higher sources, they dip into scientific works, they try “Acoustics” and “Temperament” as found in Treatises and Encyclopaedias, and apply themselves seriously to understanding what they read ; these seekers are the temporary seekers, they cannot be classed with the students proper, those who settle to a course of study, and to whom the treatises written by teachers who are authorities upon the subject

enquired for, give abundant brain work, those teachers in consequence being to them satisfying as expositors. Special books also there are for students in which information upon all the various systems of temperament may be found gathered together, and mathematically expounded.

My audience.—The seekers I have in mind for my audience, are those chiefly who are to be looked upon as “wanderers” in a chosen region, either by inclination, or having a definite purpose, explorers desiring to acquire knowledge of a particular kind for the pleasure of self-enlightenment. For many of these the academic form is too dry, it leaves them athirst, and knowing this, by long experience, I incline by preference to the daily freshness of the familiar style, as the most suitable for popular exposition.

I do not propose to add to the number of books published upon organ building for amateurs, that field has of late years been fully occupied, neither do I intend to describe the arrangements of sound boards and pipes or to enter into details of mechanism, which everyone in the least degree conversant with organ construction already knows. The organist who is in practical touch with the organ factory, will soon learn how far it is permissible for him to attempt the rectification of matters that have gone wrong, whether in tuning, or in structural details, but the organist who is ignorant of organ interiors and their conditions, or who is without natural mechanical aptitude, should be content to keep his head on the outside, rather than run the risk of disturbances more serious than those that vexed him. It is so easy to make matters worse.

My note of warning should not be read as designed to debar everyone except trained tuners from undertaking to tune the organ in any degree. The question is an individual one, and probably to be ruled by circumstances. If an organist feels

himself fully equipped in knowledge, and is in a position to take the responsibility by all means let him try. Every adventure is an experience. To faintheart I would say "Fear not, be of good cheer, but don't raise the dust."

In writing this little book my endeavour has been to explain to all sorts of people, in a way they can understand, the how and why of organ tuning. There is nothing abstruse in the matter whatever.

Modern Organ Tuning is written :—

For those who know nothing about it, and want to know more.

For those who know something yet are eager to strengthen their musical standing, are anxious it may be, to be more thoroughly grounded in the nature of these things, and of the mind's way of dealing with them on scientific lines.

And, for those who always find interest in musical matters, and gladly gather information from whatever source may seem likely to make good additions to memories storehouse, to present new readings of the past, to offer novel insight into things thought, and perhaps prepare occasion for a pleasant outlook of comprehensive views for future moods of contemplation.

The Plan.

First,—to lighten the subject, and for artistic interest in the past—we proceed by way of historic development, and tracing the origin of the organ to the single pipe common to the people of early times, find in *the lay of the fingers* the first apportionments of a musical scale, a scale or system of four notes or sounds, accepted by the voice as accordant with

natural inclination, and by the ear as agreeable, a scale which is the foundation of our diatonic scale, and indeed of the music of every clime where musical scales are known.

Next we compare pipes with strings, and see in pipes the first determinants of fixed tones, copied as standards of pitch, vouched for by the voice originally, and maintained true by the tradition of the ear. Strings having no permanence of pitch beyond the hour, and requiring to be verified from time to time by the ear could not be bearers of a standard of pitch, nevertheless, since strings by the lyre and monochord, were the only means by which the ancient theoreticians demonstrated the laws of their musical system, we are obliged to bring them into our scheme of elucidation of our own scales, as derived from the old Greek astronomers and mathematicians, for with them, as with the Egyptians who were their teachers, music was allied to astronomy and to doctrines of "the music the spheres."

We then take up the earliest Greek scale, and are led to see how, in historic record through a period of a thousand years, it grew and grew under the hands of their famous philosophers, until it became the complete diatonic system.

A strangely long period of evolution (750 B.C. to 250 A.D.), and at its close, harmony, even then, unthought of. And stranger still—these ancient philosophers knew nothing of the real thing, they spent so much thought upon, so many days, nay years, of speculation and study and experiment. Yet they arrived as it were by a fortuitous course, almost at the very verge of the truth ; there needed but another step to make the discovery,—not for another thousand years was the secret revealed, and the disclosure of the important truth was reserved for a great astronomer of a different race equally gifted.

