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THE

Secrets of the Voice

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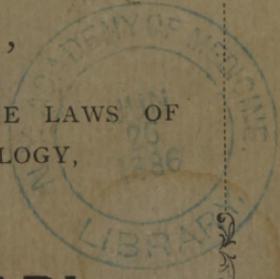
SINGING,

EXPLAINED ACCORDING TO THE LAWS OF
ACOUSTICS AND PHYSIOLOGY,

— BY —

EMILIO BELARI,

*EX-TENOR OF THE PARIS ITALIAN OPERA, PROFESSOR
OF SINGING AND PERFECTING THE VOICE.*



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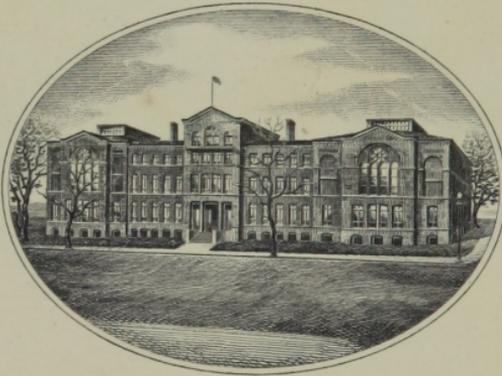
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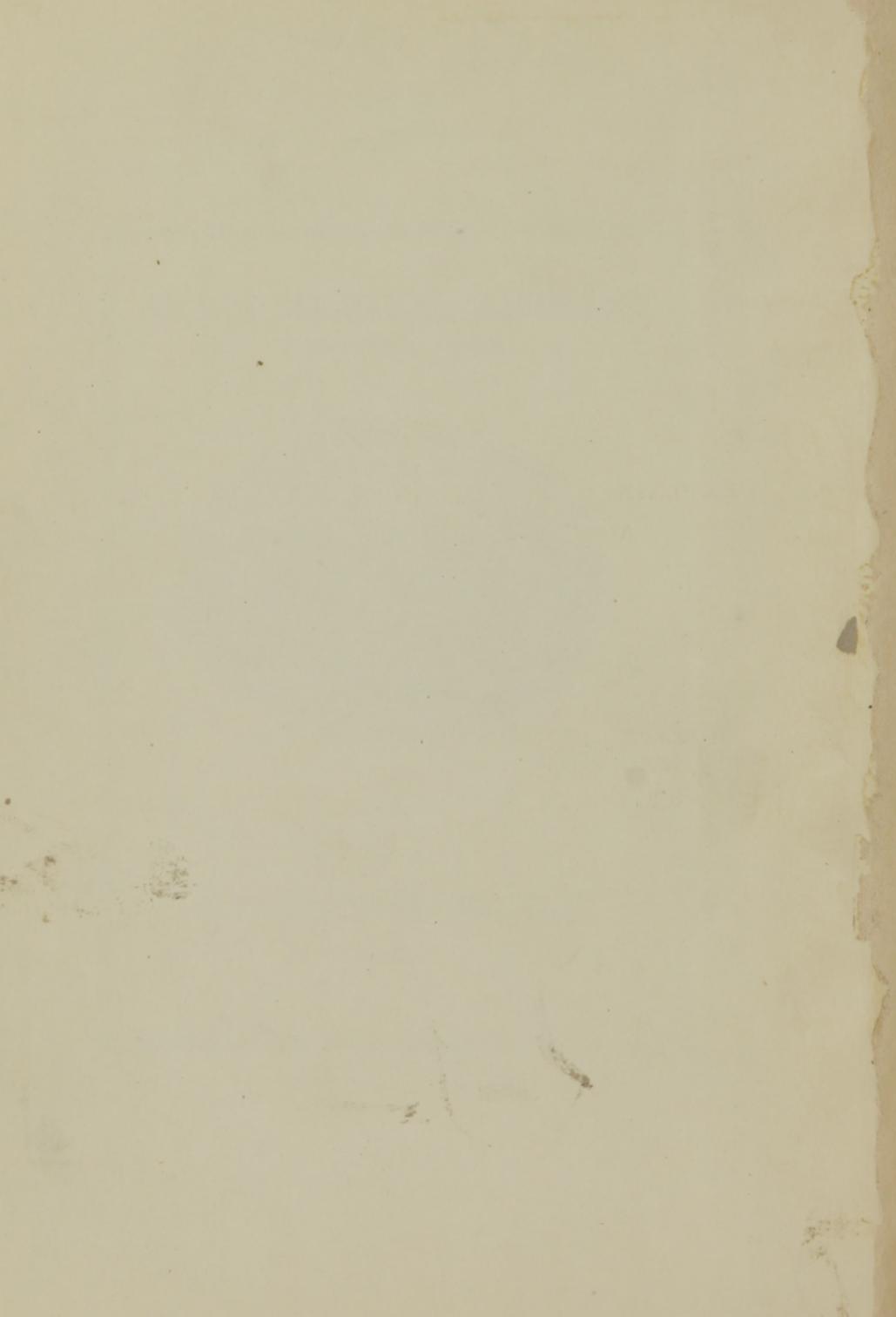
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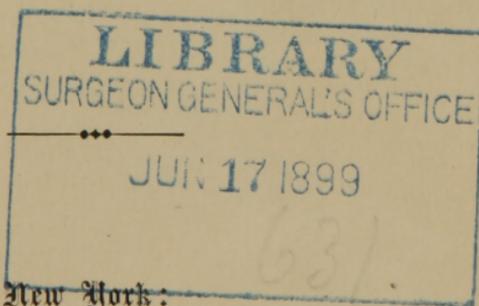
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PREFACE.

I applied myself to the study of vocal physiology desirous of knowing the cause of the difficulties met with at each step in the study of singing, seeing that neither methods nor the most renowned professors of Europe could efface my doubts on this subject. I wished to comprehend exactly the phenomena of the voice, and I sought in nature the causes which produce them, as the most positive way of arriving at the desired end. I have studied them as profoundly as the manners of investigation that science possesses to day permit, and guided by the observations of eminent physiologists I obtained what I desired; that is to say, I became able not only to explain to myself that which professors told me were vocal mysteries, but I was also able to know perfectly what the voice is and how it is formed, in order to educate it properly. I had

written a long work on this difficult and complicated matter, so little known to professors and artists who have written on the voice (Manuel Garcia, M. Bataille and Madame Seiler are exceptions) but animated by the desire of contributing with all my might to the progress of the art of singing, and encouraged by the warm reception of my little pamphlet *The Way to Study Singing with Profit*, I decided to publish this extract, in which I have united as succinctly as possible the fruit of my observations, and the necessary knowledge to eradicate the erroneous ideas that cause so much harm to teaching and consequently to the art itself.

I have not pretended to write a book which can of itself teach how to sing; that is not possible, and I should never have imagined a parallel absurdity. I have confined myself exclusively to the explanation of the phenomena of the voice without occupying myself with what belongs to its education, or the art of singing, for these will be the objects of my

later publications. For the moment I think I have thrown sufficient light on certain points to enable those to see clearly who have given themselves up to teaching.

I might have still more enlarged in certain chapters had I wished to enter into small details, but I have been better pleased to withdraw from my work all that could tire the intelligence of persons lacking certain scientific knowledge, wishing to make myself understood even by professors and pupils who have no other instruction than *solfège*.

I have a strong hope that the points I have enlightened in this work will be well received by learned professors, and I am persuaded that they can greatly profit by it if they will take the trouble to meditate upon all that I have consigned here, for if my work has no other worth, it has at least the merit of being based on the practical observation of several years of study, and of also being an exact narration of the process employed by nature in the production of the voice.

CHAPTER I.

THE VOICE.

BRIEF HISTORY OF THE VOCAL PROBLEM.—DEFINITION OF THE VOICE.—THE TRUE DEFINITION.

The study of vocal mechanism has occupied men from time immemorial, as much from the standpoint of art as of science. From the time of Hippocrates, 460 years B.C., up to our time different theories have been advanced, more or less well founded, to explain the production of this phenomenon, and the knowledge of it followed step by step the progress of physics, anatomy and physiology in such a way that at the time of Hippocrates, and even Aristotle, when the sciences were in an embryo state, there existed but a faint and imperfect idea of the formation of the voice. * The progress of science was so slow that it required more than three centuries to advance one step in this complicated matter, as is proved by

writings containing nothing new or important until the appearance of a special treatise *On the Voice*, written by Gallienus about one hundred years B. C., in which he already shows more profound, although very incomplete, knowledge of the functions of the vocal organs.

The knowledge of anatomy advanced and increased up to the XVI century, from which time began the true progress. Anatomy and vocal physiology, enriched by remarkable discoveries entered the road of progress, and their advancement would have been much more rapid had physics, in its relations to acoustics, arrived at the same height.

F. d'Acuapendente, who lived in the last half of the XVI century, already knew all the parts which compose the vocal apparatus, and was the first to present the glottis fulfilling the important functions belonging to it in the production of the voice.

From this time forward progress was much more rapid, although not as much so as may have been desired. At the beginning of the XVII century, physics and anatomy having advanced extraordinarily, favored—little though it was—the resolution of the problem of the voice which for so long a time was the

theme of predilection among naturalists, physicians and artists, and each one tried to give a satisfactory solution, which if not the true one at least gave new light for subsequent discoveries.

From the time of F. d' Acupendente until 1741 when Ferrein made his experiments for the first time with the larynx of a dead body, other celebrities such as Mersenne, Perault, Dodar, etc., wrote on the same subject and their theories differed, although more or less well founded.

The investigations of Ferrein were followed by those of Dutrochet, who, having made a conscientious study of the anatomy of the vocal organ, and thoroughly understanding the laws of the production of sound, exposed a theory which differed from all the opinions advanced up to that time and which contained some true points.

Geoffroy Saint Hiliare, Malgaigne, Felix Savart, Magendie, Bichat, Biot, Despinay, Gerdi, Bennati, C. de Latour, Colombat, Richerand, Berard, Müller, Longet, Donizetti the immortal composer, Manuel Garcia the celebrated professor of singing, Bataille professor of the Paris conservatory, Doctor

Edouard Fournié, and several others we could also name, tried with more or less satisfactory results, to resolve the vocal problem, but not one among them had the good fortune to bring forward an acceptable theory on the phonic organ, except Manuel Garcia in 1855.

In order to render their theories more comprehensible, authors have compared the vocal organ to musical instruments, and those which merit the greatest acceptance are those which compare it to reed instruments.

Gallienus was the first to compare the voice to these instruments, but by examining with care the marvellous manner in which the phonic organ performs its functions (as simple in its composition as it is infinite in its results), we coincide with the opinion of Gerdi, who says, that up to the present time there exists no mechanical instrument which can compare with it, for not one is susceptible of the infinite modulations to which the vocal organ lends itself. It is, says an illustrious writer, the instrument *par excellence* and the most precious way that music possesses for its execution.

