glands of the lymphatics in the predisposition to scrofula. But we draw within the pale of speculation, where we ought not to venture except in conjunction with nicely detailed facts from careful observation.

We made the preceding observations in the Meath Hospital, where every facility was kindly offered to us in our pursuits by Doctor Stokes and by Doctor Graves, to whom we are indebted for the liberty of publishing the cases we have detailed.

EXPLANATION OF PLATE II.

- a.* The fibres alluded to generally in the several cases.
- b.* Those of them with adherent globules, spoken of in the case of Bryan.
- c.* Refers to the composite globules mentioned in the case of Farrell.

The groundwork of the plate represents the general appearances of tubercle, taken from the matters of cough.

(To be continued.)

ART. II.—*Treatise on Congenital Club-foot*. By Dr. JULES GUERIN, Directeur de l'Institute Orthopédique de la Muette, Paris.*

[Translated from the French by S. LENOX L. BIGGER, M.B., T.C.D., L.R.C.S.I., Surgeon to the Adelaide Hospital.]

THE last discussion at the Academy has proved that scientific men are not yet satisfied with respect to the etiology of conge-

* At the *concours* for the great surgical prize in the Académie des Sciences, the following report was made on this paper :—" M. J. Guérin a encore établi l'existence d'un ordre nouveau de pieds-bots congénéaux produits par la retraction musculaire convulsive pendant la vie fœtale. Cet ordre de causes dont l'origine sera démontrée plus bas, offre des caractères qui ne permettent pas de les confondre avec les causes qui produisent d'autres espèces des pieds-bots congénéaux."

nital club-foot. All the doctrines proposed from the days of Hippocrates to our own, have been, one after another, placed in the seat of honour. The doctrines of faulty positions of the fœtus, mechanical pressure, primitive deformities of the bones, arrests of development, and of the predominant action of certain muscles, have found their supporters and opponents. Might it be that, as sometimes happens, each of those doctrines was true within certain limits, and as many persons who took part in the discussion endeavoured to establish, that congenital club-foot might depend alternately on the different causes which had been assigned to it. Far as I may be from absolute opinions, I am still forced, by the evidence of facts, to reject this mixed doctrine, at least in its pretensions to introduce different and totally opposite influences, such as have hitherto been adduced, to account for this malformation, as the essential causes of congenital club-foot. No doubt, the present epoch is one in which, in the greater number of medical questions, all kinds of theories may take possession, with some appearance of foundation, of the same facts, because these facts are only seen at a distance, and superficially examined. But as soon as observation and analysis have discovered their elements, and determined their number, their differences and relations, then the false theories, which only rest on vague generalities, or on more or less ingenious hypotheses, fall to the ground in order to leave truth in possession of the profound and multiplied results of keen observation. Thus, every critique on false theories, becomes useless, for the demonstration of the truth carries at once the criticism and condemnation of the error. I shall not now, therefore, discuss the value of the different explanations by the aid of which authors have endeavoured to account for the formation of congenital club-foot. I shall be satisfied with explaining the etiology which has been suggested by the observation of material facts, and which appears to me capable of resolving all the difficulties of the question. If this theory be true, it will be well to avoid an useless discussion, which could

only substitute one hypothesis for another; but let it not be deemed true unless it be consistent not only with the collection of facts, but also with the whole of the elements composing these facts, and if it cannot also explain the combinations and varieties of every kind which they can produce.

I. OF CONGENITAL CLUB-FOOT, WHEN OCCURRING ALONG
WITH OTHER ARTICULAR DEFORMITIES IN MONSTERS
AND IN THE FŒTUS.

Whilst seeking to arrange and study congenital articular deformities from their origin, that is to say, in the fœtus itself, I was struck with this fact, that they are marked, developed, and grouped together in very considerable number in certain monsters, in whom the brain and spinal cord are deficient, or even in those where there are notable alterations and displacements of these organs. I have met with, and described in my paper presented to the Academy of Sciences, a certain number of acephalous monsters with complete spina bifida, in which all the deformities which occur in the articulations were to be found collected together, such as deviations of the spine, luxations of the jaw, the femur, the knee; luxations or subluxations of the elbows, wrists and ankles, club-feet and hands, in fine, displacements more or less extensive and complete of all the articular surfaces. Accompanying this first general fact was to be found another not less general or less distinctly marked: it was this, that all deformities, when carried to the greatest degree on both sides, were accompanied by a general retraction of the muscles going to the altered parts, to a very considerable extent, and the deviations took place in the direction of such retraction. This double fact of deformities of all the articulations and general muscular retraction cannot be accounted for by a faulty position of the fœtus, or compression from the parts surrounding it, because many luxations, such as those of the jaw and femora, evidently cannot be the result of such causes, and because many distortions and articular curvatures took place in a direction op-

posed to those of the ordinary movements, and were carried to such a degree that it was impossible not to impute the deformity of the skeleton to the very active and considerable shortening of the muscles. Thus, in some cases the head was turned completely backwards, and approached the sacrum by means of a double antero-posterior curvature of an extreme degree, whilst the fasciculi of sacro-lumbar and long dorsal muscles directed themselves in a right line between the two extremities of the spine, and formed the cord to its curvatures; it was the same when the leg was strongly bent forward on the thigh, and the patella strongly drawn up on the thigh, the rectus muscle was stretched between the pelvis and patella, thus opposing itself to all reduction of the limb; it was similar when the forearm was bent backwards on the arm, forming an angle posteriorly with shortening and extreme tension of the triceps brachiei, and luxation of the olecranon upwards and backwards on the posterior surface of the humerus.