The organ now takes up the tale. The adoption of the Greek modes in the vocal services of the Church, and the changes they underwent, although points of musical interest do not concern the present enquiry, so passing over many centuries, during which the instrument was but a clumsy aid to the Church, a time at last is arrived at when harmony having developed, the fixed tones of a keyboard, with duo-decimal scale are found to be incompatible with harmony; hence a demand for some kind of "temperament," so called, hence long periods of use of "mean-tone temperament," "unequal temperament," and in the end "equal temperament," which rules at the present day, and after all takes us back to the old Aristoxenean equal scale of twelve semitones, 350 B.C., a scheme unpracticable then, but now by science readjusted for practical ends. This is the scale to be tuned to, by us to be equalised with full sense of the progressive increase of vibrations in the rise of the steps of pitch; and for this equalisation, absolutely accurate means of accomplishment are provided.

Completing the historical cycle, the way is open to discourse upon the nature of the organ pipe, to investigate the causes of the always "out-of-tuneness" of the organ, and why it should need tuning, to show that all the open pipes of the organ are really closed pipes, that in music itself there is no octave, that there is no consonance but the unison, that there are no possible ratios applicable to music except vibration ratios, no tuning that is not a rectification of numbers, and other seeming paradoxes worth thinking about, by those who can go beyond the duplicities of words, and look upon facts of nature face to face.

finally, the whole theory of Tuning is thoroughly gone into, and step by step fully explained. Tables are given of the figures

of the Vibration-ratios belonging to the several notes of the scale calculated upon different standards of pitch. Tables also of the beats which arise from Tuning, and their proportional numbers given for the chief intervals in the progression through-out the scale, and the process shown by which these are arrived at with scientific precision. The different methods that are practised in organ tuning are explained, and a body of instruction presented which it is hoped may be read with profit by many inquirers and may, perhaps, stimulate to more earnest observation.

SECTION II.

The Origin of the Organ.

In the early days.—The organ can be traced back to very ancient times in history, even beyond the land of myth. Pan is the reputed designer of the first collection of pipes of different lengths, bound together and blown by wind, and the Syrinx or Pan's pipes is the true representative of the ancestry of the organ ; seen in our Punch and Judy shows it is a curious instance of survival of primitive design.

The Greeks were much given to crediting a complete and perfect type to their mythical originators. Apollo had his complicated Lyre as Pan his completed pipes, yet it is evident from what we know of progressive civilisation that long periods of time must have been passed before such a condition, showing marvellous ingenuity, could have been attained in instruments of music. Single pipes would first have been handled and brought into use, then two. When two pipes were first combined and held in the mouth to be played by one breath, then we may consider the organ was foretold. Many instances of such double pipes occur in other lands more ancient than Greece.

The earliest Pan's pipes consisted probably of not more than three or four pipes. This may be inferred from the lyres of the earliest period, which shows but three strings.

The method at first adopted with pipes, of blowing across an open end, was the most natural we can imagine ; then a hole

formed at the side of a pipe such as we have in our flutes seems as easy for producing sounds, and it was but a step to add other holes. Another method chance experiment brought about, which was necessary before our organ could begin to show any mechanical adaptation. In cutting the reed-stem accident would soon reveal that the joint afforded a half plugged top, and this diminished hole would be equally fit for producing sound, and again, a simple slanting cut would at some early period lead the way to the whistle form at the head of the pipe. This familiar form is called "the fipple." When invented, or by whom we cannot tell, history has no record of the time when this most important change in the pipe took place, giving the mouth a new control over the pipe. The fipple mouth was a significant advance simple as it was, fixing the type for after ages. The organ is indeed founded upon it, our great diapasons being but whistles, and all the flue or flute work nothing but whistles. At some early time, too, another discovery was made, when some followers of Bacchus found that the goat-skin in which they stored the wine, could be used to play the pipe, and the wine bag became the wind-bag. The bag-pipe was a very great advance in organ-work, since it suggested the still greater invention a bellows weighted, so that by pressure the strength of tone was increased.