In fact, of all sonorous bodies existing in nature, of all instruments produced by art, not one, we repeat, is susceptible of the marvellous

effects produced by the voice. The singing of birds, and the sounds of most perfect instruments appeal only to the imagination, but the human voice, possessing the faculty of imitating all sounds with their infinite inflections, touches the heart, appeals to the passions, and by an inexplicable effect we identify ourselves with the person who sings and participate with him in his sentiments of grief, joy, hate, or tenderness.

What then is the voice ?

This is apparently a very simple question, but one that science has not been able to answer for twenty-three centuries.

In order to justify what we have just said we will cite the definitions which seem to us the most worthy to be given, although few give any idea of what the voice really is.

Platon says : The voice is a concussion in the air which penetrates the soul by means of the ears.

Piorry : The voice consists of a particular sound ordinarily produced by the passage of air exhaled in the respiratory canals.

Malgaigne : The voice is a particular sound ordinarily produced by the passage of the air exhaled in the air canals.

Richerand and Berard: The voice is an appreciable sound resulting from the vibration experienced by the air sent out from the lungs when crossing the glottis.

Magendie: We understand by voice, that it is the sound produced in the larynx at the moment that air passes that organ on entering or passing out of the trachea.

Adelon: Voice, sound produced in the larynx at the moment that the air exhaled passes that organ, the intrinsic muscles of the glottis being in a contracted state.

Nysten: The voice is an appreciable sound produced by the air expelled from the lungs when crossing the glottis; some of all the sounds a man or an animal can produce with his larynx in speaking, singing or crying.

Gerdi: Voice consists in producing a sound in the larynx.

Longet: The voice is a sound produced by man and certain animals by expelling the air from the lungs across the glottis.

Fournié: The voice is a sound produced by a particular reed, formed by modifiable walls, under the influence of muscular action, the vibrating part being formed by the mucous filling which limits the edges of the

glottis. The vibrations are provoked by the passage of air across the glottis.

Of the definitions just given the last is without doubt the most exact, as it gives a true idea of what the voice is, and of the manner of its formation.

If after these definitions, more or less exact, more or less complicated, due to very respectable scientific authorities, we are permitted to add our own, we would say *that the voice is the product of the vibrations of vocal bands, occasioned by the air contained in the lungs being expelled across the glottis.*

This definition, based on the laws of acoustics applied to the constitution of the vocal organs, is the simplest, clearest and most concrete that we could offer to all minds.

There is no doubt but that the voice is the product of vibrations of the vocal bands, and not of vibrations of air, although we have seen it so stated even in some works recently published.

The celebrated anatomist Ferrein thus demonstrated it during the middle of last century by saying, when speaking of his experiences, that in touching the vocal bands with pincers the sound ceases, and that the

sound strikes or ceases to strike the ear the moment the vibrations are seen to commence or cease. Later Magendie and others confirmed the assertion of Ferrein by their experiments, and to further it still more the laryngoscope aids us to observe more clearly.

CHAPTER II.

REGISTERS OF THE VOICE.

IMPROPER DENOMINATIONS THAT THEY HAVE RECEIVED,
 AND ORIGIN OF THE FALSE CLASSIFICATION.—BASIS
 OF THE TRUE CLASSIFICATION.—NATURAL,
 MIDDLE AND UPPER REGISTERS, AND
 PHYSIOLOGICAL CHARACTERS BY
 WHICH THEY ARE DISTIN-
 GUISHED FROM EACH
 OTHER.

The theory of registers is a question of great importance, as it directly affects the education of the voice and the art of singing well. There has been so much raving on this subject that we should be obliged to write immense volumes did we propose to combat all the false doctrines that have been advanced on this subject. The disorder, confusion and disunion that exist between professors of singing and physiologists on the classification of registers, undoubtedly arise from—1st, That

the professors lack physiological knowledge to explain the vocal mechanism during singing, and in that case their affirmations have no importance whatever. 2d. That the physiologists were not singers. 3d. That they have made experiments on animals or on mechanical instruments, or observations on singers educated in a determined school, and by a method that was not based on the true mechanism employed by nature for the production of the voice. Starting from a false basis they necessarily erred.

In order to discover the truth, we have followed another path, confident that being a singer and physiologist we had a better chance of solving this problem, and we were not deceived. We made our observations on all kinds of uncultivated voices of both sexes, we compared these observations with those obtained from singers educated in different schools and by different processes, we educated several individuals by the means that we saw indicated by nature, and the results were so rapid and successful that we were able to form excellent voices in persons who had been told by other professors that they were incapable of singing. After these repeated proofs

we became convinced that our theory on registers is the one distinctly indicated by nature; for laryngoscopic observations, practice, our own experience and the experience of others have clearly demonstrated it. We are the more convinced as the laws of acoustics and physiology give weight to our theory, and this proves that we have not been deceived either by our sense of sight or the laryngoscopic mirror. We have invented nothing, for nothing can be invented on this subject without falling into error, consequently in exposing the theory of the registers, we have merely related a fact that exists in nature and which nature herself revealed to us.

We here renounce giving the different opinions on this subject, and the divers theories to which physiologists have had recourse to demonstrate them, for this would confuse a question that, having great importance in the education of the voice, we repeat, ought to be clearly presented in order to avoid errors, which from ignorance or routine descend from master to pupil. Fortunately physiological knowledge is to-day very much advanced, and has made all desirable progress in whatever relates to the organ of the voice, to expel all

false doctrines propagated, even by some celebrities, in the art of singing.

In order that we may be better understood, and to give an exact idea of what is meant by registers, we should say before going further, that if we examine the voice of an individual by having him run the entire length of the vocal scale, we shall observe that when he arrives at a certain degree of elevation there is a movement of the larynx and the qualities of sound vary sensibly.

It is these changes of voice that have been denominated registers, called chest, half-chest, head, mixed, falsetto, etc.; but these denominations are improper because in naming the first register, chest, it was given to be understood that the tones comprised in this register were formed in the chest, that those comprised in the second called half-chest, head or mixed participated in their formation, of the chest and head, and lastly that the tones of the third register had a different origin from the others which is a grave error, as we shall demonstrate in the following. All tones have the same origin, all are formed in the vocal bands, the lowest the same as the highest. It is the place of resonance and the direction of the sound that changes.

The error existing in the classification of registers arises principally from the fact that the vocal mechanism has not been taken into consideration, and instead of starting from a principle founded on the physiological functions of the organs, the theory is based only on the effect produced by the voice on the ear, and it was natural to err greatly in taking only the qualities of timbre for a foundation.

To establish then the true classification of registers, it is necessary to start from the process employed by nature for the production of the voice, and completely put aside the qualities of timbre, for they depend on the parts of the vocal instrument which contribute to the modification of the sound, by giving it a particular character in relation with the sentiment or passion that one wishes to express in singing.

In this way we arrived at the discovery of truth, and took into strict account not only the phenomena which we observed with admiration in some voices, but also the difficulties which presented themselves in singing, and we learned at the same time the way to overcome them without being obliged to leave this work to time as is done by ignorant professors.

Man, as well as woman, employs or can employ three different processes for the emission of the voice. These three processes are the true registers of the voice, and to distinguish them we will call them the *first* or *natural register*, *second* or *medium* and *third* or *upper*.

Now let us pass to the explanation of the mechanism employed by nature for the formation of the voice in each one of its registers.

FIRST OR NATURAL REGISTER.

The first register is common to all voices, either educated, or in their natural or uncultivated state. The characters which distinguish the voice in the natural register consists in its greater volume and fullness, and that it is produced without effort or fatigue. During the emission of tones comprised in this register, the larynx is found placed at the lower part of the neck, the glottis presents a longitude of from fifteen to twenty-five millimetres, the vocal bands take a horizontal direction, and show their entire thickness, and their edges become more or less thin according to the tension of the muscles that act on them.

When we wish to emit a low tone, the arytenoid cartilages approach each other, making by their movements the vocal bands also approach each other, but they leave a small interval or opening towards the anterior part. This opening—which extends longitudinally towards the posterior part—marks, under the impulsion of air, the part of the vocal membrane in vibration; this membrane being very thick and lightly stretched, ought naturally to produce low, voluminous tones.

As the tone raises, the larynx undergoes an ascensional movement, increasing at the same time the antero-posterior diameter of its cavity; the vocal bands take an oblique position from high to low and from back to front, increasing in tension and elasticity. The opening diminishes and the glottis becomes shorter; consequently *the voice in the first or natural register is formed by the longitudinal tension of the vocal bands, by the tension of the same in the sense of thickness, and by the longitudinal modification of the glottis.*

These three actions augment their intensity in proportion as the sound advances toward the upper tones of the register, but the movement is so insignificant, that it is necessary to

ascend a fourth or a fifth to be able to appreciate the phenomenon of which we have just given a succinet explanation.

The number of notes comprised in the natural register vary according to the individual, being more extended in man than in woman for reasons that we shall see later.

Once arrived at the limit of this register it is impossible to produce new sounds, for the muscular forces are no longer sufficient to engender new modifications capable of provoking new sounds, that is to say, that the muscles which extend and the muscles which contract the vocal bands exercise an equal force, and "as two equal contrary forces destroy each other" there results an immobility in the vocal bands, which, being excessively stretched, cannot yield to the action that seeks to unite them.

To be able to continue ascending the scale, it is necessary to change the state of the parts mentioned, so that the organ will be disposed to emit a succession of sounds of qualities different from those produced in the natural register.

SECOND OR MIDDLE REGISTER.

The change of which we have just spoken takes place in fact, by a general and rapid

movement having for object the approaching of the sides of the thyroid cartilage, the diminishing of the transversal diameter of the larynx, and the lessening of the longitudinal tension. All this makes the longitudinal lessening of the glottis possible, and the glottis is reduced to from ten to fifteen millimetres in length, and this favors the production of ascending tones which in the limit of the first register became impossible.

In proportion as the voice ascends, the the cavity of the mouth gradually increases by the lowering of the tongue, by the outward and upward projection of the lips, and by the elevation of the veil of the palate. The posterior pillars tend to approach each other when the upper notes of this register are sung; consequently *the voice in the second register is formed by the longitudinal diminishing of the glottis, and by the diminishing of the longitudinal tension of the vocal bands.*

The movement of the muscles is barely perceptible in the second register, on account of the small dimensions to which the glottis is reduced.

The passage from the natural to the medium register is not generally easy for

either *contralti* or *bassi*. The latter acquire the second register with difficulty, and can only make use of it in the two or three upper tones of the voice.

The difficulty of the passage depends, as we have said, on the change that takes place in the larynx, and education ought to procure ease of transition, in order that the sound of the second register may differ as little as possible from those of the natural register.