In these articular displacements, opposed to those which result from even exaggerated normal movements, it is impossible not to recognize convulsive muscular retraction. I have also given examples in which, besides exaggerated and normal articular distortions, there existed angular curvatures arising from consolidated fractures in the shafts of the long bones, corresponding to the retracted muscles: these fractures cannot be attributed to accident, because they are accompanied by general deformity of the articulations, and because in certain cases they are found symmetrically to affect the same bones in each of the four limbs, and the hollow of the angles which they form looks towards the most retracted muscles. Besides, we perceive along them the nerves stretched and shortened, and sensibly hypertrophied. Finally, in examining the remains of the brain and the spinal canal, I have sometimes found the membranes torn, broken, having disappeared in part, with or without remains of the cerebral substance and spinal marrow, and the cavity of the cranium reduced to a very small irregular space formed by the

breaking down of its walls, which were disjointed and partly destroyed. In this first series of facts, so strongly marked, it appeared to me impossible to mistake two results materially explained, viz. the existence of *convulsive* muscular retraction caused by an affection of the cerebro-spinal system, which had destroyed more or less completely the brain and spinal marrow, and the existence of this retraction as the direct agent of all the articular deformities which took place in the direction of the shortening of the muscles. I viewed it as the most exaggerated action of a cause carried to the greatest degree of intensity, which showed itself in a material form in its effects so general, and marked in so energetic a manner, but which cease to be directly recognizable, when it has acted only feebly, locally, or indistinctly. In other words, I think I have discovered, that the general articular deformities were the most advanced stage, and the most general expression of convulsive muscular retraction, and that it was the result of a central affection of the cerebro-spinal system ; whilst that simple congenital articular deformities, confined to a part of the skeleton, as simple club-foot, are only the last stage of this retraction approaching to the zero of action, and produced in these cases by a very limited alteration of the nervous centres, or simply by a peripheric action of one or other of its dependencies. I had already adopted this induction from the perfect anatomical similitude which exists between the club-feet found in certain monsters and those found unaccompanied by other deformity in new-born infants. For we see that the greater number of monsters of the class spoken of, have club-feet precisely similar to those regarded as the type of congenital club-foot in infants otherwise well formed. But this analogy (the value of which we shall now examine) is not sufficient to render my induction irreproachable. It was thus I attempted to render it so. If it be true, I said, that, general articular deformities in acephalous and other monsters, and simple congenital club-foot in the foetus arrived at its full time, and in other respects well formed, represent the two extremes of action

of one and the same cause. If it be true, that on one side it be altogether the nervous system which has been virtually disturbed in one of its centres, and all the muscles under its dependence violently convulsed; if on the other, it be only a weak attack of the same affection which has only acted partially on the periphery of the system, and lightly on a single order of muscles, it ought to be possible to find intermediate cases representing decreasing degrees of action of the same cause, from its most exaggerated influence to its most feeble; and it ought to be possible to follow in this series of decreasing actions from the same cause the parallel series of its effects, which would establish an uninterrupted chain between the products of its greatest degree of intensity and those in which it will be manifested only in an indirect and nearly indistinguishable manner; so that the general deformity of monsters, and the simple club-foot, are truly related to one another with respect to their common origin, by a series of intermediate cases establishing the insensible transition of one of these extreme cases to another. This is what I have endeavoured to accomplish, and I think I have accomplished its execution. Having given examples of acephalous monsters in which the brain and spinal marrow had entirely disappeared, I also described numerous cases of monsters in which the nervous centres were not entirely wanting, but had been partially destroyed; those, for example, in which the brain and spinal cord were pushed from their half-destroyed cavities, and had undergone remarkable displacements, and were accompanied by hydrocephalic and hydro-rachidian pouches of greater or less dimensions. The generality of articular deformities observed in the preceding category, coincides with the state of the brain and spinal marrow, viz., luxations and subluxations of all the articulations united with general muscular retraction. In this second arrangement of facts, the alteration of the nervous system could not be mistaken in its relation to the state of the muscles, since the material traces of alteration in the brain and cord, and in their envelopes, still existed, and the retraction of

the muscles, was as well marked as in the instance of the preceding category, where the nervous centres had disappeared under the influence of disease.

In a third series of facts, I collected human fœtuses and those of calves, in which hydrocephalus, largely developed, without destruction of the walls of the cranium or vertebral canal, coincided with general muscular retraction, and those permanent deformities before indicated; here was a less marked degree of the affection which had acted with greater intensity in the preceding cases.

Immediately after these I placed those fœtuses in which the superior extremities were well formed, whilst the vertebral column and all the articulations of the inferior extremities were the seat of curvatures, luxations, abnormal flexures, and club-foot. In the subjects of this category there was alteration and destruction of a single portion of the cord; that situated most inferiorly characterized by a hydro-rachidian pouch, with fissure, or incomplete spina bifida in the last lumbar or sacral vertebræ. The cord, when exposed, presented in these situations more or less extensive ramollissement, with adhesions or partial destruction of the membranes. Need it be said, that in these cases the extent of deformity was proportioned to the extent of their cause.

In another category I collected a series of fœtuses in which the deformities were confined to the right side of the body, and in every instance characterized by the retraction of the muscles coinciding with traces of an old cerebral affection of one side of the brain. This series of facts presented a confirmation of the results furnished by the preceding, viz., the limitation of the deformities being equable to the limitation of their cause.

Lastly, having endeavoured to follow up in the living after-birth, the continuation of the same relation between these two orders of facts, I combined a series of observations comprising cases of decreasing deformity, from the simultaneous deformity of the feet, the hands, and the spine, to the deformity of a single

foot or hand, each of them coinciding with the unequivocal traces of a cerebral affection which had preceded birth. These observations were sufficiently often repeated and submitted to the criticism of scientific men appointed to report on and determine their value.

This uninterrupted chain of decreasing manifestations from one and the same cause, conducting the facts step by step where the evidence was material to those when it commences to be only the result of induction, ought to be sufficient; for our actual physiological knowledge of the relations which exist between the cerebro-spinal system and the muscles, is sufficiently precise and positive to permit us to conclude in seeing, on the one part, a material alteration of one or other of these two centres, and on the other, a general or partial convulsion of the muscular system, that the first is the cause of the second.

