** A THESIS **

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A clinical and pathological study of an unusual case of progressive muscular dystrophy - type facio-scapulo-humeral - with special reference to its nosology and pathogeny.

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- P R E F A C E -

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R. M. M.

- C O N T E N T S -

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INTRODUCTION.

The essential aim of this thesis is a careful, comprehensive record of the clinical details of a case of progressive muscular dystrophy (type facio-scapulo-humeral), along with the results of a systematic investigation of the pathological material which it furnished. From the very outset was recognised the futility of seeking to base anything in the shape of crystalized opinions on the clinical or pathological facts, which a single case, however carefully investigated, presented to us. Accordingly, in the attempted realization of our aim we have constantly kept before us the necessity for the most scrupulous accuracy of description, and have sought to reflect in our phraseology the degree of actual, personal conviction with which we have penned each statement. But certain facts particular to this case of dystrophy, which we shall immediately specify, have either forced on our consideration certain broad questions that we have felt bound to answer, or demanded an explanation of their essential significance. In our treatment of these considerations our object has been to

limit, as far as possible, the conclusions at which we have arrived to the particular case that necessitated their treatment. In short, our desire throughout has been to collect and weigh evidence, not to attempt a final judgment.

As has just been stated, certain facts in the following record are so suggestive as to raise certain questions for consideration. It has, therefore, been thought advisable to preface our treatment of the matter with a general argument, so that the reader may peruse our clinical and pathological records with a knowledge of the questions which certain of their facts logically raise.

It is now some fifteen years since Erb finally completed the separation of the dystrophies from the spinal amyotrophies. He based that separation on clinical grounds, and proceeded to show how the clinical observer might predict the details of the morbid anatomy of any case of muscular atrophy, progressive in character. Further than that he was not, however, prepared to go, but advocated that, although capable of that distinction, the dystrophies and the spinal amyotrophies should be considered as two phases of one pathogenetic process, a disturbance of the trophic influence of the anterior spinal neurone. Even the great authority of Erb's name was not able to prevent the still birth of this hypothesis. The trend of opinion has steadily been towards an absolute separation of the two diseases. The fact that the dystrophies are not associated with any discoverable anatomical lesion in the nervous system is now regarded as proving that the dystrophic process is entirely independent of any nervous influence; their tendency to appear in families and their usual onset in infancy and early adult life have suggested that the morbid process is radically a congenital, defective formation of muscular tissue. The one disease is, therefore, a congenital muscular affection; the other is the result of a nervous affection. It is impossible to imagine a

more absolute distinction than this; it allows of no compromise. However, satisfactory as it may prove to the morbid anatomist, it, not infrequently, is a stumbling block to the clinical observer. For instance, in the subject of the following record the onset of the malady occurred about the age of fifty - a fact which is irreconcilable with the purely muscular hypothesis. But, further, the association of a psychopathic heredity along with the coincident development of a psychopathic state rendered this fact all the more remarkable and inevitably raised the question of the pathogenetic process of this particular instance. This matter we have discussed at some length, and have sought to support our conclusions by adducing evidence from other sources to show that these are warranted.

Although we owe to Erb the final separation of the dystrophies from the spinal amyotrophies and their distinction as a definite, morbid entity, it cannot be forgotten that several observers had come within measurable distance of anticipating his generalization. These observers had recognised, as clinically atypical, certain cases of progressive muscular atrophy, and had demonstrated in several of these cases a common, anatomical speciality. They were, however, so taken up with emphasising the slight differences, which existed between their respective cases, as to lose sight of the profound analogies that existed between them. Accordingly, each observer described his particular group of cases as an essential type of progressive muscular atrophy and jealously guarded its autonomy. We have fallen heir to these generic titles, and, as they carry with them many of the unwarranted prejudices which gave them origin, then tend, in any given case, to obscure the issues at stake. In no instance is this more truly exemplified than in the titles, which may be applied to the form of dystrophy that our patient exhibited. In his case the distribution of the dystrophic process was facio-scapulo-humeral. To this type of distribution modern

writers indiscriminately apply the titles, "Infantile form of Duchenne" and "the form of Landouzy and Dejerine." The inapplicability, so far as our case is concerned, of the first of these titles is too apparent to require emphasis, whereas the second title is associated with such restricted views of the significance of the involvement of the facial muscles as to make it equally unsuitable. We have, therefore, been tempted to discuss the exact significance of this particular distribution of the dystrophic process, and, more especially, the significance of the involvement of the facial muscles in the dystrophic process.

Finally, the nerve-cell changes, which the Nissl method demonstrated in the motor cells of the cervical enlargement of our patient's spinal cord, demand that we attempt an explanation of their significance. From the very facts of the case any such attempt, if, indeed, it escapes being inadequate and inconclusive, must appear largely hypothetical. The introduction of a new histological method is, of necessity, followed by a period of transition in our conceptions of many pathological processes. Our most cherished theories, if they actually escape the melting pot, may have to be curtailed and remodelled to square with the facts revealed by a more precise method of investigation. The Nissl method has produced such a transition stage in the sphere of neurological pathology. By its aid we are able to recognise minute nerve-cell changes which were formerly hidden from us. Investigators have shown that these changes are usually consequent on certain physiological states of the organism as a whole or on certain pathogenetic process at work in the nervous system itself. But any attempt to recognise from the particular character of these nerve-cell changes, which process is responsible for them, must be regarded as having been largely futile. It is now, however, generally held that lesions of the chromatic part of the cell do not represent more than a reaction to a disturbing force and are reparable; changes of the achromatic substance must

be regarded as degenerative and irreparable. On the other hand, our knowledge of the consequence of these nerve-cell changes on the functional activity of the neurone is more explicit. While the chromatic substance probably plays an important part in the functional metabolism of the neurone, function may remain intact within certain limits of its structural alteration. Function is, however, entirely suppressed when the structural dispositions of the achromatic part are altered as they appear intimately related to nervous conduction. These, then, are the guiding principles that we must follow in attempting to estimate the significance of these particular nerve-cell changes; an attempt which involves the necessity of deciding whether they are due to a physiological state or to a morbid process, and, if possible, the especial nature of the causative process.

In our detailed treatment of these considerations, it has been thought that continuity of argument, if, indeed, such a desideratum be possible, would be best attained by considering them in the following order:-

(1) The clinical significance of involvement of the facial muscles in cases of progressive muscular atrophy and dystrophy.

(2) The pathogeny of the case of progressive muscular dystrophy which forms the subject of this essay.

(3) The significance of the nerve-cell changes presented by the motor cells of the cervical enlargement in this case of dystrophy.

CLINICAL DETAILS.

The patient, A. Baxter, 68 years of age, was admitted to Woodilee Asylum on the 19th August, 1903. The facts of the medical certificates, under which he was admitted, were as follows: "He is stupid and restless; te talks in a rambling fashion; his memory is very defective, and he is subject to insane impulses." HEREDITY:- A satisfactory "family history" was not obtained; the following bare facts represent all that was known of Baxter's stock. His Father and Mother died at advanced ages; but, although his Mother had been bedridden for a considerable time, a definite disease could not be assigned as the cause of death in either instance. Beyond the fact that several of his maternal uncles and aunts had died of consumption in early adult life, nothing

ADDENDUM.

Family history:- Baxter was one of a family of three; of whom an unmarried sister died in middle life from consumption, while a married brother, a man of robust health, ten years ago, was under treatment for several months, in Bothwell Asylum. Nothing is known of this brother's family.

As far as possible, the subjects of the foregoing narrative were personally seen with, in every instance, a negative result. PREVIOUS HEALTH:- In infancy he had smallpox. About twenty years ago he had dysentery and yellow fever in the West Indies. His convalescence, though protracted, was complete; but, ever since then, he has been subject to severe attacks of diarrhoea, with generalised abdominal pain and haemorrhagic motions. These attacks usually followed an indiscretion is his dietary. Sixteen years ago he fell from the rigging of a ship to the deck, and sustained injuries which caused him to lie up for a month. He does not connect this mishap in any way with his present debilitated condition.

HABITS and CIRCUMSTANCES:- The patient has lived a hard life. From boyhood up to his accident, sixteen years ago, he was a sailor. He was always rated as "able bodied"; the majority of his voyages were on sailing ships and he always found himself equal to everything in his day's work. During this period he indulged in frequent drinking bouts, but saved considerable sums of money from his wages. Since his accident he has been working either as a stevedore or as a stoker on coasting steamers. During this period, he has drunk as much whisky as he could get, and has squandered all his savings.

HISTORY of PRESENT ILLNESS:- About six years ago he began to express himself as feeling unfit for a good day's work, but persevered at it with, however, gradually lengthening periods of idleness. These remissions, which were accompanied by great exhaustion and a steadily increasing unhealthiness of his appearance, were put down by his friends to the irregular life he was leading. It was, indeed, this moral degradation that appealed to them as the most striking alteration in his condition, and which manifested itself in an absolute disregard for all social and family ties, by an absence of personal restraint and the loss of all interest in life. Eleven months ago he had to give up work. Since then he has become steadily weaker and more depraved; has lost, to a marked extent, his memory; and, quite recently, has developed delusions of suspician regarding his wife. On several occasions these have led him to attempt to do her some injury.

PHYSICAL EXAMINATION. (Nov. 1, 1903). The following represents his condition on the first occasion on which he came under our observation. The patient is confined to bed. He can assume any decubitus, but prefers the dorsal. He is able to move, unassisted, in and out of bed. Station, in all its refinements, is normal. When walking about he carries his head erect and his back straight; nothing atypical is noted in his gait.

The facies has a peculiar, stereotyped, sad expression; whatever sentiment he may express the physiognomy has no correlation with it, but preserves a mask-like expression in strong contrast with the animation of the eye. The brow has several well marked wrinkles. The eyebrows are prominent, but he can only approximate, or pucker them with difficulty. The eyes are widely opened, and are usually full of tears. Elevation of the upper eyelids is well carried out although its amplitude of movement is inconsiderable. The lids can be completely shut. During repose the mouth is half open. The upper lip, whose free border is well formed, is curled on itself, as is also the lower. The patient can approximate the lips perfectly, but he cannot form the buccal slit into a complete circle, as in whistling. When he laughs the transverse diameter of the mouth becomes unduly elongated. The alae nasi move slightly during forced respiration and when he bears the upper incisors. He can puff out his cheeks, but cannot keep the air in them under much pressure.

The tongue is symmetrical but rather large; it is protruded in the middle line, and the intrinsic muscles do not show fine movements. The sense of taste is quite sharp. There is a general defect in articulation, but it does not conform to any recognised type, and seems to depend on the lack of precision in the movements of the lips. The palate moves well on phonation. Mastication and deglutition are perfectly accomplished.

There is a well marked arcus senilis in both eyes. The pupils are equal, and respond to light, on accommodation, and consensually. There is no paresis of the orbital muscles. No contraction of the visual fields is noted, and the retinae, beyond undue tortuosity of the vessels, appear normal.

The cervical and nuchal muscles appear firm and well developed.

The appearance of the shoulder-girdles is very striking. They have slipped downwards and forwards, so that both sterno-

clavicular articulations are on a lower plane than both acromio-clavicular articulations; both supra-clavicular triangles face rather forwards, and looked at from the front, the outlines of their posterior margins are broken by the projection upwards of the inner angles of the scapulae. The scapulae are unduly prominent and ill applied to the thorax; with their inner angle as axis, they have undergone a degree of rotation, the lower angle being approximated to the vertebral column and the outer angle depressed. Although this simulates, it does not characteristically present the condition of alar scapulae. Of the muscles around the shoulder-girdles, which can be examined by inspection and palpation, the deltoidei, the supraspinati, the infraspinati and the teretes majores are alone satisfactorily represented. Behind, the trapezii the latissimi dorsi and the serrati magni have practically disappeared; in front, the left pectoral mass is only represented by a slight fleshiness of the anterior axillary fold, while on the right side even this is absent.

The erectores spinae muscles seem well developed, as also the muscles of the abdominal wall. No deformity of the vertebral column is noted.

The well nourished condition of the muscles of the fore arms is in striking contrast with the atrophic condition of the muscles of the arms. The forearms are those of a fairly muscular man; and, in no single instance, is it possible to demonstrate by inspection or palpation the slightest degree of atrophy of their muscles. The left brachialis anticus, on the contrary, has almost disappeared; the left biceps is only represented by a thin ribbon of muscle; and the left triceps, although comparatively well represented, is markedly affected by the atrophic process. The muscles of the right arm are not involved to such an extent, but the relative degree to which identical muscles are affected is strictly comparable; thus, in both arms, the brachialis anticus is most affected and the coraco-brachialis

least. Both hands appear quite normal, there is no suggestion of deformity, the thenar and hypothenar eminences present nothing abnormal in their size or in their power, as is also the case with the interossei.

The measurements of the upper limbs are as follows:-

Arm:	Smallest diameter:	right $7\frac{1}{4}$"	left $7\frac{3}{4}$"
Forearm:	1" below bend of elbow:	" $10\frac{1}{2}$"	" 10"
	at the wrist:	" $7\frac{1}{8}$"	" 7"

One of the most striking clinical features of this case is the range and power of the movements that the patient can carry out with his arms, and which are out of all proportion with the atrophic condition of the majority of the muscles of both scapulo-humeral groups. During repose, the arms hang by the sides, the forearms are slightly flexed on the arms and semi-pronated. With a weight of 10 lbs. in either hand, he can raise both arms above his head, and sweep them down across his chest, or hold them out in front of him, at right angles to the trunk, and circumduct them until they meet behind. He can exert a considerable power in thrusting or pushing forward. These movements are briskly but smoothly carried out, and seem to be due to the well nourished condition of each deltoideus, which, supplemented by the supraspinatus, the infraspinatus, the rhomboidei, the teretes muscles and, probably, the subscapularis muscle, is capable of carrying out the movements that are occasioned in health by the latissimus dorsi, the trapezius, the pectorals, and the serratus magnus.

It is impossible to arrive at any concise idea of the exact muscular apparatus involved in any given movement; but, after careful investigation, the following analysis of the muscles, which are especially involved in some of the simpler movements, has been attempted. As in health, elevation of the arm to a right angle is carried out by the anterior fibres of the deltoid, but elevation above this level is carried out in the following

fashion; the inner scapular border is fixed by the rhomboidei and the lower scapular angle is rotated outwards, so that, not merely is the already existing scapular rotation (outer angle downwards) corrected, but the outer angle is elevated to such an extent that, if slight flexion of the elbow be allowed, the hand can be made to touch its fellow above the head. The arm is lowered from this position by the force of Gravity, and by the gradual relaxation of the muscles involved in its elevation, but in this movement he cannot overcome the slightest resistance; for example; he is not able to pull the chain which controls the valve of a cistern of an ordinary sanitary fitting. The arm is carried forwards by the anterior fibres of the deltoid and the supraspinatus , but, although the palms may be approximated in front, they cannot be pressed together with energy sufficient to retain an ordinary book between them.

Pronation and supination of the forearms are well performed; but if there be any weight in the hand, he cannot flex the forearm of that side on the arm without moving the former into a position midway between pronation and supination.

There is nothing of interest to note about the condition of the muscles of the lower extremities. The measurements of the lower limbs, at the following diameters, are:-

Thigh:	middle of femur :	16½ inches.
	2" above the knee:	14¾ "
Leg:	1" below the knee:	12 "
	middle of calf:	14½ "

Common tactile sensation is quite sharp and its localization is fairly accurate. The sense of pain, the sense of temperature, and the sense of weight are normal; the patient, however, cannot tell the sharp end of a pencil from the blunt.

The superficial reflexes are all active. The knee jerks and the Achilles tendon jerks are normal. The triceps jerks are abolished, but the wrist tendons jerks are active on both sides.

The plantar reflex is flexor in type. Ankle clonus cannot be elicited. The bladder and bowel reflexes are normal.

The skin, hairs and nails have a well nourished appearance, and no vaso-motor disturbances are noted.