The difficulty found in this register in pronouncing certain syllables consists in the fact that the tongue, especially its base, directs itself backward in order to diminish the diameter of the vocal tube and push the epiglottis towards the orifice of the pharynx.

This position of the tongue prevents its articulating with freedom, because of the immobility maintained by the muscular action at its base, and is a great obstacle in passing to the natural register without a sensible transition in the sonorous qualities of the two registers. This is the reason that when the change is brusque, we observe in some singers a rapid movement of the lower part of the face, in order to leave the muscles of

the neck and larynx in a condition to take instantaneously the proper position for the note that they wish to emit.

Study ought to correct this movement, or at least render it but slightly perceptible.

The middle register is the most proper for execution or agility, for the glottis, being reduced to small dimensions, as we have seen, the muscular movement is hardly perceptible and this facilitates rapidity of vocalization, and renders execution in an ascending sense less difficult.

Again, this is the register the most susceptible of being extended, and for this reason many professors admit of but two registers; but if it is true that many singers use this register to the limit of the vocal scale, there are others in exchange who cannot do this, and are only able to here produce from two to four tones. And as exceptions, numerous though they may be, do not make a rule, and as there exists physiologically a third register which *contralti*, *soprani* and *tenori* make use of, we are going to make it known.

THIRD OR UPPER REGISTER.

The third or upper register has a proper character that distinguishes it from the other

two, and its compass varies extraordinarily according to the individual.

These physiological characters have such great analogy with those of the natural register, and there can be obtained by study so much resemblance in the sonorous characters of the two, that an ear of little experience can easily confound them, especially in the upper tones.

From this springs the general belief that the highest tones of the vocal scale can be produced with the natural register, (some physiologists have also committed this error) and this has given rise to the celebrated C chest (*do de poitrine*) a farce that has been a rich mine of gold for its inventor and for those who have since known how to profit by it.

To demonstrate the error, it is sufficient to give the physiological characters which distinguish the third register, since it is produced by a mechanism different from that of the other two, and its sonorous qualities are also dissimilar.

In proportion as one reaches the limit of the second register, greater difficulty is found in the emission, so much so as to become im-

possible for some individuals to produce new sounds on account of the antagonism established between the intrinsic muscles of the larynx, as we have already said in speaking of the natural register. It is necessary, then, to make a new movement that will permit a change in the general state of the instrument, and to place it in proper conditions for the production of new tones in an ascending sense. This change takes place in fact, and the result is to dispose the organ so that it can augment the longitudinal tension of the vocal bands, diminish the tension in the sense of thickness, and increase the longitudinal dimensions of the glottis, which takes place by means of lessening the contraction of the thyro-arytenoid muscles, and by increasing the the tension of the posterior arytenoid muscles.

All the parts aid this end in an energetic manner, as can be seen externally by the ascensional movement that the larynx undergoes. However, this movement is not altogether indispensable, either for the production of the voice in the third register, or in the middle register, for when one sings with the sombre *timbre*, of which we shall speak later, the larynx rests almost always in the inferior

part of the neck in order to give more volume to the sounds. Therefore *the voice in the third register is produced by the increase of the longitudinal tension of the vocal bands, by lessening the tension in the sense of thickness, and by the longitudinal increase of the glottis.* Thus, then, the falsely called *do de poitrine*, so celebrated in Duprez was but a *do* in the third register, produced with a clear *timbre*, and the *do* sharp of Tamberlick, no less celebrated, is equally a *do* sharp of the third register of sombre *timbre*.

To give to these tones the qualities of fullness, volume and sonority found in the natural register, it is necessary to considerably augment the cavity of the mouth by forming an oval with the lips, and sending the column of air outward towards the nasal cavities, and as the vocal bands will be found to be very much extended longitudinally, leaving a large space between them, it requires a large quantity of air energetically sent out to produce a voluminous and intense sound.

This is the only mechanism that need be employed by those wishing to obtain the same result as these celebrated tenors just named. We obtained it without great difficulty, and

we are persuaded that with a well constituted organ, which supposes a powerful, energetic voice, one will easily obtain this, although his voice may be but slightly posed in the normal conditions of the phonation. However, we do not advise too much this way of producing an effect on the public with only one tone, for the extreme tones of the voice cannot be abused without detriment to those to which sonority is indispensable and which are most used in singing. If among those who have never exercised their vocal organ, there still exists doubt as to the impossibility of producing the superior tones of the vocal scale with the natural register, it will be sufficient for them to remember the difference existing in the physiological characters of the extreme registers.

Let us end then by repeating, that the C chest so celebrated everywhere, exists only in the imagination, for vocal physiology demonstrates the impossibility of producing the superior tones of the vocal scale with the proper position of the first or natural register, no matter what the nature, conditions and qualities of the voice may be. Already the importance of this tone (C chest) has greatly

diminished, for with the adoption of the French pitch (the most rational and most in accordance with nature) the tenor is rare, who can not reach this note. Imagination does a great deal, and the public must know that it is *do* in order to applaud and appreciate it, otherwise it has the same effect as *A* or *B* flat.

CHAPTER III.

TIMBRE.

A LITTLE HISTORICAL SKETCH.—WHAT TIMBRE IS.—
 FAULTS, GUTTURAL, NASAL, ETC., IMPROPERLY
 CALLED TIMBRE.—CAUSES THAT PRODUCE
 THEM AND THE WAY TO CORRECT
 THEM.—GENERAL TIMBRES CLEAR
 AND SOMBRE.—OPINIONS ON
 THEIR FORMATION.

The most remarkable men of science, from Pythagoras down to Helmholtz, have worked seeking the resolution of the acoustic phenomenon known to us under the name of *timbre*.

Kepler, Laplace, Poisson, Euler, d'Alembert and several others, understood (guessed rather) this mysterious phenomenon but could not explain it. Galilée, Newton, Euler and Bernouille in their researches on movements of vibration gave the elements necessary to understand the tonality and intensity of

sounds ; but all their efforts miscarried when they wished to explain the other particular quality of sound which permits the ear to distinguish the same note in different instruments, Rameau had already taken a long step towards the resolution of this problem ; he knew that sound was composed of other simple sounds, as is light of different rays, but lacking mechanical means that would permit him to analyze it, he left his work incomplete. Biot went still further ; he discovered the mystery and although he was also destitute of material means to demonstrate it, he announced the truth (demonstrated later by Helmholtz) as a probability.

In fact Helmholtz in his acoustic researches discovered this mystery by satisfactorily explaining this particular property of sound called *timbre*, demonstrating why we distinguish the same note in different instruments.

Here is the phenomenon explained in a few words.

Suppose some note of the piano which we will call the fundamental sound. If we press down the key representing this note we set the corresponding string in motion and it vibrates its entire length, and if we listen attentively

we shall hear different notes lower and higher but weaker than the fundamental note, as though this one, in its vibratory movement, struck divers strings which in their turn produced the sounds two, three, or four times higher like distant echoes becoming extinct little by little. This phenomenon, perfectly appreciable to a trained ear takes place because the vibrating string set in motion subdivides spontaneously into two, three, four and even more parts after having produced the fundamental sound.

We see, then, that sound is composed of partial tones called harmonics and consequently it can divide itself.

Helmholtz was able to decompose it by means of a very ingenious apparatus that he named a *résonnateur*, thus not only proving that the fundamental sound is composed of partial notes of different intensity, but also that all sounds are not equally rich in harmonics, that it is to the co-existence of these partial sounds reaching the ear blended with the fundamental sound that we owe the auditory sensation known as *timbre*; therefore the difference observed in sounds depends upon the number of harmonics.

The law of the series of harmonics, as Biot says, varies according to the form of the sonorous body, and in fact it is demonstrated that stringed instruments are richer in harmonics than wind instruments.

The appreciation of harmonics becomes more difficult in the vocal instrument; however Rameau already knew in 1750 that there responds to the fundamental sound of man's voice two higher harmonics represented by the fifth of the octave and the major third of the double octave.

Having once demonstrated that the difference between two sounds depends on the number of harmonics, and the resonance of these on the nature of the form of the instrument, we can easily explain the diversity of *timbres* that man's voice produces known under the name of vowels.

Only in the vocal instrument is it found possible to produce the same tone with different sonorous qualities and this constitutes one of its greatest advantages over mechanical instruments, for this reason we rightly say that the latter speak uniquely to the imagination, while the voice, thanks to its divers *timbres*,

harmonizes perfectly with the passions one wishes to express in singing.

There are but two *timbres* distinguished in singing, the clear and the sombre, also known as *voce bianca* (white voice) and *voce rotonda* (round voice) and these are, as their names indicate, the colors that the singer takes advantage of to form a contrast and produce the desired effect.

Manuel Garcia and others make mention of divers *timbres*, such as the hoarse, guttural, nasal, etc., but we believe that on the ground of art they ought not to be considered as true *timbres* but as faults of emission that should be corrected, or as the consequences of the pathological state of the vocal organ or some of its parts. For instance, the hoarse *timbre* is often found even in pure voices when (for some cause as may be observed by the aid of the laryngoscope) the vocal membrane becomes thicker and more moist than usual, its vibrations being disturbed by the liquid with which it is impregnated, are unequal, and as a result the sounds are low and hoarse. If the humidity existing in the vocal membrane is abundant the sounds will also appear muffled. When the cause has disappeared and the voice has

acquired its usual limpidity, the vocal membrane will be found to be transparent, very thin and very elastic, and the vibrations will be uniformly produced, striking the ear agreeably.

The guttural *timbre* is produced by a shrinking of the vocal tube at the posterior part of the throat; this disposition may be congenital by the effect of great enlargement of the tonsils, or artificially produced by the desire or tendency that many individuals have to emit the tones with more volume than they possess naturally.

In the first case it is very difficult, not to say impossible, to completely efface this defect. It can however be corrected to a great extent by the way we shall indicate in another work on the education of the voice, which will soon follow this one.

The nasal *timbre*, as the name indicates, is caused by sending the tone through the nose instead of by the mouth. This fault is easily corrected, for sometimes it is sufficient to show the difference of sonority existing between a nasal tone and one that resounds in the mouth, and the pupil will easily learn to do the second by reason of its sonority, volume, and intensity.

We see then that the *timbres* hoarse, guttural, nasal, etc., should be considered as faults of emission and never as true *timbre*.

Our dear friend Signor Antonio Cordero, a professor of great talent and a great student, although but little known, has made known some *timbres* in his *Escuela completa de canto*, as vices that voices can acquire, although after having considered the *clear* and *sombre* as principal *timbres* he says : that "the voice can produce many *timbres* because we naturally express all our sensations by a different sound adapting itself when we experience the sensations in reality ;" but if this is really what we understand scientifically by *timbre*, each one of these sounds ought not to be artistically considered as a different *timbre*, but as a modification of the principal *timbres*, they being the extremes between which all others are comprised.