Immediate observation being able to convert this induction into incontestible fact, I have had recourse to it, and endeavoured to establish its nature directly. If those changes occur in reality during intra-uterine life, as I have established, it may, and it ought to happen, that some days or months after birth, the same causes occurring should produce the same effects; that is to say, should cerebro-spinal affections develop themselves, they should give rise to retraction of certain muscles, and this retraction to deformities similar to those produced by the same causes before birth. Although the pathological conditions are not exactly the same in these two cases, and we may reasonably suppose that the intra-uterine life is in every way the most favourable, both on account of the greater susceptibility of the nervous system, and the greater laxity of the articulations, to the development of the conditions we here speak of, still I have been able to find a certain number of cases where these conditions are produced after birth, with all the same elements which distinguish them in intra-uterine life. Thus, I have given cases of simultaneous deformities of all the joints, therein comprised luxations of both femora and club-

feet, supervening on a cerebral affection, occurring two or three months after birth in children at first well formed. As to simple club-foot, occurring after birth, and consecutive to a convulsive affection, I have noted so large a number of cases, that I do not think it any longer necessary to enumerate them. In fact, it is almost the only cause which produces them, particularly at the period of dentition. Shall I add, that every day we have under our eyes retractions in which the temporary muscular contractions represent the first degrees and most simple forms of club-feet and hands in children, attacked with simple convulsions.

The meaning of these facts has not hitherto been appropriated, because, being presented singly, they had but slight value, and because the attention not being specially called to the forms affecting the limbs in these kinds of temporary contractions, the close connexion was not perceived between these transient deformities, and those which are genuine and permanent.

Thus then a part of that immense distance which appeared to intervene between the general deformities of monsters, and simple congenital club-foot, is filled by a series of facts, all united together in such a manner that the first affords a key to the second, the second to the third, the third to the fourth, until we arrive insensibly at the last link of the chain of regularly decreasing effects dependant upon one sole and only cause. This first endeavour was the easiest. With the knowledge we possess of the subjugation of the muscular system of locomotion, to the cerebro-spinal system, and with examples in which immediate traces of a material affection of one of these two centres coincident with retractions of the muscles, it became impossible to refuse the novel etiology which I have adduced for congenital club-foot, at least for that which coincides with the other deformities, and with direct traces of disease of the brain or spinal marrow. I would remark before proceeding, that by affections of the cerebro-spinal system, I do not mean

only those which are recognizable by material alteration of the tissues or envelopes of the brain or spinal marrow; I mean also by this term, affections which are only marked by a general functional disturbance, by traces of convulsions with or without paralysis, which in the last analysis depend upon a certain physical modification of the nervous system. If this modification be not recognizable to our actual means of investigation, it is because it is too transitory, and depends on conditions which are not as yet known in physiology. In this category of affections, the characters drawn from functional disturbance, and their general expression, supply the want of material appreciable alteration. Hence, whatever may be the convulsive affection which has produced the series of multiplied deformities in which club-foot forms only a part, this affection evidently causes the active and permanent retraction of certain muscles, and this retraction causes the production of deformities, amongst which club-foot is to be found.

II. ON CONGENITAL CLUB-FOOT, WHEN OCCURRING ALONE IN THE FETUS AND INFANT, WITH OR WITHOUT DIRECT MARKS OF A CEREBRO-SPINAL AFFECTION.

There exist two separate states, when club-foot occurs without any other deformity; either it coincides with general traces of an old convulsive affection, or these traces no longer exist, and the deformity is the only exterior effect which appears of the disease. In the first of these, the researches published give a precise signification to the least material vestiges of the nervous disease, and permit of applying to them the interpretation furnished by the most direct alterations. Thus having noticed these cases where total or partial destruction of the brain and spinal cord afford the elucidation to the retraction of the muscles of the limbs, we can discover the same affection in the less marked, more distant, and less significant traces of the convulsive disease. Inequality in the eyes, different degrees of intensity in their visual faculty, exaggerated development of the

cranium, difference of angle in the frontal prominences, drawing of the features, and diminution of one side of the face, relative feebleness or incomplete paralysis of one-half of the body ; finally, many other peculiarities less compound and less definable, the collection of which composes the mask of those individuals chronically affected with convulsive affections, all these manifestations, I repeat, are sufficient to permit of the application of the etiology of convulsive muscular retraction to the cases of club-foot which they accompany, furnished by the most evident cases of multiplied deformities in monsters and in the foetus. But beyond this last fact, where the general manifestation of the cause, the history of which I am writing, appears to stop or to circumscribe its limits in relation to club-foot, commences the most difficult part of my attempt, that having for its object the attaching to the etiology of active or convulsive muscular retraction, those club-feet not accompanied by general characters of a nervous affection. For I acknowledge at once that the proofs given in the first part of this treatise are not sufficient in rigorous reasoning to allow of my claiming simple club-foot as a consequence of active muscular retraction ; this requires further elucidation.

First, let us observe how this cause proceeds, when it acts in its slightest degree. The convulsive affection quitting the nervous centres either localizes itself immediately on the muscles of the foot exclusively, or limited from the origin to the circumference of the system, it shows itself in some particular nervous branches by contracting the muscles only to which they are distributed. In these two cases there is nothing, or scarcely anything in the general appearance or entire economy of the patient to indicate the cause of the disease. It is requisite to assist in producing facts to be able to speak positively on them. If these facts really exist, it will be sufficient for those who have directed their observation towards pathological phenomena of this kind, to name them. Physicians accustomed to see many children know, that particularly at the period of dentition and

during certain eruptive diseases, it is not uncommon to observe one or more muscles of a limb or of the neck contract themselves suddenly without any other convulsive phenomena. I shall not speak of many other circumstances, as attacks of rheumatism, common colds, where the same observations are pertinent. In those cases there is sufficient evidence that the disease is carried more or less directly on one or more nerves of the periphery of the system, consequently on the muscles which they supply. What is the result? That the existence of simple club-foot, produced by this localization of a convulsive cause, is no longer a gratuitous hypothesis, but an established fact in the infant, and a probable one in the foetus; because the organic elements of the foetus and the infant are the same nearly in the degree of their development and their powers of reaction against analogous pathognomonic influences as may well be supposed. This consideration is, doubtless, not sufficient, wherefore it is only given as a transition to proofs of a more direct nature. Thus, then, simple club-foot in the foetus and in the infant, from local muscular retraction, is both a possible and a probable circumstance. Let us see, however, if there do not exist more direct, more material means, and positive characters to place the reality of this fact beyond doubt, that is to say, let us find out if the fact of muscular retraction can account for all the circumstances of simple congenital club-foot, and if this fact reveals itself in its proper characters, clearly appreciable in the parts where it occurs, in such a way as to present in its form, constitution, and the elements which surround it a collection of characters, by the aid of which we can supply the absence of more general characters of the convulsive affection, and pronounce on its origin with as much certainty as in those cases where the alteration of the nervous centres can be materially proved. It is only by fulfilling these conditions, that the chain which extends from the multiplied deformity of monsters to simple club-foot shall become rigorously complete.