The pulse averages 68 beats per minute and is regular in force and rhythm. The arterial system is rigid and tortuous and at many points the arteries feel like cartilaginous tubes. The apex beat is situated in the 5th intercostal space, 4¼" to the left of the midsternal line: At the level of the 5th rib the cardiac dulness measures 3¾". The cardiac sounds are free from murmur, but the second aortic sound is accentuated.

The chest is barrel-shaped. During ordinary respiration little movement of the thoracic wall is noted, but the abdominal wall moves freely. The percussion note is generally hyperresonant. The R.M. is puerile in character and is accompanied, at either base, with large moist and dry râles.

The abdominal examination is negative.

The urine has a specific gravity of 1025. It is of acid reaction and does not contain albumen, blood nor sugar.

ELECTRICAL EXAMINATION:- In the examination with faradism currents induced at comparatively infrequent intervals have been employed (8 to 10 per second); but in several instances, which will be indicated in our tables, the intervals were more frequent (20 to 30 per second).

The constant current was obtained from the electric main; the strength was regulated by a shunt rheostat and the current used was measured by a D'Arsonval galvanometer. The use of a current reverser permitted the examination to be made alternately with the kathode and anode poles under, as nearly as possible, the same conditions.

In both methods of examination the indifferent electrode measured 4" by 6", and the exploring electrode was a circle ¾" in diameter.

FARADIC CONTRACTILITY.

The facial muscles.	Right.	Left.
*Orbicularis palpebrarum	5 inches	5½ inches.
Zygomatici major et minor.....	6½ "	7 "
Levator labii superioris.....	7½ "	7½ "
Buccinator.....	7½ "	7½ "
*Orbicularis oris.....	4¾ "	6 "
Frontalis.....	7½ "	7½ "
Temporal.....	7¾ "	7½ "
Masseter.....	7½ "	7½ "
*Facial Nerve.....	6¾ "	6¾ "

*In these observations the currents had from 20 to 30 intervals per second.

When either facial nerve is stimulated with a current of 6¾", although the majority of the facial muscles on the corresponding side contract, the orbicularis oris and the orbicularis palpebrarum are not excited. If the left facial be stimulated with a current of 5¼" the left orbicularis oris is excited. The patient will not allow the use of stronger currents.

The Muscles of the Neck.	Right.	Left.
Splenius.....	6¾ inches.	6¾ inches.
Sterno - cleido - mastoid.....	7¼ "	7¼ "
Levator Auguli scapulae.....	7 "	7 "
Hyoid muscles.....	7 "	7 "
Supra clavicular point.....	6¾ "	6¾ "

When a current is used to stimulate either supraclavicular point, the deltoid, the coraco-brachialis and the supinator longus, on the side stimulated, are excited, but the biceps, and the brachialis anticus do not respond; when the left supra-clavicular point is stimulated with a current of 5¾" the left biceps contracts: the patient cannot suffer the use of currents sufficiently powerful to ensure contractions in the right biceps or either brachialis anticus.

The shoulder girdle muscles.	Right	Left
Rhomboidei.....	6¾ inches	6¾ inches
Infraspinatus.....	7 "	7 "
Supraspinatus.....	7¼ "	7¼ "

The trapezius, the pectoralis major, the latissimus dorsi, and the serratus magnus do not respond, on either side, to any current that the patient will bear.

The muscles of the upper limb;	Right	Left
Deltoid.....	7 inches	7¼ inches
Biceps.....	5½ "	6¼ "
Triceps.....	6½ "	7 "
Coraco-brachialis.....	6¾ "	7 "
Brachialis Anticus.....	5 "	5½ "
Supinator longus.....	7 "	7 "
Pronator radii teres.....	7¼ "	7¼ "
Extensor communis digitorum.....	7¼ "	7¼ "
Extensor minimi digiti.....	7¼ "	7¼ "
Flexor sublimis digitorum.....	7¼ "	7¼ "
Flexor profundus digitorum.....	7 "	7 "
Flexor carpi radialis.....	7¼ "	7¼ "
Extensor carpi radialis.....	7¼ "	7¼ "
Palmaris longus.....	7¼ "	7¼ "
Abductor longus pollicis.....	7¼ "	7¼ "
Flexor longus pollicis.....	7¼ "	7¼ "
Extensor longus pollicis.....	7¼ "	7¼ "
Thenar Group.....	7½ "	7½ "
Hypothenar Group.....	7 "	7 "
Interossei.....	7¼ "	7¼ "

Thigh Muscles.	Right	Left
Quadratus Femoris.....	6¾ inches	6¾ inches
The Adductors.....	7 "	6¾ "
Biceps.....	7¼ "	7 "

The muscles of the feet and legs respond to currents varying between $6\frac{3}{4}$" and $7\frac{1}{4}$".

Galvanic Contractility.

The patient could not suffer the use of currents sufficiently strong to excite contraction of the facial muscles.

The shoulder girdle muscles.	Right.		Left.	
	K.C.C.	A.C.C.	K.C.C.	A.C.C.
Rhomboidei.....	10 M.A.	16 M.A.	15 M.A.	20 M.A.
Deltoid.....	16 "	24 "	20 "	28 "
Supraspinatus.....	14 "	18 "	11 "	16 "
Infraspinatus.....	16 "	18 "	13 "	22 "

It was impossible to employ currents of sufficient strength to excite contractions in the trapezius, the pectoralis major, the latissimus dorsi and the serratus magnus muscles.

The muscles of the arm.	Right.		Left.	
	K.C.C.	A.C.C.	K.C.C.	A.C.C.
Biceps.....	20 M.A.	24 M.A.	24 M.A.	35 M.A.
Triceps.....	22 "	30 "	28 "	38 "
Coraco-brachialis.....	12 "	16 "	14 "	19 "
Brachialis anticus.....	No response obtainable.			

The muscles of the forearms, hands and lower limbs respond to galvanic currents of medium strength.

In every instance the contraction wave had a normal character.

CLINICAL COURSE:- The period during which the patient remained under observation was sharply, yet naturally, divided into two by the incidence of a tubercular lesion in the left lung that proved rapidly fatal. During the first moiety- extending roughly to eleven months- the clinical picture was that of a steadily progressing atrophy of the muscles already affected but with little tendency for the process to spread to the unaffected muscles: in the second moiety- of 4 months duration- all the features of acute phthisis pulmonalis were superadded.

On July 15, 1904, the patient's condition was as follows:-

The expression of the face is unaltered. During sleep the eyelids of both eyes are not completely approximated, but the hiatus on the right side is more marked than that on the left. Under the influence of the will the eyelids of the left eye can be approximated but with little strength, whereas those of the right eye are hardly approximated. The amplitude of movement of both upper eyelids is distinctly more restricted than on admission. There is no apparent change in the muscles of the shoulder girdles, trunk and upper limbs. Fibrillary contractions are, however, noted in the right supinator longus. If the muscle has been in a quiescent state, previous to the examination, no fibrillation is noted; however, a smart tap with the edge of the stethoscope is sufficient to elicit it in an indefinite and evanescent fashion; or, if the muscle be freely exercised previous to the examination typical fibrillation develops spontaneously and persists for a considerable time. Although the muscle is soft and lacking in tone, there is no alteration in its responses to the faradic and galvanic currents.

On July 31, 1904, examination of the chest revealed nothing striking to percussion, but on auscultation the R.M. appeared deficient at the left apex and the enpiratory portion was broken up by fine moist râles.

August 25, 1904. For the past few days the patient has complained of severe pains in both legs. His description of these pains is suggestive of "lightning pains". Sensation is normal in the legs and the reflexes are active.

Sept. 4, 1904. A catarrhal conjunctivitis has developed in the right eye.

Sept.20, 1904. There are now well marked signs of softening at the left apex. The patient constantly complains of a dull, aching pain in the small of the back associated with some tenderness over the second lumbar spine. Occasionally, he experiences paroxysms of violent pains shooting down the course

of both sciatics. There are no other sensory symptoms and the motor and reflex functions of the lower extremities are normal. The condition of the right eye is very unsatisfactory. The conjunctivitis has resisted all treatment, and a corneal ulcer has developed.

Oct. 19, 1904. To-day the patient is sinking. There is marked dulness at both bases with bronchial breathing and medium-sized moist râles.

Oct.22, 1904. The patient died early this morning.

MENTAL CONDITION:- On admission the patient's mental condition was that of toxic confusional insanity. He was confused in mind; he could not give any rational account of himself, and was quite ignorant of time or place. He declared that his wife had stolen all his money and had sent him here to be killed. The voice of God, however, always warned him in time to prevent the attendants realizing this. He sometimes refused to take his food as it was poisoned. At other times he became very impulsive, would threaten those near him, and would even throw at them whatever he could lay hold of.

During residence the outstanding features gradually left him, and he settled down to a very considerable extent. He was, however, very fickle in temper, but, as a general rule, took little interest in what went on about him and expressed no desire to see or talk with his relatives. On one occasion he was allowed home on probation, but he was so difficult to manage that he had to be re-admitted within three days.

MORBID ANATOMY.

The autopsy was performed 12 hours after death.

The body was that of a markedly emaciated man, especially of the arms and trunk. The thorax was flattened in its autero-posterior diameter. The circumferences of the thorax, measured at the level of the nipples was 29" and, at the level of the xiphoid cartilage, 28". The right arm at the bicipital region measured 7" in circumference, while at the same level the left measured 7½". The forearms, in both instances, measured 1" below the bend of the elbow, had a circumference of 9½".

While laying open the peritoneal and pleural cavities we saw that the muscles of the abdominal wall, the intercostal muscles and the triangularis sterni muscle were normal in colour and thickness; the diaphragm did not present any evidence of atrophy.

The lungs were so adherent that, after removing the heart, they had to be extirpated "en masse" with the rest of the pleural contents. On section, at both apices several small deeply pigmented areas were disclosed, and, in addition, at the left apex there were several small cavities. The cavities did not contain pus but their walls were shredy and friable. Surrounding these and extending well into the upper lobe, the lung tissue was markedly congested; and towards the base of the right lung there was a nodule of hypostatic congestion.

The pericardial fluid was normal in amount. The aortic and pulmonic valves were competent. The heart cavities contained large masses of antemortem clot. The heart muscle was soft and flabby. The mitral and tricuspid valves were normal. The aorta showed scattered patches of atheroma. The left coronary vessel was markedly atheromatous; the portion in the anterior-ventricular septum was absolutely rigid and cut like cartilage so that the lumen was very small indeed.

The liver was large, soft and flabby. The gall-bladder was distended with bile.

The spleen was soft and pulpy.

The kidneys were soft and of good size. The capsules were somewhat adherent and the cortices slightly thinned.

The skull was symmetrical and thick. The duramater was slightly thickened. The pia-arachnoid was somewhat opaque. The Pacchionian bodies were large and prominent. The convolutions were large and simple with shallow sulci. The cortex was of good consistency, pink in colour and exhibited well marked striation. There was tubercular caries of the second and third lumbar, vertebral bodies, with an entradural collection of thick, curdy pus. The cord was of fair consistency and of average size throughout.

A careful dissection of the muscles of the limbs and trunk was made; but, as an examination of the face was refused, no idea of the condition of the facial muscles was gathered, with the exception of the frontalis, and orbicularis palpebrarum which were examined after reflecting the scalp. On both sides the frontalis muscle, although undoubtedly affected by the atrophic process, was still recognisable as a definite muscular mass; but no undoubted vestige of the right orbicularis palpebrarum was discovered, while, on the left side, a few brownish strands were all that remained of this muscle.

The nuchal muscles were normal in colour and thickness, as were also the muscles of the neck.

The right and left trapezius were represented by membranes about the thickness and colour of ordinary chamois leather, but with several coarser strands, which appeared to be muscular tissue, running through them. It was found impossible to satisfactorily delimit what was left of the muscles from the subcutaneous tissue. The same difficulty was experienced in the case of both latissimi dorsi, which were affected in equal degree. The rhomboidei, the teretes, the supraspinati, the infraspinati, the erectores spinae and the subscapulares muscles

were well represented and had a healthy appearance.

The pectoralis major, on both sides, was involved to about the same degree as the trapezius; each pectoralis minor and each serratus magnus muscle, although comparatively well represented, was of a uniform greyish yellow colour.

In both arms the deltoid and coraco-brachialis muscles were well represented, and had a healthy colour throughout. The left biceps in its greatest diameter measured about 1¼" and the right biceps about ¾". Both muscles had a dull yellowish grey colour on the surface, but, on section, they presented a speckled appearance, dark brown areas being interspersed with yellowish grey areas; the latter predominated at the periphery. The right and left brachialis anticus muscles had a uniform dull, grey colour; they had a fibrous consistency and measured at their greatest diameter about ½". The triceps in both arms were in every way similar to the biceps.

The muscles of both forearms and both hands were well represented and had a healthy colour.

Nothing abnormal was noted in any of the muscles of both lower limbs.

The muscles of the tongue, the hyoglossus genio-hyo-glossus and stylo glossus muscles with the muscles of the soft palate, larnyx, and pharnyx were normal in thickness and colour.

MORBID HISTOLOGY.

THE MUSCLES:- Pieces were taken from the left biceps, deltoid, brachialis anticus, latissimus dorsi, trapezius, pectoralis major, orbicularis palpebrarum and supinator longus. They were fixed and hardened for 24 hours in 10% formalin. The staining methods employed were haematoxylin and eosin, haematoxylin and Van Gieson, Marchi, and haemalum and sudan III.

From their microscopical details these muscles may be conveniently arranged in the following four classes:-

(1) Muscles which presented a perfectly normal appearance (the deltoid, and the supinator longus.)

(2) Muscles which presented various alterations from comparatively normal areas to areas devoid of any muscular fibres (the biceps and the triceps.)

(3) Muscles which presented at no point the appearance of normal muscular tissue, but were not altogether devoid of muscular fibres (the orbicularis palpebrarum, the pectoralis major and the brachialis anticus.)

(4) Muscles which were quite devoid of muscular strands (the trapezius, and the latissimus dorsi.)

For the sake of brevity we shall describe in detail the appearances of a muscle from each of these Groups, with the exception of the first, as the most careful examination failed to detect anything abnormal in their microscopic structures.

THE BICEPS:- A transverse section, examined under the low power, shows that the morbid process has a very erratic distribution. It indiscriminately and individually affects the muscular fasciculi so that one showing the most profound structural alterations is often found in the midst of, and sharply defined from, comparatively normal fasciculi. It is, however, questionable if a single fasciculus may be regarded as perfectly normal. Although the muscular fibres may have a perfectly normal appearance, there invariably is a hyperplastic condition of the perimysium and

endomysium, especially well marked in the neighbourhood of their vessels. Even at this stage the vessels show a marked condition of periarteritis and endarteritis and in their immediate vicinity a few globules of fat. The earliest change, which has been detected in the muscular fibres, is an undue inequality of their diametrical measurements. This inequality is due to a decrease, rather than an increase, in the size of the fibres. In such an area the greatest diametrical measurement we met with was 0.06 mm. While a diameter of 0.035 mm. indicates the average with a minimum of 0.02 mm. As the hyperplastic condition of the connective tissue increases so does the variation in size of the muscular fibres become accentuated. It is then that hypertrophied muscle fibres appear. In a fasciculus showing well marked fibrosis a fibre measuring 0.1 mm. in diameter is met with. About this stage the muscle fibres begin to lose their affinity for the muscular stains we employed, and in certain areas this is so marked that, even with the Van Gieson stain, it is impossible to distinguish them from the surrounding tissue. Following this, possibly as a result, there is a gradual diminution in the number of discoverable fibres in a fasciculus up to the point of absolute disappearance. In the latter case the cast of a muscular fasciculus remains made up of a network of fairly coarse connective tissue containing fat globules and with a hyaline material in its larger meshes. This glassy material takes on a bright pink colour with the Van Gieson stain but only stains faintly with the eosin and haemalum stains.