For this reason in speaking of general *timbres* we do not speak of *chiaro bianco* (clear white) nor of *chiaro rotondo* (clear round) names of which we make use in our practical lessons on the education of the voice to distinguish and make better known to our pupils the principal phases that the clear *timbre* presents in singing.

The *chiaro rotondo timbre* is merely a modification of the *chiaro blanco* or simple clear *timbre* resembling the *sombre timbre* and serves as a bond of union between the two, rendering the change from one to the other insensible.

To produce it, it is only necessary to round the cavity of the mouth by slightly lowering the tongue and directing the column of air towards the palate. The sound thus modified acquires a certain roundness that renders it agreeable and of great effect, and facilitates *piano* singing of the tones uniting the registers.

GENERAL TIMBRES.

The formation of *timbres* of the voice, as well as the theory of registers, caused discussions by the diverse opinions of physiologists: one party sustaining that the clear *timbre* was the natural *timbre* of the voice, and that the *sombre* was produced by a particular voice exacting a special mechanism, others sustaining that an indistinct usage could be made of one or the other without the necessity of a new mechanism.

Such is the opinion of modern physiologists and in our opinion it is exact, for without

altering the conditions of the glottis we can emit the same tone with different *timbres*, changing only the dimensions of the vocal tube, as we shall see in the following.

It has been said that the clear *timbre* is the natural *timbre* of the voice, and there will be no reason for not admitting this opinion if we remark that it is proper to the first register, because it is favored by the disposition in which all parts of the organ in this register are found.

The clear *timbre*, as an eminent physiologist remarks, is more general in northern than southern countries, and he believes that language can greatly influence this and also the less musical organization of men of the north. We believe the conditions of the climate have a great deal to do with this question and have a direct influence on the gravity of the voice, since the clear *timbre* belongs to cold countries in which low voices abound, and the sombre *timbre* to warm countries producing high voices. At all events it is certain that all voices, however opposed they may be in character, find the faculty of making indistinct use of one *timbre* or the other.

In order to have a just idea of the clear *timbre* it suffices to pronounce the vowel *A* (ah) aloud and we shall observe the following disposition: 1st, augmentation of the isthmus of the throat; 2nd, diminishing of the opening of the pharynx; 3d, diminishing of the cavity of the mouth; 4th, enlargement of the orifice of the mouth.

If we wish to pass from clear to sombre *timbre* while holding the same note, it is sufficient to enlarge the pharynx and cavity of the mouth as though the orifice of the mouth was rounded and contracted forming a sort of oval as in pronouncing the vowel *O*. In this disposition of the vocal tube the column of air that it contains resounds in the cavity of the mouth giving to *A* a more obscure sound, making it resemble *O*.

Such is the sombre *timbre* depending only on a modification of the vocal tube, the characters of which are reduced to four; 1st, decreasing the isthmus of the throat; 2nd, enlarging the pharynxian canal or opening of the pharynx; 3d, increasing the vocal cavity; 4th, diminishing the orifice of the mouth. All this tends to augment the sonority of the column of air giving a greater roundness and charm to the sound.

To favor the conditions of *timbre*, the larynx ordinarily undergoes a descending movement although it is not a necessary condition. The object of this movement is to lengthen the vocal tube and augment the quantity of air that it contains; all this added to the large opening presented by the pharynx exacts a more energetic expiratory impulsion. This explains the fatigue experienced by always making use of the sombre *timbre*, and it can speedily produce complete ruin of the organ. To obviate part of this difficulty it is necessary to keep the larynx in the position it has in the natural voice, trying not to exaggerate the sombre *timbre* in the higher notes, but to partly employ it when the character of the music demands it. The augmentation of the dimensions of the mouth-cavity, and the low position occupied by the tongue, principally at its base forming a canal, explains the difficulty experienced in pronouncing certain syllables, as we have already said, especially in the upper tones of the second register, above all when the vowels *A* and *E* enter into their composition. In this case *Ah* takes somewhat the sound of *O*, the *A* of *Ah*, *E* of *U*, (French) and the consonants are less accented from which results

a confused and defective pronunciation principally in words containing *N* that singers badly taught change to *R* to facilitate the emission. For this reason we have *amarti* or *amanati* instead of *amanti*, and *tarto* or *tanato* instead of *tanto*.

Correct pronunciation is an essential condition in a singer, and this is another reason why exaggeration of the sombre *timbre* should be avoided.

To unite all means to produce a *bel ensemble* is the principal and most difficult work of the singer.

CHAPTER IV.

INTENSITY OF SOUNDS.

THEORIES ON INTENSITY.—CAUSES ON WHICH IT DEPENDS.—THE WAY TO SWELL A TONE.—VOLUME.—
 CAUSES ON WHICH IT DEPENDS.—HOW TO INCREASE THE VOLUME OF THE VOICE.

The question taken up in the present chapter is the most important point in the education of the voice, and the great obstacle that singers must overcome in order to attain perfection in their art. It exacts great precaution on the part of the professor, and no less prudence on the part of the pupil, on account of the numerous difficulties it presents, and the great confusion it can produce in the vocal organ.

The mechanism on which intensity of sounds is based is extremely simple, and it is perhaps on account of this same simplicity that so much perplexity arises ; for this reason

we blame the teachers—when we speak of errors that exist in teaching singing—who, without the necessary knowledge of the art they profess, commence education by having the pupil swell the tone without having first *posed* his voice in the normal conditions of phonation; for in order to purely diminish a sound, it is necessary to first reach the summit of perfection and facility in the use of the general mechanism.

Several theories have been invented to explain this vocal phenomenon, placing the question in different ways, as could not be avoided when each one was obliged to present a theory on the intensity of sounds that was *en rapport* with the one he invented to explain the mechanism of the voice; but all these theories are in reality reduced to one system, although differently interpreted by those who favored the theory of languets, and those who defended the theory having for principle the vibrations of air. Among the first we find Müller as the representative, and among the latter Dodar, and Longet whose system of compensation is somewhat unlike that invented by Dodar.

Müller, not considering the phenomena observed in languet instruments, in which low

tones can be produced by very strong impulsion and high tones with a less energetic impulsion, invented his system of compensation, neglecting other peculiarities that ought not to be slighted, and which the celebrated physiologist probably did not ignore.

To-day there are instruments constructed with metallic tongues by which the *forte* and *piano* are produced without in the least altering the sound, and even those with rubber blades have been so perfected that the sound hardly varies from the fifth to the sixth part of a tone in passing from *piano* to *fortissimo*.

The progress of industry, then, has entirely overturned the complicated system of compensation.

Besides, when Müller made his experiments with the larynx of a corpse and observed that sound ascended or descended according as the impulsion of air was more or less energetic, (because the bands extended more or less) he did not consider the influence of life on the membranous tissues nor the principle which says: "*that intensity of sounds in bodies rigid by tension, increases or diminishes according as the tension is more or less strong,*" independent of the energy of the moving agent of the vibrations.

According to this principle, the height of the sound produced by the vocal bands depends upon the increase of tension, and the tone descends as the tension decreases, which is contrary to the theory of Müller, who pretends that in order to produce a *forte* with the same elevation of sound the tension ought to diminish in a greater proportion than the pressure of air increases.

This system of compensation, as we have just seen, is contrary to the laws of physics, for every one knows that a guitar or violin string, or cord of a piano produces a sound as much higher as the tension is strong and *vice versa*.

Dodar, the celebrated physician of Louis XIV, otherwise explained the formation of tones, and made the intensity of sounds depend on the degree of the opening of the glottis.

This is an error, for it has been demonstrated that the glottis can produce different tones with the same opening by simply changing the tension of the vocal bands. He explains the *forte* and *piano* of each tone by saying that the glottis enlarges to let more air escape, and closes that less may escape; that it enlarges as much as is necessary for the

degree of force that one wishes to give, and that it closes as much as is necessary to pass from *forte* to *piano* without altering the tone, and that the quantity of air is of but little importance provided it has the required velocity.

The explanation is truly ingenious, and that it may lack nothing, he considers the transversal diameter of the glottis divided into 9632 parts: but as it is demonstrated that the mouth of a tube cannot enlarge or diminish without variation of tone, Dodar's system falls by its base, as well as Longet's, who also explains the foundation of tones by the degree of the opening of the glottis and the rapidity of air, by supposing that the opening of the glottis can vary sufficiently between each tone to produce the *forte* and *piano* without altering the tone.

If this was true, we should have as a result that the glottis of a bass could produce a greater number of tones than that of a soprano, as it is longer; but it is the contrary.

All theories and systems (ingenious though they may be) invented to explain the phenomenon of which we speak, will necessarily end in error if they have not for their base the fixed principles of acoustics agreeing with anatomy and vocal physiology.

If we take for a base the principle demonstrated by science which says ; that “ *the intensity of sounds depends on the quantity of matter put in motion, and upon the energy with which the sonorous vibrations strike the ear,*” and, if besides, we consider the impossibility of changing the mouth of an instrument, or the tension of a cord without altering the sound, notwithstanding the energy of the agent producing the vibrations, we shall see that to emit the same tone *forte* or *piano*, the tension of the vocal bands and the opening of the glottis ought always to be the same. The impulsion of air only varies, if it is feeble it will produce a feeble vibration of the bands, and a *piano* tone will be the result, if on the contrary it is strong, the vocal bands will vibrate with energy and produce a strong tone. Consequently, we are bound to say: *that the intensity of the sounds of the voice depends upon the energy with which air is sent out across the glottis, and on the tension of the vocal membrane made to vibrate.*

The muscular powers mark the degree of the tensions of the bands, proper to each tone : this added to the influence that life exerts on them, prevents the increase of tension under

a strong impulsion of air as happens to rubber blade instruments which have served to experiment with.

When we began our studies on the physiology of the voice, we were misled by an observation—without doubt not very conscientious—that made us for some time a partisan of the ideas of Longet, and to prevent any one who may have the curiosity to repeat our observations from experiencing the same doubts, we will not pass in silence a fact that can give rise to confusion and doubt if the observation is not carefully made.

Our error began, when at the commencement of a swell we observed a small opening in the centre of the vocal bands, that enlarged as the sound increased in force. This made us believe that contrary to all laws of physics, and by one of those mysterious phenomena of life that science has not penetrated, Longet's system of compensation was exact, as the laryngoscope seemed to demonstrate. The confusion of our ideas became still greater, when it showed us that during the emission of tones in the third register the contrary phenomenon was observed. That is to say, that in the *forte* the transversal opening of the

glottis was small, and that it enlarged in proportion as the sound diminished. However, it is very easy to explain this phenomenon which is not in any way opposed to the physical theory we have just spoken of.