Probably I am not the only person who has met cases of

club-foot in which the retraction of the muscles was incomplete and still easy to overcome. These club-feet were well marked, and presented the most characteristic forms of congenital club-foot. When I made an effort to reduce them with the hand, I was surprised to see the foot instantly recover its normal configuration, for some time they remained in this state, then sudden contraction of the muscles, evidenced by the projection of their tendons, reproduced the affection before my eyes, which had existed previous to the reduction. I have observed this fact very frequently. In these cases, is it possible to mistake congenital muscular retraction operating in an intermittent manner, alternately relaxing and quiescent, the subjugation of similar results to the same cause, and which is observed in a permanent form in the ordinary cases of congenital club-foot? For in both cases there are the same forms and the same directions. The degrees and duration alone vary. The same result is repeated almost every instant, affording the same information in the most ordinary cases of club-foot in infants, and principally during the treatment of the deformity. In repose the foot ordinarily presents a less marked degree of club-foot; suddenly the retraction of the muscles on which it depends, increases it under the influence of voluntary movements, or when the child cries, and along with it the club-foot, partially reduced by machinery or diminished by the relaxation of repose, reappears more strongly marked than before, with all the characters of form and direction which depend on the special action, and on the intensity of action of the muscles which are the seat of retraction. This observation may always be made when the subject is affected with double club-foot; almost always one is less strongly marked than the other; in it the muscles still enjoy a certain degree of contractility, and this contractility, temporarily exercising itself, acts in the direction of the existing forms of the deformity, and adds temporarily to those forms a development proportioned to the sum of the new contraction, added to the permanent retraction. I shall add the following fact to

the preceding, which completes their signification. I had to treat twins, each affected with double congenital club-foot, without any external general signs of a convulsive affection. I cured them completely of their deformity. The treatment had ceased about six months, when one of them was seized with a cerebral affection, which in three days brought the two club-feet into the same state they had been in previous to their cure. I treated and cured them anew, and as if the first experience were not sufficient, a year after, the same subject was seized with convulsions, not so strong as the preceding, and one of the club-feet only, the one which had been most strongly marked reappeared, but in a less degree than before. In these three cases, that is to say, at birth and after the first and second attack of the cerebral affection, the club-feet presented themselves with the forms and anatomical elements perfectly identical. However, at their birth these twins presented appearances of most perfect health, and the double deformity was the only trace of any intra-uterine affection. Here we cannot mistake the material and appreciable repetition of a fact which occurred during intra-uterine life, that is to say, at an epoch and in conditions when it was impossible directly to prove it ; but the results, perfectly identical before and after birth, allow of our concluding on the identity of the effects and the identity of their causes.

III. ON THE PROXIMATE CHARACTERS OF CLUB-FOOT, PRODUCED BY CONVULSIVE MUSCULAR RETRACTION.

I have established in my general work on deformities the following law: "The essential causes of deformities possess a certain specific action with regard to the deformities which they produce, and each of these causes exhibits itself externally by peculiar characters by the aid of which we may in general, from the deformity, diagnosticate the cause, and from the cause diagnosticate the deformity." This law, which I have applied up to the present, to all deformities of the osseous system, would not be exact did it not exhibit itself in the actual cases, and the

etiology of muscular retraction would be ill-founded if the fact which serves as its basis were not recognizable by well determined specific characters. The conclusion now to be drawn, I am of opinion, accounts for this double condition.

In congenital club-foot we must take into consideration two orders of characters, those which belong to all the anatomical varieties of the deformity, and which are its general characteristics, and those which are united to the different forms which it is susceptible of assuming, which are its special characteristics. These two classes of characters (equally significant and of common expression since they arise from one and the same cause, which they tend to explain), express in fact each in its own limits the fact of convulsive muscular retraction. But in this treatise I shall only enter on the consideration of the relation of the general characters with muscular retraction, leaving that of the particular forms proper to each variety of club-foot for a future essay.

The most prominent character of congenital club-foot which can be proved in all subjects affected with this deformity, is the fibrous transformation of the affected muscles. This change can be seen most easily in the muscles of the calf of the leg. I have established in another work the following: "That the muscles always have a tendency to pass into the fibrous state when they are submitted to a permanent or extraordinary contraction." Besides, the muscles in convulsive muscular retraction, having been actually shortened, are submitted to continued tension, the effects of which increase in proportion to the degree and duration of this tension. We can then see that if the shortening of the muscles were passive or consecutive, as many of the proposed theories would lead us to believe, this shortening would only take place so as to meet the difference in reduction of the space comprised between their points of insertion, in order to adapt itself to this space, and they would suffer no more tension than in the natural state. This character alone has been always sufficient to enable me to distinguish the active muscular, or primitive retraction, from the passive or consecutive retrac-

tion. This double result I put beyond doubt by numerous dissections of chronic deformities of every kind. In congenital club-foot in particular, I have always found the gastrocnemii and solei muscles two-thirds passed into the fibrous state. The fleshy portion was always sensibly shortened, and reduced to a third or fourth of its length. In certain cases it had even completely disappeared, and had given place to strong, knotted, fibrous bands. This result, which I have observed to be very constant, is also to be found in the foetus prematurely born. It cannot then be regarded as an accidental or remote effect of the deformity, but as an essential character of muscular retraction carried to a certain degree.