In the areas, which show little beyond hyperplasia of the connective tissue, the high power shows a marked contrast between the nuclear elements of the muscular and the connective tissue. The former are not notably increased and show no special avidity for the nuclear stains; the latter are markedly increased and stain very intensely. This may be taken as applying generally but in other situations where the hyperplasia is more marked, it

is more difficult to be perfectly convinced on the point. The cross sections of the muscle fibres lose their Cohnheim's areas at a very early period, in many cases before the fibres lose their power of selective staining. The casts of muscular fasciculi described above, are composed of trabeculae of very vascular connective tissue, while the fine hyaline material in its larger meshes appears quite structureless. These vessels exhibit all stages of endarteritis obliterans.

Under the low power a longitudinal section shows the various muscular fasciculi sharply differentiated from each other by thick strands of connective tissue arising from the larger vessels. From these strands, fine processes of connective tissue may be seen penetrating into the interior of the fasciculi. The vessels which accompany these processes and from many suggestive appearances probably precede their ingrowth, are very tortuous and imperfectly formed. Everywhere in the immediate trail of these vessels small fat droplets are seen. The nerve-fibres appear perfectly healthy and do not show any recent degeneration with Marchi's method of staining. The muscle fibres appear very tortuous and have an unequal calibre.

Under the high power the same distinction is noted between the nuclei of the connective tissue and the muscular fibres; but it is impossible to be quite certain that there is not, in any single instance, an increase in size or actual proliferation of the muscular nuclei. In the connective tissue, chains of nuclei 0.25 mm. in length are frequently met with, and very commonly a rouleau of red blood corpuscles is seen, probably, indicating that they are concerned in the formation of blood vessels. The muscular fibres show a variety of changes. In the areas which are comparatively normal a slight variation in the calibre of the fibre at different points of its course, with a tendency to waviness, are all that is noticed as abnormal. In the more affected areas some fibres retain their striation

and their affinity for the ordinary muscle stains, even when reduced to ¼ of their normal size. They tend to develop coarse, longitudinal fissures. Other fibres tend to lose their striation before they have become markedly diminished in size and simultaneously lose their avidity for the muscle stains. This loss is not uniform for at certain points in the course of some fibres the affinity for the muscle stains is retained, and if these points be carefully focussed, faint, incomplete striation is detected. These fibres may remain thus, or develop a fine, wavy, longitudinal lineation. A few fibres have been seen exhibiting these two appearances at different parts of their course. The connective tissue varies greatly in appearance. In some bundles it may be seen growing luxuriantly between the muscular fibres and tending to entwine them with fairly coarse fibrils. In other bundles it has completely overwhelmed them and only the lack of homogeneity in the staining reaction allows us to regard the bundle as composed of connective tissue and muscular debris. Finally, it may have a fine wavy fibrillation quite analagous to that of tendon but lacking the characteristic cellular elements of that tissue. If a piece of this tissue be teased out, it is found to consist of fairly coarse wavy fibres of connective tissue and broad hyaline looking masses which readily fissure.

THE BRACHIALIS ANTICUS.- In no section of this muscle, which we examined, is a single muscular fasciculus encountered that has anything like a normal appearance. Although, here and there, a fasciculus exhibits a few muscular fibres that vary greatly in size and shape, the greater part of these sections present the same structural details as are described in the most affected areas of the biceps.

It is, however, in this muscle that the conditions of the intramuscular nerves and the muscle spindles can be most conveniently studied. These structures stand prominently out from the debris of the morbid process. The intramuscular nerves are of fair size and do not exhibit any hyperplasia of their

connective tissue. Sections stained by Marchi's method do not exhibit any evidence of recent degeneration in their intramuscular nerve-fibres and Weigert's haematoxylin stains the myelin sheaths of these fibres. In regard to the muscle spindles, it is remarkable how numerous they are; it is by no means uncommon to meet as many as three in one field of a $\frac{1}{3}$ inch objective. The nerves to the spindles all stain well. The striations of the intrafusal muscle fibres are well marked and vary between 0.02 mm. and 0.03 mm. It is indeed, striking to meet these apparently healthy muscle fibres in the midst of debris of muscular tissue which is entirely devoid of a healthy muscle fibre. In several instances the capsule has an irregular outline.

LATISSIMUS DORSI:- Did we not know where those sections had been taken from, it would be impossible to conclude from internal evidence what organic tissue they are supposed to represent. Under the low power they are found to be made up of interlacing tracts of a "composite tissue" enclosing, here and there, islets of tissue, roughly, similar to areolar tissue. In many situations the "composite tissue" has a necrotic appearance; it has a structureless ground substance which exhibits no staining reaction, and the few vessels, which it contains, are distended with blood, have markedly thickened walls, with, frequently, a perivascular deposition of fat. At other situations this tissue has a spongy appearance; the structureless ground substance still forms the basis into which occurs an ingrowth of vascular channels having very imperfect walls with, as a further step, the formation of fairly coarse strands of connective tissue in the form of a very loose reticulum. At no point do the islets of fatty tissue present the typical appearance of loose areolar tissue. In fact, all the steps of their origin from the "composite tissue" may be traced in any section. At the outset they are composed of a few fat spaces in the midst of a necrotic area; such areas are most frequently met with in the immediate

neighbourhood of a vessel of large calibre. The subsequent changes consist in the vascularization of the small necrotic areas, interspersed between the fat spaces; but, as the structureless ground substance disappears, fatty droplets take its place.

Under the high power the nuclei are generally noted to be undergoing disintegration. Very few remain in a perfectly normal condition; the majority take on the stain irregularly and have a beaded appearance, with a very indefinite outline. In the highly necrotic areas a uniform powdery appearance is imparted to the structureless ground substance by the nuclear stains. Further, the vascular channels are found to have very imperfect walls, and, indeed, in many instances, they are irregular spaces having no definite line of partition from the structureless ground substance.

THE BRAIN:- Pieces from the motor areas were fixed in Orth's fluid. The sections were stained by Nissl, Weigert-Pal and Marchi's methods.

Throughout all the cortical layers small round cells and Deiter's cells are present in considerable numbers, but most especially in the layer of large pyramids. These large pyramidal cells, though loaded with yellow, granular pigment, have a normal appearance as have also the small and medium-sized pyramids. The sections stained by Marchi's method yield no evidence of degenerated fibres. The tangential, the super-radial and inter-radial fibres are well seen and exhibit no change. There is considerable thickening of the pia-arachnoid, and there is fibrosis of the middle and outer coats of the medium-sized arteries, but there is no endarteritis.

The efferent tracts in the internal capsule, crura, pons and medulla are perfectly normal.

In the pons and medulla there is no diminution in the number of cells lying around the floor of the fourth ventricle. A few cell-bodies exhibiting slight structural changes- increase

in size with loss of normal contour, central chromatolysis and lack of definite demarcation of the nuclear outline- are encountered in the nucleus of the seventh nerve; but such changes are not confined to this group, and, indeed, in the cells of the tenth nucleus such changes, are, if anything, more frequently met with.

THE SPINAL CORD:- The spinal cord was fixed and hardened in Orth's fluid. It was then embedded in photoxylin, and the sections stained by the methods employed in our examination of the brain. The segments of the cervical enlargement were, however, cut in serial section and every tenth section was stained by Nissl's method and examined. It was not considered necessary to employ the same detail in our investigation of the rest of the spinal cord.

THE CERVICAL ENLARGEMENT (Segments C1, 2, 3, 4, 5, 6, 7, 8; D1,2,)

In these segments the anterior cornuae are well formed and no diminution is noted in the number of the cell-bodies which they contain. Many of these cells, however, exhibit marked structural alterations. As the frequency, and situation of these affected cells vary greatly in the different segments, we have attempted to roughly delimit their distribution by estimating the percentage of altered cells found in the various cell groups of each segment. In each segment these percentages have been calculated on the total number of cells, and the number of affected cells counted in the various cell groups of all the sections we have examined. The results may be tabulated thus:-

No. of Segment.	Anterior mesial Group		Antero-posterior mesial Group		Antero-lateral Group		Postero-lateral Group.	
	Right	Left	Right	Left	Right	Left	Right	Left.
C.1	5%	7%	60%	53%	Not represented.		Not represented.	
2	5%	6%	58%	62%	"	"	"	"
3	3%	6%	22%	25%	"	"	"	"
4	1%	4%	4%	8%	25%	27%	35%	32%
5	3%	1%	Not represented.		36%	26%	48%	88%
6	1%	4%	"	"	30%	48%	25%	84%
7	1%	3%	"	"	32%	24%	43%	40%
8	2%	1%	"	"	10%	12%	20%	8%
D. 1	1%	1.5%	"	"	4%	16%	8%	8%
D. 2	1%	2%	"	"	4%	3%	Not represented.	

The affected cells exhibit many varieties of structural alteration. In many instances they have a swollen appearance and are globular in contour. The chromatic masses appear small and do not present their normal, regular disposition, while, especially at the cone of origin of the axis-cylinder, they may be seriously disintegrated: the nuclear outline is usually somewhat hazy and ill defined. On the other hand, some may exhibit deep staining at their periphery with the rest of their protoplasm clear, delicately tinted or powdered with fine, chromatic dust; it is usually impossible to clearly differentiate

their nucleus: not a few of these cells are bereft of processes. In marked contrast to this, many cells are atrophied and have a fusiform or crescentic shape with the processes broken off short; the cell-protoplasm is clear and devoid of chromatic particles and it may even appear finely granular, highly refractile, and exhibit no affinity for the staining reagent. There is invariably dislocation of the nucleus, and it is often found resting on the periphery; the nucleolus may be swollen and have an irregular outline. Finally, not infrequently, all that remains of the nerve-cell is a yellowish mass of pigment, with, perhaps, a few chromatic particles surrounding it, but no evidence of a nucleus.

The sections stained by Marchi and Weigert-Pal's methods do not reveal anything abnormal in the white matter; they show nothing worthy of note in the interlacement of fibres in the grey matter of the anterior-cornua; while the anterior nerve-roots appear in every way normal.

DORSAL REGION (Segments 4, 6, 8, 10, 12) ; and LUMBAR ENLARGEMENT: The anterior horns are well formed, and there is no diminution either of the cells or the fibres composing them. The conditions of these cells, and the cells of Clarke's column were carefully investigated. Speaking generally, it may be said that, while it was by no means uncommon to find cells exhibiting structural abnormalities- irregularities of size and shape, various degrees of chromatolysis, and an excess of pigment- yet in no instance could they be considered as other than sporadic. It was rare to find more than one affected cell in any cell-group, and no particular cell-group seemed especially liable to exhibit such cells.

Marchi and Weigert-Pal's methods revealed nothing abnormal in sections from these regions.

THE PERIPHERAL NERVES:- The facial, the musculo-cutaneous, and the spinal accessory nerves were examined with negative results.

THE SPINAL GANGLIA:- The cells in the spinal ganglia exhibited no abnormalities of structure.

PATHOLOGICAL HISTOLOGY.

The histological changes, encountered in the cell elements of the affected muscles, indicate a disturbance of their normal nutritional balance; they essentially amount to a replacement of the proper tissue elements by connective tissue. In the present state of our knowledge, it is idle seeking to dogmatise as to which side of the balance the initial disturbing force falls upon. A primary affection of the muscle fibres is regarded by many observers as the upsetting force in this nutritional instability; but there are not wanting many observers who assert that the disturbance of the nutritional equilibrium depends upon the proliferation of the connective tissue. We must, therefore, emphasise the fact that, in our sections, no histological evidence is found to support the view that the initial step of the morbid process occurs in the muscle fibres. Erb, who is the foremost exponent of this view, emphasises the importance of the frequent hypertrophy of a muscle fibre with a numerical increase of its nuclei. Although he does not categorically state that he considers this phase to be the first step of the morbid process, he leads us to infer as much. He is, however, very emphatic on the point that this phase is an early alteration in the muscle fibre, probably, preceding the hyperplasia of the connective tissue.

In our sections, it is true, we frequently meet with hypertrophied muscle fibres having at least, a questionable numerical increase of their nuclei; but such fibres have never been found in an area which was comparatively little affected. On the contrary, it may be said that we only meet with them in fairly markedly affected areas. Further, while we commonly see hypertrophied fibres in transverse sections, yet in longitudinal sections we have not seen a single fibre uniformly enlarged throughout its whole extent. As a rule, they are of varying calibre, tortuous, and billowy- phenomena which appear to

largely depend on the highly contractile quality of connective tissue and the semi-fluid consistency of the sarcous elements. It is easy to see how such fibres in transverse sections may appear atrophied, or hypertrophied, according to the level at which the section has been taken. We cannot, therefore, accept this hypertrophy as undoubtedly an inherent, vital phenomenon or regard it as an early- probably the initial phase of the morbid process in the muscle fibre.

As a matter of fact, in the sections which we have examined the muscle fibre changes and the connective tissue changes cannot be separated in point of time; they appear simultaneously and proceed "pari passu." A disparity in the diameters of the muscle fibres,- a disparity which in no single instance is dependent on a hypertrophy of one or more fibres- and a hyperplasia of the connective tissue are the coincident evidences of the process having extended to a fasciculus. As the hyperplasia of the connective tissue waxes so the muscle fibre changes become the more gross, and, there can be little doubt the exuberant fibrous tissue soon becomes a serious embarrassment to the vitality of the proper muscle elements. The muscle fibre may react in one of two ways; it may persist as a gradually attenuating fibre with well marked striation and a tendency to form longitudinal fissures, or it may lose its striation and its affinity for the ordinary muscle stains, and melt into the encroaching connective tissue. It is in the latter class of fibres that we meet granular, and hyaline, degenerative changes. Sooner or later, the fasciculus is replaced by a "composite tissue" in which no undoubted muscle fibre may remain- the debris of the morbid proeess- consisting of a connective tissue network and the altered muscle fibres. This debris is gradually removed by an ingrowth of capillaries carrying with them a loose areolar tissue; and, ultimately, all that is left to represent the muscle are a few masses of vascularizing necrotic tissue,

separated by comparatively large areas of areolar-like tissue.

The early period at which the new formed connective tissue becomes infiltrated with fat is worthy of note. In muscle fasciculi, whose perimysium and endomysium show but the slightest hyperplasia, isolated fat droplets are noted in the interstices of the overgrown connective tissue, especially in the neighbourhood of a vessel. Whatever be the cause of this infiltration, we cannot but recognise in it a characteristic feature of the morbid process. From first to last, it is an invariable consequent on the morbid process, and, while at no period does it reach proportions capable of obscuring the diminished bulk of the muscles, in the end it replaces the greater part of their proper tissue elements.

The changes which we have described in the blood vessels are very similar to those described by Babes in pseudo-hypertrophied muscles. Looked at from the point of view of these changes, the morbid process appears to be largely one of the proliferation, and obliteration of blood vessels. The initial hyperplasia of the connective tissue is always most marked in the vicinity of the vessels and its luxuriant growth is associated with the formation of fairly well formed vascular channels. But when the process has completely destroyed a muscle fasciculus these vessels show a tendency to become completely obliterated. Consequent on this, we have an ingrowth of very poorly formed vascular channels which bring about the absorption of what we have called the debris of the morbid process and substitute in its place loose areolar-like tissue. This is most characteristically seen in the latissimus dorsi and the trapezius, where we see a highly vascular network of ill formed vascular channels, ramifying in a tissue of very low vitality. We do not profess to find in these vascular changes- as Babes does in the vascular changes of pseudo-hypertrophied muscles- the "fons et origo" of the morbid process. They indeed play an important part in

its consummation but are far from explaining, as we shall immediately see, all the facts of the case.