In the first case, the impulsion of air is not sufficient to separate the vocal bands their entire length, and make them vibrate when separated, and it is only the centre that obeys the feeble impulsion of air, but if they are regarded attentively with a magnifying glass, it will be seen that they vibrate their entire length, although it is imperceptible to the naked eye. If the energy of the impulsion of air is increased, they will acquire sufficient force to separate the bands their entire length without increasing their tension, consequently as the number of molecules put in motion is always the same, the sounds will not change.

In the second case, as the vocal bands are naturally separated, and an energetic impulsion of air cannot take place without some resistance at the orifice in passing out, it is evident that they ought to approach each other to allow the air to strike them with the force necessary to produce an intense sound, and that they will separate to allow a certain quan-

tity of air to escape without striking them, and thus weaken the impulsion until it is lowered to the degree necessary to produce weak tones.

The anatomical dispositions of the upper register exact this special modification in the transversal diameter of the glottis: which, like the preceding case, does not in the least alter the tension of the vocal bands. This is the explanation of the phenomenon that could give rise to doubts in a person not attentively observing.

The intensity of tones comprised in the first or natural register, can easily increase or diminish, even in voices that are not educated, for the disposition of the glottis in this register makes it easily obey the greatest or least pressure of air to produce the desired effect.

The result of all we have said then is, that the intensity of the sounds of the voice depends on three inseparable circumstances, viz: *upon the energy with which air is sent across the glottis, upon the greater or less resistance that the lips of the glottis oppose to the passage of air, and lastly, upon the tension of the vibrating membrane.*

These three circumstances explain why it is easier to increase sounds than to diminish

them, when we swell the upper tones of the natural register or those already above this register; for the increasing impulsion of expiration favors vibrations, while diminishing is prejudicial, consequently it is necessary to lessen the expiratory force very slowly and always in the same degree, in order that the lips of the glottis do not cease to vibrate their entire length, otherwise the sound vacillates, and the moment arrives when it ceases altogether and air continues to escape without causing vibration.

As we have seen, the mechanism used to swell a tone could not be more simple. It offers, however, an immense difficulty in practice, and its cause we have not seen explained in any singing method nor in any physiological treatise. The principal professors of Europe, and the few singers who can swell a tone of whom we have demanded an explanation, have not satisfied us either; but our constant observation and proper experience, have led us to discover that the stumbling block consists of the difficulty in regulating the action of the diaphragm during expiration, to facilitate the separation of the vocal bands that takes place during the *diminuendo* of the sound *filé*, by

combining the two actions with the direction given to the column of air exhaled to produce the resonance in the proper place. This operation is difficult to execute, and exacts great care not to change the nature of the conditions of the sound, until all the means are combined and one can pass from *forte* to *piano* without a brusque transition.

We believe we should say that the separation of the vocal bands does not alter the tone, since they always retain the same degree of tension, the object of their separation being to diminish the resistance they oppose to the escape of air, all of which results in the production of a tone of little intensity.

It is a general fault among beginners and artists who do not know how to swell a tone, to strongly contract the muscles of the larynx and abdomen to insensibly lessen the sound; and if it is true that they succeed, it is at the sacrifice of the beauty and duration of the tone; it is forced, does not produce the desired effect, and causes great fatigue, while on the contrary the duration of a *piano* tone should serve as a repose for the singer. This repose is not obtained suddenly without a brusque change, and this, as we have already

said, destroys the effect and homogeneity of the tones *filés*.

In order then to avoid this brusque transition, we must commence the tone as *piano* as possible, increase it slowly and insensibly, and decrease it in the same way before attaining the last degree of force, ceasing the tone when it is seen that a change will take place, or by sustaining it as long as possible in this degree of intensity without effort.

The duration of expiration will be short at the commencement, but it will increase little by little until the highest degree is attained; and until then it is necessary to avoid effort on the part of the pupil to sustain the tone a longer time, and effort reveals itself by the color of the face and the sanguine injection of the eyes and veins of the neck. Such efforts oppose the results sought, and can produce grave consequences in the organ, such as congestion of the vocal membrane which will lead to aphony.

This exercise is simple of itself, but difficult and dangerous to execute; for this reason it exacts prudence and ability on the part of the teacher, and patience and perseverance on the part of the pupil, as has been said, for it

is not possible to accomplish in an hour the work of long days without being exposed to the loss of all.

VOLUME OF SOUNDS.

There is but little to say on the volume of the voice in relation to education, but as volume is often confounded with intensity, it seems to us opportune to signal the difference existing between the two.

Volume of sound is—so to speak—independent of its intensity, for although this depends above all on the energy of the moving agent of the vibrations, and the resistance of the vibrating body, volume has for first cause the force of impulsion and the quantity of matter set in motion.

If, for instance, the force of impulsion is strong, and the resistance weak, we shall have an intense sound without volume. If the force of impulsion is strong and a small quantity of matter is made to vibrate, the sound will again be intense but without volume. If, on the contrary, the impulsion is weak and there is a great quantity of vibrating matter, the sound will have volume and little intensity from all of which we see, that volume of sound de-

pende above all on the force of impulsion, and the quantity of molecules put in motion.

This is for sonorous bodies in general, but the vocal organ possesses the faculty of increasing or diminishing the volume of sounds without changing the quantity of vibrating matter, by enlarging only the vocal tube so that the column of air here contained resounds in the cavity of the mouth, as happens when one sings with the *sombre timbre*.

CHAPTER V.

THE VOICE ACCORDING TO SEX.

THE DIFFERENCES EXISTING BETWEEN VOICES OF THE TWO SEXES, AND CAUSES WHICH PRODUCE THEM.

We said, in the second chapter, that man and woman employ the same process in emitting sounds.

There exists, however, a great difference in the two voices, depending principally upon the dimensions of the organ, which also renders different the conditions of *timbre*, intensity, volume and compass. Both possess the same registers, but while man makes use principally of the first or natural—and the most beautiful—woman can only make use of it to emit a small number of tones, although her larynx possesses the conditions exacted by this register.

This phenomenon—having no importance whatever for the greater number of professors

by whom it is unperceived—cannot escape the attention of an observing man, and exacts an explanation.

We have seen, while occupied with the registers, that the physiological conditions characterizing the natural register are represented by the simultaneous tension of the vocal bands in their length and thickness, and by the progressive closing of the glottis from the back forward. We know, besides, that the fullness and volume of sounds depend principally on the longitudinal dimensions of the glottis. If we consider, then, that the glottis of woman is from the eight to ten-thousandth part of a metre smaller than that of man, and that to fulfill the second condition of the register she is obliged to diminish in length, we shall have for result that the dimensions will be so much diminished that they become insufficient to produce sounds in the conditions belonging to the natural register, besides, the antagonism of the two tensions in length and thickness exacts a stronger impulse than is permitted by the constitution of the feminine larynx.

The anatomical disposition and constitution of the feminine larynx favor the longi-

tudinal tension of the bands, and as the voice in the third register is produced by tension exclusively in a longitudinal sense, this explains the greatest facility for execution and change of *timbre* in this register; for the longitudinal tension provokes obliquity of the bands, and obliquity in its turn, change of *timbre*. During the emission of tones in the natural register, for instance, the bands vibrate perpendicularly to the axis of the trachea, and these vibrations communicate themselves to the column of air contained in the trachea, but at the moment the change takes place vibrations are produced on a plan oblique to the axis, and the sound then resounds in the vocal tube only, that is to say in the space comprised between the glottis and lips.

This difference of *timbre* has led many professors to believe that woman passes directly from the first to the third register, which is not so. Woman sings in the second register, and in the same way that man does, although there is but little difference in the two registers, for the disposition of the vocal tube and the place of resonance are almost the same in one register as in the other.

The facility that the feminine larynx possesses of practicing the longitudinal tension to the most extreme limits, gives it the power of augmenting the number of upper tones as high as *E* and *F* above the *G* clef.

The difference of *timbre* in the two sexes depends on the quantity and quality of the elements constituting the vocal bands.

The muscular mass is less in the feminine sex, the vocal membrane thinner and more transparent, the mucous more delicate, and the consistency and dimensions of the parts constituting the vocal tube are also different. Thus, then, if we remember what we have said elsewhere on the subject of *timbre*, it will be easy to understand this difference, for if the nature and form of the instrument change, the *timbre*—that is to say the number of harmonics—will also change.

There is less intensity and volume in the voice of woman, for these two qualities of sound depend upon the energy of the vibrations and upon the quantity of matter put in motion, and as with her the muscles producing the impulsion of air are more feeble and the vocal bands smaller, it is evident that they

ought to produce a sound less intense and of less volume.

The pitch and compass of the voice differ also in the two sexes. Woman sings an octave higher than man, that is to say that while *A* in the second space of the *G* clef produces in a tenor 870 vibrations according to French pitch, the same tone in a soprano produces double or 1740, although the difference in the size of the two larynx is hardly a fourth part, but as the vocal membrane of woman is thinner than that of man, for this reason she can produce higher tones.

There is less difference in the compass; if man can easily produce more low tones, woman on her side can augment the compass of the vocal scale and execute difficult passages on the highest tones, for without doubt the smaller the instrument the greater facility it offers for the execution of different movements necessary for the production of elevated tones.

The difference existing in the voices of the two sexes depends principally, as we have seen, on the dimensions of the vocal instrument.

The voice of woman, considered from the standpoint of art, offers fewer advantages

than that of man on account of its possessing fewer variations of *timbre* adaptable to all the passions, that will express them with the truth that art exacts.

In another sense "woman," says Gerdy, "has a weaker voice than man: the *timbre* is sweeter, more harmonious and suave; it is a charm given her by nature to move us, soften us, bewitch us, vanquish and subdue us. It seems that the fibres of our hearts are always in unison with it."

CHAPTER VI.

THE VOICE IN ITS DIFFERENT STAGES.

THE VOICE DURING INFANCY.—THE VOICE DURING PUBERTY OR CHANGE OF VOICE.—ITS MANIFESTATIONS, CAUSES, AND PRECAUTIONS THAT SHOULD BE TAKEN.—PHENOMENA.—VOICE OF ADULTS.—DECADENCE OF THE VOICE.

The means possessed to day for the study of nature's phenomena open a wide field to the student and observer, and permit him to penetrate even the most fathomless mysteries. It is not many years ago that the mechanism of the voice seemed to some an impenetrable mystery; but the discovery of the laryngoscope has lent its aid to science and explained the mystery in an entirely satisfactory manner. It is, then, to the laryngoscope that we owe the explanation of the phenomena of the voice.

The disagreeable cry of an infant, as soon as it opens its eyes to light, is the expression

of a sentiment, a need that the maternal instinct readily comprehends. The constitution of the vocal organs does not yet permit it to make its wants known in any other way, as the organs do not yet possess any of the conditions necessary for the production of the voice, but in proportion as it enters into relations with exterior life, its organs develop and acquire the conditions proper to phonation.