The most ancient Organ.—The earliest representations of an organ are crude, and shew only six or seven pipes stuck up on the top of a little box. Wherever early organs are illustrated or spoken of the dates are surrounded by uncertainties. One certain point is established that Cestius, an Egyptian, invented the Hydraulic Organ about 300 B.C. and as that exhibits much mechanical knowledge we can thereby judge how long a period must then have elapsed since the time when the most simple ancient organ had a real existence.

As the centuries passed, pipes were added to pipes. At first it seems that the admission of air was effected by a slider under each pipe like the lid of dominoe boxes, for it was for the separate sustaining of tone that an organ was wanted, and we are told of sounds from organ pipes that could be heard half a mile away, and from Jerusalem to the Mount of Olives. At long gaps of time more pipes were added, then valves, and rods to pull down the valves by a string, then keys, (though it is doubtful, even by centuries, at what date the actual keyboard was brought into use), ranks of pipes added to ranks, then pedals, and at some intervening date, we know not when, the reed-pipes, and in this fashion the Organ grew. How long a stretch of history it is from the little beginning of Pan, up to the great organs that are the monuments of our own times.

Pipes or strings ?—After Pan came Apollo to whom the Greeks say they were indebted for the seven-stringed Lyre. The ability to produce an instrument with this number of strings implies considerable skill in workmanship. The question as to which came earliest as the progenitor of a musical scale, pipes or strings, is answered in favour of pipes, because at a time when civilization was in its childhood these were easiest to obtain and bring into use ; to provide lengths of string made from gut that should prove to be of the exact thickness that under tension would give required notes, this must needs have demanded long industrial practice, and education of ear likewise, for strings afford no standard themselves ; whereas pipes fix their standard, so that we, recovering pipes from tombs in Greece and in Egypt, know that they bring to us the standards of tone as existing thousands of years ago, unaltered though sounded to-day.

The voice was the first measurer, was the original standard of pitch for all. And the pipe is delegated to hold the pitch.

Leaving the organ for a while, there is matter for thought to be found in the pipes themselves, and the part they played in fixing the primitive scale of sounds, for my conviction is that pipes were the first placers of sounds in relations of such nature as to form a series or scale of sounds and so that by the fact of usage these pipes became lawgivers, were potential in the life of the people, and fixed the custom. Briefly it may be explained in this way,—when men found that they could produce sounds from river reeds or pipe stems of bamboo blown across by the mouth and afterwards could obtain and vary such by making side holes, the lay of the three or four fingers would first cause them to place the outlets or sound-holes in the easiest position for the fingers, and it would be afterwards that they would notice the relation of the sounds and be set seeking by little shiftings to make the sounds correspond nearly with some of the accustomed tones of the voice. In fact, the first of impulses is the impulse to imitate, and imitation becomes a subsequent factor in heredity. Old examples of the Egyptian “summarah” and “arghool,” shew how enduring are the old habits and feelings, for modern specimens differ but little from the most ancient.

The exact ways of development can only be guessed at now, but there is a large amount of evidence tending to induce and confirm the belief that the set of fixed sounds popularly adopted as the scale for pipes, gave the law to the strings in the first instance for imitation.

The Egyptian pipes just named are sounded, not flute-like with mouth-hole, but by little strips of reed cut up from the body of the pipe as in a boy’s oat-straw squeaker, a method so ancient that the pipe with a beating reed was most likely the first in order possessing the series of sideholes, and establishing a scale.

In these two forms of pipe, the flute-pipe and the beating reed-pipe, are found the remote ancestors of the organ; between the new and the old are many Eras of Civilization,—nothing more. At the present day the ingenious compilations called “specifications” make heavy demands upon our faith, yet all their lists of high-sounding words are reducible to two terms,—the flute Department, the Reed Department.

Another department of investigation will next occupy attention, namely, the origin of our musical scale, after which the Organ topic will be resumed.