Finally, the perfectly normal state of the muscle spindles, which has been noted even in the most advanced areas of structural disintegration, is a fact at once striking and difficult to explain. Whatever view we adopt regarding the nature of the morbid process, the normal condition of these structures remains enigmatical. If we profess to see in the process a primary affection of the muscle fibres leading to their atrophy, the uniformly normal condition of the intrafusal muscle fibres remains to be explained. On the other hand, the normal capsule of the muscle spindles, which shows no tendency to encroach on its contents, is hard to reconcile with the idea of the process being a primary interstitial sclerosis. To say that the muscle spindle is nutritionally independent of the muscle in which it is situated is simply to beg the question. What is the inherent faculty, which the muscle spindle has preserved, that is capable of preserving the normal balance of its nutrition, although situated in a muscle the seat of an advanced stage of structural disintegration? A satisfactory answer to this question would go a long way to explain the character of the abnormal process in the affected muscles. No such answer has been attempted, and, indeed, in the present state of our knowledge, seems impossible. The normal proeess of nutrition appears to be a more complicated matter than we are accustomed to consider it; and in a given organ probably depends on a mechanism which controls the amount of blood diverted to each constituent tissue element. This mechanism is, in essence, the expression of the relative functional activity of the tissue elements; so that each particular tissue element is supplied with just sufficient blood to keep it in its normal state relative to the other component tissue elements. It is, we are inclined to believe, the derangement of some such mechanism that is responsible for the

morbid changes in our muscles, and, when we consider how the anatomical and pathological characters of such a derangement may vary, appears to go a long way to explain the variety of clinical and histological facts presented by the muscular atrophies, progressive in character.

ON THE CLINICAL SIGNIFICANCE OF THE INVOLVEMENT OF THE FACIAL MUSCLES IN CASES OF MUSCULAR ATROPHY, OR HYPERTROPHY, PROGRESSIVE IN CHARACTER:-

This question opens up to us an interesting historical field, and can only be satisfactorily answered by a more or less detailed account of the evolution of our present views on the subject. Besides, as these historical considerations have not received the place they merit in our medical literature, this course appears all the more essential. The paucity of the observations in Britain of this clinical phenomenon is probably the cause of this neglect; but when we consider the vital questions which have been raised in this connection and are not finally settled, it can hardly be considered out of place in a thesis of this sort to deal with this side of our subject at some length.

The first observation of progressive muscular atrophy with participation of the facial muscles is due to Cruveilheur.

> L.A., 18, presents generalised emaciation of the muscular system accompanied by general paralysis of movement. The muscles of the face participate in this atrophy and paralysis. The face is expressionless and gives the patient a foolish air. One muscle of the face, the orbicularis palpebrarum, has alone been respected, yet its contraction is very incomplete.
>
> AUTOPSY:- Nervous system intact. Atrophy of nearly all the muscles of the body.

Cruveilheur contrasts this case with one in which the muscles of the tongue and the muscles of deglutition were co-incidently affected.

Two years later Duchenne reported many examples of atrophy of the orbicularis oris in the course of progressive muscular atrophy, but in these cases they alone were affected. Ten years later he recorded twelve cases of muscular atrophy that,

several years before the muscles of the trunk and the upper extremity had become affected, appeared in the muscles of the face to which it gave a "physiognomie particulère." He held that this onset of the process in the muscles of the face ought to be considered characteristic of progressive muscular atrophy of infancy. We must not, however, overlook the fact that Duchenne regarded the progressive muscular atrophy of infancy and adult life as the same disease and in support of this he recorded the following triple observation:-

> Progressive muscular atrophy commenced in the cases of a brother and sister, at the age of five in the facial muscles; some years later involvement of the arms and trunk ensued. Their father, at the age of forty-five, became affected by the same disease with the same progressive involvement as in his children but without the facial muscles becoming involved.

In 1873, Eichorst recorded the observations he had made on a family, which presented six generations of atrophics. In every instance the process had commenced in the muscles of the legs. The incidence of the process occurred in adolescence or adult life with one exception: in which case it occurred in infancy and affected the muscles of the face.

During all this time progressive muscular atrophy was, of course, accepted as a clinical unity, but the advance in the study of nervous diseases had separated from it the following: the results of acute anterior poliomyelitis, chronic forms of poliomyelitis, chronic multiple neuritis, the atrophies following joint affections, syringo-myelia and the various secondary spinal amyotrophies. Nevertheless, under the title progressive muscular atrophy, there remained a large number of anomalous cases. Leyden, however, in 1876, proposed to separate, under the title "hereditary", the group of progressive muscular atrophies which

occurred in families; and Moebius, three years later, brought pseudo-hypertrophic paralysis, which also frequently occurs in families, into one group with Leyden's.

In 1883, Zimmerlin published the clinical history of two atrophic families. In both instances they conformed to the type scapulo-humeral, and in one of these families, two members had the facial muscles involved. The families of this observation differed from those of the hereditary form of Leyden-Mobius in that at no time did they present clinically any evidence of hypertrophy or pseudo-hypertrophy. In the same year Erb described his juvenile form. Under this title he gathered a group of cases he had been studying, which differed in symptoms, development, localisation and the actual condition of the tissues from the well defined spinal form. He then proceeded to show that the hereditary form of Leyden, and pseudo-hypertrophic paralysis belonged to this group and suggested that these muscular conditions were not spinal but purely muscular affections in which the nervous system appeared to be intact.

The following year Remak published a case of juvenile muscular atrophy (Erb's form) with involvement of the facial muscles and remarked on this clinical fact: "nothing analogous has been seen since Duchenne and his point of view has not even found a place in medical text books." It is indeed strange to note the air of scepticism which pervaded at this time German medical literature regarding Duchenne's description. Moebius considered the infantile form of Duchenne as "somewhat mythical." Erb only admitted its existence with the greatest reserve, and Strumpell, although he admitted its existence, emphasised its profound analogy with the juvenile form of Erb.

Such, roughly, was the state of our knowledge when, in 1885, Landouzy and Dejerine published their account of "Myopathie

Atrophique Progressive." Under this title, in marked distinction to Duchenne, they sought to establish an autonomy for cases of progressive muscular atrophy with participation of the facial muscles, and they suggested that it should be considered the muscular malady par excellence around which, as a type, we ought to group the infinite varieties of amyotrophy. The facts which led these observers to assign a special nosological category to such cases are best given in their own words:

> "Myopathie atrophique progressive by its essential, original physiognomy can be recognised among all the progressive muscular atrophies. Its symptomatic originality (type facio-scapulo-humeral), its etiological peculiarity (hereditary affection), its anatomical distinction (absence of neuropathy) and its characteristic evolution (slow course) make it for general pathologists the prototype of pure, simple and idiopathic myopathies: pure, because there never is, in the course of the malady, any mixture of sensory paralytic or trophic troubles; simple, because it is not mixed with the amyotrophies nor is there adipose or intramuscular sclerosis; idiopathic, because the affection is a true constitutional myopathy arising, evolving, resting or progressing on its own account."

In this academic definition of "myopathie atrophique progressive" etiological, clinical and pathological facts are adduced to differentiate it from, on the one hand, the myelopathies and, on the other hand, the myopathies of other observers; but to adequately apprise the value of this definition we must consider in some detail not only the significance of these facts but the other myopathies from which they are supposed to differentiate this form.

And first, as regards the myopathies of other observers, from the point of view of these authors they fell into two large classes; in the one, hypertrophy more or less marked, more or

less general always existed, in the other, hypertrophy was always absent. Into the first class naturally fell ordinary pseudo-hypertrophic paralysis, the atrophie musculaire hereditaire of Leyden-Moebius and a certain number of cases gathered by Erb under the title juvenile form. These three forms were myopathies with a more or less marked tendency to hypertrophy but having, as bonds between them, a frequent hereditary origin, an onset before the twentieth year and integrity of the face. In their second class they placed myopathie atrophique progressive, the scapulo-humeral form of Zimmerlin and the Femoro-tibial form of Eichorst. These were myopathies which had at no period of their course hypertrophy of any muscle, or part of a muscle, and, as a general rule, exhibited involvement of the facial muscles.

The etiological data, which these observers considered as warranting this separation of the myopathies into these two classes, depended on the differences of their direct hereditary transmission. Heredity played an all important role in the causation, as they conceived it, of the myopathies; and so constantly has an exhaustive research, if direct heredity were absent, revealed a collateral source that they doubt the possibility of a myopathy originating de novo. But the pseudo-hypertrophic form was a congenital dyscrasia which usually affected the male sex, while myopathie atrophique progressive was a true hereditary disease and in its incidence sex did not play any part. Further, as pseudo-hypertrophy always begets pseudo-hypertrophy, and myopathie atrophique always begets myopathie atrophique, they hold that however strong the clinical and pathological evidence in favour of regarding these two diseases as different clinical forms of the same pathological process might be, such true breeding would still weigh strongly in favour of separating them.

But, far from admitting any clinical evidence in favour

of this unity, they affirmed that clinically the involvement of the facial muscles, the absence of a real increase in size of the muscles and the essential chronicity of the atrophic process sharply differentiated myopathie atrophique progressive from the pseudo-hypertrophies.

"In infants the commencement in the muscles of the face ought to be considered as constant, and Duchenne, as we know, laid great stress on the importance of this clinical character. One can conceive, however, as possibilities either an origin in the muscles of the upper limb or a co-incident origin in the muscles of the arms and face. The onset in adolescence and adult life can assume many types. The face may be first affected and matters ensue as when the affection develops in infancy; the face may be affected after the limbs or it may not be affected at all. But given an atrophic whatever be his age, at whatever period the affection may have commenced if he presents atrophy of the face and no bulbar symptoms he is a myopathic. In pseudo-hypertrophy, the process may rarely spread to the muscles of the face, but the muscles of mastication are also affected."

"At no epoch of myopathie atrophique progressive is hypertrophy ever present, true or false, total or partial, temporary or permanent, in a muscle, or fragment of a muscle; from first to last an atrophy of the muscular system forms the only, and unique, symptom of the disease."

"Myopathics are atrophics who ought to live twenty, thirty, and even forty, years; in certain unsatisfactory hygienic surroundings they tend to contract tubercle. If the prognosis be grave it is not necessarily fatal. Pseudo-hypertrophics seldom attain twenty years."

Finally, they regarded the respective pathological lesions as irreconcilable with the view that pseudo-hypertrophic paralysis and myopathie atrophique progressive were one and the same disease.

> "In myopathie atrophique progressive the essential lesion is a simple atrophy of the muscular fibre, with, or without, preceding hypertrophy, and, as far as the alteration of the sarcous elements, the lesion is fellow to that of pseudo-hypertrophic paralysis. But when we consider the alterations of the connective tissue the homology ceases. In terms of general pathology, we have in both instances to do with a parenchymatous cirrhosis, but the first is an atrophic cirrhosis and the second is a hypertrophic cirrhosis."

About this time Charcot had a most interesting group of cases of myopathy under observation at the Saltpetrière, and in October, 1885, his pupils P. Marie and G. Guinon published the results of this investigation. In this most illuminative paper the clinical details are given of a case of pseudo-hypertrophic paralysis with no apparent change in the bulk of the muscles, a transition case between pseudo-hypertrophic paralysis and the juvenile form of Erb, and four cases of the infantile form of Duchenne. They suggest that these three forms of myopathy should be gathered together under the title "primitive progressive myopathy", for, although there are differences of degree between them, such as slight variation in the localisation of the morbid process, as a rule the most striking analogies abound; and they insist that, if these three forms are to be distinguished, it must be as individuals and not as different species. They then proceed to confute in detail the facts on which Landouzy and Dejerine based their arguments for the autonomy of myopathie atrophique progressive. They point out that far from being a characteristic feature of Erb's juvenile form, the presence in

any given case of hypertrophy appears to depend on the particular muscles affected; thus, certain muscles invariably exhibit the atrophic form of myopathy while others equally often exhibit the hypertrophic form. On the other hand, they cannot convince themselves that hypertrophy is constantly absent in the infantile form of Duchenne, for, in one of their cases, the deltoid, triceps, and crural muscles presented a peculiar consistency quite analogous to that in pseudo-hypertrophy; while in other two the orbicularis oris muscle not merely appeared hypertrophied but presented "nodes on contraction" which is a common phenomenon in a pseudo-hypertrophied muscle. Lastly, they sum up the situation in the following trenchant paragraph:-

> "Myopathie atrophique progressive and Erb's juvenile form are so similar that in describing the one, we trace the principal features of the other. The muscles atrophied or respected are identical in the two forms; the electrical reactions (quantitative not qualitative) the absence of fibrillary movement, the muscular retractions and the character of the tendon reflexes are the same in both diseases. A notable difference is the affection of the facial muscles in one and not in the other; but, in presence of the similarity of all the other characters, this solitary fact does not suffice to demonstrate a different nature for the two affections. We see here only a particular localisation of a morbid process. Besides, Landouzy and Dejerine recognise a scapulo-humeral form of their myopathy. In our opinion, this form is no other than the juvenile form of Erb. It is true that Landouzy and Dejerine emphasise the fact that in their scapulo-humeral form there is no hypertrophy, while it exists in the juvenile form of Erb. But this is too transitory and treacherous a sign to be taken much account of, and Erb is far from pretending that he has always observed it."

After showing the identity of these two affections, it logically follows that pseudo-hypertrophic paralysis is absolutely of the same nature as the infantile form of Duchenne. But these authors prefer to show by facts that the two affections are not so far apart as one might at first sight believe.

"Is this pseudo-hypertrophy, which appears so especial, very different from atrophy? Clinically, they may exist together in the same patient; anatomically, paradoxical as it may seem, nothing under the microscope, so resembles a pseudo-hypertrophied muscle as an atrophied muscle."

"There remains the face. In a certain number of pseudo-hypertrophics the face, perhaps more frequently than we think, is more or less affected. Duchenne was struck with the stupidity of the physiognomy of pseudo-hypertrophics, and at first this led him to describe the affection as depending on a cerebral lesion. Klochner notes, "the expression of the face is sleepy and stupid but the intelligence is normal." From these cases we may gather that the facial muscles are not always intact, although in these cases the muscular lesion did not amount to a demonstrable motor paralysis. But there is an actual paralysis of these muscles in the following cases; Heller noted in a case, "his manners are apathetic, the expression is extinct, the pallid, pasty visage has a stupid expression, due to the hanging lower lip, to the flabby features, to the lazy mimicry which appear to depend on the lack of energy in the facial muscles." Duchenne, himself, describes the facial condition in one case thus: "the muscles of the face appear to have undergone the same change and functionate as badly as those of the limbs."

Having established the unity of the morbid process in the different forms of primitive progressive myopathy, these authors

admit that they see no inconvenience, as long as this fact is borne in mind, in recognising these forms clinically. They advise us to continue to apply the title "pseudo-hypertrophic paralysis" to those cases in which hypertrophy predominates over atrophy, the title "juvenile form of Erb" to those cases in which the atrophy predominates over the hypertrophy and the title "Infantile form of Duchenne" to those cases in which the face is obviously affected. They, however, enter a caveat against Erb's view that the age at which the process develops influences in any way the clinical features of the process.

In 1891, Erb, in his epoch-making monograph, suggested the title "dystrophia muscularis pregressiva" for the idiopathic muscular atrophies of a progressive character, and, although he had never met with a case in which the muscles of the face were affected, he associated this form with his juvenile form, and with the pseudo-hypertrophic form. He further suggested a classification which has met with fairly wide approval. He divided the dytrophies into those which occur in youth and adult life. Of the cases which occur in childhood, he recognised an hypertrophic and atrophic form and of the latter form those with primary involvement of the facial muscles and those without.

1. Dystrophia Muscularis Progressiva Infantum.

   (A) Hypertrophic form:

      (a) With pseudo-hypertrophy.
      (b) With real hypertrophy.

   (B) Atrophic Form:

      (a) With primary involvement of the face (Infantile form of Duchenne.)
      (b) Without involvement of the face.