In the living, the same character is recognizable in the particular form and consistence of the calf of the leg. In very young subjects it already appears without its usual form and consistence; it is very short, more elevated, and as if pressed towards the popliteal space. The leg in children affected with club-foot is characteristic, resembling a cone gradually and regularly diminishing, the base of which, of a diameter much larger than the other parts of its length, corresponds directly to the head of the tibia. Whatever remains of the fleshy part of the calf is hard and resisting. Sometimes forming ridges or angles which can be felt through the skin along the border of the gastrocnemius and soleus muscles, which, by the resistance they give, show beyond doubt their fibrous nature. I repeat that these peculiarities are to be found in very young subjects even when the retraction is slight. In the adult these characters are perfect: the hardness of the calf increases, its projection diminishes in proportion, and this diminution proceeds sometimes even to the disappearance of the entire fleshy structure. The leg presents the same diameter through its entire length. This form externally corresponds to the complete fibrous transformation of the muscles.

To these significative characters I shall add the following: in more than one hundred club feet of which I took the mea-

surement both before and after treatment, I have always remarked that they presented a reduction in length, but an increase of thickness varying in degrees, but which is almost appreciable to the naked eye. The club-foot is shorter, larger, and more collected into a mass than the ordinary foot ; moreover, independent of the special forms proper to each of its varieties, it is generally excavated or vaulted in such a manner as to permit it only to touch the earth, supposing the foot drawn down, by its extremities, that is by the heel and end of the metatarsus. This shortening, enlargement, and arching of the foot, are not owing, as might at first be believed, to the gait of the subject, and cannot be considered as consecutive effects of the deformity : they are primitive characters, because we observe them in very young subjects, as well as those advanced in age, and in the pes-equinus as well as in the varus, and in the different combinations of these two principal forms. As a consequence of these characters also we may remark, that the toes are not prolonged from the metatarsis after the usual manner, but as if strained between the two orders of antagonist muscles, which are too short in relation to the skeleton, they are first elevated on the metatarsal bones, and then flexed in such a manner that their free extremities are applied to the plantar edge of the metatarsus, and protected by its projecting before them like a cushion : this characteristic, with the preceding, are direct evidence of muscular retraction. There are many dorsal and plantar muscles which restrain and prevent the development of the foot in length, which cause it to become arched, shortened, and thickened, and the toes to be bent back on the metatarsus. The best way of assuring one's self of these facts, is by observing them when they are not produced in the most complete and regular manner. When, for example, it happens that the retraction occurs only in the flexors or extensors of the great toe, or in the muscles of the other toes only. The contrast which then exists causes the influence and characters of the cause to be better appreciated in the respective position of the toes. These observations may ap-

pear superfluously minute, and of trifling importance at first, because we have only proved up to the present moment the most apparent and general elements of club-foot, whilst the most delicate, and if I may so express myself, constitutional particularities have escaped observers who have seen in club-foot only one and the same accident of form. But in regarding this with analytic eye, we see the multiplied results of an identical but complex cause, the complexity of which is perfectly represented by the multiplicity of accidents of form to which it gives rise. Finally, in remarking that the muscular retraction, whatever may be the variety of club-foot, generally engages a greater or less number of muscles, we can understand that the result of this simultaneousness of actions ought to be a collection of effects correlative to the multiplicity of elements in the cause. This brings me to the most significant character of muscular retraction.

We see in every variety of club-foot one or more muscles stretched, and in relief under the skin, precisely in the direction of the force necessary to be exerted to produce each variety of the deformity. This connexion between the retraction of these muscles and the form of club-foot which depends upon them, can be rendered more palpable by endeavouring to restore the parts to their natural situation, for in proportion to the efforts made, we can see and feel the contracted muscles project; we may add, that immediately after the section of the same muscles the natural form reappears more or less completely, particularly when the operation is performed on young persons. I could explain this fact more fully, including as it does in itself alone the formula of the special characters of club-foot; but it is necessary here to explain the different anatomical varieties which occur in relation to retraction. This question is intimately connected with the one on which I am treating, and its solution throws new light on the difficulty which I seek to overcome, but on account of the discoveries and controversies into which this subject must lead me, I propose to make it the object of a separate

treatise. For the present I shall confine myself to the remark, that each form of club-foot carries with it muscular projection or reliefs, which show clearly the fact of special retraction localized in this or that muscle, because it is to the special retraction of certain muscles that the different varieties of this deformity are subject.

The fibrous transformation of the muscles, the shortening, elevation, and sometimes disappearance of the elevation of the calf of the leg, its consistence, hardness, resistance ; the shortening, thickening, and arching of the foot ; the turning back or extension of the toes ; the tension, projection, and clonic shortening of the muscles in the direction in which the different species of club-foot are produced : such, in fine, are the general characters which exhibit collectively, as well as individually, the fact of muscular convulsive retraction. I think I shall no longer leave any doubt as to the community of origin which I assign to congenital club-foot, accompanied or not by material traces of cerebro-spinal affections, by saying, that the different characters enumerated above are equally observable in both cases ; in other words, they offer an identity of forms and material accidents, as they proceed to a similar origin. We may observe, that it is not necessary to render this demonstration accurate, that every example of club-foot should contain the whole of the characters which I have described ; but a collection of these characters, amongst which one or two may be wanting, or be only incompletely marked ; because the identity of cause does not necessarily imply an equal intensity of action or equality in the number or degrees of the results.

V. ON THE CONSTITUTION AND ESSENTIAL SIGNIFICATION OF CONVULSIVE MUSCULAR RETRACTION.

The fact of convulsive muscular retraction, considered as a fact, and as a cause of congenital club-foot, cannot then be doubted, whether we regard it in its own existence and under the immediate influence of the nervous affection which causes it,

or in the characters to which it gives rise. But under either of these considerations, it cannot be regarded as a simple and absolute phenomenon. Its constitution, eminently complex and variable, has a signification as different in regard to its origin as in regard to the immediate results which it produces. The first symptom which strikes us in the consideration of muscular retraction is the shortening of the muscle. However, this symptom is not alone, and does not always act in the same manner. To this symptom, the most directly appreciable, are united two others which it is necessary also to specify.