The enquiry into origin.—The enquiry embraces two distinct subjects, the origin of the organ, and the origin of the musical scale. These two are so linked together in our design that, for clearness sake, I am compelled as it were to take them in parallel lines for investigation. If there is a little repetition it will not harm the steady advance.

The whole attention of Greek philosophers, who amongst their studies astronomical and mathematical, included music, seems to have been directed to strings. Upon strings alone their learned disquisitions have been written. I do not know that they make mention of pipes for investigation. With the Chinese it was the opposite. They had a complete system of the lengths and proportions of pipes, and made their little She'ng organs long before nimble-footed Pan piped in the groves of Dodona to illusioned Greeks.

Pythagoras quite in the dark.—Men of various races were in early days long content with three or four notes to form their simple scale of musical sounds, and these comprised what we term a fourth.

Thus the fourth, with its interposed divisions variously placed, constitutes the first musical scale known to men. The

Greeks called this a tetrachord. Upon my making the claim for the system of four sounds as constituting the first musical scale known to men, some will be ready to say:— “What about the pentatonic scale?” My reply is that I support myself by the authority of Dr. A. J. Ellis who stated that he had come to the conclusion that the pentatonic scale had been derived from a tetrachordal scale. Let it be plainly understood that I have no wish to trouble any school of harmony. I am an innocent bystander. The enquiry into “origin” is quite apart from doctrines of harmony, yet I have heard that the prejudice unprogressive musicians have in favour of the fifth, blinds many to the essential nature of the fourth as the foundation of the musical scale. The fourth to them is quite subordinate, allowed notice only as the inversion of the fifth. The alienation of thought has been due to Pythagoras, the ancient Greek philosopher. Pythagoras by his scheme of ratios, as demonstrated by the relative proportions of lengths of strings, established a theoretical basis for the musical sounds elicited from them. His scheme, worked out upon the monochord or “canon” as he called it, had a sensible value at that period. To him the fifth was a cherished consonance, next best to the octave, hence its pre-eminence since in musical learning. Strictly speaking, the unison, it is now shown, is the only consonance, there is none other. This statement is not to be taken as having reference to rules in musical teaching or formal exposition. Pythagoras was completely in the dark as to the true nature of musical sounds, he had no idea of vibrations as affecting pitch, and their ratios as defining intervals, and knowing nothing of harmony as we know it,—

“He builded better than he knew”

and although later scientific insight makes it evident that he did not lay his foundations deep enough, he was the first to find a

theoretical basis for musical structure, and in his day there was no other more reasonable in view.

What Pythagoras did will be explained in the next section. The system of music existed already, he did not create it, he taught the Greeks how to analyse it.

Step by Step.—How step by step our diatonic scale developed, how it has become what it is gradually by slow degrees, —does anybody know? Certainly. Wise men in their libraries find much; the erudition is deep, and they can expound it in their own way; but it is the way of the student, not intended to attract the casual reader. The “Wanderer” in literature, after reading many pages, would not readily obtain the clear account he was seeking.

My impression, from wide experience, is that few musicians make a thorough examination of the subject; having had occasion to go into the matter of the Greek System on the historical side, I saw how confused it was, and how necessary to examine author against author in order to arrive at the true assignment of steps and changes in those distant times. For the purpose of this book a clear historic review seems to me a desirable thing, for tuning means the bringing of musical sounds into conformity with some ideal division of a scale, old or new. With this consideration in mind I have thought that it would be useful to take, from my larger paper of enquiry upon the subject, some of the salient points, and to make a brief sketch in the hope that to you it will be acceptable as a record well worth knowing, and helpful also to a better understanding of the systems of temperament practiced in recent times. Taking care not to burden this enquiry with too much learning or semblance of learning, enough may be set out to bring home to the mind the conception of a chain of historic facts.

The evolution of a musical scale should be interesting, even to musicians who would not make the subject a study. At all events my desire has been to make it interesting.

SECTION III.

The Basis of the Musical Scale.