2. Dystrophia Muscularis Progressiva Juvenum Vel Adultorum (Erb.)

This classification is obviously a compromise between the views of Landouzy and Dejerine and those of Charcot, and Marie and Guinon. It has consequently all the evils of a compromise; for, while giving to Landouzy and Dejerine that which no one would seek to take from them, it hopelessly obscures the point at issue. Landouzy and Dejerine professed to see in facial involvement the hall mark of a peculiar type of myopathy; Marie and Guinon only saw in this clinical phenomenon a particular localisation of the morbid process. The facts of the case are notoriously against the former view. Far from being characteristic of a class of the atrophic form of infantile dystrophy, it is not uncommon in the pseudo-hypertrophic form of infantile dystrophy and sometimes accompanies the juvenile and adult forms. The fact of the primary origin of the process in the facial muscles remains; but Landouzy and Dejerine, far from regarding this as a characteristic feature of their form, recognised that the facial muscles might be involved after the trunk muscles. Duchenne, it is true, emphasised the fact that a primary origin in the facial muscles was characteristic of an onset in infancy, but he had not met with this clinical phenomenon in youth or adult life nor had he met with any exception to a primary onset in the facial muscles.

Keeping all the facts of the case before us, we cannot assign any special significance to the primary involvement of the facial muscles. The observers who assert that it is characteristic of the infantile form, have lost sight of the influence which heredity exerts in stamping the type of the dystrophic distribution. It is, indeed, in this hereditary influence that we must seek for the reason of much of our difficulty in arriving at a satisfactory clinical classification of the dystrophies. What may be best called "type" appears to depend largely on the direct or family heredity, and to a less degree on the hereditary influence which makes for racial solidarity. It is a truism that an atrophic family breeds true to type, but it is not so evident

that type is in any way influenced by racial considerations. Can we, however, otherwise explain the comparative frequency of the infantile form of Duchenne in France and its infrequency in Germany, Britain, and America; or, further, the real differences which exist between the isolated cases described in the latter countries and those described by Duchenne, Landouzy and Dejerine, Marie and Guinon, and others? Whether this suggested explanation be true or not, the fact remains that the infantile form, as originally described by Duchenne, is a family dystrophy rarely seen outside of France. It must then be admitted that any classification which recognisis it as a distinct entity can in the long run only lead to confusion. A restricted utility it may have in certain instances, but it forces on us anything but a philosophical attitude towards the general principle of the involvement of the facial muscles. This clinical phenomenon may occur in any of the recognised types of dystrophy and can only be regarded as a particular localisation of the dystrophic process. If, then, it appears convenient to regard this particular localisation as an earmark for purposes of classification, the most rational criterion to adopt is the degree which the process has reached in this site and not the relative period of its incidence.

Further, Landouzy and Dejerine professed to find in the discrete involvement of the facial muscles in the atrophic process a pathognomonic sign of myopathic as opposed to myelopathic, progressive, muscular atrophies: "given an atrophic whatever be his age, at whatever period the affection may have commenced, if he presents atrophy of the facial muscles and no bulbar symptoms, he is a myopathic." It is impossible to apprise too highly the value of this dictum for, as far as clinical observation can establish a pathognomonic sign, it is incontrovertable.

On the other hand, the fact that bulbar symptoms are superadded to the involvement of the facial muscles does not exclude

the possibility of the process being myopathic. Landouzy and Dejerine, themselves, emphasise the fact that in pseudo-hypertrophic paralysis the muscles of mastication are sometimes involved along with the facial muscles. Among others Westphal, Gowers, and Oppenheim corroborate this finding. However, with the advance of our knowledge of the anatomy of the nervous system, an anatomical basis has been established on which to build our clinical deductions. Mendel has shown that the orbicularis palpebrarum is ennervated through the facial nerve from the nucleus of the 3rd nerve, and Gowers has demonstrated that the hypoglossal nucleus similarly ennervates the orbicularis oris. Accordingly, if in any given case the orbiculares oris and palpebrarum be affected and the muscles of the eye and tongue remain intact, the patient is a myopathic. But even this refinement appears unable to bear the strain of clinical experience. Oppenheim has found derangement of the lateral movement of the eye, nystagmus, and some laryngeal palsy in a case of juvenile atrophy; while Gowers has found it impossible to say whether a case, which exhibited a simultaneous affection of the ocular muscles and the orbicularis palpebrarum, was of myopathic or myelopathic origin.

In making a brief summary of the following five points we hold that they fairly apportion the significance which the clinical observer is entitled to note in connection with the involvement of the facial muscles in cases of muscular atrophy, progressive in character.

1. The discrete involvement of the facial muscles is, as far as we know, pathognomonic of progressive muscular dystrophy.

2. The association of bulbar symptoms with facial involvement does not exclude the possibility of the process being dystrophic in character.

3. In the dystrophies the discrete involvement of the facial muscles can only be regarded as a particular localization

of the dystrophic process.

4. While the onset of the dystrophic process in the muscles of the face is characteristic of an atrophic form of the progressive muscular dystrophy of infancy, it may ensue at any epoch of the other forms of dystrophy.

5. If, for convenience of classification we tentively group together cases with involvement of the facial muscles, it is more philosophical to accept, as our criterion, the extent which the process has reached rather than the epoch at which it developed.

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ON THE PATHOGENESIS OF OUR CASE OF PROGRESSIVE MUSCULAR DYSTROPHY:

We must now attempt to explain the pathogenesis of this case of progressive muscular dystrophy. As we have already seen, two hypotheses have been formulated, regarding the pathogenesis of the dystrophic process. It will, therefore, be for clearness, if we first outline the main points of these hypotheses and then consider which helps us to an intelligent appreciation of the origin of the morbid process in the affected muscles of our patient.

At the present moment the majority of observers hold that the dystrophies are local muscular affections quite independent of the nervous system. Gowers puts this view very clearly: "all the diseases of this class seem to depend on a defective tendency in the development of the germinal tissue which forms muscles; they are essentially congenital diseases. Although they are, in most cases, merely potential maladies at the time of birth, and sometimes for years afterwards- even occasionally during a considerable part of life- the morbid tendency does sometimes attain actual development in the earlier years." Thus considered, the essential element in those diseases is an imperfec development of the proper tissue elements of the muscles. That defect may be quantitative as in cases where there is a congenital absence of one or more muscles; or it may be qualitative in which cases, sooner or later, a defective vitality of the muscular fibres results. That defective vitality may manifest itself by a defective growth of the muscular fibre which leads to its ultimate disappearance, or there may be a coincident overgrowth of the connective tissue elements with, or without, a perverted formation of fat cells. Babinski and Onanoff have attempted, in harmony with this hypothesis, to explain why the dystrophic process should single out certain muscles. They ascertained that in a five months foetus the muscles which were most developed

were the supinator longus, the serratus magnus, the latissimus dorsi, the rhomboidei, the middle and lower parts of the trapezius, the orbicularis oris, the quadriceps extensor cruris, the tibialis anticus, and, to a less extent, the deltoid, the biceps humeri, the triceps, the infraspinatus, the subscapularis and the flexor muscles of the thigh; the hand muscles were least developed. As the muscles ranked first are the muscles specially affected in the dystrophies these authors conclude that in those diseases the muscles which are first developed are the first to undergo degeneration. Recently, in view of the frequency of myotonic contractions, analogous to those of Thomsen's disease, in the symptom complex of the dystrophies, there has been, especially on the part of French writers, an attempt to bring into line, as purely myopathic diseases, the dystrophies, myotonia (Thomsen's disease) and myoplegia (Paralysie familiale paroxystique.)

In direct opposition to this view, Knoll pointed out, as long ago as 1872, that a nervous origin could alone satisfy all the questions which a consideration of the pathogenesis of the dystrophies involved. Erb, after a careful consideration of the whole matter, has placed the weight of his approval on this side of the balance. His view cannot be better expressed than in his own words: "it is tempting to suppose that we have to do with a kind of trophoneurosis having its origin in the trophic centres of the cord- a disturbance of the functions of these centres which finds its expression in the very complicated muscle changes of the disease. While, on this supposition there are, as a rule, no coarse nerve changes, now and then, and after the affection has lasted a long time or been very intense, such a change does become visible." According to his hypothesis the distinction between the spinal amyotrophies and the dystrophies is more apparent than real. In the former a coarse, anatomical lesion of the trophic centres results in a degeneration of the muscle fibres

with fibrillar twitchings, the reaction of degeneration, etc; in the latter a functional disturbance of the trophic centres manifests itself as muscular dystrophy with all its characteristic signs.

In our present connection the hypothesis of Erb is by far the more suggestive. It is hard to conceive a defective tendency in the development of the germinal tissue which forms muscle, that would furnish muscular tissue fit to cope with the rough and tumble of a sailor's life during, at the very lowest computation, three decades. If, however, we take it for granted that such a malady may remain potential for, at least, fifty years, three decades of which have subjected them to the greatest possible strain, it only makes it the more difficult to understand how this potentiality may become kinetic in muscles already advanced in the retrograde changes of senescence. It is quite in consonance with the teaching of general pathology that a muscle fibre, may, in development, receive a taint which will prevent its ever reaching a period of acme; or if it should reach, and enter upon such a period, cut short its allotted span. General pathology cannot, however, furnish us with any instance of a congenital defect in development lying dormant during the periods of evolution and acme to waken up during the period of involution; for, be it remembered, in the dystrophies the pathological lesions in the muscles cannot ever be regarded as an exaggeration of the normal process of involution.

On the contrary, leaving out of account for the present the nerve-cell changes found in the motor cells of the cervical enlargement, the neurotrophic hypothesis comes pat to our purpose. Our patient's heredity is psychopathic not myopathic. The striking feature of his personal history is his gradual mental perversion which was co-incident with, of it did not precede, the onset of the dystrophic process in the muscles. From being an industrious worker, sawing a considerable portion of his wages, an affectionate

husband and a dutiful father, he becomes a depraved drunkard who, after squandering his savings, only works that he may get the means to indulge his craving for alcohol. Such a change in morale can only be accounted for by a deterioration of the cortical cells responsible for the moral faculty. What the exciting cause of this deterioration may be, whether it be an exaggeration of the normal senile involution of these cells or the effect of some toxin, does not concern us here. The essential point for us is that a process of deterioration is active among the nerve cells of a patient the subject of a muscular atrophy, progressive in character. It is then only natural, if not inevitable, to conclude that this atrophy is in some way dependent on the spread of this process of deterioration to the cells which form the trophic centres responsible for the nutrition of these muscles.

If we regard, as indeed we must, this view as giving the more satisfactory explanation of the facts of the case, we find ourselves confronted by two questions which must be satisfactorily answered before we can definitely accept it. Can the occurrence in our dystrophic patient of symptoms indicating grave deterioration of certain cortical nerve-cells be considered as merely fortuitous?; or, is the evidence against any nervous influence in the dystrophic process so emphatic as to make our interpretation of this occurrence unwarrantable? These questions open up too wide a field to be adequately treated in such a thesis as this. We shall, therefore, content ourselves by producing evidence to prove that this occurrence cannot be considered as fortuitous, and that our interpretation is quite warrantable.

The occurrence in the dystrophies of symptoms indicating grave, concomitant mischief in the central nervous system is too frequent to be considered as fortuitous. Erb emphasises the frequency of mental aberrations in dystrophics themselves and in their families of some form of neurosis. Joffroy and Achard

record its development, at the age of 55, in a hysterical subject. Dejerine and André Thomas describe in a dystrophic subject the "main succulante" which since its description by Marinesco and Marie has been considered as a neurotic phenomenon occurring almost exclusively in syringomyelia and hemiplegia. Valdez Angino reports a case in which pseudo-hypertrophy co-exists with Friedrich's ataxia. Lannois, finally, demonstrates the frequency of myotonic contractions in the dystrophies which, as we shall attempt to show later, probably indicates an instability of the nervous system. It is, therefore, by no means a rarity to find evidence of nervous instability in the dystrophies.

Is then the evidence in favour of the myopathic character of the dystrophic process so conclusive as to make our interpretation of this frequent association quite unwarrantable? In our textbooks the aetiological influence of heredity, the characteristic distribution of the affected muscles- a distribution not referable to the distribution of their spinal trophic centres- and the absence of any pathological lesion in the nervous system are considered as presumptive evidences that the nerve-cell exerts no influence in the dystrophic process; accordingly, the dystrophies are sharply contrasted with the myelopathies. But these facts, while fairly representing in general terms essential differences between these two diseases, are far from being so absolute as to warrant any radical conclusions regarding their respective pathogenesis. Indeed, it may be said that in proportion to the care with which we investigate these facts the less value do they assume as presumptive evidences of the purely myopathic nature of the dystrophic process, and the more clearly is it brought home to us that the dystrophies cannot be separated by a hard and fast line from the myelopathies. Let us then in some detail investigate these facts and the considerations which, in this particular connection, affect their value.

Speaking generally we may say that, in marked distinction

to the myelopathies, the dystrophies are direct hereditary diseases. Strumpell, indeed, doubts whether there is such a disease as acquired progressive atrophy, but when we say that there is not in the myelopathies the same tendency for several members of one family to be affected, we merely state the facts of the case. Nevertheless, direct heredity is not unknown in the myelopathies; Gowers, and Virchow have met with examples in adult life; Werding, Hoffman, Bruce, and Beevor describe a family form in children. On the other hand, 50% of the cases of myelopathy have a neuropathic heredity, whereas, Erb found a neuropathic heredity in eight, of the eighteen dystrophic families he had investigated. From such evidence it is obvious that heredity as an aetiological factor cannot be regarded as sharply dividing the myelopathies from the dystrophies. Heredity plays a large part in the causation of both diseases, and in both instances the heredity may be direct, although this is met with far more frequently in the dystrophies. Further, the fact that in the dystrophies a neuropathic heredity may exist along with a direct dystrophic heredity is distinctly suggestive that they are merely two aspects of one hereditary influence, an instability of the nerve-cells.

Again, in the dystrophies the distribution of the affected muscles is in marked contrast with that pretaining in the myelopathies. In the myelopathies the distribution reflects the course of a nerve-plexus or the propinquity of trophic centres in the spinal cord. Clinically, this distribution is regarded as the hall mark of atrophic processes of nervous origin and, as it is not followed in the dystrophies, it appears quite reasonable to assume that the dystrophic process is quite independent of the nervous system. If this rule were absolute it would be impossible to controvert its authority. But Oppenheim and Cassier have described a case of "primitive muscular atrophy" which presented the clinical picture of the class neurotic pro-

gressive muscular atrophy; while Dejerine and André Thomas have reported a case of progressive muscular atrophy- type Aran-Duchenne which had been considered quite typical by every observer who studied it yet post mortem no lesion was discovered in the nervous system. In marked distinction to these cases, but no less suggestive, is the case reported by Strumpell in which a gross lesion was discovered in the nervous system, although the atrophy had a localisation similar to that considered typical of the dystrophies. Such cases prevent us from drawing a hard and fast clinical line between the dystrophies and the myelopathies, and prove that the dystrophies may present the hall mark of an atrophy of nervous origin. Little as this affects the diagnostic value of this characteristic distribution yet it entirely subverts the dictum that the dystrophies are independent of any nervous influence because they do not present the characteristic distribution of an atrophy of nervous origin.

Further, the following case forces us with, if anything, greater conviction to the conclusion that the nerve-cell may play a part in the dystrophic process. Here, in brief, are the details of this striking case:-

> M.aet 25. There was no heredity; he had perfect health up to the onset of the present illness. At 18 he noticed a weakness in elevating the left shoulder; gradual but steady aggravation until at 24 he had to give up work.
>
> Clinically, he had atrophy of the left side of the face, shoulder, arm, and to a less extent, forearm. No fibrillar tremor: a deformity of considerable standing in the left scapula: special senses normal: brisk response of the wasted muscles to mechanical stimulation: the affected muscles respond to lesser galvanic and faradic currents than the normal muscles; no polar change.