The nervous affection which causes muscular retraction, and which precedes it, acts differently and with different results according to its mode and degree of action. In convulsions of short duration the muscles are retracted but to a feeble degree, and only during the continuance of the convulsion. In a more intense degree, the retraction continues in a permanent manner after the convulsion, and the muscles are deprived besides of a part of their voluntary contractibility; in a still more intense degree of the nervous affection, the retraction of the muscle begins to diminish: it can be even overcome for a moment, but the voluntary retraction is lost more and more every moment till it is entirely gone. In the last degree of the action of the cause which produces these different forms and degrees of the same state, another symptom occurs in appearance completely different, and which is only the last result of the nervous affection producing muscular retraction, viz., complete paralysis of the muscle in which it is seated. In this case the muscular fibre cannot be immediately shortened where the retraction has been overcome; but the muscle appears struck with inactivity, deprived of all kinds of motion, and having no other characters of vitality than those shared in common with rudimentary and amorphous tissues. Incomplete temporary retraction, complete retraction with permanent shortening, and incomplete paralysis and retraction without constant shortening, and com-

plete paralysis, are only effects from the same cause influenced by different modes and degrees of action. This is not an hypothesis, but the result of observations continually applied in all stages and modifications of this disease, and to all the varieties and shades of deformity which it causes. What proves this is, that in the same subject affected with numerous deformities, sometimes one of the feet is completely paralysed, while the other is affected with common club-foot. Sometimes, in the same club-foot, the muscles are seen retracted with very considerable shortening without sensible paralysis, in juxta position with other muscles not shortened but completely paralysed. Lastly, one of the feet presents sometimes a state intermediate between fixed contraction and paralysis, that is to say, contraction and incomplete paralysis, whilst the other foot shows one of the two preceding states in its most strongly marked degree.

These facts I have observed a great number of times, and have published a numerous series of examples. It is then useless to enter on more lengthened details on the essence of the phenomena of retraction, in order to show the intimate affinity existing between these different forms of the same state, and to prove that convulsive retraction comprehends in it the elements of paralysis, that is a peculiar form of paralysis, and a state passing into paralysis. The fact just cited establishes this matter sufficiently. We can call to mind also, that in many persons affected with hemiplegia, the muscles have presented a succession of these different conditions, convulsions, spasmodic contractions, and paralysis; and that certain of them, a long time after the attack, present the combination of retraction with paralysis. What then is the result of studying the etiology of deformities, and of club-foot in particular? It is, that muscular retraction is no longer a simple and absolute fact; that the muscles behave themselves differently with regard to the joints which they are destined to move, according as they are simply retracted with little or no paralysis, or completely paralysed. Here is now a second element to introduce in the appreciation of the

effect of the convulsive affection on the muscles which it attacks, and in the appreciation of the action of retracted muscles in the formation of club-foot. There is a third which proceeds naturally from the two former.

When we examine attentively what occurs in the development of congenital club-foot in infants, we readily perceive that the deformity does not present at its commencement the degree which it assumes afterwards, that it does not remain stationary, but often augments with the growth, and in direct ratio to the growth of the subject. All authors who have studied club-foot, and who have remarked this fact, explain it by hypothesis which I think it useless to examine here. The important matter, however, is, that many of them have stated the fact of the increase of the club-foot in connexion with the increase of the skeleton. This new element for etiological demonstration of club-foot appeared at first to belong to the field of muscular retraction considered in immediate activity, and would be really the case if the convulsive retraction did not exercise upon the muscles any other action than that of shortening produced at once without any effect on the future development of the muscles. However it is not so ; the muscles which have been the seat of congenital contractions always remain proportionally shorter than similar ones which have been unaffected, their relative shortness has reference not only to the fact that they have been contracted at a given time, but to this, that they cannot follow the development of the skeleton ; and also to this, that the muscles are not animated with a force of development equal to that of the other parts. These muscles carry inherently an element of paralysis which prevents them following the elongation of the osseous system. Does not this fact confirm the connexion which I have established above between paralysis and contraction considered as an approach to paralysis ; the radical force of the retracted muscle is diminished by the affection which determines the retraction, and this diminution makes itself sensibly felt during the whole duration of the normal development

of the other parts, and even then it does not stop altogether. I have seen cases in which certain muscles primitively retracted had been so much deprived of their power of increasing, that after puberty they had hardly acquired the dimensions proper to early infancy. Insufficiency or arrest of development consecutive to muscular retraction, forms then the third element of muscular retraction, and consequently a third element amongst the essential causes of club-foot. We may add, that in cases where paralysis is complete the muscle becomes diminished and atrophied, whilst the body is growing, and does not preserve any longer sufficient consistence to give opposition to the growth of its antagonists. This fact, placed beyond doubt by the anatomy of the muscles, as any one may observe, contributes to throw light on the cause of the external forms of many varieties of club-foot.

Independently of the three influences which we have mentioned, viz., retraction, properly so called, or shortening of the muscle; paralysis and consecutive arrest of development, which constitute the complex fact of retraction, and compose the etiological formula of club-foot; there exist two other complementary influences connected to each of the three essential elements, varying the expression of the results: I mean the *degree* of each of them and of their *situation* in relation to the muscles which they occupy. It is not an indifferent matter that the shortening of retracted muscles exists to this or that degree, but it is evident, on the contrary, that on the degree of shortening depend certain characters and directions of the club-foot; the same may be said of the seat of the retraction. The question to be decided is, whether all the muscles of the foot, or some of them only, may be the seat of the primitive shortening. For, *a priori*, there could be no reason why this or that muscle of the leg should be more exempt from this pathological state than any other, since all receive nervous branches coming from the same trunks. The seat of retraction in the different muscles of the foot is a fact placed beyond doubt by observation

and experience. I have given a great number of cases in which could be distinctly seen the combination of different modes and different degrees of retraction alternately or collectively, occupying the different muscles of the leg and foot. It is sufficient to know the possibility of this fact in order to show its frequency in most common cases. Numerous examples shall be given in the history of the different varieties of club-foot. The shortening, paralysis, and arrest of development consecutive on retracted muscles, considered as inherent to the complex phenomenon of retraction, the situation and degree of this retraction in relation to the muscles which it occupies, such are the elements of the general formula of the etiology of congenital club-foot.