Until the age of puberty—which varies with the climate, the constitution of the individual and his manner of living—there exists but little difference in the voices of the two sexes, but when this moment arrives, a great revolution takes place in the organization, and the differences become noticeable. The voice of the boy begins to take the character of the voice of a man, and that of the tender young girl the character of the voice of a woman.

CHANGE OF VOICE.

Change of voice—the supreme moment that the great revolution which completely transforms life physical and moral—takes place sooner in woman than in man, and in warm countries sooner than in cold regions.

In the former it takes place at the age of eight or ten years, in the latter about the fifteenth year, and in temperate climates at an intermediate age.

Without further considering the modifications that certain organs so closely connected with those of the voice undergo, we will simply say that the signs of puberty reflect themselves in a more pronounced manner on the moral side of woman than man. The little innocent girl, whose childish joys did not before permit her to think of other things than her toys, the greatest charm of which was to make a noise and to be always in motion, now hides herself in solitude sad and dejected, to secretly indulge in the dreams and fancies that interior sensations hitherto unknown to her have awakened in her imagination.

The modifications are less sensible in her voice than in a masculine voice, and sometimes imperceptible, especially if she is not studying singing and does not use her voice too much in speaking. The diapason of the voice lowers from one to two tones, and acquires more force and vigor.

The change is always anticipated in woman notwithstanding the conditions of the climate

in which she lives, and among the middle class it sometimes takes place earlier than among the poor, which, according to Hippocrates, is on account of the manner of living. "The theatre, balls, and reading novels," says Doctor Fournié, "are also causes, which, by exalting the sensibilities, provoke precipitancy in the movements of nature."

With man the change is less difficult than with woman, it takes place in a less sensible manner, but the modifications undergone by the voice are more perceptible, especially in the *timbre* and diapason.

These alterations are caused by the organic modifications that the vocal bands and their moving agents undergo. The vocal membrane which was before thin, elastic and transparent, acquires more consistency, and we now see it less diaphanous, less elastic and thicker, which necessarily affects the state of the voice. This modification of the integrant parts of the vocal organ is ordinarily accompanied by considerable inflammation, in which case the voice becomes completely extinct until the physiological work is ended, when it reappears with characters more or less good according to the degree of perfection that the organ has acquired.

The modifications experienced by the moving agents of the vocal bands in their form and dimensions are not less considerable; for during the period of the change all the constituent parts of the larynx acquire double the dimensions they had before. This augmentation perfectly explains the modification undergone by the *timbre* and diapason, the latter in man descending an octave. When children do not sing, the transition is sometimes less sensible, but if on the contrary they do sing, it often takes exaggerated proportions; the voice becomes hoarse and also uneven, until it produces a high instead of a low tone and *vice versa*; at other times one wishes to sustain a tone that has been well taken when suddenly it jumps a third or fifth higher or lower, at other times still it produces complete aphony.

The period of the change can continue, according to some physiologists, from six months to three years. During this time it is much better to suspend all vocal studies, at least during the first year and the rest of the time continue them with great precaution, for the physiological work that is operating in the larynx can occasion throat difficulties and sometimes complete loss of voice. This may hap-

pen even when one does not practice singing, and on the contrary it sometimes happens that some individuals find themselves possessors of beautiful voices after puberty, who before had not the slightest indication.

The phenomena that take place during the change do not always follow in the same order, we see them under different forms, sometimes the voice becomes veiled, at other times hoarse, etc., etc., and it does not acquire stable, sonorous conditions until the development of the larynx is entirely completed, and this takes place at seventeen or eighteen years of age in woman, and from eighteen to twenty in man.

We would willingly give here the curious opinions of several physiologists as to the causes of the change and the care that should be taken by young people during this period, but we are prevented by the fear of causing prejudice while seeking to avoid it, not knowing into whose hands our book may fall.

THE VOICE OF ADULTS.

When once the first period of the change of voice is passed, all the parts constituting the vocal organ continue to develop slowly, and the voice little by little acquires force and com-

pass to the age of twenty-three years in woman, and twenty-five in man, a time when physiological work ceases altogether. It is then that the pupil makes the most of his voice, for the organ being in the fullness of its faculties more easily obeys the will and consequently executes with more precision. It is not until the ages respectively indicated that ossification of the cartilages of the larynx commences. This operation has sufficient duration to allow the pupil to possess the theoretical and practical knowledge exacted by the art of singing. This destroys the general belief existing among ignorant professors that it is impossible for a young man to become a singer, who has not exercised his voice before he attained twenty-five years of age, because the rigidity of the organs will not permit it.

The ages of twenty-three in woman and twenty-five in man are certainly not the best to commence vocal study, but neither do they offer all the difficulties believed in the education of the organ if it is done with intelligence, for the voice at this age has the advantage of not being exposed to other modifications than those imposed by study.

Voices whose education was begun after the entire development of the organ, are more solid and last longer, for they can be preserved to an advanced age if they have been well educated.

A man's voice lasts longer because his nature does not undergo the alterations to which woman is subject, but it is impossible to determine the period of its existence, as it varies according to the vigor of the person and his mode of life. The abuse of tobacco, spirituous liquors and other abuses that enfeeble certain organs so intimately related to those of the voice, are also causes that powerfully contribute to the extinction of the vocal faculties. The first symptoms of decadence are the extinction of the *mezza-voce*, the trembling of high tones, and difficulty in producing the upper tones of the natural register (called chest.) The disappearance of the *mezza voce* is the result of loss of the transparency of the vocal membrane, it becomes thicker and attaches itself to the contiguous ligaments from which it cannot detach itself but by a great impulsion of air; the trembling of the high tones results from lack of energy in the contracting muscles to maintain the

necessary rigidity in the vocal bands, and finally, difficulty in producing the upper tones of the natural register is caused by the fact of the muscles having become too weak to make the effort necessary to produce these tones.

These symptoms, that appear slowly and progressively in man, present themselves sometimes suddenly in woman, revealing themselves by a hoarseness that lowers the diapason of the voice and alters the qualities of *timbre*.

Man preserves certain faculties longer and loses them slowly while they disappear suddenly in woman and at a less advanced age. The suppression at a certain age of a certain phenomenon in woman produces an organic modification in the larynx, it becomes congested, the mucous that recovers it is of a reddish color, the circulation more active, and the mucous secretions more abundant, the cartilages acquire more consistency, the vocal membrane is thicker and loses its diaphanous quality. All these symptoms explain the sudden change in the feminine voice.

CHAPTER VII.

CLASSIFICATION OF VOICES.

BASS.—BARITONE.—TENOR.—CONTRALTO.—MEZZO-SOPRANO.—SOPRANO.—INTERMEDIATE VOICES.—WHAT SHOULD BE THE BASIS OF A GOOD CLASSIFICATION.—CONSEQUENCES OF AN ERROR IN CLASSIFYING A VOICE.—INDICATIONS BY WHICH THEY MAY BE RECOGNIZED.

If the classification of voices according to the individual is of great importance to art in general, it is not less so in the education of voices. But in order that the classification may respond to the needs of art, it should be based on the qualities by which sounds are distinguished, and which are, the compass, *timbre*, intensity and volume. If the compass only is considered in the classification, it is evident that there will be serious errors committed, for it frequently happens that we notice in uncultivated voices, and even in voices badly educated, baritones with the compass of a

tenor, and tenors finding difficulty in singing higher than a baritone. This exceptional circumstance is not sufficient to qualify the first a tenor and the second a baritone. The same note in both differs in *timbre*, volume and intensity : if for example we take *E* fourth space *G clef*—a tone belonging to both voices—we shall find that the tenor easily emits it with good quality of *timbre*, as intense and with as much volume as is permitted by the vocal membrane set in motion without effort, for the glottis preserves almost its entire length. The baritone produces the same tone, but it is necessary for him to make a great effort, for his vocal bands being longer must have a stronger tension, and this greater tension will necessarily modify, as we have already said, the qualities of *timbre*, intensity and volume which cannot be the same as in the tenor. The same difference will be found by comparing the contralto with the soprano. In view then of the conditions of the compass, *timbre*, intensity and volume, we divide the voice into six classes, three for each sex, viz : bass, baritone, and tenor, belonging to the masculine sex ; contralto, mezzo-soprano and soprano, belonging to the feminine.

The bass voice is the lowest, and its sonorous qualities depend upon the considerable thickness of the vocal membrane, the great length of the vocal bands, and the resonance of sounds in trachea. The first and second conditions alone suffice to produce low sounds, and thus influence, as we know, *timbre* and intensity. As to the resonance in the trachea, we have already said that it takes place while the vocal bands vibrate on a plane perpendicular to the axis of the trachea, and also that the excessive tension of the bands give them an oblique direction from the front backward, and, as the length of the vocal bands in a bass is sufficient to run the full compass of the voice by combining the two tensions in the sense of length and thickness, besides the closing of the glottis at the back without hardly rendering the obliquity of the bands perceptible, we find why sounds resound in the trachea. This also explains why it is so difficult for them to pass to the second register. Those who become able to make use of this register extend their voices to *F*.

The baritone voice is distinguished from the preceding by its higher diapason, its *timbre* and less volume and intensity, for the vocal

bands of a baritone are shorter and the vocal membrane thinner.

The same note given by the bass and baritone will have less volume in the latter, because the bands are shorter and thinner, and should be more extended; and this tension diminishes the resistance that the passage of air should meet. Thus, then, as we have seen that the volume of a sound depends upon the resistance that air finds in passing out and the energy of impulsion in relation to the quantity of matter set in motion, the result will be that the note given by a baritone should have less volume than the bass.

The upper tones of the natural register are easier and more intense in the baritone, because the circumstances that we have just indicated are favorable in a baritone to a more facile production of these tones.

All that we have said when comparing a baritone with a bass can be applied to a tenor compared with a baritone.

The larynx of a tenor is smaller, the glottis shorter, the vocal bands thinner, and the vocal membrane thinner and more transparent, which explains the possibility of producing higher sounds and at the same time of less volume.

The longitudinal difference existing between the vocal bands of a bass and those of a tenor, explains why the tenor finds greater ease in the passage of the registers, and why there is but very little difference in the qualities of *timbre* of the three registers.

The contralto voice is the lowest of the feminine sex, for contralti possess a larynx of more volume, their vocal bands are longer, and the vocal membrane somewhat thicker. Their organ is more visible from the exterior than in the soprano on account of the predominance of the *antero-posterior* dimensions of the thyroid cartilage, the sides of which project at a very pronounced angle. The vestibule of the glottis is also more prolonged.

What we have said on the subject of the change of registers in a bass can be applied to the contralto, for this reason so much difficulty is found in passing from the first to the second register, and the *timbre* is so different.