The author, M. Debray, mentions a similar case reported by Rissoline under the name "atrophie myotonique", and classed by

him as midway between progressive muscular atrophy and Thomsen's disease. He, himself, considers the osseous lesion,present in both cases, as probably responsible for the wasting in the surrounding muscles; the reception of abnormal sensations in the spinal cord probably causing a functional derangement in the trophic motor cells in the surrounding segments. Unfortunately this case lacks the definiteness which a post mortem examination alone can give. But the fact of its limitation for 7 years to one side of the body- hemi facio-scapulo-humeral- can only be explained by a central nervous origin; the involvement of the facial muscles, the absence of bulbar symptoms, the characteristic distribution of the affected muscles, the absence of the reaction of degeneration and the presence of symptoms suggestive of Thomsen's disease, force us to consider the atrophic process as dystrophic in character. Here, then, is a dystrophy due to functional or organic derangement of the trophic nerve-cells.

The morbid anatomy of the dystrophies presents one fact which, in itself, appears sufficient to confute the hypothesis of their nervous origin, the constant absence of any discoverable, uniform lesion of the trophic spinal-neurone. Heubner, and Frohmaier, it is true, have described marked nerve-cell changes. Lockhart Clarke and Gowers have found granular disintegration in the intermediate grey substence on either side in front of the posterior vesicular tract; Gombault has detected changes in the peripheral nerves, especially near the muscles; while Furstner and Babes noted changes in the intramuscular nerves and especially in the end-plates. These observations lack uniformity, and until they are further substantiated we cannot put much weight on them.

As to the muscular lesions found in the dystrophies, they are, in every way, identical with those found in a muscle severed from its trophic centres. Joffroy and Achard, Erb, Hitzig, and Dejerine and Huet agree that even in such undoubtedly spinal cases

as acute anterior poliomyelitis the microscope shows the same changes in the muscle fibres and connective tissue as are found in the dystrophies. Any differences noted have been in the matter of degree; the essential changes have been always identical In this field research has recently received a fresh stimulus by the work of Sherrington, Forster, and Ruffani on the muscle spindles and much interest has been exhibited as to how the muscle spindles behave in all forms of atrophy.

Sherrington found the leg muscles of a cat, whose sciatic had been severed for 150 days, completely degenerated. In these muscles he found that the muscle spindles contained fat but their intrafusal fibres were well preserved and had well marked striation, although the nerve-fibres passing to the spindles were degenerated. It would, therefore, appear that the intrafusal muscle fibres are trophically independent of the afferent and efferent nerve-fibres.

The condition of the muscle spindles in progressive muscular atrophy has been investigated by Marinesco and Blocq, Pillet, Forster, and Batten. They all agree that the muscle spindles remain normal in this form of atrophy. Forster found that in muscles, which were completely atrophied, the nerve-fibres inside the spindles and the nerve-fibres passing to the spindles were well preserved, while the intrafusal muscle fibres were in every way healthy.

Batten, Graunbaum, and Spiller have investigated the condition of the muscle spindles in the dystrophies. Batten, in the Leyden form, and Spiller, in the juvenile form, did not find any morbid change; Graunbaum, however, in a case of pseudo-hypertrophic paralysis, found the muscle spindles as a whole unaffected but, in a few, there was a diminution in size of an intrafusal fibre with a deposit of hyaline material around it. In the case under discussion, as we have seen, the muscle spindles were in every way normal.

From our present point of view the fact that the intrafusal muscle fibres remain intact in the dystrophies and the progressive atrophies of nervous origin is of little value, as these fibres have been demonstrated to be trophically independent of the nervous system. If, however, they had been affected in the dystrophies, this fact would have offered incontrovertable evidence that the dystrophic process is independent of any nervous influence as any atrophic process in these fibres could only arise from a cause in the muscle fibres themselves. On the other hand, it would be illogical to argue that the dystrophic process is dependent on some nervous influence because these fibres, which are trophically independent of the nervous system, remain unaffected by it. But, while research in this direction has not given us any positive data to go upon, it may be fairly said that it is the purely muscular hypothesis which is inestimably the poorer for this want.

To sum up, we may, from the point of view of morbid anatomy, divide the progressive atrophies into those which have a gross lesion in the nervous system, and those which have not. As long as we keep pathogenetical considerations in the background this classification is most helpful; but, if we profess to find a proof in the absence of a gross lesion in the nervous system that the morbid process in the muscles is always independent of any nervous influence, complications at once arise. For, if we colour our scheme of classification with such a consideration, we have to find a place for those cases which are inexplicable apart from a nervous influence and do not present any structural change in the nervous system to account for this influence. Spiller logically defines the position when he says, "it is proper to consider dystrophy as a disease usually distinct from spinal muscular atrophy, but transitional forms connect the myopathic and myelopathic forms of atrophy." But the mind of man does not find a habitable city in such an opinion; it craves for such a

hypothesis as Erb has formulated. As a working hypothesis Erb's suggestion is of all the greater value because it attempts no definite explanation of the extent or essence of the nervous influence. This is, however, neither the time nor the place to judge the trustworthiness of any hypothesis. In the present indefinite state of our knowledge the observer must be content to treat each case on its own merits; he must try to catch the proper perspective of its facts and deduce from them the probable pathogeny. It cannot, therefore, be said, since the purely muscular hypothesis has failed to give a satisfactory explanation of the pathogeny of our case, that we have made an unwarrantable assumption in seeking an explanation in some disturbance of the trophic influence of the anterior spinal neurone.

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ON THE NERVE-CELL CHANGES FOUND IN OUR CASE OF PROGRESSIVE MUSCULAR DYSTROPHY.

In our case the presence of histological changes in the nerve-cells of the anterior cornuae of the cervical enlargement forces on our consideration the following questions: do these changes amount to a pathological lesion? and, if this be answered in the affirmative, what relationship, if any, exists between this lesion and the dystrophic process in the muscles?

What, then, is the significance of these nerve-cell changes? Before accepting any definite, pathological process as explanative we must clear aside certain considerations, which may make for controversy. The localisation of these changes to a definite group of cells in a definite area of the spinal cord allows us at once to put out of court, as probable causes of these changes, the terminal intoxication of bacterial origin, and the preagonistic burst of temperature. Such causes would have produced generalized, not localized, nerve-cell changes; this remark applies also to post mortem changes.

It is not so easy, however, to exclude the possibility of these changes being of a physiological regressive character. These physiological nerve-cell changes have been investigated by Hodge, Pugnat, Marinesco, Robertson and Orr, and Luzenberger. Robertson and Orr in a case of uncomplicated senility in a woman aged 90 found large collections of pigment in the interior of the cells, often replacing the greater part of the protoplasm. A large proportion of these cells appeared otherwise perfectly healthy; but in others there was shrinkage of the cell-body and loss of its angular form, dissolution of the Nissl bodies and disintegration of the nucleus. In many instances a few stained granules represented all that remained of the nucleus and Nissl bodies. Marinesco has studied the life history of the nerve-cell with great detail. He noted, as characteristic of its involution, a decrease in size of the cell-body and a diminution

in size of the Nissl bodies, especially in the perinuclear region. He amphasised the fact that these changes do not affect all the cells in equal degree, healthy cells being always found alongside of others in an advanced state of involution. Luzenberger has, however, found these changes apart from senility and many observers agree that most healthy brains and spinal cords exhibit a few cells showing such changes. He suggests as an explanation of this histological fact that, even in the healthiest nerve-cell community, there may be certain cells which, through some hereditary or acquired cause, have become unable to maintain a correspondence with their environment.

In our case the histological changes noted in the nerve-cells might have been considered as those of physiological regression, if they had not been definitely limited to the anterior cornual cells of the cervical enlargement. But, as has been established by Marinesco, the characteristic feature of physiological regression is its universal, eccentric distribution. The changes are never confined to any group of cells. Far from being in any way localized it is usual to find the process affecting one or more cells in every healthy group. But Luzenberger's discovery and explanation of regressive changes in nerve-cells, apart from senility, must give us pause. Following out the lines of Luzenberger's hypothesis, is it possible that this group of nerve-cells have been unable to maintain a normal correspondence with their environment? Mott's suggestion that the place of incidence of any lesion in the spinal cord largely depends on the occupational strain to which the patient is subjected adds verisimilitude to this view. In his day's work as a sailor, our patient's arms and shoulders must have been subjected to the greatest strain. If, then, we take for granted that he had inherited a defective vital tendency of the anterior cornual cells as a whole, which predisposed them to early participation in the normal senile regressive changes, the first participants

in this process would be, according to Mott's view, those situated in the cervical enlargement. In this highly hypothetical argument, there is nothing really unwarranted but it is hard to reconcile it with the other facts of the case. Such an explanation carries us over the border line and brings us face to face with a pathological lesion, even though it be merely an exaggerated phase of the normal involution phase of the neurone. Consequent to this lesion, we should expect to find evidence of secondary degeneration in the peripheral nervous system. So many nerve-cells have undergone such marked, structural alterations that evidence of recent or long standing degeneration of their axis-cylinders must, of necessity, be found, if not in the peripheral nerves, at least, in the intramuscular nerves. As this evidence is not forthcoming, we are forced to conclude that any morbid process, which, acting on the nerve-cell, produces Wallerian degeneration in its axis-cylinders cannot be regarded as responsible for the nerve-cell changes in our case.

It is in this fact that we probably find the true explanation of these nerve-cellchanges. In their original treatise Landouzy and Dejerine go out of their way to point out that the healthy state of the nuclear cells of the facial nerves in a patient, who had been the subject of facial atrophy for over 20 years is a striking proof that suppressed function of a motor nerve-cell as in old standing amputations is not sufficient to modify its structure. But the work of Gudden, Hayem and Forel, Nissl, Marinesco, Lugaro and Van Gehuchtan has placed beyond question the fact that in nerve-cells the suppression of function modifies their structure. This change is perhaps best known by Marinesco's name, "reaction à distance." It differs from Wallerian degeneration in ascending the phyiological stream of conduction and affecting the cell at the central end of the cut nerve instead of descending and attacking the peripheral end.

Marinesco recognises two phases in this reactive process;

in the first he describes progressive chromatolysis which usually commences at the origin of the axis-cylinder, and in the second disintegration of the trophoplasm with emigration of the nucleus to the periphery. Lugaro recognises these two phases and calls the first the "reactive phase", and the second the "degenerative phase." He further points out that, although the cells of the spinal ganglia exhibit similar changes after injury to the peripheral branch of their prolongations, they are not affected by section of the central branch. He explains this difference by supposing that the sensory nerve-cell is affected by the cessation of external stimuli and the motor nerve-cell by suppression of the discharge of energy, which it elaborates. Van Gehuchtan has questioned the existence of the degenerative phase and asserts that the destruction of the cell is uncommon, and, when it occurs is probably due to loss of the nucleus caused by an exaggerated displacement from swelling of the cell. These differences of opinion are probably due to dissimilar conditions in the investigations on which they are based; it is now generally agreed that the age and variety of the animal experimented with, the nature of anddistance from the cell-body of the actual lesion exerts some influence in the course of the process.

The majority of these observations were conducted on the lower neurone of the motor path. It has, however, been shown that the cortical giant cells of Betz may exhibit similar changes. Dotto and Pusateri, Von Monakow and Marinesco- in old standing capsular lesions- Ceni, and Ballet and Faure- in experimental hemisection of the cord- and Marinesco- in pathological lesions of the pyramidal tracts- have all described analagous changes in the Betz cells. Recently, in old standing cases of amputation and peripheral lesions of the same nature, Campbell has found these nerve-cell changes in the Betz cells.

These facts all go to prove that in man the motor nerve-cells are very sensitive to any interference with the discharge of the

energy which they elaborate. Any cause, which interferes with this normal discharge, is liable to react on the structure of the cell-body. It matters not where the lesion be situated; but, as a general principle the nearer it is situated to the cell-body the earlier do these nerve-cell changes set in. Further, the lesion may even be outwith the neurone itself for, as Campbell has demonstrated, reaction occurs in the cell-body of the upper neuron of the motor path when the axis-cylinder of its complementary lower neurone sustains a lesion. The reactive process when once established in the cell-body, leads to its corporeal disintegration unless the barrier to the discharge of its energy be removed.

From the essential characteristics of "reaction à distance" which we have just summarized we should expect reasoning "a posteriori" that the nerve-cell changes in our case are due to this pathological process. The atrophied condition of a large number of the muscles, ennervated by the cervical enlargement, resulting in the complete destruction of innumerable muscle fibres, must have prevented the discharge of nervous energy from a proportionately large number of nerve-cells in this region of the spinal cord. As a result of this suppression of their nervous discharge, we should expect reactive changes leading to the corporeal disintegration of these nerve-cells. A serious objection to this line of argument at once arises; as the muscle fibre does not form an integral part of the lower motor neurone its destruction need not necessarily react on the cell-body. The gravity of this objection is considerably mitigated by the fact that to cause these nerve-cell changes the lesion, which prevents the escape of the nerve-energy, need not, of necessity, be situated within the neurone. In short, it is the suppression of the nervous discharge, and not the lesion itself, which causes the structural changes in the cell-bodies. But, in addition, it must be borne in mind that, while it is reasonable to consider the muscle fibre as anatomically distinct from the lower motor

neurone, yet to say that they are phyiologically connected is hardly to state the true facts of the case. The tone and nutrition of a muscle fibre is so intrinsically connected, with the lower motor neurone that we can only think of them as a physiological unit. It is, therefore, not unreasonable to expect that this integrity holds good pathologically, and that the disappearance, through atrophy, of the muscle fibres, which are normally stimulated by a lower motor neurone by closing up the only channel for the escape of its nerve-energy must cause the structural changes in its cell-body that are invariably consequent on suppression of nervous discharge.

But, assuming that we have here a rational explanation of these nerve-cell changes, can we hold it as explaining the fact of the intact peripheral nervous system? The serious disintegration of the structure of the achromatic substance and the loss of the nucleus, noted in a fair proportion of these cells, inevitably lead us, if the individuality which we have been forced to give the neurone goes for anything, to expect structural alterations in their axis-cylinders. As these axis-cylinders have never been in any sense of the term cut off from the trophic influence of their nerve-cells, we may put Wallerian or secondary degenerations out of account; but we cannot treat in this way retrograde changes which are identical, at least, as far as the chemistry of their myelinic changes is concerned, with that described by Waller. In many instances such changes appear to depend on an inherited, or acquired, defective vitality of the nerve-cell. We are, at present, in the dark as to the extent, or essence, of the nerve-cell changes which are responsible for those myelinic changes. But, as far as recorded observations go, it is indeed questionable if such myelinic changes accompany even the most profound degree of reactive, nerve cell changes.

The majority of the observers, who have studied the condition of the peripheral nerves in amputation stumps agree that

they are reduced in calibre, the fibro-cellular tissue in them is increased in quantity, the perineurium is thickened and sometimes myxoid or fatty and the healthy fibres are reduced in numbers by about one half; these changes diminish in severity as one ascends the trunk. Marie has described increase in the calibre of the nerve, and the presence of "ilôts de degeneration" in which some five to twenty delicate nerve-fibres, possessing an almost imperceptible white sheath, may be seen. He looked upon these as degenerated remnants of an originally healthy fibre. Fleming, who has thoroughly investigated this matter, both experimentally and in the nerves from amputation stumps, was not impressed either by the increase of the connective tissue or by the number of fibres which disappeared. In an ulnar nerve, taken from an amputation stump of ten years standing, he found changes which led him to the conclusion that it was mainly the fine or vaso-motor fibres which suffered in this "ascending degeneration" and that these changes became less obvious as the nerve was traced centrally.

It appears then that when a neurone is thrown out of physiological action that there is a structural disintegration of its cell-body and that these changes may proceed to considerable limits before resulting changes manifest themselves in their peripheral axones. While not wishing to emphasise the fact of the intact peripheral nervous system, we desire to point out it is not incompatible with advanced reactive changes in the cell-bodies of the anterior spinal neurones. It may be that in our case the process was not of sufficiently long standing to allow of the development of these changes, or that the comparatively restricted area affected caused changes too delicate for the methods which we employed. On the other hand, it appears to us impossible to explain these facts on any other basis.