In what precedes, I have only had in view the determination of the primitive elements of this etiology, which act previous to birth, and which proceed directly from the essential influence of this cause. At a later period, progression and all the movements of the foot come to add a secondary influence. I have purposely avoided accounting for the action of consecutive causes, in order not to complicate and obscure the theory which I had to present. I shall, however, specify in a more precise manner the degree of action of the secondary influences produced by the intervention of these assisting causes.

V. DOES CONGENITAL CLUB-FOOT EXIST PRODUCED BY OTHER CAUSES THAN ACTIVE MUSCULAR RETRACTION ?

The question is here alone concerning congenital club-foot ; consequently the different influences which could give birth to consecutive club-foot have not been taken into consideration. I shall merely mention, as a thing perfectly admitted, that the different diseases of the bones and articulations of the foot, may more or less alter its form. Scrofula, rachitis, wounds, inflammation of the muscles, and other morbid causes, supposing that they could reach the foetus, can determine subluxations and deformities of the foot. The name of club-foot has been impro-

perly given to many of these, but these deformities do not present any of the genuine characters of true club-foot ; besides they have marks of their origin—the traces of scrofula, rachitis, and injuries cannot be mistaken. We may remark besides, that were the foetus submitted to the accidental causes we have mentioned, such as wounds, contusions, and other analogous influences, these causes would only act in determining contraction of the muscles, consequently they would enter into the etiology which I myself have established. They must be counted under muscular retraction. Whether the causes of this retraction be general or local, as the retraction is owing, as I have said, to a lesion of the nervous centres, or if it be the result of a local cause acting on one or more branches of nerves, it is still muscular retraction which comes in play, and which is the cause of club-foot. Consequently, in establishing the general etiology of congenital club-foot, on this fact I have ruled in advance all the influences of whatever nature they may be, which can give birth to muscular retraction. There is then no real foundation in the separating of things which unite in the same fact, when muscular retraction, cerebro-spinal affections, rheumatism, contusions, wounds, inflammations of the muscles are proposed successively as different causes of congenital club-foot. I can state the same for the opinions of Duverney, and Delpech, which are only partially true, because they express one of the consequences or one of the attributes of the fact of muscular retraction which they had not suspected. The first speaks of the unequal tension of the muscles and ligaments as the cause of club-foot, which is at least, as far as regards the muscles, empirically exact ; the other, of the insufficient development of the muscles of the calf combined with a primitive irregularity of the two spinal fasciculi, and of the two halves of the body, which is perfectly true as far as regards the insufficiency of development of the muscles, but is not correct in what concerns the hypothetic explanation of this part of the fact. But I repeat that these opinions are not true, except where they bear, contrary to the will and

forethought of their authors, on the fact of muscular retraction, of which they express only one of the attributes.

Having shown the truth in the causes cited, with some appearance of foundation, outside the field of etiology peculiar to myself, is only a small fraction, a dependance on this etiology, it remains for me to examine the really different causes which have been admitted up to this period, and which still have their partisans. These causes may be reduced to three, viz., a primitive displacement of the osseous surfaces of the foot, (doctrine of Scarpa); the attitudes of the fœtus, arising from determined mechanical pressure whether of the uterus or external influences, which comes to the same thing; finally, arrest of development. I have said at the commencement of this treatise, that the truth contains the criticism of error. Let us place for an instant the fact of muscular retraction beside these three orders of hypothesis, and we shall see if there be need of any troublesome demonstration to prove the vagueness and weakness of the latter when compared with evidence of the accurate truth of the former.

Scarpa raised the very question in other terms which he sought to resolve, without perceiving it when he established that the displacement of the articular surfaces in club-foot is primary, the shortening of the muscles secondary. But what could have caused the displacement of the bones? what, in other words, was the cause of the club-foot? The doctrine of Scarpa was not then at unity. No where could the aphorism *sublata causa tollitur effectus* be more properly applied. For when the section of the retracted muscles is made, the articular surfaces recover their relations with the greatest facility. Those who have followed the theory of Scarpa, and have sought to perpetuate his doctrine, appear to me to have shown less of judgment and sagacity than of regard for a great name.

The theory of mechanical pressure and of faulty positions of the fœtus to whatever cause they may be attributed, have a show at least of real influences, but they do not answer expectation. It is true, that the fœtus may be incommoded, pressed upon,

and its extremities held in faulty positions ; but these causes, real as they are, can they produce true club-foot ? I reply, without hesitation, that they cannot. The mechanical pressure of the uterus produces a certain deformity of the foot, which has been confounded with club-foot ; but this deformity, like all the rest, carries the traces of its origin. Starting with the conviction that there might be cases in which the narrowness of the uterus, in proportion to the fœtus, might exhibit itself upon the latter, I examined for many months all the fœtuses and new-born children which came from the Maternité, at Clamart. In a very large number of them, I saw a peculiar disposition of the feet quite characteristic of the cause producing it. This consisted in an extreme flattening of the foot transversely, so that there was no longer a plantar or a dorsal surface ; no hollow at the tarsus or metatarsus, neither elevation of the instep, nor appearance of heel ; in a word, none of those elevations which give character to the different parts of the foot. The whole consists of a kind of fleshy layer, the superior border of which confounds itself with the leg, the inferior is free, and holds the place of the plantar surface. This deformity of the foot has, therefore, its own peculiar characters, and has not any of those belonging to true club-foot. Thus the heel is not elevated, nor are the muscles of the calf rendered tense, nor the calf itself gathered up and shortened ; no tendon is seen projecting under the skin ; when an attempt is made to restore the foot, it is evident that all the parts equally participate in the irregular form which it is necessary to overcome ; that all resist equally, bones, ligaments, muscles and skin, in such a manner that we have under view the exact image of a body flattened in all points of its two opposite sides by a cause, which has compressed it uniformly, following a single action, and not a series of irregular plans and changing directions, as must occur to form the assemblage of elevations, depressions, and contortions, the combination of which constitutes club-foot. Let us add, that for the treatment of these special deformities it is

sufficient to employ some few slight means continued through a certain period, and that the cutting of any tendons does not accelerate the restoration of the natural form.