The intermediate voice between the contralto and soprano is the mezzo-soprano, higher than the first and lower than the second. It corresponds to the baritone voice in man.

The soprano marks the limit of the vocal scale in the upper tones on account of the smallness of the larynx.

The sides of the thyroid cartilage of the soprano form an angle sufficiently obtuse, the vestibule of the glottis has a rounded form, the vocal bands are very short, and the vocal membrane very thin, of great transparency and very elastic. The compass of the soprano is generally the same as the tenor, although she sings an octave higher for we have seen that a soprano tone produces double the number of vibrations that the same tone given by a tenor produces. The condition of her organ, so favorable to the production of high tones, permits some soprano to extend their voices a third or a fourth higher than the tenor, but generally she runs the two octaves of *do*.

Besides the voices that we have classified, there are intermediate voices that take different names according as they partake more or less of the principal voice. Thus, there is the *basso cantante*, between the bass and baritone, that is to say, a voice higher than the first and lower than the second. For this reason we hear of *mezzo-contralto* or *contralto-mezzo-soprano* according as the voice partakes more of the contralto or soprano. There is also between the baritone and tenor a voice called

to day high baritone, and it is the same as the ancient *tenor basso*.

Art cannot strictly admit this denomination of voices that in reality signifies nothing, and as the difference separating them from the principal voice is so slight, and one by study can easily acquire one or two high or low tones, and as the extreme notes are seldom executed in singing, we believe the professor should try to perfectly characterize the intermediate voices by making them enter into the general classification; and to do this he should extend the scale towards the lower or higher sounds according to the leaning and adaptability of each voice.

The classification of voices in an uncultivated state presents some difficulties, and the professor who acts lightly in this matter exposes himself to the commission of grave errors. There are those who believe entirely the contrary, and who even dare to pretend that it suffices to simply examine the parts constituting the vocal organ, to decide whether an individual possesses a voice in such or such conditions. Such a belief cannot be seriously entertained, and reveals a stupid charlatanism on the part of the proclaimer.

But let us put these digressions aside and return to the principal subject.

We said that the classification of voices in an uncultivated state is very difficult. It is true, for the numerous faults that they ordinarily possess can easily deceive the inexperienced master, and for this reason it is necessary to observe carefully the pupil, if the characters that distinguish each voice according to the class to which it belongs, are not sufficiently manifest, as to leave no possible doubt. "While there are men effeminate in their physiognomy or their manners but who in reality are not," says Señor Antonio Cordero in his *Escuela completa de canto* "there are also voices that are thin and *too white*, that in reality are not, because the conditions do not always proceed from natural sound, but from a wrong emission, and in this case the true sound, which is ordinarily strong and manly, often remains hidden."

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"Virgin voices are sometimes heard of great compass, and from this fact only they are given names that their quality rejects, and mistakes are also made in a contrary sense if they have small compass. I would say then,

that when a voice is tried, the following should decide the professor in classifying it: the kind of sound, his particular physiognomy and special character" or as we have said he should consider the diapason, volume and intensity, three conditions by which we distinguish one sound from another.

"An uncultivated bass voice" continues the intelligent professor, "can belong to this class though he easily attacks upper *G* and can only go to *B* natural second line of the *F* clef. A baritone will not cease to be a baritone if he easily sings *B flat* of the tenor and even lower *G* of the bass, and a tenor can give but high *G* without being for that reason a baritone, etc."

"The errors committed by professors deceived by the special compass, either too great or too small, of uncultivated voices, have produced very grave consequences with those who have a passion for the exercise of singing, and have prevented some from following a career that could have gained, perhaps, both fame and fortune, and who would have honored their country and their director."

The gift of divining, so to speak, the excellencies that a voice can hide under so great a number of faults that it does not

appear serviceable, does not belong to every one.

The celebrated contralto and professor of singing Eugenia Garcia owed the discovery of her voice to the intelligence of our respected friend and eminent critic M. de la Madelaine, who having heard her sing with a little sympathetic soprano voice, and divining a treasure under such slight faculties presented her to Manuel Garcia, who in few lessons transformed her to a contralto, and rendered her one of the most distinguished singers of our time.

In our professional practice we have often had similar transformations. They are not miracles, for as soon as the voice commences to enter the normal conditions of phonation, it clearly shows to which class it belongs, and the professor must be very ignorant not to see that which is as clear as light.

A thousand similar examples could be cited, but it seems to us useless, and we will end this chapter by giving a simple sketch of certain signs that can guide in the classification of uneducated voices.

That of a soprano shows some flexibility, and some disposition for execution, and its

force is principally in the upper tones which are given without great effort.

A mezzo-soprano voice appears sometimes rigid, the lower tones sufficiently full, and there is difficulty in the upper tones, but little execution, sufficient force in the medium tones and a certain dramatic character.

The contralto, with rare exceptions, has not much facility in the upper tones, which are generally of a character and quality different from the rest of the voice, while the lower tones are facile, round and of a male *timbre*; it rarely reveals a tendency to execute.

The tenor shows facility in the tones *F* and *G*, and he attacks them with force and ease, but the lower tones *C* and *D* are very feeble.

It is sometimes very difficult to recognize baritones for it is very easy to confound them with tenors if they are high, and with bassos if they are low. They are distinguished however from the tenor by their great ease in taking the low tones which have more volume, and they show difficulty in continuing to ascend higher than upper *E*. The force of their voice rests principally in the tones from low *C* to upper *E* which have more *timbre* and volume than the tenor.

The bass and low baritone are also sometimes confounded, and the first distinction is that the bass has more facility, more force and more volume than the baritone in the inferior octave, and that it is difficult for him to attack the higher tones, and on the contrary has ease and volume in the lower tones.

If, in spite of all, the bass easily takes upper *C*, *D* and *E*, and one sees the possibility of his continuing higher, there is reason to think he may be a baritone.

All these signs may vary infinitely and are not at all infallible. For this reason before classifying a voice, it is better to dispose it to enter into the normal way of phonation, and observe the principal characters that it presents and to which side the preference leans.

In this way one is less exposed to errors, and the credit of a professor will not find itself compromised.

CHAPTER VIII.

SPECIAL VOICES.

THE VOICE OF EUNUCHS.—THE VOICE OF MR. DUPRAT.
—THE FEMALE TENOR.

The origin of eunuchs is attributed to different causes by different writers. Some believe them to be the object of a cruel vengeance, others believe that jealousy was the instigator of the idea of creating eunuchs, in order to have faithful guardians for women. Marcellin attributes this diabolical invention to Semiramide carried away by a blind passion, but this idea is contradicted by several, who prove that before Semiramide there were already eunuchs among the Egyptians.

Nebuchadnezzar made eunuchs of his prisoners, and in Greece the priests of Diana made themselves eunuchs before taking the priestly investiture. The salutary influence of christianity on customs diminished this bar-

barity, but did not succeed in stamping it out until after several centuries. The *role* of eunuchs began to change and the *castrati*, *spadones* and *thlibiæ*—names that were given them according to the form of the operation—were utilized in public festivals, and ended by being an important element in the catholic temples of Spain, Italy and France, where this barbarous habit reigned down to a period not very remote.

The voices of *spadones* and *thlibiæ*—known lately under the general name of *castrati*—were used later in theatrical representations, and some of them attained, such perfection in the art of singing, that they were spoken of as models by celebrated professors. Their rare aptitude for the divine art opened the doors of palaces to them, and loaded them with riches and honors to such a degree, that several—Farinelli among them—obtained such prestige at court as to possess great influence over the destinies of countries.

Doctor Fournié says that during the Crimean war he had occasion to examine eunuchs at Constantinople, externally only, as the laryngoscope had not then been invented. He says that their diapason is never as high as

that of children, that it is more or less elevated depending upon whether the operation was performed before or after puberty. The vocal sound has more volume than in children but has never the force, energy or power of the voice of man. As to its *timbre*, it does not resemble the voice of man, woman or child.

The larynx of eunuchs, he adds, is smaller than that of man, the cartilages are softer, less developed and can be easily depressed with the finger. There is an evident delay in the ossification of the cartilages.

If we think of the differences existing in voices according to the constitution of the larynx, as we have already seen, we shall understand the characteristic qualities of the voices of these unhappy beings, and we shall also understand their great aptitude for vanquishing the difficulties of singing,

THE VOICE OF MR. DUPRAT.

The contralto or soprano voices that have been heard in catholic temples of Europe, were voices of eunuchs, or of men who, by force of art, had become able to imitate the voice of woman in its full compass by means of the *falsetto*. It is the voice of *falsetti*, purely

artificial, that sometimes issues from the larynx of a robust bearded man. The annals of art have no record of the phenomenon of natural soprano voices among the masculine sex. A singular case, which is perhaps the only one of this kind, is Mr. Duprat so well known in Paris, who, without any artificial means whatever, and without having received other vocal education than that belonging to the feminine sex, naturally sang with a very beautiful, clear, fresh, flexible soprano voice of great compass. On account of its being natural, this vocal rarity astonished physiologists, and has been a constant object of study and observation, and Mr. Duprat himself has always been ready and willing to aid them, in spite of the annoyances caused him by the desires of some to study, and the mere curiosity of others.

The examination of certain exterior organs showed nothing in particular that could indicate a small development of the larynx, nor did his anatomical conformation.

Mr. Duprat was married when very young, and soon became the father of a family. When we became acquainted with him, he was about thirty-four or thirty-five years of

age, and he himself told us that his voice had not altered in the least during twelve or fourteen years, except as it improved by study by gaining force and volume, but always in the conditions of a soprano.

The dimensions of his larynx are very small, the glottis much reduced, and the vocal bands very thin in their anterior part and somewhat larger in their posterior part. This great difference makes the bands join at their largest extremity when they emit a sound, and this so reduces, the dimensions of the glottis that it can only produce elevated tones. The sides of the thyroid cartilages are very small, flexible, and without any sign of ossification.

The small interior extension of the larynx, and the fear of abusing Mr. Duprat's amiability prevented our making as thorough an examination as we could have desired, we observed, however, that the conformation of certain parts of the larynx was not exactly similar to the larynx of woman.

It is without doubt on account of this difference, that the voice presents a certain quality that leads one to guess something of the masculine sex. Perhaps it is the prejudice resulting from the idea that it is a man singing,

but this is not a reason for not comprehending that after what we have said of the conformation of this exceptional larynx, it ought naturally to produce sounds corresponding to the feminine voice.

THE FEMALE TENOR.

A phenomenon no less rare than the one just spoken of, was the apparition on the operatic stage of a female tenor in whom all the papers were interested a few years ago. The success obtained by this woman in playing tenor *roles* was not very satisfactory, for if her voice possessed all the qualities of a tenor, her vocal and stage education added to her feminine manners, which did not disappear under her masculine costume, could not charm the attention of the public.