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Fig. I.

This portrait was taken on Jan. 12, 1904.

It exhibits the displacement of the shoulder-girdles (acromio-clavicular articulations on a lower plane than the sterno-clavicular articulations, the projection upward of the inner scapular angles and the inclination forward of the supraclavicular triangles); the atrophy of the pectoral masses. The well nourished forearms contrast with the notably emaciated arms.

Fig. 1.

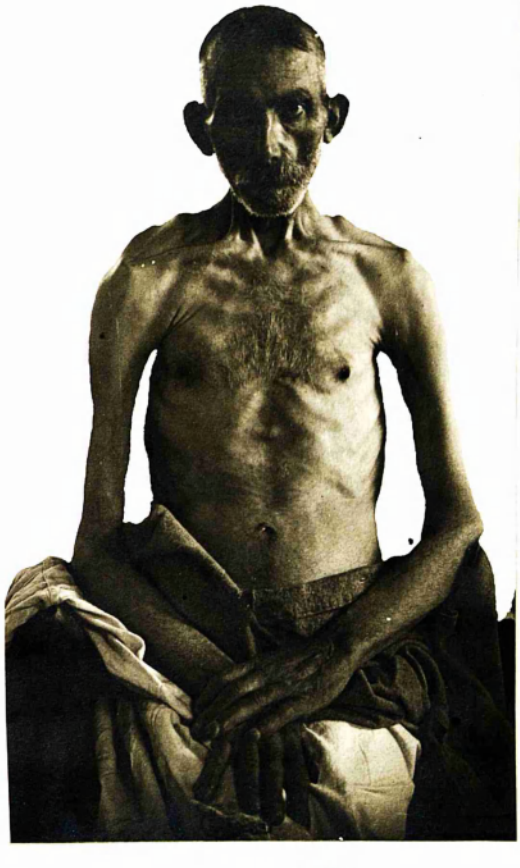


Fig. II.

This view serves to demonstrate the vicious rotation of the scapulae (outer angle downward), and the approach to the condition of " alar scapulae" (especially well seen on the left side). The well nourished condition of the right deltoid is very striking.

Fig. II.

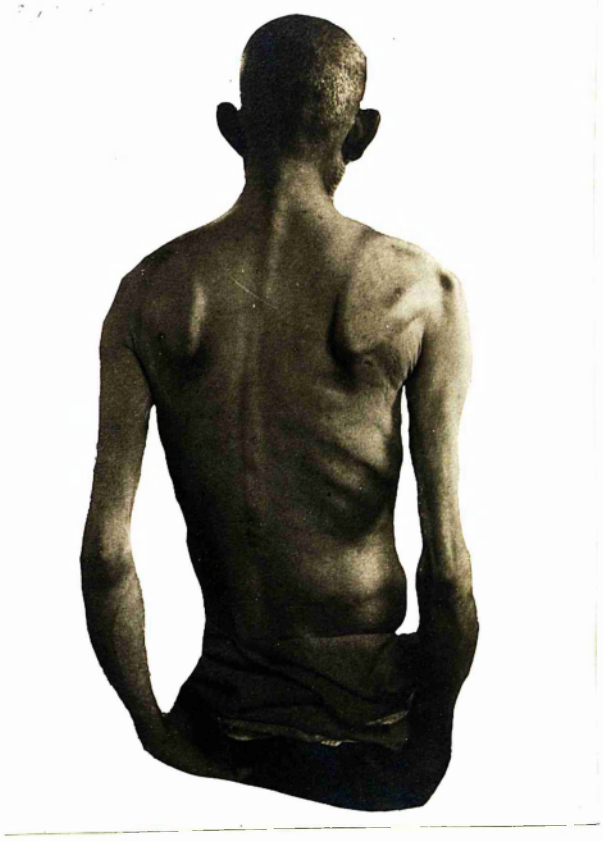


Fig. III.

This view exhibits the degree of upward dislocation of the scapulae.

Fig. III.

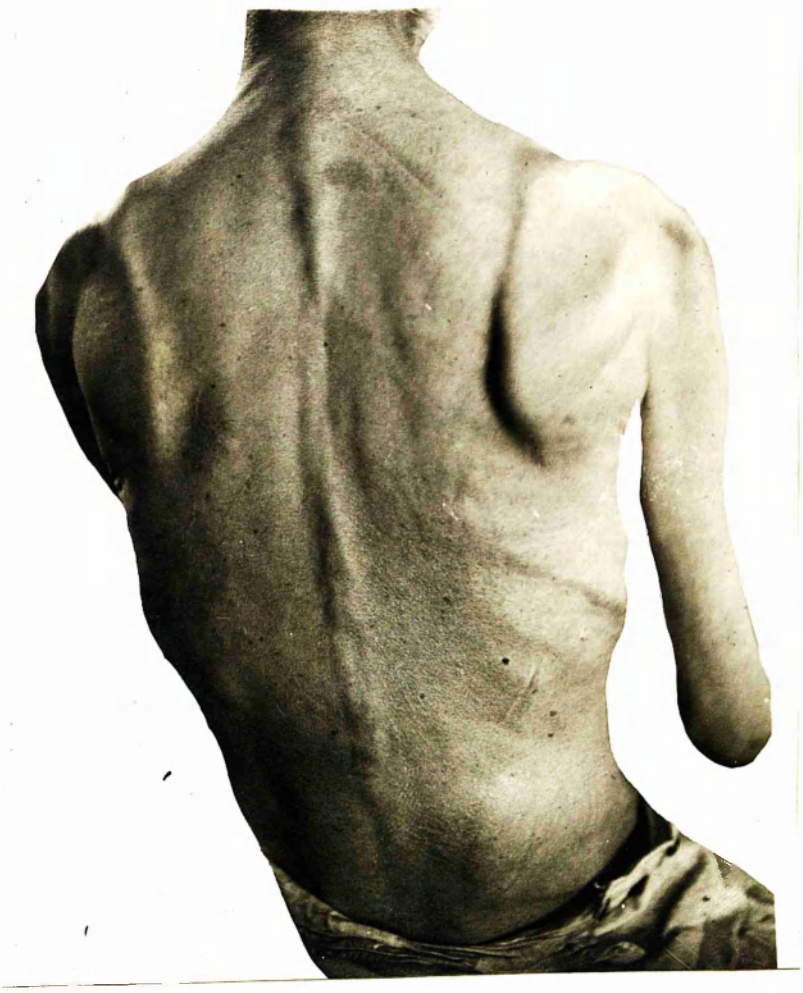


Fig. IV.

T.S. biceps ; haematoxylin and sudan III; magnified 50 diameters.

This section portrays an early stage of the process. The most notable feature is the thickening of the vessels; in their immediate neighbourhood there is a hyperplasia of the connective tissue with a few fatty droplets (stained black).

Fif. V.

T.S. biceps; haematoxylin and Van Gieson; magnified 50 diameters.

This section demonstrates a further stage of the process; there is now a general hyperplasia of the connective tissue (most notably of the perimysium): the inequality of the diameters of the muscle fibres is very apparent (the greatest diameter is 0.1mm. the smallest is 0.015mm.).

Fig. IV.

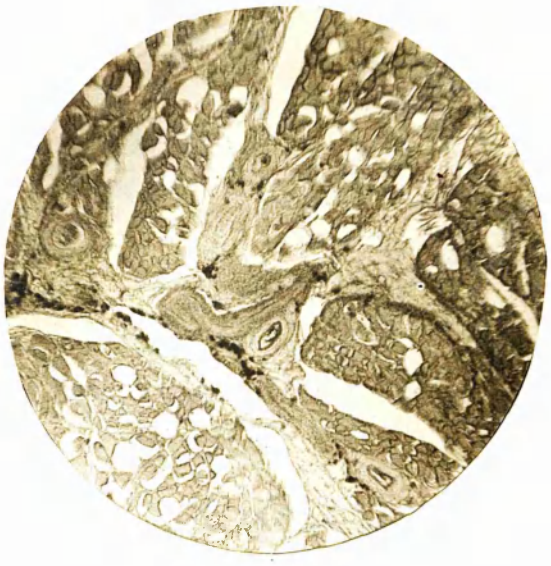


Fig. V.

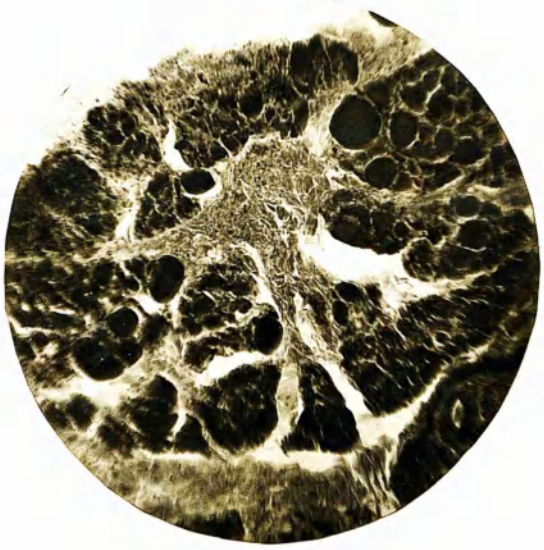


Fig. VI.

L. S. biceps; haematoxylin and eosin; magnified 250 diameters;.

This section illustrates the wavy contour and varying calibre of the muscle fibres. The majority have lost their striation but in one instance striation is well marked. There is a numerical increase of the interstitial nuclei. They stain intensely and reach gigantic dimensions. In one muscle fibre there is a suggestion of numerical increase of its nuclei .

Fig. VII.

L. S. biceps; haematoxylin and Van Gieson; magnified 250 diameters.

The muscle fibres in this section exhibit different affinities for the muscle stain employed. One fibre reacts normally to the picric acid and has well marked striation; the other two fibres show little affinity for the picric acid and have very incomplete and indistinct striation.

Fig. VI.

Fig. VII.

Fig. VIII.

L. S. biceps; haematoxylin and Van Gieson; magnified 250 diameters.

In this section three fibres are seen, which have retained their striation and their affinity for the muscle stain. They have, however, developed longitudinal fissures.

Fig. IX.

L. S. biceps; haematoxylin and Van Gieson; magnified 250 diameters.

This section has pretty much the appearance of tendon, but the cellular elements are very different from those characteristic of that tissue and the fibres do not stain homogeneously. A new-formed blood vessel passes through it surrounded by fatty droplets.

Fig. VIII.

Fig. IX.

Fig. X.

A teased speciman; stained with haemalum; magnified 250 diameters.

This depicts the hyaline masses found in teased specimens of the tissue depicted in Fig. IX.

Fig. XI.

T.S. latissimus dorsi; haematoxylin and eosin; magnified 50 diameters.

This tissue has a distinctly necrotic appearance and at one point a localised infiltration of fat has occured. Two vessels are seen; one, in transverse section, is distended with blood; both show well marked sclerosis of their walls.

Fig. X.

Fig. XI.

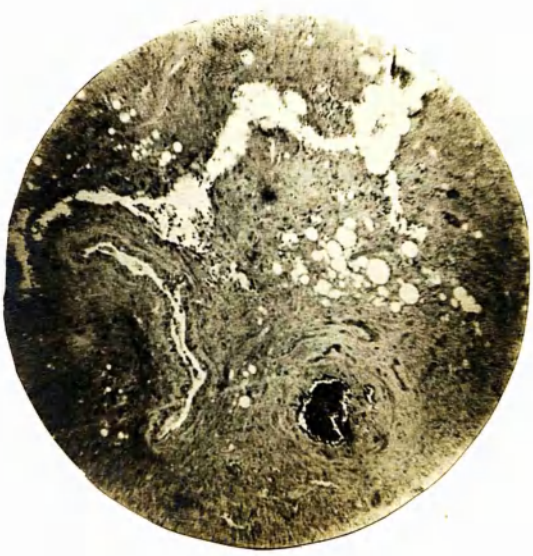


Fig. Xii.

T. S. latissimus dorsi; haematoxylin and eosin; magnified 50 diameters.

In the upper half of this section the tissue has a necrotic appearance into which there is an ingrowth of very ill- formed vessels from the lower half. The latter is fairly organised.

Fig. XIII.

T. S. latissimus dosi; haematoxylin and eosin; magnified 50 diameters.

In this area the vascularisation is now completed and the site of the fatty infiltration has an areolar-like appearance.

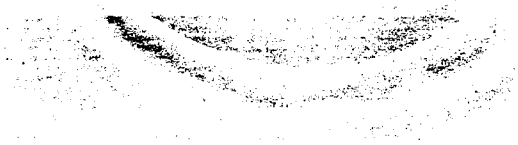


Fig. XII.

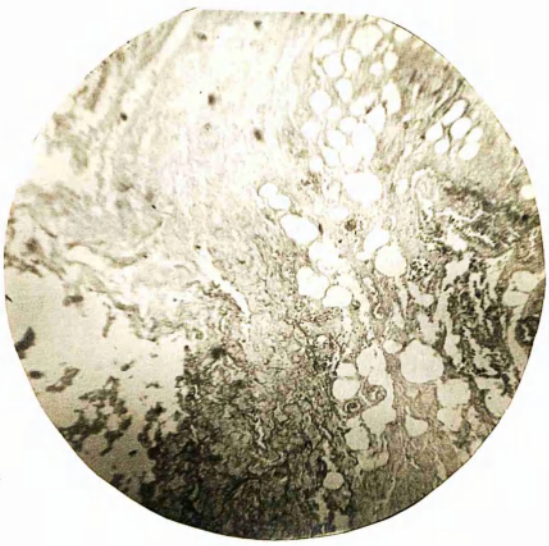
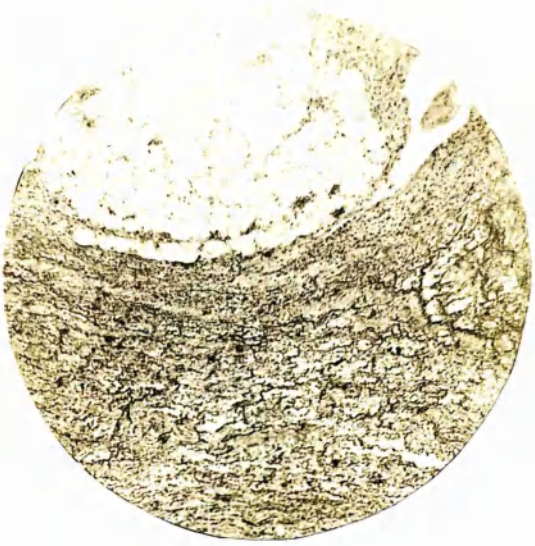


FIg. XIII.



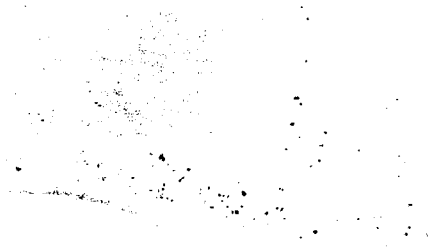


Fig. XIV.

T.S. latissimus dorsi; haematoxylin and eosin; magnified 250 diameters.

This field demonstrates the structure of the areolar-like tissue. The small areas between the fat spaces are seen to be patches of vascularising necrotic tissue (the blood vessels are very ill-formed).

Fig. XV.

L.S. triceps; haematoxylin and Van Gieson; magnified 50 diameters.

This section shows the growth into a muscle fasciculus of a very tortous vessel carrying with it a process of actively proliferating connective tissue.

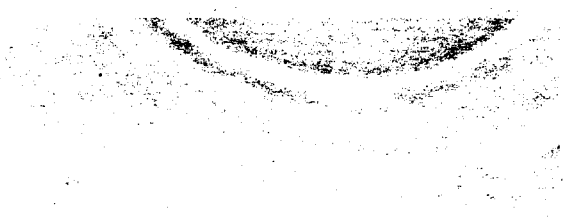


Fig. XIV.