What has been said anticipates my answer to the second question proposed, whether pressure of the uterus on the fœtus could produce true club-foot. It would puzzle the most intelligent person to produce on this elliptical or circular body by pressure, effects always bearing the same characters, the appearances of the surface so rigorously in relation to the direction of the retracted muscles, the *pes equinus*, *varus*, *valgus* and *talus*, and all the combinations which result from the association of their different forms with one another, without causing a remark that the thickening of the foot, the extension and turning back of the toes, the contraction of the calf, the particular form of the limb, and lastly, the fibrous transformation of the muscles, would with difficulty accord with the doctrine of faulty positions of the fœtus in the liquor amnii, and of its pressure against the walls of the uterus.

I consider it useless to dwell on the theory of arrest of development. I said to myself, that at a period when facts are only observed from a distance and examined in their most superficial appearances, it might serve as a pretext for all kinds of theories; but though the doctrine of arrest of development has been useful to science in other respects, in club-foot it does not afford the slightest pretext for its adoption.

VI. RESUME AND CONCLUSIONS.

This treatise, intended to establish a new etiology of congenital club-foot, contains the explanation of the analysis of a fact which has not hitherto been studied in relation to congenital deformities, viz., convulsive muscular retraction considered as the essential cause of congenital club-foot. I have placed the existence of this fact beyond doubt, by a great number of observations collected from monsters and fœtuses; observations in which we can follow step by step the correspondence between

muscular retraction and the material alteration of the cerebro-spinal system, from the complete destruction of the brain and spinal marrow, to the alteration of a single circumscribed point in one of these centres. I have shown that each of these cases of the best characterized congenital club-foot coincident with a great number of other articular deformities, are, as well as the deformities, the result of convulsive muscular retraction, characterized by an extreme shortening of the greater part of the muscles of the trunk and limbs.

Passing to the study of those cases of simple club-foot, in which the retraction is limited alone to the muscles of the limb, I have shown that in those cases, where the convulsive affection has at first been general, showing itself by unequivocal traces in the features of the face, conformation of the skull, the direction of the eyes, inequality of power in the two sides of the body, or where it has only acted locally, and is confined to some nervous branches, and consequently to some muscles, this state constitutes simple contraction. In the second category of facts we can recognize the peculiar nature of the deformity by means of the immediate characters of muscular retraction in relation to deformity of the skeleton. These characters are of two kinds, general characters, which belong to all varieties of club-foot, and especial characters, which are peculiar to each of its varieties. The general characters, the only ones which I could indicate in this treatise, are the following: in the dead body, the fibrous transformation of the retracted muscles, and principally those of the calf of the leg, the natural consequence of continued and exaggerated tractions to which the muscles are submitted. In the living body the change of form and tissue of the calf, which is flattened, shortened, and elevated as if it were gathered up into the popliteal space with hard and resisting edges, the shortening, arching, and thickening of the foot, the turning back or extension of the toes, the exact relation between the form and direction of the deviating parts of the foot and the contracted muscles, which are stretched resisting

and projecting under the skin; finally, the almost immediate restoration of the regular form by the section of the retracted muscles. Seeking then to determine the constitution and essential signification of the phenomenon of convulsive muscular retraction, I showed that this phenomenon is neither simple nor absolute, but compound, and of variable expression, according to its different stages. Thus I showed that convulsive retraction comprehends three distinct elements, which have each their own peculiar influence, viz., the immediate shortening of the muscle, a certain degree of paralysis, and a consecutive arrest of development, which prevent it from proceeding in its growth with the growth of the skeleton, and which increases, during the growth of the subject, the primitive shortening of the retracted muscles; so that every deformity examined after the access of the disease which has caused muscular retraction is the result of three elements constituting this retraction. Besides, I have shown, that these three elements exercise a variable influence on the development, form and increase of club-foot, according to their degree and situation, and to the different muscles of the foot and leg in which they occur.

In the latter part of this treatise I tested the question whether there existed other causes of congenital club-foot, or if the causes formerly admitted could give origin to deformities presenting the characters which I have attributed to club-foot owing to muscular retraction. Recalling to mind the law which I have established on the specific nature of the external characters combined with the specific nature of the causes, I have shown that amongst the influences admitted by authors, some are purely imaginary, and merit no consideration, others are real, but are either the indirect discoveries of more or less distant consequences of muscular retraction, or of consequences implied under muscular retraction, or they constitute the real causes of deformity, but the deformities to which they give rise have not the true characters of genuine club-foot, and on the contrary present characters peculiar to the cause which deter-

mines them. Amongst these last I have cited a deformity of the foot, produced by compression of the foetus in the uterus, a deformity which has not been specified hitherto, and which consists in a general transverse flattening of the foot, in which all the parts of the extremity equally participate, bones, ligaments, muscles and skin, in such a way as perfectly to explain the uniform mode of action of a continued mechanical pressure.

Having submitted to the Academy the contents of this memoir, and the principal facts which it contains, I shall close with the following conclusions :

1st. That congenital club-foot is the product of convulsive muscular retraction, or contraction of the muscles of the leg and foot. This retraction may be produced by a general or local affection of the nervous system.

2nd. Congenital club-foot, when wanting general or direct traces of a convulsive affection, carries with it immediate characters, by the aid of which we can always recognize the nature of its cause.

3rd. The fact of muscular retraction is complex ; comprehending three distinct elements ; immediate shortening of the muscle, a certain degree of paralysis, and consecutive shortening or arrest of development of the retracted muscle ; each of these elements concurs to perform its part in the formation of club-foot, and acts differently according to the degree and seat of the retraction in relation to the muscles which it affects.

4th. There does not exist any other cause of congenital club-foot except convulsive muscular retraction ; other circumstances capable of deforming the feet before birth, impress their own peculiar characters, which makes them easily recognizable, and prevents their being confounded with genuine club-foot.