The beginning of the scale.—To begin at the beginning ; muscle is the basis of the musical scale. The muscles of the throat and larynx have dictated the primary intervals of the scale. The time and rhythm of music have in like manner in the early stage been regulated by the muscles of the chest, of the arms, and of the legs, simply in the fact, ever in evidence, that they automatically apportion degrees of effort, and times of renewing of effort. Man moves as he must. His race and constitution order his gait and bearing, as they ordain his heart-beat.

Vocal communication.—The organ of voice is so constituted that the healthy muscles find it easier to make, when the mind incites to effort, steps of definite degrees in vocal pitch, than to take mincing irregular steps. This it may fairly be assumed was man's way to a defined division of vocal effort, long before song was thought of as a connection of sounds. Call it vocal communication. To this end the voice suits itself to distance with a natural calculation of effort to effect. If we have to go out of our ordinary talking level, for emphasis, or from emotion, or with the intent to be heard a little distance off, the first natural interval is that one familiar to us as the interval of the fourth, because it is easiest to do so ; to rise to the interval called a fifth, means the exercise of greater effort, a more deliberate attempt to arrest attention, and the voice makes that further degree of effort when the distance is greater

than before ; to communicate at a still greater distance will demand a rise of voice to an octave, that is to say to that repetition of a first sound at a higher pitch called an octave. Thus it comes home to our judgment that the use of the voice follows upon predisposed lines, as is the case in walking and in breathing.

In all our argument it should be borne in mind that the terms, fourth, fifth, octave, are quite artificial, are signs founded on *vision*, or the numbering of strings of the lyre.

When did music as a system begin ?—As music, the beginning of a scale might well be believed to have originated in religious use spontaneously. Intervals of vocal pitch belonging first in accustomed use to the daily life of man, were naturally taken and incorporated in the earliest rites and ceremonies, however rude the civilisation. Savage tribes now give warranty for this ascription. By priestly intonation in appeal to the Gods, the rising and falling of the voice by rule in a certain manner, became a custom, and in time a formal regulation by authority. Research shews that with the peoples of Persia, India, China, Arabia, Egypt and Greece “the fourth” was the chosen interval that was the basis of the musical scale of each ; both in the pipes they used, and in the stringed instruments, the evidences are the same. The civilisation of these peoples dates back to ages so remote, that although many thousand years yield records of established usage of scales thus founded, yet without question it must be acknowledged that to reach that state of civilization vast periods of time had been necessary.

Dr. A. J. Ellis states as the result of his enquiry into 139 different scales of various nations that his assured conclusion was, “the predominance of the fourth, and the mere evolution of the fifth, in Greece, Arabia, India and Japan . . . the fifth never had the same predominance as the fourth.”

The system of the Tetrachord.—Having become known to us through the writings of certain Greek philosophers fragments of which have been preserved, the system of the Tetrachord has therefore been assigned to the Greeks, and the development of it has been recorded only in their language. Yet its origin is undoubtedly Egyptian, long before the time of the Greeks.

The Lyre being the typical form of instrument in which the tetrachord was in evidence, the attention of philosophers was given to *stringed* instruments, pipes having no share in their regard, possibly because the playing of pipes was a professional art, whereas any philosopher could twang strings.

The invention of the primitive lyre is attributed to Mercury, and his instrument had but three strings, corresponding, it was said, to the three seasons into which the Greek year was divided. This evidently was but a variant of the Egyptian tradition giving to Hermes the lyre of three strings, symbolising the three seasons of Egypt, spring, summer and winter of four months each. A three-stringed lyre is shown in several Egyptian wall-paintings, it is carried lightly on the shoulders of women in the procession; whether the several strings had any prescribed pitch, or were only struck to point the rhythms of the chant or song we cannot tell. It is said that Linus added the "lichanos" or forefinger string, making the fourth string. The lyre of Mercury, so tradition asserts, had the three strings—thus comprising the fourth, fifth and octave, according to our terminology.

e—a—e, or, e—b—e.