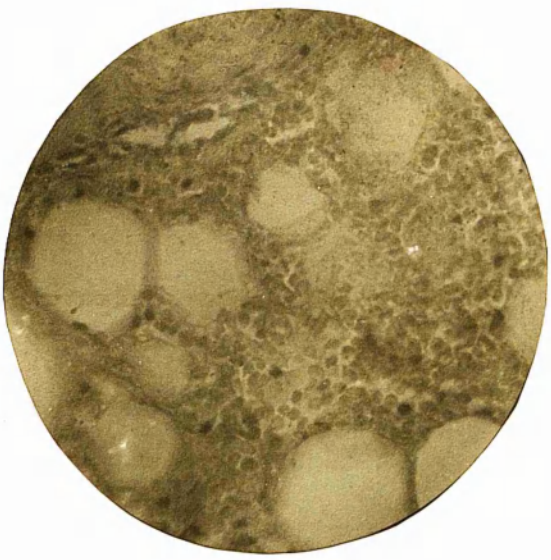


Fig. XV.

Fig. XVI.

T. S. brachialis anticus; haematoxylin and eosin; magnified 250 diameters.

This section illustrates the capillary ingrowth which occurs into the hyaline masses portrayed in fig. XVII.

Fig. XVII.

T. S. brachialis anticus; haemalum and sudan III; magnified 50 diameters.

This section illustrates the tortuosity of the arterioles (one vessel is cut in three situations) and the thickening of their walls (periarteritis and endarteritis). There is now little trace of the muscle fibres; the fasciculi are composed of a network of fibrous tissue with hyaline masses in its interstices. Fat droplets are scattered throughout the fibrous tissue.

Fig. XVI.

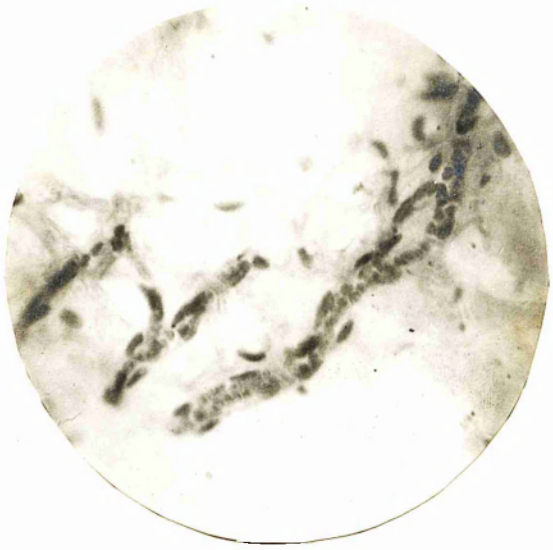


Fig. XVII.

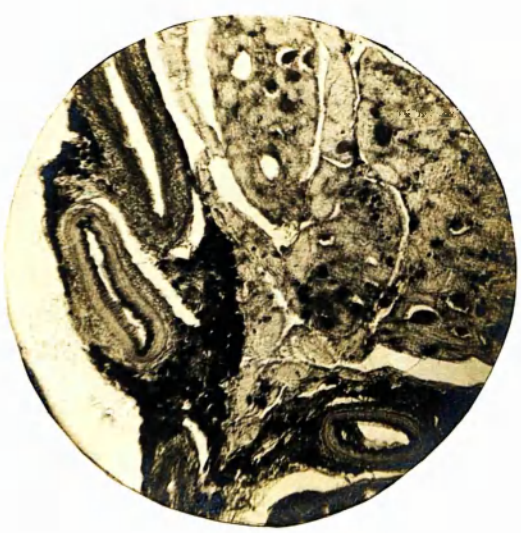


Fig. XVIII.

T. S. brachialis anticus; haematoxylin and eosin; magnified 250 diameters.

The arteriole seen here has marked fibrosis of its walls especially at the lower corner. It is impossible to sharply differentiate it from the surrounding tissue. At the upper corner the intima has been torn off and projects into the lumen.

Fig. XIX.

T. S. trapezius; haematoxylin and eosin; magnified 250 diameters.

This serves to illustrate the character of the ill-formed vascular ingrowth which occurs into the necrotic areas (see Fig. XII.) situated in the latissimus dorsi and trapezius. No definite vessel wall can be determined even with the most careful focussing.

Fig. XVIII.

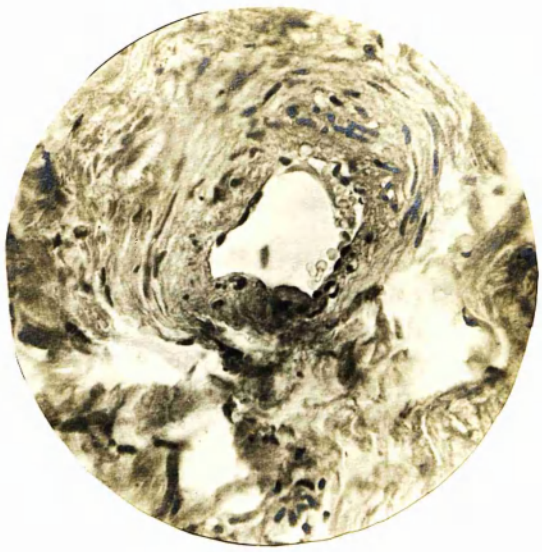
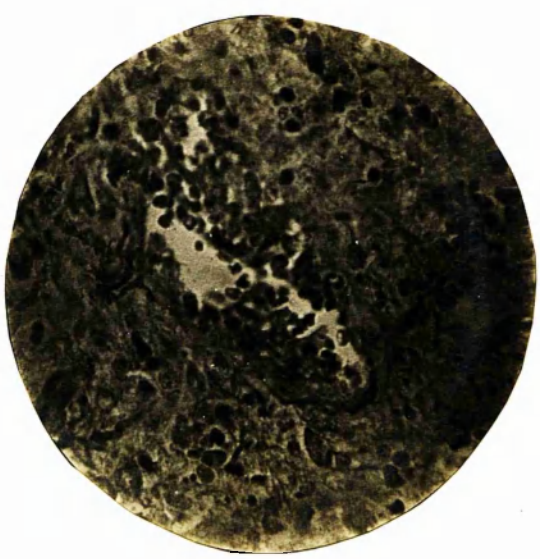


Fig. XIX.



Figs. XX. and XXI.

T.S. brachialis anticus, and T.S. triceps; Weigert's haematoxylin; magnified 50 diameters.

These illustrate the normal condition of the intramuscular nerves.

Fig. XX.

Fig. XXI.

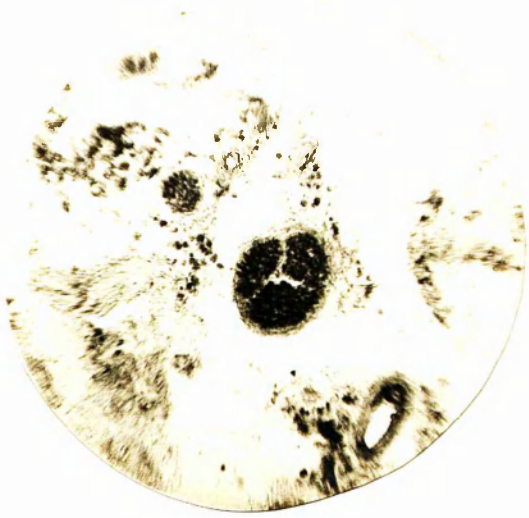


Fig. XXII.

T. S. Spinal accessosy nerve; haematoxylin and eosin; magnified 50 diameters.

This illustrates the normal condition of the nerve bundles and the supporting tissue.

Fig. XXIII.

T. S. brachialis anticus; Weigert's haematoxylin; magnified 50 diameters.

In this disintegrated area the normal muscle spindle stands out in a very striking fashion.

Fig. XXII.

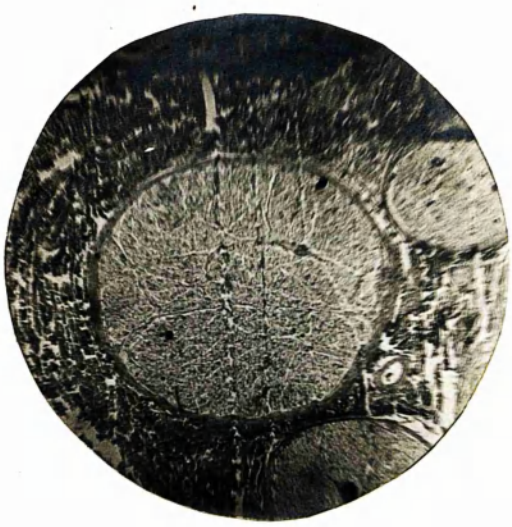


Fig. XXIII.

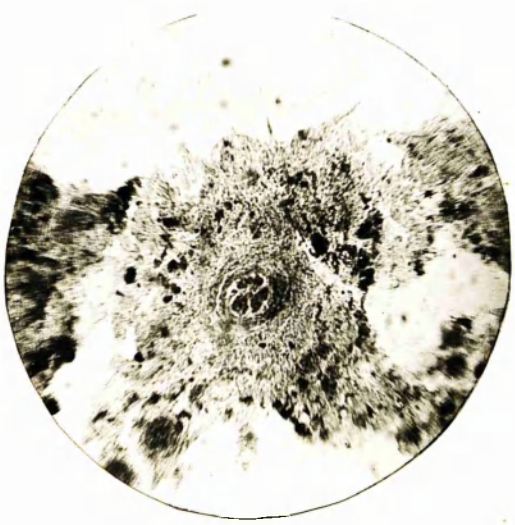


Fig. XXIV.

T.S. brachialis anticus; haematoxylin and eosin; magnified 250 diameters.

In this case the muscle spindle has been cut rather oblique. The normal intrafusal muscle fibres stand out in a very striking fashion as there is not the slightest trace of an ordinary muscle fibre in the neighbourhood. The nerve to the spindle is seen and is in every way healthy.

Fig. XXV.

T.S. brachialis anticus; haematoxylin and eosin; magnified 250 diameters.

This section involves the middle zone of the spindle. The intrafusal muscle fibres are seen to be of small diameter but are in every way healthy.

Fig. XXIV.

Fig. XXV.

Fig. XXVI.

L. S. triceps; Weigert's haematoxylin; magnified 50 diameters.

This section shows a longitudinal section of a muscle spindle. There is no sclerosis of its capsule. The nerve fibres appear normal and the intrafusal muscle fibres have retained their striation.

Fig. XXVII.

Nerve-cell from the left anterior cornua of the 5th cervical segment; thionin blue (Nissl's method); magnified 250 diameters.

The cell serves to show what we consider to to be the normal condition of the cells of this region. There is, however, slight central chromatolysis.

Fig. XXVI.

FIg. XXVII.

Figs. XXVIII, and XXIX.

Nerve-cells from the left anterior cornua of the 3rd cervical segment; thionin blue (Nissl's method); magnified 250 diameters.

In fig. XVIII the cell has a globular contour and is bereft of its processes; chromatolysis is confined to the cone of origin of the axone.

In fig. XXIX the nerve-cells are atrophied and of irregular contour; they have lost their processes. In the lower two the nucleus is peripherally situated and the protoplasm has a uniform, powdery (blue) appearance.

Fig. XXVIII.

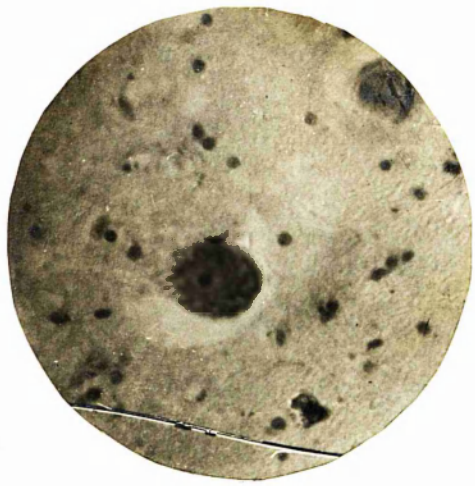


Fig. XXIX.

Figs. XXX, and XXXI.

Nerve-cells from the anterior cornua of the 4th cervical segment; thionin blue (Nissl's method); magnified 250 diameters.

The cells have lost their normal contour and are bereft of their processes; their nuclei are displaced and the protoplasm has a uniform, pale, blue colour.

In fig. XXXI there is a mass of pigment, crescentic in shape, at the periphery of the cell.

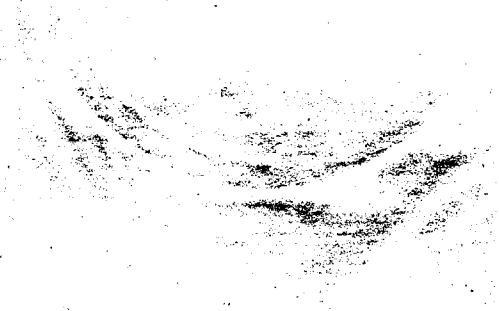


Fig. XXX.

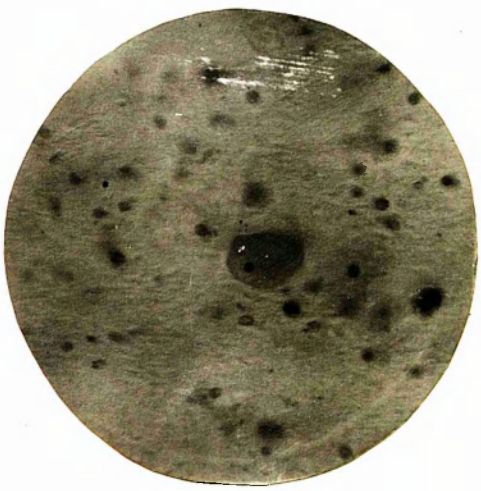
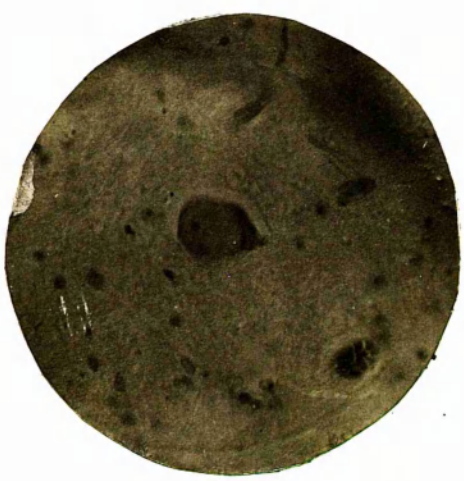


Fig. XXXI.



Figs. XXXII, and XXXIII.

Nerve-cells from the anterior cornua of the 4th cervical segment; thionin blue(Nissl's method); magnified 250 diameters.

The protoplasm of one of the nerve-cells in fig. XXXII does not react to the stain while the other has a halo of powdery, chromatophilic particles.

IN fig. XXXIII the cells are practically masses of pigment and do not possess any chromatophilic particles.

Fig. XXXII.

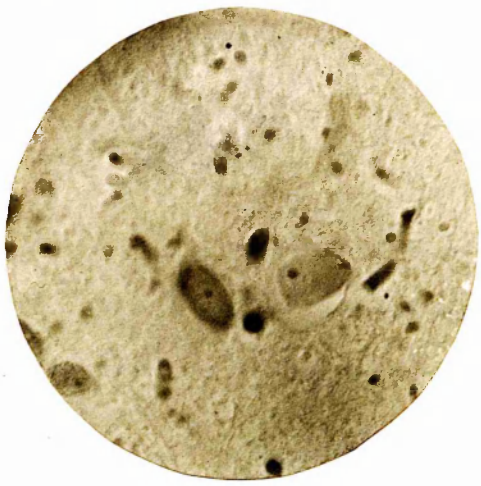


Fig. XXXIII.