A few days after her appearance in the theatre she was engaged for a *café chantant* in the Latin quarter of Paris, where she was the delight of students and *grisettes*. It was there that we were led by curiosity to hear her, and we also appreciated the vocal conditions of the female tenor.

The voice of this young lady was strong, extended, somewhat flexible, of clear *timbre*

and sometimes quite sympathetic. The natural register, from *B* natural below the *G* clef, had as much volume as the generality of real tenors up to *E* fourth space, she attacked each tone naturally and without effort, sometimes sung *F* and even *F* sharp, but with difficulty and by excessively opening the mouth. These tones were disagreeable. She used the sombre *timbre* but little, she either did not know how to use it or it was not necessary for the kind of songs sung in certain *cafés chantants*. She made the change of register from middle *D* to *E* when she sang a serious piece, the *timbre* was then more agreeable, and she easily sang *G*, *A* and *B* flat which had the qualities of a tenor, although the tones, still higher, often resembled a feminine voice.

She completely ignored the art of using her voice well. The features of her face, and even her manners were feminine. Causes independent of our will prevented our making an interior examination of the vocal organs, which externally showed no peculiarity to the naked eye.

CHAPTER IX.

VOCAL ILLUSIONS.

VENTRILOQUISTS.

However insignificant certain facts may appear at first thought, they should not pass unperceived by the student, especially when the object of his special study is knowledge of vocal mechanism. Be the importance of an object great or small, science does not stop before it, but studies all phenomena however common they may appear to those lacking the necessary instruction to appreciate the transcendency, usefulness or necessity of understanding these phenomena. Those that we are about to explain have no importance whatever, it is true, in the education of the voice, but the man who consecrates himself to this difficult study ought to ignore nothing relating to it, in order to be able to explain, if

asked, certain phenomena which appear incomprehensible. How many times vocal illusions deceive the inexperienced professor and make him lead the voice by a way not intended by nature! This results in faults of emission, and accounts for there being so few voices well educated which responds to the exigencies of art.

For the singer and conscientious artist there is nothing trivial in anything relating directly or indirectly to the voice. For this reason we have not been willing to pass certain phenomena in silence to which no physiologist, before Mr. Lachapelle, gave the attention they merited, as much by their mechanism as by the influence they have exerted at certain times on certain beliefs, and even on the destinies of some ancient people.

We, who live in the century of positivism, in a century having no faith either in predictions or witchcraft, in a century agreeing with nothing but truth over which the torches of science have shed their light, ought to make known a phenomenon already explained by modern physiology, and which has given rise to so much mystification.

Ancient authors, who were interested in ventriloquists, have spoken of them only in a mysterious manner or told amazing stories.

The eastern astrologers and conjurers abounding among the Jews, were merely clever ventriloquists, who took advantage of the candor and ignorance of the superstitious for their own profit.

Such was the abuse and abundance of necromancers among the people of Israel, that those following the profession of conjurer or magician were punished by death,

Christianity came to overthrow these false prophets, and the enlightenment of our century admits of neither conjurers nor enchanters.

The phenomenon of which we speak is attributed by some to the invention of the devil, by others less credulous to a particular voice, the mechanism of which they completely ignore.

Before Mr. Lachapelle, no other author, as we have already said, had interested himself in this phenomenon that perhaps our readers have been able to appreciate at the theatre, circus, or spiritualist reunions, and they have also observed how complete is the illusion. In fact ventriloquism is not superhuman and is

not an individual speaking with the abdomen, as the etymology of the word would seem to indicate and as is generally believed, since it is impossible to speak with the abdomen.

Authors, who later interested themselves in this study, were more careful, but their opinions are extremely varied. Some sustain that ventriloquists produce the voice at the moment of aspiration, and others, for instance Müller, that the voice forms during aspiration. The latter seems the most natural, for otherwise it would be necessary to admit the existence of a second larynx under the natural larynx, placed in such a way as to be able to produce articulated sounds at the moment of aspiration. As this special organ does not exist, and as the larynx of ventriloquists do not present any extraordinary peculiarity, it is impossible to admit the opinions of Amman, Nollet, Haller, Masson and others.

For us, without a doubt, the voice of the ventriloquist is produced at the moment of aspiration, for a few years ago we possessed the faculty of imitating, with great exactitude, the sounds of several instruments, and by force of exercise we could also pronounce several words like a ventriloquist merely for pleasure,

to the great amusement of our college comrades. At that time we had no idea whatever of what a ventriloquist was, but after having heard at the theatre a *cléver* conjurer, who perfectly imitated the singing of some birds and the voices of certain animals approaching or receding, according to the farce played by the conjurer, we were so surprised and our young imagination so vividly impressed, that we should have thought ourselves perfectly happy had we been able to do what that man did.

The sound of the clarinet, hautbois, violoncello, horn, guitar, harmonium, the noise of certain mechanical instruments, and the voices of persons speaking or singing in the distance, etc., etc., all were in a short time easy for us to imitate, and more than once our *grand orchestre* concerts were the charm of family reunions, and enraged our aged professor of philosophy, who could not imagine from whence came that infernal concert of dogs, cats, chickens, canaries, etc., that raised a tempest with the pupils, and ended by the professor becoming angry and dismissing the class before the time, which was our object.

The articulation of words, imitating the voice of a person at a distance was less easy,

and for this reason the illusion was less perfect when we spoke, and after reaching the age of reason and beginning serious study, we became unable through lack of practice.

All the noises, voices, and sounds that we once imitated were produced by contractions of the larynx aided by the special disposition of the tongue exacted by each sound. The lips remained immobile, sometimes completely closed, sometimes naturally parted, the column of air resounding in the trachea, or the nasal cavities according to the necessity.

It is utterly impossible to explain in detail the particular mechanism of this phenomenon, as we cannot make use of the laryngoscope.

The eminent physiologist, Doctor Fournié, to whom we owe the greater part of our physiological knowledge, explained by a very exact reasoning, the process used by ventriloquists to render the illusion complete. The following is his explanation: "In ventriloquism we must consider two things, 1st, how ventriloquists contrive in a general manner to produce the illusion of a sound at a distance, 2nd, search in the organism for the parts which produce this illusion."

“ In a picture representing a landscape, the objects placed in the foreground are drawn in proportions relatively larger than the objects placed in the background ; at the same time the form of the latter is less distinct, they are as if plunged in a cloudy space in which all the details melt, and it is by these characters that our eyes distinguish objects at a distance from those near. That which the painter does for the eyes should be done by the ventriloquist for the ears. Distant sounds seem higher to us, they are weaker and the words less distinctly articulated, consequently he is obliged to force himself to produce with his glottis these elevated, weak, thin sounds like those coming from a distance.”

“ This is the way done by operatic choruses placed in the wings, they imitate the singing of persons at a distance, but this only is not sufficient to produce the illusion.”

“ Our organs of sensation mutually aid each other in giving us a complete notion of objects. The ear, for instance, can judge of a sound loud or weak, simple or composite, low or high ; but when it is a question of appreciating the distance or direction of a sound, the hearing becomes insufficient, as it can only

judge of distances by the intensity of sounds, and this sign is evidently deceiving. In order to fully appreciate distance we need the help of sight, for it is by seeing the sonorous body itself that we can determine whether a body is near or distant."

"When hearing has not the aid of sight, the judgment remains uncertain, and it suffices to fix our mind on a certain point to be persuaded that the sound really proceeds from that point. It is on this imperfection of the sense of hearing unable by itself to appreciate distances, that the second condition necessary to complete this illusion is based. The ventriloquist must not only produce elevated sounds, but he must also hide their origin by the immobility of the parts aiding in their emission; in this way the ears of the spectators, not being guided by the sense of sight easily accept the direction indicated by the intelligent mimicry of the ventriloquist."

"To satisfy the first condition, the ventriloquist generally takes the octave of sounds employed when in ordinary conversation, and as the sounds he produces should not be too intense nor too voluminous, he gives very small dimensions to his glottis. The oblique

and vertical fascies of the thyro-arytenoidian muscles approach by their contraction, the vocal bands at the back on a great extension, in such a way that the passage they circumscribe forward may be very small. This is for the production of sounds."

"To disguise the origin of the sound and give it a muffled *timbre*, the ventriloquist cedes but very little air; he exhales while *holding* his respiration, this *retained* exhalation demands a certain effort. In this way the air is not violently thrown out, and the sonorous vibrations are, so to speak, imprisoned in the interior of the air canals. For the same reason the base of the tongue is carried backward, the epiglottis is applied to the orifice of the larynx; the mouth is almost entirely closed, and the lips leave a small opening for the passage of air and the possible articulation of words. These are formed by the anterior part of the tongue, the base of this organ being strongly contracted below and at the back. As a result, articulation is not as perfect as in ordinary speaking, but this imperfection contributes to the illusion."

"The ability to speak as a ventriloquist is not the result of a particular conformation of

our organs : man can by practice succeed in easily producing this illusion."

This is also our opinion based on results obtained by us at another epoch.

THE MARIONETTES.

The mechanism of the voice of the marionette has no importance or application, as we have already said, in vocal education, it is uniquely an object of amusement, but since physiologists as eminent as Abbe Lachapelle have given attention to it, we ought not to pass it in silence.

This vocal phenomenon—the invention of which is attributed to the Austrian colonel Baron Mengen—is merely the production of a particular voice resembling that of a small child attributed to a doll, that the illusion may be more complete.

Our readers have without doubt, witnessed this innocent spectacle, very much in vogue among conjurers and circus clowns to give gayety to their representations, and which consists of conversation between a man and a doll, throwing in here and there *bons mots* which excite more or less laughter according to the wit of the executor.

This special ability, perfectly possessed by two of our friends, once charmed us, and to day procures us an object of study.

The mechanism made use of by our friends is exactly like that described in several treatises on vocal physiology, and does not in the least resemble that employed by ventriloquists as Mr. Lachapelle, as well as others, seem to suppose, who have not taken into consideration certain peculiarities that can be appreciated by simple sight; such as the enlarging of one side of the face, the turning and outward projection of the lips, and a more pronounced movement for articulation. But those adopting this as a speculation understand perfectly how to hide these peculiarities, by fixing the attention of the spectators on the doll by means of movements that they make it execute.

The man's larynx takes no part whatever in the production of the marionette's voice. The ability consists in being able to form an artificial glottis with the aid of the tongue, the inside of the cheek and the teeth of the same side of the upper jaw.

The characters of the sound produced by this imperfect glottis, are not exactly those of

a child's voice, and articulation is not quite perfect, but all the special peculiarities distinguishing them from the human voice are precisely those which contribute most to render the illusion more perfect. It is an analogous process employed by those who imitate the singing of birds, the sounds of musical instruments, etc., etc.

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