The evolution of a scale.—Emerging from the mists of fable we hear of an early period in which the octave became disused, and nothing remained but the fourth in its rudimentary

condition, divided next into two steps, and after that separated in three divisions resulting in an interval comprising two tones and a lesser tone, or two steps and a half, so that the whole is marked by four sounds ; this series then undesignated, arrived after a time at a stage when it *was* designated, and known thereafter by the word "tetra" signifying "four," and the inclusive system was called a "tetrachord."

We import our ways of speech upon musical subjects, into the consideration of these ancient matters, and necessarily so, but it is essential to a right apprehension to remember that Greeks had no other way of naming the sounds except by the names they gave to each string, thus the forefinger string was called "lichanos," and the others had their distinct appellations. They had no sense of tonic as we have, no system of harmony, no musical stave, no use of the letters *a, b, c,* etc., to denote their music. In later times they had a kind of letter note method, curiously crude, yet elaborate, alphabetical letters upside down, letters lying on the side, letters mutilated, and signs for instrumental sounds different from those for the sounds of the voice.

This knowledge was by the merest accident preserved to us in a solitary manuscript by Alypius 115 B.C.

The earliest Tetrachord.—For many centuries previous to 700 B.C. the Greeks seem to have been content with one system of four sounds or notes. By them Music was regarded as an aid to regulate by rule the inflections of the voice, the emphasis and the pauses in the recitation of their epic poetry. Innovation was prohibited by law, but in the course of time laws were overlooked.

The most ancient form may be represented thus, considering the extreme sounds to embrace the interval,—

$$e \text{ } _ \text{ } f \text{ --- } a$$

it was the initiatory stage afterwards completed as,

$$e \text{ } _ \text{ } f \text{ --- } g \text{ --- } a$$

only that it should be read from right to left.

(The sign — indicates whole tone, and $_$ semitone).

The man's voice was the guide, and from time immemorial the *a* was the standard of pitch, by ruling of the ear.

(The *a* below middle C—top line—bass clef).

From father to son, from teacher to scholar, the tradition of pitch was carried on. The string affected by heat and by moisture, and by the strain when twanged, never remains accurately to pitch, and although pipes and strings have run a parallel course, we find no evidence of pipes being actually cared for by lyre players as guiding them in setting the pitch. Plutarch tells us that it was the custom for *reciters* to have a pitch pipe sounded by an attendant to keep their voices to the pitch and mentions an ivory pipe being used for the practice, but from earliest times it would seem that lyrists of all sorts, and players on stringed instruments of every nation, find the habit of the ear sufficient for the purposes of their art, that indeed, the musical ear relies upon itself for tuning.

The laws of the tetrachord. The strings were tuned in relation to the *a* falling a fourth to *e*. The extreme sounds were fixed sounds, the two inner sounds movable in small degrees ; the two upper notes were to be a whole tone apart and the two lower notes a semitone apart, though the exact extent of these might vary, so that the question was, the largeness of the semitone. There is reason to believe that a division had been attained, tuned by ear, giving very closely both a true major

third from the one extreme note, and a true minor third from the other extreme note.

Under these simple laws, the lyre existed up to the time of Terpander, who added three strings. Now why was Terpander allowed to do this? I think I have found the solution, as will be seen presently.

The historic record which I have worked out and here drawn up, will, I imagine, give a clearer idea of the development of the primitive scale than the "Wanderer" could obtain for himself by the reading of many books. The dates are given as about the time in the man's life when his public doings were likely to be recognized as of importance. Generally, in history, the names are associated with dates of birth and death, as inclusive limits.

The Historic Record.

From the foundation of Athens, B.C. 1556	<i>a</i>	
to the time of Terpander <i>circa</i> B.C. 650, a	<i>g</i>	↓
period of nine hundred years, the ancient	<i>f</i>	
racial or inherited system of the tetrachord	<i>e</i>	
retained its hold upon the people.		

The original names given to the strings are probably lost, for instance, the highest, the *a*, could not have been called the *mese* or middle, there being no middle position until Terpander added the three above *a*. The enlargement of the lyre from four to seven strings was a very serious change. This was his scheme, from *a* down to *e*, from *a* up to *d*.

